



## MEMO

TO: Faculty Senate

FROM: Steve Wojtkiewicz, Senator & Faculty Senate Secretary

SUBJECT: Agenda for Monday January 18, 2020

LOCATION: 4 PM on Zoom (<https://clarkson.zoom.us/j/759755486>)

DATE: January 18, 2020

Faculty Senate: <https://intranet.clarkson.edu/administrative/faculty-senate/>

Faculty Senate Feedback: <https://forms.gle/5SRAjZPpQyKD9Nw39>

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- I. Approval of Agenda
- II. Approval of Meeting Minutes from November 16, 2020 (Sen. Doc. #2021-39)
- III. Communications
  - a. No Contact Order Policy (Sen. Doc. #2021-28)
  - b. CU COVID-19 TESTING POLICY -Nov 10th 2020 (Sen. Doc. #2021-29)
  - c. MS CS non-Thesis Proposal (Sen. Doc. #2021-30)
  - d. CAP approval memo of EHS changes (Sen. Doc. #2021-31)
  - e. CAP approval memo of MS Computer Science non-thesis (Sen. Doc. #2021-32)
  - f. Curriculum Proposal for MS in Artificial Intelligence Sen. Doc. #2021-33)
  - g. Memo re Changes to Academic Regulations (Sen. Doc. #2021-34)
  - h. Provost's Council Dec 7 Minutes (Sen. Doc. #2021-35)
  - i. Provost's Memo re OM changes regarding chairs (Sen. Doc. #2021-36)
  - j. Revised MS Computer Science non-thesis proposal (Sen. Doc. #2021-37)
  - k. MS in Cybersecurity Proposal (Sen. Doc. #2021-38)
- IV. Old Business
- V. New Business
  - a. Board of Trustees' Presentation "M&A Framework Discussion"
  - b. Discussion of Course Cancellation Policy
  - c. Faculty Suggestions for CFO Search Committee
  - d. No Contact Order Policy (Sen. Doc. #2021-28)
  - e. EHS Curriculum changes (Sen. Doc. #2021-31)
  - f. MS Computer Science non-thesis option (Sen. Doc. #2021-32 and #2021-37)
  - g. Provost's Memo re OM changes regarding chairs ((Sen. Doc. #2021-36)

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Clarkson Faculty Senate Time: January 18, 2020 04:00 PM Eastern Time (US and Canada)

<https://clarkson.zoom.us/j/759755486> Meeting ID: 759 755 486

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Dial by your location: +1 646 876 9923 US (New York)+1 312 626 6799 US (Chicago)



Clarkson

FACULTY SENATE  
8 Clarkson Avenue  
Potsdam, New York 13699

**MEMO**

TO: Faculty Senate

FROM: Steve Wojtkiewicz, Senator & Faculty Senate Secretary

SUBJECT: Minutes of Senate Meeting held on Monday November 16, 2020

LOCATION: Zoom (<https://clarkson.zoom.us/j/759755486>)

Faculty Senate: <https://intranet.clarkson.edu/administrative/faculty-senate/>

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Senate Members: Banavar, Cohen, Fite, Fiske (*ex-officio*), Provost Hannigan (*ex-officio*), Graveline, MacKinnon, Melville, Michalek, Mousavian, Scrimgeour, Stephenson, Wallace, Wojtkiewicz, and York

Guests: S. Andreescu, P. Athavale, E. Backus, J. Ball, S. Bird, K. Chezum, A. Colak, S. Davis, L. Ettinger, T. Giffin, H. Irizarry-Quinones, K. Janoyan, V. LaFay, T. Langen, Z. Lin, T. Lufkin, J. Knack, A. McGaheran, C. McGregor, L. Perry, A. Ohl, F. Ormsbee, S. Powers, M. Richards, S. Rivera, C. Robinson, S. Robinson, S. Schuckers, C. Snyder, J. Stokes, R. Thomas, Wentao Wu, and S. Zeigler

4:01 pm Meeting called to order by chair Kevin Fite.

**I. Approval of Agenda**

**II. Approval of Meeting Minutes from Oct. 19, 2020 (Sen. Doc. #2021-27)**

Minutes stand approved as distributed in the agenda packet.

**III. Communications**

Chair Fite reviewed communications.

- a. Revised CAP Curriculum Checklist (Fall 2020) (Sen. Doc. #2021-18)
- b. Updated Land Use Areas Map (Sen. Doc. #2021-19)
- c. HR Updates to Short Term Disability and Sick Leave Policies (Sen. Doc. #2021-20)
- d. Kelly Education and Adjuncts- Faculty Senate Presentation (Sen. Doc. #2021-21)
- e. ADVANCE COVID-19 & Tenure Documents (Sen. Doc. #2021-22)
- f. EHS Curriculum Change Proposal (Sen. Doc. #2021-23)
- g. CAP Approval Memo Data Analytics Name Change Proposal (Sen. Doc. #2021-24)
- h. Minutes of October 5, 2020 Provost's Council Meeting (Sen. Doc. #2021-25)
- i. Minutes of November 2, 2020 Provost's Council Meeting (Sen. Doc. #2021-26)

**IV. Old Business**

**V. New Business**

**a. Data Analytics Name Change Proposal (Sen. Doc. #2021-24)**

Motion to endorse by Scrimgeour(Wallace). Motion Carried.

**b. HR Updates to Short Term Disability and Sick Leave Policies (A. McGaheran) Faculty (Sen. Doc. #2021-20)**

Ms. McGaheran shared a presentation (Sen. Doc #2021-20) which outlined changes to Clarkson's sick leave policy as dictated by new NYS state law. Details are given in. Changes apply to anyone receiving a Clarkson paycheck including faculty, graduate research assistants, and graduate teaching assistants.

**c. Kelly Education and Adjuncts (C. McGregor) (Sen. Doc. #2021-21)**

Ms. McGregor shared a presentation(Sen. Doc #2021-21) concerning the investigation of contracting Kelly Education to handle the hiring of all adjuncts. Concerns were raised concerning who would be responsible for any new additional costs. A suggestion was made to make sure that all department chairs had been briefed on this proposed policy. Concerns were raised if this policy would lead to the hiring of additional adjuncts in place of TT and teaching track faculty.

**d. COVID and Tenure (A. Stephenson) (Sen. Doc. #2021-22)**

<https://www.nationalacademies.org/our-work/investigating-the-potential-impact-of-covid-19-on-the-careers-of-women-in-academic-science-engineering-and-medicine>

Senator Stephenson outlined some of the activities occurring at other universities and documented by the National Academies concerning the impact of COVID on the tenure/promotion process. Some of these are documented in Sen.Doc #2021-22. This discussion originated from discussions arising in the Women's Faculty Lunch and also from discussions amongst additional participants in Clarkson's NSF ADVANCE grant. Senator Stephenson said she would be reaching out to senators to help facilitate engagement from their constituents concerning this topic. She also proposed that she would lead an effort to construct a report for Senate consideration for possible adoption at Clarkson.

**e. *Ad-Hoc* Committee on Faculty Governance and Other Shared Governance Activities**

Chair of Ad-Hoc committee Senator Cohen led a discussion concerning the activities of and the current charge of the committee (Sen. Doc#2021-03b) and how that charge relates to broader shared governance issues raised in the SRP report and COACHE survey and how to proceed, whether those broader items should be added to the ad-hoc committee's charge or a phased approach be implemented. It was decided that this topic warranted further discussion but that the ad-hoc committee should proceed with its original charge at the current time.

**5: 38 pm Motion to adjourn by York (Wallace). Meeting Adjourned.**

**MEMORANDUM**

To: Faculty Senate, Administrative Council

From: Offices of Dean of Students, Human Resources, Title IX

Date: November 11, 2020

Subject: Creation of a University No Contact Order Policy

The Offices of the Dean of Students, Human Resources, and Title IX provide for your review and feedback the enclosed No Contact Order Policy for University implementation. The addition of the No Contact Order Policy will ensure the University's compliance with NYS Article 129-B. The proposed policy has been reviewed by the University's legal counsel.

This policy will be a new addition to each of the following: Undergraduate Regulations, Graduate Regulations, and Operations Manual. The policy is consistent for students and employees.

## No Contact Orders

The Dean of Students, Chief Human Resources Officer, Title IX Coordinator, or designees may issue a No Contact Order (NCO) requiring a student to refrain from avoidable direct or indirect contact or other interaction with one or more other members of the campus community. This may occur, among other circumstances, when the Disciplinary Officer or designee determines that such restrictions are advisable to protect the physical or emotional safety or well-being of specific members of the campus community and/or the orderly functioning of campus operations. Students are expected to comply with NCOs in accordance with the Code of Student Conduct, which provides that “Failure to comply with instructions of administrative officials, including resident advisers, who have duly identified themselves.”

The issuance of a NCO is not a disciplinary action and does not appear on academic, employment, or disciplinary records, unless the individual subsequently violates the NCO. A NCO is designed to provide a measure of relief for an individual who wishes to maintain distance from another individual. A NCO cannot guarantee that the individuals will not encounter one another on campus, but it does establish parameters for those encounters in terms of distance and communication. The parties are each afforded the opportunity for a prompt review of the need for interim or accommodative measures, including the potential modification of these measures. The parties are each allowed to submit evidence in support of, or in opposition to, the request. The University reserves the right to obtain evidence independent of the parties. If a NCO is in place, any alleged violations of the NCO are investigated. In the event a violation is substantiated, further restrictions may be imposed and/or disciplinary action may be warranted.

The University will consider all facts and circumstances that may be relevant to whether an NCO should be issued, including, but not limited to, the following factors:

- When there are allegations, threats, or evidence of physical violence by one person against another;
- When there are allegations, threats, or evidence of emotional abuse or harassment by one person of another;
- When there is a substantial risk of emotional harm from continued contact between persons;
- When continued contact between persons may have a material impact on campus disciplinary proceedings; and
- When there are allegations of serious University policy violations.

“Contact” includes, but is not necessarily limited to, in-person contact, telephone calls, email, texts and other forms of electronic communication, social media-based messages or postings, and third party communications including through proxies.

NCOs may include additional protective measures or other terms specific to the safety, well-being, or other needs of either or both parties subject to the NCO, when deemed necessary by the University. Any additional terms shall be expressly stated in the NCO. Additional protective measures or other terms need not be reciprocal. They may include, but are not limited to, the following:

- Restricting an individual from being in close proximity to the other individual;

- Restricting or limiting an individual's access to certain campus locations or events, including, but not limited to, specific residential, academic, dining, co-curricular or extra-curricular, and/or work spaces;
- Requiring that the individuals not be enrolled in the same academic course(s); and
- Restricting contact at non-University owned locations or sponsored events.

The University may review all NCOs annually. Each NCO will remain in effect until the graduation or withdrawal or termination of employment of at least one of the parties, unless the NCO expressly provides otherwise or is modified or rescinded by the University. A student seeking the modification or rescission of an NCO shall make the request to the administrator who issued the NCO. The issuing administrator shall consult with both parties before determining whether or not to modify or rescind the NCO.

Violations of NCO are subject to discipline under the Code of Student Conduct , Operations Manual, or the retaliation provisions of the Equal Opportunity, Harassment, and Nondiscrimination Policy, as appropriate.

Individuals who have interpersonal conflicts that do not raise concerns for individual health and safety will not be granted NCOs. These individuals should pursue other forms of conflict resolution offered through the appropriate administrative office.

## EMPLOYEE COVID-19 TESTING POLICY

**Date:** November 12, 2020

**Status:** Pending

**Policy Type:** University

**Contact Office:** Human Resources

**Oversight Executive:** Chief Human Resources & Deputy Chief Inclusion Officer

**Applies To:** This Policy currently applies to all Faculty and Staff across departments, Institutes, Centers and Schools in the Potsdam campus, who would be returning to work on campus effective January 4, 2021. However, based on requirements by the state or increase in cases of COVID 19, Clarkson reserves the right to adjust this policy to include all faculty and staff working on site across all our campuses.

**Table of Contents:** Policy Statement

1. [Purpose](#)
2. [Definitions](#)
3. [Policy Statement](#)
4. [Procedures](#)

**Policy Purpose:** To protect the health and safety of the Clarkson community by monitoring potential instances of COVID-19 infection and to utilize that information to reduce transmission.

**Definition of Terms in Statement:** **COVID-19 Test** – A laboratory test that identifies SARS-CoV-2, the virus that causes COVID-19, such as RT-PCR

**Negative Test Results-** As per CDC, a negative test result means that you probably did not have COVID-19 at the time your sample was collected. The test result only means that you did not have COVID-19 at the time of testing. Therefore, it is advisable to monitor your symptoms, and observe infection control practices such as social distancing, wearing face coverings, regular handwashing and other measures.

**Positive Test Results** – As per the CDC, a positive COVID-19 test means you currently have or recently had the virus.

For additional COVID-19 related definitions, please see COVID-19 Interim Policies ([COVID-19 Interim Policies](#))

**Policy Statement:** As a precautionary measure to reduce the spread of COVID-19, **ALL** employees required to be on campus effective **January 4, 2021**, will need to undergo mandatory testing for COVID-19 prior to reporting to work, and at times and dates established by Clarkson University.

This use of COVID-19 testing has been incorporated as a part of our comprehensive approach to reducing transmission in our campuses and is being implemented as an addition to other precautions such as symptom screening, contact tracing etc to help slow and stop the spread of the virus.

Testing is only one method of addressing the risk of COVID-19 transmission. All employees tested are also expected to adhere continually to all other published policies regarding the reduction of COVID-19 transmission such as, but not limited to, hand washing, wearing a face covering, completion of the daily screening, and physical distancing.

This testing policy is consistent with applicable federal, state and local health, safety and employment laws, including with respect to employee privacy and confidentiality.

This policy applies only to requests by Clarkson University for an employee to undergo testing as part of an overall employee testing program. All individuals who have concerns about their own health or the health of a member of their household should contact their primary care provider and request a RT-PCR test.

**Procedures:** The following procedures will be followed:

**General:**

All faculty and staff returning to campus on or after January 4, 2021 will need to obtain a **mandatory COVID-19 test through the Clarkson on-campus testing process** and return to campus only on the **receipt of a negative test result**.

- If you are required to work on campus, you will be contacted with a date and time to report to the campus testing area. Once you have completed the test, Clarkson will inform you of your result within 48 hours.
- Testing will be administered by a third-party testing company and/or a local health care affiliate selected by Clarkson University.
- Testing may occur prior to an employee's return to work on site, as a condition of the employee's continued work on campus, and/or at any other time at the sole discretion of the University.
- The University may administer routine testing through random sampling of faculty, staff, and student employees.
- Testing costs and any expenses related to testing of Clarkson employees through this program are covered by the University.



- All of our testing protocols have been developed with St. Lawrence Health Systems and St. Lawrence County Public Health and in line with federal, state and local health and safety laws.
- Employee testing requirements will be applied in a consistent, non-discriminatory manner in accordance with all applicable laws and regulations and state and federal guidelines.
- Employee test results will not be included in an employee's personnel file.
- Testing times will be coordinated, when possible, with work shifts. Where applicable, employees can work remotely during this time of testing and waiting for results (with supervisor approval).

**Test Scheduling and location:**

Employees will be contacted via Clarkson email to schedule the testing date and time as well as the details of the testing location and process.

**What to Expect of the Test:**

Employees will need to undergo COVID-19 testing on campus. The current plan is that this will be a Nasal RT PCR test (RT-PCR). Specimens will be collected through a process that involves a self-administered nose swab. The test only takes a few minutes and is not as invasive as other ones. Please note that as more testing options are available, Clarkson may use multiple sources and other applicable tests.

**Consent to Testing:**

Employees must consent to testing before scheduling any testing. You will be contacted for completion of the consent form prior to testing.

**Notification of Results:**

- Clarkson will inform you of the results of the test via your Clarkson email.
- Test results are expected within 48 hours of testing.
- Testing results will otherwise be held private and confidential by Clarkson and it's testing partner except as required to be disclosed by law (e.g., with the applicable public health authority).

**🔗 *Employees with a Negative Test Result***

- Will be able to return to work on campus.
- As per CDC, a negative test result means that you did not have COVID-19 at the time of testing or that your sample was collected too early in your infection. Therefore, it is always advisable to monitor your symptoms, and observe infection control practices such as social distancing, wearing face coverings, regular handwashing and other measures.
- Must continue to adhere to all safety policies and procedures put in place by Clarkson University, requirements put in place by the CDC, New York State, and the St. Lawrence County Health System as well as their own state health department requirements if they are not NY residents.

📌 **Employees with a Positive Test Result**

- If test result is positive, you must [isolate](#) as per CDC guidelines and must NOT report to work.
- Must be symptom free for 3 days (72 hours) without the use of fever-reducing medications and have an improvement in respiratory symptoms (e.g. cough, shortness of breath) before returning to work. Please follow CDC-recommended steps.
- Are not allowed to return to work until they have met the criteria to discontinue home isolation and have consulted with a Health Care Provider and state or local health department.
- Must continue to adhere to all safety policies and procedures put in place by Clarkson University, requirements put in place by the CDC, New York State, as well as their own state health department requirements if they are not NY residents.
- Should inquire if NYS Paid Leave Options for COVID-19 are available, if applicable.
- Please also refer to the Positive Diagnosis and Exposure during COVID-19 and Contact Tracing during COVID-19 policies for more information on steps to take in case of a positive diagnosis ([Positive Diagnosis or Exposure during COVID-19](#), [Contact Tracing during COVID-19](#)).

**Testing requirements for Athletic Staff:**

To ensure the health and safety of Clarkson coaches, athletic staff and student-athletes, coaches and athletic staff who have direct and close contact will be required to:

- Obtain the mandatory COVID-19 test mentioned above, prior to returning to campus.
- In addition, they are required to be tested 3 times per week through the Clarkson on-campus testing process.

**Compensation:**

Non-Exempt employees will be compensated for time spent traveling and waiting for the administration of a test as well as any scheduled hours between taking the test and receiving the test results.

**Failure to Comply:**

For approval to be on campus, ALL employees need to **comply with the mandatory COVID-19 testing procedure**. If this testing criteria for entry to work, along with the other entry requirements and screening procedures are not met, employees will **not** be allowed entry to work on campus **or** return to campus. Failure to comply with testing requirements will disqualify an employee from working on site and in turn, may impact their ability to do their job.

**Duration of Policy:**

- This policy will be in effect until further notice.

**Related  
Information:**

**Policy Background:** N/A

**Major Category:** Human Resources Department

**Category Cross  
Reference:**

**Process:**

**Next Scheduled  
Review:**

**Approved By, Date:**

**Revision History:**

**MEMO**

To: The Faculty Senate, Clarkson University

From: Dr. Natasha Banerjee, Chair of the Graduate Committee of Computer Science

Re: Proposal to Change **Master of Science in Computer Science Program (currently Thesis Only)** to **Master of Science in Computer Science with Thesis and Non-Thesis Options**

**Executive Summary**

In this document, we are proposing to expand the Master of Science in Computer Science which is presently a thesis-only degree to a Master of Science (MS) in Computer Science (CS) that has both thesis and non-thesis options. Our move is motivated by the following factors:

- **Explosion of jobs in Computer Science (CS):** Given the explosion of jobs in computer science (CS) fields such as artificial intelligence (AI), data science, machine learning, cybersecurity, networking, and software development, together with the demands for candidates with specialized expertise in these areas, it is becoming imperative to provide healthy offerings of Masters degrees in these areas. The CS department at Clarkson has developed strengths in theory, artificial intelligence (AI), graphics & visualization, software, security, systems, and networks, making it ripe to offer MS in CS with project-based non-thesis options in a diverse range of areas.
- **Strong connections with companies seeking professional MS degrees in CS:** Over the past decade, members of the CS department have been actively involved in forging connections with companies such as Kitware Inc., Delsys, CACI, AFRL, GE, and BAE systems. These companies as well as existing contacts at IBM are actively seeking graduates with extensive course-based backgrounds in the aforementioned computer science areas. They are also highly interested in having their current employees receive MS degrees that demonstrate a breadth of CS experience through courses and project development.
- **Increasing numbers of international students demonstrating desire for professional MS degrees in CS:** Additionally, we are seeing an influx of international students from a diverse range of countries, many of whom are seeking professional graduate programs in CS.
- **Preparedness for potential pandemic-influenced uptick in college enrollment:** Our move is also motivated with the desire to be prepared for the strong probability that the economic downturn caused by the COVID-19 pandemic will cause college enrollment to rise, especially in professional MS programs, as people seek to improve job prospects through these programs, similar to the uptick after the 2008 recession<sup>1</sup>. We wish to be prepared to effectively cater to their individual needs, in order that they are well-prepared to re-enter a changed job market. Given our ongoing strengths in offering online education, we are well-poised to deliver diverse modes of CS education, in traditional, distance, and hybrid modes.

Currently, the Computer Science at Clarkson department offers a PhD in Computer Science, and also offers the MS in Computer Science with thesis option as an interdisciplinary program jointly administered by the Department of Electrical & Computer Engineering. For candidates seeking

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<sup>1</sup> <https://hechingerreport.org/how-the-2008-great-recession-affected-higher-education-will-history-repeat/>

professional degrees with a diverse course base to strengthen their resumes, neither program helps meet the purpose.

- The PhD is geared toward advancement of fundamental research, and does not serve the need of candidates interested in a 1-2 year degree program intended to develop professional skills in desired fields of computer science.
- While the current thesis-based MS is a 2-year program, the demands of a thesis correspond to demonstration of merit at applied research, which lies well outside the interest area of a large body of candidates for the MS program.
  - Our communications with Colleen Thapalia, Director of International Graduate Admissions & Recruitment, as well as conversations with undergraduate students at Clarkson, personal connections, colleagues, and professionals in industry are revealing that candidates who would have been willing to come to Clarkson for an MS in CS are dissuaded by the current thesis-based MS program offered in the department.
  - Students who do join often demonstrate difficulty in completing the thesis portion of the program, with at least two students having had to switch to MS in Basic Sciences in order to graduate despite having completed all courses.
  - Given the uncertainty of success in getting MS students to do a thesis, the graduate committee often has to reject students who apply to the current thesis-based MS. In 2019 alone, the graduate committee rejected 16 applicants to the MS program; however, reviewers had deemed that these applicants would be apt, and would see greater success, if the MS has a non-thesis option.

Our goal is to expand the MS in CS to have both thesis and non-thesis (i.e. project-based) options. The non-thesis option will have 6 credits of project work.

For all courses listed in the Degree Requirements in the Description that follows, we currently have faculty assigned to teach the courses. No new faculty will be needed. Also, no equipment will be needed. Each class is expected to grow by 8+ students (pro forma with estimate can be found in Section 5 of the Project Description), so courses listed in the Degree Requirements may need to be moved to slightly larger rooms to accommodate the growth in students.

We are requesting **one graduate teaching assistant (TA) line** as part of this proposal. Given the general growth in the department in undergraduate student enrollment, and the fact that we are simultaneously initiating an MS in Artificial Intelligence with thesis and non-thesis options, which is expected to add 6 students, on average, three courses that are common to both programs are expected to see a growth of 14 students in the first year, which is expected to double to 28 students in the third year. With each class seeing 14 students in the first year, i.e., the additional load is expected to become  $3 \times 14$  or 42 students, which is expected to double to 84 students by Year 3. The TA is requested to support providing effective instruction to the enhanced student load. As the program grows, we expect to need more resources in the form of teaching assistants, and new faculty members if the class sizes grow to a point that classes need to be divided into multiple sections for effective delivery of instruction. Section 6 provides a detailed justification for this request.

## Description

### 1. Degree Requirements

The following table provides a summary of the degree requirements for the proposed non-thesis option in the MS in CS and the altered thesis option in the MS in CS.

Requirements	Non-thesis Option	Thesis Option
General	Minimum of 30 credit hours, of which minimum 24 must be course work and minimum 6 must be project work	Minimum of 30 credit hours, of which minimum 18 must be course work, minimum 2 must be seminar, and 10 must be thesis work
Foundation Course Requirement	CS 547 (Computer Algorithms, 3 credits)	CS 547 (Computer Algorithms, 3 credits)
Programming Courses Requirement	2 3-credit courses from an approved list of courses that qualify as requiring a substantial amount of programming	2 3-credit courses from an approved list of courses that qualify as requiring a substantial amount of programming
Electives	<ul style="list-style-type: none"><li>• 4 3-credit electives, students are recommended to select electives in a field of specialization.</li><li>• 1 3-credit course that is a computer engineering course focusing on a computer science topic.</li></ul>	<ul style="list-style-type: none"><li>• 2 3-credit electives, one of which should be a 600-level course that focuses on research topics in computer science.</li><li>• 1 3-credit course that is a computer engineering course focusing on a computer science topic.</li></ul>
Project Work	2 3-credit project courses (CS 613 and CS 614)	N/A
Thesis Work	N/A	Maximum 10 credits
Seminar	N/A	2 1-credit seminar courses (CS 707 & CS 708)

It is possible for one course to fulfill more than one requirement. E.g., the course CS 552 which is cross-listed with EE 505 fulfills the programming course requirement and the requirement of being a computer engineering course focusing on a computer science topic. Since a 3 credit course will be used to fulfill requirements that would typically require 6 credits worth of courses (3 credits for the programming requirement + 3 credits for CompE course with CS topic requirement), the student will have to make up the remaining  $6-3=3$  credits by taking any CS 500-level course or above to fulfill the general 30-credits requirement.

The non-thesis option can be completed in 1 to 1.5 years, while the thesis option can be completed in 1.5 to 2 years. Example completion tracks are shown in Section 3. All courses, except the project courses CS 613 and CS 614, and the course CS 574 (Natural Language Processing) are already available in the course catalog. The current 600-level course CS 668 will be converted to a 500-level version (CS 668 --> CS 574) in line with the department's vision to make training in electives such as vision and language processing accessible to a wider audience. New course approval forms are only required for the project, thesis, and seminar courses. A course change request form is required to convert CS 668 to CS 574. New course and course change forms have been included as attachments.

**Distance option:** The program will be available as a distance option to students registered as distance learning students. All courses offered by the department have distance sections, and the program has flexibility whereby all requirements (i.e., minimum of 30 credits) can be completed at a distance.

Section 7 lists the approved list of courses that count as programming courses, and also lists courses that can be taken for specialized electives for the specialization direction / research topic.

**2. Learning objectives, outcomes, and methods to assess accomplishment of learning objectives.**

Non-thesis option:

<b>Learning Objective</b>	<b>Learning Outcome</b>	<b>Assessment of Success</b>
Acquiring of foundational CS knowledge	Students will be equipped with foundational knowledge of computer algorithms by taking CS 547.	<ul style="list-style-type: none"> <li>● Grade statistics for students in program taking CS 547</li> </ul>
Acquisition of breadth in CS through programming expertise	Students will take at least 2 courses containing material with substantial programming.	<ul style="list-style-type: none"> <li>● Grade statistics for students in program across programming courses</li> <li>● Student reports of course experience in exit surveys</li> </ul>
Project development expertise	Students will do 6 credits worth of project work which will culminate in the design and end-to-end implementation of a project topic in computer science, with a comprehensive project report.	<ul style="list-style-type: none"> <li>● Grade statistics for students in program across project development courses (CS 613 and CS 614)</li> <li>● Summary statistics of project report evaluations from graduate committee</li> <li>● Student reports of course experience and impact of project development experience in finding internships and full-time positions through exit surveys</li> <li>● Survey of companies at career fair and via email questionnaires to gauge contribution of project development experience toward candidate quality</li> </ul>
Depth of knowledge for jobs in CS disciplines	Students will take 16 credits worth of electives to acquire targeted depth of knowledge to be competitive for jobs in CS disciplines such as AI, ML, data science, visualization, software, cybersecurity, systems, and networks.	<ul style="list-style-type: none"> <li>● Grade statistics for students in program across elective courses</li> <li>● Student reports of course experience and impact of specialized electives in finding internships and full-time positions through exit surveys</li> <li>● Survey of companies at career fair and via email questionnaires to gauge contribution of specialized electives toward candidate quality</li> </ul>



Thesis option:

<b>Learning Objective</b>	<b>Learning Outcome</b>	<b>Assessment of Success</b>
Acquiring of foundational CS knowledge	Students will be equipped with foundational knowledge of computer algorithms by taking CS 547.	<ul style="list-style-type: none"> <li>● Grade statistics for students in program taking CS 547</li> </ul>
Acquisition of breadth in CS through programming expertise	Students will take at least 2 courses containing material with substantial programming.	<ul style="list-style-type: none"> <li>● Grade statistics for students in program across programming courses</li> <li>● Student reports of course experience in exit surveys</li> </ul>
Readiness for higher degrees in CS	Students will do 10 credits worth of thesis work, involving MS-level research in a CS area of interest, culminating in a thesis defense before a committee.	<ul style="list-style-type: none"> <li>● Grade statistics for students in program across thesis courses (CS 634)</li> <li>● Reports of performance from thesis advisors</li> <li>● Student reports of course experience and impact of thesis experience toward pursuing PhDs</li> <li>● Counts of students entering PhD programs after thesis-based MS in CS</li> </ul>
Depth of knowledge for jobs in CS disciplines	Students will take 6 credits worth of electives together with research experience through working on their thesis to acquire targeted depth of knowledge to be competitive for jobs in CS disciplines such as AI, ML, data science, visualization, software, cybersecurity, systems, and networks.	<ul style="list-style-type: none"> <li>● Grade statistics for students in program across courses</li> <li>● Student reports of course experience and impact of specialized electives and research experience in finding internships and full-time positions through exit surveys</li> <li>● Survey of companies at career fair and via email questionnaires to gauge contribution of specialized electives toward candidate quality</li> </ul>

### 3. Sequencing Plan

#### 1 year completion option for non-thesis option

Year 1 Fall	Year 1 Spring
CS 547 – Computer Algorithms (3 credits)	CS 551 – Artificial Intelligence (Elective III, 3 credits)
CS 572 – Computer Vision (Elective I, 3 credits)	CS 572 – Image Understanding (Elective IV, 3 credits)
CS 550 – Software Design & Development (Programming I, 3 credits)	CS 559 – Human-Computer Interaction (Programming II, 3 credits)
CS 570 – Deep Learning (Elective II, 3 credits)	EE 505 – Computer Graphics (CompE course with CS focus, 3 credits)
CS 613 – CS Projects I (3 credits)	CS 614 – CS Projects II (3 credits)

#### 1.5 year completion option for non-thesis option

Year 1 Fall	Year 1 Spring	Year 2 Fall
CS 547 – Computer Algorithms (3 credits)	CS 551 – Artificial Intelligence (Elective III, 3 credits)	CS 555 – Computer Networks (Elective IV, 3 credits)
CS 572 – Computer Vision (Elective I, 3 credits)	CS 559 – Human Computer Interaction (Programming II, 3 credits)	CS 614 – CS Projects II (3 credits)
CS 550 – Software Design & Development (Programming I, 3 credits)	EE 505 – Computer Graphics (CompE course with CS focus, 3 credits)	
CS 570 – Deep Learning (Elective II, 3 credits)	CS 613 – CS Projects I (3 credits)	

### 1.5 year completion option for the thesis option

Year 1 Fall	Year 1 Spring	Year 2 Fall
CS 547 – Computer Algorithms (3 credits)	CS 559 – Human Computer Interaction (Programming I, 3 credits)	CS 572 – Computer Vision (Programming II, 3 credits)
CS 570 – Deep Learning (Elective I, 3 credits)	EE 505 – Computer Graphics (CompE course with CS focus, 3 credits)	CS 634 – Thesis (7 credits)
CS 634 – Thesis (3 credits)	CS 649 – Current Issues in Machine Learning (Elective II, 3 credits)	
CS 707 – Seminar I (1 credit)	CS 708 – Seminar II (1 credit)	

#### 4. Catalog entry for MS in Computer Science Program (listing thesis and non-thesis options)

##### MS in Computer Science Program

*Natasha K. Banerjee, Chair of the Graduate Committee of the Department of Computer Science*  
[nbanerje@clarkson.edu](mailto:nbanerje@clarkson.edu)

*Christopher A. Lynch, Chair of the Department of Computer Science*  
[clynch@clarkson.edu](mailto:clynch@clarkson.edu)

The Department of Computer Science offers a graduate program leading to degree of Master of Science (offered interdisciplinary with the Department of Electrical and Computer Engineering) in Computer Science. The program is designed to increase fundamental knowledge in computer science, provide a strong background in programming, prepare students for specialization in industry and research through taking targeted electives, and provide students with end-to-end problem solving through project development or research and thesis writing. The department provides the advantage of close personal association between graduate students and faculty, giving special attention to individual needs and interests.

## **MS Requirements**

In addition to the general requirements for the MS degree that are established by the University, a student is required to satisfy the following set of requirements:

1. A minimum of 30 credit hours of graduate level work
2. Each student's program of study must be approved by the Graduate Committee

Those students who are not fully prepared to pursue graduate work in computer science may be required to take the course CS 511, Foundations in Computer Science. In addition, students with very little to no background in computer science may be required to take undergraduate computer science courses, for which graduate credit will not be given.

Two options are offered, the **non-thesis option** and the **thesis option**.

### **Non-thesis option overview**

The non-thesis option requires a minimum of 30 credit hours, of which minimum 24 must be course work and minimum 6 must be project work, done by taking a two-course project sequence consisting of CS 613 and CS 614, and culminating in a project in computer science with a project report.

### **Thesis option overview**

Minimum of 30 credit hours, of which minimum 18 must be course work, minimum 2 must be seminar credits, and 10 must be thesis work, done by taking thesis credits under course numbers CS 634.

### **Common Requirements Across the Thesis and Non-thesis Options**

The following requirements are common to both options, and provide foundational knowledge and breadth of knowledge in programming:

1. 1 foundation course in CS 547 Computer Algorithms
2. 2 courses that qualify as requiring a substantial amount of programming.

Students are advised to consult the Graduate Committee of the Department of Computer Science to obtain a full listing of courses that qualify for the breadth courses and the course that qualifies as requiring a substantial amount of programming. Under certain circumstances, the Graduate Committee may waive the requirement that the student take one or more of the above courses. Students are recommended to consult the Graduate Committee to determine if and what requirements can be waived. For each course waived, students will be required to take an alternate course in its stead in order to fulfill the requirement for 18 credit hours of course work.

**Additional Program Requirements for the Non-thesis Option for MS in Computer Science:**

1. At least 5 restricted elective courses will be taken from the courses offered in computer science or computer engineering departments. Of these 5 courses, 1 must be a computer engineering course with relevant emphasis on computer science topics. 4 are recommended to be courses that focus on attaining specialization in a field of computer science. The department has strengths in theory, artificial intelligence, software, graphics & visualization, security, systems, and network. Students are advised to consult with the Computer Science Graduate Committee to determine appropriate specialization courses for the area of the student's interest.
2. Project work credit will comprise of a minimum of 6 credit hours, and will involve working on a two-semester project done by taking a 2-course sequence (CS 613 and CS 614). Project ideas from all faculty affiliated with the program will be made available to MS students. The student will be responsible for submitting an end-to-end implementation of a project in computer science, together with a project report. The report will be turned in to the Computer Science Graduate Committee for evaluation.

**Additional Program Requirements for the Thesis Option for MS in Computer Science:**

1. At least 3 restricted elective courses will be taken from the courses offered in computer science or computer engineering departments as selected by the student and their advisor. Of these 3 restricted elective courses, 1 must be a computer engineering course with relevant emphasis on computer science topics. Of the remaining 2, 1 must be a 600-level course that focuses on research topics in computer science, and it is recommended that the courses be in a focused area of specialization. Students should consult with their advisors to identify courses in these categories.
2. 2 seminar credits: To earn a seminar credit, students must enroll in a seminar course in Computer Science (CS 707 and CS 708).
3. Thesis credit will comprise a maximum of 10 credit hours of the 30 credit hour minimum. All students must have a research advisor by the end of their first semester of study and must submit a research proposal to the Examination Committee by the end of the semester before they plan to graduate. The research advisor will be a faculty member in the Department of Computer Science, or affiliated with the department through a courtesy appointment. The department has strengths in theory, artificial intelligence, software, graphics & visualization, security, systems, and networks. An overview of research areas in the department can be found at: <https://www.clarkson.edu/academics/arts-sciences/computer-science/research-areas>. The Examination Committee shall consist of a minimum of 3 faculty members. All students must complete a thesis and defend it orally to their Examination Committee. 2 copies of the completed thesis must be submitted to the University.

## Program Length

All work done for the master's degree in computer science is to be completed within five calendar years, although it is normative to complete the non-thesis option in 1 to 1.5 years, and the thesis option 1.5 to 2 years.

## Computer Science Faculty

Professors Daqing Hou, Christopher Lynch, Jeanna Matthews, Christino Tamon, Chuck Thorpe; Associate Professors Natasha Banerjee, Sean Banerjee, Alexis Maciel; Assistant Professors Shafique Chaudhry, Soumyabrata Dey, Faraz Hussain

## 5. Pro forma

The following Pro forma details the expected revenue from *additional* students under the non-thesis option, and does not include the current revenue already obtained through the thesis option.

Fees per credit	Fees after 30% discount	Credits per semester (1 Year)	Revenue from credits (1 Year)	Credits per semester (1.5 year, Year 1)	Revenue from credits (1.5 year, Year 1)	Credits per semester (1.5 year, Year 2)	Revenue from credits (1.5 year, Year 2)
\$1,388.00	\$971.60	15	\$14,574.00	12	\$11,659.20	6	\$5,829.60

Scenario 1: 8 students joining Year 1, 50% of students have 1 year completion, 50% have 1.5 year completion, growth of 2 students per year: ideal scenario)									
Year	Semester	#Students (1 year completion)	#Students (1.5 year completion, Year 1)	#Students (1.5 year completion, Year 2)	Total students (FTE)	Revenue from Students	Cost to Run Program at Start (Semester Tuition + Stipend for one TA)	Total Cost	Revenue to University
1	1	4	4	0	8	\$ 104,932.80	\$ 31,076.00	\$ 31,076.00	\$ 73,856.80
1	2	4	4	0	8	\$ 104,932.80	\$ 31,076.00	\$ 31,076.00	\$ 73,856.80
2	1	5	5	4	14	\$ 154,484.40	\$ 31,076.00	\$ 31,076.00	\$ 123,408.40
2	2	5	5	0	10	\$ 131,166.00	\$ 31,076.00	\$ 31,076.00	\$ 100,090.00
3	1	6	6	5	17	\$ 186,547.20	\$ 31,076.00	\$ 31,076.00	\$ 155,471.20
3	2	6	6	0	12	\$ 157,399.20	\$ 31,076.00	\$ 31,076.00	\$ 126,323.20

Scenario 2: 8 students joining Year 1, 50% of students have 1 year completion, 50% have 1.5 year completion, no growth students per year)									
Year	Semester	#Students (1 year completion)	#Students (1.5 year completion, Year 1)	#Students (1.5 year completion, Year 2)	Total students (FTE)	Revenue from Students	Cost to Run Program at Start (Semester Tuition + Stipend for one TA)	Total Cost	Revenue to University
1	1	4	4	0	8	\$ 104,932.80	\$ 31,076.00	\$ 31,076.00	\$ 73,856.80
1	2	4	0	0	8	\$ 104,932.80	\$ 31,076.00	\$ 31,076.00	\$ 73,856.80
2	1	4	4	4	12	\$ 128,251.20	\$ 31,076.00	\$ 31,076.00	\$ 97,175.20
2	2	4	0	0	4	\$ 58,296.00	\$ 31,076.00	\$ 31,076.00	\$ 27,220.00
3	1	4	4	4	12	\$ 128,251.20	\$ 31,076.00	\$ 31,076.00	\$ 97,175.20
3	2	4	4	0	8	\$ 104,932.80	\$ 31,076.00	\$ 31,076.00	\$ 73,856.80

## 6. Resources Requested for Running of the Program

**One Graduate Teaching Assistant (TA) line** is requested by the department to successfully cater to the expected growth in students. The CS department has already seen a rise in its undergraduate and graduate course enrollment. Additionally, the department is simultaneously

creating a new MS in Artificial Intelligence (AI) with thesis and non-thesis options, to serve a rapidly growing market. With the simultaneous creation of the MS in AI with thesis and non-thesis options, and the expected addition of students through the expansion of the MS in CS to include non-thesis options, our class sizes are expected to grow for several classes that are common to the two programs. Given the already ongoing growth, and the future expected growth through the two graduate programs, department members have expressed concern that our current teaching assistant support is insufficient to successfully administer the department courses. The pro forma included in Part 4 shows three scenarios: super-optimistic growth (2 students per year added in both programs), optimistic growth (1 student per year added in both programs), and stable (i.e. counts maintained).

Specifically, **one graduate teaching assistant line** is requested at the start of the program to support the growth of four classes: CS 547 (Computer Algorithms), CS 551 (Artificial Intelligence), CS 549 (Computational Learning), and CS 570 (Deep Learning). All classes are required core courses for the MS in AI program. CS 547 is a required core course for the MS in CS. Machine learning (taught in CS 549 or the Computational Learning class), artificial intelligence deep learning are the current hot topics in computer science, and are expected to remain so for a considerable period of time. They are courses that fulfill either programming or electives for specialization in the MS in CS, and will end up being taken by students enrolled in the MS in CS program. CS 547 will see a growth by the bold numbers listed in the last row of Table 2. If each new student MS in CS takes 2 of the remaining 3 courses, then on average 2 of the 3 classes will see a growth by the bold numbers listed in the last row of Table 1, i.e., along with CS 547, 3 total classes will see this growth. Assuming each of 3 classes seeing a growth of 14 students in Year 1, the total student load that will need to be handled in terms of tasks such as instruction, grading, and office hour assistance is  $3 * 14$  or 42 in Year 1. In actuality, the load will be higher since all MS in AI students are required to take all 4 courses. We therefore anticipate needing TA support to effectively handle the additional load over the three classes, coupled with the growth we have already seen and continue to see in our undergraduate courses. None of these courses currently have TA support. This support in the form of one TA will be needed in all three scenarios, i.e., stable, optimistic growth, and super-optimistic growth.

With optimistic growth, the number of students is expected to grow to 20 by Year 4, 22 by Year 5, and 24 by Year 6. By Year 4, administrative responsibilities to manage 22 new students + 7 students from the prior year or 29 students (increasing for years beyond) will be demanding enough that the program administrator for both programs will require course reduction in order to handle the administrative workload. Currently, a single faculty member in the Department of Computer Science (Dr. Natasha Banerjee) will be managing both programs. Administrative responsibilities for the program administrator include

1. Conducting Spring and Fall orientation sessions for students in the two programs,
2. Conducting open houses in Summer to advertise the program,
3. Connecting with companies to attract more students,

4. Conducting one-to-one meetings with students to provide personalized planning of their curriculum,
5. Fielding project topics from the department, institutional, and local community for students pursuing the project-based option,
6. Supervising and assessing projects,
7. Connecting students with faculty members for research,
8. Managing student requests for course waivers or exceptions,
9. Resolving conflicts that may arise regarding courses, projects, or research,
10. Performing formative and summative assessment of the program by collecting individualized data from students.

As numbers rise, several of the above responsibilities rise in proportion. To offset the workload of the program administrator, we anticipate needing a supporting instructor starting Year 4 in the event of optimistic growth (i.e., adding 1 student a year for both programs, or 2 students in total).

With super-optimistic growth (i.e., 2 students per year to both programs or 4 students total), the number of new students is expected to rise to 22 by Year 3 and 30 by Year 5. With this rise in number of students, it is expected that we will see students with a diverse range of interests, and coupled with the rapid advancement and diversification of the two fields CS and AI, it is expected that a tenure-track faculty member will be needed to cater to student interests. Additionally, student load enrolled in the four classes CS 547, CS 551, CS 549, and CS 570 is expected to rise to  $3 * 30$  or 90 by Year 5 (again, most likely the load will be higher due to the overlap with the prior year). At this point, a second TA is anticipated starting Year 5 in order to ensure effective instructional support.

## **7. Course lists for Programming Courses and Specialized Electives**

For all lists below, if a course is not in the list but may qualify as fulfilling the requirement for the list, the student petition the Graduate Committee to request inclusion of that course toward fulfilling the requirements corresponding to that list.

### **7.1. Programming Courses**

CS 544: Operating Systems  
CS 545: Compiler Construction  
CS 549: Computational Learning  
CS 550: Software Design & Development  
CS 551: Artificial Intelligence  
CS 552: Computer Graphics  
CS 559: Human-Computer Interaction  
CS 561: Mixed Reality  
CS 570: Deep Learning



CS 572: Image Understanding  
CS 652: Computer Vision  
CS 668: Natural Language Processing

## **7.2. Electives**

Some courses may span multiple areas of CS. 600-level courses are also offered on a fluid basis, which can be taken as specialized electives in one or more categories. Categories will be announced to graduate students when the course is offered.

### *7.2.1 Theory & Algorithms*

CS 541: Automata Theory & Formal Languages  
CS 542: Computational Complexity  
CS 545: Compiler Construction  
CS 549: Computational Learning  
CS 556: Cryptography  
CS 558: Formal Methods for Program Verification

### *7.2.2 Artificial Intelligence & Applications*

CS 549: Computational Learning  
CS 550: Software Design & Development  
CS 551: Artificial Intelligence  
CS 559: Human-Computer Interaction  
CS 560: Database Systems  
CS 565: Mobile Robotics and Human-Machine Interaction  
CS 570: Deep Learning  
CS 572: Image Understanding  
CS 573: Computer Vision  
CS 574: Natural Language Processing (converted from CS 668)  
CS 649: Current Issues in Machine Learning  
CS 675: Fairness, Accountability, and Transparency in AI and Automated Systems

### *7.2.3 Graphics & Visualization*

CS 552: Computer Graphics  
CS 559: Human-Computer Interaction  
CS 561: Mixed Reality  
CS 573: Computer Vision

### *7.2.4 Software*

CS 550: Software Design & Development  
CS 558: Formal Methods for Program Verification

CS 559: Human-Computer Interaction

CS 560: Database Systems

#### *7.2.5 Security*

CS 556: Cryptography

CS 557: Computer & Network Security

CS 558: Formal Methods for Program Verification

CS 657: Advanced Topics in Computer Security

#### *7.2.6 Systems & Networks*

CS 544: Operating Systems

CS 557: Computer & Network Security

CS 555: Computer Networks

CS 644: Current Issues in Operating Systems Research

CS 654: Current Issues in Networking Research

### **7.3. CE Courses with CS Focus**

EE 505: Computer Graphics

EE 507: Computer Networks

EE 510: Computer & Network Security

EE 568: Database Systems

EE 652: Computer Vision

### **7.4. Courses that fulfil the research requirement**

These are only applicable to the thesis option for the MS in CS. With the exception of CS 634 (Thesis), a range of 600-level courses are offered by the department that satisfy this requirement. Note that CS 607/CS 608: Topics in Computer Science and CS 611/CS 612: Topics in Applied Computer Science will count if they at the very least fulfill the requirement of having research literature review and a project component. Students should consult with their advisors to identify courses in these categories.

**Summary of New/Changed Courses** (Course approval forms can be found in pages following this page; sample syllabi can be found after the NYSED change form since they are required for the NYSED change form as well.)

1. **New Course: CS 613 - CS Projects I.** This course is being introduced as the first course in a 2-course sequence intended to enable students under the non-thesis MS in CS to complete projects in computer science. A new course form for CS 613 can be found in the following pages, and a sample syllabus can be found after the NYSED change form. Both the new course form and the sample syllabus contain a description of the course and its outcomes. The new course form will be filed with SAS upon approval of the proposed program. The instructor for the course will be Dr. N. Banerjee, who has indicated consent through the letter found in the approvals portion of this proposal.
2. **New Course: CS 614 - CS Projects II.** This course is being introduced as the first course in a 2-course sequence intended to enable students under the non-thesis MS in CS to complete projects in computer science. A new course form can be found in the following pages, and a sample syllabus can be found after the NYSED change form. Both the new course form and the sample syllabus contain a description of the course and its outcomes. The new course form will be filed with SAS upon approval of the proposed program. The instructor for the course will be Dr. N. Banerjee, who has indicated consent through the letter found in the approvals portion of this proposal.
3. **Changed Course: CS 668 - Natural Language Processing: Course number changed from CS 668 to CS 574.** This change is being performed to remain in line with the department's aim to make training in CS fields such as machine learning, computer vision, and natural language processing accessible to a wider audience by lowering the course number from being a second-level research elective to a first-level graduate course. Due to the difference in numbering (600 vs 500), we have been advised that even though it is a course change rather than a new course, the procedure requires that we file a deactivation form for CS 668 and we file a new course form for CS 574. The following pages contain the new course form for CS 574 and the deactivation form for CS 668. A sample syllabus is also included for CS 574 after the NYSED form. The instructor for the course will be Dr. S. Banerjee, who has indicated consent through the letter found in the approvals portion of this proposal.
4. **Changed Course: EE 652 - Computer Vision: Course number changed from EE 652 to EE 573.** This change is being performed to remain in line with the department's aim to make training in CS fields such as machine learning, computer vision, and natural language processing accessible to a wider audience by lowering the course number from being a second-level research elective to a first-level graduate course. Due to the difference in numbering (600 vs 500), we have been advised that even though it is a course change rather than a new course, the procedure requires that a deactivation form for EE 652 be filed, and a new course form for EE 573 be filed. The following pages contain the new course form for EE 573 and the deactivation form for CS 652. A sample syllabus is also included for EE 573 after the NYSED form. The instructor for the course will be Dr. N. Banerjee, who has indicated consent through the letter found in the approvals portion of this proposal. In particular, EE 573 will be cross-listed with CS 573, which is already being taught by Dr. N. Banerjee.

# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

**School** School of Arts and Sciences  
**Department** 16400-Computer Science

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: CS613 Cross-listed Subject & Number:  N/A or \_\_\_\_\_

Course Title: CS Projects I

Course Description:

This course is the first in a two-course sequence on project development as part of the non-thesis option for the Master of Science in Computer Science, that culminates in a two-semester project for a computer science application. During CS Projects I, students will propose a problem to be solved for a computer science application relevant to their field of interest, perform background research, provide a proposal document discussing their approach to solving the problem, and present a talk on their findings and their proposed approach.

Pre/Corequisites (if any) None

Number of Credits: 3 Grading Basis: Pass/Fail When Offered: When Needed

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

Indicate course to be changed \_\_\_\_\_ (Incl. any cross-listings)

Title \_\_\_\_\_

Subject or Catalog Number \_\_\_\_\_  Grading basis **Select**

Number of Credits \_\_\_\_\_  When offered **Select**

Deactivate course \_\_\_\_\_  Reactivate course \_\_\_\_\_

Prerequisite **Select** \_\_\_\_\_

Corequisite **Select** \_\_\_\_\_

Course equivalency **Select** \_\_\_\_\_  
*(if 2+ departments are involved, both must sign)*

Course description (enter new description below):  
\_\_\_\_\_

Common Experience:  
 Knowledge area **Select** CSO CGI EC IA IG STS UNIV  
 Communication point **Select** C1 C2  
 Technology course **Select**

**APPROVALS** [Electronic Signature Instructions](#)

Department Chair/Director: \_\_\_\_\_ Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any): \_\_\_\_\_ Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any): \_\_\_\_\_ Date: \_\_\_\_\_

Common Experience Committee: \_\_\_\_\_ Date: \_\_\_\_\_

Dean: \_\_\_\_\_ Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

**SAS USE ONLY**

Date entered into Catalog \_\_\_\_\_ Effective Semester: \_\_\_\_\_

Notes: \_\_\_\_\_

# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

**School** School of Arts and Sciences  
**Department** 16400-Computer Science

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: CS 614 Cross-listed Subject & Number:  N/A or \_\_\_\_\_

Course Title: CS Projects II

Course Description:

This course is the second in a two-course sequence on project development as part of the non-thesis option for the Master of Science in Computer Science, that culminates in a two-semester project for a computer science application. During CS Projects II, students will work on providing an end-to-end implementation for the problem proposed during CS 613; will write a comprehensive report on their implementation, detailing challenges encountered, approaches to address challenges, and potential for future work; and will present a talk on their implementation.

Pre/Corequisites (if any) CS 613

Number of Credits: 3 Grading Basis: Pass/Fail When Offered: When Needed

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

**Indicate course to be changed** \_\_\_\_\_ (Incl. any cross-listings)

- Title \_\_\_\_\_
- Subject or Catalog Number \_\_\_\_\_  Grading basis **Select**
- Number of Credits \_\_\_\_\_  When offered **Select**
- Deactivate course  Reactivate course
- Prerequisite **Select** \_\_\_\_\_
- Corequisite **Select** \_\_\_\_\_
- Course equivalency **Select** \_\_\_\_\_  
*(if 2+ departments are involved, both must sign)*

Course description (enter new description below):

- Common Experience:
- Knowledge area **Select** CSO CGI EC IA IG STS UNIV
  - Communication point **Select** C1 C2
  - Technology course **Select**

**APPROVALS**

[Electronic Signature Instructions](#)

Department Chair/Director:  Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any):  Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any):  Date: \_\_\_\_\_

Common Experience Committee:  Date: \_\_\_\_\_

Dean:  Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

**SAS USE ONLY**

Date entered into Catalog \_\_\_\_\_ Effective Semester: \_\_\_\_\_

Notes: \_\_\_\_\_

# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

**School** School of Arts and Sciences  
**Department** 16400-Computer Science

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: CS 574 Cross-listed Subject & Number:  N/A or \_\_\_\_\_

Course Title: Natural Language Processing

**Course Description:**

This course introduces students to the fundamental concepts and ideas in natural language processing (NLP). In this course students will learn how to create systems that are able to understand and produce language for applications ranging from plagiarism detection to information extraction to automated summarization. The course will focus on four key areas: understanding and recognizing words; syntax (i.e. structure of language); semantics (i.e. meaning of language); pragmatics/discourse (i.e. interpretation of language in context). Students will be introduced to document similarity techniques using frequency and sequence based techniques; n-gram models; parts of speech tagging; named entity recognition; word sense disambiguation; machine translation; use of deep learning in NLP. Students will work with large scale datasets spanning from open source repositories to news articles. As part of the course students will read the latest literature in NLP and provide oral and written summaries. Prerequisites: CS 344 and STAT 383 (or equivalent, with consent of instructor)

Pre/Corequisites (if any) CS 344 and STAT 383 or equivalent

Number of Credits: 3 Grading Basis: Graded When Offered: Select

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

**Indicate course to be changed** \_\_\_\_\_ (Incl. any cross-listings)

- Title \_\_\_\_\_
- Subject or Catalog Number \_\_\_\_\_  Grading basis Select
- Number of Credits \_\_\_\_\_  When offered Select
- Deactivate course \_\_\_\_\_  Reactivate course \_\_\_\_\_
- Prerequisite Select \_\_\_\_\_
- Corequisite Select \_\_\_\_\_
- Course equivalency Select \_\_\_\_\_  
*(if 2+ departments are involved, both must sign)*

Course description (enter new description below):

- Common Experience:
- Knowledge area Select CSO CGI EC IA IG STS UNIV
  - Communication point Select C1 C2
  - Technology course Select

**APPROVALS** [Electronic Signature Instructions](#)

Department Chair/Director:  Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any):  Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any):  Date: \_\_\_\_\_

Common Experience Committee:  Date: \_\_\_\_\_

Dean:  Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

**SAS USE ONLY**

Date entered into Catalog \_\_\_\_\_ Effective Semester: \_\_\_\_\_

Notes: \_\_\_\_\_

# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

**School** School of Arts and Sciences ▼  
**Department** 16400-Computer Science ▼

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
 See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: \_\_\_\_\_ Cross-listed Subject & Number:  N/A or \_\_\_\_\_

Course Title: \_\_\_\_\_

Course Description:  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Pre/Corequisites (if any) \_\_\_\_\_

Number of Credits: \_\_\_\_\_ Grading Basis: **Select**  When Offered: **When Needed**

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

**Indicate course to be changed** CS 668 (Incl. any cross-listings)

Title \_\_\_\_\_

Subject or Catalog Number \_\_\_\_\_  Grading basis **Select**

Number of Credits \_\_\_\_\_  When offered **Select**

Deactivate course  Reactivate course

Prerequisite **Select** \_\_\_\_\_

Corequisite **Select** \_\_\_\_\_

Course equivalency **Select** \_\_\_\_\_  
 (if 2+ departments are involved, both must sign)

Course description (enter new description below):  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Common Experience:

Knowledge area **Select** CSO CGI EC IA IG STS UNIV

Communication point **Select** C1 C2

Technology course **Select**

**APPROVALS**

[Electronic Signature Instructions](#)

Department Chair/Director: \_\_\_\_\_ Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any): \_\_\_\_\_ Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any): \_\_\_\_\_ Date: \_\_\_\_\_

Common Experience Committee: \_\_\_\_\_ Date: \_\_\_\_\_

Dean \_\_\_\_\_ Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

SAS USE ONLY	
Date entered into Catalog _____	Effective Semester: _____
Notes: _____	

# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

**School** School of Arts and Sciences  
**Department** 16400-Computer Science

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

## New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED

Subject & Number: EE 573 Cross-listed Subject & Number:  N/A or CS 573

Course Title: Computer Vision

**Course Description:**

This course will cover an overview of basic theoretical underpinnings and practical applications of computer vision, with particular emphasis on geometrical techniques underlying 2D and 3D vision. Topics covered include, but are not restricted to, estimation of image transformations, image formation, pose estimation, camera calibration, epipolar geometry, structure-from-motion, stereo reconstruction, filtering, interest point detection, motion estimation, image segmentation, and object recognition. Students will be expected to read and implement research papers on seminal and modern techniques in computer vision. Prerequisites: CS 142 or EE 262 and MA 339 (or equivalent, with consent from the instructor).

Pre/Corequisites (if any) 2-course programming sequence (CS142/EE262 equivalent) and linear algebra (MA339 equivalent)

Number of Credits: 3 Grading Basis: Graded When Offered: Select

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

## Change a course currently on record (only complete those fields which are changing)

**Indicate course to be changed** \_\_\_\_\_ (Incl. any cross-listings)

- Title \_\_\_\_\_
- Subject or Catalog Number \_\_\_\_\_  Grading basis Select
- Number of Credits \_\_\_\_\_  When offered Select
- Deactivate course \_\_\_\_\_  Reactivate course \_\_\_\_\_
- Prerequisite Select \_\_\_\_\_
- Corequisite Select \_\_\_\_\_
- Course equivalency Select \_\_\_\_\_  
*(if 2+ departments are involved, both must sign)*

Course description (enter new description below):

- Common Experience:
- Knowledge area Select CSO CGI EC IA IG STS UNIV
  - Communication point Select C1 C2
  - Technology course Select

### APPROVALS

### Electronic Signature Instructions

Department Chair/Director:  Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any):  Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any):  Date: \_\_\_\_\_

Common Experience Committee:  Date: \_\_\_\_\_

Dean:  Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

**SAS USE ONLY**

Date entered into Catalog \_\_\_\_\_ Effective Semester: \_\_\_\_\_

Notes: \_\_\_\_\_



# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

School School of Arts and Sciences ▼  
 Department 16400-Computer Science ▼

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 See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: \_\_\_\_\_ Cross-listed Subject & Number:  N/A or \_\_\_\_\_

Course Title: \_\_\_\_\_

Course Description:  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Pre/Corequisites (if any) \_\_\_\_\_

Number of Credits: \_\_\_\_\_ Grading Basis: Select ▼ When Offered: When Needed ▼

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

Indicate course to be changed EE 652 (Incl. any cross-listings)

Title \_\_\_\_\_

Subject or Catalog Number \_\_\_\_\_  Grading basis Select ▼

Number of Credits \_\_\_\_\_  When offered Select

Deactivate course  Reactivate course

Prerequisite Select \_\_\_\_\_

Corequisite Select \_\_\_\_\_

Course equivalency Select \_\_\_\_\_  
(if 2+ departments are involved, both must sign)

Course description (enter new description below):  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Common Experience:  
 Knowledge area Select CSO CGI EC IA IG STS UNIV  
 Communication point Select C1 C2  
 Technology course Select

**APPROVALS** [Electronic Signature Instructions](#)

Department Chair/Director: \_\_\_\_\_ Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any): \_\_\_\_\_ Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any): \_\_\_\_\_ Date: \_\_\_\_\_

Common Experience Committee: \_\_\_\_\_ Date: \_\_\_\_\_

Dean \_\_\_\_\_ Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

**SAS USE ONLY**

Date entered into Catalog \_\_\_\_\_ Effective Semester: \_\_\_\_\_

Notes:  
 \_\_\_\_\_  
 \_\_\_\_\_



## Change or Adapt a Registered Program\*

Use this form to request program changes that require approval by the State Education Department (see chart on the following page). For **programs that are registered jointly** with another institution, all participating institutions must confirm support for the changes.



This application should **NOT** be used for the following types of requests:

- Proposals for new programs
- Requests for changes to registered programs preparing Teachers, Educational Leaders, and Other School Personnel
- Requests for changes to programs preparing Licensed [Professionals](#); or
- Requests to add the Distance Education Format to a Registered Program

(**Note:** If the only requested change is to add the distance education format to an existing registered program, institutions need only complete and submit the [Application to Add the Distance Education Format to a New or Registered Program](#).)

The application materials for requests for changes to registered programs preparing Teachers, Educational Leaders, and Other School Personnel or Licensed Professionals can be found at:

<http://www.highered.nysed.gov/ocue/aipr/register.html>

For requests to changes to Doctoral programs: please [contact](#) the Office of College and University Evaluation (OCUE).

### Directions for submission of request:

1. Create a **single** PDF document that includes the following completed forms:
  - Request to Change or Adapt a Registered Program
  - Master Plan Amendment Supplement and Abstract (if applicable)
  - External Review of Certain Degree Programs and Response (if applicable)
  - [Application to Add the Distance Education Format to a New or Registered Program](#), (if applicable).
2. Create a separate PDF document for any required syllabi (see p. 2 of form, Changes in Program Content)
3. Attach the PDF documents to an e-mail.
4. Send e-mail to [OCURevAdmin@nysed.gov](mailto:OCURevAdmin@nysed.gov)

When submitting to the mailbox, include the following elements in the subject line of the e-mail:

Institution Name, Degree Award, and Program Title

E.g., Subject: AAA College, Request for Change, Master of Science, English Literature

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\* **CUNY and SUNY** institutions: contact System Administration for Request for Change submission process.

## Changes and Adaptations Requiring State Education Department Approval

### Changes in Program Content (all programs)

1. Any of the following substantive changes:
  - Cumulative change from the Department's last approval of the registered program of one-third or more of the minimum credits required for the award (e.g., 20 credits in an associate degree program)
  - Changes in the program's focus or design (e.g., eliminating management courses in a business administration program), including a change in the program's major disciplinary area
  - Adding or eliminating an option or concentration
  - Eliminating a requirement for completion, including an internship, clinical, cooperative education, or other work-based experience
  - Altering the liberal arts and science content in a way that changes the degree classification, as defined in Section 3.47(c)(1-4) of [Regents Rules](#)

### Other Changes (all programs)

2. Program title
3. Program award (e.g., change in degree)
4. Mode of delivery (**Note:** if the change involves adding a **distance education format** to a registered program, please complete the [Application to Add the Distance Education Format to a New or Registered Program](#).)
5. Discontinuing a program
6. A format change that alters the program's financial aid eligibility (e.g., from full-time to part-time, or to an abbreviated or accelerated semester)
7. A change in the total number of credits of any certificate or advanced certificate program

### Establishing New Programs Based on Existing Registered Programs

8. Creating a dual-degree program from existing registered programs
9. Creating a new program from a concentration/track in an existing registered program

#### PLEASE NOTE:

Establishing an existing program at a new location requires new registration of the program. If the requested action changes the program's major disciplinary area, master plan amendment may be needed if the revised program represents the institution's first program in that major subject area, at that degree level. If a requested **degree title** is not authorized for an institution chartered by the Board of Regents, charter amendment will be needed.



NEW YORK STATE EDUCATION DEPARTMENT  
 Office of Higher Education—Office of College and University Evaluation  
 89 Washington Avenue, Albany, NY 12234  
 (518) 474-1551 Fax: (518) 486-2779  
<http://www.highered.nysed.gov/ocue/>  
[OCURevAdmin@nysed.gov](mailto:OCURevAdmin@nysed.gov)

## Request to Change or Adapt a Registered Program

Item	Response <i>(type in the requested information)</i>
<b>Institution name and address</b>	Clarkson University 8 Clarkson Ave, Potsdam, NY 13699  <i>Additional information:</i> <ul style="list-style-type: none"> <li>▪ Specify campus where program is offered, if other than the main campus:</li> </ul>
<b>Identify the program you wish to change</b>	Program title: Master of Science in Computer Science  <u>Award</u> (e.g., B.A., M.S.): MS  Credits: 30  <u>HEGIS code</u> : 0701.00  <u>Program code</u> : 82110
<b>Contact person for this proposal</b>	Name and title: Natasha Banerjee, Associate Professor  Telephone:_(315) 268-3831_____ Fax:_____ E-mail: nbanerje@clarkson.edu
<b>CEO (or designee) approval</b>	Name and title: Signature and date:  <div style="background-color: black; color: white; padding: 2px;">             If the program will be registered jointly with another institution, provide the following information:           </div> Partner institution's name: Name and title of partner institution's CEO: Signature of partner institution's CEO:

- For **programs that are registered jointly** with another institution, all participating institutions must confirm their support of the changes.

**Check all changes that apply and provide the requested information.**

Changes in Program Content (*Describe and explain all proposed changes; provide a side-by-side comparison of the existing and newly modified programs.*)

- Cumulative change from the Department's last approval of the registered program that impacts one-third or more of the minimum credits required for the award (e.g., 20 credits in an associate degree program)
- Changes in a program's focus or design
- Adding** or eliminating an **option** or concentration
- Eliminating** a requirement for program completion
- Altering the liberal arts and science content in a way that changes the degree classification, as defined in Section 3.47(c)(1-4) of [Regents Rules](#)

**If new courses are being added as part of the noted change(s)**, provide a syllabus for each new course and list the name, qualifications, and relevant experience of faculty teaching the course(s). Syllabi should include a course description and identify course credit, objectives, topics, student outcomes, texts/resources, and the basis for determining grades.

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Other Changes (*describe and explain all proposed changes*)

- Program title**
- Program award**
- Mode of Delivery** (**Note:** if the change includes adding a **distance education format** to a registered program, please complete the [Application to Add the Distance Education Format To a New or Registered Program.](#))
- Discontinuing a program:** indicate the date by which the program will be discontinued.<sup>1</sup>
- Format change** (e.g., from full-time to part-time, or to an abbreviated or accelerated semester)
  - a) Indicate proposed format:
  - b) Describe availability of courses and any change in faculty, resources, or support services:
  - c) Use the Sample Program Schedule in the [Application for Registration of a New Program](#) to show the sequencing and scheduling of courses in the program.
  - d) If the revised program will be offered through a nontraditional schedule, provide a brief explanation of the schedule, including its impact on financial aid eligibility.
  - e) Confirm that for each (one) credit there is at least 15 hours (of 50 minutes each) of instruction and at least 30 hours of supplementary assignments.

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<sup>1</sup> If any students do not complete the program by the proposed termination date, the institution must request an extension of the registration period for the program or make other arrangements for those students.

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## Establishing New Programs Based on Existing Registered Programs

### [ ] **Creating a dual-degree program** from existing registered programs

- a) Complete the following table to identify the existing programs:

	<b>Program Title</b>	<b>Degree Award</b>	<b>Program Code</b>
Program 1			
Program 2			

- b) Proposed dual-degree program (title and award):<sup>2</sup>
- c) Courses that will be counted toward both awards:
- d) Length of time for candidates to complete the proposed program:
- e) Use Task 3: Sample Program Schedule from [Application for Registration of a New Program](#) to show the sequencing and scheduling of courses in the dual-degree program.

### [ ] **Creating a new program from a concentration/track in an existing program.**

If the new program is based **entirely** on existing courses in a registered program, provide the current program name, program code, and the following information:

**Note:** this abbreviated option applies only if a master plan amendment is NOT required **and** there are no new courses or changes to program admissions and evaluation elements. If these conditions are not met, submit a new registration application for the proposed program.

- a) Information from the [Application for Registration of a New Program](#):
- Task 1 and Task 2a
  - Task 3 - Sample Program Schedule
  - Task 4 - Faculty information charts (full-time faculty, part-time faculty, and faculty to be hired)
- b) Brief description of the proposed program and rationale for converting the existing coursework to a separately registered program:
- c) Expected impact on existing program:
- d) Adjustments the institution will make to its current resource allocations to support the program:
- e) Statement confirming that the admission standards and process and evaluation methods are the same as those in the existing registered program.

**Note:** if the change involves **establishing an existing registered program at a new location**, complete a new registration application for the proposed program.

---

<sup>2</sup> Only candidates with the capacity to complete the requirements of both degrees shall be admitted to a dual-degree program.

### Summary of Proposed Changes:

1. The foundation course requirement of CS 541 is being eliminated, and being replaced by a free elective.
2. The current MS in CS program is thesis-based only. A non-thesis option is being added to the MS in CS program. After this change, there will be two options, a thesis option and a non-thesis option. The non-thesis option differs from the thesis option in terms of 15 credits.
  - In the thesis option, the 12 credits are split as follows:
    - 10 credits are thesis credits (i.e., CS 634)
    - 2 credits are seminar credits (i.e., 1 credit of CS 707 and 1 credit of CS 708)
    - 3 credits are for a 600-level research elective
  - In the non-thesis option, the 15 credits are split as follows:
    - 6 credits in a 2-course sequence ending in a project (i.e., CS 613 and CS 614; these are new courses introduced as part of this proposal, and sample syllabi have been provided)
    - 9 credits are for 3 electives at the 500-level and above
3. The above changes exceed one-third or more of the minimum credits required for award (i.e., 30 credits).

### Side-by-side comparisons are provided as follows:

Original MS in CS (Thesis-Based)	Changed Thesis-Based MS in CS (hereafter called Thesis Option in MS in CS) <ul style="list-style-type: none"> <li>• Differences between thesis option and non-thesis option are in red</li> <li>• Changes from original thesis-based MS in CS are highlighted in yellow</li> </ul>	Added Non-thesis Option to MS in CS <ul style="list-style-type: none"> <li>• Differences between thesis option and non-thesis option are in red</li> </ul>
Foundation Course: CS 547 – Computer Algorithms (3 credits)	Foundation Course: CS 547 – Computer Algorithms (3 credits)	Foundation Course: CS 547 – Computer Algorithms (3 credits)
Foundation Course: CS 541 – Automata Theory and Formal Languages (3 credits)	Removed; does not exist	Does not exist
2 courses that fulfill the requirement of having substantial programming (6 credits)	2 courses that fulfill the requirement of having substantial programming (6 credits)	2 courses that fulfill the requirement of having substantial programming (6 credits)
1 Computer Engineering course with Computer Science focus (3 credits)	1 Computer Engineering course with Computer Science focus (3 credits)	1 Computer Engineering course with Computer Science focus (3 credits)
1 600-level research elective	1 600-level research elective (3 credits)	Does not exist
Not applicable	1 elective at the 500-level and above (3 credits)	4 electives at the 500-level and above (12 credits)
CS 634 -- Thesis (10 credits)	CS 634 – Thesis (10 credits)	Not applicable
CS 707 – Seminar (1 credit) + CS 708 – Seminar (1 credit)	CS 707 – Seminar (1 credit) + CS 708 – Seminar (1 credit)	Not applicable
Not applicable	Not applicable	CS 613 – CS Projects I (3 credits) + CS 614 – CS Projects II (3 credits)

**Note:** Two new courses are being proposed as part of the proposal, particularly the 2-course sequence CS 613 and CS 614, that enables students to do a project. Sample syllabi are provided for these courses. Additionally, two courses that were originally offered as research courses at the 600-level (particularly CS 668 --- Natural Language Processing and EE 652 --- Computer Vision) are being transformed to be at the 500-level (as CS 574 and EE 573 respectively) to enable the training provided through those courses to be accessible to a wider audience. Syllabi are provided for these two transformed courses as well.

# CS613: CS Projects I

Fall 2021, 3 credits

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## Instructor

Dr. Natasha Banerjee: Has a background in computer vision and machine learning, also serve as the Chair of the Graduate Committee in Computer Science. Will be the liaison to field project ideas from the CS department and the Clarkson community.

## Course Description

This course is the first in a two-course sequence on project development as part of the non-thesis option for the Master of Science in Computer Science, that culminates in a two-semester project for a computer science application. During CS Projects I, students will propose a problem to be solved for a computer science application relevant to their field of interest, perform background research, provide a proposal document discussing their approach to solving the problem, and present a talk on their findings and their proposed approach.

## Course Objectives:

- To ideate new problems involving project development in computer science
- To build motivation for the problem through perusal of background literature

## Delivery Method (on campus, online, synchronous, asynchronous, etc.)

On campus  
Online  
Synchronous/Asynchronous

## Prerequisites

None

## Instructional Materials

### Textbook(s)

None

### Other Reading Materials

None

## Technology

### Minimum Technology Skills

- Use a learning management system
- Use e-mail with attachments
- Create and submit files in commonly used word processing formats



- Be familiar with programming languages, IDEs, and tools for software development

## Course Outcomes (CO)

CO1: Students will propose a problem to be solved for a computer science application relevant to students' field of interest

CO2: Students will perform background investigation of related work

CO3: Students will write a proposal document that summarizes problem motivation, related work, proposed project, and project plan with task breakdown, milestones, expected outcomes, and tentative schedule.

CO4: Students will present a talk on their findings and proposed project plan.

## Grading

### Grade Ranges

#### Graduate Letter Grades

Course Average	Grade	Quality Points
97+	A+	4.0
93-96	A	4.0
90-92	A-	3.667
87-89	B+	3.334
84-86	B	3.0
80-83	B-	2.667
76-79	C+	2.334
70-75	C	2.0
<70	F	0

### Breakdown

Activity	Percent of Final Grade
Second week one-pager describing proposed work	10%
Mid-semester report describing progress on background investigation	25%
Proposal document summarizing project plan	40%
Talk presenting findings and project plan	35%
<b>Total</b>	<b>100%</b>

## Course Policies

### **Etiquette Expectations & Learner Interaction**

Educational institutions promote the advance of knowledge through positive and constructive debate--both inside and outside the classroom. Please visit and follow: [Netiquette and Electronic Learner Interaction Guidelines](#).

## Institutional Policies

### **Institutional Policies & Regulations**

#### **Academic Integrity**

Students are expected to abide by the standards of academic honesty as described in the [Clarkson Regulations](#). The work or words of others must be properly cited. Please refer to Clarkson Library's [Guide to Plagiarism](#) and [Citing Sources](#).

#### **Students with Disabilities Policy**

**Clarkson University welcomes inquiries and applications** from individuals who have disabilities. Information relating to disabling conditions is not a determining factor in admission decisions. The University strives to make all facilities and programs accessible to students with disabilities by providing appropriate academic adjustments and other appropriate modifications (accommodations), as necessary. Timely notification of any need for accommodations due to a disability is encouraged so that the Office of Accommodative Services (OAS) may provide for students in an efficient manner.

For more information or other appropriate campus referrals, contact:

Director of Accommodative Services  
Clarkson University  
PO Box 5645  
Potsdam, NY 13699-5635  
Phone: 315-268-7643  
Fax: 315-268-2400  
Email: [oas@clarkson.edu](mailto:oas@clarkson.edu)  
[Office of AccessABILITY Services Website](#)

# CS614: CS Projects II

*Spring 2022, 3 credits*

---



## Instructor

Dr. Natasha Banerjee: Has a background in computer vision and machine learning, also serve as the Chair of the Graduate Committee in Computer Science. Will be the liaison to field project ideas from the CS department and the Clarkson community.

## Course Description

This course is the second in a two-course sequence on project development as part of the non-thesis option for the Master of Science in Computer Science, that culminates in a two-semester project for a computer science application. During CS Projects II, students will work on providing an end-to-end implementation for the problem proposed during CS 613; will write a comprehensive report on their implementation, detailing challenges encountered, approaches to address challenges, and potential for future work; and will present a talk on their implementation.

## Course Objectives:

- To perform comprehensive project development for end-to-end problem solving in computer science
- To effectively communicate approach and end results through written and oral forms

## Delivery Method (on campus, online, synchronous, asynchronous, etc.)

On campus  
Online  
Synchronous/Asynchronous

## Prerequisites

None

## Instructional Materials

### Textbook(s)

None

### Other Reading Materials

None

## Technology

### Minimum Technology Skills

- Use a learning management system
- Use e-mail with attachments
- Create and submit files in commonly used word processing formats
- Be familiar with programming languages, IDEs, and tools for software development

## Course Outcomes (CO)

CO1: Students will work on providing end-to-end implementation for problem proposed during CS 613 by using programming languages, IDEs, and software development tools appropriate to their chosen project.

CO3: Students will write a comprehensive report on their implementation detailing challenges encountered, approaches to address challenges, and potential for future work.

CO4: Students will present a talk on their implementation and scope for future work stemming from their project.

## Grading

### Grade Ranges

#### Graduate Letter Grades

Course Average	Grade	Quality Points
97+	A+	4.0
93-96	A	4.0
90-92	A-	3.667
87-89	B+	3.334
84-86	B	3.0
80-83	B-	2.667
76-79	C+	2.334
70-75	C	2.0
<70	F	0

### Breakdown

Activity	Percent of Final Grade
Weekly one-page reports discussing incremental progress	10%
Mid-semester report describing progress so far	25%
Final project report	40%

Talk	35%
<b>Total</b>	<b>100%</b>

## Course Policies

### **Etiquette Expectations & Learner Interaction**

Educational institutions promote the advance of knowledge through positive and constructive debate--both inside and outside the classroom. Please visit and follow: [Netiquette and Electronic Learner Interaction Guidelines](#).

## Institutional Policies

### **Institutional Policies & Regulations**

#### **Academic Integrity**

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For more information or other appropriate campus referrals, contact:

Director of Accommodative Services  
Clarkson University  
PO Box 5645  
Potsdam, NY 13699-5635  
Phone: 315-268-7643  
Fax: 315-268-2400  
Email: [oas@clarkson.edu](mailto:oas@clarkson.edu)  
[Office of AccessABILITY Services Website](#)

# CS574: Natural Language Processing

Spring 2022, 3 credits

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## Instructor

Dr. Sean Banerjee: Has a background in machine learning and statistical methods in analysis of large-scale open source repositories of text-based content such as problem reports.

## Course Description

This course introduces students to the fundamental concepts and ideas in natural language processing (NLP). In this course students will learn how to create systems that are able to understand and produce language for applications ranging from plagiarism detection to information extraction to automated summarization. The course will focus on four key areas: understanding and recognizing words; syntax (i.e. structure of language); semantics (i.e. meaning of language); pragmatics/discourse (i.e. interpretation of language in context). Students will be introduced to document similarity techniques using frequency and sequence based techniques; n-gram models; parts of speech tagging; named entity recognition; word sense disambiguation; machine translation; use of deep learning in NLP. Students will work with large scale datasets spanning from open source repositories to news articles. As part of the course students will read the latest literature in NLP and provide oral and written summaries.

## Course Objectives:

- To learn the theory underlying NLP including understanding of words, language structure, semantics, and interpretation in context
- To solve practical problems in NLP using computational approaches for document similarity analysis on large-scale textual datasets

## Delivery Method (on campus, online, synchronous, asynchronous, etc.)

On campus  
Online  
Synchronous/Asynchronous

## Prerequisites

Course in data structures and algorithms (CS 344 at Clarkson or equivalent)  
Course in probability and statistics (STAT 383 at Clarkson or equivalent)

## Instructional Materials

### Textbook(s)

None

## Other Reading Materials

None

## Technology

### Minimum Technology Skills

- Use a learning management system
- Use e-mail with attachments
- Create and submit files in commonly used word processing formats
- Be familiar with Python and Perl

## Course Outcomes (CO)

CO1: Students will learn about key concepts in NLP, particularly word understanding, syntax, semantics, and pragmatics/discourse.

CO2: Students will learn to work with document similarity techniques using a variety of approaches.

CO3: Students will learn to perform language understanding from large-scale text datasets.

CO2: Students will learn to evaluate recent literature in NLP.

## Grading

### Grade Ranges

#### Graduate Letter Grades

Course Average	Grade	Quality Points
97+	A+	4.0
93-96	A	4.0
90-92	A-	3.667
87-89	B+	3.334
84-86	B	3.0
80-83	B-	2.667
76-79	C+	2.334
70-75	C	2.0
<70	F	0

### Breakdown

Activity	Percent of Final Grade
Four assignments on Python/Perl-based implementations of theoretical knowledge gained in	60% (each assignment will be worth 15% of the final grade)

natural language processing	
Half-semester-long project on self-proposed task in NLP. Breakdown: <ul style="list-style-type: none"> <li>• Project proposal</li> <li>• Project implementation</li> <li>• Project report</li> <li>• Project presentation</li> </ul>	40% Breakdown: <ul style="list-style-type: none"> <li>• 5%</li> <li>• 15%</li> <li>• 10%</li> <li>• 10%</li> </ul>
<b>Total</b>	100%

## Course Policies

### Etiquette Expectations & Learner Interaction

Educational institutions promote the advance of knowledge through positive and constructive debate--both inside and outside the classroom. Please visit and follow: [Netiquette and Electronic Learner Interaction Guidelines](#).

## Institutional Policies

### Institutional Policies & Regulations

#### Academic Integrity

Students are expected to abide by the standards of academic honesty as described in the [Clarkson Regulations](#). The work or words of others must be properly cited. Please refer to Clarkson Library's [Guide to Plagiarism](#) and [Citing Sources](#).

#### Students with Disabilities Policy

**Clarkson University welcomes inquiries and applications** from individuals who have disabilities. Information relating to disabling conditions is not a determining factor in admission decisions. The University strives to make all facilities and programs accessible to students with disabilities by providing appropriate academic adjustments and other appropriate modifications (accommodations), as necessary. Timely notification of any need for accommodations due to a disability is encouraged so that the Office of Accommodative Services (OAS) may provide for students in an efficient manner.

For more information or other appropriate campus referrals, contact:

Director of Accommodative Services  
Clarkson University  
PO Box 5645  
Potsdam, NY 13699-5635



Phone: 315-268-7643

**Fax:** 315-268-2400

**Email:** [oas@clarkson.edu](mailto:oas@clarkson.edu)

[Office of AccessABILITY Services Website](#)

# EE573: Computer Vision

Fall 2021, 3 credits



## Instructor

Dr. Natasha Banerjee: Has a background in computer vision and machine learning.

## Course Description

This course will cover an overview of basic theoretical underpinnings and practical applications of computer vision, with particular emphasis on geometrical techniques underlying 2D and 3D vision. Topics covered include, but are not restricted to, estimation of image transformations, image formation, pose estimation, camera calibration, epipolar geometry, structure-from-motion, stereo reconstruction, filtering, interest point detection, motion estimation, image segmentation, and object recognition. Students will be expected to read and implement research papers on seminal and modern techniques in computer vision. Prerequisites: CS 142 or EE 262 and MA 339 (or equivalent, with consent from the instructor).

## Course Objectives:

- To understand the geometrical foundation of 2D and 3D computer vision
- To understand how to use learning-based techniques to solve practical problems in vision

## Delivery Method (on campus, online, synchronous, asynchronous, etc.)

On campus

Online

Synchronous/Asynchronous

## Prerequisites

Second-level programming course (CS 142 or EE 262 at Clarkson or equivalent)

Course in linear algebra (MA 339 at Clarkson or equivalent)

## Instructional Materials

### Textbook(s)

None

### Other Reading Materials

None

## Technology

### Minimum Technology Skills

- Use a learning management system
- Use e-mail with attachments

- Create and submit files in commonly used word processing formats
- Be familiar with MATLAB and Python

## Course Outcomes (CO)

CO1: Students will learn the geometrical foundations of computer vision by taking modules in image transformations, image formation, pose estimation, structure from motion, and stereo reconstruction.

CO2: Students will learn about modern approaches to perform semantic tasks in computer vision such as segmentation and recognition by taking modules in filtering, interest point detection, and learning-based vision.

## Grading

### Grade Ranges

#### Graduate Letter Grades

Course Average	Grade	Quality Points
97+	A+	4.0
93-96	A	4.0
90-92	A-	3.667
87-89	B+	3.334
84-86	B	3.0
80-83	B-	2.667
76-79	C+	2.334
70-75	C	2.0
<70	F	0

### Breakdown

Activity	Percent of Final Grade
Five assignments on MATLAB/Python-based implementations of theoretical knowledge gained in geometrical and learning-based vision	60% (each assignment will be worth 12% of the final grade)
Half-semester-long project on self-proposed task in computer vision. Breakdown: <ul style="list-style-type: none"> <li>• Project proposal</li> <li>• Project implementation</li> <li>• Project report</li> <li>• Project presentation</li> </ul>	40% Breakdown: <ul style="list-style-type: none"> <li>• 5%</li> <li>• 15%</li> <li>• 10%</li> <li>• 10%</li> </ul>
<b>Total</b>	<b>100%</b>

## Course Policies

### **Etiquette Expectations & Learner Interaction**

Educational institutions promote the advance of knowledge through positive and constructive debate--both inside and outside the classroom. Please visit and follow: [Netiquette and Electronic Learner Interaction Guidelines](#).

## Institutional Policies

### **Institutional Policies & Regulations**

#### **Academic Integrity**

Students are expected to abide by the standards of academic honesty as described in the [Clarkson Regulations](#). The work or words of others must be properly cited. Please refer to Clarkson Library's [Guide to Plagiarism](#) and [Citing Sources](#).

#### **Students with Disabilities Policy**

**Clarkson University welcomes inquiries and applications** from individuals who have disabilities. Information relating to disabling conditions is not a determining factor in admission decisions. The University strives to make all facilities and programs accessible to students with disabilities by providing appropriate academic adjustments and other appropriate modifications (accommodations), as necessary. Timely notification of any need for accommodations due to a disability is encouraged so that the Office of Accommodative Services (OAS) may provide for students in an efficient manner.

For more information or other appropriate campus referrals, contact:

Director of Accommodative Services  
Clarkson University  
PO Box 5645  
Potsdam, NY 13699-5635  
Phone: 315-268-7643  
Fax: 315-268-2400  
Email: [oas@clarkson.edu](mailto:oas@clarkson.edu)  
[Office of AccessABILITY Services Website](#)

Included after this page are letters of approval from the following stakeholders in the program (in the order listed below):

- Faculty with primary appointments in the Department of Computer Science
  - Dr. N. Banerjee
  - Dr. S. Banerjee
  - Dr. S. Dey
  - Dr. C. Lynch
  - Dr. A. Maciel
  - Dr. J. Matthews
  - Dr. C. Tamon
  - Dr. C. Thorpe
- Faculty with courtesy appointments in the Department of Computer Science
  - Dr. S. Chaudhry (Reh School of Business --- commitment is only restricted to thesis advisement, and therefore remains unchanged from the original thesis-based MS in CS)
  - Dr. D. Hou (Department of Electrical and Computer Engineering)
  - Dr. F. Hussain (Department of Electrical and Computer Engineering --- commitment is only restricted to thesis advisement, and therefore remains unchanged from original thesis-based MS in CS)
- Dr. C. Lynch, Chair of the Department of Computer Science
- Dr. P. McGrath, Chair of the Department of Electrical and Computer Engineering (since the program is joint between CS and ECE)
- Dr. W. Jemison, Dean of the Coulter School of Engineering
- Dr. T. Langen, Interim Dean of the School of Arts & Sciences
- Approval from the Provost's Council



June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Serving as administrator of the program and de facto academic advisor for all students,
- 2) Running the newly proposed CS Project Courses, numbered CS 613 and CS 614,
- 3) Advising student theses for the thesis-based option,
- 4) Ensuring continued successful running of thesis and seminar courses through communications with faculty members involved, and
- 5) Serving as instructor for the following courses:
  - a. CS 552 (Computer Graphics) that serves as a specialized elective (also cross-listed as EE 505 that serves as a computer engineering elective course with computer science content),
  - b. CS 561 (Mixed Reality) that serves as a specialized elective, and
  - c. CS 573 (Computer Vision) that will serve as a specialized elective; this course will also be cross-listed as EE 573 with Dr. N. Banerjee as instructor. EE 573 will be converted from the current course EE 652, and will serve as a computer engineering elective course with computer science content. The conversion will be performed by deactivating EE 652, and creating EE 573 as a new course, as per the guidelines laid down for course approvals. Sample syllabus for EE 573 has been provided (the course is identical to the currently offered CS 573).

Thank you,

A handwritten signature in black ink, appearing to read "NKBanerjee".

Natasha Kholgade Banerjee, Ph.D.  
Associate Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [nbanerje@clarkson.edu](mailto:nbanerje@clarkson.edu)



Clarkson™

DEPARTMENT OF COMPUTER SCIENCE

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following courses:
  - a. CS 550 (Software Design & Development) that serves as a specialized elective,
  - b. CS 559 (Human-Computer Interaction) that serves as a specialized elective, and
  - c. CS 574 (Natural Language Processing, which will be converted from the current course EE 668) that will serve as a specialized elective. This conversion will be performed by deactivating EE 668, and creating a new course for CS 574. Sample syllabus for CS 574 has been provided in this proposal.

Thank you,

A handwritten signature in black ink, appearing to read "S Banerjee".

Sean Banerjee, Ph.D.  
Associate Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [sbanerje@clarkson.edu](mailto:sbanerje@clarkson.edu)



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DEPARTMENT OF COMPUTER SCIENCE

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following courses:
  - a. CS 570 (Deep Learning) that serves as a specialized elective, and
  - b. CS 572 (Image Understanding) that serves as a specialized elective.

Thank you,

A handwritten signature in blue ink that reads "Soumyabrata Dey".

Soumyabrata Dey, Ph.D.  
Assistant Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [sdey@clarkson.edu](mailto:sdey@clarkson.edu)





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DEPARTMENT OF COMPUTER SCIENCE

June 9, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following courses:
  - a. CS 551 (Artificial Intelligence) that serves as a specialized elective, and
  - b. CS 558 (Formal Methods for Program Verification) that serves as a specialized elective,
  - c. CS 653 (Automated Reasoning) that serves as a specialized elective.

Thank you,

A handwritten signature in cursive script that reads "Christopher A. Lynch".

Christopher Lynch  
Chair and Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [clynch@clarkson.edu](mailto:clynch@clarkson.edu)



Clarkson™

DEPARTMENT OF COMPUTER SCIENCE

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following courses:
  - a. CS 541 (Automata Theory & Formal Languages) that serves as a specialized elective, and
  - b. CS 542 (Complexity Theory) that serves as a specialized elective.

Thank you,

A handwritten signature in blue ink that reads "Alexis Maciel".

Alexis Maciel, Ph.D.  
Associate Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [alexis@clarkson.edu](mailto:alexis@clarkson.edu)



June 1, 2020

To Whom It May Concern:

I have some concerns about the current proposal for a non-thesis option in the Master of Science in Computer Science program, but am generally supportive of the direction. If this proposal or a modified version is approved, I intend to participate in the program in the following ways:

- 1) I have regularly been advising student theses for the thesis-based option and would continue to do so where there is a match between my current research and the interests of current students.
- 2) I have been teaching a variety of courses commonly taken by students in the Master of Science in Computer Science program and would continue to do so as my teaching workload permits. I suspect it will be necessary and appropriate for others to teach some of these courses as well. These courses include:
  - a. CS 544 (Operating Systems) that serves as a specialized elective,
  - b. CS 555 (Computer Networks) that serves as a specialized elective (also cross-listed as EE507 that serves as a computer engineering elective course with computer science content), and
  - c. CS 557 (Computer & Network Security) that serves as a specialized elective (also cross-listed as EE510 that serves as a computer engineering elective course with computer science content).
  - d. CS 600 level courses (including CS 644, CS 649, CS 654 and CS 657 that satisfy the requirement for a research-based course at the graduate level.

Thank you,

A handwritten signature in black ink that reads "Jeanna Matthews".

Jeanna Matthews, Ph.D.  
Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [jnm@clarkson.edu](mailto:jnm@clarkson.edu)



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DEPARTMENT OF COMPUTER SCIENCE

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following courses:
  - a. CS 547 (Computer Algorithms) that serves as a core course,
  - b. CS 549 (Computational Learning) that serves as a specialized elective,
  - c. Alternating CS 545 (Compiler Construction) and CS 556 (Cryptography) every year; both courses serve as specialized electives.

Thank you,

A handwritten signature in green ink, appearing to read "Christino Tamon".

Christino Tamon, Ph.D.  
Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [tino@clarkson.edu](mailto:tino@clarkson.edu)



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DEPARTMENT OF COMPUTER SCIENCE

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following course or equivalent:
  - a. CS 565 (Mobile Robotics and Human-Machine Interaction) that serves as a specialized elective.

Thank you,

A handwritten signature in black ink that reads "Chuck E Thorpe".

Chuck Thorpe, Ph.D.  
Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [cthorge@clarkson.edu](mailto:cthorge@clarkson.edu)



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DEPARTMENT OF COMPUTER SCIENCE

June 10, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the creation of a new Master of Science in Artificial Intelligence program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option.

Thank you,

A handwritten signature in blue ink that reads "Shafique Ahmad Chaudhry".

Shafique Ahmad Chaudhry, Ph.D.

Instructor, Reh School of Business

(Research Assistant Professor, Courtesy Appointment in the Department of Computer Science)

Clarkson University, Potsdam, NY 13699-5720

Email: [schaudhr@clarkson.edu](mailto:schaudhr@clarkson.edu)



Clarkson™

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following course:
  - a. CS 560 (Database Systems) that serves as a specialized elective (cross-listed as EE 568 that serves as a computer engineering elective course with computer science content).

Thank you,

Daqing Hou, Ph.D.  
Professor, Department of Electrical & Computer Engineering  
(Courtesy Appointment in the Department of Computer Science)  
Clarkson University, Potsdam, NY 13699-5720  
Email: [dhoul@clarkson.edu](mailto:dhoul@clarkson.edu)



Clarkson™

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the creation of a new Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option.

Thank you,

A handwritten signature in blue ink that reads "Faraz Hussain".

Faraz Hussain, Ph.D.

Assistant Professor, Department of Electrical & Computer Engineering

(Courtesy Appointment in the Department of Computer Science)

Clarkson University, Potsdam, NY 13699-5720

Email: [fhussain@clarkson.edu](mailto:fhussain@clarkson.edu)





June 29, 2020

To Whom It May Concern:

This package is to create a non-thesis based MS in Computer Science. We currently have a thesis-based MS in Computer Science. However, many potential students are scared away by the thesis requirement, and some students who end up attending Clarkson do not have the interest or the ability to complete an MS thesis. This proposal would simultaneously attract new students to come to Clarkson, and it will help the workload of faculty members who will not be advising weaker students on a thesis.

This proposal was put to a vote in the CS department. It received seven votes in favor and one abstention. We have included letters from the CS department members stating their willingness to teach courses in this program. We are teaching these courses anyway for our thesis based MS in Computer Science, so it is not really a change. In the letter, one faculty member has expressed reservations about the proposed program. That reservation relates to resources for the program. As stated, we are not teaching any new courses. We have asked for one additional TA, to handle the additional students we will get. Otherwise we only need more resources if we attract a huge amount of new students after several years. At that point, we would request new resources from the university. This faculty member suspects "it will be necessary and appropriate for others to teach these courses as well". This is not relevant to the proposal, as these courses are not required courses for this program.

The MS in CS program is jointly run by the ECE department. We have included a letter of support from the Chair of the ECE department, along with letters from the two ECE faculty members who could be involved with advising students for the program.

In summary, we are excited to introduce this proposal. It has been badly needed for awhile. It will be a win-win for the students and the faculty.

Thank you,

A handwritten signature in cursive script that reads "Christopher A. Lynch".

Christopher Lynch  
Chair and Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [clynch@clarkson.edu](mailto:clynch@clarkson.edu)

June 15, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that, as the Chair of the Department of Electrical & Computer Engineering that collaborates with the Department of Computer Science to administer the interdisciplinary program, I approve of the proposed modifications.

In particular, our unit is affected due to the inclusion of the following courses in the proposal as programming and/or specialized electives: EE 568 (Databases), EE 507 (Computer Networks), EE 505 (Computer Graphics), EE 510 (Computer & Network Security), and EE 573 (Computer Vision, modified down to a 500-level course from EE 652). Dr. Daqing Hou, Professor in the Department of Electrical & Engineering has already provided his letter documenting his consent to teach EE 568.

The remaining courses are taught by faculty members with primary appointments in the Department of Computer Science. Particularly, EE 507 and EE 510 is taught by Dr. Jeanna Matthews, and EE 505 is taught by Dr. Natasha Banerjee. EE 573 will be taught by Dr. Natasha Banerjee who has been teaching the original 600-level version of the course EE 652 for five years, and has already discussed her goal to list the course at the 500-level. Both faculty members have provided their letters documenting their intent to teach the courses.

Additionally, Dr. Daqing Hou and Dr. Faraz Hussain (Professor and Assistant Professor, respectively, in the Department of Electrical & Computer Engineering) have courtesy appointments in the Department of Computer Science, and have provided their documented consent to continue advising students in the thesis-based version of the Master of Science program whose research intersects with their area of expertise.

Thank you,



Paul McGrath, Ph.D.  
Chair Department of Electrical & Computer Engineering  
Clarkson University, Potsdam, NY 13699-5720  
Email: pmcgrath@clarkson.edu



Clarkson

COULTER SCHOOL OF  
ENGINEERING

8 Clarkson Avenue  
Potsdam, New York 13699  
315-268-6509

July 2, 2020

MEMORANDUM

From: William D. Jemison, Dean of Engineering  
To: Natasha Banerjee, Graduate Committee Chair, CS Department

I am writing to endorse the proposal that the Master's degree in Computer Science provide a non-thesis option. This option is consistent with current university (and NYSED) policy outlined on page 13 of the graduate catalog<sup>1</sup>.

Offering the program in a distance format is also mentioned in the proposal. I strongly endorse that option as well.

Please feel free to contact me if you have any questions.

Sincerely,

A handwritten signature in black ink, appearing to read "W D Jemison".

William D. Jemison, Ph.D.  
Dean of Engineering  
Tony Collins Professor of Innovative Engineering Culture  
Fellow, IEEE

---

1

<https://www.clarkson.edu/sites/default/files/2019-10/2019-2020-Clarkson-University-Graduate-Catalog.pdf>



August 2, 2020

From: **Prof. Tom Langen, School of Arts & Sciences Interim Dean, Clarkson University**  
To: **Academic Leadership Council, Faculty Senate**  
Re: **non-Thesis Track Computer Science M.S. Degree Program**

The Clarkson School of Arts & Sciences strongly supports the course-based, non-thesis M.S. Degree Program in Computer Science proposal put forth by the Department of Computer Science. This is a timely and well thought-out proposal that reinforces the strengths of the Department of Computer Science, and adds to Clarkson's reputation as a leader in technical graduate education.

This graduate degree program will address the interest of Clarkson computer science or software engineering alumni, computer science B.S. degree holders more widely, and corporate partners of Clarkson University. It addresses the need of computer scientists who pursue applied careers to take additional course work at the graduate level without a need to conduct research. The program holds the promise of generating significant revenue, and will add to Clarkson's growing reputation in computer science. This graduate degree program is comprised existing courses taught by current Computer Science and Electrical and Computer Engineering faculty members; the department has the capacity to adequately support the program. **In the short-term, this degree program merits the commitment of one new TA line.** I support this commitment, with the caveat that if the program does not meet its enrollment goals, this TA line may be terminated.

The resource commitment needed to deliver this program is minimal, and therefore a rigorous market analysis and revenue projection at this stage is not warranted. Should there be intention grow this program, and increase capacity through use of adjunct instructions, expanded delivery of only courses, or coursework at other Clarkson campuses, this would warrant student a market and revenue study. .

Respectfully,

A handwritten signature in black ink that reads "Tom Langen". The signature is written in a cursive, flowing style.

**Tom A. Langen, Ph.D**

*Interim Dean, School of Arts & Sciences  
Professor, Depts. of Biology & Psychology  
Clarkson University*



# Clarkson

September 15, 2020

To Members of Faculty Senate:

Please accept this letter as notification, we, the Provost's Council, endorse the following item voted unanimous, to move forward in the internal approvals process:

Academic Program	Date of Vote
MS in Computer Science, Non-Thesis Program	9/7/2020

Please advise if there are questions or concerns.

Sincerely,

Amanda J. Pickering  
Executive Director of Academic Affairs  
Office of the Provost



## MEMORANDUM

TO: Faculty Senate (K.Fite, President; S. Wojtkiewicz, Secretary)  
FROM: Stefan Grimberg, Chair Curriculum and Academic Policy Committee  
Cc: Susan Powers, Alan Rossner  
SUBJECT: Curricular changes to the Environmental Health Science BS degree program  
DATE: December 6, 2020

The CAP committee recommends unanimously the proposed curricular changes to the Environmental Health Science BS program as outlined in the Senate Document 2021-23.

Upon review of the complete document the following minor inconsistencies were identified by the committee and are provided to the file prepare to correct them as needed:

- P 6, anticipated impacts CSoE and A&S were confusing - 5 years mentioned once, then 4-5 years, then 3-5 years
- P 16, Points seem to add up to a different amount (210) from what is listed (250)?
- P 18, Grading guidelines numerical percentage categories seemed to contain errors e.g, A+ vs A (95-96; what grade would be received?); also C vs F (gap between 60 and 68)



**WALLACE H. COULTER SCHOOL OF ENGINEERING**  
*Technology Serving Humanity*

## **MEMORANDUM**

**TO:** Faculty Senate (K.Fite, President; S. Wojtkiewicz, Secretary)  
**FROM:** Stefan Grimberg, Chair Curriculum and Academic Policy Committee  
**Cc:** Natasha Banerjee  
**SUBJECT:** Changes to MS in Computer Science Program to include non-thesis option  
**DATE:** December 8, 2020

The CAP committee approves the change to the MS in Computer Science program to include a non-thesis option. In reviewing the proposal the committee had the following comments/suggestions:

- **TA-Support:** The proposal request an extra TA position to assist in the anticipated extra grading effort in several computer science courses. The justification is further based on the recent enrollment increase in the computer science department (both graduate and undergraduate students). Given that the justification is not solely based on the anticipated growth of the MS program the committee suggest for the computer science department chair to request additional TA support through the Dean and Provost instead of linking it to this particular program proposal.
- Consider adding courses from Data Analytics Program as electives. The electives suggested for the degree program only include computer science or electrical engineering courses. The committee members suggest for the program proposer to consider courses offered across the university that may complement the proposed course offering (e.g. course offered through the data analytics program).
- It would be helpful to provide some example project topics for the new courses. That could aid in the recruitment of students.
- P 30, sum of % in "Breakdown" was 110%, not 100%
- Pp 32-33, same problem as in #5 for sum of % in "Breakdown" totaling 110% rather than 100%



**To:** The Faculty Senate, Clarkson University

**From:** Dr. Natasha Banerjee, Chair of the Graduate Committee of Computer Science

**Subject:** Proposal to Create a New Master of Science in Artificial Intelligence

**Date:** December 1, 2020

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### Executive Summary

In this document, we are proposing to create a Master of Science in Artificial Intelligence (MS in AI) with both thesis and non-thesis options. Our move is motivated by the following factors:

- **Expansion in jobs in and related to AI:** The proliferation of intelligent systems in the consumer space, and in sectors such as defense and healthcare, has led to an explosion in jobs in areas related to AI, such as machine learning, data science, computer vision, language processing, robotics, healthcare analytics, multi-modal system design, and intelligent edge computing, several of which are demanding rapid development of specialization in AI. Educational institutions in the US and abroad have begun to offer MS in AI degrees to enable targeted training of professionals for AI-related jobs (examples of these institutions may be found in Section 8 of the description following this summary). The COVID-19 pandemic is expected to contribute to the expanding the demand of AI-related jobs, as organizations such as businesses, schools, and government agencies seek to analyze data on disease spread, access to healthcare and basic amenities, employment options, and virtualization of jobs, for effective long-term planning to return to normalcy. The CS department at Clarkson has over the past half decade developed strengths in diverse arms of AI through strategic hires, and is well-poised to offer an MS in AI.
- **Strong connections with companies:** Members of the CS department have been actively involved in forging connections with companies such as IBM, Kitware Inc., Delsys, CACI, AFRL, GE, and BAE systems. These companies have expressed interest in recruiting students trained in AI, as well as ensuring that their current employees have the opportunity to receive targeted training in AI.

Our goal is to offer a novel MS in AI that provides thesis and non-thesis (i.e., project-based) options to students for completion, enabling students to have choices in honing specializations for industry and research. The thesis option will involve course work and research culminating in a thesis through 10 credits of thesis work. The non-thesis option will have course work and 6 credits of project development relating to AI relevant topics.

For all courses listed in the Degree Requirements in the Description that follows, we currently have faculty assigned to teach the courses. No new faculty will be needed. Also, no equipment will be needed. Each class is expected to grow by 6+ students (pro forma with estimate can be found in Section 5 of the Project Description), so courses listed in the Degree Requirements may need to be moved to slightly larger rooms to accommodate the growth in students. As course sizes grow, we will require resources in the future the form of graduate teaching assistants (TAs), and instructional support to offload the workload of the program administrator. Also, given the rapidly evolving landscape of AI, as new developments in AI arise, e.g., in the form of explosion of machine learning models to form separate sub-groups, or new models in fields such as vision, robotics, and natural language processing, new tenure-track faculty lines will be required.



# Description

## 1 Degree Requirements

The following table provides a summary of the degree requirements for the non-thesis and thesis options in the proposed MS in AI program.

Requirements	Non-thesis Option	Thesis Option
General	Minimum of 30 credit hours, of which minimum 24 must be course work and minimum 6 must be project work.	Minimum of 30 credit hours, of which minimum 18 must be course work, minimum 2 must be seminar, and 10 must be thesis work.
Algorithms Foundation Course	CS 547 (Computer Algorithms)	CS 547 (Computer Algorithms)
AI Foundation Courses	CS 551 (Artificial Intelligence) CS 549 (Computational Learning) CS 570 (Deep Learning)	CS 551 (Artificial Intelligence) CS 549 (Computational Learning) CS 570 (Deep Learning)
Specialized Electives	4 courses on topics related to AI from an approved list	2 courses on topics related to AI from an approved list
Project Work	2 project courses (CS 615 & CS 616)	N/A
Thesis Work	N/A	Maximum 10 credits
Seminar	N/A	2 seminar courses (CS 709 & CS 710)

The non-thesis option can be completed in 1 to 1.5 years, while the thesis option can be completed in 1.5 to 2 years. Example completion tracks are shown in Section 3. All courses, except the project courses CS 615 and CS 616, the thesis course CS 635, the seminar courses CS 709 and CS 710, and the course CS 574 (Natural Language Processing) are already available in the course catalog. The current 600-level course CS 668 will be converted to a 500-level version (CS 668 → CS 574) in line with the department's vision to make training in AI-related electives such as vision and language processing accessible to a wider audience. New Course Approval forms are required for the project, thesis, and seminar courses. The conversion of CS 668 to CS 574 will be done by filing a course removal form for CS 668, and filing a new course form for CS 574, as per the SAS requirements, since the course numbering will be changing from 600-level to 500-level. New course and course change forms have been included as attachments.

**Distance option:** The program will be available as a distance option to students registered as distance learning students. All courses offered by the department have distance sections, and the program has flexibility whereby all requirements (i.e., minimum of 30 credits) can be completed at a distance.

Section 7 lists the approved list of courses that count for specialized electives.

## 2 Learning Objectives, Outcomes, and Assessment

### Non-thesis option

Learning Objective	Learning Outcome	Assessment of Success
Acquiring of foundational knowledge	Students will be equipped with foundational knowledge of computer algorithms and artificial intelligence.	<ul style="list-style-type: none"> <li>Grade statistics for students in program taking CS 547, CS 549, CS 551, and CS 570.</li> </ul>
Project development expertise	Students will do 6 credits worth of project work which will culminate in the design and end-to-end implementation of a project topic in AI, with a comprehensive project report.	<ul style="list-style-type: none"> <li>Grade statistics for students in program across project development courses (CS 615 and CS 616).</li> <li>Summary statistics of project report evaluations from AI committee.</li> <li>Student reports of course experience and impact of project development experience in finding internships and full-time positions through exit surveys.</li> <li>Survey of companies at career fair and via email questionnaires to gauge contribution of project development experience toward candidate quality.</li> </ul>
Depth of knowledge for jobs in AI disciplines	Students will take 12 credits worth of specialized electives to acquire targeted depth of knowledge to be competitive for jobs in AI such as data science, computer vision, language processing, and machine learning.	<ul style="list-style-type: none"> <li>Grade statistics for students in program across elective courses.</li> <li>Student reports of course experience and impact of specialized electives in finding internships and full-time positions through exit surveys.</li> <li>Survey of companies at career fair and via email questionnaires to gauge contribution of specialized electives toward candidate quality.</li> </ul>

### Thesis option

Learning Objective	Learning Outcome	Assessment of Success
Acquiring of foundational knowledge	Students will be equipped with foundational knowledge of computer algorithms and artificial intelligence.	<ul style="list-style-type: none"> <li>Grade statistics for students in program taking 547, CS 549, CS 551, and CS 570.</li> </ul>
Readiness for higher degrees in AI	Students will do 10 credits worth of thesis work, involving MS-level research in an AI area of interest, culminating in a thesis defense before a committee.	<ul style="list-style-type: none"> <li>Grade statistics for students in program across thesis courses (CS 635).</li> <li>Reports of performance from thesis advisors.</li> <li>Student reports of course experience and impact of thesis experience toward pursuing PhDs.</li> <li>Counts of students entering PhD programs after thesis-based MS in AI.</li> </ul>
Depth of knowledge for jobs in AI disciplines	Students will take 12 credits worth of specialized electives to acquire targeted depth of knowledge to be competitive for jobs in AI such as data science, computer vision, language processing, and machine learning.	<ul style="list-style-type: none"> <li>Grade statistics for students in program across elective courses.</li> <li>Student reports of course experience and impact of specialized electives in finding internships and full-time positions through exit surveys.</li> <li>Survey of companies at career fair and via email questionnaires to gauge contribution of specialized electives toward candidate quality.</li> </ul>

### 3 Sequencing Plan

#### 1 year completion plan for non-thesis option:

Year 1 Fall	Year 1 Spring
CS 547: Computer Algorithms (3 credits)	CS 551: Artificial Intelligence (3 credits)
CS 549: Computational Learning (3 credits)	CS 572: Image Understanding (Specialized Elective II, 3 credits)
CS 570: Deep Learning (3 credits)	CS 559: Human Computer Interaction (Specialized Elective III, 3 credits)
CS 573: Computer Vision (Specialized Elective I, 3 credits)	CS 552: Computer Graphics (Specialized Elective IV, 3 credits)
CS 615: AI Projects I (3 credits)	CS 616: AI Projects II (3 credits)

#### 1.5 year completion plan for non-thesis option:

Year 1 Fall	Year 1 Spring	Year 2 Fall
CS 547: Computer Algorithms (3 credits)	CS 551: Artificial Intelligence (3 credits)	CS 573: Computer Vision (Specialized Elective IV, 3 credits)
CS 549: Computational Learning (3 credits)	CS 559: Human Computer Interaction (Specialized Elective II, 3 credits)	CS 616: AI Projects II (3 credits)
CS 550: Software Design & Development (Specialized Elective I, 3 credits)	CS 572: Image Understanding (Specialized Elective III, 3 credits)	
CS 570: Deep Learning (3 credits)	CS 615: AI Projects I (3 credits)	

#### 1.5 year completion plan for thesis option:

Year 1 Fall	Year 1 Spring	Year 2 Fall
CS 547: Computer Algorithms (3 credits)	CS 551: Artificial Intelligence (3 credits)	CS 570: Deep Learning (3 credits)
CS 549: Computational Learning (3 credits)	CS 572: Image Understanding (Specialized Elective II, 3 credits)	CS 635: AI Thesis (7 credits)
CS 573: Computer Vision (Specialized Elective I, 3 credits)	CS 635: AI Thesis (3 credits)	
CS 709: Seminar I (1 credit)	CS 710: Seminar II (1 credit)	

## 4 Catalog Entry for MS in Artificial Intelligence Program

### MS in Computer Science Program

*Natasha K. Banerjee, Chair of the Graduate Committee of the Department of Computer Science*  
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*Christopher A. Lynch, Chair of the Department of Computer Science*  
[clynch@clarkson.edu](mailto:clynch@clarkson.edu)

The Department of Computer Science offers a graduate program leading to a degree of Master of Science in Artificial Intelligence. The program is designed to provide comprehensive foundational knowledge for artificial intelligence (AI), prepare students for specialization in industry and research by taking targeted electives, and provide students with end-to-end problem solving through project development or research and thesis writing. The department provides the advantage of close personal association between graduate students and AI faculty, giving special attention to individual needs and interests.

### MS Requirements

In addition to the general requirements for the MS degree that are established by the University, a student is required to satisfy the following set of requirements:

1. A minimum of 30 credit hours of graduate level work.
2. Each student's program of study must be approved by the Graduate Committee.

Those students who are not fully prepared to pursue graduate work in artificial intelligence may be required to take the course CS 511, Foundations in Computer Science. In addition, students with very little to no background in computer science (necessary for preparedness for graduate work in AI) may be required to take undergraduate computer science courses, for which graduate credit will not be given.

Two options are offered, the non-thesis option and the thesis option.

### Non-thesis Option Overview

The non-thesis option requires a minimum of 30 credit hours, of which minimum 24 must be course work and minimum 6 must be project work, done by taking a two-course project sequence consisting of CS 615 and CS 616, and culminating in a project in computer science with a project report.

### Thesis Option Overview

Minimum of 30 credit hours, of which minimum 18 must be course work, minimum 2 must be seminar credits, and 10 must be thesis work, done by taking thesis credits under course numbers CS 635.

### Common Requirements Across the Thesis and Non-thesis Options

The following requirements are common to both options, and provide foundational knowledge and breadth of knowledge in programming:

1. 1 algorithms foundation course: CS 547 (Computer Algorithms)
2. 3 AI foundation courses:
  - (a) CS 551 (Artificial Intelligence)
  - (b) CS 549 (Computational Learning)
  - (c) CS 570 (Deep Learning)

For those students who can demonstrate that they have successfully completed comparable graduate-level courses before coming to Clarkson, the AI Committee may waive the requirement that the student take these specific courses upon request from the student.

### **Additional Program Requirements for the Non-thesis Option for MS in Artificial Intelligence**

1. At least 4 specialized elective courses will be taken from an approved list, which corresponds to courses related to AI, either as applications of AI, or as courses that complement AI through software/system development.
2. Project work credit will comprise of a minimum of 6 credit hours, and will involve working on a two-semester project done by taking a 2-course sequence (CS 615 and CS 616). The student will be responsible for submitting an end-to-end implementation of a project in artificial intelligence, together with a project report. The report will be turned in to the AI Committee for evaluation.

### **Additional Program Requirements for the Thesis Option for MS in Artificial Intelligence**

1. At least 2 specialized elective courses will be taken from an approved list, which corresponds to courses related to AI, either as applications of AI, or as courses that complement AI through software/system development.
2. 2 seminar credits: To earn a seminar credit, students must enroll in a seminar course in Artificial Intelligence (CS 709 and CS 710).
3. Thesis credit will comprise a maximum of 10 credit hours of the 30 credit hour minimum. All students must have a research advisor by the end of their first semester of study and must submit a research proposal to the Examination Committee by the end of the semester before they plan to graduate. The research advisor will be a faculty member in the Department of Computer Science, or affiliated with the department through a courtesy appointment, and doing research in AI. Faculty research in the Department of Computer Science can be found here<sup>1</sup>. The Examination Committee shall consist of a minimum of 3 faculty members. All students must complete a thesis and defend it orally to their Examination Committee. 2 copies of the completed thesis must be submitted to the University

### **Program Length**

All work done for the master's degree in artificial intelligence is to be completed within five calendar years, although it is normative to complete the non-thesis option in 1 to 1.5 years, and the thesis option 1.5 to 2 years.

### **Artificial Intelligence Faculty**

*Professors Christopher Lynch, Jeanna Matthews, Christino Tamon, Chuck Thorpe; Associate Professors Natasha Banerjee, Sean Banerjee; Assistant Professors Soumyabrata Dey*

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<sup>1</sup><https://www.clarkson.edu/academics/arts-sciences/computer-science/research-areas>

## 5 Pro forma

The following pro forma details the expected revenue from additional students through two sources: (i) thesis and non-thesis options in this MS in AI program, and (ii) a non-thesis option in the MS in CS program which is being proposed through a separate proposal in concurrence with this MS in AI program. Because of the synergies between the two programs, disambiguating their revenue generation models is infeasible, and not organic to the running of the programs. The programs will be administered by a single administrator. Therefore, a single pro forma is presented covering the expected rise in number of students, revenue, and resources that would be needed as the programs progress. Three scenarios are considered: a super-optimistic scenario where both programs show growth of 2 students/year, an optimistic scenario where both programs show growth of 1 student/year, and a stable scenario where both programs retain the same number of students per year. At the start it is assumed that 6 students will join the MS in AI program and 8 students will join the MS in CS program.

Year 1 prediction for CS made using applicants rejected from thesis-based MS (16), with assumption of 50% of accepted applicants enrolling into program (i.e., 8)										
Fees per credit	Fees after 30% discount	Credits per semester (1 Year)	Revenue from credits (1 Year)	Credits per semester (1.5 year, Year 1)	Revenue from credits (1.5 year, Year 1)	Credits per semester (1.5 year, Year 2)	Revenue from credits (1.5 year, Year 2)	Instructor Cost to Offload One Course from Administrator	Total Cost	Revenue to University
\$1,388.00	\$971.60	15	\$14,574.00	12	\$11,659.20	6	\$5,829.60			
<b>Super-optimistic growth: 8 students joining Year 1 for CS, 6 students joining Year 1 for AI, 50% students have 1 year completion, 50% have 1.5 year completion, growth of 2 students/year in each program</b>										
Year	Semester	#Students (1 year completion)	#Students (1.5 year completion, Year 1)	#Students (1.5 year completion, Year 2)	Total students (FTE)	Revenue from Students	Semester Tuition + Stipend for TA	Instructor Cost to Offload One Course from Administrator	Total Cost	Revenue to University
1	1	7	7	0	14	\$ 183,632.40	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 152,556.40
1	2	7	7	0	14	\$ 183,632.40	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 152,556.40
2	1	9	9	7	25	\$ 276,906.00	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 245,830.00
2	2	9	9	0	18	\$ 236,098.80	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 205,022.80
3	1	11	11	9	31	\$ 341,031.60	\$ 31,076.00	\$ 30,000.00	\$ 61,076.00	\$ 279,955.60
3	2	11	11	0	22	\$ 288,565.20	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 257,489.20
4	1	13	13	11	37	\$ 405,157.20	\$ 31,076.00	\$ 30,000.00	\$ 61,076.00	\$ 344,081.20
4	2	13	13	0	26	\$ 341,031.60	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 309,955.60
5	1	15	15	13	43	\$ 489,282.80	\$ 62,152.00	\$ 45,000.00	\$ 107,152.00	\$ 382,130.80
5	2	15	15	0	30	\$ 393,498.00	\$ 62,152.00	\$ 45,000.00	\$ 107,152.00	\$ 286,346.00
6	1	17	17	15	49	\$ 533,408.40	\$ 62,152.00	\$ 45,000.00	\$ 107,152.00	\$ 426,256.40
6	2	17	17	0	34	\$ 445,964.40	\$ 62,152.00	\$ 45,000.00	\$ 107,152.00	\$ 338,812.40
* Instructor anticipated to offset load of teaching from program admin										
** Two TAs anticipated; Additional tenure-track faculty anticipated to handle increased load and diversity of interest										
<b>Optimistic growth: 8 students joining Year 1 for CS, 6 students joining Year 1 for AI, 50% students have 1 year completion, 50% have 1.5 year completion, growth of 1 student/year in each program</b>										
Year	Semester	#Students (1 year completion)	#Students (1.5 year completion, Year 1)	#Students (1.5 year completion, Year 2)	Total students (FTE)	Revenue from Students	Semester Tuition + Stipend for TA	Instructor Cost to Offload One Course from Administrator	Total Cost	Revenue to University
1	1	7	7	0	14	\$ 183,632.40	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 152,556.40
1	2	7	7	0	14	\$ 183,632.40	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 152,556.40
2	1	8	8	7	23	\$ 250,672.80	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 219,596.80
2	2	8	8	0	16	\$ 209,865.60	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 178,789.60
3	1	9	9	8	26	\$ 282,735.60	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 251,659.60
3	2	9	9	0	18	\$ 236,098.80	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 205,022.80
4	1	10	10	9	29	\$ 314,798.40	\$ 31,076.00	\$ 30,000.00	\$ 61,076.00	\$ 253,722.40
4	2	10	10	0	20	\$ 262,332.00	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 231,256.00
5	1	11	11	10	32	\$ 346,861.20	\$ 31,076.00	\$ 30,000.00	\$ 61,076.00	\$ 285,785.20
5	2	11	11	0	22	\$ 288,565.20	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 257,489.20
6	1	12	12	11	35	\$ 378,924.00	\$ 31,076.00	\$ 30,000.00	\$ 61,076.00	\$ 317,848.00
6	2	12	12	0	24	\$ 314,798.40	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 283,722.40
* Instructor anticipated to offset load of teaching from program admin										
<b>Stable: 8 students joining Year 1 for CS, 6 students joining Year 1 for AI, 50% of students have 1 year completion, 50% have 1.5 year completion, no growth of students per year</b>										
Year	Semester	#Students (1 year completion)	#Students (1.5 year completion, Year 1)	#Students (1.5 year completion, Year 2)	Total students (FTE)	Revenue from Students	Semester Tuition + Stipend for TA	Instructor Cost to Offload One Course from Administrator	Total Cost	Revenue to University
1	1	7	7	0	14	\$ 183,632.40	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 152,556.40
1	2	7	7	0	14	\$ 183,632.40	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 152,556.40
2	1	7	7	7	21	\$ 224,439.60	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 193,363.60
2	2	7	7	0	14	\$ 183,632.40	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 152,556.40
3	1	7	7	7	21	\$ 224,439.60	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 193,363.60
3	2	7	7	0	14	\$ 183,632.40	\$ 31,076.00	\$ -	\$ 31,076.00	\$ 152,556.40

## 6 Requested Resources

In line with the Computer Science Department's recent vision to promote accelerated growth, we are separately putting forward a proposal to expand the current thesis-based MS in Computer Science to have non-thesis options, in conjunction with the current MS in AI proposal.

This is to bring to your attention that as part of the other proposal, we are requesting a graduate teaching assistant (TA) to support the simultaneous growth at the start of both programs. The TA request is not being made as part of this proposal, but when fulfilled through the other proposal, it will benefit the initiation of both programs.

Though this proposal does not make an explicit request for a TA at the start of the MS in AI program, as class sizes in the MS in AI program grow, we will require resources in the future in the form of additional graduate teaching assistants (TAs). Also, given the rapidly evolving landscape of AI, as new developments in AI arise, e.g., in the form of explosion of machine learning models to form separate sub-groups, or new models in fields such as vision, robotics, and natural language processing, future new tenure-track faculty lines will be required.

## 7 Course Lists for Specialized Electives

If a course is not in the list below but may qualify as fulfilling the requirement for the list, the student petition the Graduate Committee to request inclusion of that course toward fulfilling the requirement of being an elective related to AI.

Course	Purpose
CS 550: Software Design & Development	For developing large systems related to AI
CS 552: Computer Graphics	Learning-based approaches used to synthesize graphics content
CS 559: Human-Computer Interaction	Intelligent user interfaces
CS 561: Mixed Reality	AI-driven understanding of geometry and illumination for augmented reality
CS 565: Mobile Robotics and Human-Machine Interaction	AI in Robotics and HRI
CS 572: Image Understanding	AI for understanding images
CS 573: Computer Vision	AI for understanding 3D geometry
CS 574: Natural Language Processing (converted from CS 668)	AI for language processing
CS 649: Current Issues in Machine Learning	600-level course on current trends and concerns in machine learning
CS 675: Fairness, Accountability, and Transparency in AI and Automated Systems	600-level course on fairness, accountability, and transparency in AI

## 8 US Institutions Offering Master's degrees in AI / Related Fields

Institution	Link to degree program
Northeastern University	<a href="https://www.northeastern.edu/graduate/program/master-of-science-in-artificial-intelligence-17839/">https://www.northeastern.edu/graduate/program/master-of-science-in-artificial-intelligence-17839/</a>
Boston University	<a href="http://www.bu.edu/academics/grs/programs/computer-science/ms-in-artificial-intelligence/">http://www.bu.edu/academics/grs/programs/computer-science/ms-in-artificial-intelligence/</a>
Drexel University (MS in Artificial Intelligence and Machine Learning)	<a href="https://drexel.edu/cc/academics/graduate-programs/ms-in-artificial-intelligence-machine-learning/">https://drexel.edu/cc/academics/graduate-programs/ms-in-artificial-intelligence-machine-learning/</a>
Carnegie Mellon University (MS in Artificial Intelligence and Innovation)	<a href="https://msaii.cs.cmu.edu/">https://msaii.cs.cmu.edu/</a>
Carnegie Mellon University (MS in Machine Learning)	<a href="https://www.ml.cmu.edu/academics/primary-ms-machine-learning-masters.html">https://www.ml.cmu.edu/academics/primary-ms-machine-learning-masters.html</a>
University of North Texas	<a href="https://engineering.unt.edu/academics/graduate/ai">https://engineering.unt.edu/academics/graduate/ai</a>
University of Pittsburgh (MS in Intelligent Systems)	<a href="http://sci.pitt.edu/academics/masters/isp/">http://sci.pitt.edu/academics/masters/isp/</a>
Stevens Institute of Technology (MS / ME in Applied Artificial Engineering)	<a href="https://www.stevens.edu/schaefer-school-engineering-science/departments/electrical-computer-engineering/graduate-programs/applied-artificial-intelligence-masters-program">https://www.stevens.edu/schaefer-school-engineering-science/departments/electrical-computer-engineering/graduate-programs/applied-artificial-intelligence-masters-program</a>
Yeshiva University	<a href="https://www.yu.edu/katz/programs/graduate/artificial-intelligence">https://www.yu.edu/katz/programs/graduate/artificial-intelligence</a>

**Summary of New/Changed Courses** (Course approval forms can be found in pages following this page; sample syllabi can be found after the NYSED form since they are required for the NYSED form as well.)

1. **New Course: CS 615 - AI Projects I.** This course is being introduced as the first course in a 2-course sequence intended to enable students under the non-thesis MS in AI to complete projects in artificial intelligence. A new course form can be found in the following pages, and a sample syllabus can be found after the NYSED form. Both the new course form and the sample syllabus contain a description of the course and its outcomes. The new course form will be filed with SAS upon approval of the proposed program. The instructor for the course will be Dr. N. Banerjee, who has indicated consent through the letter found in the approvals portion of this proposal.
2. **New Course: CS 616 - AI Projects II.** This course is being introduced as the first course in a 2-course sequence intended to enable students under the non-thesis MS in AI to complete projects in artificial intelligence. A new course form can be found in the following pages, and a sample syllabus can be found after the NYSED form. Both the new course form and the sample syllabus contain a description of the course and its outcomes. The new course form will be filed with SAS upon approval of the proposed program. The instructor for the course will be Dr. N. Banerjee, who has indicated consent through the letter found in the approvals portion of this proposal.
3. **New course: CS 635 - AI Thesis.** This course is being introduced to enable students in the thesis-based MS in AI to acquire thesis credits as a part of their completion requirements. A new course form can be found in the following pages, and a sample syllabus can be found after the NYSED form. Both the new course form and the sample syllabus contain a description of the course and its outcomes. The new course form will be filed with SAS upon approval of the proposed program. Each faculty member will receive a section number for thesis advisement. The AI thesis courses are in line with already established thesis courses in the Computer Science department for graduate programs in CS. The sample syllabus is shown for one instructor.
4. **New Course: CS 709 - Seminar in Artificial Intelligence.** This course is being introduced as the first course in a 2-course sequence intended to enable students under the thesis-based MS in AI to engage in seminars under the direction of their research advisor. A new course form can be found in the following pages, and a sample syllabus can be found after the NYSED form. Both the new course form and the sample syllabus contain a description of the course and its outcomes. The new course form will be filed with SAS upon approval of the proposed program. Each faculty member will receive a section number for conducting their seminar. The AI seminar courses are in line with already established seminar courses in the Computer Science department for graduate programs in CS. The sample syllabus is shown for one instructor.
5. **New Course: CS 710 - Seminar in Artificial Intelligence.** This course is being introduced as the second course in a 2-course sequence intended to enable students under the thesis-based MS in AI to engage in seminars under the direction of their research advisor. A new course form can be found in the following pages, and a sample syllabus can be found after the NYSED form. Both the new course form and the sample syllabus contain a description of the course and its outcomes. The new course



form will be filed with SAS upon approval of the proposed program. Each faculty member will receive a section number for conducting their seminar. The AI seminar courses are in line with already established seminar courses in the Computer Science department for graduate programs in CS. The sample syllabus is shown for one instructor.

6. **Changed Course: CS 668 - Natural Language Processing: Course number changed from CS 668 to CS 574.** This change is being performed to remain in line with the department's aim to make training in CS fields such as machine learning, computer vision, and natural language processing accessible to a wider audience by lowering the course number from being a second-level research elective to a first-level graduate course. Due to the difference in numbering (600 vs 500), we have been advised that even though it is a course change rather than a new course, the procedure requires that we file a deactivation form for CS 668 and we file a new course form for CS 574. The following pages contain the new course form for CS 574 and the deactivation form for CS 668. A sample syllabus is also included for CS 574 after the NYSED form. The instructor for the course will be Dr. S. Banerjee, who has indicated consent through the letter found in the approvals portion of this proposal.

# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

**School** School of Arts and Sciences  
**Department** 16400-Computer Science

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: CS615 Cross-listed Subject & Number:  N/A or \_\_\_\_\_

Course Title: AI Projects I

Course Description:

This course is the first in a two-course sequence on project development as part of the non-thesis option for the Master of Science in Artificial Intelligence, that culminates in a two-semester project for an AI application. During AI Projects I, students will propose a problem to be solved for an AI application relevant to their field of interest, perform background research, provide a proposal document discussing their approach to solving the problem, and present a talk on their findings and their proposed approach.

Pre/Corequisites (if any) None

Number of Credits: 3 Grading Basis: Pass/Fail When Offered: When Needed

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

**Indicate course to be changed** \_\_\_\_\_ (Incl. any cross-listings)

Title \_\_\_\_\_

Subject or Catalog Number \_\_\_\_\_  Grading basis **Select**

Number of Credits \_\_\_\_\_  When offered **Select**

Deactivate course \_\_\_\_\_  Reactivate course \_\_\_\_\_

Prerequisite **Select** \_\_\_\_\_

Corequisite **Select** \_\_\_\_\_

Course equivalency **Select** \_\_\_\_\_  
*(if 2+ departments are involved, both must sign)*

Course description (enter new description below):

Common Experience:

Knowledge area **Select** CSO CGI EC IA IG STS UNIV

Communication point **Select** C1 C2

Technology course **Select**

**APPROVALS**

Electronic Signature Instructions

Department Chair/Director:  Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any):  Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any):  Date: \_\_\_\_\_

Common Experience Committee:  Date: \_\_\_\_\_

Dean:  Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

**SAS USE ONLY**

Date entered into Catalog \_\_\_\_\_ Effective Semester: \_\_\_\_\_

Notes: \_\_\_\_\_

# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

**School** School of Arts and Sciences  
**Department** 16400-Computer Science

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: CS 616 Cross-listed Subject & Number:  N/A or \_\_\_\_\_

Course Title: AI Projects II

Course Description:  

This course is the second in a two-course sequence on project development as part of the non-thesis option for the Master of Science in Artificial Intelligence, that culminates in a two-semester project for an artificial intelligence application. During AI Projects II, students will work on providing an end-to-end implementation for the problem proposed during CS 613; will write a comprehensive report on their implementation, detailing challenges encountered, approaches to address challenges, and potential for future work; and will present a talk on their implementation.

Pre/Corequisites (if any) CS 615

Number of Credits: 3 Grading Basis: Pass/Fail When Offered: When Needed

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

Indicate course to be changed \_\_\_\_\_ (Incl. any cross-listings)

- Title \_\_\_\_\_
- Subject or Catalog Number \_\_\_\_\_  Grading basis Select
- Number of Credits \_\_\_\_\_  When offered Select
- Deactivate course  Reactivate course
- Prerequisite Select \_\_\_\_\_
- Corequisite Select \_\_\_\_\_
- Course equivalency Select \_\_\_\_\_  
*(if 2+ departments are involved, both must sign)*

Course description (enter new description below):

- Common Experience:
- Knowledge area Select CSO CGI EC IA IG STS UNIV
  - Communication point Select C1 C2
  - Technology course Select

**APPROVALS** [Electronic Signature Instructions](#)

Department Chair/Director:  Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any):  Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any):  Date: \_\_\_\_\_

Common Experience Committee:  Date: \_\_\_\_\_

Dean:  Date: \_\_\_\_\_

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**SAS USE ONLY**

Date entered into Catalog \_\_\_\_\_ Effective Semester: \_\_\_\_\_

Notes: \_\_\_\_\_

# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

**School** School of Arts and Sciences  
**Department** 16400-Computer Science

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: CS 635 Cross-listed Subject & Number:  N/A or \_\_\_\_\_

Course Title: AI Thesis

Course Description:

Each student does independent, original work on a project under the guidance and supervision of an instructor. A grade on all of the credits for this work presented in satisfaction of the requirements for a degree is given when those requirements are completed.

Pre/Corequisites (if any) \_\_\_\_\_

Number of Credits: 1-15 Grading Basis: Thesis When Offered: When Needed

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

**Indicate course to be changed** \_\_\_\_\_ (Incl. any cross-listings)

Title \_\_\_\_\_

Subject or Catalog Number \_\_\_\_\_  Grading basis **Select**

Number of Credits \_\_\_\_\_  When offered **Select**

Deactivate course \_\_\_\_\_  Reactivate course \_\_\_\_\_

Prerequisite **Select** \_\_\_\_\_

Corequisite **Select** \_\_\_\_\_

Course equivalency **Select** \_\_\_\_\_  
*(if 2+ departments are involved, both must sign)*

Course description (enter new description below):

Common Experience:  
 Knowledge area **Select** CSO CGI EC IA IG STS UNIV  
 Communication point **Select** C1 C2  
 Technology course **Select**

**APPROVALS**

Electronic Signature Instructions

Department Chair/Director:  Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any):  Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any):  Date: \_\_\_\_\_

Common Experience Committee:  Date: \_\_\_\_\_

Dean:  Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

**SAS USE ONLY**

Date entered into Catalog \_\_\_\_\_ Effective Semester: \_\_\_\_\_

Notes: \_\_\_\_\_

# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

**School** School of Arts and Sciences  
**Department** 16400-Computer Science

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See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: CS 709 Cross-listed Subject & Number:  N/A or \_\_\_\_\_  
Course Title: Seminar in Artificial Intelligence I

Course Description:  

Students participate in a research seminar, or prepare and deliver an oral presentation on a research topic, as determined by their research advisor.

Pre/Corequisites (if any) \_\_\_\_\_

Number of Credits: 1-15 Grading Basis: Thesis When Offered: When Needed

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

**Indicate course to be changed** \_\_\_\_\_ (Incl. any cross-listings)

- Title \_\_\_\_\_
- Subject or Catalog Number \_\_\_\_\_  Grading basis **Select**
- Number of Credits \_\_\_\_\_  When offered **Select**
- Deactivate course  Reactivate course
- Prerequisite **Select** \_\_\_\_\_
- Corequisite **Select** \_\_\_\_\_
- Course equivalency **Select** \_\_\_\_\_  
*(if 2+ departments are involved, both must sign)*

Course description (enter new description below):

- Common Experience:
- Knowledge area **Select** CSO CGI EC IA IG STS UNIV
  - Communication point **Select** C1 C2
  - Technology course **Select**

**APPROVALS**

[Electronic Signature Instructions](#)

Department Chair/Director:  Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any):  Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any):  Date: \_\_\_\_\_

Common Experience Committee:  Date: \_\_\_\_\_

Dean:  Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

**SAS USE ONLY**

Date entered into Catalog \_\_\_\_\_ Effective Semester: \_\_\_\_\_

Notes: \_\_\_\_\_

# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

**School** School of Arts and Sciences  
**Department** 16400-Computer Science

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: CS 710 Cross-listed Subject & Number:  N/A or \_\_\_\_\_  
Course Title: Seminar in Artificial Intelligence II

Course Description:  

Students participate in a research seminar, or prepare and deliver an oral presentation on a research topic, as determined by their research advisor.

Pre/Corequisites (if any) \_\_\_\_\_  
 Number of Credits: 1-15 Grading Basis: Thesis When Offered: When Needed  
 Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

**Indicate course to be changed** \_\_\_\_\_ (Incl. any cross-listings)

- Title \_\_\_\_\_
- Subject or Catalog Number \_\_\_\_\_  Grading basis **Select**
- Number of Credits \_\_\_\_\_  When offered **Select**
- Deactivate course  Reactivate course
- Prerequisite **Select** \_\_\_\_\_
- Corequisite **Select** \_\_\_\_\_
- Course equivalency **Select** \_\_\_\_\_  
*(if 2+ departments are involved, both must sign)*

Course description (enter new description below):

- Common Experience:
  - Knowledge area **Select** CSO CGI EC IA IG STS UNIV
  - Communication point **Select** C1 C2
  - Technology course **Select**

**APPROVALS**

Electronic Signature Instructions

Department Chair/Director:  Date: \_\_\_\_\_  
 Equivalent Course Dept Chair (if any):  Date: \_\_\_\_\_  
*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*  
 School Curriculum Committee (if any):  Date: \_\_\_\_\_  
 Common Experience Committee:  Date: \_\_\_\_\_  
 Dean:  Date: \_\_\_\_\_  
 Date forwarded to SAS: \_\_\_\_\_

**SAS USE ONLY**  
 Date entered into Catalog \_\_\_\_\_ Effective Semester: \_\_\_\_\_  
 Notes: \_\_\_\_\_

# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

**School** School of Arts and Sciences  
**Department** 16400-Computer Science

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: CS 574 Cross-listed Subject & Number:  N/A or \_\_\_\_\_

Course Title: Natural Language Processing

**Course Description:**

This course introduces students to the fundamental concepts and ideas in natural language processing (NLP). In this course students will learn how to create systems that are able to understand and produce language for applications ranging from plagiarism detection to information extraction to automated summarization. The course will focus on four key areas: understanding and recognizing words; syntax (i.e. structure of language); semantics (i.e. meaning of language); pragmatics/discourse (i.e. interpretation of language in context). Students will be introduced to document similarity techniques using frequency and sequence based techniques; n-gram models; parts of speech tagging; named entity recognition; word sense disambiguation; machine translation; use of deep learning in NLP. Students will work with large scale datasets spanning from open source repositories to news articles. As part of the course students will read the latest literature in NLP and provide oral and written summaries. Prerequisites: CS 344 and STAT 383 (or equivalent, with consent of instructor)

Pre/Corequisites (if any) CS 344 and STAT 383 or equivalent

Number of Credits: 3 Grading Basis: Graded When Offered: Select

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

**Indicate course to be changed** \_\_\_\_\_ (Incl. any cross-listings)

- Title \_\_\_\_\_
- Subject or Catalog Number \_\_\_\_\_  Grading basis Select
- Number of Credits \_\_\_\_\_  When offered Select
- Deactivate course \_\_\_\_\_  Reactivate course \_\_\_\_\_
- Prerequisite Select \_\_\_\_\_
- Corequisite Select \_\_\_\_\_
- Course equivalency Select \_\_\_\_\_  
*(if 2+ departments are involved, both must sign)*

Course description (enter new description below):

Common Experience:

- Knowledge area Select CSO CGI EC IA IG STS UNIV
- Communication point Select C1 C2
- Technology course Select

**APPROVALS**

Electronic Signature Instructions

Department Chair/Director:  Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any):  Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any):  Date: \_\_\_\_\_

Common Experience Committee:  Date: \_\_\_\_\_

Dean:  Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

**SAS USE ONLY**

Date entered into Catalog \_\_\_\_\_ Effective Semester: \_\_\_\_\_

Notes: \_\_\_\_\_

# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

**School** School of Arts and Sciences ▼  
**Department** 16400-Computer Science ▼

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
 See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: \_\_\_\_\_ Cross-listed Subject & Number:  N/A or \_\_\_\_\_

Course Title: \_\_\_\_\_

Course Description:  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Pre/Corequisites (if any) \_\_\_\_\_

Number of Credits: \_\_\_\_\_ Grading Basis: **Select** ▼ When Offered: **When Needed** ▼

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

**Indicate course to be changed** CS 668 (Incl. any cross-listings)

Title \_\_\_\_\_

Subject or Catalog Number \_\_\_\_\_  Grading basis **Select** ▼

Number of Credits \_\_\_\_\_  When offered **Select**

Deactivate course  Reactivate course

Prerequisite **Select** \_\_\_\_\_

Corequisite **Select** \_\_\_\_\_

Course equivalency **Select** \_\_\_\_\_  
*(if 2+ departments are involved, both must sign)*

Course description (enter new description below):  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Common Experience:  
 Knowledge area **Select** CSO CGI EC IA IG STS UNIV  
 Communication point **Select** C1 C2  
 Technology course **Select**

**APPROVALS**

[Electronic Signature Instructions](#)

Department Chair/Director: \_\_\_\_\_ Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any): \_\_\_\_\_ Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any): \_\_\_\_\_ Date: \_\_\_\_\_

Common Experience Committee: \_\_\_\_\_ Date: \_\_\_\_\_

Dean \_\_\_\_\_ Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

SAS USE ONLY	
Date entered into Catalog _____	Effective Semester: _____
Notes: _____	





**Application for the Registration of New Graduate and Undergraduate  
Curricula/Programs – Including Programs to be Offered in Distance Education  
Format**

**Important Information**

1. This application is for use by institutions of higher education that hold an absolute charter or permanent authority to award degrees seeking to register **general academic curricula**.
2. **Do not** use this application for the following program proposals:
  - Programs preparing teachers, educational leaders, or other school personnel
  - Programs preparing licensed professionals
  - Programs leading to doctoral level degrees
  - Programs leading to a credit-bearing Certificates or Advanced Certificates
  - Proposals for revisions to existing registered programs (including title changes, curricular changes, etc.)
3. Program registration is based upon standards in the Regulations of the Commissioner of Education (8 NYCRR Chapter II, Subchapter A). The Department registers individual curricula/programs rather than the institution as a whole, but the registration process includes, in some instances, an assessment of institutional-level compliance with some of the standards.
4. This application includes attestations/assurances, by the Chief Administrative or Academic Officer/Provost of the institution, on behalf of the institution, concerning the institution's compliance with statutory and regulatory requirements related to the standards for curricula/program registration and operation of higher education programs in New York State.
5. The Department will audit compliance and, if an institution is found to be out of compliance with one or more standard to which it attested compliance, that finding may lead to denial of: (1) re-registration of the program, pursuant to §52.1(l) of the Regulations of the Commissioner of Education and (2) the ability of the institution to utilize attestations in future applications for program registration; and in certain circumstances may warrant deregistration of the program.
6. Program proposals from SUNY and CUNY System institutions must be submitted to the Department by the System Administration. Contact the System Administration for information concerning relevant proposal submission requirements.

7. The Department reserves the right to request additional information and/or clarification of any information provided by the institution that may be necessary for the Department to make a registration decision concerning the proposed program.

## Submission Instructions

Applications for program registration will be accepted in **electronic format only** via the instructions below. Hard copy applications will not be accepted or reviewed by the Department and will not be retained.

1. Create a single PDF document that includes the following documents:
  - The completed Application for the Registration of New Graduate and Undergraduate Curricula/Programs, with all required signatures included;
  - Any request for a Master Plan Amendment and associated information and materials that may be required concerning this program proposal (see below); and
  - Any external review of the proposed program that is required (see below).
2. Attach the PDF document to an e-mail.
3. Send the e-mail (with attachment) to [OCUERevAdmin@nysed.gov](mailto:OCUERevAdmin@nysed.gov).
4. The subject line of the email should include the name of the institution, the degree award and the program title. For example:

Subject: ABC College, Master of Science, English Literature.

## Master Plan Amendments

If this program proposal necessitates a Master Plan Amendment, additional information and materials related to that request will be required. Please refer to information on the Department's web site at: <http://www.highered.nysed.gov/ocue/aipr/guidance/gpr2.html> for information on Master Plan Amendments to determine if such an amendment is required for this program proposal and to access the Master Plan Amendment Supplement.

## External Review

Please refer to <http://www.highered.nysed.gov/ocue/aipr/guidance/gpr9.html> for information about when an external review of a proposed program is required. If such a review is required, that material must be submitted with the program registration application.

## General Information

Institution (Legal Name)	Institution Code
Clarkson University	412500
Proposed Program Title	Degree Award
Master of Science in Artificial Intelligence	Master of Science
Address of Any Campus Where the Proposed Program Will Be Offered (main and/or branch campuses)	Full-time or Part-time <sup>1</sup>
8 Clarkson Avenue, Box 5815, Potsdam, NY 13699	Full-time
All Program Format(s) (standard, distance education <sup>2</sup> , evening, weekend and/or other)	HEGIS Code
Standard, distance education	0701.00
Joint Registration IHE (if applicable)	Total Number of Credits
	30
Lead Contact [First Name, Last Name, Title]	Telephone Number
Natasha Banerjee, Assistant Professor, Chair of Graduate Committee of Computer Science	(315) 268-3831
Email Address	
nbanerje@clarkson.edu	

<sup>1</sup> Please refer to §52.2(c) and §145-2.1 of the Regulations of the Commissioner for definitions and information concerning full and part time study. Note: Only programs registered as full time are eligible for TAP. Programs are subject to audit by the NYS Office of the State Comptroller and the Higher Education Services Corporation (HESC) for financial aid compliance purposes.

<sup>2</sup> If a major portion of the program (50% or more) can be completed through study delivered by distance education then the program must be registered in the distance education format. Hybrid or blended courses do not count toward the 50%.

## Attestation and Assurances

On behalf of the institution, I hereby attest to the following:

That all educational activities offered as part of this proposed curriculum are aligned with the institutions' goals and objectives and meet all statutory and regulatory requirements, including but not limited to Parts 50, 52, 53 and 54 of the Rules of the Board of Regents and the following specific requirements:

That credit for study in the proposed program will be granted consistent with the requirements in §50.1(o).

That, consistent with §52.1(b)(3), a reviewing system has been devised to estimate the success of students and faculty in achieving the goals and objectives of the program, including the use of data to inform program improvements.<sup>3</sup>

That, consistent with §52.2(a), the institution possesses the financial resources necessary to accomplish its mission and the purposes of each registered program, provides classrooms and other necessary facilities and equipment as described in §52.2(a)(2) and (3), sufficient for the programs dependent on their use, and provides libraries and library resources and maintains collections sufficient to support the institution and each registered curriculum as provided in §52.2(a)(4), including for the program proposed in this application.

That, consistent with 52.2(b), the information provided in this application demonstrates that the institution is in compliance with the requirements of §52.2(b), relating to faculty.

That all curriculum and courses are offered and all credits are awarded, consistent with the requirements of §52.2(c).

That admissions decisions are made consistent with the requirements of §52.2(d)(1) and (2) of the Regulations of the Commissioner of Education.

That, consistent with §52.2(e) of the Regulations of the Commissioner of Education: overall educational policy and its implementation are the responsibility of the institution's faculty and academic officers, that the institution establishes, publishes and enforces explicit policies as required by §52.2(e)(3), that academic policies applicable to each course as required by §52.2(e)(4), including learning objectives and methods of assessing student achievement, are made explicit by the instructor at the beginning of each term; that the institution provides academic advice to students as required by §52.2(e)(5), that the institution maintains and provides student records as required by §52.2(e)(6).

That, consistent with §52.2(f)(2) of the Regulations of the Commissioner of Education, the institution provides adequate academic support services and that all educational activities offered as part of a registered curriculum meet the requirements established by state, the Rules of the Board of Regents and Part 52 of the Commissioner's regulations.

CHIEF ADMINISTRATIVE or ACADEMIC OFFICER/ PROVOST	
Signature	Date
Type or print the name and title of signatory	Phone Number

<sup>3</sup> The Department reserves the right to request this data at any time and to use such data as part of its evaluation of future program registration applications submitted by the institution.

## Program Purpose, Objectives and Targets

<p><b>Program Purpose</b></p> <p><i>Department Expectation: Clearly define a program purpose that is aligned to the degree award and program title.</i></p>				
<p>The goal of the Master of Science in Artificial Intelligence program is to provide students with mastery of artificial intelligence (AI) with theoretical and practical components, through the acquisition of foundational knowledge in AI algorithm development, development of depth of expertise in artificial intelligence through specialized electives in fields involving AI applications and systems; and choices to engage in project development experience and communication through a non-thesis option or to engage in research and thesis writing through a thesis option. The program will prepare students for the demands of future specialized opportunities in artificial intelligence in industry and higher education.</p>				
<p><b>Program Objectives</b></p> <p><i>Department Expectation: Articulate between 1 and 3 program-level (curriculum-level) objectives that are clearly defined and directly aligned with the program purpose and proposed degree award.</i></p>				
1. Equip students with strong foundation of AI knowledge through courses in algorithms, artificial intelligence, machine learning, and deep learning.				
2. Empower students with depth of knowledge for success in specialization directions fields involving AI applications and systems by taking specialized elective courses.				
3. Provide students with comprehensive self-driven solving of large problems in AI applications, either through project development in the non-thesis option or through research in the thesis option, with emphasis on oral and written communication.				
<p><b>Program Targets - Department Expectation:</b> Establish realistic enrollment, retention, graduation, and job placement targets for this program that are connected to the reviewing system by which the success of students and faculty in achieving such goals and objectives of the program are determined. <i>Note:</i> There are not specific Department defined targets required for the registration of curricula. The Department expects institutions to establish targets that reflect the espoused quality of the program, and to periodically and systematically review such targets are they related to program implementation.</p>				
<p><b>Enrollment Projections</b></p> <p><i>The Department assumes that Year 5 enrollment projections will be full-capacity relative to existing and new resources planned. Assumptions: Starting at 6 students; 1/2 at incoming have 1-year completion; 1/2 at incoming have 1.5-year completion; growth of 2 students per year.</i></p>				
Year 1	Year 2	Year 3	Year 4	Year 5
6	11	16	21	26
<b>Annual Retention Rate Target (%)</b>		<b>Target graduation rate (%)</b>		<b>Target Job Placement Rate (%)</b>
80%		80%		70%

## Curriculum and Course Information

Please provide the following:

1. The applicable sample student program schedule table:

- Table A: Undergraduate Program Schedule; or
- **Table B: Graduate Program Schedule**

**When completing the program schedule table please refer to the requirements in §52.2(c) of the Regulations of the Commissioner concerning completion of Associate, Baccalaureate and Master’s degree programs.**

2. Please list the course titles for all new courses included as part of the proposed program, and, either attach the course syllabi or, if such syllabi are not yet available, provide course descriptions and objectives in the chart below.

New Course Titles	Indicate that course syllabi are attached or, provide course descriptions and objectives (if course syllabi are not available)
CS 615 (AI Projects I)	This course is the first in a two-course sequence on project development as part of the non-thesis option for the Master of Science in Artificial Intelligence, that culminates in a two-semester project for an AI application. During AI Projects I, students will propose a problem to be solved for an AI application relevant to their field of interest, perform background research, provide a proposal document discussing their approach to solving the problem, and present a talk on their findings and their proposed approach.
CS 616 (AI Projects II)	This course is the second in a two-course sequence on project development as part of the non-thesis option for the Master of Science in Artificial Intelligence, that culminates in a two-semester project for an AI application. During AI Projects II, students will work on providing an end-to-end implementation for the problem proposed during CS 613; will write a comprehensive report on their implementation, detailing challenges encountered, approaches to address challenges, and potential for future work; and will present a talk on their implementation.
CS 635 (AI Thesis)	Each student does independent, original work on a project under the guidance and supervision of an instructor. A grade on all of the credits for this work presented in satisfaction of the requirements for a degree is given when those requirements are completed.
CS 709 (Seminar in Artificial Intelligence I)	Students will present a talk on a paper related to their thesis research in AI.
CS 710 (Seminar in Artificial Intelligence II)	Students will present a talk on a paper related to their thesis research in AI.
CS 574 (Natural Language Processing)	This course introduces students to the fundamental concepts and ideas in natural language processing (NLP). In this course students will learn how to create systems that are able to understand and produce language for applications ranging from plagiarism detection to information extraction to automated summarization. The course will focus on four key areas: understanding and recognizing words; syntax (i.e. structure of language); semantics (i.e. meaning of language); pragmatics/discourse (i.e. interpretation of language in context). Students will be introduced to document similarity techniques using frequency and sequence based techniques; n-gram models; parts of speech tagging; named entity recognition; word sense disambiguation; machine translation; use of deep learning in NLP. Students will work with large scale datasets spanning from open source repositories to news articles. As part of the course students will read the latest literature in NLP and provide oral and written summaries. <b>Note:</b> This course is currently offered at an upper graduate (i.e., 600) level as CS 668. We intend to make it available at a lower graduate level as CS 574 for wider accessibility. This will involve filing CS 668 as a new course.

**Table B: Graduate Program Schedule (1 year plan for non-thesis option)**

- Indicate academic calendar type:  Semester  Quarter  Trimester  Other (describe):
- Label each term in sequence, consistent with the institution's academic calendar (e.g., Fall 1, Spring 1, Fall 2)
- Use the table to show how a typical student may progress through the program; copy/expand the table as needed.

Term: Fall 1				Term: Spring 1			
Course Number & Title	Credits	New	Prerequisite(s)	Course Number & Title	Credits	New	Prerequisite(s)
CS 547 – Computer Algorithms	3	No	Undergraduate course in Data Structures and Algorithms (CS 344 at Clarkson), undergraduate course in Discrete Mathematics (MA 211 at Clarkson)	CS 551 – Artificial Intelligence	3	No	Undergraduate course in Data Structures and Algorithms (CS 344 at Clarkson)
CS 549 – Computational Learning	3	No	Undergraduate course in Automata Theory and Formal Languages (CS 345 at Clarkson) Co-requisites: CS 547	CS 572 – Image Understanding (Specialized Elective II)	3	No	Second-level undergraduate course in programming (CS 142 / EE 262 at Clarkson), undergraduate course that covers matrix multiplication (MA 232 / MA 239 / MA 339 at Clarkson)
CS 573 – Computer Vision (Specialized Elective I)	3	No	Undergraduate course in Data Structures and Algorithms (CS 344 at Clarkson), undergraduate course in Linear Algebra (MA 339 at Clarkson)	CS 559 – Human Computer Interaction (Specialized Elective III)	3	No	Second-level undergraduate course in programming (CS 142 / EE 262 at Clarkson), undergraduate course that covers matrix multiplication (MA 232 / MA 239 / MA 339 at Clarkson)
CS 570 – Deep Learning	3	No	Second-level undergraduate course in programming (CS 142 / EE 262 at Clarkson), undergraduate course in Linear Algebra (MA 339 at Clarkson)	CS 552 – Computer Graphics (Specialized Elective IV)	3	No	Second-level undergraduate course in programming (CS 142 / EE 262 at Clarkson), undergraduate course that covers matrix multiplication (MA 232 / MA 239 / MA 339 at Clarkson)
CS 615 – AI Projects I	3	Yes		CS 616 – AI Projects II	3	Yes	
Term credit total:	15			Term credit total:	15		
<b>Program Totals:</b>	<b>Credits: 30</b>	Identify any comprehensive, culminating element(s) (e.g., thesis or examination), including course number if applicable: <i>A project report culminating from the 2-semester project done through the CS 615 / CS 616 sequence, with presentation</i>					
<b>New</b> = indicate if new course <b>Prerequisite(s)</b> = list prerequisite(s) for the noted course							



**Table B: Graduate Program Schedule (1.5 year plan for non-thesis option)**

- Indicate academic calendar type:  Semester  Quarter  Trimester  Other (describe):
- Label each term in sequence, consistent with the institution's academic calendar (e.g., Fall 1, Spring 1, Fall 2)
- Use the table to show how a typical student may progress through the program; copy/expand the table as needed.

Term: Fall 1				Term: Spring 1			
Course Number & Title	Credits	New	Prerequisite(s)	Course Number & Title	Credits	New	Prerequisite(s)
CS 547 – Computer Algorithms	3	No	Undergraduate course in Data Structures and Algorithms (CS 344 at Clarkson), undergraduate course in Discrete Mathematics (MA 211 at Clarkson)	CS 551 – Artificial Intelligence	3	No	Undergraduate course in Data Structures and Algorithms (CS 344 at Clarkson)
CS 549 – Computational Learning	3	No	Undergraduate course in Automata Theory and Formal Languages (CS 345 at Clarkson) Co-requisites: CS 547	CS 559 – Human Computer Interaction (Specialized Elective II)	3	No	Undergraduate course(s) in Object-oriented Programming and Graphical User Interface Design (CS 242 or EE 408 at Clarkson)
CS 550 – Software Design & Development (Specialized Elective I)	3	No	Undergraduate course(s) in Object-oriented Programming and Graphical User Interface Design (CS 242 at Clarkson), undergraduate course in Data Structures and Algorithms (CS 344 at Clarkson)	CS 572 – Image Understanding (Specialized Elective III)	3	No	Second-level undergraduate course in programming (CS 142 / EE 262 at Clarkson), undergraduate course that covers matrix multiplication (MA 232 / MA 239 / MA 339 at Clarkson)
CS 570 – Deep Learning	3	No	Second-level undergraduate course in programming (CS 142 / EE 262 at Clarkson), undergraduate course in Linear Algebra (MA 339 at Clarkson)	CS 615 – AI Projects I	3	No	
Term credit total:	12			Term credit total:	12		
Term: Fall 2				Term: N/A			
Course Number & Title	Credits	New	Prerequisite(s)	Course Number & Title	Credits	New	Prerequisite(s)
CS 573 – Computer Vision (Specialized Elective IV)	3	No	Undergraduate course in Data Structures and Algorithms (CS 344 at Clarkson), undergraduate course in Linear Algebra (MA 339 at Clarkson)				
CS 616 – AI Projects II	3	No					
Term credit total:	6			Term credit total:			
<b>Program Totals:</b>		<b>Credits: 30</b>	Identify any comprehensive, culminating element(s) (e.g., thesis or examination), including course number if applicable: <i>A project report culminating from the 2-semester project done through the CS 615 / CS 616 sequence, with presentation</i>				
<b>New</b> = indicate if new course		<b>Prerequisite(s)</b> = list prerequisite(s) for the noted course					

**Table B: Graduate Program Schedule (1.5 year plan for thesis option)**

- Indicate academic calendar type:  Semester  Quarter  Trimester  Other (describe):
- Label each term in sequence, consistent with the institution's academic calendar (e.g., Fall 1, Spring 1, Fall 2)
- Use the table to show how a typical student may progress through the program; copy/expand the table as needed.

Term: Fall 1				Term: Spring 1			
Course Number & Title	Credits	New	Prerequisite(s)	Course Number & Title	Credits	New	Prerequisite(s)
CS 547 – Computer Algorithms	3	No	Undergraduate course in Data Structures and Algorithms (CS 344 at Clarkson), undergraduate course in Discrete Mathematics (MA 211 at Clarkson)	CS 551 – Artificial Intelligence	3	No	Undergraduate course in Data Structures and Algorithms (CS 344 at Clarkson)
CS 549 – Computational Learning	3	No	Undergraduate course in Automata Theory and Formal Languages (CS 345 at Clarkson) Co-requisites: CS 547	CS 572 – Image Understanding (Specialized Elective III)	3	No	Second-level undergraduate course in programming (CS 142 / EE 262 at Clarkson), undergraduate course that covers matrix multiplication (MA 232 / MA 239 / MA 339 at Clarkson)
CS 573 – Computer Vision (Specialized Elective IV)	3	No	Undergraduate course in Data Structures and Algorithms (CS 344 at Clarkson), undergraduate course in Linear Algebra (MA 339 at Clarkson)	CS 635 – AI Thesis	3	No	
CS 709 – Seminar in Artificial Intelligence I	1	No		CS 710 – Seminar in Artificial Intelligence II	1	No	
Term credit total:	10			Term credit total:	10		
Term: Fall 2				Term: N/A			
Course Number & Title	Credits	New	Prerequisite(s)	Course Number & Title	Credits	New	Prerequisite(s)
CS 570 – Deep Learning	3	No					
CS 635 – AI Thesis	7	No					
Term credit total:	10			Term credit total:			
<b>Program Totals:</b>				Identify any comprehensive, culminating element(s) (e.g., thesis or examination), including course number if applicable: <i>A thesis document and defense culminating from research done as part of the thesis credits.</i>			
		<b>Credits: 30</b>					
<b>New</b> = indicate if new course				<b>Prerequisite(s)</b> = list prerequisite(s) for the noted course			

## Faculty Information

Existing Core Faculty				
<i>Department Expectations: Identify the specific faculty members that will be responsible for setting the curricular objectives, teaching program courses, advising students, and determining the means by which program and course objectives are measured. <b>Identify the program director.</b> Core faculty members must meet minimum academic qualifications as identified in Part 52.2(b) of regulation, and be of sufficient depth and breadth to provide leadership, direction, and discharge other responsibilities critical to the start-up of the program.</i>				
<i><b>Note:</b> Faculty curricula vitae or resumes should not be attached to this application and should only be provided if specifically requested by the Department.</i>				
Faculty Member Name, Title, and Rank (in ascending order of last name)	Courses to be taught	Full-time or Part-time; if Full-time identify % of time to the program	Highest Earned Degree, Discipline, IHE	Additional qualifications which demonstrate professional competence relative to the specific program.
Sean Banerjee, Associate Professor	CS 550: Software Design & Development; CS 559: Human-Computer Interaction CS 574: Natural Language Processing	Full-time, 20%	PhD	Expertise in machine learning in software engineering, multi-modal sensing, and human-computer interaction
Natasha Banerjee, Associate Professor, <b>Program Director</b>	CS 552: Computer Graphics; CS 561: Mixed Reality; CS 573: Computer Vision CS 615: AI Projects I CS 616: AI Projects II	Full-time, 20%	PhD	Expertise in computer vision, computer graphics, virtual/augmented reality, and machine learning
Soumyabrata Dey, Assistant Professor	CS 570: Deep Learning; CS 572: Image Understanding	Full-time: 20%	PhD	Expertise in computer vision, image processing, and machine learning
Christopher Lynch, Professor, Department Chair	CS 551: Artificial Intelligence	Full-time: 10%	PhD	Expertise in artificial intelligence
Jeanna Matthews, Professor	CS 649: Current Issues in Machine Learning alternated with CS 675: Fairness, Accountability, and Transparency in AI and Automated Systems	Full-time: 10%	PhD	Expertise in fairness, accountability, and transparency in AI and automated systems
Christino Tamon, Professor	CS 547: Computer Algorithms CS 549: Computational Learning	Full-time: 20%	PhD	Expertise in machine learning theory
Chuck Thorpe, Professor	CS 565: Mobile Robotics and Human-Robot Interaction	Full-time: 10%	PhD	Expertise in robotics

**Faculty to be Hired: Not Applicable**

*Department Expectations: Identify the specific job title, courses to be taught, and qualifications for each position and the specific timeline by which the faculty member(s) will be hired. The job descriptions and minimum qualifications of faculty to be hired meet the meet minimum academic qualifications as identified in Part 52.2(b) of Commissioner's regulation. The date provided by which faculty to be hired will be in place must be clear and directly connected to when they are needed to discharge their responsibilities during program implementation. The Department reserves the right to request more information concerning recruitment and hiring of faculty if it is needed to make a determination concerning compliance with program registration standards.*

Position Title, and Rank	Highest Earned Degree, Discipline, and additional qualifications	Courses to be taught	Date by which they will begin job duties

# CS615: AI Projects I

Fall 2021, 3 credits

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## Instructor

Dr. Natasha Banerjee: Has a background in computer vision and machine learning, also serves as the Chair of the Graduate Committee in Computer Science. Will be the liaison to field project ideas from the CS department and the Clarkson community.

## Course Description

This course is the first in a two-course sequence on project development as part of the non-thesis option for the Master of Science in Artificial Intelligence, that culminates in a two-semester project for an artificial intelligence application. During AI Projects I, students will propose a problem to be solved for an artificial intelligence application relevant to their field of interest, perform background research, provide a proposal document discussing their approach to solving the problem, and present a talk on their findings and their proposed approach.

## Course Objectives:

- To ideate new problems involving project development in artificial intelligence (AI)
- To build motivation for the problem through perusal of background literature

## Delivery Method (on campus, online, synchronous, asynchronous, etc.)

On campus  
Online  
Synchronous/Asynchronous

## Prerequisites

None

## Instructional Materials

### Textbook(s)

None

### Other Reading Materials

None

## Technology

### Minimum Technology Skills

- Use a learning management system
- Use e-mail with attachments
- Create and submit files in commonly used word processing formats

- Be familiar with programming languages, IDEs, and tools for AI software development

## Course Outcomes (CO)

CO1: Students will propose a problem to be solved for an artificial intelligence application relevant to students' field of interest

CO2: Students will perform background investigation of related work

CO3: Students will write a proposal document that summarizes problem motivation, related work, proposed project, and project plan with task breakdown, milestones, expected outcomes, and tentative schedule.

CO4: Students will present a talk on their findings and proposed project plan.

## Grading

### Grade Ranges

#### Graduate Letter Grades

Course Average	Grade	Quality Points
97+	A+	4.0
93-96	A	4.0
90-92	A-	3.667
87-89	B+	3.334
84-86	B	3.0
80-83	B-	2.667
76-79	C+	2.334
70-75	C	2.0
<70	F	0

### Breakdown

Activity	Percent of Final Grade
Second week one-pager describing proposed work	10%
Mid-semester report describing progress on background investigation	25%
Proposal document summarizing project plan	35%
Talk presenting findings and project plan	30%
<b>Total</b>	<b>100%</b>

## Course Policies

### **Etiquette Expectations & Learner Interaction**

Educational institutions promote the advance of knowledge through positive and constructive debate--both inside and outside the classroom. Please visit and follow: [Netiquette and Electronic Learner Interaction Guidelines](#).

## Institutional Policies

### **Institutional Policies & Regulations**

#### **Academic Integrity**

Students are expected to abide by the standards of academic honesty as described in the [Clarkson Regulations](#). The work or words of others must be properly cited. Please refer to Clarkson Library's [Guide to Plagiarism](#) and [Citing Sources](#).

#### **Students with Disabilities Policy**

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For more information or other appropriate campus referrals, contact:

Director of Accommodative Services  
Clarkson University  
PO Box 5645  
Potsdam, NY 13699-5635  
Phone: 315-268-7643  
Fax: 315-268-2400  
Email: [oas@clarkson.edu](mailto:oas@clarkson.edu)  
[Office of AccessABILITY Services Website](#)

# CS616: AI Projects II

*Spring 2022, 3 credits*

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## Instructor

Dr. Natasha Banerjee: Has a background in computer vision and machine learning, also serve as the Chair of the Graduate Committee in Computer Science. Will be the liaison to field project ideas from the CS department and the Clarkson community.

## Course Description

This course is the second in a two-course sequence on project development as part of the non-thesis option for the Master of Science in Artificial Intelligence, that culminates in a two-semester project for an artificial intelligence application. During AI Projects II, students will work on providing an end-to-end implementation for the problem proposed during CS 615; will write a comprehensive report on their implementation, detailing challenges encountered, approaches to address challenges, and potential for future work; and will present a talk on their implementation.

## Course Objectives:

- To perform comprehensive project development for end-to-end problem solving in artificial intelligence (AI)
- To effectively communicate approach and end results through written and oral forms

## Delivery Method (on campus, online, synchronous, asynchronous, etc.)

On campus  
Online  
Synchronous/Asynchronous

## Prerequisites

None

## Instructional Materials

### Textbook(s)

None

### Other Reading Materials

None



## Technology

### Minimum Technology Skills

- Use a learning management system
- Use e-mail with attachments
- Create and submit files in commonly used word processing formats
- Be familiar with programming languages, IDEs, and tools for AI software development

## Course Outcomes (CO)

CO1: Students will work on providing end-to-end implementation for problem proposed during CS 615 by using programming languages, IDEs, and software development tools appropriate to their chosen project.

CO3: Students will write a comprehensive report on their implementation detailing challenges encountered, approaches to address challenges, and potential for future work.

CO4: Students will present a talk on their implementation and scope for future work stemming from their project.

## Grading

### Grade Ranges

#### Graduate Letter Grades

Course Average	Grade	Quality Points
97+	A+	4.0
93-96	A	4.0
90-92	A-	3.667
87-89	B+	3.334
84-86	B	3.0
80-83	B-	2.667
76-79	C+	2.334
70-75	C	2.0
<70	F	0

### Breakdown

Activity	Percent of Final Grade
Weekly one-page reports discussing incremental progress	10%
Mid-semester report describing progress so far	25%
Final project report	35%

Talk	30%
<b>Total</b>	<b>100%</b>

## Course Policies

### **Etiquette Expectations & Learner Interaction**

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## Institutional Policies

### **Institutional Policies & Regulations**

#### **Academic Integrity**

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#### **Students with Disabilities Policy**

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Clarkson University  
PO Box 5645  
Potsdam, NY 13699-5635  
Phone: 315-268-7643  
Fax: 315-268-2400  
Email: [oas@clarkson.edu](mailto:oas@clarkson.edu)  
[Office of AccessABILITY Services Website](#)

# CS635: AI Thesis

Fall 2021, 3 credits

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## Instructor

Dr. Natasha Banerjee: Has a background in computer vision and machine learning, also serves as the Chair of the Graduate Committee in Computer Science. Will be the liaison to field project ideas from the CS department and the Clarkson community.

## Course Description

Students will use this course number to acquire thesis credits as part of their completion requirements, while they continue to make progress on their thesis research in the thesis-based MS in AI.

## Course Objectives:

- To perform research in solving a novel problem in AI-driven robotics and computer vision

### Delivery Method (on campus, online, synchronous, asynchronous, etc.)

On campus  
Online  
Synchronous/Asynchronous

### Prerequisites

None

## Instructional Materials

### Textbook(s)

None

### Other Reading Materials

None

## Technology

### Minimum Technology Skills

- Use a learning management system
- Use e-mail with attachments
- Create and submit files in commonly used word processing formats
- Be familiar with programming languages, IDEs, and tools for AI software development

## Course Outcomes (CO)

CO1: Students will collaborate with their research advisor to solve a novel problem in AI-driven robotics

and computer vision.

CO2: Students will present a research proposal document if taking this course during their penultimate semester, or defend a thesis if taking this course during their ultimate semester.

## Grading

Grading is based on a pass/fail criterion. To pass, students demonstrate that they making satisfactory progress on performing AI research through deliberation with their research advisor.

During their penultimate semester, grading will be based on satisfactory completion of the research proposal document with chapters on problem motivation, background research, current work to date, and proposed work for the thesis.

During their penultimate semester, grading will be based on satisfactory completion of a thesis document with chapters on problem motivation, background research, and novel work performed by the student, together with successful defense of the thesis.

## Course Policies

### **Etiquette Expectations & Learner Interaction**

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## Institutional Policies

### **Institutional Policies & Regulations**

#### **Academic Integrity**

Students are expected to abide by the standards of academic honesty as described in the [Clarkson Regulations](#). The work or words of others must be properly cited. Please refer to Clarkson Library's [Guide to Plagiarism](#) and [Citing Sources](#).

#### **Students with Disabilities Policy**

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For more information or other appropriate campus referrals, contact:

Director of Accommodative Services

Clarkson University

PO Box 5645

Potsdam, NY 13699-5635

Phone: 315-268-7643

**Fax:** 315-268-2400

**Email:** [oas@clarkson.edu](mailto:oas@clarkson.edu)

[Office of AccessABILITY Services Website](#)

# CS709: Seminar in Artificial Intelligence I

Fall 2021, 3 credits

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## Instructor

Dr. Natasha Banerjee: Has a background in computer vision and machine learning, also serves as the Chair of the Graduate Committee in Computer Science. Will be the liaison to field project ideas from the CS department and the Clarkson community.

## Course Description

This course is one of two courses that enables students performing a thesis as part of the Master of Science in Artificial Intelligence, to complete a seminar requirement. Students will perform background research of work in artificial intelligence, present their findings via a talk, and discuss how they plan to draw inspiration from the work for their research.

## Course Objectives:

- To perform background research on work in artificial intelligence
- To demonstrate mastery in presenting prior work and connecting it to ongoing research

## Delivery Method (on campus, online, synchronous, asynchronous, etc.)

On campus  
Online  
Synchronous/Asynchronous

## Prerequisites

None

## Instructional Materials

### Textbook(s)

None

### Other Reading Materials

None

## Technology

### Minimum Technology Skills

- Use a learning management system
- Use e-mail with attachments
- Create and submit files in commonly used word processing formats
- Be familiar with programming languages, IDEs, and tools for AI software development

## Course Outcomes (CO)

CO1: Students will perform comprehensive background literature review in their area of research.

CO2: Students will present a talk on their findings that demonstrates mastery of understanding of prior work and ability to connect to ongoing research.

CO3: Students will demonstrate ability to intelligently deliberate over questions and engage in discussions during their presentation.

## Grading

Grading is based on a pass/fail criterion. To pass, students must get more than 70%.

Activity	Percent of Final Grade
Presentation content	25%
Presentation style	25%
Delivery	25%
Question answering and discussion engagement	25%
<b>Total</b>	<b>100%</b>

## Course Policies

### Etiquette Expectations & Learner Interaction

Educational institutions promote the advance of knowledge through positive and constructive debate--both inside and outside the classroom. Please visit and follow: [Netiquette and Electronic Learner Interaction Guidelines](#).

## Institutional Policies

### Institutional Policies & Regulations

#### Academic Integrity

Students are expected to abide by the standards of academic honesty as described in the [Clarkson Regulations](#). The work or words of others must be properly cited. Please refer to Clarkson Library's [Guide to Plagiarism](#) and [Citing Sources](#).

#### Students with Disabilities Policy

**Clarkson University welcomes inquiries and applications** from individuals who have disabilities. Information relating to disabling conditions is not a determining factor in admission decisions. The University strives to make all facilities and programs accessible to students with disabilities by providing appropriate academic adjustments and other appropriate modifications

(accommodations), as necessary. Timely notification of any need for accommodations due to a disability is encouraged so that the Office of Accommodative Services (OAS) may provide for students in an efficient manner.

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Director of Accommodative Services

Clarkson University

PO Box 5645

Potsdam, NY 13699-5635

Phone: 315-268-7643

**Fax:** 315-268-2400

**Email:** [oas@clarkson.edu](mailto:oas@clarkson.edu)

[Office of AccessABILITY Services Website](#)



# CS710: Seminar in Artificial Intelligence II

Fall 2021, 3 credits

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## Instructor

Dr. Natasha Banerjee: Has a background in computer vision and machine learning, also serves as the Chair of the Graduate Committee in Computer Science. Will be the liaison to field project ideas from the CS department and the Clarkson community.

## Course Description

This course is the second of two courses that enables students performing a thesis as part of the Master of Science in Artificial Intelligence, to complete a seminar requirement. Students will perform background research of work in artificial intelligence, present their findings via a talk, and discuss how they plan to draw inspiration from the work for their research.

## Course Objectives:

- To perform background research on work in artificial intelligence
- To demonstrate mastery in presenting prior work and connecting it to ongoing research

## Delivery Method (on campus, online, synchronous, asynchronous, etc.)

On campus  
Online  
Synchronous/Asynchronous

## Prerequisites

None

## Instructional Materials

### Textbook(s)

None

### Other Reading Materials

None

## Technology

### Minimum Technology Skills

- Use a learning management system
- Use e-mail with attachments
- Create and submit files in commonly used word processing formats
- Be familiar with programming languages, IDEs, and tools for AI software development

## Course Outcomes (CO)

CO1: Students will perform comprehensive background literature review in their area of research.

CO2: Students will present a talk on their findings that demonstrates mastery of understanding of prior work and ability to connect to ongoing research.

CO3: Students will demonstrate ability to intelligently deliberate over questions and engage in discussions during their presentation.

## Grading

Grading is based on a pass/fail criterion. To pass, students must get more than 70%.

Activity	Percent of Final Grade
Presentation content	25%
Presentation style	25%
Delivery	25%
Question answering and discussion engagement	25%
<b>Total</b>	<b>100%</b>

## Course Policies

### Etiquette Expectations & Learner Interaction

Educational institutions promote the advance of knowledge through positive and constructive debate--both inside and outside the classroom. Please visit and follow: [Netiquette and Electronic Learner Interaction Guidelines](#).

## Institutional Policies

### Institutional Policies & Regulations

#### Academic Integrity

Students are expected to abide by the standards of academic honesty as described in the [Clarkson Regulations](#). The work or words of others must be properly cited. Please refer to Clarkson Library's [Guide to Plagiarism](#) and [Citing Sources](#).

#### Students with Disabilities Policy

**Clarkson University welcomes inquiries and applications** from individuals who have disabilities. Information relating to disabling conditions is not a determining factor in admission decisions. The University strives to make all facilities and programs accessible to students with disabilities by providing appropriate academic adjustments and other appropriate modifications

(accommodations), as necessary. Timely notification of any need for accommodations due to a disability is encouraged so that the Office of Accommodative Services (OAS) may provide for students in an efficient manner.

For more information or other appropriate campus referrals, contact:

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**Fax:** 315-268-2400  
**Email:** [oas@clarkson.edu](mailto:oas@clarkson.edu)  
[Office of AccessABILITY Services Website](#)

# CS574: Natural Language Processing

Spring 2022, 3 credits

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## Instructor

Dr. Sean Banerjee: Has a background in machine learning and statistical methods in analysis of large-scale open source repositories of text-based content such as problem reports.

## Course Description

This course introduces students to the fundamental concepts and ideas in natural language processing (NLP). In this course students will learn how to create systems that are able to understand and produce language for applications ranging from plagiarism detection to information extraction to automated summarization. The course will focus on four key areas: understanding and recognizing words; syntax (i.e. structure of language); semantics (i.e. meaning of language); pragmatics/discourse (i.e. interpretation of language in context). Students will be introduced to document similarity techniques using frequency and sequence based techniques; n-gram models; parts of speech tagging; named entity recognition; word sense disambiguation; machine translation; use of deep learning in NLP. Students will work with large scale datasets spanning from open source repositories to news articles. As part of the course students will read the latest literature in NLP and provide oral and written summaries.

## Course Objectives:

- To learn the theory underlying NLP including understanding of words, language structure, semantics, and interpretation in context
- To solve practical problems in NLP using computational approaches for document similarity analysis on large-scale textual datasets

## Delivery Method (on campus, online, synchronous, asynchronous, etc.)

On campus  
Online  
Synchronous/Asynchronous

## Prerequisites

Course in data structures and algorithms (CS 344 at Clarkson or equivalent)  
Course in probability and statistics (STAT 383 at Clarkson or equivalent)

## Instructional Materials

### Textbook(s)

None

### Other Reading Materials

None

## Technology

### Minimum Technology Skills

- Use a learning management system
- Use e-mail with attachments
- Create and submit files in commonly used word processing formats
- Be familiar with Python and Perl

## Course Outcomes (CO)

CO1: Students will learn about key concepts in NLP, particularly word understanding, syntax, semantics, and pragmatics/discourse.

CO2: Students will learn to work with document similarity techniques using a variety of approaches.

CO3: Students will learn to perform language understanding from large-scale text datasets.

CO2: Students will learn to evaluate recent literature in NLP.

## Grading

### Grade Ranges

#### Graduate Letter Grades

Course Average	Grade	Quality Points
97+	A+	4.0
93-96	A	4.0
90-92	A-	3.667
87-89	B+	3.334
84-86	B	3.0
80-83	B-	2.667
76-79	C+	2.334
70-75	C	2.0
<70	F	0

### Breakdown

Activity	Percent of Final Grade
Four assignments on Python/Perl-based implementations of theoretical knowledge gained in natural language processing	60% (each assignment will be worth 15% of the final grade)
Half-semester-long project on self-proposed task in NLP. Breakdown:	40% Breakdown:

<ul style="list-style-type: none"> <li>• Project proposal</li> <li>• Project implementation</li> <li>• Project report</li> <li>• Project presentation</li> </ul>	<ul style="list-style-type: none"> <li>• 5%</li> <li>• 15%</li> <li>• 10%</li> <li>• 10%</li> </ul>
<b>Total</b>	100%

## Course Policies

### Etiquette Expectations & Learner Interaction

Educational institutions promote the advance of knowledge through positive and constructive debate--both inside and outside the classroom. Please visit and follow: [Netiquette and Electronic Learner Interaction Guidelines](#).

## Institutional Policies

### Institutional Policies & Regulations

#### Academic Integrity

Students are expected to abide by the standards of academic honesty as described in the [Clarkson Regulations](#). The work or words of others must be properly cited. Please refer to Clarkson Library's [Guide to Plagiarism](#) and [Citing Sources](#).

#### Students with Disabilities Policy

**Clarkson University welcomes inquiries and applications** from individuals who have disabilities. Information relating to disabling conditions is not a determining factor in admission decisions. The University strives to make all facilities and programs accessible to students with disabilities by providing appropriate academic adjustments and other appropriate modifications (accommodations), as necessary. Timely notification of any need for accommodations due to a disability is encouraged so that the Office of Accommodative Services (OAS) may provide for students in an efficient manner.

For more information or other appropriate campus referrals, contact:

Director of Accommodative Services  
Clarkson University  
PO Box 5645  
Potsdam, NY 13699-5635  
Phone: 315-268-7643  
Fax: 315-268-2400

**Email:** [oas@clarkson.edu](mailto:oas@clarkson.edu)

[Office of AccessABILITY Services Website](#)



THE STATE EDUCATION DEPARTMENT / THE UNIVERSITY OF THE STATE OF NEW YORK / ALBANY,  
NY 12234

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## Application to Add the Distance Education Format To a New or Registered Program<sup>1</sup>



This application should NOT be used to add the Distance Education Format to the following types of programs or proposals:

- Programs Preparing Teachers, Educational Leaders, and Other School Personnel

The application materials for those types of proposals can be found at:

<http://www.highered.nysed.gov/ocue/aipr/register.html>

Doctoral programs: please [contact](#) the Office of College and University Evaluation.

### Directions for submission of application:

1. For an application to add the distance education format to an **existing general academic (non-licensure) program**:

Create a **single** PDF document that includes the following completed forms:

- Application to Add the Distance Education Format
- CEO (or Designee) Approval Form

Attach the PDF document to an e-mail and send to:

[OCURevAdmin@nysed.gov](mailto:OCURevAdmin@nysed.gov)

When submitting to the mailbox, include the following elements in the subject line of the e-mail:

Institution Name, Distance Education Format, Degree Award, and Program Title

E.g., Subject: AAA College, Distance Education Format, Master of Science, English Literature

2. For an application to add the distance education format to a **proposed general academic (non-licensure) program**:

Complete the form and include it in the application PDF document.

3. For proposals to add distance education to a proposed or existing program in a **licensed profession** or a related field, complete this distance education form but submit it to the [Office of the Professions](#).

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<sup>1</sup> CUNY and SUNY institutions: contact System Administration for application submission process.



**Task 1 Institution and Program Information: Complete this task for applications to add the distance education format to an existing program.**

<b>Institution Information</b>	
<b>Institution Name:</b>  Institution Code (6 digits):  <i><b>The name and code of the institution should reflect the information found on the <a href="#">Inventory of Registered Programs</a></b></i>	Clarkson University  412500
Institution Address:	8 Clarkson Ave
City:	Potsdam
State/Country:	NY
Zip:	13699
<a href="#">Regents Regions:</a>	North Country Region
Specify campus(s) of the institution where program is offered, if other than the main campus:  <i><b>The name and code of the location(s) should reflect the information found on the <a href="#">Inventory of Registered Programs</a></b></i>	
Specify any other additional campus(s) where the program is offered besides the ones selected above:	
If any courses will be offered off campus, indicate the location and number of courses and credits:	
If the program will be registered jointly with another institution, please	

provide the partner institution's name:	
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**Program Information for Existing Programs: *Program information should reflect the information found on the [Inventory of Registered Programs](#)***

Program Code: (for <a href="#">registered programs</a> only)	
Program Title:	Master of Science in Artificial Intelligence
<a href="#">Degree Award</a> :	Master of Science
<a href="#">HEGIS code</a> :	0701.00

<b>Contact Information</b>	
Name of contact person	Natasha Kholgade Banerjee
Title of contact person:	Associate Professor; Chair, Graduate Committee of the Department of Computer Science
Telephone	<b>(315) 268-3831</b>
Fax:	
Email:	nbanerje@clarkson.edu

Instructions	
Guidance for this task can be found by clicking here: <a href="#">Review Process for Approval of Programs in the Distance Education Format</a>	
1. Anticipated enrollment in distance program	
Initial Enrollment: 3	Maximum by year 3: 6
2. Program Information	
a). <b>Term length</b> (in weeks) for the distance program: 15	
b). <b>Is this the same as term length for the classroom program?</b> <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
c). <b>How much “instructional time” is required per week per credit for a distance course in this program</b> (do not include time spent on activities that would be done outside “class time”, such as research, writing assignments, or chat rooms) Answer: 1 hour	
d). <b>What proportion of the program will be offered in Distance Education format?</b> Answer: 100% (30 credits)	
e). <b>What is the maximum number of students who will be enrolled in an online course section?</b> Answer: 20	

Part A: Institution-wide Issues: Submit this part for the <b>first</b> Distance Education program proposed by your institution. This will be kept in a master file, and will not need to be resubmitted for each new proposed online program, unless there are changes.
I. Organizational Commitment
1. Describe your institution’s planning process for Distance Education, including how the need for distance access was identified, the nature and size of the intended audiences, and the provisions for serving those audiences.  Answer: N/A (this is not the first Distance Education program for Clarkson University)
2. Describe your institution’s resources for distance learning programs and its support services to ensure their effectiveness. What course management system does your institution use?  Answer: N/A (this is not the first Distance Education program for Clarkson University)
3. Describe how faculty are trained and supported in developing and teaching online courses, including the pedagogical and communication strategies to function effectively. Describe the qualifications of those who train faculty, or are otherwise in charge of online education.  Answer: N/A (this is not the first Distance Education program for Clarkson University)

4. If your institution uses courses or academic support services from **another provider**, describe the process used (with faculty participation) to evaluate their quality, academic rigor, and suitability for the award of college credit and a degree or certificate.

Answer: N/A (this is not the first Distance Education program for Clarkson University)

5. Does your institution have a clear **policy on ownership of course materials** developed for its distance education courses? How is this policy shared with faculty and staff?

Answer: N/A (this is not the first Distance Education program for Clarkson University)

## II. Learner Support

1. Describe how your institution provides distance students with **clear information** on:

- Program completion requirements, including which courses, if any, **must** be taken in an on-ground, face-to-face format
- The nature of the learning experience
- Any specific student background, knowledge, or technical skills needed
- Expectations of student participation and learning
- The nature of interaction in the courses.
- Any technical equipment or software required or recommended
- Scheduling of online and on-ground sections of the same course

Answer: N/A (this is not the first Distance Education program for Clarkson University)

2. Describe how your institution provides distance learners with adequate **academic and administrative support**, including academic advisement, technical support, library and information services, and other student support services normally available on campus. Do program materials clearly define how students can access these support services?

Answer: N/A (this is not the first Distance Education program for Clarkson University)

3. Describe how **administrative processes** such as admissions and registration are made available to distance students, and how program materials inform students how to access these services.

Answer: N/A (this is not the first Distance Education program for Clarkson University)

4. What **orientation** opportunities and resources are available for students of distance learning?

Answer: N/A (this is not the first Distance Education program for Clarkson University)

**Part B: Program-Specific Issues:** Submit this part for **each new request** to add Distance Education Format to a registered program.

## III. Learning Design

1. How does your institution ensure that the **same academic standards and requirements** are applied to the program on campus and through distance learning? If the curriculum in the Distance Education program differs from that of the on-ground program, please identify the differences.

Answer: The administrator for a program ensures equitable dissemination of information regarding program requirements and updates through email communication with all on-campus and distance

students. The program administrator maintains and updates the email list regularly at the start of each semester. At the start of each semester, the administrator runs an orientation session that is broadcast to all new on-campus and distance students. The session is synchronously conducted via the platform Echo as well as recorded for asynchronous access. The session covers program objectives, curriculum, recommended trajectories for specializations in various fields, and contacts and research areas for faculty members involved in the program through teaching and research. The program administrator serves as the de facto advisor for each on-campus and distance student in the program. During the orientation, the program administrator informs students that they should feel free to reach the program administrator via email to discuss completion of requirements, specialization interest and corresponding courses, concerns with courses, choice of research and project work, and contacts with appropriate faculty members. The program administrator also advises students to seek office hour time via Zoom for face-to-face discussion of the aforementioned aspects.

For each course, faculty members are asked to use standard university-supported education and administration platforms Moodle and PeopleSoft to post instructional material and conduct administrative tasks. Prior to the start of the semester, faculty members are requested to post a syllabus to Moodle so that all students, on-campus and distance, have access to an overview of the course content. During instruction, faculty are asked to use technologies that ensure equitable access of instruction to on-campus and distance students. These technologies include the university-supported Echo platform for classroom recording of whiteboard, professor, slides, and tablet content; use of in-class tablets that are recorded via Echo; use of a university-supported pocket-mike linked to Echo to record the instructor communication; and use of dark marker colors when large-scale whiteboard use is required. During synchronous mode capture, the university-supported tool Zoom is used, and faculty members are asked to repeat questions asked by in-class students for the benefit of distance students, to remind distance students to feel free to use the questions tool in Zoom to post their queries, and to review and address questions asked by distance students to the class. Assignments are posted to Moodle using the assignment feature, and faculty members post individual assignment scores to Moodle, and final grades to PeopleSoft to enable online viewing of assessment.

The curriculum in the Distance Education **does not differ** from the on-ground program.

2. Are the courses that make up the distance learning program offered in a sequence or configuration that allows **timely completion of requirements**?

Answer: Yes. All courses that are part of the program, including core courses (Computer Algorithms, Computational Learning, Deep Learning, and Artificial Intelligence), elective courses, project courses, seminar courses, thesis courses are offered once a year, every year, enabling students consistent access to course instruction.

3. How do faculty ensure that **the technological tools** used in the program are appropriate for the content and intended learning outcomes?

Answer: All faculty use PeopleSoft as the standard university-supported administrative tool, and Moodle as the standard university-supported education platform. All faculty also use the university-supported video conferencing platforms Echo and Zoom to deliver synchronous and asynchronous video-based education.

4. How does the program provide for appropriate and flexible interaction between faculty and students, and among students?

Answer: The program administrator introduces the faculty involved and their research areas during the online-accessible and recorded orientation session. The administrator provides their contact information, and each faculty member provides a short description of their research area and the courses that they teach. Faculty use Moodle and email communication by accessing student emails

through PeopleSoft to send announcements to students for their classes. To answer questions regarding course material or to discuss research and project advisement, faculty engage with students via email and via Zoom for face-to-face conversations.

**5. How do faculty teaching online courses verify that students are doing their own work?**

Answer: Faculty use assessments in the form of assignments, projects, and exams that are designed to prevent students from passing off answers from the Internet or from other students as their own. Assignments involve multiple sequential components, where students need to solve mathematical problems and/or write code. Assignments in this program require the use of input data, e.g., images, audio, and text, that must be self-generated, e.g., through a camera, robot, or microphone, where the use of online data or data provided by another person would greatly limit success in completing the assignment. Students are required to provide a description of how they solved the problem, and faculty compare the description to the material provided by the student. Faculty also perform online searches of material such as computer code or descriptions to gauge whether work has been plagiarized from online sources or code repositories such as GitHub. Nearly all courses have one component involving a self-proposed and self-implement project. For this project, students are required to write a proposal discussing what they plan to do, and faculty members verify that submitted projects meet the proposal description. Students are also required to present their project, and write a report about their implementation. Faculty members perform online searches to ensure that student code is self-provided. Exams involve application of concepts learnt in class to solve a practical problem that is created by the instructor and unlikely to be found directly online in the form created by the instructor.

**IV. Outcomes and Assessment**

**1. Distance learning programs are expected to produce the **same learning outcomes** as comparable classroom-based programs. How are these learning outcomes identified -- in terms of knowledge, skills, or credentials -- in course and program materials?**

Answer: The learning outcomes and skills attained for the program are specified in the Graduate Catalog for Clarkson University that is accessible through Clarkson's website. The Catalog is updated yearly in July to ensure that it reflects the most current status of the program objectives. For each course, the corresponding instructor is required to create a syllabus that identify the learning objectives and outcomes for the course at the start of the semester. The syllabus is posted to the instructor's online course folder on Moodle at the start of the semester for universal access.

**2. Describe how the **means chosen for assessing student learning** in this program are appropriate to the content, learning design, technologies, and characteristics of the learners.**

Answer: Student learning in this program is assessed in courses through multiple short programming assignments, problem-solving and conceptual assignments, long programming projects with presentations and reports, and examinations. Student learning is also assessed via presentation of a thesis defense in front of a thesis committee for the thesis version of the course, and presentation of a semester-long capstone project implementation and report in front of the program committee for the non-thesis version of the course. The use of assignments and projects with presentations and reports is appropriate for the target content, technologies, and learners, as the program is designed to equip learners with the skills needed to conduct work in various fields of artificial intelligence, where the skills needed include understanding a problem, recognizing the approach needed to address the problem, writing a computer-code-based implementation, arriving at concrete results, and presenting the results in a manner that can be grasped by target audiences. The use of examinations is apt for the learners, as they aim to ensure that basic concepts fundamental to machine learning, artificial intelligence, and allied fields such as computer vision, robotics, and natural language processing become second nature to the learners, enabling learners to be competitive in the workforce by having the skill to rapidly attack problems through sound background knowledge. Evaluation of thesis defense is appropriate for learners interested in research, both in industry and in higher education. Evaluation of capstone

projects is apt for learners desiring success at pursuing large-project development characteristic of industry settings.

## V. Program Evaluation

1. What process is in place to monitor and **evaluate the effectiveness** of the distance learning program on a regular basis?

Answer: The program administrator will collect student performance data in the form of grades and qualitative evaluation for distance students from faculty members involved in the program through once a semester formative assessments and summative assessments at the time of program requirement completion, to assess how students are faring in classroom, research, and project courses. The program administrator will also administer yearly and exit surveys to distance students broken down to enquire about aptness of course material; and effectiveness of core courses, elective courses, project courses, and thesis work for future career objectives, e.g., acquisition of skillset for current job, promotion, or new job search, or pursuance of higher degrees; desire for new courses and directions for new courses.

2. How will the evaluation results will be used for **continuous program improvement**?

Answer: The program administrator will summarize the data collected from faculty on student performance, and the student interviews to determine whether changes are needed to the core courses and electives, or whether new courses should be added, particularly covering directions not currently covered but deemed valuable by students. Changes to courses such as addition of new material relevant to the course will be communicated to faculty members, and faculty and the program administrator will come up with a plan to accommodate new material in the courses. To assist with use of faculty evaluations by students in program improvement, the program administrator will work closely with the department chair to engage faculty with taking student recommendations into future course adaptation. Requests for new courses will be communicated by the program administrator to the department and university administration. The program administrator in conjunction with the department chair will be engaged in advocacy of continuous program improvement taking student and faculty recommendations into account.

3. How will the evaluation process assure that the **program results in learning outcomes appropriate to the rigor and breadth** of the college degree or certificate awarded?

Answer: The program administrator will summarize student success metrics garnered through formative and summative assessments by faculty reports and student interviews, as well as student research/project work as evaluated by thesis and project committees to assess the attainment of learning outcomes. To ensure that students perform at the level appropriate to the rigor and breadth sought, students will be provided with support mechanisms in the form of office hours with the program administrator (also the de facto advisor) and with the faculty members involved in the program. Students will be recommended to remain in constant communication with administrators and course instructors to track formative progress.

## **Sample Projects that Students Will Perform in the AI Projects Sequence (CS615/CS616)**

1. AI-driven view-independent parking spot detection from outdoor cameras
2. Detection of congestion in general use locations such as dining areas, multi-purpose rooms, and corridors using overhead cameras
3. Face detection and recognition for authorized access to spaces
4. Automated image-based detection of safe practices such as mask wearing and safe distancing
5. Automated recognition of lap completion in track or swimming environments using overhead cameras



Included after this page are letters of approval from the following stakeholders in the program (in the order listed below):

- Faculty with primary appointments in the Department of Computer Science
  - Dr. N. Banerjee
  - Dr. S. Banerjee
  - Dr. S. Dey
  - Dr. C. Lynch
  - Dr. J. Matthews
  - Dr. C. Tamon
  - Dr. C. Thorpe
- Dr. C. Lynch, Chair of the Department of Computer Science
- Dr. T. Langen, Interim Dean of the School of Arts & Sciences
- Approval from the Provost's Council



Clarkson™

DEPARTMENT OF COMPUTER SCIENCE

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the creation of a new Master of Science in Artificial Intelligence program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Serving as administrator of the program and de facto academic advisor for all students,
- 2) Running the newly proposed AI Project Courses, numbered CS 615 and CS 616,
- 3) Advising student theses for the thesis-based option,
- 4) Ensuring continued successful running of thesis and seminar courses through communications with faculty members involved, and
- 5) Serving as instructor for the following courses:
  - a. CS 552 (Computer Graphics) that serves as a specialized elective,
  - b. CS 561 (Mixed Reality) that serves as a specialized elective, and
  - c. CS 573 (Computer Vision, which will be converted from the current course CS 652) that will serve as a specialized elective.

Thank you,

A handwritten signature in black ink, appearing to read "NKBanerjee".

Natasha Kholgade Banerjee, Ph.D.  
Associate Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [nbanerje@clarkson.edu](mailto:nbanerje@clarkson.edu)



Clarkson™

DEPARTMENT OF COMPUTER SCIENCE

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the creation of a new Master of Science in Artificial Intelligence program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following courses:
  - a. CS 550 (Software Design & Development) that serves as a specialized elective,
  - b. CS 559 (Human-Computer Interaction) that serves as a specialized elective, and
  - c. CS 574 (Natural Language Processing, which will be converted from the current course CS 668) that will serve as a specialized elective.

Thank you,

A handwritten signature in black ink, appearing to read "S Banerjee".

Sean Banerjee, Ph.D.

Associate Professor, Department of Computer Science

Clarkson University, Potsdam, NY 13699-5815

Email: [sbanerje@clarkson.edu](mailto:sbanerje@clarkson.edu)



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DEPARTMENT OF COMPUTER SCIENCE

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the creation of a new Master of Science in Artificial Intelligence program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following courses:
  - a. CS 570 (Deep Learning) that serves as a core course, and
  - b. CS 572 (Image Understanding) that serves as a specialized elective.

Thank you,

A handwritten signature in blue ink that reads "Soumyabrata Dey".

Soumyabrata Dey, Ph.D.  
Assistant Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [sdey@clarkson.edu](mailto:sdey@clarkson.edu)



Clarkson™

DEPARTMENT OF COMPUTER SCIENCE

June 9, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the creation of a new Master of Science in Artificial Intelligence program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following courses:
  - a. CS 551 (Artificial Intelligence) that serves as a core course.

Thank you,

A handwritten signature in cursive script that reads "Christopher A. Lynch".

Christopher Lynch  
Chair and Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [clynch@clarkson.edu](mailto:clynch@clarkson.edu)



June 1, 2020

To Whom It May Concern:

I have some concerns about this current proposal for a new Master of Science in Artificial Intelligence program, but am generally supportive of the direction. If this proposal or a modified version is approved, I intend to participate in the program in the following ways:

- 1) Advising student theses for the thesis-based option where there is a match between my current research and the interests of current students.
- 2) Teaching elective courses that may be of interest to students in the program.

I will specifically mention that I have been teaching a course, CS 649 Current Issues in Machine Learning. I have been teaching it with a focus on Fairness, Accountability and Transparency in Machine Learning and Computer-Assisted Decision Making. I believe this course and the coverage of AI Ethics more broadly could be relevant and important contribution to the program.

Thank you,

Jenna Matthews, Ph.D.  
Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [jnm@clarkson.edu](mailto:jnm@clarkson.edu)



Clarkson™

DEPARTMENT OF COMPUTER SCIENCE

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the creation of a new Master of Science in Artificial Intelligence program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following courses:
  - a. CS 547 (Computer Algorithms) that serves as a core course, and
  - b. CS 549 (Computational Learning) that serves as a core course.

Thank you,

A handwritten signature in green ink, appearing to read "Christino Tamon".

Christino Tamon, Ph.D.  
Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [tino@clarkson.edu](mailto:tino@clarkson.edu)



Clarkson™

DEPARTMENT OF COMPUTER SCIENCE

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the creation of a new Master of Science in Artificial Intelligence program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following course or equivalent:
  - a. CS 565 (Mobile Robotics and Human-Machine Interaction) that serves as a specialized elective.

Thank you,

A handwritten signature in black ink that reads "Charles E. Thorpe".

Chuck Thorpe, Ph.D.  
Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [cthorge@clarkson.edu](mailto:cthorge@clarkson.edu)





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DEPARTMENT OF COMPUTER SCIENCE

June 29, 2020

To Whom It May Concern:

This package is to create a non-thesis based MS in Artificial Intelligence. We currently run an MS in Computer Science. The CS department has lots of expertise in the area of Artificial Intelligence. We already teach many courses in that area. In addition, this is a growing area of Computer Science, and I see no signs that it will stop growing. It is a perfect niche for Clarkson to start a degree, and it would make Clarkson a pioneer in this field.

This proposal was put to a vote in the CS department. It received seven votes in favor and one abstention. We have included letters from the CS department members stating their willingness to teach courses in this program. These are courses that we currently teach as electives in our Computer Science program. One faculty member has expressed reservations about the proposed program in their letter. The reservation relates to resources for the program. Since the courses taught are already electives, the only reason we may require new resources is if this program attracts many new students. At that point we would ask the administration for more resources.

This degree is the perfect direction for the university. And this is the perfect time for Clarkson to move in this direction.

Thank you,

A handwritten signature in cursive script that reads "Christopher A. Lynch".

Christopher Lynch  
Chair and Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [clynch@clarkson.edu](mailto:clynch@clarkson.edu)



July 7, 2020

From: **Prof. Tom Langen, School of Arts & Sciences Interim Dean, Clarkson University**  
To: **Academic Leadership Council, Faculty Senate**  
Re: **Computer Science M.S. Degree Programs (Thesis, non-Thesis Tracks) in Artificial Intelligence**

The Clarkson School of Arts & Sciences strongly supports the M.S. Degree Program (thesis and non-thesis) in Artificial Intelligence proposal put forth by the Department of Computer Science. This is a timely and well thought-out proposal that reinforces the strengths of the Department of Computer Science, and adds to Clarkson's reputation as a leader in technical graduate education.

This graduate degree program will address the interest of Clarkson computer science or software engineering alumni, computer science B.S. degree holders more widely, and corporate partners of Clarkson University. The program holds the promise of generating significant revenue, and will add to Clarkson's growing reputation in computer science. This graduate degree program is comprised of new and existing courses taught by current Computer Science faculty members; the department has the capacity to adequately support the program. In the short-term, this degree program merits the commitment of one new TA line. Should it grow as anticipated, a faculty line and more teaching assistants will be required to meet capacity.

Respectfully,

A handwritten signature in black ink that reads "Tom Langen". The signature is written in a cursive, flowing style.

**Tom A. Langen, Ph.D**

*Interim Dean, School of Arts & Sciences  
Professor, Depts. of Biology & Psychology  
Clarkson University*



Clarkson

December 7, 2020

To Members of Faculty Senate:

Please accept this letter as notification, we, the Provost's Council, endorse the following item voted unanimous, to move forward in the internal approvals process:

Academic Program	Date of Vote
New Program Proposal: MS in Artificial Intelligence	12/7/2020

Please advise if there are questions or concerns.

Sincerely,

A handwritten signature in cursive script that reads "Amanda J. Pickering".

Amanda J. Pickering  
Executive Director of Academic Affairs  
Office of the Provost

# EXECUTIVE SUMMARY

## MARKET ANALYSIS OF ARTIFICIAL INTELLIGENCE (AI)

SUMMARY AUTHOR: NATASHA BANERJEE

ANALYSIS PERFORMED BY: MICHAEL WALSH

Summarized is an assessment of the market potential for AI using Burning Glass, with full credit to Michael Walsh, Executive Director of the Engineering Management Program, Clarkson for performing the original analysis. Overall, the outlook is excellent both in the country at large, as well as in the North-East region. Job postings with AI demand are on the rise, with over 100k postings with AI requested as a skillset in the last 12 months, and a steady growth projected over the next decade. Salary prospects are also promising, with average salaries around \$100k, and jobs in software development---many of which request AI skillsets today---starting at \$88k. While, unsurprisingly, the highest job postings are in California, job postings are also high in Texas, New York, and the DC area. To keep up with the demand for AI, degrees conferred by technology institutions in fields such as Computer Science (CS) or Data Science that provide training in AI has gone up by 72% between 2014 to 2018. In the North-East region, the market share appears to be cornered by private institutions, which is a positive sign for Clarkson. It is encouraging to note that the percentage of postings in sectors requiring AI, such as Finance, Manufacturing, Retail, Education, and Health Care, is higher in the 2019-2020 cycle than in prior cycles. This trend is in line with the move toward intelligence permeating consumer fields. The pandemic has revealed our lack of immediate readiness for solving problems in health care, logistics, finance, manufacturing, retail, and education. Given the predictive power of intelligence-based data analysis, it is not surprising that AI is desirable in consumer fields. Given that the pandemic has significantly changed the consumer landscape, with there being a high likelihood of stay-at-home work and personal endeavors driving personalized targeting of consumer products and services, it comes with no surprise that more positions will require candidates to show proficiency in AI-related skills.

While the presence of Syracuse University and University of Rochester in the marketplace may be perceived as a concern, further research reveals that they may play less of a role in directly targeting provision of depth-focused AI training to fulfill job demands in AI. Syracuse University has an MS in CS<sup>1</sup>, where students may obtain expertise in AI by taking AI courses as electives. A general MS in CS such as theirs typically covers breadth in other areas such as programming, systems, and/or CS theory, thereby leaving little space within the program to develop depth of AI expertise. Clarkson's proposed MS in AI targets depth-based AI training by devoting all 30 credits toward building an AI foundation. Syracuse also has an Applied Masters's in Data Science degree<sup>2</sup> through their School of Information Systems, however the focus is more on data analytics rather than AI, with courses on business analytics, data warehousing, and information visualization. The degree lacks courses such as machine learning (ML), deep learning, natural language processing (NLP), vision and/or robotics, that are seen as foundational toward developing expertise in working with AI on the job. Perhaps the Goergen Institute for Data Science at University of Rochester, which offers an MS in Data Science degree<sup>3</sup>, may be perceived to be the bigger competitor.

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<sup>1</sup> <https://onlinegrad.syracuse.edu/engineering/computer-science/>

<sup>2</sup> <https://ischool.syr.edu/academics/applied-data-science-masters-degree/>

<sup>3</sup> <http://www.sas.rochester.edu/dsc/graduate/ms.html>

Through Goergen's Data Science degree, students take core courses in statistical methods and data mining, and concentration courses that could include AI, deep learning, NLP, vision, ML through the Computational Methods concentration track. However, Clarkson's proposed MS in AI offers the following advantages: (1) The core courses in Clarkson's proposed AI program are CS courses. This reflects our endeavor toward a modern CS-based push with a focus on a combination of math, programming, and algorithm analysis, which is the angle that companies are seeking in order to drive intelligent software development. The core courses in the Goergen Data Science program consist of statistics and data mining, demonstrating that their goal is a math/statistics-based push rather than the CS-based push desired by companies seeking AI proficiency. (2) Given the CS focus, most courses in the proposed MS in AI program have a robust coverage of programming-based problem-solving for a variety of disciplines under AI such as ML, NLP, vision, and robotics. (3) Clarkson's proposed program contains robotics as an elective, as the goal is to incorporate interaction with embedded systems and hardware as part of the training. We see training in hardware and software as essential to remain ahead of the AI growth curve. With continued program growth, we plan to add more courses related to robotics and multi-modal system and hardware development. (4) The per-credit hour rates of University of Rochester are higher (1,784 for Arts and Sciences which hosts the MS in Data Science)<sup>4</sup>. Among other universities in the North-East region, RIT has a graduate certificate in AI<sup>5</sup>, but it only has 2 core courses (foundations of intelligent systems, and introduction to ML) and one elective, making it substantially weaker than the proposed program.

The analysis suggests the positive observation that market alignment between AI and career outcomes of postings is high. One concern that may be noted from an overall glance at the assessment is that 91% of the aligned postings, i.e., postings that advertise request for AI skills, advertise a BS degree as required education rather than an MS degree. This may be explained by noting many of the career outcomes mapped to AI, e.g., Computer Systems Engineer and Information Security Engineer, largely do not require an AI background, and typically consider it more of a plus rather than an essential skill, which is why a BS is sufficient for those fields. For job postings that truly do require AI skills, an assessment of BS degrees within and outside the country demonstrates that AI-related courses are largely electives rather than core courses in CS or Computer Engineering BS degrees. Students with a technology BS are not likely to be prepared to enter the job market with comprehensive AI training. Coupled with the rising demand for AI in a variety of sectors as discussed on Page 1 of this summary, we note that the skills growth projection performed by Burning Glass confirms our assertions that demand for AI and associated fields such as ML and robotics will see growth over the next few years, while demand for information technology may be on the decline, suggesting that a shift toward AI training is necessary. If job postings in these sectors advertise for AI skills, companies are likely to expect that candidates be able to pick up skills such as TensorFlow upon entry, validating the need for an MS in AI. If companies do hire candidates with a BS degree and the candidates do not possess an AI background, then companies will seek to partner with an institution providing MS degrees in AI to enable students to acquire the training at an MS level. Given these observations, we are at an opportune moment to corner the market on providing MS degrees in AI.

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<sup>4</sup> <https://www.rochester.edu/adminfinance/bursar/billing-and-payment/tuition-fees-2020-2021/>

<sup>5</sup> <https://www.rit.edu/study/artificial-intelligence-computer-science-adv-cert>

# VALIDATE: EMPLOYMENT POTENTIAL

## PROJECT CRITERIA

Validate	Programs
States	New Hampshire, New Jersey, New York, Pennsylvania, Connecticut, Vermont, Massachusetts
Degree Level	Master's degree
Time Period	11/1/2019 - 10/31/2020
Selected Programs	Artificial Intelligence (11.0102)
Career Outcomes mapped to Selected Programs of Study	Computer Systems Engineer / Architect, Mobile Applications Developer, Computer Programmer, Software Developer / Engineer, Cyber / Information Security Engineer / Analyst, Data Scientist, Chief Information Officer / Director of Information Technology, Computer Scientist, Business Intelligence Architect / Developer, Data Warehousing Specialist, Webmaster / Administrator, Network Engineer / Architect, Software QA Engineer / Tester, Database Administrator, Web Developer, Data Engineer, Technology Consultant, IT Project Manager

## HOW MANY JOBS ARE THERE FOR YOUR GRADUATES?

For your project criteria, there were **100,097** job postings in the last 12 months.

Compared to:

- 5,632,249 total job postings in your selected location
- 574,071 total job postings requesting a Master's degree in your selected location

The number of jobs is expected to **grow** over the next 10 years.

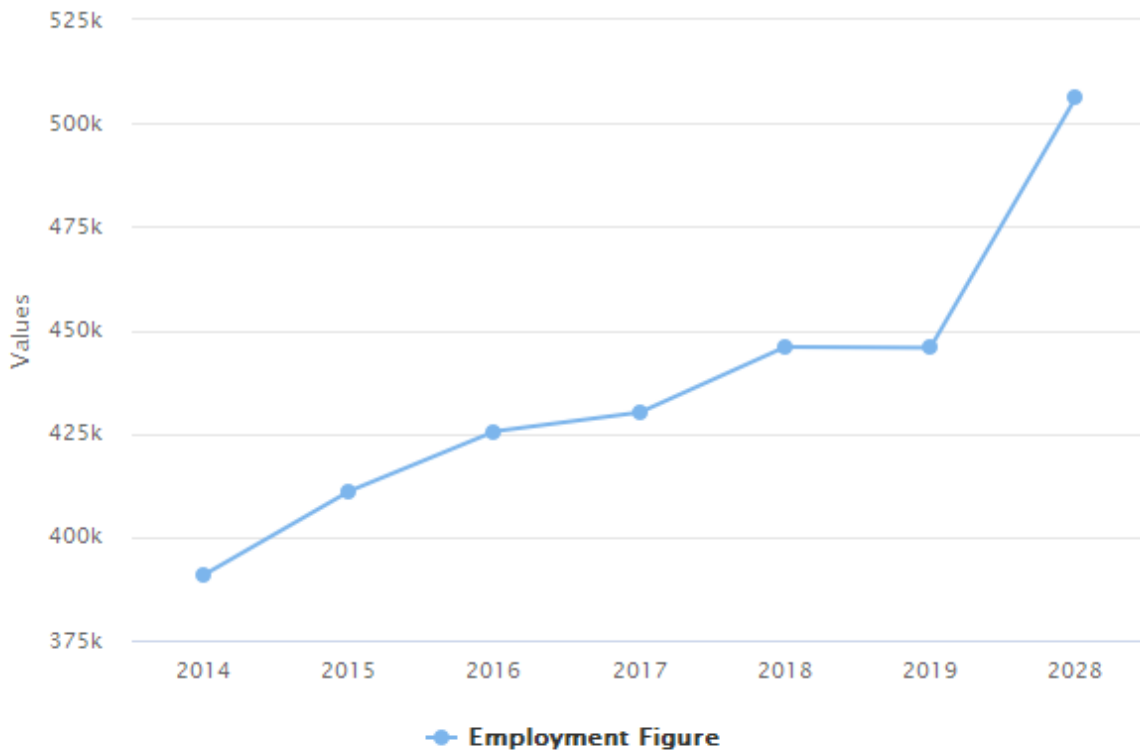
## GROWTH BY GEOGRAPHY

Geography	Selected Occupations	Total Labor Market	Relative Growth
Selected States	13.55 %	5.93 %	High
Nationwide	12.10 %	4.24 %	High

\* Selected States include New Hampshire, New Jersey, New York, Pennsylvania, Connecticut, Vermont, Massachusetts

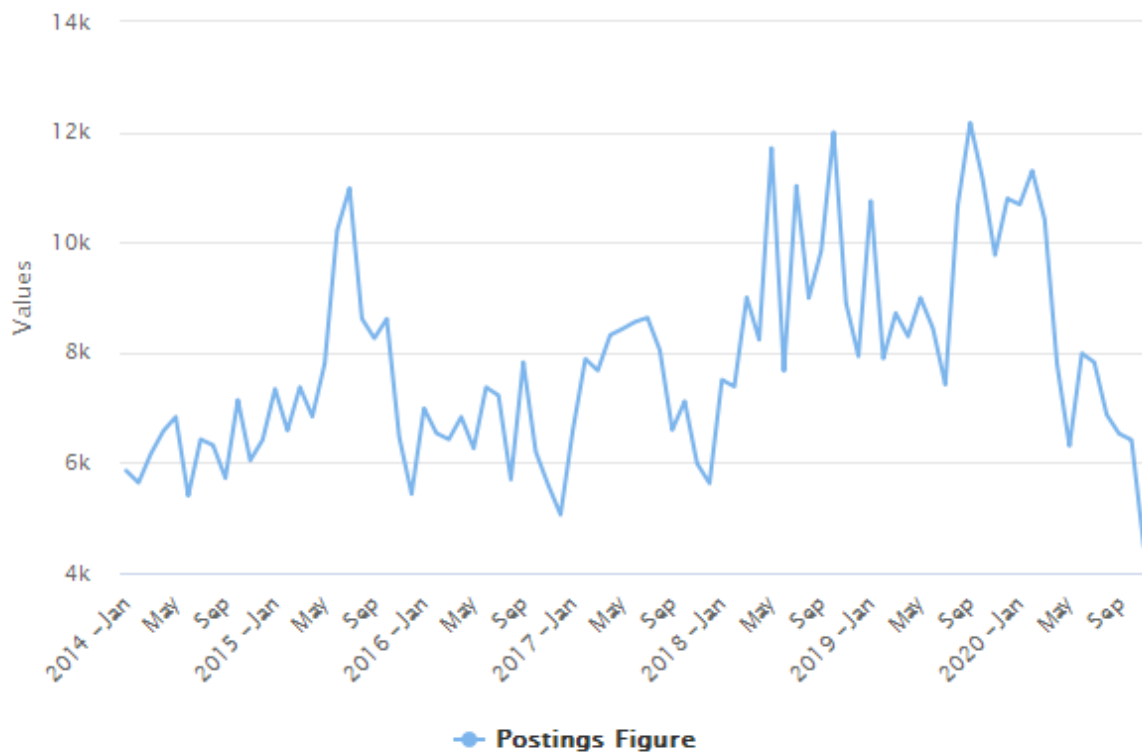
#### HOW HAS EMPLOYMENT CHANGED FOR CAREER OUTCOMES OF YOUR PROGRAM?

	2014	2015	2016	2017	2018	2019	2028
Employment (BLS)	390,900	411,090	425,530	430,110	445,920	445,733	506,118



Employment data between years 2019 and 2028 are projected figures.

POSTINGS TRENDS



#### DETAILS BY OCCUPATION

Occupation Group	Postings	LQ	Employment (2019)	Employment Growth (2018 - 2019)	Projected Employment Growth (2019-2028)
Software Development	53,244	1.0	281,523	-4.2%	19.5%
Network and Systems Engineering	20,131	0.8	78,361	-13.1%	11.2%
IT Managers	11,737	1.1	122,001	-3.8%	4.8%
Database Specialists	7,630	1.1	53,371	-17.3%	8.7%
Data Analysis and Mathematics	4,997	1.2	3,410	-8.3%	25.9%
Business Intelligence	2,247	0.9	180,162	2.4%	25.6%
Network and Systems Support	111	1.2	29,841	-30.9%	15.3%



## HOW VERSATILE IS MY PROGRAM?

Graduates of this program usually transition into any of the 7 different occupation groups:

Occupations Group	Market Size (postings)	Percentage of Career Outcome demand
Software Development	53,244	53.2%
Network and Systems Engineering	20,131	20.1%
IT Managers	11,737	11.7%
Database Specialists	7,630	7.6%
Data Analysis and Mathematics	4,997	5.0%
Business Intelligence	2,247	2.2%
Network and Systems Support	111	0.1%



## WHAT SALARY WILL MY GRADUATES MAKE?

The average salary in **your region** for graduates of your program is **\$106,717**

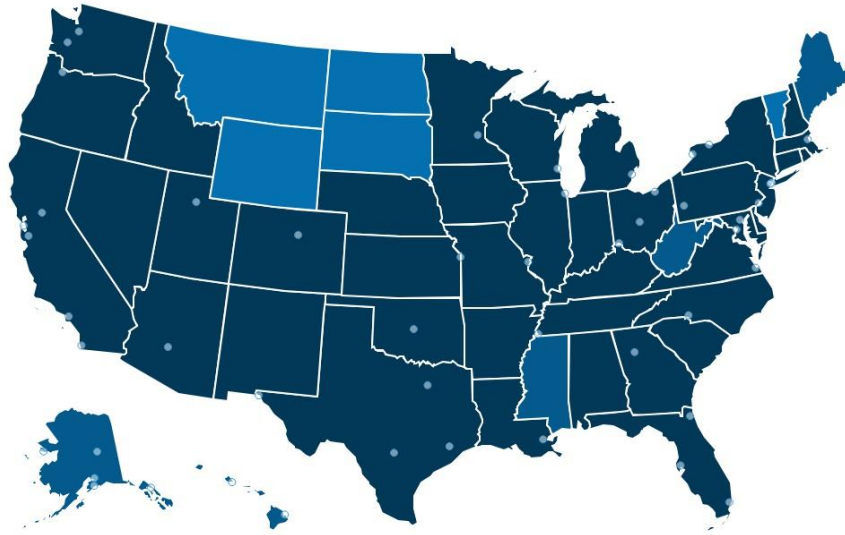
This average salary is **Above** the average living wage for your region of **\$34,641**



Salary numbers are based on Burning Glass models that consider advertised job posting salary, BLS data, and other proprietary and public sources of information.

Occupation Group	0-2 Years	3-5 Years	6+ Years
Software Development	\$87793	\$101932	\$109389
IT Managers	\$99677	\$112013	\$118881
Network and Systems Engineering	\$92076	\$101363	\$111352
Data Analysis and Mathematics	\$106525	\$116369	\$122046
Database Specialists	\$94826	\$103368	\$112759
Business Intelligence	\$96617	\$101298	\$105544
Network and Systems Support	\$0	\$74776	\$0

WHERE IS THE DEMAND FOR MY GRADUATES?



#### TOP LOCATIONS BY POSTING DEMAND

Location	Postings
California	127,562
Texas	54,944
Virginia	39,739
New York	33,220
Massachusetts	25,118
North Carolina	23,831
Washington	21,774
Illinois	21,121
Florida	21,112
Colorado	20,970

# VALIDATE: COMPETITIVE LANDSCAPE

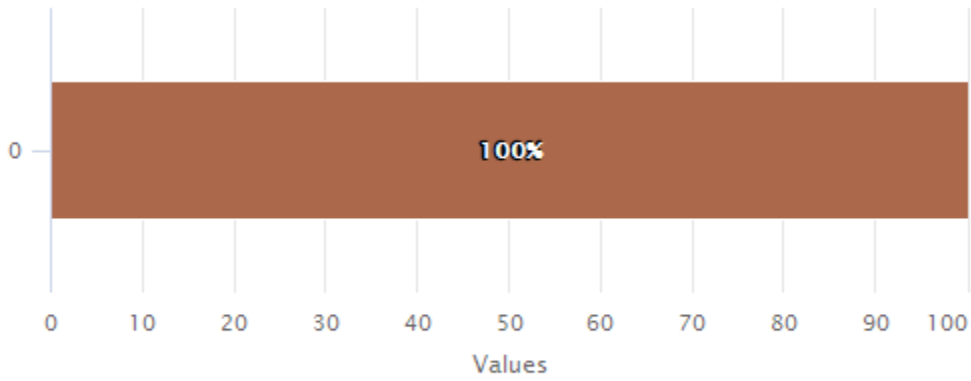
## PROJECT CRITERIA

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Degree Level	Master's degree
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## OVERVIEW

	#	% Change (2014-2018)
Degrees Conferred	167	72%
Number of Institutions	6	100%
Average Conferrals by Institution	28	-12.50%
Median Conferrals by Institution	10	-70.60%

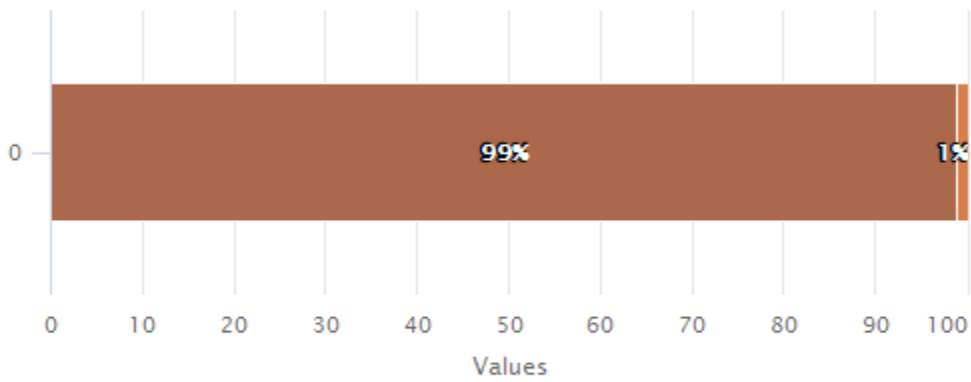
## MARKET SHARE BY PROGRAM



● Artificial Intelligence

Program	Conferrals (2018)	Market Share (%)
Artificial Intelligence	167	100.00%

#### MARKET SHARE BY INSTITUTION TYPE



● Private ● Public

Institution Type	Conferrals (2018)	Market Share (%)
Private	166	99.40%
Public	1	0.60%

#### TOP INSTITUTIONS

Institution	School Type	Market Share (2018)	Market Share Change	Conferrals (2018)	Conferrals Change (2014-2018)
Carnegie Mellon University	Private	44.91%	-14.88%	75	29.30%
University of Pennsylvania	Private	41.92%	6.87%	70	105.90%
Brandeis University	Private	10.18%	10.18%	17	100.00%
Syracuse University	Private	1.80%	1.80%	3	100.00%
University of Rochester	Private	0.60%	0.60%	1	100.00%
University of Pittsburgh-Pittsburgh Campus	Public	0.60%	-4.55%	1	-80.00%

## TOP PROGRAMS

Program	Market Share (2018)	Market Share Change	Conferrals (2018)	Conferrals Change (2014-2018)
Artificial Intelligence	100.00%	0.00%	167	72.20%

## ACTIVE COMPETITORS

Institution	School Type	Market Share (2018)	Market Share Change	Conferrals (2018)	Conferrals Change (2014-2018)
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# VALIDATE: MARKET ALIGNMENT

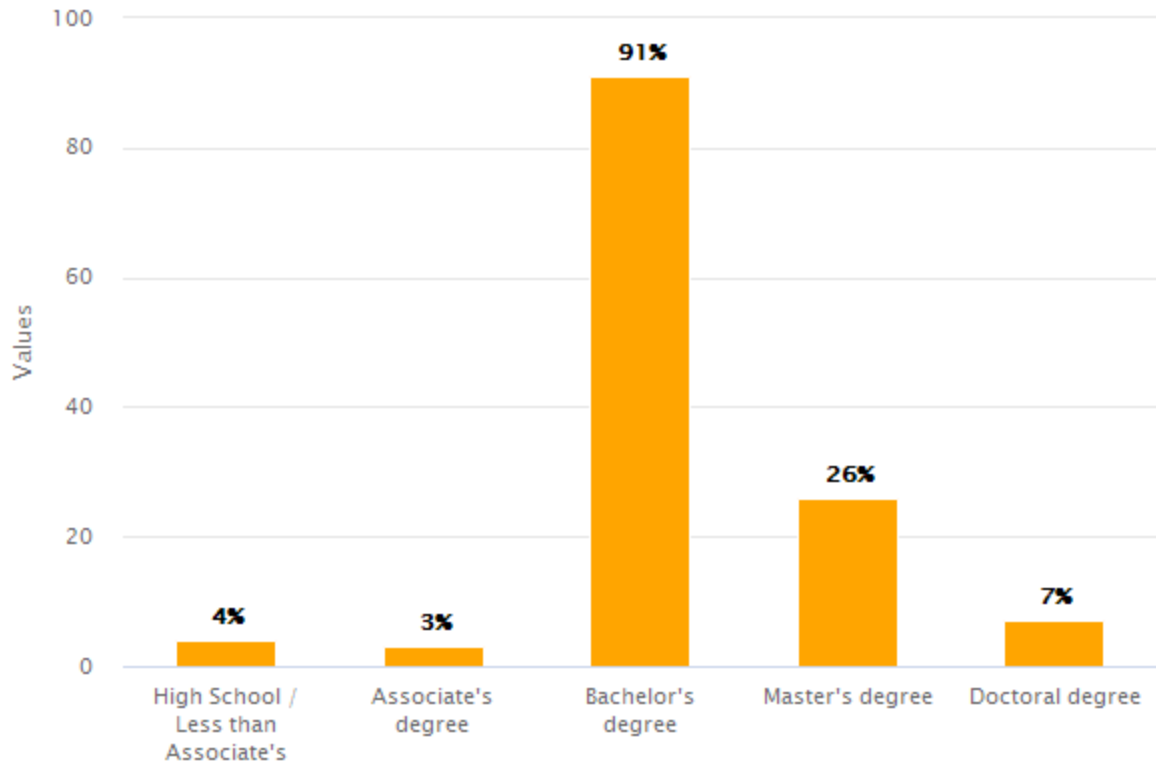
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## PROJECT CRITERIA

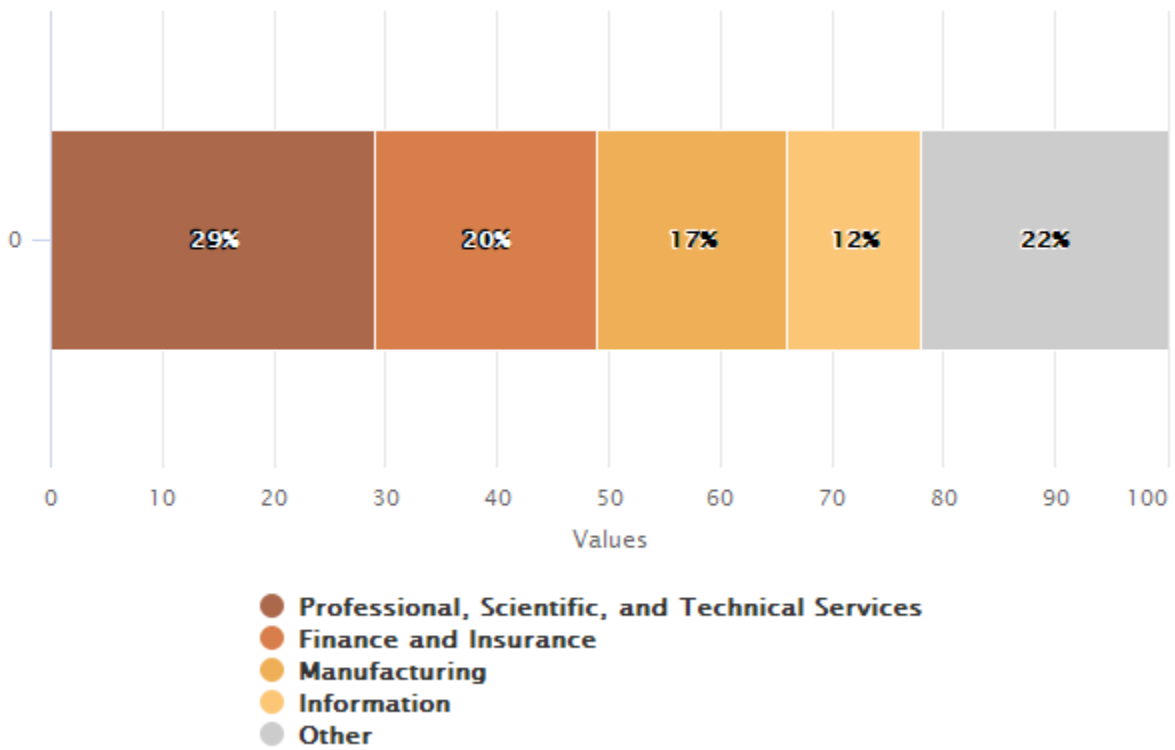
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States	New Hampshire, New Jersey, New York, Pennsylvania, Connecticut, Vermont, Massachusetts
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## JOB POSTINGS BY ADVERTISED EDUCATION (%)

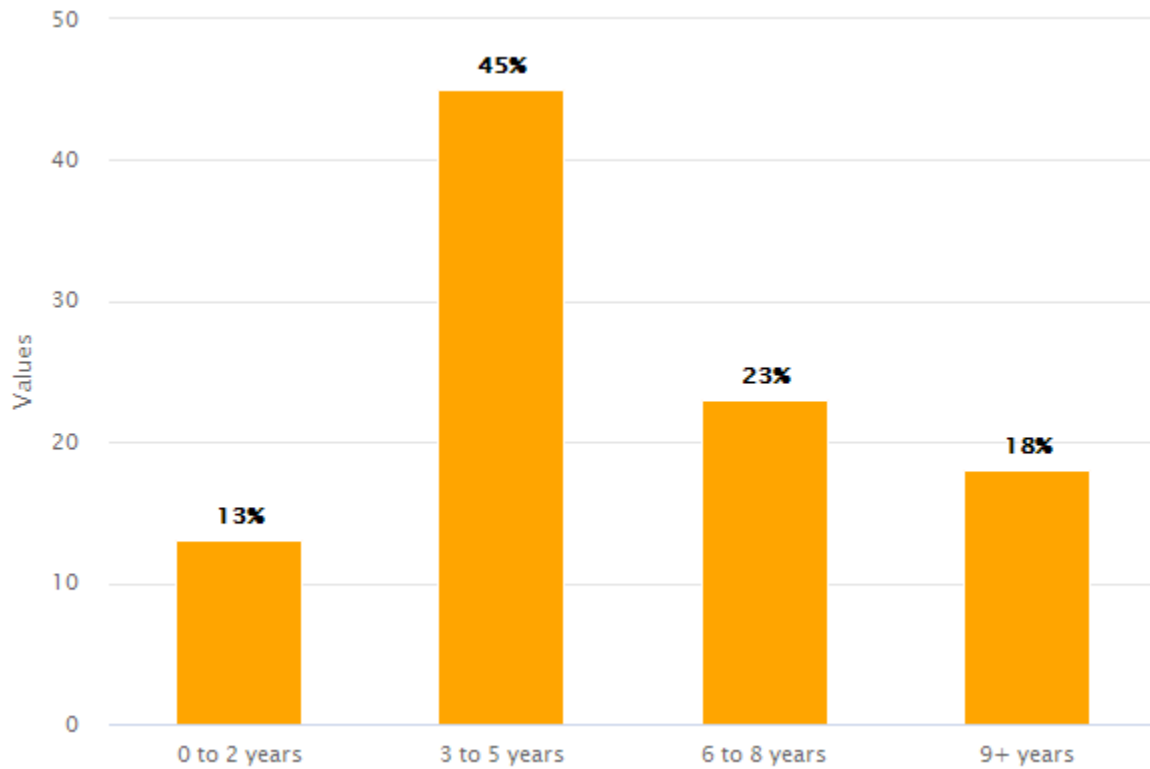


#### JOB POSTINGS BY INDUSTRY (%)





## JOB POSTINGS BY EXPERIENCE REQUESTED (%)



## TOP TITLES

**Experience Level:** All Experience

Title	Postings	Market Share (%)
Software Engineer	886	1.59%
Data Scientist	862	1.55%
Senior Software Engineer	750	1.35%
Devops Engineer	492	0.89%
Senior Data Scientist	460	0.83%
Software Developer	436	0.78%
Scrum Master	364	0.66%
Data Engineer	358	0.64%
Java Developer	322	0.58%
Entry Level Software Engineer	316	0.57%
Project Manager	307	0.55%
Senior Data Engineer	226	0.41%

It Project Manager	218	0.39%
Systems Engineer	215	0.39%
Solutions Architect	181	0.33%

## TOP EMPLOYERS HIRING

**Experience Level:** All Experience

Employer	Postings	Market Share (%)
Deloitte	1,896	3.41%
Humana	911	1.64%
Amazon	666	1.20%
Mathworks	655	1.18%
Raytheon	623	1.12%
The Bank of New York Mellon	510	0.92%
IBM	505	0.91%
Applied Materials	497	0.89%
Bloomberg	407	0.73%
Capital One	358	0.64%
BAE Systems	260	0.47%
Verizon Communications Incorporated	250	0.45%
The PNC Financial Services Group, Inc.	241	0.43%
Citi	229	0.41%
Microsoft Corporation	228	0.41%

# VALIDATE: KEY COMPETENCIES

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## TOP 15 SPECIALIZED SKILLS

Skill	Postings	Projected Growth	Salary Premium	Competitive Advantage
Java	30525 (29.69%)	-13.18%	No	No
SQL	28167 (27.39%)	-13.3%	No	No
Python	25935 (25.22%)	61.12%	No	No

Software Development	23700 (23.05%)	5.78%	No	No
Software Engineering	23581 (22.93%)	7.27%	No	No
JavaScript	15759 (15.33%)	6.81%	No	No
Project Management	15580 (15.15%)	-19.74%	No	No
Linux	13248 (12.88%)	-12.57%	No	No
C++	11716 (11.39%)	-24.09%	No	Yes
Scrum	11323 (11.01%)	39.96%	No	No
Oracle	10655 (10.36%)	-16.26%	No	No
Data Science	9946 (9.67%)	112.27%	No	No
Machine Learning	9621 (9.36%)	102.54%	No	No
DevOps	9514 (9.25%)	107.85%	Yes	No
Git	8785 (8.54%)	59.81%	No	No

## TOP 15 BASELINES SKILLS

Skill	Postings
Communication Skills	37422 (36.4%)
Teamwork / Collaboration	27143 (26.4%)
Problem Solving	19264 (18.74%)
Planning	16221 (15.78%)
Research	14951 (14.54%)
Writing	13329 (12.96%)
Troubleshooting	11510 (11.19%)
Creativity	11385 (11.07%)
Written Communication	7790 (7.58%)

Organizational Skills	7673 (7.46%)
Presentation Skills	6872 (6.68%)
Detail-Oriented	6812 (6.63%)
Leadership	5934 (5.77%)
Microsoft Excel	5774 (5.62%)
Mentoring	5669 (5.51%)

#### TOP 15 SOFTWARE PROGRAMMING SKILLS

Skill	Postings	Projected Growth	Salary Premium	Competitive Advantage
Java	30525 (29.69%)	-13.18%	No	No
SQL	28167 (27.39%)	-13.3%	No	No
Python	25935 (25.22%)	61.12%	No	No

Software Development	23700 (23.05%)	5.78%	No	No
Software Engineering	23581 (22.93%)	7.27%	No	No
JavaScript	15759 (15.33%)	6.81%	No	No
Linux	13248 (12.88%)	-12.57%	No	No
C++	11716 (11.39%)	-24.09%	No	Yes
Scrum	11323 (11.01%)	39.96%	No	No
Oracle	10655 (10.36%)	-16.26%	No	No
Git	8785 (8.54%)	59.81%	No	No
NoSQL	7759 (7.55%)	42.13%	No	No
Microsoft C#	7569 (7.36%)	-25.69%	No	No
UNIX	7051 (6.86%)	-61.89%	No	No
Object-Oriented Analysis and Design (OOAD)	6672 (6.49%)	-28.56%	No	No

## TOP 15 SKILL CLUSTERS

Skill	Postings
Software Development Principles	49366 (48.01%)
SQL Databases and Programming	31262 (30.4%)
Java	30820 (29.98%)
Scripting Languages	29377 (28.57%)
System Design and Implementation	24777 (24.1%)
Project Management	20374 (19.82%)
JavaScript and jQuery	20224 (19.67%)
Database Administration	18947 (18.43%)
Operating Systems	18319 (17.82%)
Software Development Methodologies	16508 (16.06%)



Business Process and Analysis	15449 (15.03%)
Cloud Solutions	15194 (14.78%)
Web Development	15170 (14.75%)
Programming Principles	15110 (14.7%)
Software Quality Assurance	14891 (14.48%)

#### TOP 15 SALARY PREMIUM SKILLS

Skill	Postings	Projected Growth	Salary Premium	Competitive Advantage
DevOps	9514 (9.25%)	107.85%	Yes	No
Big Data	7912 (7.7%)	22.31%	Yes	No
Apache Hadoop	6525 (6.35%)	19.63%	Yes	No
Extraction Transformation and Loading (ETL)	5527 (5.38%)	51.42%	Yes	No
Performance tuning	2775 (2.7%)	-12.95%	Yes	No

#### TOP 15 COMPETITIVE ADVANTAGE SKILLS

Skill	Postings	Projected Growth	Salary Premium	Competitive Advantage
C++	11716 (11.39%)	-24.09%	No	Yes
Product Development	5031 (4.89%)	-4.41%	No	Yes
Computer Engineering	4430 (4.31%)	6.12%	No	Yes

## TOP 15 CERTIFICATIONS

Skill	Postings	Salary Premium	Competitive Advantage
Security Clearance	3180 (3.09%)	No	No
Project Management Certification	2820 (2.74%)	No	No
Certified Information Systems Security Professional (CISSP)	2536 (2.47%)	No	No
Project Management Professional (PMP)	1639 (1.59%)	No	No
IT Infrastructure Library (ITIL) Certification	1529 (1.49%)	No	No
Certified ScrumMaster (CSM)	1249 (1.21%)	No	No

Certified Information Systems Auditor (CISA)	994 (0.97%)	No	No
Certified Information Security Manager (CISM)	983 (0.96%)	No	No
SANS/GIAC Certification	815 (0.79%)	No	No
Driver's License	700 (0.68%)	No	No
Cisco Certified Network Professional (CCNP)	661 (0.64%)	No	No
Cisco Certified Network Associate (CCNA)	637 (0.62%)	No	No
Information Systems Certification	573 (0.56%)	No	No
CompTIA Security+	517 (0.5%)	No	No
Cisco Certified Security Professional	405 (0.39%)	No	No

#### TOP 15 SALARY PREMIUM CERTIFICATIONS

Skill	Postings	Salary Premium	Competitive Advantage
No certificates available			

#### TOP 15 COMPETITIVE ADVANTAGE CERTIFICATIONS

Skill	Postings	Salary Premium	Competitive Advantage
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No certificates available

## Skills Analysis

### Active Selections

CT, MA, NH, NJ, NY, PA, VT, Information Technology: Artificial Intelligence

## Skill Metrics

### Job Postings

Last 12 Months

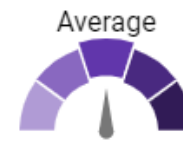


### Projected Growth

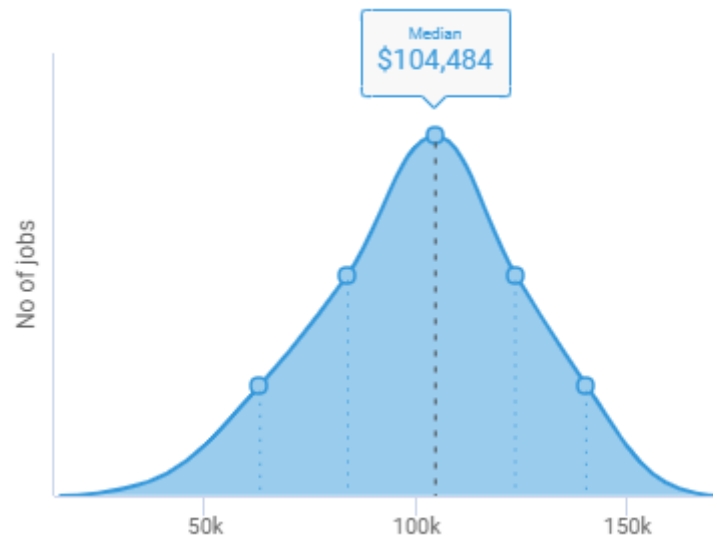
10 Years



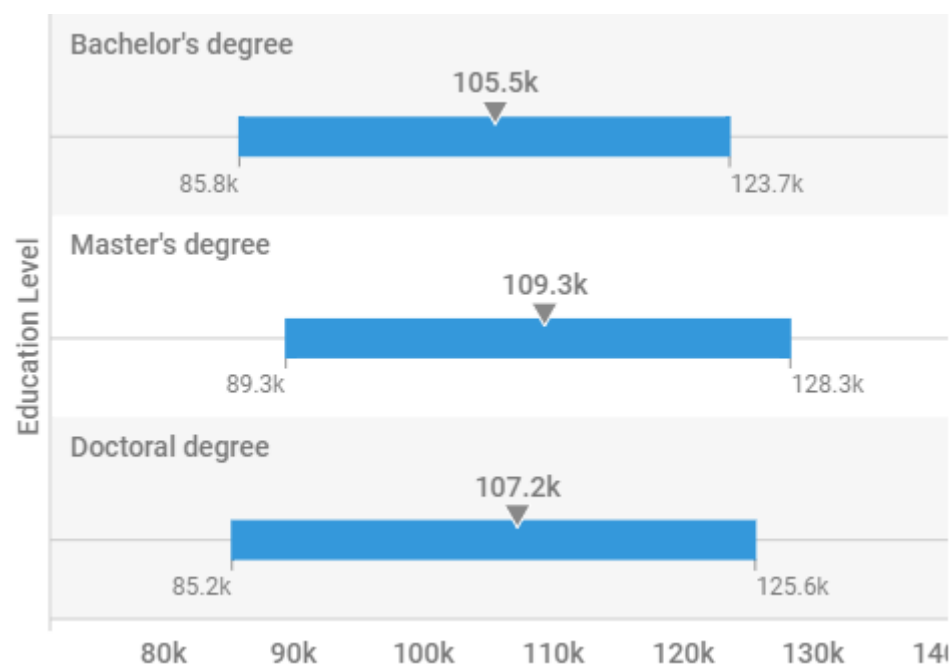
### Location Quotient



## Salary Overall

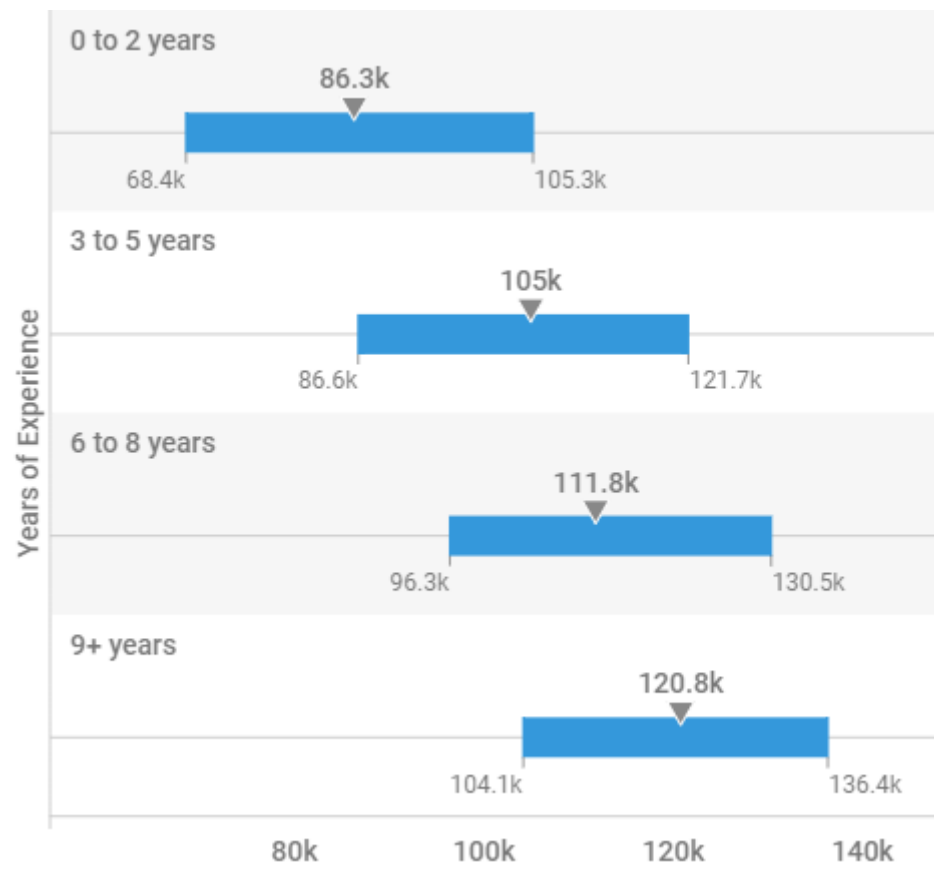


## Salary By Education

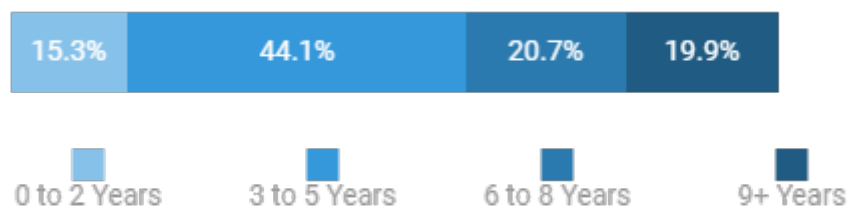


Salary distribution is not shown for education levels with insufficient sample size

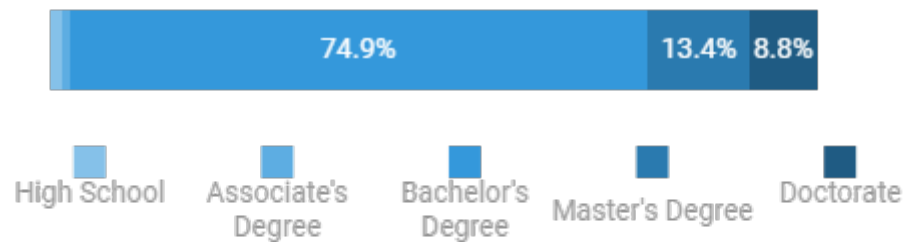
## Salary By Experience



## Years of Experience



## Education Level



## Top Occupations Requesting Skill(s)

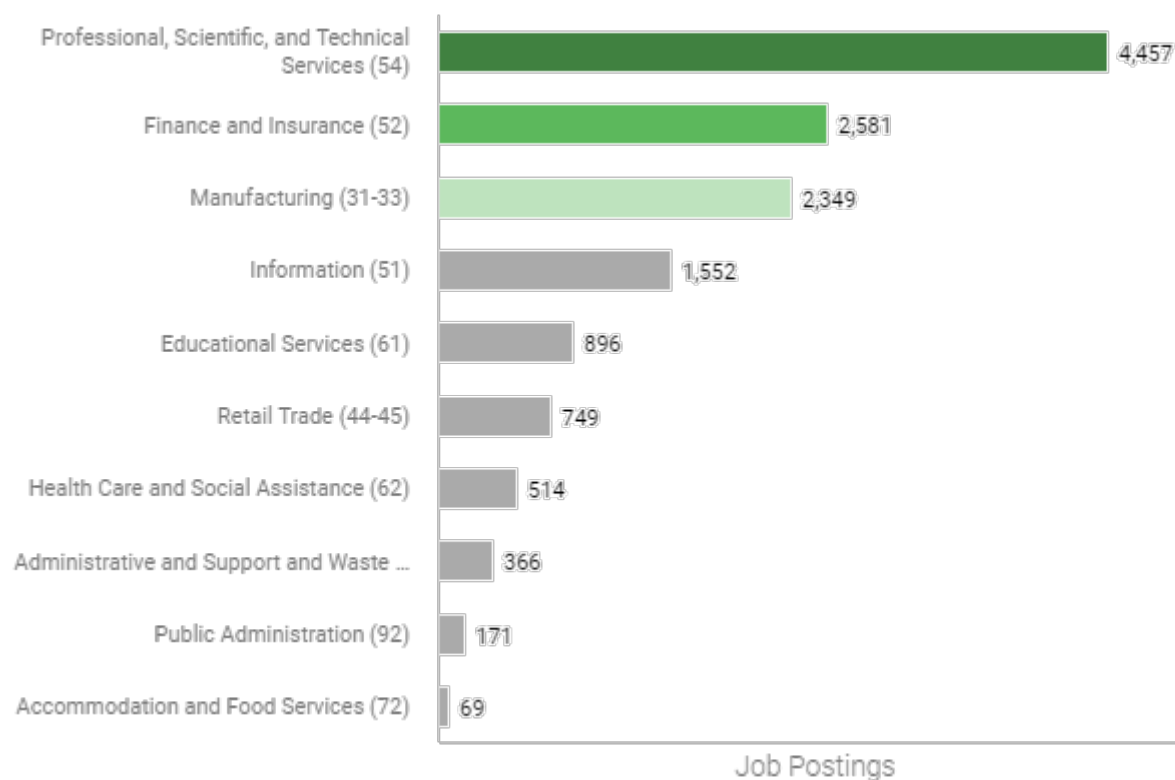
Occupation	Associated Education Level
Software Developer / Engineer	Bachelor's
Data Scientist	Bachelor's
Network Engineer / Architect	Bachelor's
Computer Systems Engineer / Architect	Bachelor's
Researcher / Research Associate	Bachelor's
Business / Management Analyst	Bachelor's
Data / Data Mining Analyst	Bachelor's
IT Project Manager	Bachelor's
Product Manager	Bachelor's
Database Architect	Bachelor's

## Top Occupations

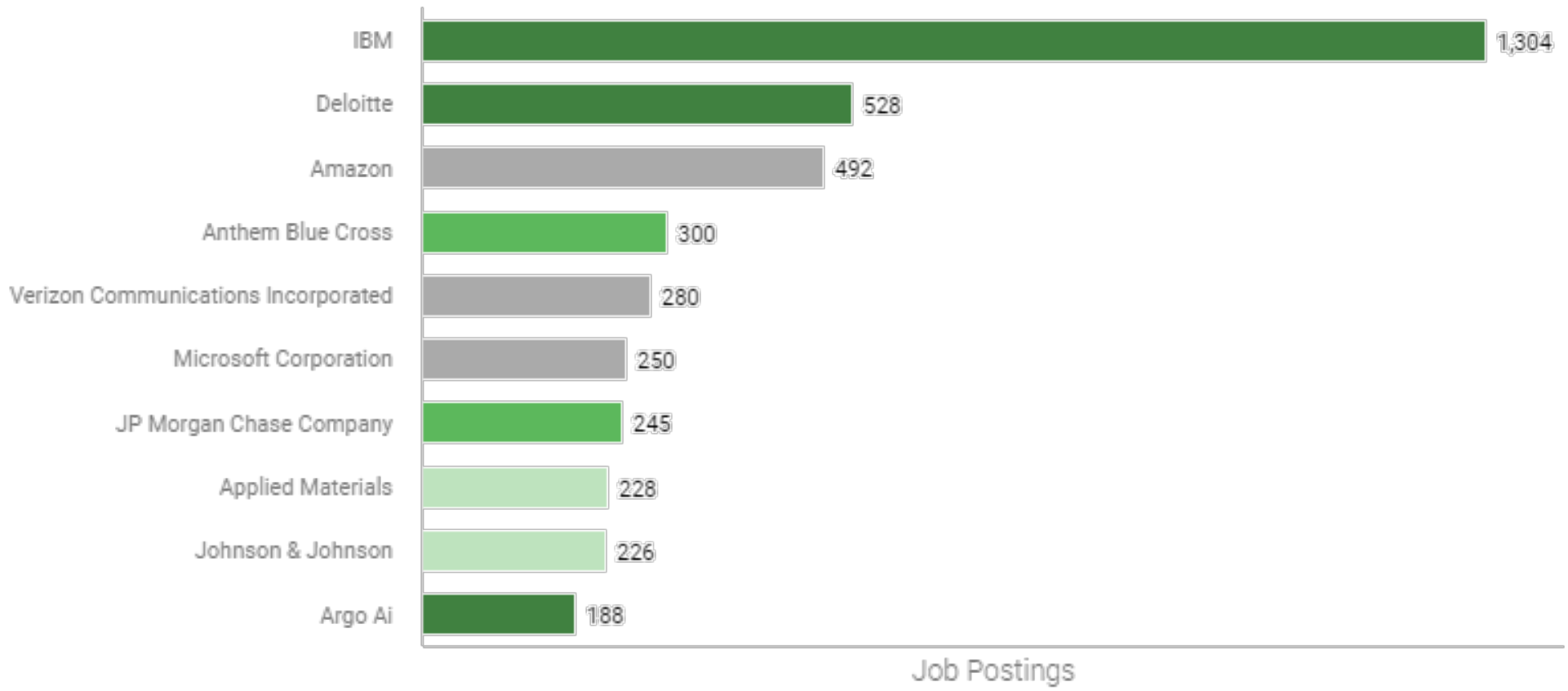
Occupation	Total Job Postings (Last 12 Months)	Job Postings Requesting Skill(s)(#)	Job Postings Requesting Skill(s)(%)	Occupation Projected Growth (10 Years)	Salary Premium	Associated Education Level
Software Developer / Engineer	166,647	2,658	1.6%	25.5%		Bachelor's degree
Data Scientist	7,705	1,728	22.4%	7.6%		Bachelor's degree
Network Engineer / Architect	26,396	972	3.7%	1.3%		Bachelor's degree
Computer Systems Engineer / Architect	23,581	631	2.7%	8.2%		Bachelor's degree
Researcher / Research Associate	18,349	577	3.1%	22%		Bachelor's degree
Business / Management Analyst	46,317	427	0.9%	9.6%		Bachelor's degree
Data / Data Mining Analyst	14,744	427	2.9%	8.2%		Bachelor's degree
IT Project Manager	33,866	377	1.1%	8.2%		Bachelor's degree
Product Manager	18,910	377	2.0%	8.9%		Bachelor's degree
Database Architect	8,829	359	4.1%	8.2%		Bachelor's degree

## Top Industries

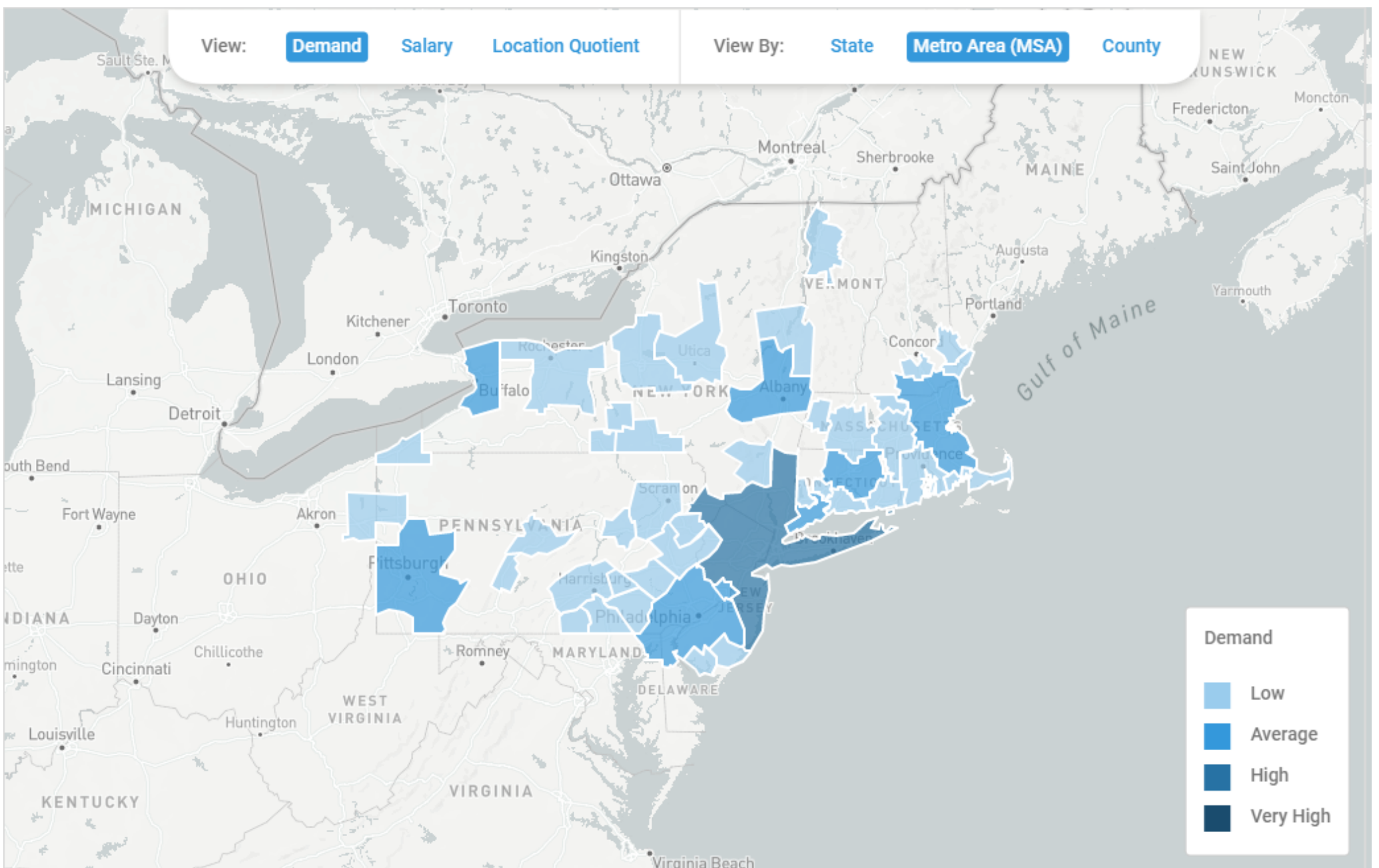
Currently displaying: 2digit



## Top Employers



## Top Locations





Metro Area (MSA)	Job Postings (Last 12 Months)	Median Salary	Location Quotient
New York-Newark-Jersey City, NY-NJ-PA	8,328	\$108k	1.3 <span>▲</span>
Boston-Cambridge-Nashua, MA-NH	4,681	\$106k	2.6 <span>▲</span>
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	1,827	\$99k	1.0 <span>▬</span>
Pittsburgh, PA	1,430	\$94k	1.8 <span>▲</span>
Hartford-West Hartford-East Hartford, CT	566	\$108k	1.4 <span>▲</span>
Trenton, NJ	412	\$105k	2.4 <span>▲</span>
Bridgeport-Stamford-Norwalk, CT	246	\$110k	0.8 <span>▼</span>
Albany-Schenectady-Troy, NY	182	\$102k	0.6 <span>▼</span>
Buffalo-Cheektowaga-Niagara Falls, NY	152	\$95k	0.4 <span>▼</span>
Harrisburg-Carlisle, PA	152	\$97k	0.7 <span>▼</span>

## Your Selections at a Glance

### Job Postings

Last 12 Months

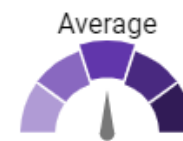


### Projected Growth

10 Years

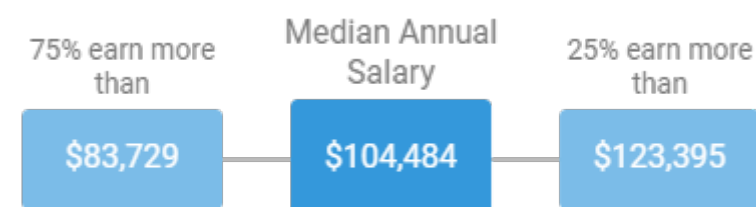


### Location Quotient



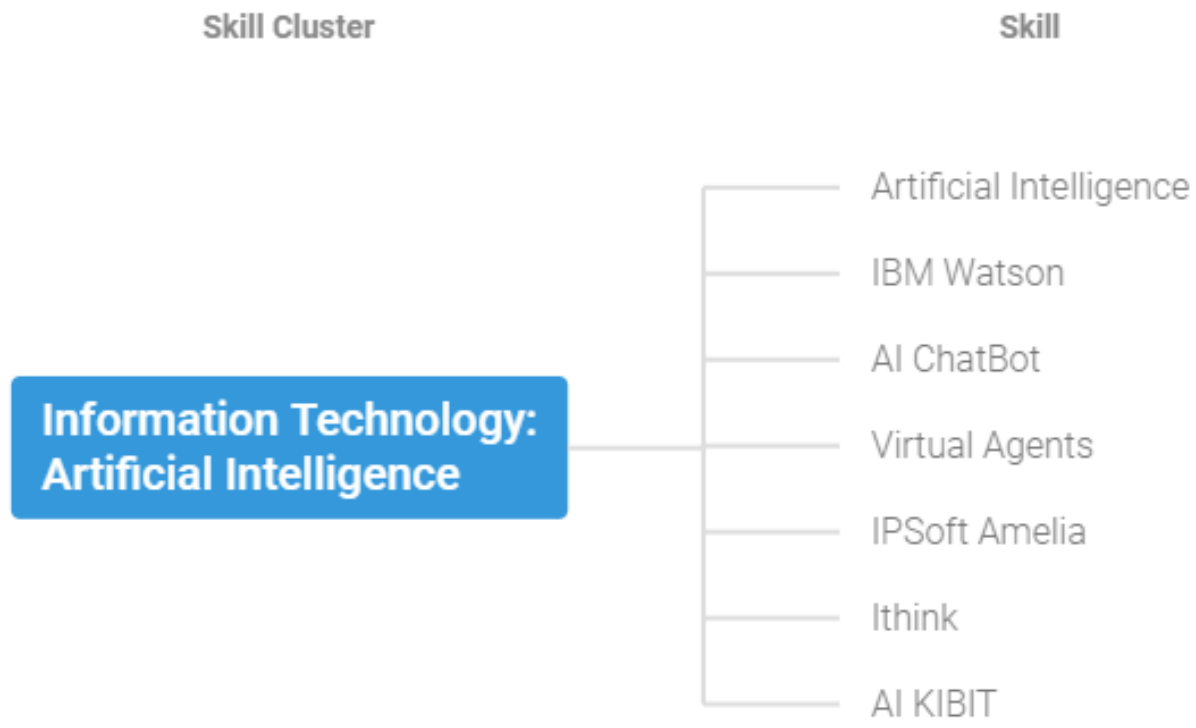
### Salary

10 Years



# Skill Taxonomy

The Information Technology: Artificial Intelligence skill cluster which comprises 7 skills.



## Top Co-occurring Skills

	Skill	Postings (Last 12 Months)
1	Artificial Intelligence	18,104
2	Machine Learning	12,898
3	Python	8,051
4	Data Science	6,323
5	Java	4,585
6	SQL	4,575
7	Big Data	3,601
8	Software Development	3,433
9	Software Engineering	3,326
10	C++	2,959

Currently displaying: Specialized Skills

Source: Labor Insight (Burning Glass Technologies)

## Employers with the Most Job Openings

Nov. 01, 2019 - Oct. 31, 2020

There are 19,373 postings available with the current filters applied.

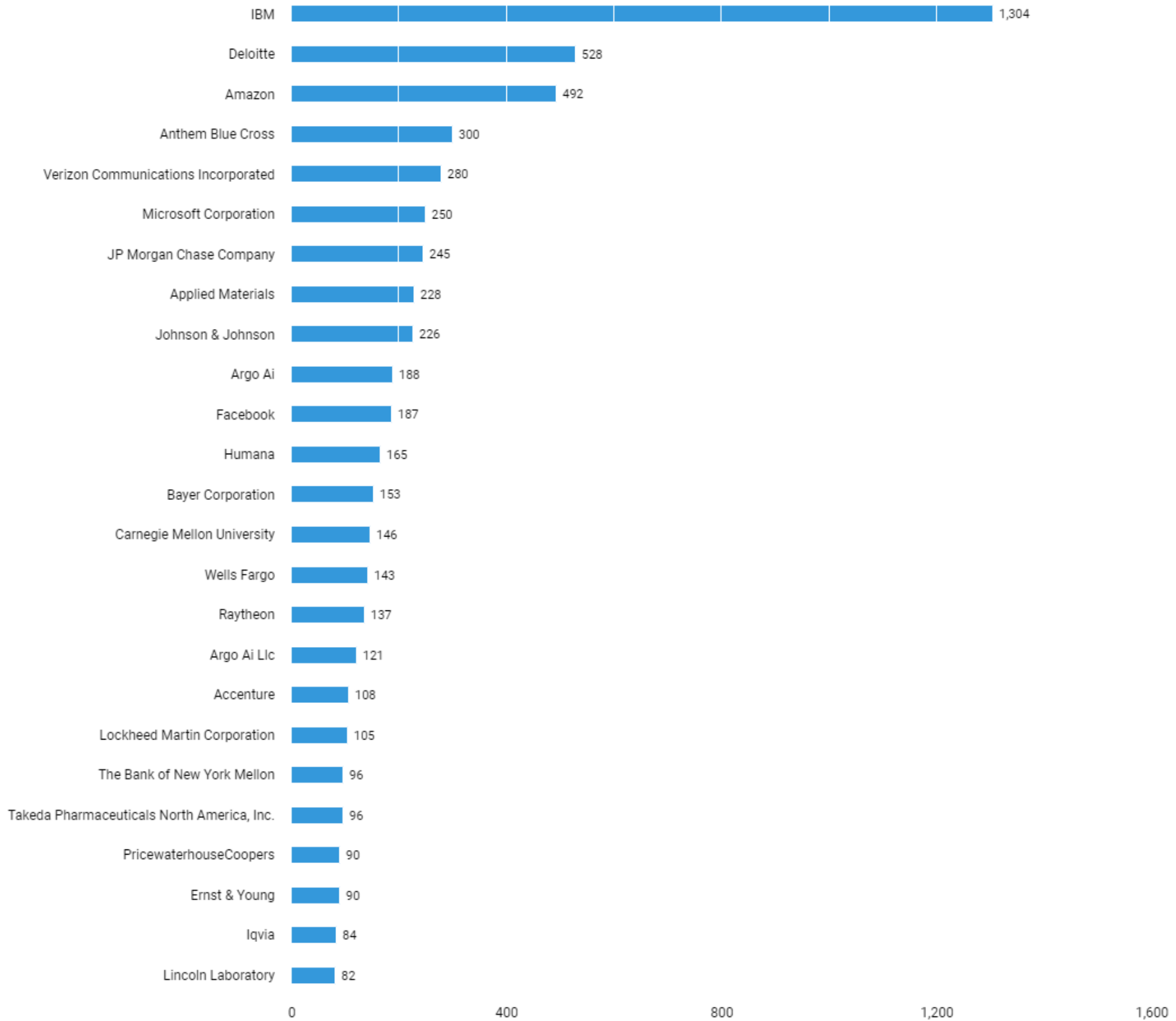
There are 2,668 unspecified postings.

## Included Postings

New postings

## Active Selections

Last 12 months (Nov. 1, 2019 - Oct. 31, 2020) AND ( State : CT OR State : MA OR State : NH OR State : NJ OR State : NY OR State : PA OR State : VT ) AND ( Cluster : Information Technology: Artificial Intelligence ) AND ( Included Postings : All New Jobs )



Source: Labor Insight (Burning Glass Technologies)

## Top Detailed Industries

Nov. 01, 2019 - Oct. 31, 2020

There are 19,373 postings available with the current filters applied.

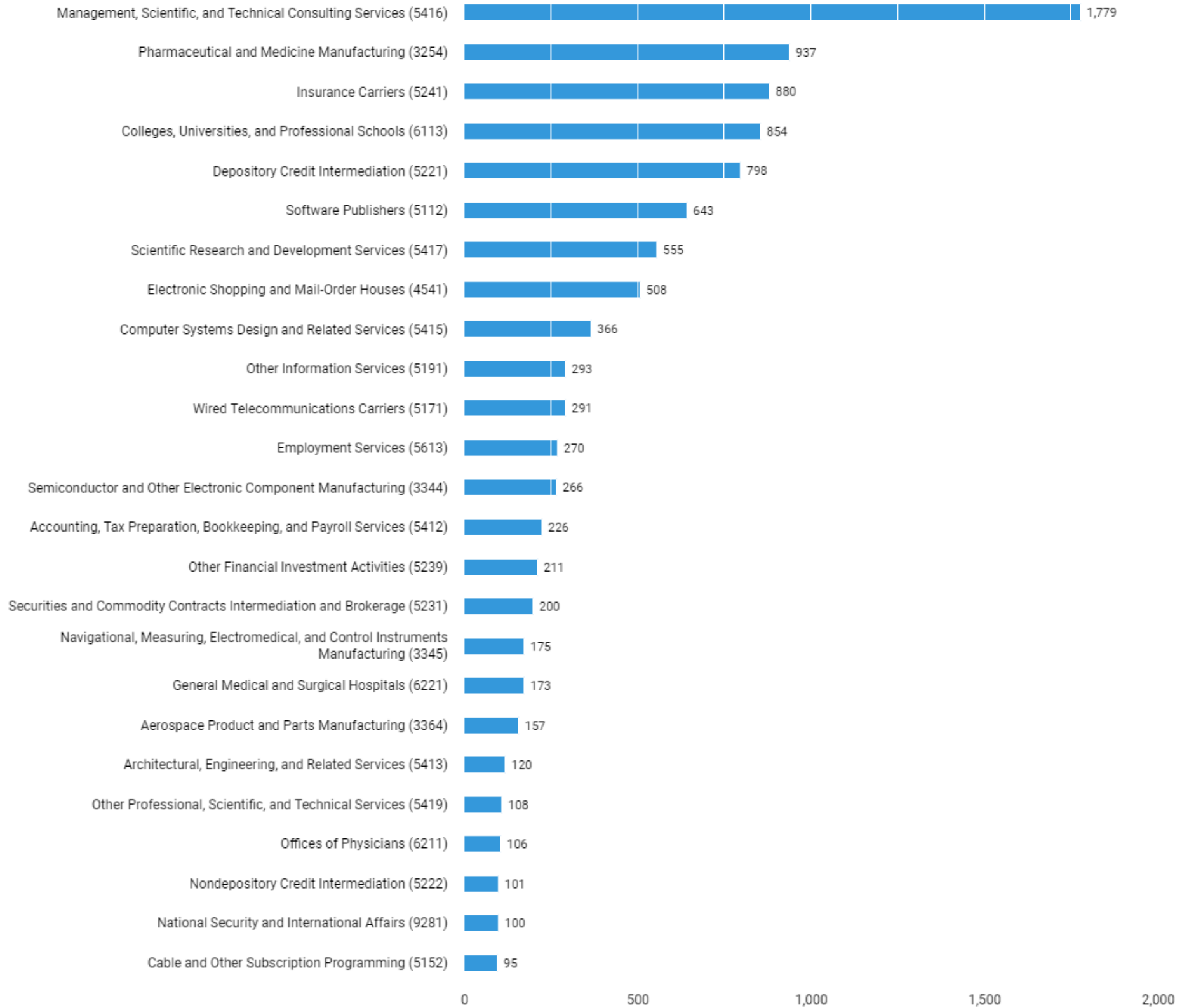
There are 7,690 unspecified postings.

## Included Postings

New postings

## Active Selections

Last 12 months (Nov. 1, 2019 - Oct. 31, 2020) AND ( State : CT OR State : MA OR State : NH OR State : NJ OR State : NY OR State : PA OR State : VT ) AND ( Cluster : Information Technology: Artificial Intelligence ) AND ( Included Postings : All New Jobs )



### Industry Sector Job Counts by Year

If the time period selected spans more than one calendar year, historic data shown will be for 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018 and 2019

Please also note that these results reflect point-in-time data and are subject to change as improvements are made to our aggregation and reporting methodologies. Burning Glass does not recommend use of this data for time series reporting.

Nov. 01, 2019 - Oct. 31, 2020

There are 19,373 postings available with the current filters applied.

There are 5,282 unspecified postings.

#### Included Postings

New postings

#### Active Selections

Last 12 months (Nov. 1, 2019 - Oct. 31, 2020) AND ( State : CT OR State : MA OR State : NH OR State : NJ OR State : NY OR State : PA OR State : VT ) AND ( Cluster : Information Technology: Artificial Intelligence ) AND ( Included Postings : All New Jobs )

Industry Sector	Total Number of Job Postings [Nov. 1, 2019 - Oct. 31, 2020]	Percentage of Total Job Postings [Nov. 1, 2019 - Oct. 31, 2020]	Percentage of Total Job Postings [Jan. 1, 2019 - Dec. 31, 2019]	Percentage of Total Job Postings [Jan. 1, 2018 - Dec. 31, 2018]	Percentage of Total Job Postings [Jan. 1, 2017 - Dec. 31, 2017]	Percentage of Total Job Postings [Jan. 1, 2016 - Dec. 31, 2016]	Percentage of Total Job Postings [Jan. 1, 2015 - Dec. 31, 2015]	Percentage of Total Job Postings [Jan. 1, 2014 - Dec. 31, 2014]	Percentage of Total Job Postings [Jan. 1, 2013 - Dec. 31, 2013]	Percentage of Total Job Postings [Jan. 1, 2012 - Dec. 31, 2012]	Percentage of Total Job Postings [Jan. 1, 2011 - Dec. 31, 2011]	Percentage of Total Job Postings [Jan. 1, 2010 - Dec. 31, 2010]
Professional, Scientific, and Technical Services	4,457	31.6%	33.9%	44.6%	45.6%	60.4%	75.5%	52.7%	56.1%	61.2%	52.7%	49.9%
Finance and Insurance	2,581	18.3%	17.0%	15.6%	17.4%	8.0%	3.6%	6.7%	5.0%	4.1%	7.8%	9.6%
Manufacturing	2,349	16.7%	14.0%	14.6%	12.5%	12.0%	8.1%	9.2%	10.3%	8.9%	12.6%	10.9%
Information	1,552	11.0%	10.5%	8.7%	9.7%	6.6%	2.7%	6.7%	6.8%	6.2%	6.2%	8.0%
Educational Services	896	6.4%	5.2%	4.4%	5.7%	7.2%	4.6%	9.3%	11.1%	9.7%	9.4%	9.0%
Retail Trade	749	5.3%	4.5%	2.9%	3.0%	1.1%	0.7%	1.5%	1.1%	1.6%	1.9%	0.3%
Administrative and Support and Waste Management and Remediation Services	366	2.6%	7.0%	3.4%	1.4%	0.7%	0.4%	0.7%	2.4%	2.8%	2.7%	6.9%
Health Care and Social Assistance	514	3.6%	2.9%	2.0%	1.5%	1.8%	1.1%	3.4%	0.8%	0.9%	0.9%	0.1%
Public Administration	171	1.2%	0.8%	0.6%	0.5%	0.3%	2.1%	5.1%	1.5%	2.0%	2.5%	1.8%
Transportation and Warehousing	60	0.4%	0.8%	0.8%	0.5%	0.4%	0.3%	0.5%	1.7%	0.9%	1.1%	0.4%
Accommodation and Food Services	69	0.5%	0.7%	0.6%	0.3%	0.3%	0.3%	1.6%	0.4%	1.0%	0.3%	1.9%
Wholesale Trade	38	0.3%	0.4%	0.4%	0.2%	0.3%	0.0%	0.4%	0.8%	0.4%	0.6%	0.5%
Real Estate and Rental and Leasing	61	0.4%	0.5%	0.1%	0.2%	0.1%	0.0%	1.5%	0.9%	0.1%	0.3%	0.0%
Utilities	57	0.4%	0.4%	0.3%	0.6%	0.0%	0.0%	0.2%	0.0%	0.0%	0.2%	0.3%
Management of Companies and Enterprises	51	0.4%	0.3%	0.4%	0.3%	0.3%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%
Other Services (except Public Administration)	13	0.1%	0.5%	0.2%	0.1%	0.3%	0.3%	0.2%	0.2%	0.0%	0.2%	0.0%
Mining, Quarrying, and Oil and Gas Extraction	28	0.2%	0.1%	0.2%	0.3%	0.0%	0.0%	0.1%	0.4%	0.2%	0.3%	0.5%
Agriculture, Forestry, Fishing and Hunting	68	0.5%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Arts, Entertainment, and Recreation	6	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.4%	0.0%	0.2%	0.0%
Construction	5	0.0%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Source: Labor Insight (Burning Glass Technologies)

## Top MSAs

Nov. 01, 2019 - Oct. 31, 2020

There are 19,373 postings available with the current filters applied.

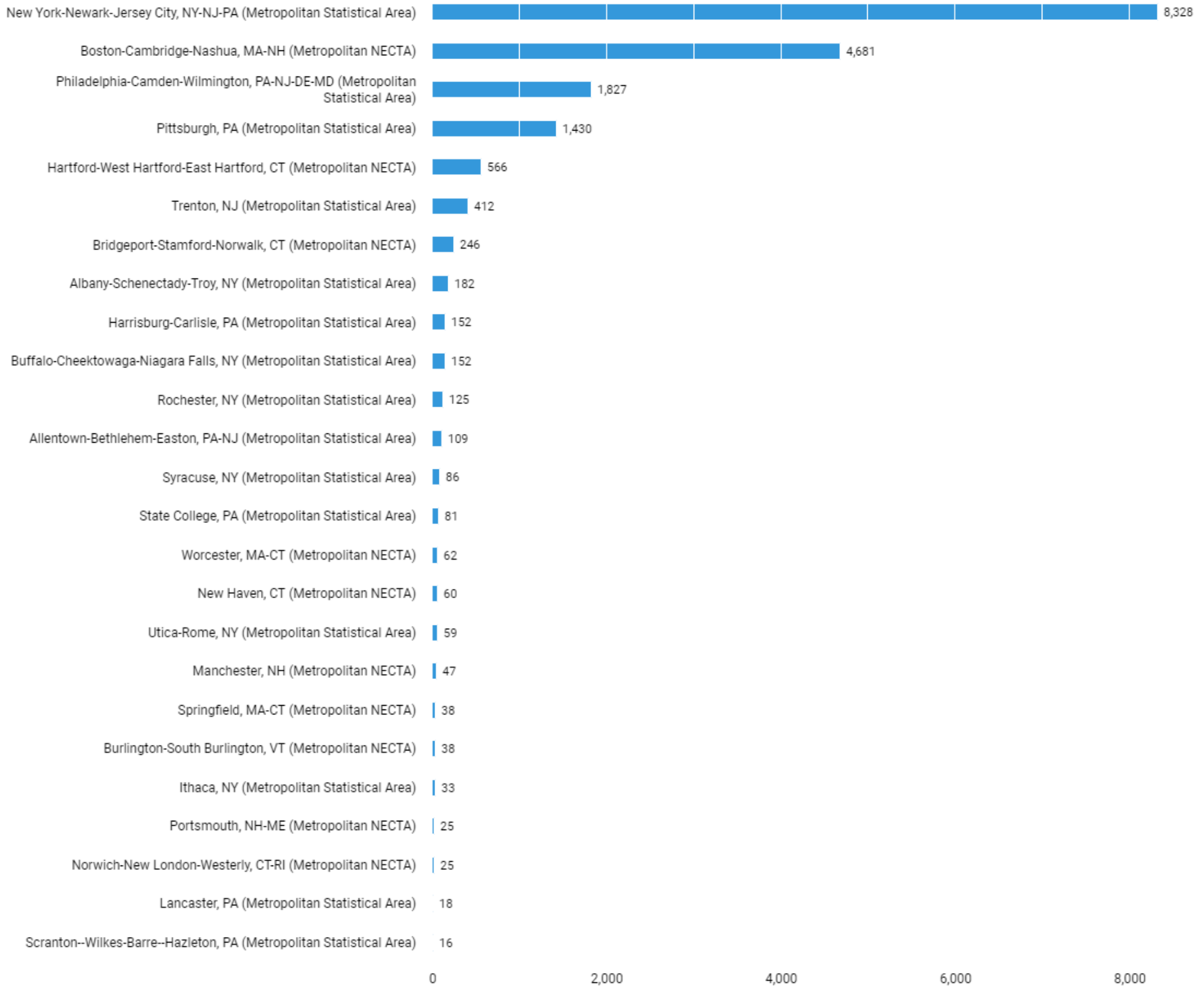
There are 415 unspecified postings.

## Included Postings

New postings

## Active Selections

Last 12 months (Nov. 1, 2019 - Oct. 31, 2020) AND ( State : CT OR State : MA OR State : NH OR State : NJ OR State : NY OR State : PA OR State : VT ) AND ( Cluster : Information Technology: Artificial Intelligence ) AND ( Included Postings : All New Jobs )



Source: Labor Insight (Burning Glass Technologies)

## Skill Clusters in Demand

For skill clusters, unspecified postings are those that have fewer than three skill clusters listed.

Nov. 01, 2019 - Oct. 31, 2020

There are 19,373 postings available with the current filters applied.

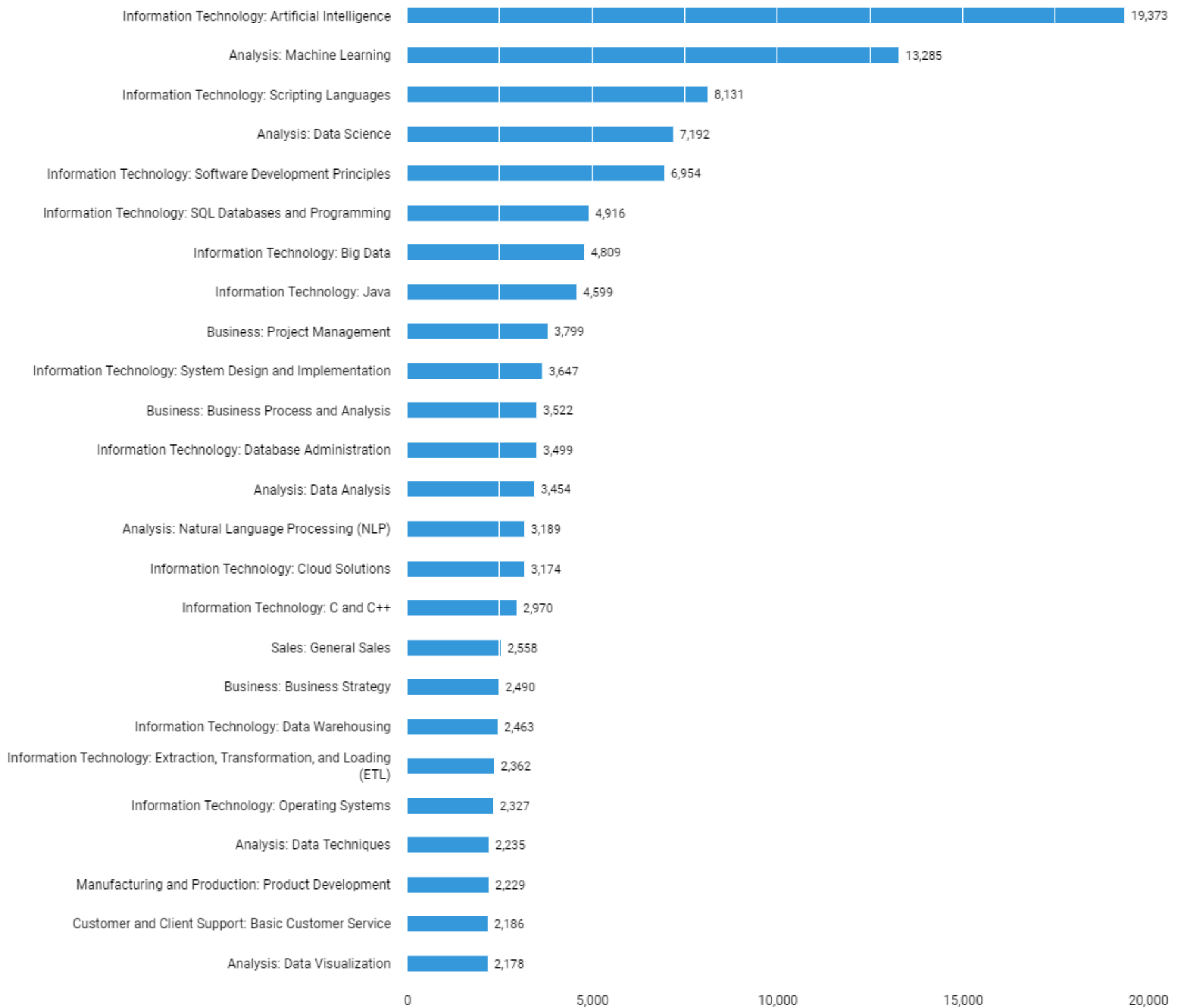
There are 0 unspecified postings.

## Included Postings

New postings

## Active Selections

Last 12 months (Nov. 1, 2019 - Oct. 31, 2020) AND ( State : CT OR State : MA OR State : NH OR State : NJ OR State : NY OR State : PA OR State : VT ) AND ( Cluster : Information Technology: Artificial Intelligence ) AND ( Included Postings : All New Jobs )



## Skill Projections

Burning Glass has developed a methodology for projecting the future demand of skills in the job market. We provide projections for individual skills and clusters of related skills. These projections combine econometric time series models with machine learning approaches to predict the growth in job posting demand for skills.

The skill projections are 2 - year projections from January 2019 - January 2021, and are available nationally (national growth category) and as a global average across all countries Burning Glass supports (global growth category). They are not affected by any additional filters such as occupation or industry. If projections are not yet available for a skill or cluster, we have indicated 'N/A'.

Nov. 01, 2019 - Oct. 31, 2020

There are 19,373 postings available with the current filters applied.

There are 0 unspecified postings.

## Included Postings

New postings

## Active Selections

Last 12 months (Nov. 1, 2019 - Oct. 31, 2020) AND ( State : CT OR State : MA OR State : NH OR State : NJ OR State : NY OR State : PA OR State : VT ) AND ( Cluster : Information Technology: Artificial Intelligence ) AND ( Included Postings : All New Jobs )

Skill Cluster	Postings Requested	National Growth Category	Global Growth Category
Information Technology: Artificial Intelligence	19,373	Growing	Growing
Analysis: Machine Learning	13,285	Growing	Growing
Information Technology: Scripting Languages	8,131	Stable	Growing
Analysis: Data Science	7,192	Growing	Growing
Information Technology: Software Development Principles	6,954	Stable	Stable
Information Technology: SQL Databases and Programming	4,916	Stable	Stable
Information Technology: Big Data	4,809	Growing	Growing
Information Technology: Java	4,599	Declining	Declining
Business: Project Management	3,799	Declining	Stable
Information Technology: System Design and Implementation	3,647	Stable	Stable
Business: Business Process and Analysis	3,522	Stable	Stable
Information Technology: Database Administration	3,499	Stable	Stable
Analysis: Data Analysis	3,454	Growing	Growing
Analysis: Natural Language Processing (NLP)	3,189	Growing	Growing
Information Technology: Cloud Solutions	3,174	Growing	Growing
Information Technology: C and C++	2,970	Declining	Declining
Sales: General Sales	2,558	Stable	Stable
Business: Business Strategy	2,490	Stable	Stable
Information Technology: Data Warehousing	2,463	Growing	Growing
Information Technology: Extraction, Transformation, and Loading (ETL)	2,362	Stable	Stable



Information Technology: Operating Systems	2,327	Declining	Declining
Analysis: Data Techniques	2,235	Stable	Stable
Manufacturing and Production: Product Development	2,229	Stable	Stable
Customer and Client Support: Basic Customer Service	2,186	Stable	Stable
Analysis: Data Visualization	2,178	Growing	Growing
Engineering: Robotics	2,121	Growing	Growing
Information Technology: JavaScript and jQuery	2,112	Growing	Growing
Business: Product Management	2,107	Stable	Stable
Information Technology: Data Management	2,079	Stable	Stable
Information Technology: Software Development Methodologies	2,067	Growing	Growing
Information Technology: NoSQL Databases	2,037	Growing	Growing
Information Technology: Distributed Computing	1,908	Growing	Growing
Information Technology: Programming Principles	1,896	Stable	Stable
Analysis: Data Mining	1,871	Stable	Stable
Information Technology: Microsoft Office and Productivity Tools	1,793	Stable	Stable
Analysis: Statistical Software	1,779	Stable	Stable
Science and Research: Research Methodology	1,742	Stable	Stable
Information Technology: Cloud Computing	1,719	Growing	Growing
Information Technology: Software Quality Assurance	1,673	Stable	Stable
Sales: Business Development	1,619	Stable	Stable
Marketing and Public Relations: Customer Relationship Management (CRM)	1,613	Stable	Stable
Finance: Budget Management	1,608	Stable	Stable
Information Technology: Other Programming Languages	1,585	Growing	Growing
Information Technology: IT Automation	1,543	Growing Rapidly	Growing Rapidly
Analysis: Statistics	1,524	Stable	Stable
Business: Leadership and Management	1,506	Stable	Stable
Information Technology: Cybersecurity	1,495	Stable	Stable

Information Technology: Microsoft Development Tools	1,463	Declining	Declining
Information Technology: Internet of Things (IoT)	1,443	Growing	Growing
Information Technology: Web Development	1,428	Declining	Declining
Media and Writing: Writing	1,372	Declining	Declining
Information Technology: Software Development Tools	1,319	Growing	Growing
Business: Business Management	1,312	Stable	Stable
Analysis: Business Intelligence	1,308	Stable	Stable
Analysis: Mathematical Software	1,302	Stable	Stable
Science and Research: Physics	1,278	Stable	Stable
Engineering: Electrical and Computer Engineering	1,276	Stable	Stable
Information Technology: Technical Support	1,256	Stable	Stable
Business: Business Solutions	1,251	Stable	Stable
Information Technology: Management Information System (MIS)	1,250	Declining	Stable
Information Technology: Data Storage	1,239	Growing	Growing
Information Technology: Oracle	1,238	Stable	Stable
Information Technology: Version Control	1,236	Stable	Stable
Marketing and Public Relations: Market Analysis	1,205	Stable	Stable
Information Technology: Enterprise Resource Planning (ERP)	1,109	Stable	Stable
Economics, Policy, and Social Studies: Economics	1,094	Stable	Stable
Information Technology: IT Management	1,078	Stable	Stable
Information Technology: Web Servers	1,072	Declining	Declining
Marketing and Public Relations: Social Media	1,059	Stable	Stable
Analysis: Mathematical Modeling	1,043	Stable	Stable
Information Technology: Systems Administration	1,028	Stable	Stable
Design: User Interface and User Experience (UI/UX) Design	1,019	Declining	Declining
Administration: Scheduling	1,004	Stable	Stable

Information Technology: Virtual Machines (VM)	881	Stable	Stable
Supply Chain and Logistics: Procurement	800	Stable	Stable
Business: People Management	767	Declining	Stable
Finance: Financial Risk Management	748	Stable	Stable
Information Technology: Test Automation	719	Stable	Stable
Engineering: Simulation	697	Stable	Stable
Business: Key Performance Indicators	696	Stable	Stable
Sales: General Sales Practices	692	Stable	Stable
Science and Research: Genetics	692	Stable	Stable
Business: Quality Assurance and Control	680	Stable	Growing
Health Care: Medical Procedure and Regulation	674	Stable	Stable
Information Technology: Computer Hardware	671	Stable	Stable
Information Technology: Information Security	671	Growing	Growing
Education and Training: Teaching	667	Stable	Stable
Marketing and Public Relations: Marketing Management	650	Stable	Stable
Business: Performance Management	637	Stable	Stable
Industry Knowledge: Computer and Information Technology Industry Knowledge	633	N/A	N/A
Information Technology: Scripting	625	Stable	Stable
Business: Business Consulting	621	Stable	Declining
Information Technology: Network Configuration	619	Declining	Declining
Marketing and Public Relations: General Marketing	609	Stable	Stable
Science and Research: Drug Development	591	Stable	Stable
Supply Chain and Logistics: Transportation Operations	566	Stable	Stable
Information Technology: General Networking	559	Declining	Declining
Information Technology: Telecommunications	556	Stable	Stable
Analysis: Business Intelligence Software	555	Stable	Declining
Business: Process Improvement	541	Stable	Stable

Industry Knowledge: Financial Services Industry Knowledge	534	N/A	N/A
Design: Graphic and Visual Design Software	533	Declining	Stable
Finance: Investment Management	533	Stable	Stable
Sales: Business-to-Business (B2B) Sales	515	Stable	Stable
Industry Knowledge: Biologics Industry Knowledge	509	N/A	N/A
Customer and Client Support: Advanced Customer Service	504	Stable	Stable
Marketing and Public Relations: Online Marketing	499	Stable	Stable
Science and Research: Biology	494	Stable	Stable
Health Care: Clinical Research	486	Stable	Stable
Sales: Account Management	477	Stable	Stable
Human Resources: Employee Training	468	Growing	Growing
Manufacturing and Production: Lean Manufacturing	462	Stable	Stable
Finance: Financial Trading	455	Declining	Declining
Health Care: Oncology	435	Stable	Stable
Marketing and Public Relations: Marketing Strategy	433	Stable	Stable
Sales: Prospecting and Qualification	429	Stable	Stable
Legal: Regulation and Law Compliance	411	Stable	Stable
Science and Research: Chemistry	404	Declining	Stable
Sales: Solution Sales Engineering	401	Stable	Stable
Information Technology: Middleware	381	Stable	Stable
Finance: Auditing	368	Stable	Stable
Finance: General Accounting	367	Stable	Stable
Education and Training: Training Programs	364	Stable	Declining
Finance: Financial Management	361	Stable	Stable
Health Care: Medical Research	360	Stable	Stable
Sales: E-Commerce	356	Stable	Stable
Marketing and Public Relations: Web Analytics	354	Stable	Stable

Media and Writing: Content Development and Management	352	Stable	Stable
Information Technology: Mainframe Technologies	350	Stable	Stable
Engineering: Imaging	345	Stable	Stable
Health Care: Radiology	345	Growing	Growing
Information Technology: Extensible Languages	343	Declining	Declining
Sales: Inside Sales	342	Stable	Stable
Engineering: Engineering Practices	340	Stable	Stable
Information Technology: Productivity Software	340	Stable	Growing
Administration: General Administrative and Clerical Tasks	334	Stable	Stable
Design: Animation and Game Design	330	Stable	Stable
Information Technology: Application Programming Interface (API)	317	Growing	Growing
Sales: Technical Sales	316	Stable	Declining
Information Technology: Basic Computer Knowledge	313	Declining	Declining
Information Technology: Network Protocols	310	Stable	Stable
Supply Chain and Logistics: Supply Chain Management	309	Stable	Stable
Information Technology: Mobile Development	308	Growing	Growing
Information Technology: Cloud Storage	305	Stable	Stable
Engineering: Drafting and Engineering Design	302	Stable	Stable
Health Care: Medical Billing and Coding	301	Stable	Stable
Finance: Fintech	299	Growing	Growing
Analysis: Mathematics	298	Stable	Stable
Information Technology: Web Design	297	Declining	Declining
Business: Contract Management	294	Stable	Stable
Health Care: Basic Patient Care	288	Stable	Stable
Finance: Financial Analysis	287	Stable	Stable
Education and Training: Program Management	285	Stable	Stable
Engineering: Quantum Mechanics	284	Growing Rapidly	Growing Rapidly
Analysis: Validation	276	Stable	Stable
Finance: Billing and Invoicing	276	Stable	Stable

Sales: Sales Management	271	Stable	Stable
Industry Knowledge: Asset Management Industry Knowledge	260	N/A	N/A
Engineering: Mechanical Engineering	259	Stable	Stable
Human Resources: Talent Management	254	Stable	Stable
Human Resources: Recruitment	251	Stable	Stable
Business: Operations Management	249	Stable	Stable
Marketing and Public Relations: Brand Management	248	Stable	Stable
Engineering: Electronic Hardware	247	Declining	Declining
Information Technology: Network File System (NFS)	243	Stable	Stable
Business: Business Communications	242	Stable	Stable
Information Technology: PHP Web	236	Declining	Declining
Health Care: Health Information Management and Security	232	Stable	Stable
Supply Chain and Logistics: Supplier Relationship Management	232	Stable	Stable
Design: Graphic and Visual Design	226	Declining	Stable
Human Resources: Human Resource Management and Planning	226	Stable	Stable
Information Technology: Advanced Microsoft Excel	224	Stable	Stable
Information Technology: Networking Hardware	222	Declining	Declining
Information Technology: Parallel Computing	222	Growing	Growing
Science and Research: Neuroscience	218	Stable	Stable
Sales: Specialized Sales	217	Declining	Stable
Architecture and Construction: General Architecture	215	Stable	Stable
Finance: Financial Reporting	215	Stable	Stable
Design: Industrial Design	213	Stable	Stable
Sales: Company Product and Service Knowledge	213	Stable	Stable
Marketing and Public Relations: Marketing Software	210	Growing	Growing

Business: Due Diligence	209	Stable	Stable
Health Care: Clinical Informatics	209	Stable	Stable
Manufacturing and Production: Manufacturing Processes	207	Declining	Declining
Engineering: Automation Engineering	205	Stable	Stable
Engineering: Process Engineering	204	Stable	Stable
Health Care: Mental and Behavioral Health Specialties	195	Stable	Stable
Administration: Administrative Support	190	Stable	Stable
Health Care: Medical Records	189	Stable	Stable
Engineering: Engineering Management	182	Stable	Stable
Engineering: Chemical Engineering	180	Stable	Stable
Information Technology: Microsoft SQL Extensions	180	Declining Rapidly	Declining Rapidly
Industry Knowledge: Retail Industry Knowledge	174	N/A	N/A
Public Safety and National Security: Surveillance	171	Declining	Declining
Legal: Intellectual Property	170	Declining	Declining
Supply Chain and Logistics: Logistics	169	Stable	Stable
Energy and Utilities: Energy Efficiency	168	Stable	Stable
Maintenance, Repair, and Installation: Equipment Repair and Maintenance	167	Stable	Stable
Science and Research: Molecular Biology	167	Stable	Stable
Finance: Mergers and Acquisitions	166	Stable	Stable

Source: Labor Insight (Burning Glass Technologies)

## Skills in Greatest Demand (Specialized Skills)

For skills, unspecified postings are those that have fewer than three skills listed.

Nov. 01, 2019 - Oct. 31, 2020

There are 19,373 postings available with the current filters applied.

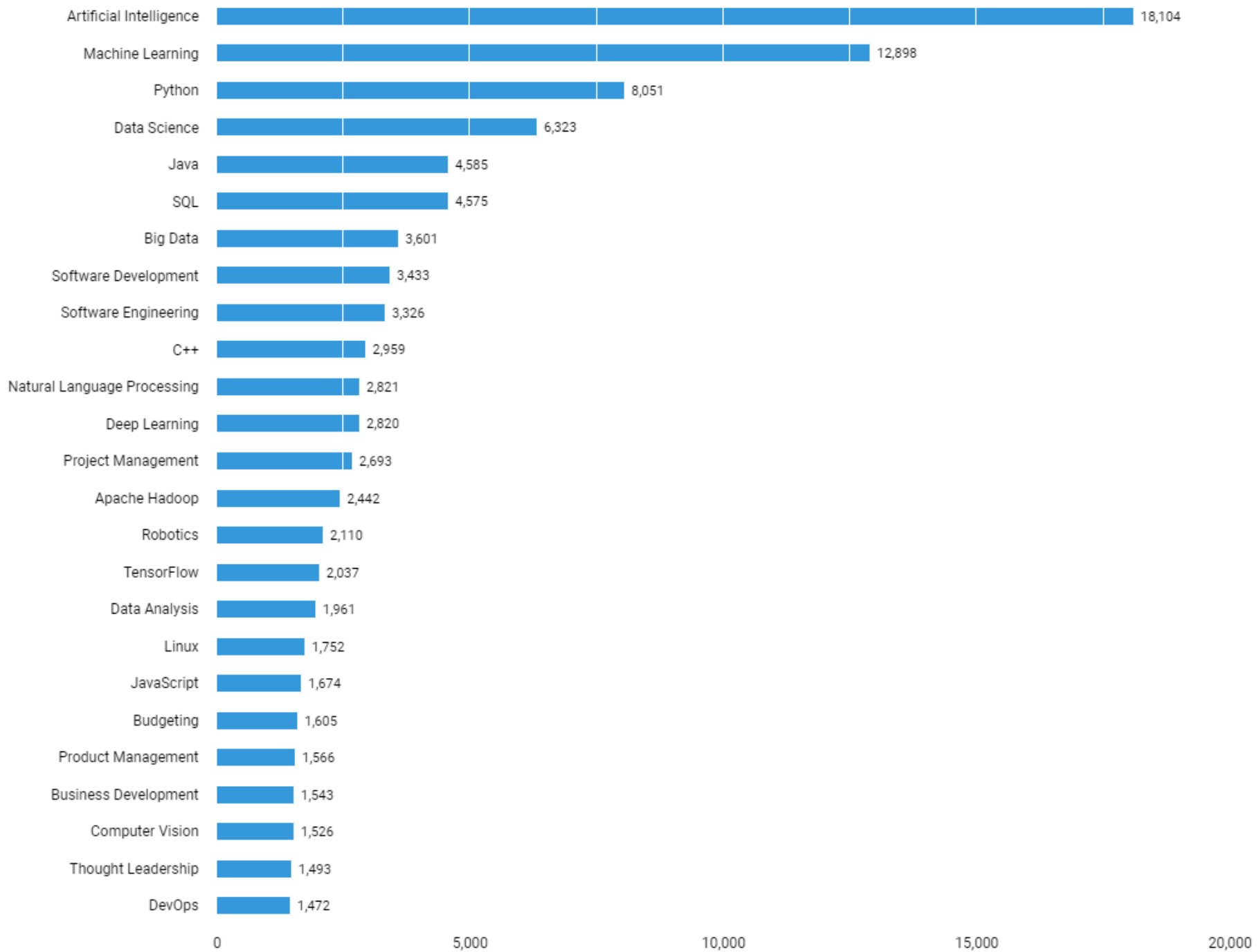
There are 53 unspecified postings.

## Included Postings

New postings

## Active Selections

Last 12 months (Nov. 1, 2019 - Oct. 31, 2020) AND ( State : CT OR State : MA OR State : NH OR State : NJ OR State : NY OR State : PA OR State : VT ) AND ( Cluster : Information Technology: Artificial Intelligence ) AND ( Included Postings : All New Jobs )





## The following skills are requested most frequently in these industries

Nov. 01, 2019 - Oct. 31, 2020

There are 19,373 postings available with the current filters applied.

There are 5,282 unspecified postings.

### Included Postings

New postings

### Active Selections

Last 12 months (Nov. 1, 2019 - Oct. 31, 2020) AND ( State : CT OR State : MA OR State : NH OR State : NJ OR State : NY OR State : PA OR State : VT ) AND ( Cluster : Information Technology: Artificial Intelligence ) AND ( Included Postings : All New Jobs )

Industry Sector		Job Postings	
<b>Professional, Scientific, and Technical Services</b>		<b>4,457</b>	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	3,758	Java	936
Machine Learning	2,459	IBM Watson	904
Python	1,550	Big Data	825
Data Science	1,229	Software Development	737
SQL	966	Natural Language Processing	658
<b>Finance and Insurance</b>		<b>2,581</b>	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	2,512	Java	688
Machine Learning	1,825	Big Data	516
Python	1,111	Natural Language Processing	502
Data Science	1,037	Apache Hadoop	475
SQL	856	Software Engineering	456
<b>Manufacturing</b>		<b>2,349</b>	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	2,320	C++	666
Machine Learning	1,680	Big Data	587
Python	1,136	Software Development	496
Data Science	966	SQL	461
Java	674	Deep Learning	459
<b>Information</b>		<b>1,552</b>	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	1,469	Java	418
Machine Learning	1,103	C++	365
Python	628	Big Data	326
Data Science	572	Software Engineering	295
SQL	420	Natural Language Processing	246

Educational Services		896	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	876	Robotics	168
Machine Learning	563	Software Engineering	131
Teaching	365	Software Development	107
Data Science	284	Computer Engineering	101
Python	221	Budgeting	93
Retail Trade		749	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	733	Amazon Web Services (AWS)	240
Machine Learning	624	Data Science	210
Python	366	Business Development	189
Software Development	296	C++	184
Java	295	Deep Learning	170
Health Care and Social Assistance		514	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	472	SQL	101
Machine Learning	328	Deep Learning	94
Python	197	Patient Care	93
Data Science	141	Cancer knowledge	92
Project Management	107	Software Development	91
Administrative and Support and Waste Management and Remediation Services		366	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	345	Big Data	91
Machine Learning	266	Java	82
Python	183	Natural Language Processing	72
Data Science	121	Apache Hadoop	65
SQL	103	Software Engineering	50
Public Administration		171	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	166	Software Development	39
Machine Learning	118	Data Analysis	34
Python	79	Big Data	32
Data Science	76	Java	32
SQL	41	Software Engineering	26
Accommodation and Food Services		69	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	65	Level design	28
Python	42	Robotics	27
Java	40	3D Printing / Additive Manufacturing (AM)	20
Game Development	29	3D computer graphics	20
Machine Learning	29	Graphic Design	20

Agriculture, Forestry, Fishing and Hunting		68	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	68	Machine Learning	20
Computer Vision	56	Project Management	20
Truck Driving	51	Software Engineering	20
C++	22	Software Development	16
Python	22	Atlassian JIRA	14
Real Estate and Rental and Leasing		61	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	56	Budgeting	14
Machine Learning	34	Big Data	9
Data Science	23	Empower	9
Python	20	Data Analysis	8
Java	16	Continuous Integration (CI)	7
Transportation and Warehousing		60	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	55	Product Management	10
Machine Learning	41	Data Analysis	8
SQL	11	Data Quality	8
Budgeting	10	Python	8
Customer Service	10	Advanced Technologies	7
Utilities		57	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	56	Data Analysis	14
Machine Learning	44	Data Science	14
Python	23	Big Data	12
Software Development	19	Information Systems	12
Internet of Things (IoT)	15	SQL	12
Management of Companies and Enterprises		51	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	51	Bioinformatics	15
Machine Learning	42	Biology	15
Data Science	32	Project Management	15
Data Mining	17	Chemistry	14
Python	17	SQL	14
Wholesale Trade		38	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	38	Automotive Industry Knowledge	7
Machine Learning	32	Sales	7
Software Development	9	C++	6
Python	8	Computer Vision	6
Agile Development	7	Project Management	6

Mining, Quarrying, and Oil and Gas Extraction		28	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	28	Business Process	13
Machine Learning	25	Extraction Transformation and Loading (ETL)	13
Python	20	Business Acumen	12
Robotics	19	Atlassian JIRA	11
Agile Development	16	Data Science	11
Other Services (except Public Administration)		13	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	13	Customer Service	3
Machine Learning	12	Deep Learning	3
Big Data	4	Git	3
Data Science	4	Java	3
Chef Infrastructure Automation	3	Linux	3
Arts, Entertainment, and Recreation		6	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	2	Acquisition Campaigns	1
Ithink	2	Business Development	1
Marketing	2	Carpentry	1
Music	2	Counter Intelligence	1
AI ChatBot	1	Data Management	1
Construction		5	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	5	ASP.NET	2
Machine Learning	3	ASP.NET MVC	2
.NET	2	Active Server Pages (ASP)	2
5G Wireless	2	Agile Development	2
AJAX	2	Android Application Development	2

## The following skills are requested most frequently in these occupations

Nov. 01, 2019 - Oct. 31, 2020

There are 19,373 postings available with the current filters applied.

There are 1,290 unspecified postings.

### Included Postings

New postings

### Active Selections

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Occupation		Job Postings	
<b>Software Developers, Applications</b>		<b>2,786</b>	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	2,607	Software Development	1,196
Machine Learning	1,943	SQL	876
Python	1,570	C++	855
Software Engineering	1,563	JavaScript	681
Java	1,387	Linux	645
<b>Computer and Information Research Scientists</b>		<b>1,905</b>	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	1,896	SQL	690
Machine Learning	1,781	Natural Language Processing	675
Data Science	1,692	Big Data	623
Python	1,548	Java	570
Deep Learning	727	TensorFlow	513
<b>Computer Systems Engineers/Architects</b>		<b>1,472</b>	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	1,369	Big Data	410
Machine Learning	1,143	Deep Learning	380
Python	756	C++	376
Data Science	494	SQL	356
Java	466	Software Development	323
<b>Marketing Managers</b>		<b>697</b>	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	668	Marketing	160
Product Management	423	Project Management	160
Machine Learning	417	Budgeting	132
Product Development	208	Customer Service	111
Data Science	171	Product Marketing	109

Operations Research Analysts		640	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	623	Java	168
Machine Learning	510	Natural Language Processing	165
Python	322	Data Science	147
C++	186	Software Engineering	118
Deep Learning	175	TensorFlow	106
Database Administrators		557	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	500	Big Data	342
Python	440	Apache Hadoop	314
Machine Learning	431	Java	289
SQL	405	Pipeline (Computing)	282
Data Science	350	Scala	273
Managers, All Other		556	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	496	Robotics	103
Machine Learning	318	Project Planning and Development Skills	79
Project Management	299	Python	79
Budgeting	177	Business Process	78
Data Science	126	Program Management	78
Business Intelligence Analysts		553	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	547	Data Analysis	231
Machine Learning	389	Tableau	178
Data Science	323	Big Data	141
SQL	289	Business Intelligence	122
Python	273	Data Visualization	114
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products		478	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	429	Complex Sales	86
Sales	377	Software as a Service (SaaS)	85
Machine Learning	194	Salesforce	80
Business Development	166	New Era	70
Business Acumen	90	Internet of Things (IoT)	66
Management Analysts		427	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	351	SQL	110
Machine Learning	246	Python	104
Business Analysis	154	Business Process	87
Project Management	140	IBM Watson	77
Data Science	111	Atlassian JIRA	72

Information Technology Project Managers		389	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	341	SQL	92
Machine Learning	228	Budgeting	81
Project Management	191	Scrum	75
Data Science	129	IBM Watson	70
Python	117	Natural Language Processing	69
Database Architects		359	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	352	Data Science	155
Machine Learning	314	Python	154
Data Architecture	231	Apache Hadoop	150
Big Data	201	SQL	140
Data Warehousing	156	Data Lakes / Reservoirs	134
Sales Managers		324	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	297	Internet of Things (IoT)	70
Business Development	197	Articulating Value Propositions	47
Sales	189	Project Management	46
Machine Learning	154	Data Management	44
Data Science	73	Software as a Service (SaaS)	42
Computer Systems Analysts		309	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	291	Java	79
Machine Learning	187	Software Development	61
SQL	116	SQL Server	58
Python	95	Tableau	58
Data Science	86	Oracle	50
Web Developers		292	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	259	SQL	61
Machine Learning	142	Data Science	58
JavaScript	124	React Javascript	56
Python	93	Software Engineering	51
Java	74	TypeScript	44
General and Operations Managers		250	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	240	Thought Leadership	49
Machine Learning	167	SQL	48
Data Science	74	Apache Hadoop	47
Python	71	Budgeting	47
Big Data	49	Project Management	39

Medical and Health Services Managers		239	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	211	Management Consulting	52
Machine Learning	107	Thought Leadership	51
Data Science	85	Chemistry	49
Python	58	Investment Banking	45
Business Case Analysis	55	Performance Management	45
Intelligence Analysts		215	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	215	IBM Watson	108
Machine Learning	169	Data Management	102
Python	136	TensorFlow	95
Java	121	Natural Language Processing	92
Microsoft Visio	112	AI ChatBot	87
Information Security Analysts		192	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	184	Python	53
Machine Learning	95	Linux	38
Information Security	94	Network Security	37
Information Systems	56	Big Data	32
Software Development	55	Business Process	28
Engineers, All Other		179	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	165	Deep Learning	51
Machine Learning	122	Neural Networks	37
Python	101	TensorFlow	36
Natural Language Processing	60	Data Science	34
Java	57	Software Engineering	31
Architectural and Engineering Managers		178	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	172	Java	41
Machine Learning	124	Software Engineering	37
Python	89	Robotics	33
Data Science	44	Physics	31
Apache Hadoop	43	SQL	29
Postsecondary Teachers, All Other		177	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	177	Robotics	25
Teaching	135	Economics	22
Machine Learning	112	Data Mining	20
Data Science	62	Big Data	18
Computer Engineering	34	Natural Language Processing	18



Computer and Information Systems Managers		151	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	150	DevOps	36
Machine Learning	108	Data Science	34
Software Development	49	Big Data	29
Budgeting	46	Python	29
Software Engineering	39	Java	21
Market Research Analysts and Marketing Specialists		145	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	111	Data Science	29
Marketing	59	Business-to-Business	28
Machine Learning	52	IBM Watson	23
Salesforce	37	Product Management	22
Tableau	31	Salesforce Marketing Cloud	20
Computer Network Architects		131	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	125	Linux	45
Machine Learning	103	Kubernetes	35
Big Data	60	SQL	31
Python	60	Software Development	27
Java	52	Software Engineering	25
Data Warehousing Specialists		126	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	125	Business Process	44
Machine Learning	100	Big Data	33
Data Science	70	Data Quality	32
Data Management	57	Data Architecture	27
Data Governance	50	Data Lakes / Reservoirs	26
Auditors		119	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	118	Budgeting	23
Public Accounting	73	Accounting	22
Audit Design	52	Financial Statements	22
Business Administration	32	Data Science	21
Customer Contact	24	SQL	21
Financial Managers, Branch or Department		117	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	116	Oracle	31
Machine Learning	67	SAP	31
Business Intelligence	36	Mergers and Acquisitions	30
SQL	33	Project Management	30
Robotics	32	Business Acumen	29

Computer Programmers		116	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	81	Business Development	15
Machine Learning	59	Python	15
IBM Watson	29	Project Management	14
Java	29	SQL	14
Robotics	21	Microsoft Azure	12
Computer User Support Specialists		113	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	82	Internet of Things (IoT)	18
Machine Learning	51	SQL	15
Python	23	Technical Support	14
Customer Service	22	Natural Language Processing	13
IBM Watson	21	Application Support	11
Clinical Research Coordinators		111	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	110	C++	20
Machine Learning	72	Data Analysis	18
Data Science	35	Python	18
Deep Learning	33	Blockchain	15
Physics	25	Project Management	15
Lawyers		109	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	109	Intellectual Property	22
Machine Learning	43	Business Process	21
Business Development	36	Thought Leadership	21
Blockchain	25	Internet of Things (IoT)	19
Litigation	23	Account Management	18
First-Line Supervisors of Office and Administrative Support Workers		102	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	99	Account Management	25
Machine Learning	43	Customer Service	22
Onboarding	32	SQL	17
Project Management	30	Product Management	15
Software as a Service (SaaS)	29	Customer Contact	14
Medical Scientists, Except Epidemiologists		99	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	99	Biomedical Engineering	23
Machine Learning	72	TensorFlow	18
Python	56	Physics	17
Deep Learning	40	C++	16
Data Science	31	Data Analysis	16

Network and Computer Systems Administrators		88	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	73	Python	31
Machine Learning	48	UNIX	26
System Administration	42	Project Management	22
IBM Watson	39	Java	21
Linux	31	Apache Hadoop	20
Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products		83	
Skills	Job Posting	Skills	Job Posting
Sales	78	IBM Watson	20
Artificial Intelligence	61	New Era	18
Technical Sales	42	Business Development	15
Prospective Clients	31	Complex Sales	13
Machine Learning	27	Request for Proposal (RFP)	13
Mechanical Engineers		82	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	82	C++	24
Machine Learning	61	Computer Vision	24
Python	34	Deep Learning	21
Mechanical Engineering	29	Systems Engineering	16
Robotics	29	Autonomous Systems	14
Statisticians		78	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	78	Data Science	22
Machine Learning	54	Python	21
Statistics	30	Microsoft Azure	20
SAS	25	Project Management	20
SQL	24	Business Strategy	15
Software Quality Assurance Engineers and Testers		76	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	69	Atlassian JIRA	21
Quality Assurance and Control	49	SQL	20
Machine Learning	37	Software Development	20
Python	33	C++	18
Linux	26	Software Engineering	17

Human Resources Specialists		71	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	70	Applicant Tracking System	18
Technical Recruiting	28	Talent Acquisition	17
Machine Learning	26	Employee Relations	12
Recruiting	24	Human Resource Information System (HRIS)	11
Onboarding	21	Software Engineering	11
Computer Occupations, All Other		68	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	67	Business Process	15
Machine Learning	45	Project Management	14
Natural Language Processing	21	Robotics	14
Enterprise Resource Planning (ERP)	17	Business Solutions	13
Management Consulting	17	Budgeting	12
Electrical Engineers		64	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	64	TensorFlow	18
Machine Learning	45	Experiments	14
Computer Engineering	36	Computer Vision	12
Python	26	Natural Language Processing	12
C++	20	Physics	12
Education Administrators, Postsecondary		60	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	51	Teaching	11
Machine Learning	38	Social Media	10
Data Science	25	Curriculum Development	9
Customer Service	15	Robotics	9
Budgeting	13	Biotechnology	8
Risk Management Specialists		57	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	52	SQL	18
Risk Management	40	R	16
Machine Learning	38	Big Data	15
Python	21	Deep Learning	15
C++	19	MATLAB	15
Financial Analysts		54	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	54	SQL	15
Machine Learning	40	Data Science	10
Python	21	Deep Learning	8
Data Analysis	19	Accounting	7
Financial Analysis	15	Corporate Finance	7

Retail Salespersons		52	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	48	Customer Service	13
Machine Learning	26	Project Management	13
Sales	24	Thought Leadership	12
Business Process	15	Internet of Things (IoT)	10
Business Development	13	Account Management	8
Administrative Services Managers		49	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	49	Python	12
Machine Learning	37	Budgeting	11
Data Science	18	Economics	11
Predictive Models	15	SQL	11
Project Management	15	Big Data	8
Computer Science Teachers, Postsecondary		48	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	46	Robotics	16
Teaching	45	Natural Language Processing	13
Machine Learning	31	Curriculum Development	12
Data Science	20	Curriculum Design	8
Computer Engineering	18	Instructional Design	8
Training and Development Specialists		48	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	47	Instructional Design	9
Machine Learning	27	Natural Language Processing	9
Python	21	Teaching	9
Data Science	16	Computer Installation and Setup	8
Content Development	9	Deep Learning	8
Engineering Technicians, Except Drafters, All Other		47	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	47	SQL	18
Machine Learning	27	Apache Hadoop	14
Java	26	DevOps	14
Python	23	AWS Elastic Compute Cloud (EC2)	12
Data Science	20	Business Process	12
Public Relations and Fundraising Managers		47	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	46	Budgeting	10
Machine Learning	22	Facebook	9
Data Science	14	Social Media	9
Project Management	12	Big Data	8
Thought Leadership	11	Business Development	7

First-Line Supervisors of Retail Sales Workers		46	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	40	Python	7
Machine Learning	24	Amazon Web Services (AWS)	6
Budgeting	11	Apache Hadoop	6
Business Development	9	Deep Learning	6
Project Management	7	Natural Language Processing	6
Commercial and Industrial Designers		45	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	41	User Research	19
Interaction Design	23	Stakeholder Management	18
Product Design	21	Information Architecture	17
Prototyping	20	Adobe Photoshop	16
Machine Learning	19	Process Design	12
Architects, Except Landscape and Naval		44	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	44	Git	11
Machine Learning	41	Java	10
Data Science	21	Big Data	9
Python	19	Deep Learning	7
Business Process	11	Graphics Processing Units (GPU)	7
Computer Hardware Engineers		43	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	43	Linux	18
Machine Learning	37	Verilog	14
Python	30	Deep Learning	12
C++	26	Data Science	9
Computer Vision	22	Robotics	9
Validation Engineers		43	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	39	Kubernetes	20
Machine Learning	31	Configuration Management	17
Python	30	Ansible	15
Linux	27	AppDynamics	15
Java	24	Apache Kafka	14
Biologists		41	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	41	Drug Discovery	21
Biology	39	Python	21
Machine Learning	38	Biomarkers	19
Bioinformatics	26	Genome	19
Data Science	24	Biotechnology	16

Maintenance and Repair Workers, General		40	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	22	Break/Fix	8
Customer Service	17	Machine Learning	8
IBM Watson	15	SAP	8
Blockchain	10	Business Intelligence	7
Watson Health	10	Enterprise Resource Planning (ERP)	7
Biostatisticians		37	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	37	Next Generation Sequencing (NGS)	17
Machine Learning	30	Biomarkers	16
Bioinformatics	26	Data Analysis	16
Python	25	Biostatistics	11
Biology	23	SAS	11
Robotics Engineers		37	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	37	Deep Learning	15
Robotics	37	Computer Vision	13
Machine Learning	30	C++	12
Python	21	Prototyping	11
MATLAB	17	TensorFlow	10
Sales Engineers		37	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	32	Request for Proposal (RFP)	16
Sales	31	Java	12
Sales Engineering	30	Product Management	12
Description and Demonstration of Products	19	Big Data	11
Machine Learning	19	Software as a Service (SaaS)	11
Video Game Designers		36	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	36	Apache Hadoop	6
Machine Learning	25	Java	6
Blockchain	8	Python	6
Cloud Computing	7	Robotics	6
Software Development	7	Big Data	5
Medical Records and Health Information Technicians		35	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	30	Adobe Analytics	7
Machine Learning	20	Budgeting	7
Project Management	15	Customer Acquisition	7
Data Science	10	Digital Marketing	7
Data Analysis	8	E-Commerce	7

Secretaries and Administrative Assistants, Except Legal, Medical, and Executive		35	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	27	Business Process	7
Administrative Support	15	IBM Watson	7
Business Development	8	Apache Hive	6
Customer Service	8	Apache Kafka	5
Scheduling	8	Abend-AID	4
Public Relations Specialists		34	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	31	Media Relations	7
Social Media	16	Business-to-Business	5
Budgeting	11	Customer Contact	5
Machine Learning	11	Robotics	5
Public Relations	9	Blog Posts	4
Teachers and Instructors, All Other		32	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	32	Software Engineering	9
Teaching	28	Course Development	8
Lecturer	24	Python	7
Data Science	17	LinkedIn	6
Machine Learning	17	Natural Language Processing	6
Technical Writers		31	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	30	Software Engineering	8
Technical Writing / Editing	23	Budgeting	7
Software Development	15	Business-to-Business	7
Machine Learning	10	Content Marketing	7
DevOps	8	Data Transformation	7
Chemists		30	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	30	Chemistry	14
Machine Learning	30	C++	11
Python	18	Drug Discovery	10
Computational Chemistry	15	Bioinformatics	8
Cheminformatics	14	Deep Learning	8
Recreation Workers		30	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	30	Level design	29
Python	30	Youtube	28
Robotics	30	Graphic Design	23
Game Development	29	3D Printing / Additive Manufacturing (AM)	22
Java	29	3D computer graphics	22



Business Continuity Planners		29	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	29	Six Sigma	28
Change Management	28	Six Sigma Black Belt	28
Data Science	28	Machine Learning	18
Lean Six Sigma	28	Atlassian JIRA	17
Project Management	28	Confluence	17
Chemical Engineers		29	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	29	Drug Discovery	18
Machine Learning	24	Immunology	14
Python	20	Clinical Development	13
Data Analysis	18	Neural Networks	13
Data Science	18	Boosting (Machine Learning)	12
Chief Executives		28	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	28	Project Management	7
Machine Learning	11	Business Development	4
Big Data	9	Data Governance	4
Data Science	8	Data Management	4
Budgeting	7	Java	4
Financial Quantitative Analysts		28	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	28	Economics	11
Python	27	SQL	11
Machine Learning	23	C++	10
Physics	18	Data Science	10
Risk Management	14	Java	10
Life Scientists, All Other		28	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	28	Data Collection	5
Machine Learning	18	3D Printing / Additive Manufacturing (AM)	4
Python	10	Chemistry	4
Data Analysis	9	Cognitive Science	4
Physics	9	Data Science	4
Software Developers, Systems Software		28	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	24	Java	7
Machine Learning	16	AJAX	6
Python	15	Amazon DynamoDB	6
Apache Kafka	8	Android Software Development Kit (SDK)	6
C++	8	AngularJS	6

Search Marketing Strategists		27	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	21	Apache Administration	6
Machine Learning	19	Apache Webserver	6
Python	10	Data Management	6
Java	8	IBM Watson	6
Data Quality	7	Indexing	6
Treasurers and Controllers		27	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	26	Financial Statements	10
Accounting	19	Corporate Finance	9
Budgeting	16	Business Process	8
Generally Accepted Accounting Principles (GAAP)	14	Cash Management	8
Financial Reporting	11	Financial Planning	7
Customer Service Representatives		25	
Skills	Job Posting	Skills	Job Posting
Customer Service	23	Sales	5
Artificial Intelligence	12	Virtual Agents	5
IBM Watson	7	Account Management	3
Enterprise Resource Planning (ERP)	6	Business Development	3
Customer Contact	5	Business Strategy	3
Sales Representatives, Services, All Other		25	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	21	Product Management	5
Machine Learning	16	Sales Cycle	5
Sales	12	Big Data	4
Customer Contact	7	Business Process	4
Customer Service	6	Customer Information Control System (CICS)	4
Aerospace Engineers		23	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	23	Embedded Systems	10
Machine Learning	18	Algorithm Development	8
Linux	13	Bash	7
Deep Learning	11	C++	7
Graphics Processing Units (GPU)	11	Physics	7

Civil Engineers		23	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	23	Deep Learning	11
Data Science	15	Big Data Analytics	10
Big Data	11	Business Development	10
Customer Contact	11	Business Acumen	9
Data Transformation	11	Machine Learning	9
Natural Sciences Managers		23	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	23	Big Data	7
Machine Learning	15	Big Data Analytics	7
Data Science	12	Biomarkers	6
Business Process	8	Data Mining	6
Clinical Development	8	Predictive Analytics	6
Copy Writers		22	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	22	Drug Development	6
Machine Learning	8	Blockchain	4
Social Media	8	Budgeting	4
Journalism	7	Business-to-Business	4
Technical Writing / Editing	7	Copywriting	4
Social Scientists and Related Workers, All Other		21	
Skills	Job Posting	Skills	Job Posting
Economics	21	Biostatistics	7
Artificial Intelligence	17	Big Data	6
Data Science	15	Epidemiology	6
Machine Learning	14	Big Data Analytics	5
Python	9	Data Collection	5
Compliance Managers		20	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	20	Change Management	4
Machine Learning	9	Compliance Management	4
Project Management	6	Meeting Facilitation	4
Information Systems	5	Meeting Planning/Facilitation	4
Business Process	4	Negotiation Skills	4
Industrial Engineers		20	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	15	Intellectual Property	5
Machine Learning	10	Business Development	4
New Era	8	E-Health	4
Software Development	8	External Auditing	4
IBM Watson	5	Internal Auditing	4

Paralegals and Legal Assistants		19	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	19	Physics	5
Machine Learning	8	Project Management	5
Computer Engineering	7	Prospective Clients	5
Litigation	5	Technical Support	5
Metadata	5	Image Processing	4
Regulatory Affairs Specialists		19	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	19	Bank Secrecy Act (BSA)	6
Machine Learning	17	Data Collection	6
Anti Money Laundering (AML)	7	Data Mining	6
Economics	7	Root Cause Analysis	5
SAS	7	Technical Writing / Editing	5
Document Management Specialists		18	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	18	Campaign Management	8
Machine Learning	11	Event Planning	8
Business Development	9	Business Strategy	7
Account Management	8	Internet of Things (IoT)	7
Blockchain	8	Sales	6
Industrial Production Managers		18	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	18	Human Machine Interface (HMI)	7
Machine Learning	15	Industrial Processes	7
Current Good Manufacturing Practices (CGMP)	8	Manufacturing Processes	7
Good Manufacturing Practices (GMP)	8	Packaging	7
Batch Records	7	Siemens Nixdorf Hardware	5
Instructional Designers and Technologists		18	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	18	Blockchain	6
Machine Learning	12	Ebusiness	6
Data Science	10	Employee Engagement	6
Good Clinical Practices (GCP)	9	Information Architecture	6
Augmented Reality (AR)	6	Internet of Things (IoT)	6
Social Science Research Assistants		18	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	18	Data Collection	7
Machine Learning	14	SPSS	7
Psychology	10	Data Analysis	6
Python	10	R	6
Data Science	9	Economics	5

Editors		17	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	17	Machine Learning	3
Journalism	13	Project Management	3
Social Media	4	Blog Posts	2
Content Curation	3	Content Management	2
Data Science	3	Facebook	2
Logisticians		17	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	17	Internet of Things (IoT)	8
Supply Chain Knowledge	17	Machine Learning	8
Blockchain	10	Business Process	7
Supply Chain Management	10	Supply Chain Solutions	7
Business Development	8	Cost Control	5
Purchasing Agents, Except Wholesale, Retail, and Farm Products		17	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	16	Supplier Management	8
Machine Learning	12	Procure-To-Pay	7
Procurement	10	Thought Leadership	7
Experiential Learning	8	Big Data	4
Performance Management	8	Technical Writing / Editing	4
Training and Development Managers		17	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	16	Business Strategy	6
Machine Learning	15	Experiments	5
Change Management	7	New Product Development	5
Technical Writing / Editing	7	Regulatory Affairs	5
Business Acumen	6	Computer Vision	4
Accountants		16	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	15	Cost Accounting	5
Accounting	9	Financial Statements	5
Account Reconciliation	7	Machine Learning	5
General Ledger	7	Oracle	5
SAP	6	Blockchain	4
Computer Network Support Specialists		16	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	16	Business Acumen	5
Microsoft Azure	10	Internet of Things (IoT)	5
Machine Learning	9	Project Management	5
Customer Service	8	AWS Redshift	4
DevOps	6	COBIT	4

Education Administrators, Elementary and Secondary School		16	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	16	Data Transformation	8
Machine Learning	11	Data Science	7
Market Strategy	11	Big Data	5
Business Strategy	8	Big Data Analytics	5
Business-IT alignment	8	Digital Marketing	5
Executive Secretaries and Executive Administrative Assistants		16	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Administrative Support	16	Project Management	9
Artificial Intelligence	15	Invoice Processing	7
Machine Learning	11	Travel Arrangements	7
Scheduling	11	Barometers	5
Expense Reports	10	Budgeting	5
Telecommunications Engineering Specialists		16	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	16	Solution Architecture	5
Telecommunications	16	Video Conferencing	5
Voice over IP (VoIP)	10	Amazon Web Services (AWS)	4
Customer Service	6	Avaya	4
Unified Communications	6	Cisco	4
Construction Laborers		15	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	15	Sales Management	12
Prospective Clients	15	Sales Prospecting	12
Sales	15	Business Process	9
Business Development	12	End Sales Processes	9
Customer Service	12	Banking Industry Knowledge	6
Credit Analysts		15	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	15	Behavior Analysis	9
Python	13	Change Management	9
SQL	13	Commercial Lending	9
Credit Risk	12	Due Diligence	9
Machine Learning	11	Empower	9
Human Resources Managers		15	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	15	Recruiting	4
Machine Learning	7	Change Management	3
Robotics	7	Computer Engineering	3
Budgeting	4	Data Science	3
Project Management	4	Experiments	3

Registered Nurses		15	
Skills	Job Posting	Skills	Job Posting
IBM Watson	11	Mental Health	6
Artificial Intelligence	8	Patient Care	5
Budgeting	7	Teaching	5
Business Development	7	Treatment Planning	5
Behavioral Health	6	Case Management	4
Construction Managers		14	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	14	Stakeholder Management	5
Budgeting	11	Biotechnology	4
Machine Learning	10	Business Development	4
Project Management	9	Current Good Manufacturing Practices (CGMP)	4
Robotics	6	Design and Construction	4
Geospatial Information Scientists and Technologists		14	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	12	.NET	6
Machine Learning	8	ArcGIS	6
Data Modeling	7	Data Structures	6
Data Science	7	Debugging	6
JavaScript	7	Deployment Models	6
Office Clerks, General		14	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	12	C++	3
Python	10	Information Technology Industry Knowledge	3
MATLAB	6	Autonomous Systems	2
Machine Learning	6	Biotechnology	2
Data Analysis	4	Capital Markets	2
Phlebotomists		14	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	14	Invoicing	14
Biology	14	Lung Cancer knowledge	14
Biotechnology	14	Medical Triage	14
Cancer knowledge	14	Nodule	14
Genomics	14	Patient Contact	14
Real Estate Sales Agents		14	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	12	Marketing Materials	4
Real Estate Experience	8	Social Media	4
Budgeting	6	Thought Leadership	4
Machine Learning	5	Business Development	3
Inside Sales	4	Social Media Marketing	3

Receptionists and Information Clerks		14	
Skills	Job Posting	Skills	Job Posting
Appointment Setting	14	Digital Sales	4
Artificial Intelligence	14	Sales	4
Automotive Industry Knowledge	10	Business-to-Business	1
Supply Chain Managers		14	
Skills	Job Posting	Skills	Job Posting
Supply Chain Knowledge	14	Blockchain	7
Artificial Intelligence	12	Process Improvement	7
Supply Chain Management	12	Enterprise Resource Planning (ERP)	6
Machine Learning	10	Procurement	5
Supply Chain Strategy	9	SAP	5
Telecommunications Line Installers and Repairers		14	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	14	Market Risk	14
Business Process	14	Risk Management	14
Credit Risk	14	COBIT	12
External Auditing	14	FFIEC	12
Financial Services Industry Experience	14	Cryptography	11
Business Teachers, Postsecondary		13	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	13	Blockchain	5
Machine Learning	12	Marketing	5
Teaching	9	Social Media	5
Budgeting	6	Big Data	4
Data Science	6	Mobile Marketing	4
Clinical Data Managers		13	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	11	Data Collection	6
Clinical Data Management	11	Quality Assurance and Control	6
Data Capture	8	Radiology	6
Data Management	8	Clinical Trials	5
Biotechnology	7	Atlassian JIRA	4
Designers, All Other		13	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	9	Prototyping	4
Machine Learning	6	Adobe Photoshop	3
Data Science	4	ElasticSearch	3
IBM Watson	4	Microsoft Sharepoint	3
Natural Language Processing	4	Product Management	3



Elementary School Teachers, Except Special Education		13	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	13	Digital Video	13
Augmented Reality (AR)	13	Educational Programs	13
Cryptography	13	Game Development	13
Customer Service	13	Java	13
Digital Photography	13	Level design	13
Interpreters and Translators		13	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	13	Data Science	3
Machine Learning	9	Journalism	3
Natural Language Processing	4	Business Process	2
Social Media	4	Business Systems Analysis	2
Customer Service	3	Computational Linguistics	2
Logistics Analysts		13	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	13	Industrial Engineering Industry Expertise	6
Supply Chain Knowledge	7	Internet of Things (IoT)	6
Advanced Technologies	6	Blockchain	5
Data Analysis	6	Business Acumen	5
Demand Planning	6	Business Operations	5
Medical and Clinical Laboratory Technicians		13	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	9	Hospital Experience	4
Machine Learning	6	IBM Watson	4
Python	5	Medical Assistance	4
Cardiology	4	New Era	4
Customer Contact	4	Product Management	4
Purchasing Managers		13	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	12	Machine Learning	4
Procurement	9	Supply Chain Management	4
Enterprise Resource Planning (ERP)	7	Computer Vision	3
Change Management	5	Contract Management	3
Cost Control	4	Manufacturing Resource Planning (MRP)	3
Actuaries		12	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	12	Economics	7
Machine Learning	12	Python	7
Data Science	8	Insurance Underwriting	6
R	8	Quantitative Analysis	6
SAS	8	Brokerage Trading	4

Astronomers		12	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	12	Neural Networks	3
Machine Learning	5	Neuroscience	3
Physics	4	Python	3
Cancer knowledge	3	Robotics	3
Experiments	3	Teaching	3
Graphic Designers		12	
Skills	Job Posting	Skills	Job Posting
Adobe Acrobat	10	IBM Watson	8
Adobe Creative Suite	10	Visual Design	7
Adobe Illustrator	10	Prototyping	6
Adobe Indesign	10	Typesetting	6
Adobe Photoshop	10	Internet of Things (IoT)	5
Manufacturing Engineers		12	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	12	Industrial Engineering Industry Expertise	6
Machine Learning	8	Business Acumen	4
Robotics	7	Business Strategy	4
Cloud Computing	6	Design of experiments (DOE)	4
Industrial Engineering	6	Human Machine Interface (HMI)	4
Regulatory Affairs Managers		12	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	12	FDA Regulations	11
Regulatory Affairs	12	Good Clinical Practices (GCP)	11
Annual Reports	11	In Vitro Diagnostic (IVD)	11
Big Data	11	Lifecycle Management	11
Big Data Analytics	11	Machine Learning	11
Biomedical Engineers		11	
Skills	Job Posting	Skills	Job Posting
Medical Imaging	10	Machine Learning	7
Java	8	Python	7
SQL	8	System Design	7
Artificial Intelligence	7	C++	6
Biomedical Engineering	7	Business Process	4
Child, Family, and School Social Workers		11	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	7	Curam	4
Account Management	4	Data Warehousing	4
Agile Development	4	Estimating	4
Child Psychology	4	Family Support	4
Conflict Management	4	Health and Human Services	4

Compensation, Benefits, and Job Analysis Specialists		11	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	8	Change Management	4
IBM Watson	7	Cloud architecture	4
Project Management	7	Data Science	4
Machine Learning	6	Financial Management	4
Business Development	5	Lifecycle Management	4
First-Line Supervisors of Helpers, Laborers, and Material Movers, Hand		11	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	9	Bitbucket	7
Machine Learning	9	Confluence	7
MySQL	9	Data wrangling	7
SQL	9	Docker Software	7
Atlassian JIRA	7	Framing	7
First-Line Supervisors of Non-Retail Sales Workers		11	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Sales	9	Consultative Sales	4
Artificial Intelligence	6	IBM Watson	4
Customer Service	6	Market Trend	4
Clinical Development	4	New Era	4
Clinical Leadership	4	Pharmaceutical Sales	4
Electronics Engineers, Except Computer		10	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	10	ArcGIS	3
Machine Learning	7	Data Modeling	3
C++	4	Python	3
Data Science	4	SQL	3
.NET	3	Data Mining	2
First-Line Supervisors of Food Preparation and Serving Workers		10	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	10	Cassandra	4
Machine Learning	8	CouchDB	4
Apache Hadoop	4	GitHub	4
Apache Webserver	4	NoSQL	4
Big Data	4	PostgreSQL	4

Health Technologists and Technicians, All Other		10	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	6	Customer Contact	4
Radiology	6	Description and Demonstration of Products	4
Machine Learning	5	Dicom	4
Budgeting	4	IBM Watson	4
Cardiology	4	Microsoft Visio	4
Inspectors, Testers, Sorters, Samplers, and Weighers		10	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	10	Process Control	3
Machine Learning	8	21 CFR Part 11	2
Quality Assurance and Control	7	Adobe Photoshop	2
Blockchain	3	Audit Planning	2
Internet of Things (IoT)	3	Automated Testing	2
Automotive Specialty Technicians		9	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	9	Truck Driving	3
Robotics	4	Vehicle Maintenance	3
Computer Vision	3	Automotive Industry Knowledge	2
Machine Learning	3	Electrical Systems	2
Motor Vehicle Operation	3	Path Planning	2
Combined Food Preparation and Serving Workers, Including Fast Food		9	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	9	Oracle	3
Machine Learning	6	SAP	3
Management Information System (MIS)	5	SQL	3
Business Process	3	Apache Hadoop	2
Natural Language Processing	3	Data Science	2
Economists		9	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	9	SQL	7
Machine Learning	9	Tableau	7
Econometrics	8	Broadcast Industry Knowledge	5
Python	8	Data Science	5
Economics	7	Medical Coding	5

Environmental Engineers		9	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	9	Environmental Models	7
Machine Learning	9	Flask	7
Data Science	8	Pipeline (Computing)	7
Biostatistics	7	Predictive Models	7
Cloud Computing	7	Process Improvement	7
First-Line Supervisors of Construction Trades and Extraction Workers		9	
Skills	Job Posting	Skills	Job Posting
Apache Spark	8	Data Science	8
Apache Webserver	8	Deep Learning	8
Artificial Intelligence	8	Machine Learning	8
Data Analysis	8	Natural Language Processing	8
Data Engineering	8	Neural Networks	8
First-Line Supervisors of Production and Operating Workers		9	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	5	Manufacturing Industry Knowledge	4
Data Science	5	Portfolio Optimization	4
Automotive Industry Knowledge	4	Process Design	4
Budgeting	4	Thought Leadership	4
Design Thinking	4	Virtual Agents	4
Mathematical Science Teachers, Postsecondary		9	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	9	Natural Language Processing	4
Machine Learning	8	Biology	3
Data Science	6	Computer Vision	3
Teaching	6	Distributed Computing	3
Cryptography	4	Facebook	3
Personal Financial Advisors		9	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	9	Machine Learning	4
Due Diligence	5	Accounting	3
Mergers and Acquisitions	5	Billing Inquiries	3
Alteryx	4	Billing Systems	3
Data Analysis	4	Blockchain	3

Sales Agents, Financial Services		9	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	7	Big Data Analytics	5
Machine Learning	6	Capital Markets	5
Sales	6	Equity Research	5
Asset Management Industry Knowledge	5	Fintech	5
Big Data	5	Investment Banking	5
Athletic Trainers		8	
Skills	Job Posting	Skills	Job Posting
Cardiopulmonary Resuscitation (CPR)	8	Orthopedics	8
Customer Contact	8	Patient Care	8
Educational Programs	8	Physical Therapy	8
IBM Watson	8	Program Evaluation	8
Medical Management	8	Sports Performance Techniques	8
Production Workers, All Other		8	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	7	Biostatistics	3
Business Process	4	Biotechnology	3
External Auditing	4	Business Strategy	3
Hardware and Software Configuration	4	Clinical Data Interchange Standards Consortium(CDISC)	3
Insurance Industry Knowledge	4	Clinical Data Management	3
Security Managers		8	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	8	Threat Analysis	6
Data Science	8	Big Data	2
Machine Learning	8	Big Data Analytics	2
Authentication	6	Budget Management	2
Staff Management	6	Budgeting	2
Transportation Planners		8	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	8	Quantum Computing	8
Consultative Sales	8	Simulation	8
Customer Service	8	Technical Writing / Editing	8
Drug Discovery	8	Thought Leadership	8
Machine Learning	8	Transportation Industry Knowledge	8

Bookkeeping, Accounting, and Auditing Clerks		7	
Skills	Job Posting	Skills	Job Posting
Accounts Payable / Accounts Receivable	4	Apache Hadoop	2
IBM Watson	4	Big Data	2
Artificial Intelligence	3	Capital Markets	2
SAP	3	Customer Billing	2
Account Reconciliation	2	Data Analysis	2
Industrial-Organizational Psychologists		7	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	7	Human Intelligence	2
Business Development	2	Machine Learning	2
Business Intelligence	2	Management Consulting	2
Client Needs Assessment	2	Market Research	2
Competitive Analysis	2	Market Strategy	2
Logistics Managers		7	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	7	Adobe Creative Suite	5
Logistics	7	Adobe Indesign	5
Robotics	7	Adobe Photoshop	5
Enterprise Resource Planning (ERP)	6	Computer Vision	5
Adobe Acrobat	5	Cost Control	5
Office and Administrative Support Workers, All Other		7	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	7	Atlassian JIRA	2
Machine Learning	5	Blockchain	2
Data Science	4	Budgeting	2
Product Management	3	Business Acumen	2
Project Management	3	Business Strategy	2
Quality Control Systems Managers		7	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	7	Software Development	4
Project Management	5	Business Intelligence	3
Quality Assurance and Control	5	Business Operations	3
Quality Management	5	Business Process	3
Machine Learning	4	Customer Service	3
Shipping, Receiving, and Traffic Clerks		7	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	6	Internet of Things (IoT)	4
Blockchain	5	Logistics	4
Account Management	4	Process Design	4
Business Case Analysis	4	Proposal Writing	4
Business Development	4	Sales	4

Storage and Distribution Managers		7	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	6	Product Management	4
Authentication	4	Stakeholder Management	4
Key Performance Indicators (KPIs)	4	Data Manipulation	3
Machine Learning	4	Data Science	3
Predictive Analytics	4	Design Thinking	3
Critical Care Nurses		6	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Budgeting	5	Trauma	4
Educational Programs	4	Treatment Planning	4
IBM Watson	4	Artificial Intelligence	2
Patient Care	4	Machine Learning	2
Teaching	4	AI ChatBot	1
Fraud Examiners, Investigators and Analysts		6	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	6	Customer Service	4
Machine Learning	6	Software Development	4
Data Analysis	5	Banking Industry Knowledge	3
Data Science	5	Benchmarking	3
Project Management	5	Business Intelligence	3
Industrial Safety and Health Engineers		6	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	5	Python	3
Machine Learning	4	Robotics	3
Motor Vehicle Operation	4	C++	2
Engineering Design	3	Data Analysis	2
Engineering Design and Installation	3	ISO Standards	2
Instructional Coordinators		6	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	6	Natural Language Processing	2
Machine Learning	5	ServiceNow	2
Python	3	Application Design	1
Customer Service	2	Augmented Reality (AR)	1
Information Systems	2	Big Data	1
Insurance Sales Agents		6	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	5	Social Media	2
Insurance Sales	3	Telemedicine	2
Annuities	2	Urgent Care	2
Budgeting	2	Agile Development	1
Primary Care	2	Analyst Relations	1



Manufacturing Production Technicians		6	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	3	MIMIX	3
Beverage Industry knowledge	3	Meraki	3
Cisco	3	Printers	3
IBM Watson	3	Role Playing Games(RPG)	3
IBM iSeries	3	SQL	3
Mechanical Engineering Technologists		6	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	6	Git	3
Data Engineering	4	Python	3
Data Science	4	Business Process	2
Machine Learning	4	Cloud Computing	2
Data Visualization	3	Information Systems	2
Medical Assistants		6	
Skills	Job Posting	Skills	Job Posting
Project Management	5	Customer Contact	4
Business Solutions	4	End-user training	4
Cardiology	4	IBM Watson	4
Clinical Experience	4	Patient Safety	4
Computer Hardware/Software Knowledge	4	Performance Management	4
Mental Health Counselors		6	
Skills	Job Posting	Skills	Job Posting
3D Modeling / Design	6	Autodesk	6
3D Studio Max	6	Cryptography	6
Adobe Photoshop	6	Employee Training	6
Artificial Intelligence	6	Faculty Training	6
Augmented Reality (AR)	6	Game Development	6
Physicians and Surgeons, All Other		6	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	6	Data Science	3
Machine Learning	6	Managed Care	3
Internal Medicine	5	Medical Coding	3
Clinical Research	3	Network Analytics	3
Customer Billing	3	Network Engineering	3
Physicists		6	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	6	BigTable	2
Chemistry	4	C++	2
Physics	4	Cryptography	2
Apache Hadoop	2	Data Engineering	2
BigQuery	2	Data Lakes / Reservoirs	2

Private Detectives and Investigators		6	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	6	Lidar	4
Machine Learning	6	Multimedia	4
Customer Contact	5	Prospective Clients	4
Biotechnology	4	Synthetic Biology	4
Customer Service	4	Autonomous Systems	1
Producers		6	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	6	Digital Marketing	4
Facebook	5	Google AdWords	4
Machine Learning	5	Journalism	4
Budgeting	4	Social Media	4
Content Management	4	Copy Editing	3
Vocational Education Teachers, Postsecondary		6	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	6	Curriculum Development	2
Machine Learning	4	Apache Hadoop	1
Teaching	4	Apache Spark	1
Data Science	3	Apache Webserver	1
Deep Learning	3	Big Data	1
Animal Breeders		5	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	5	Caffe Deep Learning Framework	2
Machine Learning	4	Cluster Analysis	2
Business Consulting	2	Clustering	2
Business Metrics	2	Data Engineering	2
Business Operations	2	Data Mining	2
Data Entry Keyers		5	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	4	Machine Learning	2
Data Entry	4	Spreadsheets	2
Customer Relationship Management (CRM)	2	.NET	1
Customer Service	2	Administrative Support	1
Database Management	2	Applied Statistics	1
Librarians		5	
Skills	Job Posting	Skills	Job Posting
AI ChatBot	4	Growth Strategies	4
Artificial Intelligence	4	Machine Learning	4
Cognitive Science	4	Management Consulting	4
Data Visualization	4	Network Operations & Service Management	4
Finance	4	Onboarding	4

Materials Scientists		5	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	5	Novel Materials	5
Chemistry	5	Physics	5
Machine Learning	5	Polymer Synthesis	5
Materials Science	5	Renewable Resources	5
Nanotechnology	5	Sealants	5
Nurse Practitioners		5	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	5	Ab Initio	1
Machine Learning	4	Amazon Redshift	1
Benefits Analysis	2	Amazon Web Services (AWS)	1
Business Case Analysis	2	Ansible	1
AWS Redshift	1	Apache Hadoop	1
Pathologists		5	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	5	Surgical Pathology	3
Pathology	5	Cancer knowledge	2
Biomarkers	3	Immunohistochemistry	2
Machine Learning	3	Project Planning and Development Skills	2
Oncology	3	Bioinformatics	1
Police Patrol Officers		5	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	5	Capital Markets	5
Asset Management Industry Knowledge	5	Change Management	5
Basel	5	Credit Risk	5
Business Process	5	Effective Communications	5
COBIT	5	FFIEC	5
Production, Planning, and Expediting Clerks		5	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	5	Data Quality	2
Machine Learning	5	Linux	2
Computer Vision	4	Network Hardware/Software Maintenance	2
Motor Vehicle Operation	3	Operations Management	2
Robotics	3	Simulation	2
Reporters and Correspondents		5	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	5	Social Media	1
Journalism	5	Surveillance	1
Cybersecurity Strategy	2	Wealth Creation	1
Fintech	2	Website Production	1
Business Development	1		

Robotics Technicians		5	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	5	Graphic Design	4
Robotics	5	Java	4
3D Printing / Additive Manufacturing (AM)	4	Level design	4
3D computer graphics	4	Lifting Ability	4
Game Development	4	Python	4
Advertising and Promotions Managers		4	
Skills	Job Posting	Skills	Job Posting
Advertising	3	Accounting	1
Artificial Intelligence	2	Advertising Industry Knowledge	1
Budgeting	2	Advertising Sales	1
Project Management	2	Business Acumen	1
Social Media	2	Business Administration	1
Aerospace Engineering and Operations Technicians		4	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	4	Note Taking	4
Computer Vision	4	Robotics	4
Graphical User Interface (GUI)	4	Software Testing	4
Machine Learning	4	Vehicle Systems	4
Motor Vehicle Operation	4		
Bill and Account Collectors		4	
Skills	Job Posting	Skills	Job Posting
Accounting	3	AS/400	1
Artificial Intelligence	2	Account Adjustment	1
Budgeting	2	Account Auditing	1
Customer Checkout	2	Applied Statistics	1
IBM Watson	2	Big Data	1
Clinical Nurse Specialists		4	
Skills	Job Posting	Skills	Job Posting
Business Development	4	New Era	4
Cardiology	4	Radiology	4
IBM Watson	4	Watson Health	4
Computer Operators		4	
Skills	Job Posting	Skills	Job Posting
IBM Watson	4	Cryptography	1
Customer Service	3	Customer Information Control System (CICS)	1
IBM iSeries	3	Data Facility Hierarchical Storage Manager (DFHSM)	1
Local Area Network (LAN)	2	Disaster Recovery Implementation	1
Computer Hardware/Software Knowledge	1	Disaster Recovery Planning	1

Cost Estimators		4	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	4	Resource Management	2
Project Management	3	AutoCAD	1
Business Acumen	2	Budgeting	1
Financial Reporting	2	Business Case Analysis	1
Machine Learning	2	Business Process	1
Education Administrators, Preschool and Childcare Center/Program		4	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	4	Content Curation	2
Thought Leadership	3	Content Development	2
Advertising Industry Knowledge	2	Content Marketing	2
Blog Posts	2	Digital Advertising	2
Business-to-Business	2	Infographics	2
Electronics Engineering Technicians		4	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	4	Repair	3
5S Methodology	3	3D Printing / Additive Manufacturing (AM)	1
Cloud Computing	3	Calibration	1
Failure Analysis	3	Computer Aided Drafting/Design (CAD)	1
Machine-To-Machine (M2M) Communications	3	Electrical Diagrams / Schematics	1
Environmental Science and Protection Technicians, Including Health		4	
Skills	Job Posting	Skills	Job Posting
Clinical Leadership	4	Sales Cycle	4
Complex Sales	4	Sales Planning	4
IBM Watson	4	Sales Training	4
New Era	4	Salesforce	4
Sales	4	Watson Health	4
Financial Examiners		4	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	4	Economics	2
Internal Auditing	3	Machine Learning	2
Risk Management	3	Market Risk	2
Anti Money Laundering (AML)	2	Model Risk Management (MRM)	2
Bank Secrecy Act (BSA)	2	Securities	2

Geophysical Data Technicians		4	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	4	Hardware Experience	4
Branding Strategy	4	IBM Storage	4
Business Acumen	4	New Era	4
Business Development	4	Sales	4
Business Solutions	4		
Health Diagnosing and Treating Practitioners, All Other		4	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	4	Lifting Ability	3
Clinical Research	3	Medical Assistance	3
Cloud Computing	3	Medical Equipment Industry Knowledge	3
Customer Service	3	Product Knowledge	3
Infectious Disease	3	Robotics	3
Interviewers, Except Eligibility and Loan		4	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	4	Prospective Clients	4
Cold Calling	4	Recruiting	4
Customer Service	4	Social Media	4
Market Research	4	Text Messaging	4
Light Truck or Delivery Services Drivers		4	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	4	JUnit	3
Java	4	Machine Learning	3
AngularJS	3	Node.js	3
Docker Software	3	Process Improvement	3
Experiments	3	Scrum	3
Loan Officers		4	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	4	Credit Risk	1
Robotics	3	Customer Billing	1
Account Management	1	Due Diligence	1
Business Acumen	1	Economics	1
Capital Markets	1	ElasticSearch	1
Mapping Technicians		4	
Skills	Job Posting	Skills	Job Posting
Artificial Intelligence	4	Computer Vision	2
Machine Learning	4	Conflict Management	2
SQL	4	Data Science	2
ArcGIS	2	Database Management	2
Business Planning	2	Design Thinking	2

<b>Mechatronics Engineers</b>		<b>4</b>	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
3D Printing / Additive Manufacturing (AM)	4	Mechanical Design	4
Artificial Intelligence	4	Mechatronics	4
Clinical Trials	4	Microcontrollers	4
MATLAB	4	Prototyping	4
Machine Learning	4	Robotics	4
<b>Occupational Health and Safety Specialists</b>		<b>4</b>	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	4	High-Performance Computing	3
Change Management	3	Level design	3
Computer Engineering	3	Machine Learning	3
Computer Vision	3	Motor Vehicle Operation	3
Configuration Management	3	Robotics	3
<b>Quality Control Analysts</b>		<b>4</b>	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	4	AWS Simple Storage Service (S3)	1
Machine Learning	3	Amazon Redshift	1
Quality Assurance and Control	3	C++	1
AWS Elastic Compute Cloud (EC2)	1	Data Mining	1
AWS Redshift	1	Data Quality	1
<b>Radio Frequency Identification Device Specialists</b>		<b>4</b>	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	4	Linux	2
Machine Learning	3	MATLAB	2
Computer Vision	2	Python	2
Engineering Documentation	2	3D Animation	1
Firmware	2	3D computer graphics	1
<b>Rough Carpenters</b>		<b>4</b>	
<b>Skills</b>	<b>Job Posting</b>	<b>Skills</b>	<b>Job Posting</b>
Artificial Intelligence	4	Clinical Data Management	4
Biostatistics	4	Clinical Data Review	4
Biotechnology	4	Data Capture	4
Business Strategy	4	Data Collection	4
Clinical Data Interchange Standards Consortium(CDISC)	4	Data Management	4

Source: Labor Insight (Burning Glass Technologies)

## Time Series Analysis

New Postings increased by 32.56% to 20,431 in the period 2018 - 2019

Jan. 01, 2010 - Nov. 25, 2020 (Data not available after Nov. 24, 2020)

There are 71,595 postings available with the current filters applied.

There are 0 unspecified postings.

## Included Postings

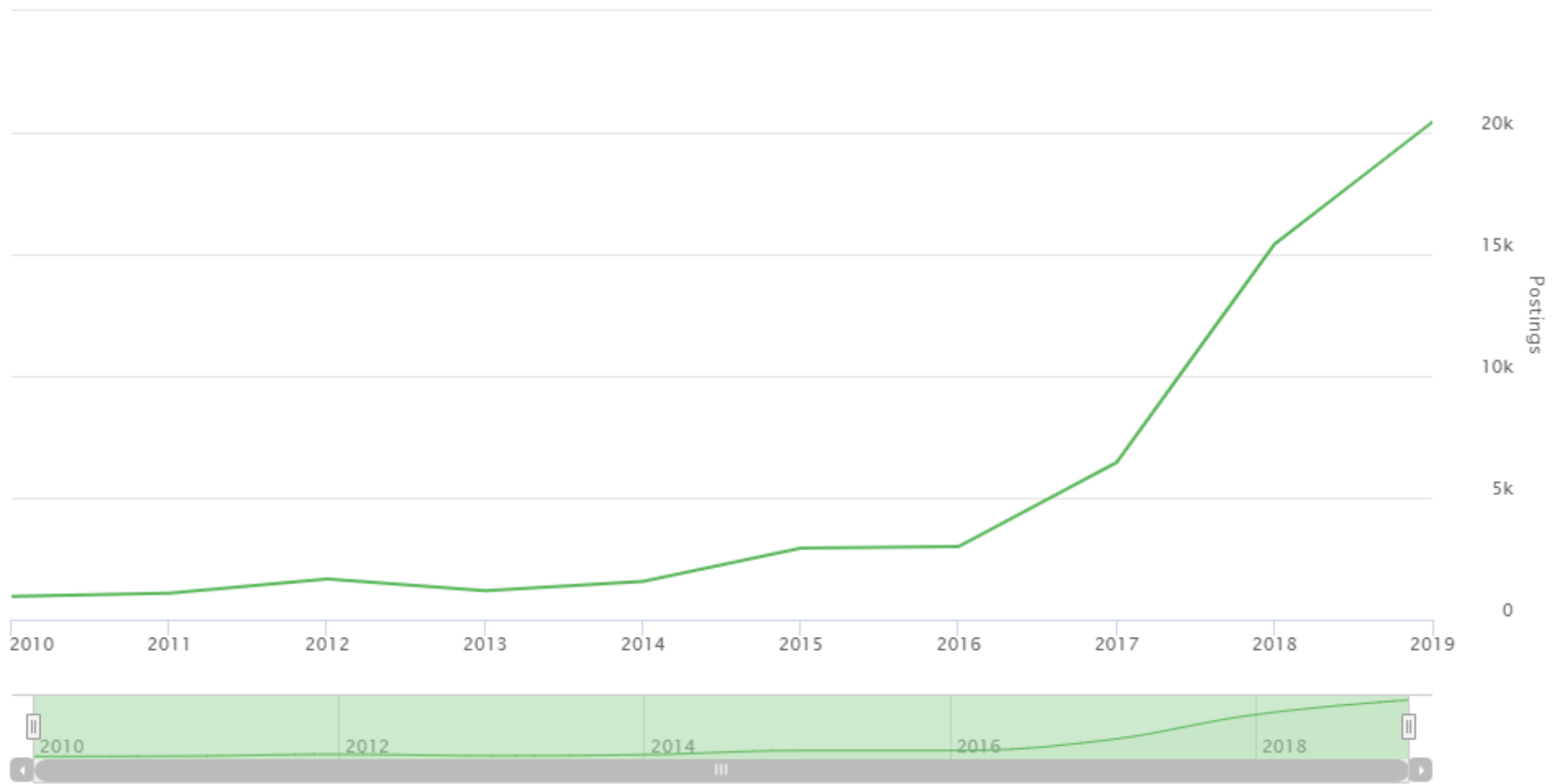
New postings

## Active Selections

Last 12 months (Nov. 1, 2019 - Oct. 31, 2020) AND ( State : CT OR State : MA OR State : NH OR State : NJ OR State : NY OR State : PA OR State : VT ) AND ( Cluster : Information Technology: Artificial Intelligence ) AND ( Included Postings : All New Jobs )

## Interval

Annually



--- Total postings





Clarkson

FACULTY SENATE

8 Clarkson Avenue

Potsdam, New York 13699

MEMO

TO: Provost Robyn Hannigan

SUBJECT: Requested Feedback/Approval on Temporary Changes to Clarkson Regulations for Spring 2021

DATE: 11 December 2020

In response to your request for approval of the draft of temporary changes to the Clarkson regulations, the Faculty Senate would like to provide the following feedback:

- The rationale for the proposed changes to II-E.2 is not clear (i.e., changing "...will not cancel .." to "...may cancel..."). Allowing instructors to cancel classes the day before or after classes seems is potentially very problematic as it may not be applied consistently by different instructors. Further, it seems to increase the temptation for students to take long weekends which works against one of the stated goals of temporarily changing the break schedule in Spring of 2021.

A possible rewording to prevent this but may make it more complicated is: "For each of their courses, instructors may cancel or reschedule the last class that meets before, or the first class that meets after, a break in the semester schedule, *except when those days are Mondays or Fridays* (i.e., long weekend, break days). "

- With regularly scheduled evening classes, the statement in III-G.3 , "No evening or weekend exams will be permitted in Spring 2021." would be improved with, "No evening exams outside of regularly scheduled class times or weekend exams will be permitted in Spring 2021."
- Also, in III-G.3, the language about evening review sessions does not seem to be necessary.
- It would be helpful if it was made clear that these temporary changes do not apply to the Health Sciences or CRC.

Sincerely,

A handwritten signature in cursive script that reads "Kevin B. Fite".

Kevin B. Fite  
Associate Professor and Chair of the Faculty Senate

**Provost's Council  
Meeting Minutes  
Monday, December 7, 2020  
1:00 pm, via Zoom Conference**

Join Zoom Meeting  
<https://clarkson.zoom.us/j/93968306380>  
Meeting ID: 939 6830 6380

**Members:** Robyn Hannigan, Suzanne Davis, Erin Draper, Kerop Janoyan, Bill Jemison, Jen Knack, Augustine Lado, Tom Langen, William MacKinnon, John Moosbrugger, Amanda Pickering, Susan Powers, Chris Robinson, Shannon Robinson, Jenna Stone, Peter Turner, Michael Walsh, Michelle Young

**1. UPDATES**

- Still working on plans for the Spring semester
- HR will be setting up process for scheduling testing and will communicate the plan over break
- Library – will be open (staff will be returning on a rotational basis)

**2. CONSENT**

- AI MS Degree Proposal. Focus of degree is on AI and Machine Learning (Software Engineering will also participate in the program). Market study shows a high demand for such a program. Kerop is working on an online version to attract students from China (and other countries). Currently working on Export Controls. In addition to working with Deb Drescher on the Articulation Agreements. Program does not need any additional faculty, no new courses – as it grows, we expect it would need a TA.

*Motion to move program forward to Faculty Senate, Motion Carried.*

- Continued discussion on Export Controls and expanding the program to International Students. This portion of the program is pending Export Control.
- Shannon will distribute Export Control information separately.

**3. GENERAL DISCUSSION**

Administrative Council Committee Proposal - Student Achievement through Student Accounts Committee. Student invoice is a line item repository of operational activity from many University units. This committee is to improve the infrastructure to insure the accuracy of the student account, including residence life room and board charges, facilities room damages, bookstore charges, scholarship application, etc. . Increases awareness of and understanding of the processes. There is often a disconnect between student advising and financial aid eligibility– open to the make of the committee evolving. Suggestion: The graduate students represented on the committee; need to add committee members to represent the undergraduate students. Candidates for the Interim CFO position are currently being interviewed. Interim CFO will take over these duties.

**4. ANNOUNCEMENTS**

- 12/11 CircleIn Faculty Presentation – Clarkson is a test site in Spring 2021. CircleIn is a study group platform. Allows students to connect through Moodle and – it is set up as a game platform. Helps to fill a gap for student engagement. It is an NSF backed model. Faculty can monitor and tutoring center can connect to students. Experience for students is gamified to

reward engagement. Students can earn Scholarships and gift cards through gamify experience. We agreed to be part of the pilot – but if faculty or students do not like it, we can pull out at the end of the pilot.

- 1/5 Interfolio Faculty180 Training for Pilot Period  
Training moved forward from the original December date, with the hopes that the faculty will be refreshed and willing to come in with open minds.  
**Action Item: Still need an ENG pilot group.**
- Departure of Peter Turner and appointment of Katie Kavanagh
- Article in the Chronicle – indicates that schools that did what we did to handle the COVID crisis, fared out well.

**Adjourned 1:40 p.m.**



Clarkson

OFFICE OF THE  
PROVOST  
8 Clarkson Avenue  
Potsdam, New York 13699  
315-268-6544  
clarkson.edu

## Memorandum

To: Faculty Senate

From: Robyn Hannigan, Provost

Re: Communication - Change to OM 2.4.0 Duties and Responsibilities of Academic Department Chairs and 2.4.1 Appointment and Tenure of Department Chairs

Date: 8 January 2021

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This memo serves as a communication regarding changes to OM Sections 2.4.0 and 2.4.1 developed and recommended by the Dean's Council.

### Current Policy

#### 2.4.0 Duties and Responsibilities of Academic Department Chairs

##### Policy Statement

As chief executive officer of the department, the chair is responsible for the proper and effective administration of the department. It is the chair's responsibility to provide the leadership to achieve the highest possible level of excellence in teaching, research, and other professional activities. The chair shall serve as representative and spokesperson for the department, and shall seek the advice and counsel of departmental colleagues and the dean of the school as appropriate. Specifically, the chair shall:

1. Supervise the execution of school and University policies within the department;
2. Formulate and execute departmental policies and procedures;
3. Assume the initiative in the recruitment of new faculty members of the highest possible quality;
4. Establish an intellectual climate and working conditions that will encourage the professional development of members of the department;
5. Make recommendations to the appropriate dean for new appointments, reappointments, salary changes, termination, tenure, leaves of absence, and promotions;
6. Prepare the budget proposal for the department and supervise expenditure of the funds allocated to the department;
7. Arrange teaching assignments and organize the teaching program to make the most efficient use of the faculty;
8. Evaluate the educational activities of the department, formulate plans for its future development, and transmit these plans to the appropriate dean;
9. Assist officers of the administration in interpreting programs, plans, and needs of the department to appropriate outside agencies;



10. Direct an effective advisory program for all students registered as majors in the department;
11. Provide the necessary departmental cooperation in interdisciplinary, interschool, and University-wide activities;
12. Supervise the use and assignment of departmental space, facilities, equipment, and supplies;
13. Recommend appointments and supervise the work of non-academic staff of the department;
14. Notify the dean of the school whenever members of departmental faculty are unable to conduct classes because of illness or absence from the village;
15. Review periodically with the departmental faculty those University regulations that bear directly on their teaching and advising functions, with particular emphasis on academic integrity.

## Revised Policy

### 2.4.0 Duties and Responsibilities of Academic Department Chairs and Academic Program Directors

#### Policy Statement

A. **Academic Department Chair** - As chief executive officer of the department, the chair is responsible for the proper and effective administration of the department. It is the chair's responsibility to provide the leadership to achieve the highest possible level of excellence in teaching, research, and other professional activities. The chair shall serve as representative and spokesperson for the department and shall seek the advice and counsel of departmental colleagues and the dean of the school as appropriate.

B. **Academic Program Director** - An academic program director acts in the same way as an academic department chair with similar roles and responsibilities. Specific roles and responsibilities of an academic program director will be necessarily distinct in scope and/or breadth from those of other academic program directors and department chairs depending on the School/Institute in which they serve. Each academic program director's roles and responsibilities will be detailed within their appointment letter and so may not encompass the entirety of duties listed below.

Specifically, the chair/**program director** shall:

1. Supervise the execution of school and University policies within the department;
2. Formulate and execute departmental/**academic program** policies and procedures;
3. Assume the initiative in the recruitment of new faculty members of the highest possible quality;
4. Establish an intellectual climate and working conditions that will encourage the professional development of members of the department/**academic program**;
5. Make recommendations to the appropriate dean/**institute director** for new appointments, reappointments, salary changes, termination, tenure, leaves of absence, and promotions;

6. Prepare the budget proposal for the department and supervise expenditure of the funds allocated to the department/~~academic program~~;
7. Arrange teaching assignments and organize the teaching program to make the most efficient use of the faculty;
8. Evaluate the educational activities of the department/~~academic program~~, formulate plans for its future development, and transmit these plans to the appropriate dean/~~institute director~~;
9. Assist officers of the administration in interpreting programs, plans, and needs of the department/~~academic program~~ to appropriate outside agencies;
10. Direct an effective advisory program for all students registered as majors in the department/~~academic program~~;
11. Provide the necessary departmental/~~programmatic~~ cooperation in interdisciplinary, interschool, and University-wide activities;
12. Supervise the use and ~~access to~~ departmental/~~programmatic~~ space, facilities, equipment, and supplies;
13. Recommend appointments and supervise the work of non-academic staff of the department/~~academic program~~;
14. Notify the dean/~~institute director of the school~~ whenever members of ~~departmental~~-faculty are unable to conduct classes because of illness or absence ~~from the village~~;
15. Review periodically with the ~~departmental~~-faculty those University regulations that bear directly on their teaching and advising functions, with particular emphasis on academic integrity.

## **Current Policy**

### **2.4.1 Appointment and Tenure of Department Chairs**

#### **Policy Statement**

**Appointment.** All appointments will be made by the president of the University. The Provost of the appropriate school shall initiate recommendations for the appointment of department chairs after careful screening of candidates in accordance with equal employment opportunity and affirmative action policies and procedures and consultation with the departmental faculty and other department chairs. The consulting process shall consist of the following: the opportunity for individuals to submit confidential personal comments, and a secret ballot of the departmental faculty conducted by the current department executive officer or a faculty member elected for the purpose, with the results revealed to the department, dean, and office of the Provost.

**Term of Office.** Department chairs shall be appointed for three-year terms and are eligible for reappointment by the Provost. Before such reappointments, reviews and evaluations of their performance will be obtained from the departmental faculty and from appropriate administrative officers and faculty members. If an administrative change seems necessary during the chair's term, the chair may request that his or her case be referred to a representative faculty review committee before final action is taken. Such a committee's findings will be reported in writing to the Provost for use in arriving at a decision.

**Period of Duty.** The department chair will be appointed on the basis of the academic year (nine months) with the understanding that additional necessary business for the department will be conducted during the summer months. However, since summer responsibilities are expected to be minimal, department chairs are permitted to undertake other assignments with or without additional remuneration within established University policies. The department chair is responsible at all times for the performance of departmental duties unless other arrangements are made in writing with the appropriate dean.

## **Revised Policy**

### **2.4.1. Appointment and Tenure of Department Chairs and Academic Program Directors**

#### **Policy Statement**

**Appointment.** Departmental chairs and academic program directors are appointed by the Dean/Institute Director, after consultation with all department faculty members and staff, and the approval of the Provost. Initial appointments are to three-year terms and are eligible for re-appointment by the Dean upon evaluation of their performance. Terms normally start at the beginning of the Clarkson fiscal year (July 1). Chairs and academic program directors serve at the pleasure of the president. Department Chairs and academic program directors will be evaluated for performance annually, with a more detailed review at the end of a three-year term in advance of renewal. Review by the Dean/Institute Director, however, can occur at any time during the term of service.

Chairs and academic program directors may be recruited by the Dean/Institute Director from within the unit, from affiliate units, or through an external search at the direction of the Dean/Institute Director and assent by the Provost. Interim or Acting chairs/academic program directors may be appointed to quickly fill vacancies, but a permanent appointment should be made as soon as possible.

**Term of Office.** Department chairs and academic program directors shall be appointed for three-year terms and are eligible for reappointment. In general, a maximum of two additional 3-year terms is typical, though in exceptional cases, a chair/academic program director may be appointed by the Dean/Director for additional terms. Before such reappointments, reviews and evaluations of their performance will be obtained from the departmental faculty and staff, as well as from appropriate administrative officers and faculty members. The department chair/academic program director can resign or be removed and replaced prior to the end of the term if deemed necessary by the Dean/Institute Director. Chairs/academic program directors who finish their service are not precluded from serving again, after a gap in service of at least three years.

**Period of Duty.** The department chair/academic program director will be appointed based on the academic year (nine months) with the understanding that additional work necessary for continuity of department/program business will be conducted during the summer months. The department chair/academic program director is always responsible for the performance of departmental/programmatic duties unless other arrangements are made in writing with the appropriate dean.



**MEMO**

To: The Faculty Senate, Clarkson University

From: Dr. Natasha Banerjee, Chair of the Graduate Committee of Computer Science

Re: Proposal to Change **Master of Science in Computer Science Program (currently Thesis Only)** to **Master of Science in Computer Science with Thesis and Non-Thesis Options**

**Executive Summary**

In this document, we are proposing to expand the Master of Science in Computer Science which is presently a thesis-only degree to a Master of Science (MS) in Computer Science (CS) that has both thesis and non-thesis options. Our move is motivated by the following factors:

- **Explosion of jobs in Computer Science (CS):** Given the explosion of jobs in computer science (CS) fields such as artificial intelligence (AI), data science, machine learning, cybersecurity, networking, and software development, together with the demands for candidates with specialized expertise in these areas, it is becoming imperative to provide healthy offerings of Masters degrees in these areas. The CS department at Clarkson has developed strengths in theory, artificial intelligence (AI), graphics & visualization, software, security, systems, and networks, making it ripe to offer MS in CS with project-based non-thesis options in a diverse range of areas.
- **Strong connections with companies seeking professional MS degrees in CS:** Over the past decade, members of the CS department have been actively involved in forging connections with companies such as Kitware Inc., Delsys, CACI, AFRL, GE, and BAE systems. These companies as well as existing contacts at IBM are actively seeking graduates with extensive course-based backgrounds in the aforementioned computer science areas. They are also highly interested in having their current employees receive MS degrees that demonstrate a breadth of CS experience through courses and project development.
- **Increasing numbers of international students demonstrating desire for professional MS degrees in CS:** Additionally, we are seeing an influx of international students from a diverse range of countries, many of whom are seeking professional graduate programs in CS.
- **Preparedness for potential pandemic-influenced uptick in college enrollment:** Our move is also motivated with the desire to be prepared for the strong probability that the economic downturn caused by the COVID-19 pandemic will cause college enrollment to rise, especially in professional MS programs, as people seek to improve job prospects through these programs, similar to the uptick after the 2008 recession<sup>1</sup>. We wish to be prepared to effectively cater to their individual needs, in order that they are well-prepared to re-enter a changed job market. Given our ongoing strengths in offering online education, we are well-poised to deliver diverse modes of CS education, in traditional, distance, and hybrid modes.

Currently, the Computer Science at Clarkson department offers a PhD in Computer Science, and also offers the MS in Computer Science with thesis option as an interdisciplinary program jointly administered by the Department of Electrical & Computer Engineering. For candidates seeking

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<sup>1</sup> <https://hechingerreport.org/how-the-2008-great-recession-affected-higher-education-will-history-repeat/>

professional degrees with a diverse course base to strengthen their resumes, neither program helps meet the purpose.

- The PhD is geared toward advancement of fundamental research, and does not serve the need of candidates interested in a 1-2 year degree program intended to develop professional skills in desired fields of computer science.
- While the current thesis-based MS is a 2-year program, the demands of a thesis correspond to demonstration of merit at applied research, which lies well outside the interest area of a large body of candidates for the MS program.
  - Our communications with Colleen Thapalia, Director of International Graduate Admissions & Recruitment, as well as conversations with undergraduate students at Clarkson, personal connections, colleagues, and professionals in industry are revealing that candidates who would have been willing to come to Clarkson for an MS in CS are dissuaded by the current thesis-based MS program offered in the department.
  - Students who do join often demonstrate difficulty in completing the thesis portion of the program, with at least two students having had to switch to MS in Basic Sciences in order to graduate despite having completed all courses.
  - Given the uncertainty of success in getting MS students to do a thesis, the graduate committee often has to reject students who apply to the current thesis-based MS. In 2019 alone, the graduate committee rejected 16 applicants to the MS program; however, reviewers had deemed that these applicants would be apt, and would see greater success, if the MS has a non-thesis option.

Our goal is to expand the MS in CS to have both thesis and non-thesis (i.e. project-based) options. The non-thesis option will have 6 credits of project work.

For all courses listed in the Degree Requirements in the Description that follows, we currently have faculty assigned to teach the courses. No new faculty will be needed. Also, no equipment will be needed. Each class is expected to grow by 8+ students (pro forma with estimate can be found in Section 5 of the Project Description), so courses listed in the Degree Requirements may need to be moved to slightly larger rooms to accommodate the growth in students.

We are requesting **one graduate teaching assistant (TA) line** as part of this proposal. Given the general growth in the department in undergraduate student enrollment, and the fact that we are simultaneously initiating an MS in Artificial Intelligence with thesis and non-thesis options, which is expected to add 6 students, on average, three courses that are common to both programs are expected to see a growth of 14 students in the first year, which is expected to double to 28 students in the third year. With each class seeing 14 students in the first year, i.e., the additional load is expected to become  $3 \times 14$  or 42 students, which is expected to double to 84 students by Year 3. The TA is requested to support providing effective instruction to the enhanced student load. As the program grows, we expect to need more resources in the form of teaching assistants, and new faculty members if the class sizes grow to a point that classes need to be divided into multiple sections for effective delivery of instruction. Section 6 provides a detailed justification for this request.

## Description

### 1. Degree Requirements

The following table provides a summary of the degree requirements for the proposed non-thesis option in the MS in CS and the altered thesis option in the MS in CS.

Requirements	Non-thesis Option	Thesis Option
General	Minimum of 30 credit hours, of which minimum 24 must be course work and minimum 6 must be project work	Minimum of 30 credit hours, of which minimum 18 must be course work, minimum 2 must be seminar, and 10 must be thesis work
Foundation Course Requirement	CS 547 (Computer Algorithms, 3 credits)	CS 547 (Computer Algorithms, 3 credits)
Programming Courses Requirement	2 3-credit courses from an approved list of courses that qualify as requiring a substantial amount of programming	2 3-credit courses from an approved list of courses that qualify as requiring a substantial amount of programming
Electives	<ul style="list-style-type: none"><li>• 4 3-credit electives, students are recommended to select electives in a field of specialization.</li><li>• 1 3-credit course that is a computer engineering course focusing on a computer science topic.</li></ul>	<ul style="list-style-type: none"><li>• 2 3-credit electives, one of which should be a 600-level course that focuses on research topics in computer science.</li><li>• 1 3-credit course that is a computer engineering course focusing on a computer science topic.</li></ul>
Project Work	2 3-credit project courses (CS 613 and CS 614)	N/A
Thesis Work	N/A	Maximum 10 credits
Seminar	N/A	2 1-credit seminar courses (CS 707 & CS 708)

It is possible for one course to fulfill more than one requirement. E.g., the course CS 552 which is cross-listed with EE 505 fulfills the programming course requirement and the requirement of being a computer engineering course focusing on a computer science topic. Since a 3 credit course will be used to fulfill requirements that would typically require 6 credits worth of courses (3 credits for the programming requirement + 3 credits for CompE course with CS topic requirement), the student will have to make up the remaining  $6-3=3$  credits by taking any CS 500-level course or above to fulfill the general 30-credits requirement.

The non-thesis option can be completed in 1 to 1.5 years, while the thesis option can be completed in 1.5 to 2 years. Example completion tracks are shown in Section 3. All courses, except the project courses CS 613 and CS 614, and the course CS 574 (Natural Language Processing) are already available in the course catalog. The current 600-level course CS 668 will be converted to a 500-level version (CS 668 --> CS 574) in line with the department's vision to make training in electives such as vision and language processing accessible to a wider audience. New course approval forms are only required for the project, thesis, and seminar courses. A course change request form is required to convert CS 668 to CS 574. New course and course change forms have been included as attachments.

Up to two graduate-level courses can be taken outside the CS department from programs, departments, and schools such as, but no limited to, Data Analytics, Engineering, Mathematics, Physics, and Biology, with the permission of either the research advisor for students in the thesis-based MS in CS or the permission of the graduate coordinator for students in the non-thesis MS in CS, and the approval of the CS graduate committee.

**Distance option:** The program will be available as a distance option to students registered as distance learning students. All courses offered by the department have distance sections, and the program has flexibility whereby all requirements (i.e., minimum of 30 credits) can be completed at a distance.

Section 7 lists the approved list of courses that count as programming courses, and also lists courses that can be taken for specialized electives for the specialization direction / research topic.

**2. Learning objectives, outcomes, and methods to assess accomplishment of learning objectives.**

Non-thesis option:

<b>Learning Objective</b>	<b>Learning Outcome</b>	<b>Assessment of Success</b>
Acquiring of foundational CS knowledge	Students will be equipped with foundational knowledge of computer algorithms by taking CS 547.	<ul style="list-style-type: none"> <li>● Grade statistics for students in program taking CS 547</li> </ul>
Acquisition of breadth in CS through programming expertise	Students will take at least 2 courses containing material with substantial programming.	<ul style="list-style-type: none"> <li>● Grade statistics for students in program across programming courses</li> <li>● Student reports of course experience in exit surveys</li> </ul>
Project development expertise	Students will do 6 credits worth of project work which will culminate in the design and end-to-end implementation of a project topic in computer science, with a comprehensive project report.	<ul style="list-style-type: none"> <li>● Grade statistics for students in program across project development courses (CS 613 and CS 614)</li> <li>● Summary statistics of project report evaluations from graduate committee</li> <li>● Student reports of course experience and impact of project development experience in finding internships and full-time positions through exit surveys</li> <li>● Survey of companies at career fair and via email questionnaires to gauge contribution of project development experience toward candidate quality</li> </ul>
Depth of knowledge for jobs in CS disciplines	Students will take 16 credits worth of electives to acquire targeted depth of knowledge to be competitive for jobs in CS disciplines such as AI, ML, data science, visualization, software, cybersecurity, systems, and networks.	<ul style="list-style-type: none"> <li>● Grade statistics for students in program across elective courses</li> <li>● Student reports of course experience and impact of specialized electives in finding internships and full-time positions through exit surveys</li> <li>● Survey of companies at career fair and via email questionnaires to gauge contribution of specialized electives toward candidate quality</li> </ul>

Thesis option:

<b>Learning Objective</b>	<b>Learning Outcome</b>	<b>Assessment of Success</b>
Acquiring of foundational CS knowledge	Students will be equipped with foundational knowledge of computer algorithms by taking CS 547.	<ul style="list-style-type: none"> <li>● Grade statistics for students in program taking CS 547</li> </ul>
Acquisition of breadth in CS through programming expertise	Students will take at least 2 courses containing material with substantial programming.	<ul style="list-style-type: none"> <li>● Grade statistics for students in program across programming courses</li> <li>● Student reports of course experience in exit surveys</li> </ul>
Readiness for higher degrees in CS	Students will do 10 credits worth of thesis work, involving MS-level research in a CS area of interest, culminating in a thesis defense before a committee.	<ul style="list-style-type: none"> <li>● Grade statistics for students in program across thesis courses (CS 634)</li> <li>● Reports of performance from thesis advisors</li> <li>● Student reports of course experience and impact of thesis experience toward pursuing PhDs</li> <li>● Counts of students entering PhD programs after thesis-based MS in CS</li> </ul>
Depth of knowledge for jobs in CS disciplines	Students will take 6 credits worth of electives together with research experience through working on their thesis to acquire targeted depth of knowledge to be competitive for jobs in CS disciplines such as AI, ML, data science, visualization, software, cybersecurity, systems, and networks.	<ul style="list-style-type: none"> <li>● Grade statistics for students in program across courses</li> <li>● Student reports of course experience and impact of specialized electives and research experience in finding internships and full-time positions through exit surveys</li> <li>● Survey of companies at career fair and via email questionnaires to gauge contribution of specialized electives toward candidate quality</li> </ul>

### 3. Sequencing Plan

#### 1 year completion option for non-thesis option

Year 1 Fall	Year 1 Spring
CS 547 – Computer Algorithms (3 credits)	CS 551 – Artificial Intelligence (Elective III, 3 credits)
CS 572 – Computer Vision (Elective I, 3 credits)	CS 572 – Image Understanding (Elective IV, 3 credits)
CS 550 – Software Design & Development (Programming I, 3 credits)	CS 559 – Human-Computer Interaction (Programming II, 3 credits)
CS 570 – Deep Learning (Elective II, 3 credits)	EE 505 – Computer Graphics (CompE course with CS focus, 3 credits)
CS 613 – CS Projects I (3 credits)	CS 614 – CS Projects II (3 credits)

#### 1.5 year completion option for non-thesis option

Year 1 Fall	Year 1 Spring	Year 2 Fall
CS 547 – Computer Algorithms (3 credits)	CS 551 – Artificial Intelligence (Elective III, 3 credits)	CS 555 – Computer Networks (Elective IV, 3 credits)
CS 572 – Computer Vision (Elective I, 3 credits)	CS 559 – Human Computer Interaction (Programming II, 3 credits)	CS 614 – CS Projects II (3 credits)
CS 550 – Software Design & Development (Programming I, 3 credits)	EE 505 – Computer Graphics (CompE course with CS focus, 3 credits)	
CS 570 – Deep Learning (Elective II, 3 credits)	CS 613 – CS Projects I (3 credits)	

### 1.5 year completion option for the thesis option

Year 1 Fall	Year 1 Spring	Year 2 Fall
CS 547 – Computer Algorithms (3 credits)	CS 559 – Human Computer Interaction (Programming I, 3 credits)	CS 572 – Computer Vision (Programming II, 3 credits)
CS 570 – Deep Learning (Elective I, 3 credits)	EE 505 – Computer Graphics (CompE course with CS focus, 3 credits)	CS 634 – Thesis (7 credits)
CS 634 – Thesis (3 credits)	CS 649 – Current Issues in Machine Learning (Elective II, 3 credits)	
CS 707 – Seminar I (1 credit)	CS 708 – Seminar II (1 credit)	

#### 4. Catalog entry for MS in Computer Science Program (listing thesis and non-thesis options)

##### MS in Computer Science Program

*Natasha K. Banerjee, Chair of the Graduate Committee of the Department of Computer Science*  
[nbanerje@clarkson.edu](mailto:nbanerje@clarkson.edu)

*Christopher A. Lynch, Chair of the Department of Computer Science*  
[clynch@clarkson.edu](mailto:clynch@clarkson.edu)

The Department of Computer Science offers a graduate program leading to degree of Master of Science (offered interdisciplinary with the Department of Electrical and Computer Engineering) in Computer Science. The program is designed to increase fundamental knowledge in computer science, provide a strong background in programming, prepare students for specialization in industry and research through taking targeted electives, and provide students with end-to-end problem solving through project development or research and thesis writing. The department provides the advantage of close personal association between graduate students and faculty, giving special attention to individual needs and interests.



## **MS Requirements**

In addition to the general requirements for the MS degree that are established by the University, a student is required to satisfy the following set of requirements:

1. A minimum of 30 credit hours of graduate level work
2. Each student's program of study must be approved by the Graduate Committee

Those students who are not fully prepared to pursue graduate work in computer science may be required to take the course CS 511, Foundations in Computer Science. In addition, students with very little to no background in computer science may be required to take undergraduate computer science courses, for which graduate credit will not be given.

Two options are offered, the **non-thesis option** and the **thesis option**.

### **Non-thesis option overview**

The non-thesis option requires a minimum of 30 credit hours, of which minimum 24 must be course work and minimum 6 must be project work, done by taking a two-course project sequence consisting of CS 613 and CS 614, and culminating in a project in computer science with a project report.

### **Thesis option overview**

Minimum of 30 credit hours, of which minimum 18 must be course work, minimum 2 must be seminar credits, and 10 must be thesis work, done by taking thesis credits under course numbers CS 634.

### **Common Requirements Across the Thesis and Non-thesis Options**

The following requirements are common to both options, and provide foundational knowledge and breadth of knowledge in programming:

1. 1 foundation course in CS 547 Computer Algorithms
2. 2 courses that qualify as requiring a substantial amount of programming.

Students are advised to consult the Graduate Committee of the Department of Computer Science to obtain a full listing of courses that qualify for the breadth courses and the course that qualifies as requiring a substantial amount of programming. Under certain circumstances, the Graduate Committee may waive the requirement that the student take one or more of the above courses. Students are recommended to consult the Graduate Committee to determine if and what requirements can be waived. For each course waived, students will be required to take an alternate course in its stead in order to fulfill the requirement for 18 credit hours of course work.

**Additional Program Requirements for the Non-thesis Option for MS in Computer Science:**

1. At least 5 restricted elective courses will be taken from the courses offered in computer science or computer engineering departments. Of these 5 courses, 1 must be a computer engineering course with relevant emphasis on computer science topics. 4 are recommended to be courses that focus on attaining specialization in a field of computer science. The department has strengths in theory, artificial intelligence, software, graphics & visualization, security, systems, and network. Students are advised to consult with the Computer Science Graduate Committee to determine appropriate specialization courses for the area of the student's interest.
2. Project work credit will comprise of a minimum of 6 credit hours, and will involve working on a two-semester project done by taking a 2-course sequence (CS 613 and CS 614). Project ideas from all faculty affiliated with the program will be made available to MS students. The student will be responsible for submitting an end-to-end implementation of a project in computer science, together with a project report. The report will be turned in to the Computer Science Graduate Committee for evaluation.

**Additional Program Requirements for the Thesis Option for MS in Computer Science:**

1. At least 3 restricted elective courses will be taken from the courses offered in computer science or computer engineering departments as selected by the student and their advisor. Of these 3 restricted elective courses, 1 must be a computer engineering course with relevant emphasis on computer science topics. Of the remaining 2, 1 must be a 600-level course that focuses on research topics in computer science, and it is recommended that the courses be in a focused area of specialization. Students should consult with their advisors to identify courses in these categories.
2. 2 seminar credits: To earn a seminar credit, students must enroll in a seminar course in Computer Science (CS 707 and CS 708).
3. Thesis credit will comprise a maximum of 10 credit hours of the 30 credit hour minimum. All students must have a research advisor by the end of their first semester of study and must submit a research proposal to the Examination Committee by the end of the semester before they plan to graduate. The research advisor will be a faculty member in the Department of Computer Science, or affiliated with the department through a courtesy appointment. The department has strengths in theory, artificial intelligence, software, graphics & visualization, security, systems, and networks. An overview of research areas in the department can be found at: <https://www.clarkson.edu/academics/arts-sciences/computer-science/research-areas>. The Examination Committee shall consist of a minimum of 3 faculty members. All students must complete a thesis and defend it orally to their Examination Committee. 2 copies of the completed thesis must be submitted to the University.

## Program Length

All work done for the master's degree in computer science is to be completed within five calendar years, although it is normative to complete the non-thesis option in 1 to 1.5 years, and the thesis option 1.5 to 2 years.

## Computer Science Faculty

Professors Daqing Hou, Christopher Lynch, Jeanna Matthews, Christino Tamon, Chuck Thorpe; Associate Professors Natasha Banerjee, Sean Banerjee, Alexis Maciel; Assistant Professors Shafique Chaudhry, Soumyabrata Dey, Faraz Hussain

## 5. Pro forma

The following Pro forma details the expected revenue from *additional* students under the non-thesis option, and does not include the current revenue already obtained through the thesis option.

Fees per credit	Fees after 30% discount	Credits per semester (1 Year)	Revenue from credits (1 Year)	Credits per semester (1.5 year, Year 1)	Revenue from credits (1.5 year, Year 1)	Credits per semester (1.5 year, Year 2)	Revenue from credits (1.5 year, Year 2)
\$1,388.00	\$971.60	15	\$14,574.00	12	\$11,659.20	6	\$5,829.60

Scenario 1: 8 students joining Year 1, 50% of students have 1 year completion, 50% have 1.5 year completion, growth of 2 students per year: ideal scenario)									
Year	Semester	#Students (1 year completion)	#Students (1.5 year completion, Year 1)	#Students (1.5 year completion, Year 2)	Total students (FTE)	Revenue from Students	Cost to Run Program at Start (Semester Tuition + Stipend for one TA)	Total Cost	Revenue to University
1	1	4	4	0	8	\$ 104,932.80	\$ 31,076.00	\$ 31,076.00	\$ 73,856.80
1	2	4	4	0	8	\$ 104,932.80	\$ 31,076.00	\$ 31,076.00	\$ 73,856.80
2	1	5	5	4	14	\$ 154,484.40	\$ 31,076.00	\$ 31,076.00	\$ 123,408.40
2	2	5	5	0	10	\$ 131,166.00	\$ 31,076.00	\$ 31,076.00	\$ 100,090.00
3	1	6	6	5	17	\$ 186,547.20	\$ 31,076.00	\$ 31,076.00	\$ 155,471.20
3	2	6	6	0	12	\$ 157,399.20	\$ 31,076.00	\$ 31,076.00	\$ 126,323.20

Scenario 2: 8 students joining Year 1, 50% of students have 1 year completion, 50% have 1.5 year completion, no growth students per year)									
Year	Semester	#Students (1 year completion)	#Students (1.5 year completion, Year 1)	#Students (1.5 year completion, Year 2)	Total students (FTE)	Revenue from Students	Cost to Run Program at Start (Semester Tuition + Stipend for one TA)	Total Cost	Revenue to University
1	1	4	4	0	8	\$ 104,932.80	\$ 31,076.00	\$ 31,076.00	\$ 73,856.80
1	2	4	0	0	8	\$ 104,932.80	\$ 31,076.00	\$ 31,076.00	\$ 73,856.80
2	1	4	4	4	12	\$ 128,251.20	\$ 31,076.00	\$ 31,076.00	\$ 97,175.20
2	2	4	0	0	4	\$ 58,296.00	\$ 31,076.00	\$ 31,076.00	\$ 27,220.00
3	1	4	4	4	12	\$ 128,251.20	\$ 31,076.00	\$ 31,076.00	\$ 97,175.20
3	2	4	4	0	8	\$ 104,932.80	\$ 31,076.00	\$ 31,076.00	\$ 73,856.80

## 6. Resources Requested for Running of the Program

**One Graduate Teaching Assistant (TA) line** is requested by the department to successfully cater to the expected growth in students. The CS department has already seen a rise in its undergraduate and graduate course enrollment. Additionally, the department is simultaneously

creating a new MS in Artificial Intelligence (AI) with thesis and non-thesis options, to serve a rapidly growing market. With the simultaneous creation of the MS in AI with thesis and non-thesis options, and the expected addition of students through the expansion of the MS in CS to include non-thesis options, our class sizes are expected to grow for several classes that are common to the two programs. Given the already ongoing growth, and the future expected growth through the two graduate programs, department members have expressed concern that our current teaching assistant support is insufficient to successfully administer the department courses. The pro forma included in Part 4 shows three scenarios: super-optimistic growth (2 students per year added in both programs), optimistic growth (1 student per year added in both programs), and stable (i.e. counts maintained).

Specifically, **one graduate teaching assistant line** is requested at the start of the program to support the growth of four classes: CS 547 (Computer Algorithms), CS 551 (Artificial Intelligence), CS 549 (Computational Learning), and CS 570 (Deep Learning). All classes are required core courses for the MS in AI program. CS 547 is a required core course for the MS in CS. Machine learning (taught in CS 549 or the Computational Learning class), artificial intelligence deep learning are the current hot topics in computer science, and are expected to remain so for a considerable period of time. They are courses that fulfill either programming or electives for specialization in the MS in CS, and will end up being taken by students enrolled in the MS in CS program. CS 547 will see a growth by the bold numbers listed in the last row of Table 2. If each new student MS in CS takes 2 of the remaining 3 courses, then on average 2 of the 3 classes will see a growth by the bold numbers listed in the last row of Table 1, i.e., along with CS 547, 3 total classes will see this growth. Assuming each of 3 classes seeing a growth of 14 students in Year 1, the total student load that will need to be handled in terms of tasks such as instruction, grading, and office hour assistance is  $3 * 14$  or 42 in Year 1. In actuality, the load will be higher since all MS in AI students are required to take all 4 courses. We therefore anticipate needing TA support to effectively handle the additional load over the three classes, coupled with the growth we have already seen and continue to see in our undergraduate courses. None of these courses currently have TA support. This support in the form of one TA will be needed in all three scenarios, i.e., stable, optimistic growth, and super-optimistic growth.

With optimistic growth, the number of students is expected to grow to 20 by Year 4, 22 by Year 5, and 24 by Year 6. By Year 4, administrative responsibilities to manage 22 new students + 7 students from the prior year or 29 students (increasing for years beyond) will be demanding enough that the program administrator for both programs will require course reduction in order to handle the administrative workload. Currently, a single faculty member in the Department of Computer Science (Dr. Natasha Banerjee) will be managing both programs. Administrative responsibilities for the program administrator include

1. Conducting Spring and Fall orientation sessions for students in the two programs,
2. Conducting open houses in Summer to advertise the program,
3. Connecting with companies to attract more students,

4. Conducting one-to-one meetings with students to provide personalized planning of their curriculum,
5. Fielding project topics from the department, institutional, and local community for students pursuing the project-based option,
6. Supervising and assessing projects,
7. Connecting students with faculty members for research,
8. Managing student requests for course waivers or exceptions,
9. Resolving conflicts that may arise regarding courses, projects, or research,
10. Performing formative and summative assessment of the program by collecting individualized data from students.

As numbers rise, several of the above responsibilities rise in proportion. To offset the workload of the program administrator, we anticipate needing a supporting instructor starting Year 4 in the event of optimistic growth (i.e., adding 1 student a year for both programs, or 2 students in total).

With super-optimistic growth (i.e., 2 students per year to both programs or 4 students total), the number of new students is expected to rise to 22 by Year 3 and 30 by Year 5. With this rise in number of students, it is expected that we will see students with a diverse range of interests, and coupled with the rapid advancement and diversification of the two fields CS and AI, it is expected that a tenure-track faculty member will be needed to cater to student interests. Additionally, student load enrolled in the four classes CS 547, CS 551, CS 549, and CS 570 is expected to rise to  $3 * 30$  or 90 by Year 5 (again, most likely the load will be higher due to the overlap with the prior year). At this point, a second TA is anticipated starting Year 5 in order to ensure effective instructional support.

## **7. Course lists for Programming Courses and Specialized Electives**

For all lists below, if a course is not in the list but may qualify as fulfilling the requirement for the list, the student petition the Graduate Committee to request inclusion of that course toward fulfilling the requirements corresponding to that list.

### **7.1. Programming Courses**

CS 544: Operating Systems  
CS 545: Compiler Construction  
CS 549: Computational Learning  
CS 550: Software Design & Development  
CS 551: Artificial Intelligence  
CS 552: Computer Graphics  
CS 559: Human-Computer Interaction  
CS 561: Mixed Reality  
CS 570: Deep Learning

CS 572: Image Understanding  
CS 652: Computer Vision  
CS 668: Natural Language Processing

## **7.2. Electives**

Some courses may span multiple areas of CS. 600-level courses are also offered on a fluid basis, which can be taken as specialized electives in one or more categories. Categories will be announced to graduate students when the course is offered.

### *7.2.1 Theory & Algorithms*

CS 541: Automata Theory & Formal Languages  
CS 542: Computational Complexity  
CS 545: Compiler Construction  
CS 549: Computational Learning  
CS 556: Cryptography  
CS 558: Formal Methods for Program Verification

### *7.2.2 Artificial Intelligence & Applications*

CS 549: Computational Learning  
CS 550: Software Design & Development  
CS 551: Artificial Intelligence  
CS 559: Human-Computer Interaction  
CS 560: Database Systems  
CS 565: Mobile Robotics and Human-Machine Interaction  
CS 570: Deep Learning  
CS 572: Image Understanding  
CS 573: Computer Vision  
CS 574: Natural Language Processing (converted from CS 668)  
CS 649: Current Issues in Machine Learning  
CS 675: Fairness, Accountability, and Transparency in AI and Automated Systems

### *7.2.3 Graphics & Visualization*

CS 552: Computer Graphics  
CS 559: Human-Computer Interaction  
CS 561: Mixed Reality  
CS 573: Computer Vision

### *7.2.4 Software*

CS 550: Software Design & Development  
CS 558: Formal Methods for Program Verification

CS 559: Human-Computer Interaction

CS 560: Database Systems

#### *7.2.5 Security*

CS 556: Cryptography

CS 557: Computer & Network Security

CS 558: Formal Methods for Program Verification

CS 657: Advanced Topics in Computer Security

#### *7.2.6 Systems & Networks*

CS 544: Operating Systems

CS 557: Computer & Network Security

CS 555: Computer Networks

CS 644: Current Issues in Operating Systems Research

CS 654: Current Issues in Networking Research

### **7.3. CE Courses with CS Focus**

EE 505: Computer Graphics

EE 507: Computer Networks

EE 510: Computer & Network Security

EE 568: Database Systems

EE 652: Computer Vision

### **7.4. Courses that fulfil the research requirement**

These are only applicable to the thesis option for the MS in CS. With the exception of CS 634 (Thesis), a range of 600-level courses are offered by the department that satisfy this requirement. Note that CS 607/CS 608: Topics in Computer Science and CS 611/CS 612: Topics in Applied Computer Science will count if they at the very least fulfill the requirement of having research literature review and a project component. Students should consult with their advisors to identify courses in these categories.

**Summary of New/Changed Courses** (Course approval forms can be found in pages following this page; sample syllabi can be found after the NYSED change form since they are required for the NYSED change form as well.)

1. **New Course: CS 613 - CS Projects I.** This course is being introduced as the first course in a 2-course sequence intended to enable students under the non-thesis MS in CS to complete projects in computer science. A new course form for CS 613 can be found in the following pages, and a sample syllabus can be found after the NYSED change form. Both the new course form and the sample syllabus contain a description of the course and its outcomes. The new course form will be filed with SAS upon approval of the proposed program. The instructor for the course will be Dr. N. Banerjee, who has indicated consent through the letter found in the approvals portion of this proposal.
2. **New Course: CS 614 - CS Projects II.** This course is being introduced as the first course in a 2-course sequence intended to enable students under the non-thesis MS in CS to complete projects in computer science. A new course form can be found in the following pages, and a sample syllabus can be found after the NYSED change form. Both the new course form and the sample syllabus contain a description of the course and its outcomes. The new course form will be filed with SAS upon approval of the proposed program. The instructor for the course will be Dr. N. Banerjee, who has indicated consent through the letter found in the approvals portion of this proposal.
3. **Changed Course: CS 668 - Natural Language Processing: Course number changed from CS 668 to CS 574.** This change is being performed to remain in line with the department's aim to make training in CS fields such as machine learning, computer vision, and natural language processing accessible to a wider audience by lowering the course number from being a second-level research elective to a first-level graduate course. Due to the difference in numbering (600 vs 500), we have been advised that even though it is a course change rather than a new course, the procedure requires that we file a deactivation form for CS 668 and we file a new course form for CS 574. The following pages contain the new course form for CS 574 and the deactivation form for CS 668. A sample syllabus is also included for CS 574 after the NYSED form. The instructor for the course will be Dr. S. Banerjee, who has indicated consent through the letter found in the approvals portion of this proposal.
4. **Changed Course: EE 652 - Computer Vision: Course number changed from EE 652 to EE 573.** This change is being performed to remain in line with the department's aim to make training in CS fields such as machine learning, computer vision, and natural language processing accessible to a wider audience by lowering the course number from being a second-level research elective to a first-level graduate course. Due to the difference in numbering (600 vs 500), we have been advised that even though it is a course change rather than a new course, the procedure requires that a deactivation form for EE 652 be filed, and a new course form for EE 573 be filed. The following pages contain the new course form for EE 573 and the deactivation form for CS 652. A sample syllabus is also included for EE 573 after the NYSED form. The instructor for the course will be Dr. N. Banerjee, who has indicated consent through the letter found in the approvals portion of this proposal. In particular, EE 573 will be cross-listed with CS 573, which is already being taught by Dr. N. Banerjee.



# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

**School** School of Arts and Sciences  
**Department** 16400-Computer Science

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: CS613 Cross-listed Subject & Number:  N/A or \_\_\_\_\_

Course Title: CS Projects I

Course Description:

This course is the first in a two-course sequence on project development as part of the non-thesis option for the Master of Science in Computer Science, that culminates in a two-semester project for a computer science application. During CS Projects I, students will propose a problem to be solved for a computer science application relevant to their field of interest, perform background research, provide a proposal document discussing their approach to solving the problem, and present a talk on their findings and their proposed approach.

Pre/Corequisites (if any) None

Number of Credits: 3 Grading Basis: Pass/Fail When Offered: When Needed

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

**Indicate course to be changed** \_\_\_\_\_ (Incl. any cross-listings)

Title \_\_\_\_\_

Subject or Catalog Number \_\_\_\_\_  Grading basis **Select**

Number of Credits \_\_\_\_\_  When offered **Select**

Deactivate course \_\_\_\_\_  Reactivate course \_\_\_\_\_

Prerequisite **Select** \_\_\_\_\_

Corequisite **Select** \_\_\_\_\_

Course equivalency **Select** \_\_\_\_\_  
*(if 2+ departments are involved, both must sign)*

Course description (enter new description below):

Common Experience:

- Knowledge area **Select** CSO CGI EC IA IG STS UNIV
- Communication point **Select** C1 C2
- Technology course **Select**

**APPROVALS**

[Electronic Signature Instructions](#)

Department Chair/Director:  Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any):  Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any):  Date: \_\_\_\_\_

Common Experience Committee:  Date: \_\_\_\_\_

Dean:  Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

**SAS USE ONLY**

Date entered into Catalog \_\_\_\_\_ Effective Semester: \_\_\_\_\_

Notes: \_\_\_\_\_

# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

**School** School of Arts and Sciences  
**Department** 16400-Computer Science

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: CS 614 Cross-listed Subject & Number:  N/A or \_\_\_\_\_

Course Title: CS Projects II

Course Description:

This course is the second in a two-course sequence on project development as part of the non-thesis option for the Master of Science in Computer Science, that culminates in a two-semester project for a computer science application. During CS Projects II, students will work on providing an end-to-end implementation for the problem proposed during CS 613; will write a comprehensive report on their implementation, detailing challenges encountered, approaches to address challenges, and potential for future work; and will present a talk on their implementation.

Pre/Corequisites (if any) CS 613

Number of Credits: 3 Grading Basis: Pass/Fail When Offered: When Needed

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

**Indicate course to be changed** \_\_\_\_\_ (Incl. any cross-listings)

- Title \_\_\_\_\_
- Subject or Catalog Number \_\_\_\_\_  Grading basis **Select**
- Number of Credits \_\_\_\_\_  When offered **Select**
- Deactivate course  Reactivate course
- Prerequisite **Select** \_\_\_\_\_
- Corequisite **Select** \_\_\_\_\_
- Course equivalency **Select** \_\_\_\_\_  
*(if 2+ departments are involved, both must sign)*

Course description (enter new description below):

- Common Experience:
- Knowledge area **Select** CSO CGI EC IA IG STS UNIV
  - Communication point **Select** C1 C2
  - Technology course **Select**

**APPROVALS**

Electronic Signature Instructions

Department Chair/Director:  Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any):  Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any):  Date: \_\_\_\_\_

Common Experience Committee:  Date: \_\_\_\_\_

Dean:  Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

**SAS USE ONLY**

Date entered into Catalog \_\_\_\_\_ Effective Semester: \_\_\_\_\_

Notes: \_\_\_\_\_

# CLARKSON UNIVERSITY

## COURSE CHANGE / APPROVAL FORM

School School of Arts and Sciences  
 Department 16400-Computer Science

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
 See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: CS 574 Cross-listed Subject & Number:  N/A or \_\_\_\_\_

Course Title: Natural Language Processing

**Course Description:**

This course introduces students to the fundamental concepts and ideas in natural language processing (NLP). In this course students will learn how to create systems that are able to understand and produce language for applications ranging from plagiarism detection to information extraction to automated summarization. The course will focus on four key areas: understanding and recognizing words; syntax (i.e. structure of language); semantics (i.e. meaning of language); pragmatics/discourse (i.e. interpretation of language in context). Students will be introduced to document similarity techniques using frequency and sequence based techniques; n-gram models; parts of speech tagging; named entity recognition; word sense disambiguation; machine translation; use of deep learning in NLP. Students will work with large scale datasets spanning from open source repositories to news articles. As part of the course students will read the latest literature in NLP and provide oral and written summaries. Prerequisites: CS 344 and STAT 383 (or equivalent, with consent of instructor)

Pre/Corequisites (if any) CS 344 and STAT 383 or equivalent

Number of Credits: 3 Grading Basis: Graded When Offered: Select

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

**Indicate course to be changed** \_\_\_\_\_ (Incl. any cross-listings)

- Title \_\_\_\_\_
- Subject or Catalog Number \_\_\_\_\_  Grading basis Select
- Number of Credits \_\_\_\_\_  When offered Select
- Deactivate course \_\_\_\_\_  Reactivate course \_\_\_\_\_
- Prerequisite Select \_\_\_\_\_
- Corequisite Select \_\_\_\_\_
- Course equivalency Select \_\_\_\_\_  
*(if 2+ departments are involved, both must sign)*

Course description (enter new description below):  
 \_\_\_\_\_

- Common Experience:
- Knowledge area Select CSO CGI EC IA IG STS UNIV
  - Communication point Select C1 C2
  - Technology course Select

**APPROVALS**

Electronic Signature Instructions

Department Chair/Director: \_\_\_\_\_ Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any): \_\_\_\_\_ Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any): \_\_\_\_\_ Date: \_\_\_\_\_

Common Experience Committee: \_\_\_\_\_ Date: \_\_\_\_\_

Dean \_\_\_\_\_ Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

**SAS USE ONLY**

Date entered into Catalog \_\_\_\_\_ Effective Semester: \_\_\_\_\_

Notes: \_\_\_\_\_

# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

**School** School of Arts and Sciences ▼  
**Department** 16400-Computer Science ▼

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
 See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: \_\_\_\_\_ Cross-listed Subject & Number:  N/A or \_\_\_\_\_

Course Title: \_\_\_\_\_

Course Description:  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Pre/Corequisites (if any) \_\_\_\_\_

Number of Credits: \_\_\_\_\_ Grading Basis: **Select** ▼ When Offered: **When Needed** ▼

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

Indicate course to be changed CS 668 (Incl. any cross-listings)

Title \_\_\_\_\_

Subject or Catalog Number \_\_\_\_\_  Grading basis **Select** ▼

Number of Credits \_\_\_\_\_  When offered **Select**

Deactivate course  Reactivate course

Prerequisite **Select** \_\_\_\_\_

Corequisite **Select** \_\_\_\_\_

Course equivalency **Select** \_\_\_\_\_  
 (if 2+ departments are involved, both must sign)

Course description (enter new description below):  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Common Experience:

Knowledge area **Select** CSO CGI EC IA IG STS UNIV

Communication point **Select** C1 C2

Technology course **Select**

**APPROVALS**

[Electronic Signature Instructions](#)

Department Chair/Director: \_\_\_\_\_ Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any): \_\_\_\_\_ Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any): \_\_\_\_\_ Date: \_\_\_\_\_

Common Experience Committee: \_\_\_\_\_ Date: \_\_\_\_\_

Dean \_\_\_\_\_ Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

SAS USE ONLY	
Date entered into Catalog _____	Effective Semester: _____
Notes: _____	

# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

**School** School of Arts and Sciences  
**Department** 16400-Computer Science

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

## New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED

Subject & Number: EE 573 Cross-listed Subject & Number:  N/A or CS 573

Course Title: Computer Vision

**Course Description:**

This course will cover an overview of basic theoretical underpinnings and practical applications of computer vision, with particular emphasis on geometrical techniques underlying 2D and 3D vision. Topics covered include, but are not restricted to, estimation of image transformations, image formation, pose estimation, camera calibration, epipolar geometry, structure-from-motion, stereo reconstruction, filtering, interest point detection, motion estimation, image segmentation, and object recognition. Students will be expected to read and implement research papers on seminal and modern techniques in computer vision. Prerequisites: CS 142 or EE 262 and MA 339 (or equivalent, with consent from the instructor).

Pre/Corequisites (if any) 2-course programming sequence (CS142/EE262 equivalent) and linear algebra (MA339 equivalent)

Number of Credits: 3 Grading Basis: Graded When Offered: Select

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

## Change a course currently on record (only complete those fields which are changing)

**Indicate course to be changed** \_\_\_\_\_ (Incl. any cross-listings)

- Title \_\_\_\_\_
- Subject or Catalog Number \_\_\_\_\_  Grading basis Select
- Number of Credits \_\_\_\_\_  When offered Select
- Deactivate course \_\_\_\_\_  Reactivate course \_\_\_\_\_
- Prerequisite Select \_\_\_\_\_
- Corequisite Select \_\_\_\_\_
- Course equivalency Select \_\_\_\_\_  
*(if 2+ departments are involved, both must sign)*

Course description (enter new description below):

- Common Experience:
- Knowledge area Select CSO CGI EC IA IG STS UNIV
  - Communication point Select C1 C2
  - Technology course Select

## APPROVALS Electronic Signature Instructions

Department Chair/Director:  Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any):  Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any):  Date: \_\_\_\_\_

Common Experience Committee:  Date: \_\_\_\_\_

Dean:  Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

**SAS USE ONLY**

Date entered into Catalog \_\_\_\_\_ Effective Semester: \_\_\_\_\_

Notes: \_\_\_\_\_

# CLARKSON UNIVERSITY COURSE CHANGE / APPROVAL FORM

School School of Arts and Sciences ▼  
 Department 16400-Computer Science ▼

This form must be used for the approval of course additions, changes, or modifications. Please use one form per course.  
 See Operations Manual section 6.1 "Procedures for Academic Changes" [http://www.clarkson.edu/hr/op\\_manual.html](http://www.clarkson.edu/hr/op_manual.html)

**New Course Offering (Complete only for brand new courses) – ALL FIELDS REQUIRED**

Subject & Number: \_\_\_\_\_ Cross-listed Subject & Number:  N/A or \_\_\_\_\_

Course Title: \_\_\_\_\_

Course Description:  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Pre/Corequisites (if any) \_\_\_\_\_

Number of Credits: \_\_\_\_\_ Grading Basis: **Select** ▼ When Offered: **When Needed** ▼

Optional: Common Experience: CSO CGI EC IA IG STS UNIV | C1 C2 | TECH

**Change a course currently on record (only complete those fields which are changing)**

**Indicate course to be changed** EE 652 (Incl. any cross-listings)

Title \_\_\_\_\_

Subject or Catalog Number \_\_\_\_\_  Grading basis **Select** ▼

Number of Credits \_\_\_\_\_  When offered **Select**

Deactivate course  Reactivate course

Prerequisite **Select** \_\_\_\_\_

Corequisite **Select** \_\_\_\_\_

Course equivalency **Select** \_\_\_\_\_  
(if 2+ departments are involved, both must sign)

Course description (enter new description below):  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Common Experience:  
 Knowledge area **Select** CSO CGI EC IA IG STS UNIV  
 Communication point **Select** C1 C2  
 Technology course **Select**

**APPROVALS** [Electronic Signature Instructions](#)

Department Chair/Director: \_\_\_\_\_ Date: \_\_\_\_\_

Equivalent Course Dept Chair (if any): \_\_\_\_\_ Date: \_\_\_\_\_

*The Chair signature certifies compliance with credit-hour requirements as outlined in Clarkson Regulations II-D*

School Curriculum Committee (if any): \_\_\_\_\_ Date: \_\_\_\_\_

Common Experience Committee: \_\_\_\_\_ Date: \_\_\_\_\_

Dean \_\_\_\_\_ Date: \_\_\_\_\_

Date forwarded to SAS: \_\_\_\_\_

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Date entered into Catalog \_\_\_\_\_ Effective Semester: \_\_\_\_\_

Notes:  
 \_\_\_\_\_  
 \_\_\_\_\_



## Change or Adapt a Registered Program\*

Use this form to request program changes that require approval by the State Education Department (see chart on the following page). For **programs that are registered jointly** with another institution, all participating institutions must confirm support for the changes.



This application should **NOT** be used for the following types of requests:

- Proposals for new programs
- Requests for changes to registered programs preparing Teachers, Educational Leaders, and Other School Personnel
- Requests for changes to programs preparing Licensed [Professionals](#); or
- Requests to add the Distance Education Format to a Registered Program

(**Note:** If the only requested change is to add the distance education format to an existing registered program, institutions need only complete and submit the [Application to Add the Distance Education Format to a New or Registered Program](#).)

The application materials for requests for changes to registered programs preparing Teachers, Educational Leaders, and Other School Personnel or Licensed Professionals can be found at:

<http://www.highered.nysed.gov/ocue/aipr/register.html>

For requests to changes to Doctoral programs: please [contact](#) the Office of College and University Evaluation (OCUE).

### Directions for submission of request:

1. Create a **single** PDF document that includes the following completed forms:
  - Request to Change or Adapt a Registered Program
  - Master Plan Amendment Supplement and Abstract (if applicable)
  - External Review of Certain Degree Programs and Response (if applicable)
  - [Application to Add the Distance Education Format to a New or Registered Program](#), (if applicable).
2. Create a separate PDF document for any required syllabi (see p. 2 of form, Changes in Program Content)
3. Attach the PDF documents to an e-mail.
4. Send e-mail to [OCURevAdmin@nysed.gov](mailto:OCURevAdmin@nysed.gov)

When submitting to the mailbox, include the following elements in the subject line of the e-mail:

Institution Name, Degree Award, and Program Title

E.g., Subject: AAA College, Request for Change, Master of Science, English Literature

---

\* **CUNY and SUNY** institutions: contact System Administration for Request for Change submission process.

## Changes and Adaptations Requiring State Education Department Approval

### Changes in Program Content (all programs)

1. Any of the following substantive changes:
  - Cumulative change from the Department's last approval of the registered program of one-third or more of the minimum credits required for the award (e.g., 20 credits in an associate degree program)
  - Changes in the program's focus or design (e.g., eliminating management courses in a business administration program), including a change in the program's major disciplinary area
  - Adding or eliminating an option or concentration
  - Eliminating a requirement for completion, including an internship, clinical, cooperative education, or other work-based experience
  - Altering the liberal arts and science content in a way that changes the degree classification, as defined in Section 3.47(c)(1-4) of [Regents Rules](#)

### Other Changes (all programs)

2. Program title
3. Program award (e.g., change in degree)
4. Mode of delivery (**Note:** if the change involves adding a **distance education format** to a registered program, please complete the [Application to Add the Distance Education Format to a New or Registered Program](#).)
5. Discontinuing a program
6. A format change that alters the program's financial aid eligibility (e.g., from full-time to part-time, or to an abbreviated or accelerated semester)
7. A change in the total number of credits of any certificate or advanced certificate program

### Establishing New Programs Based on Existing Registered Programs

8. Creating a dual-degree program from existing registered programs
9. Creating a new program from a concentration/track in an existing registered program

#### PLEASE NOTE:

Establishing an existing program at a new location requires new registration of the program. If the requested action changes the program's major disciplinary area, master plan amendment may be needed if the revised program represents the institution's first program in that major subject area, at that degree level. If a requested **degree title** is not authorized for an institution chartered by the Board of Regents, charter amendment will be needed.





NEW YORK STATE EDUCATION DEPARTMENT  
 Office of Higher Education—Office of College and University Evaluation  
 89 Washington Avenue, Albany, NY 12234  
 (518) 474-1551 Fax: (518) 486-2779  
<http://www.highered.nysed.gov/ocue/>  
[OCUERevAdmin@nysed.gov](mailto:OCUERevAdmin@nysed.gov)

## Request to Change or Adapt a Registered Program

Item	Response <i>(type in the requested information)</i>
<b>Institution name and address</b>	Clarkson University 8 Clarkson Ave, Potsdam, NY 13699  <i>Additional information:</i> <ul style="list-style-type: none"> <li>▪ Specify campus where program is offered, if other than the main campus:</li> </ul>
<b>Identify the program you wish to change</b>	Program title: Master of Science in Computer Science  <u>Award</u> (e.g., B.A., M.S.): MS  Credits: 30  <u>HEGIS code</u> : 0701.00  <u>Program code</u> : 82110
<b>Contact person for this proposal</b>	Name and title: Natasha Banerjee, Associate Professor  Telephone: <u>(315) 268-3831</u> _____ Fax: _____ E-mail: <a href="mailto:nbanerje@clarkson.edu">nbanerje@clarkson.edu</a>
<b>CEO (or designee) approval</b>	Name and title: Signature and date:  <div style="background-color: black; color: white; padding: 2px;">If the program will be registered jointly with another institution, provide the following information:</div> Partner institution's name: Name and title of partner institution's CEO: Signature of partner institution's CEO:

- For **programs that are registered jointly** with another institution, all participating institutions must confirm their support of the changes.

**Check all changes that apply and provide the requested information.**

Changes in Program Content (*Describe and explain all proposed changes; provide a side-by-side comparison of the existing and newly modified programs.*)

- Cumulative change from the Department's last approval of the registered program that impacts one-third or more of the minimum credits required for the award (e.g., 20 credits in an associate degree program)
- Changes in a program's focus or design
- Adding** or eliminating an **option** or concentration
- Eliminating** a requirement for program completion
- Altering the liberal arts and science content in a way that changes the degree classification, as defined in Section 3.47(c)(1-4) of [Regents Rules](#)

**If new courses are being added as part of the noted change(s)**, provide a syllabus for each new course and list the name, qualifications, and relevant experience of faculty teaching the course(s). Syllabi should include a course description and identify course credit, objectives, topics, student outcomes, texts/resources, and the basis for determining grades.

---

Other Changes (*describe and explain all proposed changes*)

- Program title**
- Program award**
- Mode of Delivery** (**Note:** if the change includes adding a **distance education format** to a registered program, please complete the [Application to Add the Distance Education Format To a New or Registered Program.](#))
- Discontinuing a program:** indicate the date by which the program will be discontinued.<sup>1</sup>
- Format change** (e.g., from full-time to part-time, or to an abbreviated or accelerated semester)
  - a) Indicate proposed format:
  - b) Describe availability of courses and any change in faculty, resources, or support services:
  - c) Use the Sample Program Schedule in the [Application for Registration of a New Program](#) to show the sequencing and scheduling of courses in the program.
  - d) If the revised program will be offered through a nontraditional schedule, provide a brief explanation of the schedule, including its impact on financial aid eligibility.
  - e) Confirm that for each (one) credit there is at least 15 hours (of 50 minutes each) of instruction and at least 30 hours of supplementary assignments.

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<sup>1</sup> If any students do not complete the program by the proposed termination date, the institution must request an extension of the registration period for the program or make other arrangements for those students.

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## Establishing New Programs Based on Existing Registered Programs

### [ ] **Creating a dual-degree program** from existing registered programs

- a) Complete the following table to identify the existing programs:

	<b>Program Title</b>	<b>Degree Award</b>	<b>Program Code</b>
Program 1			
Program 2			

- b) Proposed dual-degree program (title and award):<sup>2</sup>
- c) Courses that will be counted toward both awards:
- d) Length of time for candidates to complete the proposed program:
- e) Use Task 3: Sample Program Schedule from [Application for Registration of a New Program](#) to show the sequencing and scheduling of courses in the dual-degree program.

### [ ] **Creating a new program from a concentration/track in an existing program.**

If the new program is based **entirely** on existing courses in a registered program, provide the current program name, program code, and the following information:

**Note:** this abbreviated option applies only if a master plan amendment is NOT required **and** there are no new courses or changes to program admissions and evaluation elements. If these conditions are not met, submit a new registration application for the proposed program.

- a) Information from the [Application for Registration of a New Program](#):
- Task 1 and Task 2a
  - Task 3 - Sample Program Schedule
  - Task 4 - Faculty information charts (full-time faculty, part-time faculty, and faculty to be hired)
- b) Brief description of the proposed program and rationale for converting the existing coursework to a separately registered program:
- c) Expected impact on existing program:
- d) Adjustments the institution will make to its current resource allocations to support the program:
- e) Statement confirming that the admission standards and process and evaluation methods are the same as those in the existing registered program.

**Note:** if the change involves **establishing an existing registered program at a new location**, complete a new registration application for the proposed program.

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<sup>2</sup> Only candidates with the capacity to complete the requirements of both degrees shall be admitted to a dual-degree program.

### Summary of Proposed Changes:

1. The foundation course requirement of CS 541 is being eliminated, and being replaced by a free elective.
2. The current MS in CS program is thesis-based only. A non-thesis option is being added to the MS in CS program. After this change, there will be two options, a thesis option and a non-thesis option. The non-thesis option differs from the thesis option in terms of 15 credits.
  - In the thesis option, the 12 credits are split as follows:
    - 10 credits are thesis credits (i.e., CS 634)
    - 2 credits are seminar credits (i.e., 1 credit of CS 707 and 1 credit of CS 708)
    - 3 credits are for a 600-level research elective
  - In the non-thesis option, the 15 credits are split as follows:
    - 6 credits in a 2-course sequence ending in a project (i.e., CS 613 and CS 614; these are new courses introduced as part of this proposal, and sample syllabi have been provided)
    - 9 credits are for 3 electives at the 500-level and above
3. The above changes exceed one-third or more of the minimum credits required for award (i.e., 30 credits).

### Side-by-side comparisons are provided as follows:

Original MS in CS (Thesis-Based)	Changed Thesis-Based MS in CS (hereafter called Thesis Option in MS in CS) <ul style="list-style-type: none"> <li>• Differences between thesis option and non-thesis option are in red</li> <li>• Changes from original thesis-based MS in CS are highlighted in yellow</li> </ul>	Added Non-thesis Option to MS in CS <ul style="list-style-type: none"> <li>• Differences between thesis option and non-thesis option are in red</li> </ul>
Foundation Course: CS 547 – Computer Algorithms (3 credits)	Foundation Course: CS 547 – Computer Algorithms (3 credits)	Foundation Course: CS 547 – Computer Algorithms (3 credits)
Foundation Course: CS 541 – Automata Theory and Formal Languages (3 credits)	Removed; does not exist	Does not exist
2 courses that fulfill the requirement of having substantial programming (6 credits)	2 courses that fulfill the requirement of having substantial programming (6 credits)	2 courses that fulfill the requirement of having substantial programming (6 credits)
1 Computer Engineering course with Computer Science focus (3 credits)	1 Computer Engineering course with Computer Science focus (3 credits)	1 Computer Engineering course with Computer Science focus (3 credits)
1 600-level research elective	1 600-level research elective (3 credits)	Does not exist
Not applicable	1 elective at the 500-level and above (3 credits)	4 electives at the 500-level and above (12 credits)
CS 634 -- Thesis (10 credits)	CS 634 – Thesis (10 credits)	Not applicable
CS 707 – Seminar (1 credit) + CS 708 – Seminar (1 credit)	CS 707 – Seminar (1 credit) + CS 708 – Seminar (1 credit)	Not applicable
Not applicable	Not applicable	CS 613 – CS Projects I (3 credits) + CS 614 – CS Projects II (3 credits)

**Note:** Two new courses are being proposed as part of the proposal, particularly the 2-course sequence CS 613 and CS 614, that enables students to do a project. Sample syllabi are provided for these courses. Additionally, two courses that were originally offered as research courses at the 600-level (particularly CS 668 --- Natural Language Processing and EE 652 --- Computer Vision) are being transformed to be at the 500-level (as CS 574 and EE 573 respectively) to enable the training provided through those courses to be accessible to a wider audience. Syllabi are provided for these two transformed courses as well.

# CS613: CS Projects I

Fall 2021, 3 credits

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## Instructor

Dr. Natasha Banerjee: Has a background in computer vision and machine learning, also serve as the Chair of the Graduate Committee in Computer Science. Will be the liaison to field project ideas from the CS department and the Clarkson community.

## Course Description

This course is the first in a two-course sequence on project development as part of the non-thesis option for the Master of Science in Computer Science, that culminates in a two-semester project for a computer science application. During CS Projects I, students will propose a problem to be solved for a computer science application relevant to their field of interest, perform background research, provide a proposal document discussing their approach to solving the problem, and present a talk on their findings and their proposed approach.

## Course Objectives:

- To ideate new problems involving project development in computer science
- To build motivation for the problem through perusal of background literature

## Delivery Method (on campus, online, synchronous, asynchronous, etc.)

On campus  
Online  
Synchronous/Asynchronous

## Prerequisites

None

## Instructional Materials

### Textbook(s)

None

### Other Reading Materials

None

## Technology

### Minimum Technology Skills

- Use a learning management system
- Use e-mail with attachments
- Create and submit files in commonly used word processing formats

- Be familiar with programming languages, IDEs, and tools for software development

## Course Outcomes (CO)

CO1: Students will propose a problem to be solved for a computer science application relevant to students' field of interest

CO2: Students will perform background investigation of related work

CO3: Students will write a proposal document that summarizes problem motivation, related work, proposed project, and project plan with task breakdown, milestones, expected outcomes, and tentative schedule.

CO4: Students will present a talk on their findings and proposed project plan.

## Grading

### Grade Ranges

#### Graduate Letter Grades

Course Average	Grade	Quality Points
97+	A+	4.0
93-96	A	4.0
90-92	A-	3.667
87-89	B+	3.334
84-86	B	3.0
80-83	B-	2.667
76-79	C+	2.334
70-75	C	2.0
<70	F	0

### Breakdown

Activity	Percent of Final Grade
Second week one-pager describing proposed work	10%
Mid-semester report describing progress on background investigation	25%
Proposal document summarizing project plan	35%
Talk presenting findings and project plan	30%
<b>Total</b>	<b>100%</b>

## Course Policies

### **Etiquette Expectations & Learner Interaction**

Educational institutions promote the advance of knowledge through positive and constructive debate--both inside and outside the classroom. Please visit and follow: [Netiquette and Electronic Learner Interaction Guidelines](#).

## Institutional Policies

### **Institutional Policies & Regulations**

#### **Academic Integrity**

Students are expected to abide by the standards of academic honesty as described in the [Clarkson Regulations](#). The work or words of others must be properly cited. Please refer to Clarkson Library's [Guide to Plagiarism](#) and [Citing Sources](#).

#### **Students with Disabilities Policy**

**Clarkson University welcomes inquiries and applications** from individuals who have disabilities. Information relating to disabling conditions is not a determining factor in admission decisions. The University strives to make all facilities and programs accessible to students with disabilities by providing appropriate academic adjustments and other appropriate modifications (accommodations), as necessary. Timely notification of any need for accommodations due to a disability is encouraged so that the Office of Accommodative Services (OAS) may provide for students in an efficient manner.

For more information or other appropriate campus referrals, contact:

Director of Accommodative Services  
Clarkson University  
PO Box 5645  
Potsdam, NY 13699-5635  
Phone: 315-268-7643  
Fax: 315-268-2400  
Email: [oas@clarkson.edu](mailto:oas@clarkson.edu)  
[Office of AccessABILITY Services Website](#)

## **Example Topics for CS Projects**

- Development of a system for capture and reconstruction of multi-modal data using multiple multi-viewpoint sensors
- Development of graphical user interfaces to enable seamless remote education
- Development of software solutions for continuous health monitoring
- Creation of software systems for visualization of dense multi-modal data
- Development of interfaces for water level monitoring through citizen science



# CS614: CS Projects II

*Spring 2022, 3 credits*

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## Instructor

Dr. Natasha Banerjee: Has a background in computer vision and machine learning, also serve as the Chair of the Graduate Committee in Computer Science. Will be the liaison to field project ideas from the CS department and the Clarkson community.

## Course Description

This course is the second in a two-course sequence on project development as part of the non-thesis option for the Master of Science in Computer Science, that culminates in a two-semester project for a computer science application. During CS Projects II, students will work on providing an end-to-end implementation for the problem proposed during CS 613; will write a comprehensive report on their implementation, detailing challenges encountered, approaches to address challenges, and potential for future work; and will present a talk on their implementation.

## Course Objectives:

- To perform comprehensive project development for end-to-end problem solving in computer science
- To effectively communicate approach and end results through written and oral forms

## Delivery Method (on campus, online, synchronous, asynchronous, etc.)

On campus  
Online  
Synchronous/Asynchronous

## Prerequisites

None

## Instructional Materials

### Textbook(s)

None

### Other Reading Materials

None

## Technology

### Minimum Technology Skills

- Use a learning management system
- Use e-mail with attachments
- Create and submit files in commonly used word processing formats
- Be familiar with programming languages, IDEs, and tools for software development

## Course Outcomes (CO)

CO1: Students will work on providing end-to-end implementation for problem proposed during CS 613 by using programming languages, IDEs, and software development tools appropriate to their chosen project.

CO3: Students will write a comprehensive report on their implementation detailing challenges encountered, approaches to address challenges, and potential for future work.

CO4: Students will present a talk on their implementation and scope for future work stemming from their project.

## Grading

### Grade Ranges

#### Graduate Letter Grades

Course Average	Grade	Quality Points
97+	A+	4.0
93-96	A	4.0
90-92	A-	3.667
87-89	B+	3.334
84-86	B	3.0
80-83	B-	2.667
76-79	C+	2.334
70-75	C	2.0
<70	F	0

### Breakdown

Activity	Percent of Final Grade
Weekly one-page reports discussing incremental progress	10%
Mid-semester report describing progress so far	25%
Final project report	35%

Talk	30%
<b>Total</b>	<b>100%</b>

## Course Policies

### **Etiquette Expectations & Learner Interaction**

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## Institutional Policies

### **Institutional Policies & Regulations**

#### **Academic Integrity**

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#### **Students with Disabilities Policy**

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For more information or other appropriate campus referrals, contact:

Director of Accommodative Services  
Clarkson University  
PO Box 5645  
Potsdam, NY 13699-5635  
Phone: 315-268-7643  
Fax: 315-268-2400  
Email: [oas@clarkson.edu](mailto:oas@clarkson.edu)  
[Office of AccessABILITY Services Website](#)

# CS574: Natural Language Processing

Spring 2022, 3 credits

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## Instructor

Dr. Sean Banerjee: Has a background in machine learning and statistical methods in analysis of large-scale open source repositories of text-based content such as problem reports.

## Course Description

This course introduces students to the fundamental concepts and ideas in natural language processing (NLP). In this course students will learn how to create systems that are able to understand and produce language for applications ranging from plagiarism detection to information extraction to automated summarization. The course will focus on four key areas: understanding and recognizing words; syntax (i.e. structure of language); semantics (i.e. meaning of language); pragmatics/discourse (i.e. interpretation of language in context). Students will be introduced to document similarity techniques using frequency and sequence based techniques; n-gram models; parts of speech tagging; named entity recognition; word sense disambiguation; machine translation; use of deep learning in NLP. Students will work with large scale datasets spanning from open source repositories to news articles. As part of the course students will read the latest literature in NLP and provide oral and written summaries.

## Course Objectives:

- To learn the theory underlying NLP including understanding of words, language structure, semantics, and interpretation in context
- To solve practical problems in NLP using computational approaches for document similarity analysis on large-scale textual datasets

## Delivery Method (on campus, online, synchronous, asynchronous, etc.)

On campus  
Online  
Synchronous/Asynchronous

## Prerequisites

Course in data structures and algorithms (CS 344 at Clarkson or equivalent)  
Course in probability and statistics (STAT 383 at Clarkson or equivalent)

## Instructional Materials

### Textbook(s)

None

## Other Reading Materials

None

## Technology

### Minimum Technology Skills

- Use a learning management system
- Use e-mail with attachments
- Create and submit files in commonly used word processing formats
- Be familiar with Python and Perl

## Course Outcomes (CO)

CO1: Students will learn about key concepts in NLP, particularly word understanding, syntax, semantics, and pragmatics/discourse.

CO2: Students will learn to work with document similarity techniques using a variety of approaches.

CO3: Students will learn to perform language understanding from large-scale text datasets.

CO2: Students will learn to evaluate recent literature in NLP.

## Grading

### Grade Ranges

#### Graduate Letter Grades

Course Average	Grade	Quality Points
97+	A+	4.0
93-96	A	4.0
90-92	A-	3.667
87-89	B+	3.334
84-86	B	3.0
80-83	B-	2.667
76-79	C+	2.334
70-75	C	2.0
<70	F	0

### Breakdown

Activity	Percent of Final Grade
Four assignments on Python/Perl-based implementations of theoretical knowledge gained in	60% (each assignment will be worth 15% of the final grade)

natural language processing	
Half-semester-long project on self-proposed task in NLP. Breakdown: <ul style="list-style-type: none"> <li>• Project proposal</li> <li>• Project implementation</li> <li>• Project report</li> <li>• Project presentation</li> </ul>	40% Breakdown: <ul style="list-style-type: none"> <li>• 5%</li> <li>• 15%</li> <li>• 10%</li> <li>• 10%</li> </ul>
<b>Total</b>	100%

## Course Policies

### Etiquette Expectations & Learner Interaction

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## Institutional Policies

### Institutional Policies & Regulations

#### Academic Integrity

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#### Students with Disabilities Policy

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For more information or other appropriate campus referrals, contact:

Director of Accommodative Services  
Clarkson University  
PO Box 5645  
Potsdam, NY 13699-5635

Phone: 315-268-7643

**Fax:** 315-268-2400

**Email:** [oas@clarkson.edu](mailto:oas@clarkson.edu)

[Office of AccessABILITY Services Website](#)

# EE573: Computer Vision

Fall 2021, 3 credits

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## Instructor

Dr. Natasha Banerjee: Has a background in computer vision and machine learning.

## Course Description

This course will cover an overview of basic theoretical underpinnings and practical applications of computer vision, with particular emphasis on geometrical techniques underlying 2D and 3D vision. Topics covered include, but are not restricted to, estimation of image transformations, image formation, pose estimation, camera calibration, epipolar geometry, structure-from-motion, stereo reconstruction, filtering, interest point detection, motion estimation, image segmentation, and object recognition. Students will be expected to read and implement research papers on seminal and modern techniques in computer vision. Prerequisites: CS 142 or EE 262 and MA 339 (or equivalent, with consent from the instructor).

## Course Objectives:

- To understand the geometrical foundation of 2D and 3D computer vision
- To understand how to use learning-based techniques to solve practical problems in vision

## Delivery Method (on campus, online, synchronous, asynchronous, etc.)

On campus

Online

Synchronous/Asynchronous

## Prerequisites

Second-level programming course (CS 142 or EE 262 at Clarkson or equivalent)

Course in linear algebra (MA 339 at Clarkson or equivalent)

## Instructional Materials

### Textbook(s)

None

### Other Reading Materials

None

## Technology

### Minimum Technology Skills

- Use a learning management system
- Use e-mail with attachments



- Create and submit files in commonly used word processing formats
- Be familiar with MATLAB and Python

## Course Outcomes (CO)

CO1: Students will learn the geometrical foundations of computer vision by taking modules in image transformations, image formation, pose estimation, structure from motion, and stereo reconstruction.

CO2: Students will learn about modern approaches to perform semantic tasks in computer vision such as segmentation and recognition by taking modules in filtering, interest point detection, and learning-based vision.

## Grading

### Grade Ranges

#### Graduate Letter Grades

Course Average	Grade	Quality Points
97+	A+	4.0
93-96	A	4.0
90-92	A-	3.667
87-89	B+	3.334
84-86	B	3.0
80-83	B-	2.667
76-79	C+	2.334
70-75	C	2.0
<70	F	0

### Breakdown

Activity	Percent of Final Grade
Five assignments on MATLAB/Python-based implementations of theoretical knowledge gained in geometrical and learning-based vision	60% (each assignment will be worth 12% of the final grade)
Half-semester-long project on self-proposed task in computer vision. Breakdown: <ul style="list-style-type: none"> <li>• Project proposal</li> <li>• Project implementation</li> <li>• Project report</li> <li>• Project presentation</li> </ul>	40% Breakdown: <ul style="list-style-type: none"> <li>• 5%</li> <li>• 15%</li> <li>• 10%</li> <li>• 10%</li> </ul>
<b>Total</b>	<b>100%</b>

## Course Policies

### **Etiquette Expectations & Learner Interaction**

Educational institutions promote the advance of knowledge through positive and constructive debate--both inside and outside the classroom. Please visit and follow: [Netiquette and Electronic Learner Interaction Guidelines](#).

## Institutional Policies

### **Institutional Policies & Regulations**

#### **Academic Integrity**

Students are expected to abide by the standards of academic honesty as described in the [Clarkson Regulations](#). The work or words of others must be properly cited. Please refer to Clarkson Library's [Guide to Plagiarism](#) and [Citing Sources](#).

#### **Students with Disabilities Policy**

**Clarkson University welcomes inquiries and applications** from individuals who have disabilities. Information relating to disabling conditions is not a determining factor in admission decisions. The University strives to make all facilities and programs accessible to students with disabilities by providing appropriate academic adjustments and other appropriate modifications (accommodations), as necessary. Timely notification of any need for accommodations due to a disability is encouraged so that the Office of Accommodative Services (OAS) may provide for students in an efficient manner.

For more information or other appropriate campus referrals, contact:

Director of Accommodative Services  
Clarkson University  
PO Box 5645  
Potsdam, NY 13699-5635  
Phone: 315-268-7643  
Fax: 315-268-2400  
Email: [oas@clarkson.edu](mailto:oas@clarkson.edu)  
[Office of AccessABILITY Services Website](#)

Included after this page are letters of approval from the following stakeholders in the program (in the order listed below):

- Faculty with primary appointments in the Department of Computer Science
  - Dr. N. Banerjee
  - Dr. S. Banerjee
  - Dr. S. Dey
  - Dr. C. Lynch
  - Dr. A. Maciel
  - Dr. J. Matthews
  - Dr. C. Tamon
  - Dr. C. Thorpe
- Faculty with courtesy appointments in the Department of Computer Science
  - Dr. S. Chaudhry (Reh School of Business --- commitment is only restricted to thesis advisement, and therefore remains unchanged from the original thesis-based MS in CS)
  - Dr. D. Hou (Department of Electrical and Computer Engineering)
  - Dr. F. Hussain (Department of Electrical and Computer Engineering --- commitment is only restricted to thesis advisement, and therefore remains unchanged from original thesis-based MS in CS)
- Dr. C. Lynch, Chair of the Department of Computer Science
- Dr. P. McGrath, Chair of the Department of Electrical and Computer Engineering (since the program is joint between CS and ECE)
- Dr. W. Jemison, Dean of the Coulter School of Engineering
- Dr. T. Langen, Interim Dean of the School of Arts & Sciences
- Approval from the Provost's Council



June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Serving as administrator of the program and de facto academic advisor for all students,
- 2) Running the newly proposed CS Project Courses, numbered CS 613 and CS 614,
- 3) Advising student theses for the thesis-based option,
- 4) Ensuring continued successful running of thesis and seminar courses through communications with faculty members involved, and
- 5) Serving as instructor for the following courses:
  - a. CS 552 (Computer Graphics) that serves as a specialized elective (also cross-listed as EE 505 that serves as a computer engineering elective course with computer science content),
  - b. CS 561 (Mixed Reality) that serves as a specialized elective, and
  - c. CS 573 (Computer Vision) that will serve as a specialized elective; this course will also be cross-listed as EE 573 with Dr. N. Banerjee as instructor. EE 573 will be converted from the current course EE 652, and will serve as a computer engineering elective course with computer science content. The conversion will be performed by deactivating EE 652, and creating EE 573 as a new course, as per the guidelines laid down for course approvals. Sample syllabus for EE 573 has been provided (the course is identical to the currently offered CS 573).

Thank you,

A handwritten signature in black ink, appearing to read "NKBanerjee".

Natasha Kholgade Banerjee, Ph.D.  
Associate Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [nbanerje@clarkson.edu](mailto:nbanerje@clarkson.edu)



Clarkson™

DEPARTMENT OF COMPUTER SCIENCE

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following courses:
  - a. CS 550 (Software Design & Development) that serves as a specialized elective,
  - b. CS 559 (Human-Computer Interaction) that serves as a specialized elective, and
  - c. CS 574 (Natural Language Processing, which will be converted from the current course EE 668) that will serve as a specialized elective. This conversion will be performed by deactivating EE 668, and creating a new course for CS 574. Sample syllabus for CS 574 has been provided in this proposal.

Thank you,

A handwritten signature in black ink, appearing to read "S Banerjee".

Sean Banerjee, Ph.D.  
Associate Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [sbanerje@clarkson.edu](mailto:sbanerje@clarkson.edu)



Clarkson™

DEPARTMENT OF COMPUTER SCIENCE

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following courses:
  - a. CS 570 (Deep Learning) that serves as a specialized elective, and
  - b. CS 572 (Image Understanding) that serves as a specialized elective.

Thank you,

A handwritten signature in blue ink that reads "Soumyabrata Dey".

Soumyabrata Dey, Ph.D.  
Assistant Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [sdey@clarkson.edu](mailto:sdey@clarkson.edu)



Clarkson™

DEPARTMENT OF COMPUTER SCIENCE

June 9, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following courses:
  - a. CS 551 (Artificial Intelligence) that serves as a specialized elective, and
  - b. CS 558 (Formal Methods for Program Verification) that serves as a specialized elective,
  - c. CS 653 (Automated Reasoning) that serves as a specialized elective.

Thank you,

A handwritten signature in cursive script that reads "Christopher A. Lynch".

Christopher Lynch  
Chair and Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [clynch@clarkson.edu](mailto:clynch@clarkson.edu)



Clarkson™

DEPARTMENT OF COMPUTER SCIENCE

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following courses:
  - a. CS 541 (Automata Theory & Formal Languages) that serves as a specialized elective, and
  - b. CS 542 (Complexity Theory) that serves as a specialized elective.

Thank you,

A handwritten signature in blue ink, appearing to read "Alexis Maciel".

Alexis Maciel, Ph.D.  
Associate Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [alexis@clarkson.edu](mailto:alexis@clarkson.edu)





June 1, 2020

To Whom It May Concern:

I have some concerns about the current proposal for a non-thesis option in the Master of Science in Computer Science program, but am generally supportive of the direction. If this proposal or a modified version is approved, I intend to participate in the program in the following ways:

- 1) I have regularly been advising student theses for the thesis-based option and would continue to do so where there is a match between my current research and the interests of current students.
- 2) I have been teaching a variety of courses commonly taken by students in the Master of Science in Computer Science program and would continue to do so as my teaching workload permits. I suspect it will be necessary and appropriate for others to teach some of these courses as well. These courses include:
  - a. CS 544 (Operating Systems) that serves as a specialized elective,
  - b. CS 555 (Computer Networks) that serves as a specialized elective (also cross-listed as EE507 that serves as a computer engineering elective course with computer science content), and
  - c. CS 557 (Computer & Network Security) that serves as a specialized elective (also cross-listed as EE510 that serves as a computer engineering elective course with computer science content).
  - d. CS 600 level courses (including CS 644, CS 649, CS 654 and CS 657 that satisfy the requirement for a research-based course at the graduate level.

Thank you,

A handwritten signature in black ink that reads "Jeanna Matthews".

Jeanna Matthews, Ph.D.  
Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [jnm@clarkson.edu](mailto:jnm@clarkson.edu)



Clarkson™

DEPARTMENT OF COMPUTER SCIENCE

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following courses:
  - a. CS 547 (Computer Algorithms) that serves as a core course,
  - b. CS 549 (Computational Learning) that serves as a specialized elective,
  - c. Alternating CS 545 (Compiler Construction) and CS 556 (Cryptography) every year; both courses serve as specialized electives.

Thank you,

A handwritten signature in green ink, appearing to read "Christino Tamon".

Christino Tamon, Ph.D.  
Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [tino@clarkson.edu](mailto:tino@clarkson.edu)



Clarkson™

DEPARTMENT OF COMPUTER SCIENCE

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following course or equivalent:
  - a. CS 565 (Mobile Robotics and Human-Machine Interaction) that serves as a specialized elective.

Thank you,

A handwritten signature in black ink that reads "Chuck E Thorpe".

Chuck Thorpe, Ph.D.  
Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [cthorge@clarkson.edu](mailto:cthorge@clarkson.edu)



Clarkson™

DEPARTMENT OF COMPUTER SCIENCE

June 10, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the creation of a new Master of Science in Artificial Intelligence program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option.

Thank you,

A handwritten signature in blue ink that reads "Shafique Ahmad Chaudhry".

Shafique Ahmad Chaudhry, Ph.D.

Instructor, Reh School of Business

(Research Assistant Professor, Courtesy Appointment in the Department of Computer Science)

Clarkson University, Potsdam, NY 13699-5720

Email: [schaudhr@clarkson.edu](mailto:schaudhr@clarkson.edu)



Clarkson™

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option, and
- 2) Serving as instructor for the following course:
  - a. CS 560 (Database Systems) that serves as a specialized elective (cross-listed as EE 568 that serves as a computer engineering elective course with computer science content).

Thank you,

Daqing Hou, Ph.D.  
Professor, Department of Electrical & Computer Engineering  
(Courtesy Appointment in the Department of Computer Science)  
Clarkson University, Potsdam, NY 13699-5720  
Email: [dhoul@clarkson.edu](mailto:dhoul@clarkson.edu)



Clarkson™

June 1, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the creation of a new Master of Science in Computer Science program that I agree to fulfil all my duties necessary for successful administration of the program, including

- 1) Advising student theses for the thesis-based option.

Thank you,

A handwritten signature in blue ink that reads "Faraz Hussain".

Faraz Hussain, Ph.D.

Assistant Professor, Department of Electrical & Computer Engineering

(Courtesy Appointment in the Department of Computer Science)

Clarkson University, Potsdam, NY 13699-5720

Email: [fhussain@clarkson.edu](mailto:fhussain@clarkson.edu)



June 29, 2020

To Whom It May Concern:

This package is to create a non-thesis based MS in Computer Science. We currently have a thesis-based MS in Computer Science. However, many potential students are scared away by the thesis requirement, and some students who end up attending Clarkson do not have the interest or the ability to complete an MS thesis. This proposal would simultaneously attract new students to come to Clarkson, and it will help the workload of faculty members who will not be advising weaker students on a thesis.

This proposal was put to a vote in the CS department. It received seven votes in favor and one abstention. We have included letters from the CS department members stating their willingness to teach courses in this program. We are teaching these courses anyway for our thesis based MS in Computer Science, so it is not really a change. In the letter, one faculty member has expressed reservations about the proposed program. That reservation relates to resources for the program. As stated, we are not teaching any new courses. We have asked for one additional TA, to handle the additional students we will get. Otherwise we only need more resources if we attract a huge amount of new students after several years. At that point, we would request new resources from the university. This faculty member suspects "it will be necessary and appropriate for others to teach these courses as well". This is not relevant to the proposal, as these courses are not required courses for this program.

The MS in CS program is jointly run by the ECE department. We have included a letter of support from the Chair of the ECE department, along with letters from the two ECE faculty members who could be involved with advising students for the program.

In summary, we are excited to introduce this proposal. It has been badly needed for awhile. It will be a win-win for the students and the faculty.

Thank you,

A handwritten signature in cursive script that reads "Christopher A. Lynch".

Christopher Lynch  
Chair and Professor, Department of Computer Science  
Clarkson University, Potsdam, NY 13699-5815  
Email: [clynch@clarkson.edu](mailto:clynch@clarkson.edu)

June 15, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that, as the Chair of the Department of Electrical & Computer Engineering that collaborates with the Department of Computer Science to administer the interdisciplinary program, I approve of the proposed modifications.

In particular, our unit is affected due to the inclusion of the following courses in the proposal as programming and/or specialized electives: EE 568 (Databases), EE 507 (Computer Networks), EE 505 (Computer Graphics), EE 510 (Computer & Network Security), and EE 573 (Computer Vision, modified down to a 500-level course from EE 652). Dr. Daqing Hou, Professor in the Department of Electrical & Engineering has already provided his letter documenting his consent to teach EE 568.

The remaining courses are taught by faculty members with primary appointments in the Department of Computer Science. Particularly, EE 507 and EE 510 is taught by Dr. Jeanna Matthews, and EE 505 is taught by Dr. Natasha Banerjee. EE 573 will be taught by Dr. Natasha Banerjee who has been teaching the original 600-level version of the course EE 652 for five years, and has already discussed her goal to list the course at the 500-level. Both faculty members have provided their letters documenting their intent to teach the courses.

Additionally, Dr. Daqing Hou and Dr. Faraz Hussain (Professor and Assistant Professor, respectively, in the Department of Electrical & Computer Engineering) have courtesy appointments in the Department of Computer Science, and have provided their documented consent to continue advising students in the thesis-based version of the Master of Science program whose research intersects with their area of expertise.

Thank you,



Paul McGrath, Ph.D.  
Chair Department of Electrical & Computer Engineering  
Clarkson University, Potsdam, NY 13699-5720  
Email: pmcgrath@clarkson.edu





Clarkson

COULTER SCHOOL OF  
ENGINEERING

8 Clarkson Avenue  
Potsdam, New York 13699  
315-268-6509

July 2, 2020

MEMORANDUM

From: William D. Jemison, Dean of Engineering  
To: Natasha Banerjee, Graduate Committee Chair, CS Department

I am writing to endorse the proposal that the Master's degree in Computer Science provide a non-thesis option. This option is consistent with current university (and NYSED) policy outlined on page 13 of the graduate catalog<sup>1</sup>.

Offering the program in a distance format is also mentioned in the proposal. I strongly endorse that option as well.

Please feel free to contact me if you have any questions.

Sincerely,

A handwritten signature in black ink, appearing to read "W D Jemison".

William D. Jemison, Ph.D.  
Dean of Engineering  
Tony Collins Professor of Innovative Engineering Culture  
Fellow, IEEE

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1

<https://www.clarkson.edu/sites/default/files/2019-10/2019-2020-Clarkson-University-Graduate-Catalog.pdf>



August 2, 2020

From: **Prof. Tom Langen, School of Arts & Sciences Interim Dean, Clarkson University**  
To: **Academic Leadership Council, Faculty Senate**  
Re: **non-Thesis Track Computer Science M.S. Degree Program**

The Clarkson School of Arts & Sciences strongly supports the course-based, non-thesis M.S. Degree Program in Computer Science proposal put forth by the Department of Computer Science. This is a timely and well thought-out proposal that reinforces the strengths of the Department of Computer Science, and adds to Clarkson's reputation as a leader in technical graduate education.

This graduate degree program will address the interest of Clarkson computer science or software engineering alumni, computer science B.S. degree holders more widely, and corporate partners of Clarkson University. It addresses the need of computer scientists who pursue applied careers to take additional course work at the graduate level without a need to conduct research. The program holds the promise of generating significant revenue, and will add to Clarkson's growing reputation in computer science. This graduate degree program is comprised existing courses taught by current Computer Science and Electrical and Computer Engineering faculty members; the department has the capacity to adequately support the program. **In the short-term, this degree program merits the commitment of one new TA line.** I support this commitment, with the caveat that if the program does not meet its enrollment goals, this TA line may be terminated.

The resource commitment needed to deliver this program is minimal, and therefore a rigorous market analysis and revenue projection at this stage is not warranted. Should there be intention grow this program, and increase capacity through use of adjunct instructions, expanded delivery of only courses, or coursework at other Clarkson campuses, this would warrant student a market and revenue study. .

Respectfully,

A handwritten signature in black ink that reads 'Tom Langen' in a cursive script.

**Tom A. Langen, Ph.D**

*Interim Dean, School of Arts & Sciences  
Professor, Depts. of Biology & Psychology  
Clarkson University*



# Clarkson

September 15, 2020

To Members of Faculty Senate:

Please accept this letter as notification, we, the Provost's Council, endorse the following item voted unanimous, to move forward in the internal approvals process:

Academic Program	Date of Vote
MS in Computer Science, Non-Thesis Program	9/7/2020

Please advise if there are questions or concerns.

Sincerely,

Amanda J. Pickering  
Executive Director of Academic Affairs  
Office of the Provost



## MEMORANDUM

TO: Faculty Senate (K.Fite, President; S. Wojtkiewicz, Secretary)  
FROM: Stefan Grimberg, Chair Curriculum and Academic Policy Committee  
Cc: Natasha Banerjee  
SUBJECT: Changes to MS in Computer Science Program to include non-thesis option  
DATE: December 8, 2020

The CAP committee approves the change to the MS in Computer Science program to include a non-thesis option. In reviewing the proposal the committee had the following comments/suggestions:

- TA-Support: The proposal request an extra TA position to assist in the anticipated extra grading effort in several computer science courses. The justification is further based on the recent enrollment increase in the computer science department (both graduate and undergraduate students). Given that the justification is not solely based on the anticipated growth of the MS program the committee suggest for the computer science department chair to request additional TA support through the Dean and Provost instead of linking it to this particular program proposal.
- Consider adding courses from Data Analytics Program as electives. The electives suggested for the degree program only include computer science or electrical engineering courses. The committee members suggest for the program proposer to consider courses offered across the university that may complement the proposed course offering (e.g. course offered through the data analytics program).
- It would be helpful to provide some example project topics for the new courses. That could aid in the recruitment of students.
- P 30, sum of % in "Breakdown" was 110%, not 100%
- Pp 32-33, same problem as in #5 for sum of % in "Breakdown" totaling 110% rather than 100%

## Addressing CAP Committee Comments

- **TA Support:** Based on the recommendation of the CAP Committee, the Chair of the CS department had a discussion with the Dean of the School of Arts & Sciences. Following is a screenshot of the Dec 8, 2020 10:59AM email from the Chair of the CS Department to the Chair and Secretary of the Faculty Senate indicating his plan to speak to the Dean:

**Christopher Lynch** <clynch@clarkson.edu> Dec 8, 2020, 10:59 AM ☆ ↩ ⋮  
to Steven, Kevin, me ▾  
I agree. We can address Bullets 2 - 5. I will discuss with the dean about TA positions.  
Chris  
⋮

The Chair of the CS Department followed this up with an email at 1:58PM after his conversation with the Dean, indicating the Dean's commitment to provide an additional TA:

**Christopher Lynch** <clynch@clarkson.edu> Dec 8, 2020, 1:58 PM ☆ ↩ ⋮  
to Steven, Kevin, me ▾  
Here is what the dean said:  
"Yes, theSoAS Dean acknowledges the requested need for an additional TA and is committed to adding a TA to cover the additional work from the growing CS programs."  
Chris  
⋮

- **Data Analytics Courses:** We have analyzed the list of courses offered by the Data Analytics program, and have determined that the following courses are candidates for being electives for the MS in CS:

IA 626: Big Data Processing and Cloud Services  
IA 628: Introduction to Big Data Architecture and Applications  
IA 640: Information Visualization  
IA 650: Data Mining  
IA 651: Applied Machine Learning

We have communicated with Boris Jukic, Director of Business Analytics, as well as the instructors of the above courses (Tyler Conlon, Joseph Skufca, Sumona Mondal, and Daqing Hou) to receive their consent. All faculty members are enthusiastic for the proposal, and have provided their support. The screenshots on the following page show the email responses from Joseph Skufca and Daqing Hou. Boris Jukic, Tyler Conlon, and Sumona Mondal have provided signed letters as well, attached after this summary of responses. As of Fri, Jan 15, department members have unanimously voted on allowing students to take up to two graduate courses in the non-thesis and thesis MS in CS outside the department, in areas such as but not limited to data analytics,

engineering, mathematics, and the sciences, with the permission of the research advisor for thesis-based MS or graduate coordinator for non-thesis MS, and the approval of the CS graduate committee.

**Daqing Hou**

to Boris, Daqing, me, Christopher, Joseph, Sumona, Tyler ▾

I support the proposal as well.

Best,

Sincerely,  
Daqing

\*\*\*\*\*

Daqing Hou, PhD  
Professor & Director, Software Engineering  
Electrical and Computer Engineering Department  
Wallace H. Coulter School of Engineering  
Clarkson University  
CAMP 127  
8 Clarkson Avenue  
Potsdam NY 13699-5720

<http://people.clarkson.edu/~dhou>

[dhou@clarkson.edu](mailto:dhou@clarkson.edu)

office: 1-315-268-7675

fax: 1-315-268-7600

**Joseph Skufca**

to Boris, me, Christopher, Sumona, Tyler, Daqing ▾

I support the proposal.

Joe Skufca  
Professor and Chair of Mathematics



SC355 315-268-2399

[jskufca@clarkson.edu](mailto:jskufca@clarkson.edu)

- **Example Project Topics** are now included after the syllabus for CS613 Projects I.
- **Errata** in breakdown values in syllabi for Projects I and Projects II are now corrected.



# Clarkson

## INTERDISCIPLINARY ANALYTICS

8 Clarkson Avenue

Potsdam, New York 13699

315-268-388

[clarkson.edu/graduate/data-analytics](http://clarkson.edu/graduate/data-analytics)

Dec 17, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that as Director of Business Analytics, I support the inclusion of courses in Data Analytics as elective choices for students pursuing the MS in CS. These courses include IA626 (Big Data Processing and Cloud Services), IA628 (Introduction to Big Data Architecture and Applications), IA640 (Information Visualization), IA650 (Data Mining), and IA651 (Applied Machine Learning). Support has been sought and received from all faculty members involved in teaching the courses.

Thank you,

*Boris Jukic*

**Boris Jukic**

*Professor, Information Systems*

*Director, Data Analytics Programs*

# Clarkson

DAVID D. REH SCHOOL OF BUSINESS

Box 5770

8 Clarkson Avenue

Potsdam, NY 13699

315-268-3884

[bjukic@clarkson.edu](mailto:bjukic@clarkson.edu)

Dec 17, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that as instructor of the Data Analytics courses IA626 (Big Data Processing and Cloud Services) and IA628 (Introduction to Big Data Architecture and Applications), I support the proposal for inclusion of the courses as elective choices in the MS in Computer Science.

Thank you,

A handwritten signature in black ink, appearing to read 'Tyler Conlon', written in a cursive style.

Tyler Conlon  
Instructor and Director of Projects and IT Infrastructure  
Data Analytics, Reh School of Business  
Clarkson University, Potsdam, NY 13699-5790  
Email: [tconlon@clarkson.edu](mailto:tconlon@clarkson.edu)





DECEMBER 17, 2020

To Whom It May Concern:

This is to notify all parties involved in the approval process for the inclusion of a non-thesis option in the Master of Science in Computer Science program that as instructor of the Data Analytics course IA650 (Data Mining), I support the proposal for inclusion of the course as an elective choice in the MS in Computer Science.

Thank you,

Sumona Mondal  
Associate Professor, Department of Mathematics  
Clarkson University, Potsdam, NY 13699-5815  
Email: [smondal@clarkson.edu](mailto:smondal@clarkson.edu)

*Sumona Mondal*

**MEMO**

**From:** Jeanna Matthews and Alexis Maciel, Department of Computer Science

**To:** Faculty Senate

**Subject:** Proposal for a Master's Degree in Cybersecurity

We are submitting a proposal to the Faculty Senate for a Master's Degree in Cybersecurity.

Market analysis conducted by Mike Walsh using Burning Glass indicates big opportunities for growth, including good regional and national employment opportunities. The proposed program builds on courses already offered in the Departments of Computer Science and Electrical and Computer Engineering, including courses in Computer and Network Security, Biometrics, Formal Methods for Program Verification, Secure Computer System Design and others. Faculty in both departments have a track record of internationally recognized research in cybersecurity and related areas. It is a natural area of growth for Clarkson and a Master's Degree in Cybersecurity has been proposed internally for several years.

The program will offer both a thesis and non-thesis option. We expect that full-time students would complete the program in 3 semesters. Completing the program part-time and in distance mode is possible. We expect the program to be attractive to students working full-time in the cybersecurity-related businesses surrounding the Air Force Research Lab in Rome, New York. We already have experience with graduate students from this area successfully completing M.S. and Ph.D. programs at Clarkson.

We can begin to offer the degree program using only existing courses and faculty members. However, especially for non-thesis students, additional elective courses are important. For students desiring to complete the degree full-time, offering core courses more frequently and more elective courses concurrently would be important. The proposal calls for a new faculty member to be hired in Computer Science with expertise in Computer Security as well as one additional TA line to support the program. Based on modest projections of program enrollment, these additional resources would be well justified by the additional tuition revenue. We project 5 part-time students and 2 full-time students in the first year, growing to 15-25 students in later years.

Our proposal contains the following:

1. A short introduction.
2. Detailed program requirements.
3. Learning objectives.
4. Semester plans for both the thesis and non-thesis options.
5. A Catalog entry.
6. Some additional information, including requested resources, prospective students and revenue projections.
7. A completed NYSED application.
8. Letters of support from Paul McGrath, chair of ECE, Chris Lynch, chair of CS, Bill Jemison, Dean of Engineering, Tom Langen, Dean of Arts and Sciences.
9. A letter of endorsement from the Provost's Council.

# Proposal for a Master's Degree in Cybersecurity

## 1. OVERVIEW

Cybersecurity is a field of growing interest around the country. Curricular guidelines for programs in Cybersecurity have been developed in recent years. At Clarkson, we have a substantial number of courses in cybersecurity and a core of faculty doing research in the area. Students have been able to focus on cybersecurity as part of the Computer Science Master's Degree for years, but here we propose a Master's Degree in Cybersecurity that we think will be a better match for many students interested in focusing even more directly on security.

This would be a joint program between the CS and ECE departments. It would be managed by a committee of faculty from both departments who do research and teach in the area of cybersecurity.

## 2. REQUIREMENTS

A Master of Science degree at Clarkson requires a minimum of 30 credits. The proposed semester-based program in Cybersecurity has two options:

Thesis Option:

- 4 core courses (12 credits)
- 2 security-related electives (6 credits)
- 2 credits of seminar (CS707, 708)
- A thesis based on cybersecurity research (1-10 credits)
- Professional electives (as needed, to bring total to 30 credits)

Non-Thesis Option:

- 4 core courses (12 credits)
- 4 security-related electives (12 credits)
- A cybersecurity project (0-6 credits)
- Professional electives (as needed, to bring total to 30 credits)

The four core courses are described in Section 2.1 and are the same for both options.

The security-related electives must be chosen from a list maintained by the program committee. A sample list is given in Section 2.2.

The thesis and project are described in Sections 2.3 and 2.4, respectively.

The professional electives must be chosen from a list maintained by the program committee. It would initially consist of most CS courses as well as EE courses with substantial CS content.

Full-time non-thesis students using a project from the course CS557/EE510 Computer and Network Security could expect to complete a degree in 3 semesters. Full-time thesis students often take 4 semesters. For part-time students including distance students working full-time, time to completion would vary with the number of courses per semester they could handle successfully. At 2 courses per semester, it would take 5 semesters to complete the non-thesis option. At 1 course per semester, it could take 10 semesters. However, it is worth noting that students can take additional project or thesis credits

rather than courses and this may be a way of speeding up completion for students with a strong background.

As required by the Clarkson regulations, students must maintain a cumulative GPA of 3.0 in courses used to meet the graduation requirements.

## 2.1. Core Courses

CS557/EE510 Computer and Network Security

CS556 Cryptography

CS555/EE507 Computer Networks

One security-related 600-level CS course

CS557/EE510 provides an overview of the subject. This is valuable even for those students in our target population who have industry experience. We have already had such students in the course and they report that they benefit from such an overview. Many projects in industry are very specific and this course provides the broader context.

CS556 is included because cryptography is the basis of many cybersecurity defenses.

CS555/EE507 is included because although physical security is important, most cyberattacks come over a network such as the Internet.

The CS 600-level courses have a research component. They include a research project (individual or group at the discretion of the instructor), or the reading and discussion of research papers, or both. The inclusion of such a course in the core requirements will be a distinguishing feature of our program. Even non-thesis students in the program will gain an appreciation of research in cybersecurity.

We currently offer two 600-level security-related courses. One focuses on current research published in venues such as USENIX Security or IEEE Security and Privacy. The other focuses on artificial-intelligence approaches to cybersecurity. Both courses are currently offered under the same number (CS657 Advanced Topics in Computer Security), but we plan to give them each their own number and title.

Students who have successfully completed at another institution a course comparable to one of the core courses can petition the program committee to replace that course by a professional elective.

## 2.2. Security-Related Electives

As stated above, the security-related electives in each option must be chosen from a list maintained by the program committee. Initially, this list would be:

- CS544 Operating Systems

- CS545 Compilers

- CS558 Formal Methods for Program Verification (revised to include cybersecurity topics)

- CS571 System Administration and Network Operations

- EE523 Introduction to Biometrics

- EE576 Secure Computer System Design

- EE622 Advanced Biometrics

- Security-related 600-level CS courses (beyond the one taken as a core course)

- Directed study courses in cybersecurity

As soon as a new cybersecurity faculty member is hired, this list would be expanded to include new courses related to that person's interests and expertise. Here are examples of courses we would be interested in adding to this list:

- Malware Identification
- Computer Forensics
- Cybersecurity Tools
- Web Security
- Malware economy
- Mobile Security
- IoT security

We expect that most of these courses would be double-listed at the 400 and 500 levels. This is an advantage because they would benefit our advanced undergraduates as well.

Here are tentative descriptions for some of these courses:

**Malware Identification** Malware, or malicious software, includes functionality both to gain entry to a vulnerable system and to exploit the victim once entry has been gained. This course will examine a range of functionality typical in modern malware and how that functionality has evolved over time. It will also cover how malware authors seek to obfuscate their software and avoid detection. We will focus on how anti-virus systems identify malware and what can be done to avoid or recover from infection.

**Computer Forensics** This course focuses on tools and strategies for examining a system after it has been compromised. We look at the evidence trails that are left on the victim system (e.g., in the file system, running software) and evidence that is left on other systems in the local environment (e.g., DNS systems, firewalls, routers). We will discuss procedures for both recovery and response.

**Cybersecurity Tools** An important part of cybersecurity education is mastering a set of common tools including IDEs for reverse engineering of software, penetration testing tools and others. This lab-based class will focus on introducing students to essential hands-on tools.

**Web Security** Attacks on real systems can arrive through many avenues, but one of the most common vectors of attack is through vulnerable web servers and web browsers. We will focus both on vectors of attack as well as best practices for security.

### 2.3. Thesis

The thesis option requires a written thesis based on cybersecurity research. The thesis will be examined by a committee of at least three Clarkson faculty appointed by the program committee. The thesis must also be defended orally to that committee. After approval by the examining committee, a thesis requires signature approval by the Dean of the Graduate School, and two copies of the thesis will be deposited in the University library.

All students must have a research advisor by the end of their first semester of study and must submit a research proposal to their thesis committee by the end of the semester before they plan to graduate.

### 2.4. Cybersecurity Project

The non-thesis option requires a cybersecurity project that can be a standalone project done for course credit. It can also be a project done as part of a security-related course or a project done for an internship

or at a full-time job. Projects that are done at work or as part of other courses do not earn additional credit; in that case, a 0-credit course will be used to record completion of the project on the student's transcript. In any case, every project must be approved in advance by the program committee. After the project is completed, a written report will be examined by the program committee, or by a faculty member designated by the program committee.

### 3. LEARNING OBJECTIVES

After completing this program, students will

1. Have an advanced understanding of cybersecurity defensive strategies including strategies for prevention, detection, recovery and response.
2. Be familiar with both the evolving trends in offensive techniques deployed by attackers and the corresponding evolution in defensive strategies that is necessary to counter attackers.
3. Gain practical skills in the use of cybersecurity tools with an emphasis on defensive techniques.

### 4. SEMESTER PLANS

3-semester plan for the thesis option:

**Fall Year 1** (10 credits)

CS555 Computer Networks, 3 credits (CORE COURSE)

CS557 Computer and Network Security, 3 credits (CORE COURSE)

Security-Related Elective, 3 credits (Example: EE576, Secure Computer System Design)

CS707 Seminar, 1 credit

**Spring Year 1** (10 credits)

CS556 Cryptography, 3 credits (CORE COURSE)

Security-Related Elective, 3 credits (Example: EE523 Introduction to Biometrics or CS558 Formal Methods for Program Verification)

CS708 Seminar, 1 credit

Thesis, 3 credits

**Fall Year 2** (10 credits)

Security-related 600-level CS course, 3 credits (Example: CS 657 Advanced Topics in Computer Security)

Professional Elective, 3 credits (Example: EE 622 Advanced Biometrics)

Thesis, 4 credits

3-semester plan for the non-thesis option:

**Fall Year 1** (9 credits)

CS555 Computer Networks, 3 credits (CORE COURSE)

CS557 Computer and Network Security, 3 credits (CORE COURSE)

Security Related Elective, 3 credits (Example: EE576, Secure Computer System Design)

**Spring Year 1** (11 credits)

CS556 Cryptography, 3 credits (CORE COURSE)

Security-related 600-level CS course, 3 credits (Example: CS657 Advanced Topics in Computer

Security)

Security Related Elective, 3 credits (Example: EE523 Introduction to Biometrics or CS558 Formal Methods for Program Verification)

Cybersecurity Project, 2 credits

**Fall Year 2** (10 credits)

Security Related Elective, 3 credits (Example: EE622 Advanced Biometrics)

Security Related Elective, 3 credits (Example: CS571 System Administration and Network Operations)

Cybersecurity Project, 4 credits

## 5. CATALOG ENTRY

### MS in Cybersecurity Program

Jeanna Matthews, Department of Computer Science

[jnm@clarkson.edu](mailto:jnm@clarkson.edu)

Christopher A. Lynch, Chair of the Department of Computer Science

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The Master of Science in Cybersecurity is designed to give students an advanced understanding of cybersecurity defensive strategies, to make them familiar with the evolving trends in offensive techniques deployed by attackers and the corresponding evolution in defensive strategies, and to allow students to gain practical skills with cybersecurity tools. The program is organized around a set of core courses and a number of security-related electives. There is a thesis and a non-thesis option. The non-thesis option requires completion of a cybersecurity project. The small size of the cybersecurity courses allow for close interaction with faculty and for attention to individual student interests.

The MS in Cybersecurity is offered jointly by the Department of Computer Science and the Department of Electrical and Computer Engineering. The program is managed by a committee of faculty with expertise in cybersecurity.

#### Prerequisites

Applicants are normally expected to have an undergraduate degree in computer science, computer engineering or software engineering. At a minimum, applicants should have completed two courses in computer programming, one course covering computer organization topics, and a mathematics course with an emphasis on proofs.

#### Requirements

The program requires a minimum of 30 credits. Here is an overview of the requirements for both options. The various elements of the requirements are described in more detail below.

Thesis option:

1. 4 core courses (12 credits)
2. 2 security-related electives (6 credits)

3. 2 credits of seminar (CS707, 708)
4. A thesis based on cybersecurity research (1-10 credits)
5. Professional electives (as needed, to bring the total to 30 credits)

Non-thesis option:

1. 4 core courses (12 credits)
2. 4 security-related electives (12 credits)
3. A cybersecurity project (0-6 credits)
4. Professional electives (as needed, to bring the total to 30 credits)

The four core courses are

- CS557/EE510 Computer and Network Security
- CS556 Cryptography
- CS555/EE507 Computer Networks
- A security-related 600-level CS course

The 600-level CS course must be chosen from a list maintained by the Program Committee. They are advanced courses that have a research component that is designed to expose students to cybersecurity research through a research project, the reading and discussion of research papers, or both.

Students who have successfully completed a course comparable to one of the core courses prior to enrolling in the program can petition the Program Committee to replace that core course by a professional elective.

The security-related electives must be chosen from a list maintained by the Program Committee.

The thesis of the thesis option must be based on cybersecurity research. The thesis will be examined by a committee of at least three Clarkson faculty appointed by the Program Committee. The thesis must also be defended orally to that committee. All students in the thesis option must have a research advisor by the end of their first semester of study and must submit a research proposal to their thesis committee by the end of the semester before they plan to graduate.

The cybersecurity project of the non-thesis option can be a standalone project done for course credit, a project done as part of a security-related course, or a project done for an internship or at a full-time job. Projects that are done at work or as part of other courses do not earn additional credit; in that case, a 0-credit course will be used to record completion of the project on the student's transcript. In any case, every project must be approved in advance by the Program Committee. After the project is completed, a written report will be examined by the Program Committee, or by a faculty member designated by the Program Committee.

The professional electives must be chosen from a list maintained by the Program Committee. This list normally includes most CS courses as well as EE courses with substantial computer science content.

### **Program Length**

Full-time students can expect to complete the thesis option in 3 or 4 semesters and the non-thesis option in 3 semesters.



## 6. ADDITIONAL INFORMATION

### 6.1. Requested Resources in Support of the Program

To support this program, we need one additional tenure-track faculty member in computer science. The four courses per year taught by this faculty member would allow the following:

- Teach CS456 Cryptography every year (currently every other year, ½ course addition).
- Teach a CS 600-level course in computer security every year (currently every other year, ½ course addition).
- Teach the basic CS557/EE510 Computer and Network Security course every semester (currently once a year, 1 course addition).
- Teach two additional courses on cybersecurity topics to be offered each year.

Over time, we expect that a new faculty member could add more two additional courses to our cybersecurity offerings by alternating the courses they teach each year. This would allow two additional cybersecurity electives to be offered in each year with a wider variety of courses offered over multiple years. This would benefit students in the Cybersecurity Master's program as well as other graduate students (Master's and PhD) and our advanced undergraduate students.

A new faculty member would also teach at least one undergraduate CS course, freeing up existing faculty to teach some of their courses more often (e.g., cryptography). Existing faculty could also offer some of the new courses we have outlined. The exact mix would vary with the interests of the new faculty member hired.

By offering Computer and Network Security every semester, we would increase the chances that Cybersecurity Master's students could complete the degree in three semesters and would also ensure that students can take this basic security course in their first year even if they need to take Computer Networks first.

We would like to hire a new faculty member who is capable of, and interested in, developing student teams to compete in the rich array of hackathons and computer security events available (e.g., ANYCon in Albany, CNYHackathon in Utica, HackUpstate in Syracuse, Hackers On Planet Earth (HOPE) in New York City, DEFCON in Las Vegas and our own HackPotsdam). Jeanna Matthews and the Applied Computer Science Labs have been attending these events and organizing a yearly hackathon with SUNY Potsdam, but we really need more faculty resources to support this effort. A faculty member who could focus more specifically on preparing students for security events and traveling with them would be ideal. As we do with the Applied CS labs now, this could be a mix of CS courses, MP courses and volunteer participation. We would request some university funding to support the travel of student teams to Hackathons and estimate that a budget of \$6000 would be reasonable to start and could then adjusted based on experience with the number of students participating and the location of the hackathons targeted.

We also request additional TA support. Initially, one full TA to support the Computer and Network Security class and the ramp up of the program should be sufficient. As we add new security electives as described in Section 2.2, and as the program grows in popularity, additional TA support would be needed (1 additional TA to support 2 security electives a year).

Faculty teaching distance students also need additional support. For some time, faculty received additional compensation for distance students in their classes. We request a return to that model.

We can begin this program using the software and lab resources of the Applied CS labs. However, if the program grows in popularity, it could become appropriate to fund special lab space and equipment that could be dedicated to security work.

To summarize, to begin offering this program, we would request 1 full TA and the permission to advertise an additional tenure track faculty position. With new faculty resources, new security electives will be developed and we would request additional TA to support them. Resources for hackathon travel, software and labs could scale with the popularity of the program.

## 6.2. Relationship to the Computer Science Master's Program

Students may naturally ask about the difference between the CS Master's Degree and the Cybersecurity Master's Degree. The primary difference is in the list of required core courses. The CS Master's Degree requires two courses in theoretical computer science (CS541 Introduction to Automata Theory and Formal Languages and CS547 Computer Algorithms) and two courses that include a substantial amount of programming (CS544 Operating Systems, CS545 Compiler Construction, CS550 Software Design and Development or CS552 Computer Graphics). Cybersecurity students would likely often take Operating Systems and Compilers, but may not be interested in taking Automata Theory and Algorithms.

## 6.3. Prospective Students

There are a group of companies focused on cybersecurity that collaborate with and support the Air Force Research Lab (AFRL) in Rome, New York. AFRL and the Information Directorate of the Air Force focus on both offensive and defensive cybersecurity. Many of these companies will pay for their employees to pursue graduate degrees and many of our undergraduate students are employed in this ecosystem of companies. Although there is a substantial overlap between the Computer Science Master's Program and the proposed Cybersecurity Master's program, for many employees at these companies, a degree in Cybersecurity would be an even better match for their interests than a degree in Computer Science. We have had a number of students from these companies in our distance classes and in particular in CS557/EE510 Computer and Network Security. The material taught in that course and in our other security-related courses has been well received by these students. Even students who focus on cybersecurity in their jobs have said that they value the breadth of security material covered and the way it helps put the very specific things they do in projects at work into perspective.

We suspect that many students interested in this program will have an undergraduate degree in computer science, computer engineering or software engineering. They would likely have taken a course on operating systems and perhaps one on computer networks. This would give them additional flexibility in choosing courses for their degree and is another reason why it is important for us to add additional courses and the additional faculty resources to support them.

Other students coming into the program would need, at a minimum:

- Two courses in programming (such as CS141 and then either CS142, EE262 or EE361)

- A course covering computer organization (such as CS241, EE260 or EE264)

- A course with emphasis on mathematical proofs (such as MA211)

Ideally, students would also have taken a course in algorithms and data structures such as CS344.

## 6.4. Market Analysis Summary and Revenue Projections

In May 2019, Jeanna Matthews and Alexis Maciel developed a proposal for a Master's Degree in Cybersecurity incorporating feedback from faculty in both Computer Science and Electrical and Computer Engineering. Mike Walsh has recently conducted market analysis on cybersecurity using data from Burning Glass (<https://www.burning-glass.com/products/labor-insight/>). It provides data on growth trends, employment prospects, and skills/content knowledge in demand (important for judging curriculum alignment with need. His report notes:

1. Large opportunity for growth
2. Good employment opportunities both regionally and nationally

His research reveals that a BS is sufficient for most jobs. However, we expect strong demand from working engineers, especially those in the cybersecurity related businesses associated with AFRL in Rome, New York. We already have substantial experience with graduate students working for those businesses taking computer science classes remotely and successfully graduating with MS and Ph.D. degrees. Developing a proposal for a Bachelor's degree in Cybersecurity would be a natural next step and as the courses and resources proposed for the Master's degree in Cybersecurity program would be accessible to our undergraduates as well. The faculty proposed for this program would be able to oversee a Bachelor's degree program as well.

One practical note from this market research is that explicitly adding programming assignments in Python to courses in Cybersecurity would enhance the attractiveness of our graduates in the job market. This does not require a change to any of the proposed courses, but is an important note for specific implementation of assignments.

We have modeled a set of revenue projections for the proposed program (see the spreadsheet that follows this section). After subtracting instructional costs, it shows revenue to the university growing from almost \$40,000 in the first year to approximately \$124,000 per year in steady state. We have modeled a mix of part-time students and full-time students. We expect the program to be especially popular with engineers working full-time in cybersecurity industry and predict the pool of part-time students to start at 5 and grows as word spreads about the program, stabilizing at 20. At 1-2 courses per semester, students could complete the program in 3 years. We also expect some students to enroll full-time in the program. We expect it to be an attractive option for some Clarkson undergrads to continue in the program and expect a growing interest from external full-time students as word of the program grows. We predict 2 full-time students to start growing to 6 in later years.

The program could get started with the courses we currently offer, but it would be essential to recruit a new faculty member in order for the first cohort of students to have the course they need to graduate. In our revenue projections, we began the first year with 1 new full time TA and a search to hire a new faculty member. We budgeted for a tenure-track assistant professor beginning in year 2. In year 3, we added \$12,000/year to pay external security professionals to teach or collaborate in the teaching of elective courses. We envision these courses as a rich set of elective courses and practical experiences for students and a win-win situation for professionals wishing to add some university teaching to their portfolio of activities. We do not envision this as an effective way to deliver the core components of the Cybersecurity program and expect interfacing with these external instructors to require work on the part of faculty managing the program. We also budgeted for \$6000/year for lab resources (hardware/software), travel to hackathons and similar expenses.

**Modeling of Revenue for MS in Cybersecurity Program**

**Notes**

Assume full price for part time students and 30% discount for full time students

Assume first year starts with course we are already offering and 1 new full time TA and search to hire a new faculty member

Assume second year and forward has full time TA and an assistant professor

Budgeting to pay professionals to teach/collaborate on additional electives in Year 3 and beyond

Without adding faculty we would not have enough classes to satisfy later year requirements

Many of these courses would accessible to Clarkson undergraduates as well opening the door for a Cybersecurity BS degree as well.

<b>Predictions</b>	Program especially popular with engineers working full time in cybersecurity industry.	<b>Key Parameters</b>	<b>Fees Per credit</b>	\$1,388.00
<b>Narrative</b>	Some Clarkson undergrads will continue in the program; Some external full time students		<b>After 30% discount</b>	\$971.60
	Predict 2-3 Clarkson students/year to start		<b>TA Salary/Benefits per seme</b>	\$12,000
	Predict growing interest from elsewhere, starting at 0 and growing in later years to 3		<b>Assistant Professor Salary/B</b>	\$50,000
	Predict pool of part time students starts at 5 and grows as word spreads, stabilizing at 20		<b>Courses Taught by Professio</b>	\$6,000
			<b>Budget for lab facilities, trav</b>	\$3,000
			<b>Credits/Semester Full Time</b>	12
			<b>Credits/Semester Part Time</b>	4.5

Year	Semester	Part-time Students	Part-time Credit Hours	Full-time students	Full-time Credit Hours	Revenue from Students	Instruction cost	Revenue to University
23	1	1	5	22.5	2	\$5,548.40	\$15,000	\$39,548.40
24	1	2	7	31.5	3	\$78,699.60	\$15,000	\$63,699.60
25	2	1	8	36	3	\$84,945.60	\$65,000	\$19,945.60
26	2	2	10	45	3	\$97,437.60	\$65,000	\$32,437.60
27	3	1	12	54	3	\$109,929.60	\$71,000	\$38,929.60
28	3	2	14	63	3	\$122,421.60	\$71,000	\$51,421.60
29	4	1	16	72	4	\$146,572.80	\$71,000	\$75,572.80
30	4	2	18	81	4	\$159,064.80	\$71,000	\$88,064.80
31	5	1	20	90	5	\$183,216.00	\$71,000	\$112,216.00
32	5	2	20	90	5	\$183,216.00	\$71,000	\$112,216.00
33	6	1	20	90	6	\$194,875.20	\$71,000	\$123,875.20
34	6	2	20	90	6	\$194,875.20	\$71,000	\$123,875.20



## **Application for the Registration of New Graduate and Undergraduate Curricula/Programs – Including Programs to be Offered in Distance Education Format**

### **Important Information**

1. This application is for use by institutions of higher education that hold an absolute charter or permanent authority to award degrees seeking to register **general academic curricula**.
2. **Do not** use this application for the following program proposals:
  - Programs preparing teachers, educational leaders, or other school personnel
  - Programs preparing licensed professionals
  - Programs leading to doctoral level degrees
  - Programs leading to a credit-bearing Certificates or Advanced Certificates
  - Proposals for revisions to existing registered programs (including title changes, curricular changes, etc.)
3. Program registration is based upon standards in the Regulations of the Commissioner of Education (8 NYCRR Chapter II, Subchapter A). The Department registers individual curricula/programs rather than the institution as a whole, but the registration process includes, in some instances, an assessment of institutional-level compliance with some of the standards.
4. This application includes attestations/assurances, by the Chief Administrative or Academic Officer/Provost of the institution, on behalf of the institution, concerning the institution's compliance with statutory and regulatory requirements related to the standards for curricula/program registration and operation of higher education programs in New York State.
5. The Department will audit compliance and, if an institution is found to be out of compliance with one or more standard to which it attested compliance, that finding may lead to denial of: (1) re-registration of the program, pursuant to §52.1(l) of the Regulations of the Commissioner of Education and (2) the ability of the institution to utilize attestations in future applications for program registration; and in certain circumstances may warrant deregistration of the program.
6. Program proposals from SUNY and CUNY System institutions must be submitted to the Department by the System Administration. Contact the System Administration for information concerning relevant proposal submission requirements.
7. The Department reserves the right to request additional information and/or clarification of any information provided by the institution that may be necessary for the Department to make a registration decision concerning the proposed program.

## Submission Instructions

Applications for program registration will be accepted in **electronic format only** via the instructions below. Hard copy applications will not be accepted or reviewed by the Department and will not be retained.

1. Create a single PDF document that includes the following documents:
  - The completed Application for the Registration of New Graduate and Undergraduate Curricula/Programs, with all required signatures included;
  - Any request for a Master Plan Amendment and associated information and materials that may be required concerning this program proposal (see below); and
  - Any external review of the proposed program that is required (see below).
2. Attach the PDF document to an e-mail.
3. Send the e-mail (with attachment) to [OCUERevAdmin@nysed.gov](mailto:OCUERevAdmin@nysed.gov).
4. The subject line of the email should include the name of the institution, the degree award and the program title. For example:

Subject: ABC College, Master of Science, English Literature.

## Master Plan Amendments

If this program proposal necessitates a Master Plan Amendment, additional information and materials related to that request will be required. Please refer to information on the Department's web site at: <http://www.nysed.gov/college-university-evaluation/proposals-requiring-master-plan-amendment> for information on Master Plan Amendments to determine if such an amendment is required for this program proposal and to access the Master Plan Amendment Supplement.

## External Review

Please refer to <http://www.nysed.gov/college-university-evaluation/external-reviews> for information about when an external review of a proposed program is required. If such a review is required, that material must be submitted with the program registration application.

## General Information

Institution (Legal Name)	Institution Code
Clarkson University	412500
Proposed Program Title	Degree Award
CYBERSECURITY M.S. DEGREE	M.S.
Address of Any Campus Where the Proposed Program Will Be Offered (main and/or branch campuses)	Full-time or Part-time <sup>1</sup>
8 Clarkson Ave, Potsdam NY 13699	Full-time or Part-time
All Program Format(s) (standard, distance education <sup>2</sup> , evening, weekend and/or other)	HEGIS Code
Standard, distance	0799.00
Joint Registration IHE (if applicable)	Total Number of Credits
	30
Lead Contact [First Name, Last Name, Title]	Telephone Number
Jeanna Matthews, Professor, Department of Computer Science	315-250-0566
Email Address	
jnm@clarkson.edu	

<sup>1</sup> Please refer to §52.2(c) and §145-2.1 of the Regulations of the Commissioner for definitions and information concerning full and part time study. Note: Only programs registered as full time are eligible for TAP. Programs are subject to audit by the NYS Office of the State Comptroller and the Higher Education Services Corporation (HESC) for financial aid compliance purposes.

<sup>2</sup> If a major portion of the program (50% or more) can be completed through study delivered by distance education then the program must be registered in the distance education format. Hybrid or blended courses do not count toward the 50%.

## Attestation and Assurances

On behalf of the institution, I hereby attest to the following:

That all educational activities offered as part of this proposed curriculum are aligned with the institutions' goals and objectives and meet all statutory and regulatory requirements, including but not limited to Parts 50, 52, 53 and 54 of the Rules of the Board of Regents and the following specific requirements:

That credit for study in the proposed program will be granted consistent with the requirements in §50.1(o).

That, consistent with §52.1(b)(3), a reviewing system has been devised to estimate the success of students and faculty in achieving the goals and objectives of the program, including the use of data to inform program improvements.<sup>3</sup>

That, consistent with §52.2(a), the institution possesses the financial resources necessary to accomplish its mission and the purposes of each registered program, provides classrooms and other necessary facilities and equipment as described in §52.2(a)(2) and (3), sufficient for the programs dependent on their use, and provides libraries and library resources and maintains collections sufficient to support the institution and each registered curriculum as provided in §52.2(a)(4), including for the program proposed in this application.

That, consistent with 52.2(b), the information provided in this application demonstrates that the institution is in compliance with the requirements of §52.2(b), relating to faculty.

That all curriculum and courses are offered and all credits are awarded, consistent with the requirements of §52.2(c).

That admissions decisions are made consistent with the requirements of §52.2(d)(1) and (2) of the Regulations of the Commissioner of Education.

That, consistent with §52.2(e) of the Regulations of the Commissioner of Education: overall educational policy and its implementation are the responsibility of the institution's faculty and academic officers, that the institution establishes, publishes and enforces explicit policies as required by §52.2(e)(3), that academic policies applicable to each course as required by §52.2(e)(4), including learning objectives and methods of assessing student achievement, are made explicit by the instructor at the beginning of each term; that the institution provides academic advice to students as required by §52.2(e)(5), that the institution maintains and provides student records as required by §52.2(e)(6).

That, consistent with §52.2(f)(2) of the Regulations of the Commissioner of Education, the institution provides adequate academic support services and that all educational activities offered as part of a registered curriculum meet the requirements established by state, the Rules of the Board of Regents and Part 52 of the Commissioner's regulations.

CHIEF ADMINISTRATIVE or ACADEMIC OFFICER/ PROVOST	
Signature	Date
Type or print the name and title of signatory	Phone Number

<sup>3</sup> The Department reserves the right to request this data at any time and to use such data as part of its evaluation of future program registration applications submitted by the institution.



## Program Purpose, Objectives and Targets

<p><b>Program Purpose</b></p> <p><i>Department Expectation: Clearly define a program purpose that is aligned to the degree award and program title.</i></p> <p>Educate cybersecurity students in the advanced content knowledge and applied skills needed to work in the cybersecurity industry, or to continue on to doctoral-level graduate or professional studies.</p>				
<p><b>Program Objectives</b></p> <p><i>Department Expectation: Articulate between 1 and 3 program-level (curriculum-level) objectives that are clearly defined and directly aligned with the program purpose and proposed degree award.</i></p>				
1. Have an advanced understanding of cybersecurity defensive strategies including strategies for prevention, detection, recovery and response.				
2. Be familiar with both the evolving trends in offensive techniques deployed by attackers and the corresponding evolution in defensive strategies that is necessary to counter attackers.				
3. Gain practical skills in the use of cybersecurity tools with an emphasis on defensive techniques.				
<p><b>Program Targets –</b></p> <p><i>Department Expectation: Establish realistic enrollment, retention, graduation, and job placement targets for this program that are connected to the reviewing system by which the success of students and faculty in achieving such goals and objectives of the program are determined. Note: There are not specific Department defined targets required for the registration of curricula. The Department expects institutions to establish targets that reflect the espoused quality of the program, and to periodically and systematically review such targets are they related to program implementation.</i></p> <p><i>Enrollment Projections: The Department assumes that Year 5 enrollment projections will be full-capacity relative to existing and new resources planned.</i></p>				
Year 1	Year 2	Year 3	Year 4	Year 5
7	10	11	13	15
<b>Annual Retention Rate Target (%)</b>		<b>Target graduation rate (%)</b>		<b>Target Job Placement Rate (%)</b>
90		90		100

## Curriculum and Course Information

Please provide the following:

1. The applicable sample student program schedule table:
  - Table A: Undergraduate Program Schedule; or
  - Table B: Graduate Program Schedule

**When completing the program schedule table please refer to the requirements in §52.2(c) of the Regulations of the Commissioner concerning completion of Associate, Baccalaureate and Master’s degree programs.**

2. Please list the course titles for all new courses included as part of the proposed program, and, either attach the course syllabi or, if such syllabi are not yet available, provide course descriptions and objectives in the chart below.

New Course Titles	Indicate that course syllabi are attached or, provide course descriptions and objectives (if course syllabi are not available)
All required courses exist and are currently taught.	

## Table A: Undergraduate Program Schedule

- Indicate academic calendar type:  Semester  Quarter  Trimester  Other (describe):
- Label each term in sequence, consistent with the institution's academic calendar (e.g., Fall 1, Spring 1, Fall 2)
- Use the table to show how a typical student may progress through the program; copy/expand the table as needed.

Term:		Credits per classification				
Course Number & Title	Cr	LAS	Maj	New	Prerequisite(s)	
<b>Term credit total:</b>						
Term:		Credits per classification				
Course Number & Title	Cr	LAS	Maj	New	Prerequisite(s)	
<b>Term credit total:</b>						
Term:		Credits per classification				
Course Number & Title	Cr	LAS	Maj	New	Prerequisite(s)	
<b>Term credit total:</b>						
Term:		Credits per classification				
Course Number & Title	Cr	LAS	Maj	New	Prerequisite(s)	
<b>Term credit total:</b>						
Term:		Credits per classification				
Course Number & Title	Cr	LAS	Maj	New	Prerequisite(s)	
<b>Term credit total:</b>						
<b>Program Totals:</b>	Credits:	Liberal Arts & Sciences:		Major:		Elective & Other:
Cr:= credits	LAS = <a href="#">Liberal Arts and Sciences</a>	Maj = major requirement	New = new course	Prerequisite(s) = list prerequisite(s) for the noted courses		

## Table B: Graduate Program Schedule

- Indicate academic calendar type:  X Semester  Quarter  Trimester  Other (describe):
- Label each term in sequence, consistent with the institution's academic calendar (e.g., Fall 1, Spring 1, Fall 2)
- Use the table to show how a typical student may progress through the program; copy/expand the table as needed.

Term: Fall Year 1 Semester			
Course Number & Title	Credits	New	Prerequisite(s)
CS 555 Computer Networks	3		Basic computer programming and computer architecture from undergraduate computer science degree.
CS 557 Computer and Network Security	3		Co-requisite CS 555.
Security related Elective (Example: EE 576, Secure Computer System Design)	3		None
Term credit total:	9		
Term: Fall Year 2 Semester			
Course Number & Title	Credits	New	Prerequisite(s)
Security Related Elective (Example: EE 622 Advanced Biometrics)	3		EE 523
Security Related Elective (Example: CS571 System Administration and Network Operations)	3		None
Cybersecurity Project	4		
Term credit total:	10		
Term:			
Course Number & Title	Credits	New	Prerequisite(s)
Term credit total:			
Term:			
Course Number & Title	Credits	New	Prerequisite(s)
Term credit total:			

Term: Spring Year 1 Semester			
Course Number & Title	Credits	New	Prerequisite(s)
CS 556 Cryptography	3		Basic computer programming and discrete mathematics from undergraduate computer science degree..
One security-related 600-level CS course (Example: CS 657 Advanced Topics in Computer Security)	3		CS 557
Security Related Professional Elective, (Example: EE 523 Introduction to Biometrics or CS 558 Formal Methods for Program Verification)	3		
Cybersecurity Project	2		
Term credit total:	11		
Term:			
Course Number & Title	Credits	New	Prerequisite(s)
Term credit total:			
Term:			
Course Number & Title	Credits	New	Prerequisite(s)
Term credit total:			



## Faculty Information

### Existing Core Faculty

*Department Expectations: Identify the specific faculty members that will be responsible for setting the curricular objectives, teaching program courses, advising students, and determining the means by which program and course objectives are measured. **Identify the program director.***

*Core faculty members must meet minimum academic qualifications as identified in Part 52.2(b) of regulation, and be of sufficient depth and breadth to provide leadership, direction, and discharge other responsibilities critical to the start-up of the program.*

**Note:** Faculty curricula vitae or resumes should not be attached to this application and should only be provided if specifically requested by the Department.

Faculty Member Name, Title, and Rank	Courses to be taught	Full-time or Part-time; if Full-time identify % of time to the program	Highest Earned Degree, Discipline, IHE	Additional qualifications which demonstrate professional competence relative to the specific program.
Jeanna Matthews, Professor	Teach Computer Network Security, Computer Networks, Operating Systems. Teach graduate electives in computer security.	Full, 20%	Ph.D., Computer Science	Current graduate teaching and research in this area.
Tino Tamon, Professor	Teach Cryptography, Compilers. Teach graduate electives in computer security.	Full, 10%	Ph.D., Computer Science	Current graduate teaching and research in this area.
Christopher Lynch, Professor and Dept. Chair	Teach Formal Methods for Program Verification. Teach graduate electives in computer security.	Full, 10%	Ph.D., Computer Science	Current graduate teaching and research in this area.
Stephanie Schuckers, Professor	Teach courses in Biometrics. Teach graduate electives in computer security.	Full, 5%.	Ph.D., Electrical Engineering	Director of the Center for Identification Technology Research (CITeR). Current graduate teaching and research in this area.

**Existing Core Faculty**

*Department Expectations: Identify the specific faculty members that will be responsible for setting the curricular objectives, teaching program courses, advising students, and determining the means by which program and course objectives are measured. **Identify the program director.***

*Core faculty members must meet minimum academic qualifications as identified in Part 52.2(b) of regulation, and be of sufficient depth and breadth to provide leadership, direction, and discharge other responsibilities critical to the start-up of the program.*

**Note:** Faculty curricula vitae or resumes should not be attached to this application and should only be provided if specifically requested by the Department.

Daqing Hou Professor	Teach graduate electives in computer security.	Full, 5%.	Ph.D., Computing Science	Current graduate teaching and research in this area.
Chen Liu, Associate Professor	Teach Secure Computer System Design. Teach graduate electives in computer security.	Full, 5%.	Ph.D., Electrical and Computer Engineering	Current graduate teaching and research in this area.
Faraz Hussain, Assistant Professor	Teach secure software development. Teach graduate electives in computer security.	Full, 5%.	PhD, Computer Science	Current graduate teaching and research in this area.
Yu Liu, Assistant Professor	Teach graduate electives in computer security.	Full, 5%	PhD, Electrical and Computer Engineering	Current research in a related area.

**Faculty to be Hired**

*Department Expectations: Identify the specific job title, courses to be taught, and qualifications for each position and the specific timeline by which the faculty member(s) will be hired. The job descriptions and minimum qualifications of faculty to be hired meet the meet minimum academic qualifications as identified in Part 52.2(b) of Commissioner’s regulation. The date provided by which faculty to be hired will be in place must be clear and directly connected to when they are needed to discharge their responsibilities during program implementation. The Department reserves the right to request more information concerning recruitment and hiring of faculty if it is needed to make a determination concerning compliance with program registration standards.*

Position Title, and Rank	Highest Earned Degree, Discipline, and additional qualifications	Courses to be taught	Date by which they will begin job duties
Assistant Prof. Computer Science	Ph.D.	Computer Forensics, Cybersecurity Tools, Malware Identification, Web Security	August 2022





Clarkson

Electrical and Computer Engineering  
8 Clarkson Avenue  
Potsdam, New York 13699  
315-268-6511  
ece@clarkson.edu

January 8, 2020

RE: Cybersecurity MS

To Whom it May Concern:

As chair of the Department of Electrical and Computer Engineering, I express my support for the implementation of the Cybersecurity MS degree program; details of which can be found in the document drafted May 21, 2019 and entitled "*Proposal for a Master's Degree in Cybersecurity*". The proposal was shared with the ECE faculty where it garnered enthusiastic support for this new venture. Of particular note is the support from Professors Daqing Hou and Faraz Hussain, who will be most closely involved with teaching courses and directing students in this program.

Sincerely,

A handwritten signature in blue ink, appearing to read "Paul McGrath", with a long horizontal flourish extending to the right.

Paul McGrath  
Professor and Chair



# Clarkson

COMPUTER SCIENCE DEPT  
8 Clarkson Avenue  
Potsdam, New York 13699  
315-268-2334  
clynch@clarkson.edu

January 8, 2021

To Whom It May Concern,

This package is to create an MS degree in Cybersecurity. We currently run an MS in Computer Science. We have also proposed an MS degree in Artificial Intelligence. Cybersecurity is another important area where there are lots of opportunities, and the need will only continue to grow. IBM and GE have encouraged us to establish a degree in Cybersecurity. We would also attract students from AFRL and associated companies.

The MS in CS program is jointly run by the ECE department, and the new MS in Cybersecurity will also be jointly run by the two departments. We have included a letter of support from the Chair of the ECE department. Both departments have expertise in the area of Cybersecurity, and we already teach courses in that area, so we could start the program immediately. The proposal requests an additional faculty member, because we need to teach some additional elective courses, and we would like a faculty member who focuses exclusively on Cybersecurity. We have also requested an additional TA position to support the growth of the program.

This proposal has been approved by the Computer Science department. We are excited to introduce this proposal, and we look forward the day we can implement this program.

Please contact me if you have any questions.

Sincerely,

A handwritten signature in cursive script that reads "Christopher A. Lynch".

Christopher Lynch  
Chair, Computer Science department

**Coulter School of Engineering**  
8 Clarkson Avenue  
Potsdam, New York 13699  
315-268-6509  
clarkson.edu

January 7, 2020

To the Curriculum and Academic Policy Committee,

I endorsed the proposed MS in Cybersecurity degree proposal as a member of the Provost's Council as indicated in the September 15th Memorandum from Amanda Pickering to the Faculty Senate. This proposal was discussed by the School of Engineering Department Chairs prior to me endorsing the proposal in the Provost's Council.

This letter further communicates my endorsement of this program as per your request. Please feel free to contact me if you have any questions.

Thank you,

A handwritten signature in black ink, appearing to read 'W. D. Jemison', with a long horizontal line extending to the right.

**William D. Jemison, Ph.D.**

*Tony Collins Professor of Innovative Engineering Culture*

*Dean of Engineering*

*Fellow, IEEE*



December 14, 2020

From: **Prof. Tom Langen, School of Arts & Sciences Interim Dean, Clarkson University**  
To: **Academic Leadership Council**  
Re: **Cybersecurity M.S. Degree Program**

The Clarkson School of Arts & Sciences and Coulter School of Engineering support a M.S. Degree Program in Cybersecurity proposal put forth by the Departments of Computer Science and Electrical & Computer Engineering. This is a timely and well thought-out proposal that reinforces the strengths of the two departments, and adds to Clarkson's reputation as a leader in technical graduate education.

This graduate degree program will address the interest of Clarkson computer science or software engineering alumni, computer science B.S. degree holders more widely, and corporate partners of Clarkson University. The program holds the promise of generating significant revenue, and will add to Clarkson's growing reputation in computer science. A market analysis and proforma indicate that this program has significant demand, the proposed program meets employer expectations, and Clarkson can compete in this area.

One challenge, however, is resources and capacity to implement the program. This graduate degree program is comprised for the most part in existing courses taught by current Computer Science and Electrical and Computer Engineering faculty members. However, there some courses will need to be taught more frequently and some new courses need to be added to the curriculum to make this program meet all learning objectives. In the longer term, there is an intention to grow this program, and increase capacity through use of adjunct instructors, expanded delivery of only courses, or coursework at other Clarkson campuses. **The proposing departments request one new TA line and one new faculty line to be searched for upon approval of the program.** .If enrollments match projections, this request is justified, as is a commitment to hire staffing that meets course demands.

Respectfully,

A handwritten signature in black ink that reads 'Tom Langen'.

**Tom A. Langen, Ph.D**

*Interim Dean, School of Arts & Sciences  
Professor, Depts. of Biology & Psychology  
Clarkson University*



# Clarkson

September 15, 2020

To Members of Faculty Senate:

Please accept this letter as notification, we, the Provost's Council, endorse the following item voted unanimous, to move forward in the internal approvals process:

Academic Program	Date of Vote
MS in Cybersecurity Program	9/7/2020

Please advise if there are questions or concerns.

Sincerely,

Amanda J. Pickering  
Executive Director of Academic Affairs  
Office of the Provost