COMPUTER SCIENCE, PHD

Degree: Doctor of Philosophy (PhD)
Field of Study: Computer Science

Admission

Requirements for admission include a strong record of scholarship in a completed bachelor's degree program in computer science and related areas, and fluency in written and spoken English. The University requires all foreign applicants to show English proficiency by achieving a TOEFL score of at least 577 on the paper-based exam or 90 on the internet-based exam. It is required that all students submit original copies of GRE scores. When applying to this program, please select the Computer Science option in your application.

Registration

Course registration (including submission of the Academic Program) can be performed through SIS. Each semester before registration, students should update any personal information that may have changed by logging onto the SIS and editing the appropriate information. All registration holds must be lifted in order to successfully complete the registration process.

PhD Policies

For PhD policies and procedures, please review the School of Graduate Studies section of the General Bulletin.

Program Requirements

Each student must satisfy requirements in the following categories:

- Course Work
- Mathematics and Science Requirement
- Research Proposal
- Qualifying Examination
- Dissertation

All programs of study must contain at least 36 credit hours of courses past the undergraduate degree. All courses must be at the 400-level or higher. 6 credit hours must be in basic science or mathematics. A minimum of 12 credit hours must be in courses outside the student's thesis area. A student must have attained a minimum 3.0 grade point average (GPA) at the time of graduation. The minimum GPA is calculated based on all courses in the student's Program of Study that carry quality points.

These regulations are in addition to the Academics Regulations of the School of Graduate Studies and the Specific Requirements for the PhD Degree of the Graduate Program in the Case School of Engineering as found in the General Bulletin of Case Western Reserve University.

Academic Advisor and Research Advisor

Upon arrival, each graduate student is assigned an academic advisor from the Computer Science (CS) program faculty, typically the CS graduate representative. By the end of the second semester of study, a PhD student should transfer to a research advisor who may or may not be the same as the academic advisor.

The research (co)advisor must be a faculty member of the university whose status is tenured, tenure-track, non-tenure-track, emeritus, and research faculty. Faculty with other status are not eligible to serve as a student (co)advisor. If the primary affiliation of the research advisor is not with the Computer Science program, the student must have a research co-advisor in Computer Science. Once a CS research (co)advisor is selected, a student consults with the CS research (co)advisor to ensure that the balance of the PhD course work constitutes a coherent program of study.

Academic Program

Each PhD student must submit an Academic Program detailing their course work, Qualifying Examination and dissertation schedules. The Academic Program lists all courses taken beyond the undergraduate degree and shows how these courses satisfy the following course requirements for the PhD:

a. The minimum course requirement beyond the BS level is 36 credit hours of courses taken for credit, at least 18 credit hours of which must be taken at CWRU. The following courses taken for credit will be acceptable:
    i. All 400-, 500-, 600-level courses.
    ii. Graduate level courses taken at other institutions approved by the student's CS advisor.
    iii. The above courses must include the following:
        1. A minimum of 12 credit hours in the student's dissertation research area (1.1).
        2. A minimum of 6 credit hours in mathematics or basic science (1.2).
        3. A minimum of 12 credit hours of breadth courses that are not in the student's dissertation research area (1.3).
            a. Note: The courses for items 1.1, 1.2, and 1.3 must be disjoint.
        4. A minimum of 18 credit hours of courses approved by the Computer Science program which can be courses used in item 1.1 and item 1.3. These approved Computer Science courses are listed below (1.4).

b. A minimum of 18 credit hours of CSDS 701.

c. The cumulative grade-point average of all CWRU courses on the program of study must be at least 3.0.

d. All PhD students are required to pass by the end of the fourth semester CSDS 400T, CSDS 500T and CSDS 600T which are 0 credit hour courses that provide students with teaching experience.

e. All PhD students are required to register for and pass three semesters of CSDS 500 before advancement to candidacy and complete a public presentation of their work.

The Academic Program must be approved by the student's CS (co)advisor and the chair of the CDS Department, and it must be approved before the student advances to candidacy.

Qualifying Examination

The Computer Science PhD qualifying examination is in the form of an oral exam and a written report, assessing the student's ability to survey a specific research topic, discuss the state-of-the-art in depth, provide a critical description of the literature, and propose creative ideas on improving the state-of-the-art. The written and oral parts of the exam are administered by a committee consisting of three faculty members. The exam is supplemented by the evaluation of the student's course performance.

Students who hold a MS degree are required to take the qualifying exam at the start of their 3rd semester, and pass the qualifying exam before the start of their 4th semester in the PhD program. Students who do not hold a MS degree are required to take the qualifying exam at the start of their 5th semester, and pass the qualifying exam before the start of their 6th semester in the PhD program.

Committee: The exam will be administered by a committee composed of at least 3 faculty members, of which at least two have primary affiliation with Computer Science and are not advisors to the student. The student can suggest committee members and the CS program director will appoint the committee, taking into account the student's suggestion and maintenance of the load balance of the faculty. If the student has research advisors at the time of the exam, then at least one advisor must be a member of the committee. No advisors can serve as the chair of the committee. The CS program director will make every effort to include a faculty member outside the research area in the committee. The committee must be appointed at least 2 months prior to the exam.

Format: The student will select a research area from the following list:

a. Algorithms and Theory
b. Artificial Intelligence
c. Bioinformatics
d. Computer Networks and Systems
e. Databases and Data Mining
f. Security and Privacy
g. Software Engineering

The exam committee will ask the student to write a report that adequately demonstrates the student's ability to perform research in their chosen area of research. Specific examples of this might be a survey of a broad area and/or approaches to a specific problem in the area. This will be followed by an oral examination.

Written Report: The student will submit a written report on the specific research problem. The report has to adequately describe the problem and justify its relevance, identify the challenges associated with the problem, provide a broad classification of existing approaches, point out their key differences and trade-offs, identify limitations, and propose solutions for these limitations. The report must be at most 10 pages in length (11 pt font, single-spaced, single column, 1" margins) and use illustrative figures, tables, and other visual material to communicate key ideas. In addition, the report must include a comprehensive list of references. The written report must be submitted to the exam committee three weeks before the date of the oral exam.

Oral Exam: In the oral exam, the student will answer questions by the committee members on a specific research problem chosen by the committee in the selected research area, assessing the knowledge, technical depth, and broader vision of the student on the problem. The committee may also ask questions on the fundamentals of computer science as they relate to the specific research problem. The student may prepare slides in advance that will help answer questions or use the chalk board (or both), but the exam will not be in the format of a presentation. The exam will be one hour in duration. All students who are taking the exam for the first time have to take their oral exam in the week prior to the beginning or in the first two weeks of the Fall semester.

Scoring: Each of the three committee members will prepare a report rating the student's exam performance according to the following criteria:

- Fundamentals: Does the student have broad knowledge of fundamental concepts in computer science that will enable the student to understand and tackle the challenges in the specific research area?
- Knowledge of Chosen Area: Does the student have sufficient technical depth and command of the key challenges and the state-of-the-art in the chosen area of research?
- Vision: Does the student demonstrate a solid understanding of the relevance of the problem in the context of scientific progress and societal needs? Does the student show creativity in innovating their chosen area of research?
- Communication. Can the student explain the concepts in an accessible and comprehensible manner and handle questions effectively?
- Overall Score for the Written Report and the Oral Exam.

Possible ratings are 2 (Pass), 1 (Retake), or 0 (Fail).

Course Work: The student's performance in all courses taken before the exam will also be considered by the CS program director in making a decision. At the time of the exam, the student must have completed at least two 400-level Computer Science courses with a "B" or above. One of these courses must be CSDS 410 or CSDS 455 or CSDS 477. The second course must be relevant to their chosen area of research. The relevance of the additional course to the research area is subject to approval by the CS Graduate Studies Committee. The following courses are pre-approved for each area:

Code	Title	Credit Hours
Required Course:		**3**
Choose one of the following:		
CSDS 410	Analysis of Algorithms	
CSDS 455	Applied Graph Theory	
CSDS 477	Advanced Algorithms	
Choose one of the following:		*3*
Algorithms & Theory Courses:		
CSDS 410	Analysis of Algorithms	
CSDS 455	Applied Graph Theory	
CSDS 477	Advanced Algorithms	
Artificial Intelligence Courses:		
CSDS 440	Machine Learning	
CSDS 459	Bioinformatics for Systems Biology	
Bioinformatics Courses:		
CSDS 458	Introduction to Bioinformatics	
CSDS 459	Bioinformatics for Systems Biology	
Computer Networks & Systems Courses:		
CSDS 425	Computer Networks I	
CSDS 427	Internet Security and Privacy	
CSDS 428	Computer Communications Networks II	
Databases & Data Mining Courses:		
CSDS 433	Database Systems	
Security & Privacy Courses:		
CSDS 427	Internet Security and Privacy	
CSDS 435	Data Mining	
CSDS 444	Computer Security	
CSDS 448	Smartphone Security	

CSDS 456	Data Privacy
Software Engineering Courses:	
CSDS 493	Software Engineering

Outcome: The final decision will be made by the CS program director based on the committee's reports and the student's coursework. The outcome of the exam will be one of Pass (the student advances to candidacy), Retake (the student has to retake the exam once more before the end of the following semester. The Retake decision can be partial, i.e. the student may be asked to retake the oral exam only, rewrite the report only, or take/retake a course), Fail (the student will be separated from the PhD program). The decision will be documented by the CS program director and the student will be sent a notification letter.

Advancement to Candidacy

A student formally advances to candidacy after passing the Qualifying Examination and finding a faculty member who agrees to be the student's research advisor. The student should advance to candidacy within one semester of passing the Qualifying Examination.

Students should submit documentation, approved by the CDS advisor(s), to the Chairman of the Graduate Studies Committee of Computer Science to be admitted to candidacy.

Students who have failed to complete the conditions above within the time limit will be separated from the PhD program. Separation may also occur in the event of failure of the student to maintain a satisfactory GPA. A student who has been separated may not undertake further study for credit toward the PhD degree. With the approval of the Department and the Dean of Graduate Studies, such a student may complete a master's degree, may register as a non-degree student or seek admission to the graduate program of another department.

Dissertation Advisory Committee

Each PhD student must form a Dissertation Advisory Committee which consists of at least 4 members of University faculty. A student's CDS (co)advisor serves as the chair of this committee. Both the chair of the committee and at least one other member must be a regular faculty member whose primary affiliation is with the Computer Science program. The committee must also include one member whose primary appointment is *not* in the Computer Science program.

Dissertation Proposal

The PhD student must write a formal thesis proposal and defend it in an oral presentation to their Dissertation Advisory Committee. Normally this is done within a year of advancing to candidacy. A student who fails to defend their thesis proposal can attempt to defend it a second time after modifying the thesis proposal, but a second failure will cause the student to be separated from the program.

Dissertation

The student's dissertation must be original research in CS which represents a significant contribution to existing knowledge in the student's research area, a portion of which must be suitable for publication in reputable research journals or selective peer-reviewed conferences. In addition to the written dissertation, the doctoral candidate must pass an oral examination in defense of the dissertation. The Dissertation Advisory Committee is responsible for certifying that the quality and suitability of the material presented in the dissertation meet acceptable scholarly standards. If the student has not publicly presented their work at a conference or similar external venue, they must also present the dissertation research in a departmental seminar.

Colloquium and Presentation Requirement
PhD Students
The requirement has two parts: (1) passing 3 semesters of CSDS 500, and (2) a public presentation.

a. *All PhD students are required to register for and pass CSDS 500 for a total of **three semesters** of the PhD Program, and this is expected before Advancement to Candidacy. (This is a 0 credit hour required course.) Students (such as students working in industry) may propose an alternative arrangement for fulfilling this requirement, by submitting a written petition to the Graduate Studies Committee.*

b. *All PhD students must give **a public presentation** of their research, in addition to their PhD dissertation defense. This presentation must be given either at a research conference or in the CDS seminar series.*

Course List for Program of Study Requirement

Code	Title	Credit Hours
CSDS 410	Analysis of Algorithms	3
CSDS 425	Computer Networks I	3
CSDS 427	Internet Security and Privacy	3
CSDS 428	Computer Communications Networks II	3
CSDS 433	Database Systems	3
CSDS 435	Data Mining	3
CSDS 438	High Performance Data and Computing	3
CSDS 440	Machine Learning	3
CSDS 442	Causal Learning from Data	3
CSDS 444	Computer Security	3
CSDS 448	Smartphone Security	3
CSDS 455	Applied Graph Theory	3
CSDS 456	Data Privacy	3
CSDS 458	Introduction to Bioinformatics	3
CSDS 459	Bioinformatics for Systems Biology	3
CSDS 466	Computer Graphics	3
CSDS 477	Advanced Algorithms	3
CSDS 491	Artificial Intelligence: Probabilistic Graphical Models	3
CSDS 493	Software Engineering	3
CSDS 496	Artificial Intelligence: Sequential Decision Making	3
CSDS 497	Artificial Intelligence: Statistical Natural Language Processing	3
ECSE 484	Computational Intelligence I: Basic Principles	3
ECSE 499	Algorithmic Robotics	3