Other Programs Offered Within the Same Discipline or in a Related Area

- Master of Computer Science (MCS)
- Doctorate in Philosophy Computer Science (PhD)

Fees and Funding

- Program fees:

  The estimated amount for university fees (https://www.uottawa.ca/university-fees/) associated with this program are available under the section Finance your studies (http://www.uottawa.ca/graduate-studies/programs-admission/finance-studies/).

  International students enrolled in a French-language program of study may be eligible for a differential tuition fee exemption (https://www.uottawa.ca/university-fees/differential-tuition-fee-exemption/).

  To learn about possibilities for financing your graduate studies, consult the Awards and financial support (https://www.uottawa.ca/graduate-studies/students/awards/) section.

Notes

- Programs are governed by the general regulations (http://www.uottawa.ca/graduate-studies/students/general-regulations/) in effect for graduate studies and the regulations in effect at Carleton University.

- In accordance with the University of Ottawa regulation, students have the right to complete their assignments, examinations, research papers, and theses in French or in English. In addition, research activities can be conducted in either English or French or both depending on the language used by the professor and the members of the research group.

- Students may include courses from both universities in their programs, and may select a supervisor from either university, but they should apply to the university with which their supervisor is associated. Their study program is administered by the university at which they are enrolled and is subject to its regulations.

Program Contact Information

Graduate Studies Office, Faculty of Engineering (https://engineering.uottawa.ca/graduate-studies-office/)
STE 1024
800 King Edward Ave.
Ottawa ON Canada
K1N 6N5

Tel.: 613-562-5347
Fax.: 613-562-5129
Email: engineering.grad@uottawa.ca

Twitter | Faculty of Engineering (https://twitter.com/uOttawaGenie/?lang=en)
Facebook | Faculty of Engineer (https://www.facebook.com/uottawa.engineering/)

Admission Requirements

For the most accurate and up to date information on application deadlines, language tests and other admission requirements, please visit

To be eligible, candidates must:

- Have a bachelor of science degree with honours in computer science (or equivalent), with a minimum average of B (70%).

Note: International candidates must check the admission equivalencies (https://www.uottawa.ca/graduate-studies/international/study-uottawa/admission-equivalencies/) for the diploma they received in their country of origin.

- Identify at least one professor who is willing to supervise your research and thesis. We recommend that you contact potential thesis supervisors as soon as possible. The thesis director must be a member of the collaborative program. The choice of supervisor will determine the primary campus location of the student. It will also determine which university awards the degree.

- Be sponsored into the collaborative specialization by a faculty member of the collaborative program, normally the thesis supervisor, who must be appointed, cross-appointed or stand as an adjunct at the primary program.

**Language Requirements**

Applicants must be able to understand and fluently speak the language of instruction (English) in the program to which they are applying. Proof of linguistic proficiency may be required.

Applicants whose first language is neither French nor English must provide proof of proficiency in the language of instruction.

Note: Candidates are responsible for any fees associated with the language tests.

**Notes**

- The admission requirements listed above are minimum requirements and do not guarantee admission to the program.
- Admissions are governed by the general regulations (http://www.uottawa.ca/graduate-studies/students/general-regulations/) in effect for graduate studies.
- Candidates must apply to the primary program and indicate in their application for admission to the master’s program in computer science that they wish to be accepted into the collaborative specialization in bioinformatics. Students are normally informed about their acceptance into the collaborative program at the same time as being informed about their admission into the primary program.

**Applying to the Co-op Option**

In order to apply to the co-op option, you must first be admitted to a program that offers co-op. The co-op option is not available to MCS students in the Accelerated Stream.

Your application must be submitted by the end of the first month of enrollment in your primary program, i.e., by the end of September.

Admission to the co-op option occurs on a competitive basis and is managed by the Co-op Office (https://coop.uottawa.ca/en/). Enquiries should be directed to that office.

To be admitted to the co-op option, you must:

- Be enrolled as a full-time student in the master’s in computer science;
- Have a cumulative grade point average of 7.0 or 75%;
- Begin the program in the Fall term;
- Be a Canadian citizen or permanent resident;
- Pay the required CO-OP fees.

**Qualifying Program**

Applicants who lack the required undergraduate preparation may be admitted to a qualifying-year program. The basis for admission to the qualifying year of the Master’s program will normally be an honours degree in a related discipline with a B average (70%), provided that the honours program in question includes the equivalent of three years of an honours computer science program. A major degree holder with superior academic standing may be considered for admission to the qualifying year with suitable background preparation.

**Program Requirements**

**Master’s with Collaborative Specialization**

The Department may require students to take additional courses, depending on their backgrounds.

Students must meet the following requirements for the master's with collaborative specialization:

**Compulsory Courses:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BNF 5106</td>
<td>Bioinformatics</td>
<td>3</td>
</tr>
<tr>
<td>9 course units in computer science (CSI) at the graduate level, including: 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 course units in Software Engineering (Category E)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 course units in the Theory of Computing (Category T)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 course units in Computer Applications (Category A) or in Computer Systems (Category S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 elective course units in computer science (CSI) at the graduate level 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Seminars:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BNF 6100</td>
<td>MSc Seminar 2</td>
<td>3</td>
</tr>
</tbody>
</table>

**Thesis:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>THM 7999</td>
<td>Master's Thesis 4, 5, 6</td>
<td>3</td>
</tr>
</tbody>
</table>

Note(s)

1. Course selection must be approved by the student’s academic advisor. A maximum of two three-unit courses at the 4000 level are permitted.
2. The seminar course in bioinformatics involves a written report, the presentation of a seminar, and regular attendance at departmental seminars.
3. Students must make a successful presentation and satisfy the attendance requirement as specified in the student handbook. The graduate seminar requirements must be fulfilled within two consecutive terms.
4. A student may be permitted to carry out thesis work off campus provided suitable arrangements are made for supervision and experimental work, and prior approval is obtained from the Joint Program Committee.

Co-op Option
(Available to students enrolled in the thesis option or the coursework and project option.)

To complete a master’s with coursework and project, you must meet the following requirements:

• Be enrolled as a full-time student in the master’s in computer science;
• Maintain a cumulative grade point average of 7.0 or 75%;
• Obtain a satisfactory grade (P) for each co-op work term:
  • CGI 6001
  • CGI 6002

Notes:

• Each work term is graded P/F (pass/fail), based on the employer’s report and on the written report completed by the student. (The report must be 30 pages long, including appendices.) The report is evaluated by the professor in charge of the graduate co-op option in Computer Science.
• The units awarded for co-op terms may not be used to obtain equivalences for other courses. In other words, the co-op units are additional to the minimum requirements of the degree.

Fast-Track from the Master’s to the PhD
Students enrolled in the master’s program in computer science at the University of Ottawa may be eligible to fast-track directly into the doctoral program without writing a master’s thesis. For additional information, please consult the "Admission Requirements" section of the PhD program.

Note: Students in the Accelerated Stream of the MCS are not eligible for fast-track to the PhD.

Minimum Requirements
The passing grade in all courses is B.
Students who fail 6 units, or whose research progress is deemed unsatisfactory are required to withdraw from the program.

Research

Research Fields & Facilities
Located in the heart of Canada’s capital, a few steps away from Parliament Hill, the University of Ottawa is among Canada’s top 10 research universities.

uOttawa focuses research strengths and efforts in four Strategic Areas of Development in Research (SADRs):

• Canada and the World
• Health
• e-Society
• Molecular and Environmental Sciences

Research at the Faculty of Engineering
Areas of research:

• Chemical and Biological Engineering
• Civil Engineering
• Electrical Engineering and Computer Science
• Mechanical Engineering

For more information, refer to the list of faculty members and their research fields on Uniweb (https://uniweb.uottawa.ca/#!arts/themes).

Courses
Not all of the listed courses are given each year. The course is offered in the language in which it is described.

A 3-unit course at the University of Ottawa is equivalent to a 0.5-unit course at Carleton University.

CSI 5100 Data Integration (3 units)
Materialized and virtual approaches to integration of heterogeneous and independent data sources. Emphasis on data models, architectures, logic-based techniques for query processing, metadata and consistency management, the role of XML and ontologies in data integration; connections to schema mapping, data exchange, and P2P systems. This course is equivalent to COMP 5306 at Carleton University.

Course Component: Lecture

CSI 5101 Knowledge Representation (3 units)
KR is concerned with representing knowledge and using it in computers. Emphasis on logic-based languages for KR, and automated reasoning techniques and systems; important applications of this traditional area of AI to ontologies and semantic web. This course is equivalent to COMP 5307 at Carleton University.

Course Component: Lecture

CSI 5102 Topics in Medical Computing (3 units)
Introductory course on data structures, algorithms, techniques, and software development related to medical computing (in particular spatial modeling). Topics may include: computational geometry algorithms for cancer treatment, medical imaging, spatial data compression algorithms, dynamic programming for DNA analysis. This course is equivalent to COMP 5308 at Carleton University.

Course Component: Lecture

CSI 5105 Network Security and Cryptography (3 units)
Advanced methodologies selected from symmetric and public key cryptography, network security protocols and infrastructure, identification, anonymity, privacy technologies, secret-sharing, intrusion detection, firewalls, access control technologies, and defending network attacks. This course is equivalent to COMP 5406 at Carleton University.

Course Component: Lecture
Prerequisites: familiarity with basic concepts in networks, network security, and applied cryptography.

CSI 5106 Cryptography (3 units)
Course Component: Discussion Group, Laboratory, Lecture, Research, Seminar, Work Term, Theory and Laboratory, Tutorial

CSI 5110 Principles of Formal Software Development (3 units)
Methodologies in formal software specification, development, and verification. The use of theorem proving, automated deduction, and other related formal methods for software correctness. Applications in program verification and secure computation. This course is equivalent to COMP 5707 at Carleton University.
Course Component: Lecture

CSI 5111 Software Quality Engineering (3 units)
Software quality issues. Quality components and metrics. Software process quality. Software reliability engineering. Software design for testability. Requirements capture and validation. Systematic design validation; grey-box approach, test design, implementation and management, case studies in validation and verification of communications software. Object-oriented design and test. Theoretical aspects. This course is equivalent to COMP 5501 at Carleton University.
Course Component: Lecture

CSI 5112 Software Engineering (3 units)
Topics of current interest in Software Engineering, such as requirements engineering, precise and advanced modelling, development processes, change management, standards, and emerging types of applications. This course is equivalent to COMP 5207 at Carleton University.
Course Component: Lecture

CSI 5113 Foundations Programming Languages (3 units)
Advanced study of programming paradigms from a practical perspective. Paradigms may include functional, imperative, concurrent, distributed, generative, aspect- and object-oriented, and logic programming. Emphasis on underlying principles. Topics may include: types, modules, inheritance, semantics, continuations, abstraction and reflection. This course is equivalent to COMP 5001 at Carleton University.
Course Component: Lecture

CSI 5115 Database Analysis and Design (3 units)
The dimensional and multidimensional data models for data warehousing. Data dependencies and decomposition. Structure and use of data definition and manipulation languages. Database economics, engineering, deployment and evolution. Issues in integrity, security, the Internet and distributed databases. Relationships to decision support systems. This course is equivalent to COMP 5503 at Carleton University.
Course Component: Discussion Group, Laboratory, Lecture, Research, Seminar, Work Term, Theory and Laboratory, Tutorial

CSI 5116 Authentication and Software Security (3 units)
Specialized topics in security including advanced authentication techniques, user interface aspects, electronic and digital signatures, security infrastructures and protocols, software vulnerabilities affecting security, non-secure software and hosts, protecting software and digital content. This course is equivalent to COMP 5407 at Carleton University.
Course Component: Lecture

CSI 5117 Applied Computational Geometry (3 units)
Design and analysis of efficient algorithms for solving geometric problems in applied fields such as Geometric Network Design, Geometric Routing and Searching. Geometric spanners, Greedy spanners, Theta-Graphs, Yao-Graphs, Well-Separated Pair Decomposition, Delaunay Triangulations. Introduction to the game of Cops and Robbers. This course is equivalent to COMP 5409 at Carleton University.
Course Component: Lecture

CSI 5118 Automated Verification and Validation of Software (3 units)
Topics in formal test derivation methods, test management, high-level, CASE-based verification and validation, data-flow & control-flow measures and metrics for assessing quality of designs and code, regression analysis & testing. This course is equivalent to COMP 5302 at Carleton University.
Course Component: Lecture

CSI 5121 Advanced Data Structures (3 units)
Simple methods of data structure design and analysis that lead to efficient data structures for several problems. Topics include randomized binary search trees, persistence, fractional cascading, self-adjusting data structures, van Emde Boas trees, tries, randomized heaps, and lowest common ancestor queries. This course is equivalent to COMP 5408 at Carleton University.
Course Component: Lecture

CSI 5122 Software Usability (3 units)
Design principles and metrics for usability. Qualitative and quantitative methods for the evaluation of software usability: Heuristic evaluation, usability testing, usability inspections and walkthroughs, cognitive walkthroughs, formal usability experimentation. Ethical concerns when performing studies with test users. Economics of usability. Integration of usability engineering into the software engineering lifecycle. This course is equivalent to COMP 5301 at Carleton University.
Course Component: Lecture

CSI 5124 Computational Aspects of Geographic Information Systems (3 units)
Computational perspective of geographic information systems (GIS). Data representations and their operations on raster and vector devices: e.g., quadtrees, grid files, digital elevation models, triangular irregular network models. Analysis and design of efficient algorithms for solving GIS problems: visibility queries, point location, facility location. This course is equivalent to COMP 5204 at Carleton University.
Course Component: Lecture

CSI 5125 Algorithms in Bioinformatics (3 units)
Fundamental mathematical and algorithmic concepts underlying computational molecular biology, physical and genetic mapping, sequence analysis (including alignment and probabilistic models), genomic rearrangement, phylogenetic inference, computational proteomics and systems modelling of the whole cell. This course is equivalent to COMP 5108 at Carleton University.
Course Component: Lecture

CSI 5126 Data Analysis (3 units)
Topics in formal test derivation methods, test management, high-level, CASE-based verification and validation, data-flow & control-flow measures and metrics for assessing quality of designs and code, regression analysis & testing. This course is equivalent to COMP 5302 at Carleton University.
Course Component: Lecture

CSI 5127 Applied Computational Geometry (3 units)
Design and analysis of efficient algorithms for solving geometric problems in applied fields such as Geometric Network Design, Geometric Routing and Searching. Geometric spanners, Greedy spanners, Theta-Graphs, Yao-Graphs, Well-Separated Pair Decomposition, Delaunay Triangulations. Introduction to the game of Cops and Robbers. This course is equivalent to COMP 5409 at Carleton University.
Course Component: Lecture

CSI 5128 Swarm Intelligence (3 units)
Collective computation, collective action, and principles of self-organization in social agent systems. Algorithms for combinatorial optimization problems, division of labour, task allocation, task switching, and task sequencing with applications in security, routing, wireless and ad hoc networks and distributed manufacturing. This course is equivalent to COMP 5502 at Carleton University.
Course Component: Lecture
CSI 5129 Advanced Database Systems (3 units)
In-depth study on developments in database systems shaping the future of information systems, including complex object, object-oriented, object-relational, and semi-structured databases. Data structures, query languages, implementation and applications. This course is equivalent to COMP 5305 at Carleton University.

Course Component: Lecture

CSI 5131 Parallel Algorithms and Applications in Bioinformatics (3 units)
Multiprocessor architectures from an application programmer’s perspective: programming models, processor clusters, multi-core processors, GPUs, algorithmic paradigms, efficient parallel problem solving, scalability and portability. Projects on high performance computing in Data Science, including data analytics, bioinformatics, simulations. Programming experience on parallel processing equipment. This course is equivalent to COMP 5704 at Carleton University.

Course Component: Lecture

CSI 5134 Fault Tolerance (3 units)
Hardware and software techniques for fault tolerance. Topics include modeling and evaluation techniques, error detecting and correcting codes, module and system level fault detection mechanisms, design techniques for fault-tolerant and fail-safe systems, software fault tolerance through recovery blocks, N-version programming, algorithm-based fault tolerance, checkpointing and recovery techniques, and survey of practical fault-tolerant systems. This course is equivalent to COMP 5004 at Carleton University.

Course Component: Lecture

CSI 5135 Information Visualization and Visual Analytics (3 units)
Principles, techniques, technology and applications of information visualization for visual data analysis. Topics include human visual perception, cognitive processes, static and dynamic models of image semantics, interaction paradigms, big data visual analysis case studies. This course is equivalent to COMP 5209 at Carleton University.

Course Component: Lecture

CSI 5136 Computer Security and Usability (3 units)
Design and evaluation of security and privacy software with particular attention to human factors and how interaction design impacts security. Topics include current approaches to usable security, methodologies for empirical analysis, and design principles for usable security and privacy. This course is equivalent to COMP 5110 at Carleton University.

Course Component: Lecture

CSI 5137 Selected Topics in Software Engineering (Category E) (3 units)
Selected topics in Software Engineering (Category E), not covered by other graduate courses. Details will be available from the School at the time of registration. This course is equivalent to COMP 5900 at Carleton University.

Course Component: Lecture

CSI 5138 Selected Topics in Theory of Computing (Category T) (3 units)
Selected topics in Theory of Computing (Category T), not covered by other graduate courses. Details will be available from the School at the time of registration. This course is equivalent to COMP 5900 at Carleton University.

Course Component: Lecture

CSI 5139 Selected Topics in Computer Applications (Category A) (3 units)
Selected topics in Computer Applications (Category A), not covered by other graduate courses. Details will be available from the School at the time of registration. This course is equivalent to COMP 5900 at Carleton University.

Course Component: Lecture

This course is equivalent to COMP 5900 at Carleton University.

Course Component: Lecture

CSI 5140 Selected Topics in Computer Systems (Category S) (3 units)
Selected topics in Computer Systems (Category S), not covered by other graduate courses. Details will be available from the School at the time of registration. This course is equivalent to COMP 5900 at Carleton University.

Course Component: Lecture

CSI 5142 Protocols for Mobile and Wireless Networks (3 units)
Link and network layer protocols of wireless networks; applications of wireless networks may be discussed. Topics may include: protocol implementation, mobile IP resource discovery, wireless LANs/PANs, and Spread spectrum. Courses CSI 6136 (SYSC 5306), CSI 5142 (COMP 5402) cannot be combined for units. This course is equivalent to COMP 5402 at Carleton University.

Course Component: Lecture

Precludes additional credit for SYSC 5306.

CSI 5146 Computer Graphics (3 units)

Course Component: Lecture

CSI 5147 Computer Animation (3 units)
Theories and techniques in 3D modeling and animation. Animation principles, categories, and history. Forward and inverse kinematics. Motion capture, editing and retargeting. Flexible bodies. Particle animation. Behavioral animation. Human modeling. Facial animation. Cloth animation and other sub-topics. This course is equivalent to COMP 5201 at Carleton University.

Course Component: Lecture

CSI 5148 Wireless Ad Hoc Networking (3 units)
Self-organized, mobile, and hybrid ad hoc networks. Physical, medium access, networks, transport and application layers, and cross-layering issues. Power management. Security in ad hoc networks. Topology control and maintenance. Data communication protocols, routing and broadcasting. Location service for efficient routing. This course is equivalent to COMP 5103 at Carleton University.

Course Component: Lecture

CSI 5149 Graphical Models and Applications (3 units)
Bayesian networks, factor graphs, Markov random fields, maximum a posteriori probability (MAP) and maximum likelihood (ML) principles, elimination algorithm, sum-product algorithm, decomposable and non-decomposable models, junction tree algorithm, completely observed models, iterative proportional fitting algorithm, expectation-maximization (EM) algorithm, Iterative conditional modes algorithm, variational methods, applications. Courses CSI 5149 (COMP 5007), ELG 5131 (EAGJ 5131) and ELG 7177 (EACJ 5605) cannot be combined for units. This course is equivalent to COMP 5007 at Carleton University.

Course Component: Lecture

Permission of the Department is required.
CSI 5151 Virtual Environments (3 units)
Basic concepts: Virtual worlds. Hardware and software support. World modeling. Geometric modeling. Light modeling. Kinematic and dynamic models. Other physical modeling modalities. Multi-sensor data fusion. Anthropomorphic avatars. Animation: modeling languages, scripts, real-time computer architectures. Virtual environment interfaces. Case studies. Courses ELG 5124 (EACJ 5204), CSI 5151 (COMP 5205) cannot be combined for units. This course is equivalent to COMP 5205 at Carleton University.

Course Component: Lecture

CSI 5152 Evolving Information Networks (3 units)
Convergence of social and technological networks with WWW. Interplay between information content, entities creating it and technologies supporting it. Structure and analysis of such networks, models abstracting their properties, link analysis, search, mechanism design, power laws, cascading, clustering and connections with work in social sciences. This course is equivalent to COMP 5310 at Carleton University.

Course Component: Lecture

CSI 5153 Data Management for Business Intelligence (3 units)
Data management problems and information technology in decision making support in business environments. Topics include advanced data modeling, semantic modeling, multidimensional databases and data warehousing, on-line-analytical processing, elements of data mining, context in data management, data quality assessment, data cleaning, elements of business process modeling. This course emphasizes concepts and techniques rather than specific applications or systems/ implementations. This course is equivalent to COMP 5111 at Carleton University.

Course Component: Lecture

CSI 5154 Algorithms for Data Science (3 units)
Algorithmic techniques to handle (massive/big) data arising from, for example, social media, mobile devices, sensors, financial transactions. Algorithmic techniques may include locality-sensitive hashing, dimensionality reduction, streaming, clustering, VC-dimension, external memory, core sets, link analysis and recommendation systems. This course is equivalent to COMP 5112 at Carleton University.

Course Component: Lecture

CSI 5155 Machine Learning (3 units)
Concepts, techniques, and algorithms in machine learning; representation, regularization and generalization; supervised learning; unsupervised learning; advanced methods such as support vector machines, online algorithms, neural networks, hidden Markov models, and Bayesian networks; curse of dimensionality and large-scale machine learning. Category T in course list.

Course Component: Lecture

CSI 5161 Principles of Distributed Simulation (3 units)
Distributed simulation principles and practices. Synchronization protocols: Optimistic vs Conservative, Deadlock detection in conservative simulations, Time warp simulation. Distributed interactive simulation: Data distribution management, Interest management, High Level Architectures (HLA), Run Time Infrastructure (RTI). Distributed web-based simulation. Distributed agent based simulation. Real time applications of distributed simulation. Distributed and collaborative virtual simulations. This course is equivalent to COMP 5606 at Carleton University.

Course Component: Lecture

CSI 5163 Algorithm Analysis and Design (3 units)
Topics of current interest in the design and analysis of computer algorithms for graph-theoretical applications; e.g. shortest paths, chromatic number, etc. Lower bounds, upper bounds, and average performance of algorithms. Complexity theory. This course is equivalent to COMP 5703 at Carleton University.

Course Component: Lecture

CSI 5164 Computational Geometry (3 units)
Study of design and analysis of algorithms to solve geometric problems; emphasis on applications such as robotics, graphics, and pattern recognition. Topics include: visibility problems, hidden line and surface removal, path planning amidst obstacles, convex hulls, polygon triangulation, point location. This course is equivalent to COMP 5008 at Carleton University.

Course Component: Lecture

CSI 5165 Combinatorial Algorithms (3 units)
Design of algorithms for solving problems that are combinatorial in nature, involving exhaustive generation, enumeration, search and optimization. Algorithms for generating basic combinatorial objects (permutations, combinations, subsets) and for solving hard optimization problems (knapsack, maximum clique, minimum set cover). Metaheuristic search, backtracking, branch-and-bound. Computing isomorphism of combinatorial objects (graphs), isomorph-free exhaustive generation. This course is equivalent to COMP 5709 at Carleton University.

Course Component: Lecture

CSI 5166 Applications of Combinatorial Optimization (3 units)
Topics in combinatorial optimization with emphasis on applications in Computer Science. Topics include network flows, various routing algorithms, polyhedral combinatorics, and the cutting plane method. This course is equivalent to COMP 5805 at Carleton University.

Course Component: Lecture

CSI 5167 Human-Computer Interaction Models, Theories and Frameworks (3 units)
A basis for graduate study in HCI with an emphasis on the application of theory to user interface design. Review of main theories of human behaviour relevant to HCI, including especially Cognitive Dimensions of Notations Framework, Mental Models, Distributed Cognition, and Activity Theory, and their application to design and development of interactive systems. This course is equivalent to COMP 5210 at Carleton University.

Course Component: Lecture

CSI 5168 Digital Watermarking (3 units)
Overview of recent advances in watermarking of image, video, audio, and other media. Spatial, spectral, and temporal watermarking algorithms. Perceptual models. Use of cryptography in steganography and watermarking. Robustness, security, imperceptibility, and capacity of watermarking. Content authentication, copy control, intellectual property, digital rights management, and other applications. This course is equivalent to COMP 5309 at Carleton University.

Course Component: Lecture

CSI 5169 Wireless Networks and Mobile Computing (3 units)
Computational aspects and applications of design and analysis of mobile and wireless networking. Topics include Physical, Link Layer, Media Access Control, Wireless, Mobile LANs (Local Area Networks), Ad-Hoc, Sensor Networks, Power Consumption optimization, Routing, Searching, Service Discovery, Clustering, Multicasting, Localization, Mobile IP/TCP (Internet Protocol/Transmission Control Protocol), File Systems, Mobility Models, Wireless Applications. Courses CSI 5169, ELG 6168 cannot be combined for units. This course is equivalent to COMP 5304 at Carleton University.
Course Component: Lecture

CSI 5173 Data Networks (3 units)
Mathematical and practical aspects of design and analysis of communication networks. Topics include: basic concepts, layering, delay models, multi-access communication, queuing theory, routing, fault-tolerance, and advanced topics on high-speed networks, ATM, mobile wireless networks, and optical networks. This course is equivalent to COMP 5203 at Carleton University.
Course Component: Lecture

CSI 5174 Validation Methods for Distributed Systems (3 units)
Review of formal specification and description techniques for distributed and open systems. Verification techniques. Correctness proofs. Verification of general properties of distributed systems. Analysis and refinement strategies. Testing techniques. Test generation strategies. Test architectures. This course is equivalent to COMP 5604 at Carleton University.
Course Component: Lecture

CSI 5175 Mobile Commerce Technologies (3 units)
Wireless networks support for m-commerce; m-commerce architectures and applications; mobile payment support systems; business models; mobile devices and their operating systems; mobile content presentation; security issues and solutions; relevant cross layer standards and protocols; case studies. Courses EBC 5175, CSI 5175 cannot be combined for units. This course is equivalent to COMP 5900 at Carleton University.
Course Component: Lecture

CSI 5180 Topics in Artificial Intelligence (3 units)
Selected topics in Artificial Intelligence (A.I.); could include A.I. programming techniques, pattern matching systems, natural language systems, rule-based systems, constraint systems, machine learning systems, and cognitive systems. Applications could include areas in Finance, Medicine, Manufacturing, Smart Cities, Semantic Web, Healthcare, Fraud Detection, Intrusion Detection, Autonomous Vehicles, Opinion mining, Sentiment Analysis or similar areas. Assignments will be both (a) programming-oriented, requiring implementation and/or extensions of prototypes in Lisp and/or Prolog and (b) research-oriented, requiring readings of special topics in current A.I. journals. This course is equivalent to COMP 5100 at Carleton University.
Course Component: Lecture

CSI 5195 Ethics for Artificial Intelligence (3 units)
Students critically examine topics in applied AI ethics through the lens of contemporary philosophy and applied ethics texts, popular media articles, and technology case studies. Topics may include: bias and fairness; explainability; accountability; privacy; deception; trust/trustworthiness; and metaphors. Methods for applying ethical considerations in technology design are introduced through hands-on design projects. (Category E)
Course Component: Lecture
The courses DTI 5310, CSI 5195 cannot be combined for units.

CSI 5200 Projects on Selected Topics (3 units)
Course Component: Lecture

CSI 5203 at Carleton University.

CSI 5206 at Carleton University.

CSI 5213 Evolutionary Computation and Artificial Life (3 units)
Study of algorithms based upon biological theories of evolution, applications to machine learning and optimization problems. Possible topics: Genetic Algorithms, Classifier Systems, and Genetic Programming. Recent work in the fields of Artificial Life (swarm intelligence, distributed agents, behavior-based AI) and of connectionism. This course is equivalent to COMP 5206 at Carleton University.
Course Component: Lecture

Precludes additional credit for COMP 4107.

CSI 5185 Statistical and Syntactic Pattern Recognition (3 units)
Topics include a mathematical review, Bayes decision theory, maximum likelihood and Bayesian learning for parametric pattern recognition, non-parametric methods including nearest neighbor and linear discriminants. Syntactic recognition of strings, substrings, subsequences and tree structures. Applications include speech, shape and character recognition. This course is equivalent to COMP 5107 at Carleton University.
Course Component: Lecture

CSI 5195 Ethics for Artificial Intelligence (3 units)
Students critically examine topics in applied AI ethics through the lens of contemporary philosophy and applied ethics texts, popular media articles, and technology case studies. Topics may include: bias and fairness; explainability; accountability; privacy; deception; trust/trustworthiness; and metaphors. Methods for applying ethical considerations in technology design are introduced through hands-on design projects. (Category E)
Course Component: Lecture
The courses DTI 5310, CSI 5195 cannot be combined for units.

CSI 5200 Projects on Selected Topics (3 units)
Course Component: Lecture

CSI 5203 at Carleton University.

CSI 5206 at Carleton University.

CSI 5213 Evolutionary Computation and Artificial Life (3 units)
Study of algorithms based upon biological theories of evolution, applications to machine learning and optimization problems. Possible topics: Genetic Algorithms, Classifier Systems, and Genetic Programming. Recent work in the fields of Artificial Life (swarm intelligence, distributed agents, behavior-based AI) and of connectionism. This course is equivalent to COMP 5206 at Carleton University.
Course Component: Lecture

Precludes additional credit for COMP 4107.

CSI 5185 Statistical and Syntactic Pattern Recognition (3 units)
Topics include a mathematical review, Bayes decision theory, maximum likelihood and Bayesian learning for parametric pattern recognition, non-parametric methods including nearest neighbor and linear discriminants. Syntactic recognition of strings, substrings, subsequences and tree structures. Applications include speech, shape and character recognition. This course is equivalent to COMP 5107 at Carleton University.
Course Component: Lecture

CSI 5195 Ethics for Artificial Intelligence (3 units)
Students critically examine topics in applied AI ethics through the lens of contemporary philosophy and applied ethics texts, popular media articles, and technology case studies. Topics may include: bias and fairness; explainability; accountability; privacy; deception; trust/trustworthiness; and metaphors. Methods for applying ethical considerations in technology design are introduced through hands-on design projects. (Category E)
Course Component: Lecture
The courses DTI 5310, CSI 5195 cannot be combined for units.

CSI 5200 Projects on Selected Topics (3 units)
Course Component: Lecture

CSI 5203 at Carleton University.

CSI 5206 at Carleton University.

CSI 5213 Evolutionary Computation and Artificial Life (3 units)
Study of algorithms based upon biological theories of evolution, applications to machine learning and optimization problems. Possible topics: Genetic Algorithms, Classifier Systems, and Genetic Programming. Recent work in the fields of Artificial Life (swarm intelligence, distributed agents, behavior-based AI) and of connectionism. This course is equivalent to COMP 5206 at Carleton University.
Course Component: Lecture

Precludes additional credit for COMP 4107.
CSI 5340 Introduction to Deep Learning and Reinforcement Learning (3 units)
Fundamental of machine learning; multi-layer perceptron, universal approximation theorem, back-propagation; convolutional networks, recurrent neural networks, variational auto-encoder, generative adversarial networks; components and techniques in deep learning; Markov Decision Process; Bellman equation, policy iteration, value iteration, Monte-Carlo learning, temporal difference methods, Q-learning, SARSA, applications.
Course Component: Lecture

CSI 5341 Learning-based Computer Vision (3 units)
Introduction to learning-based computer vision; statistical learning background; image processing and filtering primer; convolutional neural networks (CNNs), network layers, computer vision data sets and competitions; computer vision problems, in particular, image classification, detection and recognition, semantic segmentation, image generation, multi-view problems and tracking.
Course Component: Lecture

CSI 5342 Ubiquitous Sensing for Smart Cities (3 units)
Course Component: Lecture

CSI 5343 AI-Enabled Communications (3 units)
Course Component: Lecture

CSI 5344 Geometry Processing (3 units)
The course covers concepts, representations, and algorithms for analyzing and processing 3D geometric datasets. Topics include shape representations (e.g., triangle meshes, points clouds, and implicit functions), and the geometry processing pipeline covering the acquisition (e.g., with laser scanning or depth cameras), reconstruction, manipulation, editing, analysis, and fabrication (3D printing) of geometric models.
Course Component: Lecture

CSI 5345 Internet of Things (IoT) Security (3 units)
The course examines security challenges related to the Internet of Things (IoT), with a focus on consumer IoT devices, software aspects including engineering design, security of communications protocols and wireless access, cryptographic mechanisms, device integration and configuration, and security of IoT applications and platforms.
Course Component: Lecture

CSI 5346 Mining Software Repositories (3 units)
Course Component: Lecture

CSI 5347 Trends in Big Data Management (3 units)
Discussion of research papers on hot topics in the area of data management. The list of topics covered in the course generally spans: Data Exploration, Data Cleaning, Data Integration, Data Mining, Data Lake Management, Knowledge Graphs, Graph Processing, Question Answering, Blockchain, Crowdsourcing, Internet of Things, Text Processing, and Training via Weak Supervision. The common characteristic among all these topics is the large scale of data.
Course Component: Lecture

CSI 5380 Systems and Architectures for Electronic Commerce (3 units)
E-commerce system architecture with a focus on relevant design patterns. Web servers, containers, and application frameworks. Web protocols, services, and client technologies. Scaleability through load balancing, clustering, and code optimization. Internazilization, accessibility, and privacy. Data mining and sharing approaches for digital targeted advertising. E-commerce user interface design and evaluation. Current research issues. Hands-on experience with an integrated set of current e-commerce tools. E-commerce development project. Courses EBC 5380, CSI 5380 cannot be combined for units. This course is equivalent to COMP 5405 at Carleton University.
Course Component: Lecture

CSI 5386 Natural Language Processing (3 units)
Overview of both rule-based or symbolic methods and statistical methods as approaches to Natural Language Processing (NLP), with more emphasis on the statistical ones. Applications such as information retrieval, text categorization, clustering, and statistical machine translation could be discussed. This course is equivalent to COMP 5505 at Carleton University.
Course Component: Lecture

CSI 5387 Data Mining and Concept Learning (3 units)
Course Component: Lecture

Permission of the Department is required.

CSI 5388 Topics in Machine Learning (3 units)
Course Component: Lecture
Permission of the Department is required.

CSI 5389 Electronic Commerce Technologies (3 units)
Business models and technologies. Search engines. Cryptography. Web services and agents. Secure electronic transactions. Value added e-commerce technologies. Advanced research questions. Courses EBC5389, CSI5389 cannot be combined for units. This course is equivalent to COMP 5401 at Carleton University.
Course Component: Lecture

CSI 5390 Learning Systems from Random Environments (3 units)
Computerized adaptive learning for random environments and its applications. Topics include a mathematical review, learning automata which are deterministic/stochastic, with fixed/variable structures, of continuous/discretized design, with ergodic/absorbing properties and of estimator families.
Course Component: Lecture

CSI 5500 Projets en informatique (3 crédits)
Volet : Cours magistral
CSI 5501 Modèles formels de l'information (3 crédits)
Volet : Cours magistral

CSI 5510 Principes de développement formel de logiciels (3 crédits)
Méthodologies pour la spécification, le développement et la vérification formels de logiciels. Utilisation d'assistant de preuves, de déduction automatisée et d'autres méthodes formelles visant l'exactitude de logiciel. Applications à la vérification de programmes et au calcul sécurisé. Ce cours est équivalent à COMP 5707 à la Carleton University.
Volet : Cours magistral

CSI 5511 Génie de la qualité des logiciels (3 crédits)
Volet : Cours magistral

CSI 5526 Algorithmes en bio-informatique (3 crédits)
Assemblage de l'ADN, recherche de gènes, comparaison de chaînes, alignement de séquences, structures grammaticales, structures secondaires et tertiaires. Les récents développements, tels que les puces d'ADN et de protéines. Travail additionnel requis dans le cas des étudiants inscrits sous la cote CSI 5526.
Volet : Cours magistral

Permission du Département est requise.

CSI 5537 Thème choisi en génie logiciel (catégorie E) (3 crédits)
Thèmes choisis en génie logiciel (catégorie E), non couverts par d'autres cours de deuxième cycle. Les détails seront disponibles à l'école au moment de l'inscription. Ce cours est équivalent à COMP 5900 à la Carleton University.
Volet : Cours magistral

CSI 5538 Thème choisi en théorie de l'informatique (catégorie T) (3 crédits)
Thèmes choisis en théorie de l'informatique (catégorie T), non couverts par d'autres cours de deuxième cycle. Les détails seront disponibles à l'école au moment de l'inscription. Ce cours est équivalent à COMP 5900 à la Carleton University.
Volet : Cours magistral

CSI 5539 Thème choisi en application informatique (catégorie A) (3 crédits)
Thèmes choisis en application informatique (catégorie A), non couverts par d'autres cours de deuxième cycle. Les détails seront disponibles à l'école au moment de l'inscription. Ce cours est équivalent à COMP 5900 à la Carleton University.
Volet : Cours magistral

CSI 5540 Thème choisi en systèmes informatiques (catégorie S) (3 crédits)
Thèmes choisis en systèmes informatiques (catégorie S), non couverts par d'autres cours de deuxième cycle. Les détails seront disponibles à l'école au moment de l'inscription. Ce cours est équivalent à COMP 5900 à la Carleton University.
Volet : Cours magistral

CSI 5555 Apprentissage machine (3 crédits)
Concepts, techniques et algorithmes en apprentissage machine; représentation, régularisation et généralisation; apprentissage supervisé; apprentissage non supervisé; méthodes avancées telles que les machines à vecteur de support, les algorithmes en ligne, les réseaux de neurones; les modèles de Markov cachés et les réseaux bayésiens; le fléau de la dimensionnalité et l'apprentissage machine à grande échelle. Catégorie T dans la liste de cours.
Volet : Cours magistral

CSI 5561 Sujets en simulation et en optimisation des systèmes (3 crédits)
Volet : Cours magistral

CSI 5563 Analyse et conception des algorithmes (3 crédits)
Volet : Cours magistral

CSI 5565 Algorithmes combinatoires (3 crédits)
Conception d'algorithmes pour résoudre des problèmes de nature combinatoire (génération exhaustive, énumération, recherche et optimisation). Algorithmes pour générer des objets combinatoires de base (permutations, combinaisons, sous-ensembles) et pour résoudre des problèmes d'optimisation difficiles (knapsack, clique maximum, couverture minimum). Recherche métaheuristique, retour arrière, branch-and-bound. Calcul de l'isomorphisme des objets combinatoires (graphes), génération exhaustive sans isomorphes. Ce cours est équivalent à COMP 5709 à l'Université Carleton.
Volet : Cours magistral

CSI 5571 Télématique : Concepts et logiciels (3 crédits)
Volet : Cours magistral

CSI 5572 Sujets en intelligence artificielle (3 crédits)
Volet : Cours magistral

Prerequisite: CSI 5389

CSI 5787 Fouille des données et apprentissage des concepts (3 crédits)
Volet : Cours magistral

CSI 5789 Technologies du commerce électronique (3 crédits)
Volet : Cours magistral
Prerequisite: CSI 4110 or equivalent.

CSI 5900 Projets de recherche en informatique / Graduate Projects in Computer Science (3 crédits / 3 units)
Ce cours est équivalent à COMP 5902 à la Carleton University. / This course is equivalent to COMP 5902 at Carleton University.
Volet / Course Component: Cours magistral / Lecture

CSI 5901 Études dirigées / Directed Studies (3 crédits / 3 units)
A course of independent study under the supervision of a member of the School of Computer Science. Ce cours est équivalent à COMP 5901 à la Carleton University. / This course is equivalent to COMP 5901 at Carleton University.
Volet / Course Component: Recherche / Research

CSI 5903 Stage en commerce électronique / Electronic Commerce Work Term (3 crédits / 3 units)
Expérience en milieu de travail. Noté S (satisfaisant) ou NS (non satisfaisant) selon les résultats du rapport écrit et l'évaluation de l'employeur. Préalable : être accepté au programme de certificat en commerce électronique (option technologie) et recevoir la permission du Comité du programme. / Practical experience. Graded S (Satisfactory) / NS (Not satisfactory), to be based on the grades obtained for the written report as well as on the evaluations of the employer.
Volet / Course Component: Cours magistral / Lecture
Permission du Département est requise. / Permission of the Department is required.

CSI 5904 Projet de recherche avancé en commerce électronique / Graduate Project in Electronic Commerce (3 crédits / 3 units)
Projet sur un sujet précis en commerce électronique mené sous la direction d'un professeur. Les cours CSI 5904, CSI 5903 ne peuvent être combinés pour l'obtention de crédits. / Project on a specific topic in electronic commerce under the supervision of a professor. Courses CSI 5904, CSI 5903 cannot be combined for units.
Volet / Course Component: Cours magistral / Lecture
Exclusion: CSI 5903.

CSI 5905 Exploitation des données volumiques en informatique / Advanced Data Warehousing in Informatics (3 crédits)
Conception et modélisation de bases de données de grande dimension. Méthodes de modélisation pour la couche des données et pour le stockage dans les bases de données. Méthodes de traitement des données et analyse de données. Applications dans le commerce électronique.
Volet / Course Component: Cours magistral / Lecture
Exclusion: CSI 5789.

CSI 5906 Études avancées en performance des systèmes / Advanced Studies in System Performance (3 crédits)
Volet / Course Component: Cours magistral / Lecture
Exclusion: CSI 5789.

CSI 5907 Études avancées en technologie des bases de données / Advanced Studies in Database Technology (3 crédits)
Conception de bases de données et de systèmes de gestion de bases de données. Méthodes d'optimisation de la performance des systèmes. Applications à la conception de bases de données.
Volet / Course Component: Cours magistral / Lecture
Exclusion: CSI 5789.

CSI 5908 Études avancées en programmation orientée objet / Advanced Object-Oriented Programming Studies (3 crédits)
Conception et implémentation de systèmes informatiques basés sur les objets. Méthodes de conception de classes. Applications à la conception de systèmes.
Volet / Course Component: Cours magistral / Lecture
Exclusion: CSI 5789.

CSI 5909 Études avancées en analyse des données / Advanced Studies in Data Analysis (3 crédits)
Méthodes et techniques d'analyse des données. Techniques d'exploration des données et de modélisation de données. Applications à la conception de systèmes.
Volet / Course Component: Cours magistral / Lecture
Exclusion: CSI 5789.

CSI 5910 Études avancées en logiciels / Advanced Studies in Software (3 crédits)
Conception et implémentation de logiciels. Méthodes de conception de systèmes de logiciels. Applications à la conception de systèmes.
Volet / Course Component: Cours magistral / Lecture
Exclusion: CSI 5789.

CSI 5911 Études avancées en logiciels embarqués / Advanced Studies in Embedded Systems (3 crédits)
Conception et implémentation de systèmes embarqués. Méthodes de conception de systèmes embarqués. Applications à la conception de systèmes.
Volet / Course Component: Cours magistral / Lecture
Exclusion: CSI 5789.

CSI 5912 Études avancées en logiciels d'interface / Advanced Studies in Interface Software (3 crédits)
Conception et implémentation de logiciels d'interface. Méthodes de conception de logiciels d'interface. Applications à la conception de systèmes.
Volet / Course Component: Cours magistral / Lecture
Exclusion: CSI 5789.

CSI 5913 Études avancées en logiciels jeux / Advanced Studies in Game Software (3 crédits)
Conception et implémentation de logiciels de jeux. Méthodes de conception de logiciels de jeux. Applications à la conception de systèmes.
Volet / Course Component: Cours magistral / Lecture
Exclusion: CSI 5789.

This is a copy of the 2021-2022 catalog.
CSI 9997 Proposition de thèse de doctorat / Doctoral Thesis Proposal
Within 8 terms following initial registration in the program, a document, generally defining the problem addressed, relating it to the literature, outlining the hypotheses, goals, research methodology, initial results and validation approach, must be submitted to an examination committee and successfully defended. Ce cours est équivalent à COMP 6908 à la Carleton University. This course is equivalent to COMP 6908 at Carleton University.

Volet / Course Component: Recherche / Research

CSI 9998 Examen général de doctorat / Ph.D. Comprehensive
A committee must be assembled and must approve at least 3 topics for written examination: typically, a major and two minor areas. An oral examination occurs if the written exam is passed. Both elements must take place within the first 4 terms following initial registration in the program. The comprehensive examination may be failed, passed conditionally (i.e., with extra course requirements) or passed unconditionally. If failed, this course may be retaken at most one time. Ce cours est équivalent à COMP 6907 à la Carleton University. This course is equivalent to COMP 6907 at Carleton University.

Volet / Course Component: Recherche / Research

BNF 5106 Bioinformatics (3 units)
Major concepts and methods of bioinformatics. Topics may include, but are not limited to: genetics, statistics & probability theory, alignments, phylogenetics, genomics, data mining, protein structure, cell simulation and computing.

Course Component: Lecture

BNF 5107 Applied Bioinformatics (3 units)
Computational knowledge discovery in and the dynamic nature of cellular networks. Includes, but is not limited to, knowledge representation, large scale data integration, data mining and computational systems biology. This course is equivalent to BIOL 5516 at Carleton University.

Course Component: Lecture

BNF 5504 Laboratoire de bioinformatique (3 crédits)
Principes d'organisation, de récupération, de manipulation et d'analyse de données moléculaires en génomique, protéomique et transcriptomique. Analyses pratiques de ces données pour résoudre des questions biologiques en utilisant des méthodes quantitatives et computationnelles.

Volet : Théorie et laboratoire
Les cours BPS 4504 et BNF 5504 ne peuvent être combinés pour l'obtention de crédits.

BNF 5506 Bioinformatics (3 crédits)
Concepts et méthodes en bioinformatique. Les sujets abordés peuvent inclure, entre autres, la génétique, les statistiques et les théories des probabilités, les alignements, la phylogénétique, la génomique et la structure de protéines.

Volet : Cours magistral

BNF 6100 MSc Seminar (3 units)
Current research topics in bioinformatics presented by PhD students and invited speakers. Oral presentation required. Graded S (Satisfactory) / NS (Not satisfactory).

Course Component: Seminar

BNF 6301 Evolutionary Bioinformatics (3 units)
Fundamental concepts in molecular evolution and hands-on experience with computer analysis of DNA sequences. Topics may include molecular sequence databases, multiple alignments and phylogenetic trees. This course is equivalent to BIOL 5201 at Carleton University.

Course Component: Lecture
Prerequisite: Graduate standing plus basic courses in genetics and evolution.

BNF 8766 Séminaire en bioinformatique (3 crédits)
Sujets courants en bioinformatique présentés par des étudiants en PhD et des conférenciers invités. Présentation orale requise. Noté S (satisfaisant) ou NS (non satisfaisant).

Volet : Séminaire