Twin Cities Campus

Computer Science Ph.D.

Computer Science and Engineering Administration

College of Science and Engineering

Link to a list of faculty for this program.

Contact Information:
Department of Computer Science and Engineering, University of Minnesota, 4-192 Keller Hall, 200 Union Street S.E., Minneapolis, MN 55455 (612- 625-4002; fax: 612-625-0572)
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- Program Type: Doctorate
- Requirements for this program are current for Fall 2020
- Length of program in credits: 55
- This program does not require summer semesters for timely completion.
- Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

The Computer Science PhD offers coursework from across a broad spectrum of theoretical and applied computer science, combined with research opportunities in nearly all areas of the field. Faculty members advise students in such areas as algorithms and theoretical computer science; numerical, parallel, and high-performance computing; distributed computing and systems; artificial intelligence, robotics, and computer vision; databases and data mining; human-computer interaction and information systems; graphics and visualization; software engineering and programming languages; computer architecture and compilers; networking; bio-informatics and computational biology; machine learning; and computer security. In addition, students may choose a course of study that integrates research in computer science with applications in other fields. Faculty from the Department of Computer Science and Engineering also participate in a variety of other graduate programs, including Bioinformatics and Computational Biology, Health Informatics, Cognitive Science, Scientific Computation, and Human Factors and Ergonomics.

Program Delivery

This program is available:

- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission

The preferred undergraduate GPA for admittance to the program is 3.45.

A degree in any major with a substantial background in computer science is required; a computer science major is preferred.

Other requirements to be completed before admission:
The program requires all applicants to complete the department's online application, as well as the University's online application. The names and email addresses of three recommenders are required; they will be asked to upload their letters of recommendation to the CS&E online application only. Scores from the General (Aptitude) Test of the GRE are also required. Students are accepted for fall admission only. The application deadline is April 1. Students seeking financial aid must apply by December 5.

Applicants must submit their test score(s) from the following:

- GRE

International applicants must submit score(s) from one of the following tests:

- TOEFL
  - Internet Based - Total Score: 85
  - Internet Based - Writing Score: 23
  - Internet Based - Reading Score: 23
- IELTS
  - Total Score: 6.5
- MELAB
  - Final score: 80

Key to test abbreviations(GRE, TOEFL, IELTS, MELAB).

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For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements

16 to 25 credits are required in the major.
6 to 15 credits are required outside the major.
24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses towards program requirements is not permitted.

A minimum GPA of 3.45 is required for students to remain in good standing.

Students are expected to complete all courses in their degree program with a GPA of at least 3.45. All courses must be taken for graduate credit and on the A-F grading basis.

Required Coursework (16 credits)

Breadth Courses (15 credits)

Select at least 3 credits from each of the 3 subject areas for a total of 9 credits, plus 6 credits from any of the subject areas, for a total of 15 credits. Courses are selected in consultation with the advisor.

Applications

Take 1 or more course(s) totaling 3 or more credit(s) from the following:

- CSCI 5115 - User Interface Design, Implementation and Evaluation (3.0 cr)
- CSCI 5123 - Recommender Systems (3.0 cr)
- CSCI 5125 - Collaborative and Social Computing (3.0 cr)
- CSCI 5127W - Embodied Computing: Design & Prototyping [WI] (3.0 cr)
- CSCI 5271 - Introduction to Computer Security (3.0 cr)
- CSCI 5461 - Functional Genomics, Systems Biology, and Bioinformatics (3.0 cr)
- CSCI 5471 - Modern Cryptography (3.0 cr)
- CSCI 5511 - Artificial Intelligence I (3.0 cr)
- CSCI 5512 - Artificial Intelligence II (3.0 cr)
- CSCI 5521 - Machine Learning Fundamentals (3.0 cr)
- CSCI 5523 - Introduction to Data Mining (3.0 cr)
- CSCI 5551 - Introduction to Intelligent Robotic Systems (3.0 cr)
- CSCI 5607 - Fundamentals of Computer Graphics 1 (3.0 cr)
- CSCI 5561 - Computer Vision (3.0 cr)
- CSCI 5608 - Fundamentals of Computer Graphics II (3.0 cr)
- CSCI 5609 - Visualization (3.0 cr)
- CSCI 5611 - Animation & Planning in Games (3.0 cr)
- CSCI 5619 - Virtual Reality and 3D Interaction (3.0 cr)
- CSCI 5707 - Principles of Database Systems (3.0 cr)

Architecture, Systems and Software

Take 1 or more course(s) totaling 3 or more credit(s) from the following:

- CSCI 5103 - Operating Systems (3.0 cr)
- CSCI 5105 - Introduction to Distributed Systems (3.0 cr)
- CSCI 5106 - Programming Languages (3.0 cr)
- CSCI 5161 - Introduction to Compilers (3.0 cr)
- CSCI 5204 - Advanced Computer Architecture (3.0 cr)
- CSCI 5211 - Data Communications and Computer Networks (3.0 cr)
- CSCI 5221 - Foundations of Advanced Networking (3.0 cr)
- CSCI 5231 *{Inactive}*(3.0 cr)
- CSCI 5451 - Introduction to Parallel Computing: Architectures, Algorithms, and Programming (3.0 cr)
- CSCI 5552 - Sensing and Estimation in Robotics (3.0 cr)
- CSCI 5708 - Architecture and Implementation of Database Management Systems (3.0 cr)
- CSCI 5751 - Big Data Engineering and Architecture (3.0 cr)
- CSCI 5801 - Software Engineering I (3.0 cr)
- CSCI 5802 - Software Engineering II (3.0 cr)

Theory and Algorithims

Take 1 or more course(s) totaling 3 or more credit(s) from the following:

- CSCI 5302 - Analysis of Numerical Algorithms (3.0 cr)
- CSCI 5304 - Computational Aspects of Matrix Theory (3.0 cr)
- CSCI 5421 - Advanced Algorithms and Data Structures (3.0 cr)

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•CSCI 5481 - Computational Techniques for Genomics (3.0 cr)
•CSCI 5525 - Machine Learning: Analysis and Methods (3.0 cr)

Colloquium (1 credit)

Take the following:

CSCI 8970 - Computer Science Colloquium (1.0 cr)

Additional Coursework (15 credits)

Outside Coursework (6 to 15 credits)

Select at least 6 credits from the following in consultation with the advisor:

AEM 5401 - Intermediate Dynamics (3.0 cr)
AEM 5451 - Optimal Estimation (3.0 cr)
AEM 8411 - Advanced Dynamics (3.0 cr)
AEM 8423 - Convex Optimization Methods in Control (3.0 cr)
BMEN 5001 - Advanced Biomaterials (3.0 cr)
BMEN 5201 - Advanced Biomechanics (3.0 cr)
BMEN 5701 - Cancer Bioengineering (3.0 cr)
BMEN 8151 - Biomedical Electronics and Implantable Microsystems (3.0 cr)
CEGE 8211 - Theory of Traffic Flow (4.0 cr)
EE 5231 - Linear Systems and Control (3.0 cr)
EE 5235 - Robust Control System Design (3.0 cr)
EE 5239 - Introduction to Nonlinear Optimization (3.0 cr)
EE 5251 - Optimal Filtering and Estimation (3.0 cr)
EE 5301 - VLSI Design Automation I (3.0 cr)
EE 5333 - Analog Integrated Circuit Design (3.0 cr)
EE 5351 - Applied Parallel Programming (3.0 cr)
EE 5355 - Algorithmic Techniques for Scalable Many-core Computing (3.0 cr)
EE 5364 - Advanced Computer Architecture (3.0 cr)
EE 5371 - Computer Systems Performance Measurement and Evaluation (3.0 cr)
EE 5373 - Data Modeling Using R (1.0 cr)
EE 5393 - Circuits, Computation, and Biology (3.0 cr)
EE 5505 - Wireless Communication (3.0 cr)
EE 5531 - Probability and Stochastic Processes (3.0 cr)
EE 5542 - Adaptive Digital Signal Processing (3.0 cr)
EE 5581 - Information Theory and Coding (3.0 cr)
EE 5585 - Data Compression (3.0 cr)
EE 5653 - Physical Principles of Magnetic Materials (3.0 cr)
EE 5741 - Advanced Power Electronics (3.0 cr)
EE 8231 - Optimization Theory (3.0 cr)
EE 8367 - Parallel Computer Organization (3.0 cr)
EE 5571 - Statistical Learning and Inference (3.0 cr)
EE 8591 - Predictive Learning from Data (3.0 cr)
IE 5531 - Engineering Optimization I (4.0 cr)
IE 5532 - Stochastic Models (4.0 cr)
MATH 5075 - Mathematics of Options, Futures, and Derivative Securities I (4.0 cr)
MATH 5165 - Mathematical Logic I (4.0 cr)
MATH 5248 - Cryptology and Number Theory (4.0 cr)
MATH 5251 - Error-Correcting Codes, Finite Fields, Algebraic Curves (4.0 cr)
MATH 5335 - Geometry I (4.0 cr)
MATH 5385 - Introduction to Computational Algebraic Geometry (4.0 cr)
MATH 5447 - Theoretical Neuroscience (4.0 cr)
MATH 5467 - Introduction to the Mathematics of Image and Data Analysis (4.0 cr)
MATH 5485 - Introduction to Numerical Methods I (4.0 cr)
MATH 5486 - Introduction To Numerical Methods II (4.0 cr)
MATH 5651 - Basic Theory of Probability and Statistics (4.0 cr)
MATH 5652 - Introduction to Stochastic Processes (4.0 cr)
MATH 5654 - Prediction and Filtering (4.0 cr)
MATH 5705 - Enumerative Combinatorics (4.0 cr)
MATH 5707 - Graph Theory and Non-enumerative Combinatorics (4.0 cr)
MATH 5711 - Linear Programming and Combinatorial Optimization (4.0 cr)
MATH 8211 - Commutative and Homological Algebra (3.0 cr)
MATH 8212 - Commutative and Homological Algebra (3.0 cr)
MATH 8253 - Algebraic Geometry (3.0 cr)
MATH 8254 - Algebraic Geometry (3.0 cr)
MATH 8270 - Topics in Algebraic Geometry (1.0 - 3.0 cr)
MATH 8301 - Manifolds and Topology (3.0 cr)
MATH 8302 - Manifolds and Topology (3.0 cr)

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MATH 8306 - Algebraic Topology (3.0 cr)
MATH 8307 - Algebraic Topology (3.0 cr)
MATH 8365 - Riemannian Geometry (3.0 cr)
MATH 8441 - Numerical Analysis and Scientific Computing (3.0 cr)
MATH 8501 - Differential Equations and Dynamical Systems I (3.0 cr)
MATH 8601 - Real Analysis (3.0 cr)
MATH 8602 - Real Analysis (3.0 cr)
MATH 8651 - Theory of Probability Including Measure Theory (3.0 cr)
MATH 8991 - Independent Study (1.0 - 6.0 cr)
ME 5241 - Computer-Aided Engineering (4.0 cr)
ME 5243 - Advanced Mechanism Design (4.0 cr)
ME 8253 - Computational Nanomechanics (3.0 cr)
ME 8390 - Advanced Topics in the Thermal Sciences : Biostabilization in Biomedicine, and Biotechnology (1.0 - 3.0 cr)
ME 8794 - Mechanical Engineering Research (1.0 - 4.0 cr)
MSBA 6321 - Data Management, Databases, and Data Warehousing (3.0 cr)
MSBA 6331 - Big Data Analytics (3.0 cr)
MSBA 6421 - Predictive Analytics (3.0 cr)
STAT 5021 - Statistical Analysis (4.0 cr)
STAT 5101 - Theory of Statistics I (4.0 cr)
STAT 5102 - Theory of Statistics II (4.0 cr)
STAT 5302 - Applied Regression Analysis (4.0 cr)
STAT 5303 - Designing Experiments (4.0 cr)
STAT 5421 - Analysis of Categorical Data (3.0 cr)
STAT 5511 - Time Series Analysis (3.0 cr)
STAT 5701 - Statistical Computing (3.0 cr)
STAT 8051 - Advanced Regression Techniques: linear, nonlinear and nonparametric methods (3.0 cr)
STAT 8053 - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)
STAT 8101 - Theory of Statistics 1 (3.0 cr)
STAT 8102 - Theory of Statistics 2 (3.0 cr)
STAT 8931 - Advanced Topics in Statistics (3.0 cr)
STAT 8932 - Advanced Topics in Statistics (3.0 cr)
STAT 8933 - Advanced Topics in Statistics (3.0 cr)

Electives (0 to 9 credits)

Select credits, as needed to complete the 31 course credits required, in consultation with the advisor. Students are encouraged, but not required, to take CSCI 8001 and 8002.

CSCI 5103 - Operating Systems (3.0 cr)
CSCI 5105 - Introduction to Distributed Systems (3.0 cr)
CSCI 5106 - Programming Languages (3.0 cr)
CSCI 5115 - User Interface Design, Implementation and Evaluation (3.0 cr)
CSCI 5117 - Developing the Interactive Web (3.0 cr)
CSCI 5125 - Collaborative and Social Computing (3.0 cr)
CSCI 5161 - Introduction to Compilers (3.0 cr)
CSCI 5204 - Advanced Computer Architecture (3.0 cr)
CSCI 5211 - Data Communications and Computer Networks (3.0 cr)
CSCI 5221 - Foundations of Advanced Networking (3.0 cr)
CSCI 5231 *{Inactive}*(3.0 cr)
CSCI 5271 - Introduction to Computer Security (3.0 cr)
CSCI 5302 - Analysis of Numerical Algorithms (3.0 cr)
CSCI 5304 - Computational Aspects of Matrix Theory (3.0 cr)
CSCI 5421 - Advanced Algorithms and Data Structures (3.0 cr)
CSCI 5451 - Introduction to Parallel Computing: Architectures, Algorithms, and Programming (3.0 cr)
CSCI 5461 - Functional Genomics, Systems Biology, and Bioinformatics (3.0 cr)
CSCI 5471 - Modern Cryptography (3.0 cr)
CSCI 5481 - Computational Techniques for Genomics (3.0 cr)
CSCI 5511 - Artificial Intelligence I (3.0 cr)
CSCI 5512 - Artificial Intelligence II (3.0 cr)
CSCI 5521 - Machine Learning Fundamentals (3.0 cr)
CSCI 5523 - Introduction to Data Mining (3.0 cr)
CSCI 5525 - Machine Learning: Analysis and Methods (3.0 cr)
CSCI 5551 - Introduction to Intelligent Robotic Systems (3.0 cr)
CSCI 5561 - Computer Vision (3.0 cr)
CSCI 5607 - Fundamentals of Computer Graphics 1 (3.0 cr)
CSCI 5611 - Animation & Planning in Games (3.0 cr)
CSCI 5619 - Virtual Reality and 3D Interaction (3.0 cr)
CSCI 5707 - Principles of Database Systems (3.0 cr)
CSCI 5708 - Architecture and Implementation of Database Management Systems (3.0 cr)

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CSCI 5715 - From GPS, Google Maps, and Uber to Spatial Data Science (3.0 cr)
CSCI 5801 - Software Engineering I (3.0 cr)
CSCI 5802 - Software Engineering II (3.0 cr)
CSCI 5980 - Special Topics in Computer Science (1.0 - 3.0 cr)
CSCI 5991 - Independent Study (1.0 - 3.0 cr)
CSCI 5994 - Directed Research (1.0 - 3.0 cr)
CSCI 8001 - Introduction to Research in Computer Science I (1.0 cr)
CSCI 8002 - Introduction to Research in Computer Science, II (2.0 cr)
CSCI 8101 - Advanced Operating Systems (3.0 cr)
CSCI 8102 - Foundations of Distributed Computing (3.0 cr)
CSCI 8115 - Human-Computer Interaction and User Interface Technology (3.0 cr)
CSCI 8117 - Understanding the Social Web (3.0 cr)
CSCI 8205 - Parallel Computer Organization (3.0 cr)
CSCI 8211 - Advanced Computer Networks and Their Applications (3.0 cr)
CSCI 8271 - Security and Privacy in Computing (3.0 cr)
CSCI 8314 - Sparse Matrix Computations (3.0 cr)
CSCI 8363 - Numerical Linear Algebra in Data Exploration (3.0 cr)
CSCI 8442 - Computational Geometry and Applications (3.0 cr)
CSCI 8551 - Intelligent Agents (3.0 cr)
CSCI 8581 - Big Data in Astrophysics (4.0 cr)
CSCI 8701 - Overview of Database Research (3.0 cr)
CSCI 8715 - Spatial Data Science Research (3.0 cr)
CSCI 8725 - Databases for Bioinformatics (3.0 cr)
CSCI 8735 - Advanced Database Systems (3.0 cr)
CSCI 8801 - Advanced Software Engineering (3.0 cr)
CSCI 8980 - Special Advanced Topics in Computer Science (1.0 - 3.0 cr)
CSCI 8991 - Independent Study (1.0 - 3.0 cr)

Thesis Credits (24 credits)

Take 24 credits after passing preliminary oral exam.
CSCI 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)

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