The PhD in Computer Science is designed to prepare students for careers in academia and industry—from conducting research to developing systems to publishing and presenting papers. The rigorous curriculum provides a broad background in the fundamentals of computer science and advanced courses in a wide range of focus areas.

The past decade has witnessed a dramatic increase in Northeastern's international reputation for research and innovative educational programs. Since 2012, the Khoury College of Computer Sciences has hired 30 outstanding faculty members and plans to continue this strategic growth in the coming years, advancing its position among the nation's top research universities. Today, the college has a diverse faculty of 62 working in a wide range of research areas. Seventeen faculty members have joint appointments with other colleges and schools, including engineering, science, business, social sciences and humanities, health sciences, and Arts, Media and Design.

Northeastern University is located in the heart of Boston, a city with one of the richest research environments in the world, with over 10,000 researchers, 50,000 graduate students, and a top startup community. Every week there are numerous talks and lectures on cutting-edge research, either at Northeastern or at other universities and research labs easily accessible from Northeastern.

Course Work
A minimum of 48 semester hours of course work beyond the BS/BA degree is required of all students.

All students must demonstrate sufficient knowledge in the fundamentals of computer science, as well as the ability to carry out research in an area of computer science.

The student must maintain a minimum grade-point average (GPA) of 3.500 among the six core courses and receive a grade of B or better in each of these courses. Students who have taken equivalent courses in other institutions may petition to be exempted from the course(s) (subject to the approval of the PhD computer science curriculum committee). Each student may repeat a course once for no more than three out of the six courses if they do not receive a B or better in the course. Students with a Master of Science in Computer Science may petition to the PhD computer science curriculum committee for an exemption from these courses. Petition forms are available on the college website.

The fields listed do not necessarily represent areas of specialization or separate tracks within the PhD program. Rather, they attempt to delineate areas on which the student must be examined in order to measure his or her ability to complete the degree. Therefore, they may be adjusted in the future to reflect changes in the discipline of computer science and in faculty interests within the Khoury College of Computer Sciences. Similarly, these fields do not represent the only areas in which a student may write his or her dissertation. They are, however, intended to serve as a basis for performing fundamental research in computer science.

Paper Requirement
To demonstrate research ability, the student is required to submit to the PhD committee a research or a survey paper in an area of specialty under the supervision of a faculty advisor. A submitted paper from a student is considered to have fulfilled the paper requirement if:

1. The paper has been submitted to a selective conference.
2. The student has made a substantial contribution to the paper.
3. The advisor has endorsed the paper with a written statement indicating the student's contribution.
4. The PhD computer science curriculum committee has voted on a positive recommendation. The committee may require a presentation from the student before making a recommendation.

Admission to Candidacy
Upon completion of the course and the research paper requirements, the student is admitted to candidacy for the PhD degree. It is highly recommended that the student complete the candidacy requirement by the end of his or her second year but no later than the third year.

Residency
One year of continuous full-time study is required after admission to the PhD candidacy. It is expected that during this period the student will make substantial progress in preparing for the comprehensive examination.

Teaching Requirement
All computer science PhD students must satisfy the teaching requirement in order to graduate. This requirement is fulfilled when the student works as a teaching assistant (TA) or instructor of record (IoR) for one semester and during this semester:

- Teaches at least 3 hours of classes
- Prepares at least one assignment, or quiz, or equivalent

PhD students are expected to satisfy the teaching requirement some time after completing their first year and at least one semester prior to scheduling their PhD defense.

Comprehensive Examination/Dissertation Proposal
After the student has achieved sufficient depth in a field of study, they prepare a proposal for the PhD dissertation. This process should take place no later than the end of the fifth year in residence. The student prepares a dissertation proposal, which describes the proposed research, including the relevant background materials from the literature. The proposal should clearly specify the research problems to be attacked, the techniques to be used, and a schedule of milestones toward completion.

The dissertation proposal must be approved by the dissertation committee. With the help of the advisor, a student selects the committee, consisting of at least four members, to be approved by the PhD computer science curriculum committee. The four members must include the advisor, two internal members, and an external member.

Upon approval of the written proposal, the student has to present the proposed work orally in a public forum, followed by a closed-door oral examination from the dissertation committee. The student may take the dissertation proposal examination twice, at most.

Doctoral Dissertation
Upon successful completion of solving the research proposed in the dissertation proposal, the candidate has an opportunity to prepare the dissertation for approval by the dissertation committee. The dissertation must contain results of extensive research and make an original contribution to the field of computer science. The work should give
evidence of the candidate’s ability to carry out independent research. It is expected that the dissertation should be of sufficient quality to merit publication in a reputable journal in computer science.

**Doctoral Committee**

With the help of the advisor, a student selects the committee, consisting of at least four members, to be approved by the PhD computer science curriculum committee. The four members must include the advisor, two internal members, and an external member.

**Dissertation Defense**

The dissertation defense is held in accordance with the regulations of the University Graduate Council. It consists of a lecture given by the candidate on the subject matter of the dissertation. This is followed by questions from the dissertation committee and others in attendance concerning the results of the dissertation as well as any related matters. The defense is chaired by the PhD advisor.

**Time and Time Limitation**

After the establishment of degree candidacy, a maximum of five years will be allowed for the completion of the degree requirements, unless an extension is granted by the college graduate committee.

**Learning Outcomes**

Students graduating with a PhD in Computer Science must:

- Gain a broad understanding of computer science fundamentals, spanning a substantial portion of the following core areas: artificial intelligence and data science, human-centered computing, software, systems, and theory
- Gain significant expertise in at least one research area in computer science
- Produce and defend original research in an area of computer science
- Be able to communicate research results effectively in both oral and written forms

**Program Requirements**

Complete all courses and requirements listed below unless otherwise indicated.

**Milestones**

Course work
Paper requirement
Admission to candidacy
Residency
Teaching requirement
Comprehensive examination/dissertation proposal
Doctoral dissertation
Doctoral committee
Dissertation defense

**Core Requirements**

A grade of B or higher is required in each course. A cumulative 3.500 GPA is required for the core requirement.

Students should refer to the course numbering table for graduate course leveling (http://catalog.northeastern.edu/graduate/academic-policies-procedures/records-transcripts).

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 6140</td>
<td>Machine Learning</td>
<td></td>
</tr>
<tr>
<td>CS 7240</td>
<td>Principles of Scalable Data Management: Theory, Algorithms, and Database Systems</td>
<td></td>
</tr>
<tr>
<td>CS 7340</td>
<td>Theory and Methods in Human Computer Interaction</td>
<td></td>
</tr>
<tr>
<td>CS 7250</td>
<td>Information Visualization: Theory and Applications</td>
<td></td>
</tr>
<tr>
<td>CS 7400</td>
<td>Intensive Principles of Programming Languages</td>
<td></td>
</tr>
<tr>
<td>CS 6410</td>
<td>Compilers</td>
<td></td>
</tr>
<tr>
<td>CS 7600</td>
<td>Intensive Computer Systems</td>
<td></td>
</tr>
<tr>
<td>CS 7610</td>
<td>Foundations of Distributed Systems</td>
<td></td>
</tr>
<tr>
<td>CS 7800</td>
<td>Advanced Algorithms</td>
<td></td>
</tr>
<tr>
<td>CS 7805</td>
<td>Theory of Computation</td>
<td></td>
</tr>
</tbody>
</table>

**Specialization Courses**

Complete 8 semester hours from the specialization course lists. (p. 2)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 5100</td>
<td>Foundations of Artificial Intelligence</td>
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</tr>
<tr>
<td>CS 5335</td>
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</tr>
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<td></td>
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<td>Advanced Machine Learning</td>
<td></td>
</tr>
<tr>
<td>CS 7180</td>
<td>Special Topics in Artificial Intelligence</td>
<td></td>
</tr>
<tr>
<td>CS 5520</td>
<td>Mobile Application Development</td>
<td></td>
</tr>
</tbody>
</table>

**Electives**

Complete 24 semester hours in the following: 24

**Dissertation**

Upon achieving PhD candidacy, complete the following (repeatable) courses for two consecutive semesters:

<table>
<thead>
<tr>
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<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 9990</td>
<td>Dissertation</td>
<td></td>
</tr>
<tr>
<td>CS 8982</td>
<td>Readings</td>
<td></td>
</tr>
</tbody>
</table>

For remaining semester(s), complete the following (repeatable) course until graduation:

<table>
<thead>
<tr>
<th>Code</th>
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</tr>
</thead>
<tbody>
<tr>
<td>CS 9996</td>
<td>Dissertation Continuation</td>
<td></td>
</tr>
</tbody>
</table>

**Specialization Course Lists**

**Artificial Intelligence**

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**Computer-Human Interface**

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</tr>
<tr>
<td>CS 5520</td>
<td>Mobile Application Development</td>
<td></td>
</tr>
</tbody>
</table>
CS 6350  Empirical Research Methods
CS 7260  Visualization for Network Science
CS 7295  Special Topics in Data Visualization
CS 7340  Theory and Methods in Human Computer Interaction

Data Science
CS 5200  Database Management Systems
CS 6140  Machine Learning
CS 6200  Information Retrieval
CS 6220  Data Mining Techniques
CS 6240  Large-Scale Parallel Data Processing
CS 7140  Advanced Machine Learning
CS 7280  Special Topics in Database Management
CS 7290  Special Topics in Data Science

Graphics
CS 5310  Computer Graphics
CS 5330  Pattern Recognition and Computer Vision

Information Security
CS 6760  Privacy, Security, and Usability
CS 7580  Special Topics in Software Engineering
CS 7810  Foundations of Cryptography
CY 5770  Software Vulnerabilities and Security
CY 6740  Network Security
CY 6750  Cryptography and Communications Security

Networks
CS 5700  Fundamentals of Computer Networking
CS 6710  Wireless Network
CS 6760  Privacy, Security, and Usability
CS 7775  Seminar in Computer Security
CS 7780  Special Topics in Networks
CY 6740  Network Security
CY 6750  Cryptography and Communications Security

Programming Languages
CS 5400  Principles of Programming Language
CS 6410  Compilers
CS 6510  Advanced Software Development
CS 7400  Intensive Principles of Programming Languages
CS 7480  Special Topics in Programming Language
CS 7485  Special Topics in Formal Methods

Software Engineering
CS 5610  Web Development
CS 6510  Advanced Software Development
CS 7580  Special Topics in Software Engineering

Systems
CS 6620  Fundamentals of Cloud Computing
CS 6650  Building Scalable Distributed Systems
CS 7600  Intensive Computer Systems
CS 7610  Foundations of Distributed Systems
CS 7680  Special Topics in Computer Systems

CY 6740  Network Security

Theory
CS 6800  Application of Information Theory
CS 7485  Special Topics in Formal Methods
CS 7800  Advanced Algorithms
CS 7805  Theory of Computation
CS 7880  Special Topics in Theoretical Computer Science
CY 6750  Cryptography and Communications Security

Game Design
CS 5150  Game Artificial Intelligence
CS 5310  Computer Graphics
CS 5340  Computer/Human Interaction
CS 5850  Building Game Engines
CS 7140  Advanced Machine Learning

Program Credit/GPA Requirements
48 total semester hours required
Minimum overall 3.000 GPA required

Plan of Study
Sample Curriculum

Year 1
Fall  Hours  Spring  Hours
Breadth course  4  Breadth course  4
Core elective  4  Core elective  4
8  8

Year 2
Fall  Hours  Spring  Hours
Breadth course  4  Breadth course  4
Open elective  4  Open elective  4
8  8

Year 3
Fall  Hours  Spring  Hours
CS 9990  0  CS 9990  0
CS 8982  8  CS 8982  8
8  8

Year 4
Fall  Hours  Spring  Hours
CS 9996  0  CS 9996  0
0  0

Year 5
Fall  Hours  Spring  Hours
CS 9996  0  CS 9996  0
0  0

Year 6
Fall  Hours  Spring  Hours
CS 9996  0  CS 9996  0
0  0

Total Hours: 48