Computer Science
PhD Student Guide

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Introduction and Purpose

Welcome! We are excited that you are pursuing your graduate study with us in the PhD program in Computer Science (CS) at Northwestern University (NU). The goal of this document is to provide a reliable, clear, and authoritative guide to the additional requirements and policies that govern the CS PhD program, augmenting the school-wide requirements presented in the first half of this handbook. We all work together to make our program and department a supportive and enthusiastic community for world-class research and scholarly advancement. Sometimes, however, a manual is simply not enough. In addition to your academic advisor, please don't hesitate to contact the CS PhD program's Director of Graduate Studies, or the Director of Graduate Admissions, or our Graduate Affairs Coordinators. Whenever you need clarification, advice, referrals, or just a sympathetic ear, please let us help you. Look for any one of us in the hallways or in our offices, and stop by to chat. If you can't find us, send us email to start the discussion, or to set up a meeting. We will always give you the time needed to address your concerns. We are here to help. Please contact and confer with us to ensure you stay connected with all the many people and opportunities afforded to you as part of Northwestern's graduate community.

Program Contacts

This section provides a general description of who has responsibility for curricular, admission, financial, and other matters in the program. The most up-to-date list of personnel can be found on the Computer Science website.

Graduate Program Assistant / Coordinator: Madeleine Agaton & Jensen Smith (CS-PHD-STUDENT-HELP@NORTHWESTERN.EDU). These staff members aid with administrative aspects of the program, including procedures, paperwork for milestones, registration issues, and other day-to-day operations. This is the initial point of contact for assistance related to the CS PhD program. Messages sent here are received by CS staff who will address your inquiry, or forward it to the appropriate person if needed.

Director of Graduate Studies (DGS): Nikos Hardavellas (CS-DGS-PHD@NORTHWESTERN.EDU). The DGS oversees the graduate program, advising students on academic matters and assisting with advisor selection and changes. The DGS also monitors academic progress and participates in decisions concerning academic probation and exclusion.

Department Chair: Samir Khuller (samir.khuller@northwestern.edu). The Department Chair is responsible for providing academic leadership, managing faculty affairs, overseeing curriculum and instruction, supporting student success along with the DGS, handling budgeting and resource allocation, coordinating departmental operations, and representing the department externally.

Learning Outcomes

At the conclusion of the doctoral program, students will be able to demonstrate their ability to find, plan, execute, document, and defend original CS research that is recognized by some research community in CS as being of high quality.

Program-Specific Academic Requirements & Policies

Common Coursework Requirements

Students must take a total of 10 quality-graded (i.e., graded in the A/B/C scale) graduate courses at Northwestern. These include COMP_SCI 401 *Introduction to Graduate Studies* (IGS), plus an additional 9 courses from a PhD track within CS.

Students should enroll in courses to accomplish the following:

- Fill gaps in intellectual background: If a course is needed to strengthen your foundation, you should enroll in and complete the course for a grade.
- Complete coursework requirements: If you have already met all intellectual requirements of your track and advisor, or you cannot find a relevant course, and still require courses to complete the minimum coursework requirement, take COMP_SCI 499 (typically with your advisor, but not necessarily with them). TGS or McCormick may impose restrictions on how many 499 courses a student can take—please see the relevant handbooks.
- Balance research and coursework: If you need to engage in graduate reading or research while also completing a graded course, you can register for COMP_SCI 499 or 590 with your advisor.
- Prioritizing research: If you already have sufficient graded coursework, and you perform funded doctorate research, you may register for COMP_SCI 590 with your advisor, or TGS 500.

Note, per TGS, COMP_SCI 499 cannot represent more than half of a student's courses during their first three quarters at Northwestern.

Core/Required Courses

Students should take COMP_SCI 401 Introduction to Graduate Studies (IGS) in the first quarter of their first year.

Track Coursework Requirements

A track in CS constitutes an overall area of shared interest among faculty that is also generally considered an area within CS as a whole. The tracks in the CS PhD program are Theory, Systems, Artificial Intelligence, Interfaces, and Computer Engineering.

Theory Track

Each student in the theory group must earn at least an "A-" in 3 courses from the following list before their qualifying exam.

- COMP_SCI 396/496 – Algorithms for Collective Decision Making
- COMP_SCI 407 – Advanced Topics in Modern Cryptography
- COMP_SCI 432 – Mechanism Design
- COMP_SCI 437 – Approximation Algorithms
- COMP_SCI 462 – Foundations of Quantum Computing and Quantum Information

- COMP_SCI 496 – Algorithms for Big Data
- COMP_SCI 496 – Computational Complexity
- COMP_SCI 496 – Foundations of Data Economics
- COMP_SCI 436 – Graduate Algorithms
- COMP_SCI 496 – Learning in Networks
- COMP_SCI 496 – Learning, Information and Data
- COMP_SCI 496 – Modern Discrete Probability
- COMP_SCI 496 – Preference Aggregation for AI Alignment
- COMP_SCI 496 – The Expansion Phenomenon in Computer Science
- COMP_SCI 496 – Theoretical Foundations of Data Science
- COMP_SCI 496 – Theoretical Machine Learning
- COMP_SCI 496 – Topics in Algorithmic Statistics

Students may substitute one of these courses with a different graduate-level theory course with the permission of the qualifying exam committee. It is possible for some course requirements in this track to be waived; see the Course Waiver Policy section.

Non-theory courses

All students must take at least two 300+ non-theory graduate courses before their thesis proposal. These courses can be non-theory CS courses and/or courses from other departments (e.g., math and economics). These courses must be approved by the student's advisor.

Systems Track

Breadth in Computer Science

Systems students are expected to have familiarity with other essential areas of Computer Science, in particular each of Theory, Artificial Intelligence/Machine Learning, and Interfaces. Courses that satisfy this requirement are listed below. Students must take one course from each category.

- **Theory:** COMP_SCI 335 (Theory of Computation), 336 (Algorithms), 496 (Graduate Algorithms), COMP_ENG 356 (Formal Verification), 357 (VLSI Design Automation), 459 (VLSI Algorithmics). *Students should be familiar with algorithms at least to the level of COMP_SCI 336 (Algorithms).*
- **Artificial Intelligence:** COMP_SCI 325 (AI Programming), 337 (Natural Language Processing), 344 (Problem Solvers), 348 (Artificial Intelligence), 349 (Machine Learning). *Students should be familiar with core AI and machine-learning topics as described in COMP_SCI 348 (Artificial Intelligence) and COMP_SCI 349 (Machine Learning).*
- **Interfaces:** COMP_SCI 330 (Human Computer Interaction), 351-1 (Graphics), 351-2 (Advanced Graphics), 352 (Machine Perception of Music), 370 (Computer Game Design), ELEC_ENG 332 (Computer Vision).

It is possible for some course requirements to be waived; see the Course Waiver Policy section.

Breadth in Computer Systems

Each student should take six courses, selected from six of the following areas, with Operating Systems, Networking, and Programming Languages and Compilers being required areas. Each area lists appropriate courses.

- **Operating Systems:** COMP_SCI 343 (Operating Systems), 441 (Virtualization), 443 (Advanced Operating Systems), 446 (Kernel Development)
- **Networking:** COMP_SCI 340 (Networking), 440 (Advanced Networking)
- **Programming Languages and Compilers:** COMP_SCI 321 (Programming Languages), 322 (Compilers), 323 (Code Analysis and Transformation)
- **Architecture:** COMP_ENG 361 (Architecture), 452 (Advanced Architecture), 453 (Parallel Architectures)
- **Databases:** COMP_SCI 339 (Database Systems)
- **Distributed Systems:** COMP_SCI 345 (Distributed Systems)
- **Parallel Systems:** COMP_SCI 358 (Parallel Computing), 368/468 (GPU Parallel Computing with CUDA)
- **Embedded Systems:** COMP_ENG 364/464 (Cyber-Physical), 365/465 (IoT), 366/466 (Embedded Systems)
- **Security:** COMP_SCI 354 (System Security), 355 (Forensics), 450 (Internet Security)
- **Performance Analysis:** COMP_SCI 442 (Dynamics)

Students planning to do their PhD thesis in the area of Security within the Systems track are expected to take COMP_SCI 354 and 450 before their qualifying exams. It is possible for some course requirements to be waived; see the Course Waiver Policy section.

Depth in Computer Systems

Systems students may be required to take additional courses, beyond the required 9 track courses, in preparation for their PhD thesis. Such additional requirements will be determined on a case-by-case basis and are at the discretion of the advisor.

Artificial Intelligence Track

AI courses

While the following courses are not required, each student should be proficient in the course material, as their content is assumed knowledge in the qualifying exam.

- COMP_SCI 325 - Artificial Intelligence Programming
- COMP_SCI 337 - Introduction to Semantic Information Processing
- COMP_SCI 338 - Practicum in Intelligent Information Systems
- COMP_SCI 344 - Design of Computer Problem Solvers

- COMP_SCI 348 - Introduction to Artificial Intelligence
- COMP_SCI 349 - Machine Learning
- COMP_SCI 371 - Knowledge Representation

Non-AI Courses

Coursework will vary depending on the exact interests and background of each student. Someone deeply interested in cognitive science might take a number of courses in psychology. Someone interested in creating new kinds of educational software might take some of their courses in the School of Education and Social Policy. Someone interested in more applied AI might take some of their courses in human-computer interaction and interface design.

Interfaces Track

There are no specific courses required for PhD students in this track. However, all students are required to demonstrate proficiency in the areas listed below. This can be achieved by taking a relevant course, or by demonstrating proficiency in the material covered by the course in some other way. Ways to demonstrate proficiency are discussed below.

- **Fundamentals of Programming:** COMP_SCI 111+, COMP_SCI 211+, COMP_SCI 214. It is important to note that these courses are not graded graduate courses and thus do not count toward the CS PhD degree's accounting requirements.
- **Theory (1 course):** COMP_SCI 335 (Theory of Computation), COMP_SCI 336 (Algorithms)
- **Systems (2 courses)**: COMP_SCI 361 (Architecture), COMP_SCI 321 (Programming Languages), COMP_SCI 322 (Compilers), COMP_SCI 339 (Database Systems), COMP_SCI 340 (Networking), COMP_SCI 343 (Operating Systems)
- **Graphics or media (1 course from any of the following categories):**
  - Audio, visual or multimedia processing: COMP_SCI 351-1 (Graphics), COMP_SCI 351-2 (Advanced Graphics), COMP_SCI 352 (Machine Perception of Music)
  - Computer games: COMP_SCI 370 (Computer Game Design), COMP_SCI 396 (various)
- **Cognitive and social systems (1 course from any of the following categories):**
  - Artificial Intelligence: COMP_SCI 348 (Artificial Intelligence), COMP_SCI 349 (Machine Learning), COMP_SCI 371 (Knowledge Representation), COMP_SCI 474 (Probabilistic Graph Models)
  - Cognitive science: An advisor-approved cognitive science course
  - Social science: An advisor-approved social science course
- **Learning sciences:** COMP_SCI 313 (Tangible Interaction Design and Learning)

Proficiency means showing knowledge comparable to getting an A in an undergraduate course on the topic at a peer institution. For programming knowledge, proficiency may, at the discretion of the advisor and the interfaces faculty, be demonstrated through significant work experience in the software industry. Students entering the CS PhD program with an undergraduate degree in computer

science will likely satisfy most, or all, of the requirements through coursework on their undergraduate transcript. Any requirements not satisfied through prior coursework must be resolved by taking the appropriate course at Northwestern.

Students entering with an undergraduate degree in CS or similar discipline should complete this work in their first year, while those with undergraduate degrees in other areas should complete this within two years.

Computer Engineering Track

A Computer Science PhD student following the Computer Engineering track is governed by the rules of the Computer Engineering Program for track coursework requirements. The Computer Engineering Program has its own program guide that outlines its rules.

Course Waiver Policy

It is important to note that courses with the same title from previous degree programs may vary in content and rigor. As a result, some PhD students may need to retake certain courses at Northwestern to ensure they develop the necessary foundation. However, if students believe they have met a program requirement through previous coursework, they should discuss a waiver with their advisor. If the student and advisor agree that the student has met the requirements of a specific course, the student may petition the program for a course waiver.

It is the responsibility of the student to make a case for how a course (or set of courses) taken at a prior institution satisfies a requirement. To substantiate such a claim, the student will need to submit a petition for a course waiver to the DGS together with supporting material. Supporting material may include their transcript, syllabus, slides, project description, homework and lab assignments, and any other supporting documentation for each class in question. The DGS, with the input of the course coordinator, will determine if a course waiver is warranted. Then, the student can either:

- Enroll in a different graduate-level course; or
- Enroll in COMP_SCI 499

COMP_SCI 499 allows the student to have more graduate reading and research, while earning course credit at the same time.

Students who transfer from the Northwestern MS program to the PhD program may count their course credits toward satisfying PhD requirements if permitted by The Graduate School (TGS).

Teaching Requirement

All PhD students in Computer Science are required to complete at least one quarter of teaching assistant (TA) duties; students may be asked to TA multiple times.

TA positions are allocated quarterly and require students to assist with a course. The time involved as a full-time TA (100% effort) is 20 hours a week. Half TAs (50% effort) have a time obligation of 10 hours

a week, and 25% TAs require 5 hours a week. These time commitments are averages across the entire quarter; time involvement during individual weeks may vary.

Other Coursework and Activities

In addition to formal coursework, participation in other activities is an important part of graduate education.

The CS department includes all the PhD students, MS students, undergraduate students, postdocs, faculty, and staff. Students are expected to actively participate in the department's community. That includes joining community events, attending seminars, research group meetings, and other scholarly events, participating in student organizations, helping and mentoring other students, and teaching. Students are also expected to contribute to departmental and CS program service activities, such as assisting with student recruitment efforts, participating in orientation events for new students, and helping to organize seminars or workshops.

Typical Computer Science PhD Timeline

Computer Science PhD students must complete all degree requirements by the end of their seventh year to remain in good standing. While this milestone deadline provides some allowance for unforeseen delays toward PhD degree completion, we expect such cases to be rare, and students to graduate within five years, as demonstrated in the below timeline:

- Year 1:
  - Advisor Selection must be completed by the end of the 3rd Quarter
- Year 2:
  - First paper should be submitted
  - Must pass qualifying exam by the end of the 8th Quarter
- Year 3:
  - Continue research progress
- Year 4:
  - Proposal must be completed by the end of the 16th Quarter
- Year 5 (and beyond):
  - Thesis Defense and Dissertation completed by the end of the 20th Quarter

MS degree during the PhD

An MS degree on the way to the PhD acts as an indicator of progress. PhD students are recommended to apply for their MS degree as soon as they are able, which is usually at the end of the fourth quarter, or slightly later.

The MS degree earned along the way to the PhD may be coursework-based, project-based, or thesis-based. To meet the requirements of a project- or thesis-based MS, students may use research conducted during the early stages of their PhD. In addition to coursework, the project- and thesis-based MS degrees require the research outcome to be approved by a committee comprised of CS faculty members. This can be accomplished through an MS defense exam. Another option, which some PhD tracks use, is to include the MS defense exam as part of the PhD qualifying exam.

You can find the Master's in Primary PhD form within GSP under the TGS Forms tab. This form is specifically used to request a master's degree along the way to the PhD in the same program. Completing this form is a necessary step before submitting other required forms for degree conferral, such as the Application for Degree and Master's Degree Completion forms, also submitted via GSP.

Program-specific Milestone Policies

Finding an Advisor

Faculty who have a full or partial appointment within CS can serve as a Primary Research Advisor. Faculty with a courtesy appointment in CS can co-advise a student along with another faculty member who has a full or partial appointment in CS. While students will meet some of our faculty when enrolled in Introduction to Graduate Studies (IGS), we encourage students to reach out directly to faculty whose work is of interest as soon as possible.

Though students are encouraged to find a Primary Research Advisor by the end of the fall quarter, they must match by the end of the third quarter to stay in good academic standing. Once matched, the student-advisor pairing must be officially declared through GSP, by formally inviting the faculty to serve as your PhD advisor, and the faculty formally accepting the invitation through GSP.

Joining a Track

The student's advisor will be part of one or more tracks and will make recommendations for the appropriate track to pursue. The student will then be expected to follow the track's requirements.

Annual Reviews

All PhD students receive annual reviews in Fall. These reviews include feedback from the faculty and a numerical evaluation from 1 to 5 of the student's work over the previous academic year, where 1 signifies "Unsatisfactory," 2 "Needs Improvement," 3 "Meets Expectations," 4 "Exceeds Expectations," and 5 "Exceptional."

Evaluations are submitted through Spring and Summer. This evaluation incorporates the following sources:

- The advisor fills out a detailed evaluation of the student in a standardized form.
- The student fills out a detailed evaluation of themselves in a standardized form.

- The program collects information from university systems that include, but are not limited to, RCR status, English testing status, and grades.

The advisor and student forms follow a similar structure, allowing faculty to directly compare the student and advisor perspectives and determine if they are on the same page.

The CS faculty meet, collectively review each student using this information, and prepare a letter summarizing the evaluation. The letter indicates whether students are making satisfactory progress, highlights accomplishments and challenges from the past year, and outlines goals for the upcoming year. It may also include deadlines for specific milestones. The letter is then sent to the student on behalf of the entire faculty. The letter is also shared with TGS.

Note that students found in violation of the Academic Integrity Policy will receive an unsatisfactory review for the academic year in which the violation occurred. Depending on the severity of the violation, additional remedial or disciplinary measures may be imposed, up to, and including, immediate exclusion from the program.

Per McCormick policy, students in their fifth year and beyond must meet with their advisor quarterly to discuss their research progress.

Thesis Committee

The thesis committee must include at least four members who meet the following criteria:

- One must be the student's advisor (generally chair of the committee)
- Three —including the committee chair— must be members of the Northwestern Graduate Faculty and must also be non-courtesy members of the CS faculty.
- One member is recommended to be external to the CS department or Northwestern.

These requirements represent the minimum composition; it is acceptable, for example, to have additional members, or to have courtesy faculty as members, provided these minimum requirements are met.

While changes to the committee composition are permitted, they are uncommon and generally discouraged.

Qualifying Exam

PhD students must take their qualifying exam by the end of their second year. The purpose of the qualifying exam is for a group of faculty in the student's track to assess whether the student is likely to successfully propose, execute, and defend a thesis. The specific requirements vary by track, but common criteria include: (1) successful completion of guided research, ideally at the level of paper submission to a quality venue, (2) a reasonable command of the research literature in the area, and (3) the ability to think and reason well.

Passing the qualifying exam advances the student to "PhD candidacy" within Northwestern. In the CS program, it indicates to the student and advisor that it is time to start working on the PhD thesis, beginning with identifying a research topic.

After the exam, the committee members give one of the following grades:

- **Pass**. The student successfully completed the qualifying exam.
- **Conditional Pass**. While the student did well on most of the exam, the faculty have identified an area of weakness that must be addressed before a "pass" is reported. A letter will outline what actions must be taken to address the weakness.
- **Fail with Possibility of Retake**. The student failed the qualifying exam, but there is evidence that the student could pass, given a specific course of action. A letter will outline what needs to be done before the student may retake the exam. A qualifying exam can be retaken only once.
- **Fail without Possibility of Retake**. The student did not pass the exam and either (1) this is their second and final attempt or (2) the committee determines there is no course of action likely to result in passing the qualifying exam.

After passing the qualifying exam, students must formally notify the CS program and TGS of the completion of this milestone. This is done by uploading in GSP a document in which the qualifying exam committee members certify the student has successfully completed the qualifying exam. Uploading an email chain with each committee member's certification suffices.

The qualifying exam is conducted by the qualifying exam committee. The composition of the qualifying exam committee and additional requirements specific to each track are listed below.

Theory Track

This track's exam tests the following:

- If the student has acquired a sufficient breadth of knowledge in computing and algorithms.
- If the student has a depth of knowledge in his or her research area.
- If the student can present research well both in written and oral form.

The qualifying exam committee consists of three or four members. The student's advisor(s) must be on the committee. The other committee members should be faculty at the Northwestern CS department or, if approved by the advisor, faculty members or researchers from other departments, universities, or research labs.

Two weeks prior to the exam, students must send their committee the paper(s) they plan to present. One week prior to the exam, students must notify the department at CS-PHD-STUDENT-HELP@NORTHWESTERN.EDU so the CS program can formally announce it to the community.

The qualifying exam typically takes 2-3 hours in total. The first part of the exam is open to the public. In the first part, the student presents either (a) the results of their research (preferably already published in a conference or journal); or (b) an in-depth survey of a research topic assigned to the student by the advisor. The topic of the presentation should be discussed with the advisor.

The second part of the exam is closed to the public; only the student and committee members can attend. During the second part of the exam, committee members ask the student technical questions related to their research area, literature on the reading list, and the core courses the student has taken. The reading list should contain 10-15 papers and book chapters. It should be approved by the committee before the exam.

Systems Track

This track's exam tests the following:

- Has the student acquired a breadth of knowledge in computer science and computer systems?
- Does the student have a depth of knowledge in their research area?
- Can the student conduct research?
- Can the student present their research well, both verbally and in writing?
- Can the student defend their research?
- Can the student think and discuss research extemporaneously? In other words, can the student think on their feet?

If students do not meet these prerequisites, they will not pass the exam.

Students should discuss their preparedness with their advisor. Once ready, students should form a committee consisting of their advisor and at least two other systems faculty members. Non-systems faculty are also appropriate in some situations, if the advisor agrees.

It is the student's responsibility to schedule the exam and reserve a conference room for it. Exams have no set length, but past exams have taken from 2 to 6 hours. When scheduling the qualifying exam, it should be scheduled for at least 2 to 3 hours. Systems qualifying exams are private: only the committee and the student are in the room.

The qualifying exam begins with the student presenting a significant piece of their research. One week prior to the exam, the student must supply their committee with a paper about the work they will present. A conference, journal, or workshop paper/talk is ideal. The committee will ask the student difficult questions about the content of the presentation and the work. The purpose of this part of the exam is to determine the student's capability in conducting, presenting, and defending research.

In the next stage of the qualifying exam, each committee member will have the opportunity to ask questions. Any technical question related to computer science is possible; however, the focus will be on systems. Many faculty members prefer to start with a question designed to test breadth or depth of knowledge in computer science. The committee may follow up on such questions and will be interested in how the student responds to questions in areas they don't know, or questions they don't know the answer to. This is a common situation in research, and the committee will want to determine how the student responds. It is appropriate and encouraged to ask questions of the committee. The committee also wants to see how the student responds in an intellectual dialog.

Artificial Intelligence Track

The AI group's qualifying exam is a one-day written exam, traditionally the Monday or Tuesday after finals week of the spring quarter. The exam is open-book, open-notes, and graded anonymously.

Interfaces Track

The qualifying exam consists of presenting the results of a completed small-to-medium-sized research project to a qualifying examination committee. The committee comprises three members of the Northwestern graduate faculty. At least two members of the committee must have a primary, secondary, or courtesy appointment in CS. Although the project may be a component of a larger group project, the work reported on must be solely by the student, not joint work with other students.

The exam has two parts: the written component and the oral component. The written component consists of a mock (or real) conference paper on the project. Although the project need not be published work, the student should identify a conference in which the project could plausibly be published and write the paper to be consistent with the submission requirements (length, etc.) for that conference. At least one week before the exam, the student must submit to the committee a final version of an advisor-approved paper that describes the work to be presented.

The oral component consists of a formal presentation of the project, as one might give at a departmental colloquium. It should be roughly 45 minutes in length, with another 15–45 minutes for questions. The purpose of the oral exam is to understand the student's analytical and research skills, although the committee may ask whatever questions it feels are appropriate.

Computer Engineering Track

A Computer Science PhD student following the Computer Engineering track is governed by the rules of the Computer Engineering Program for qualifying exam requirements. The Computer Engineering Program has its own program guide that outlines its rules.

Prospectus (Thesis Proposal)

The thesis proposal is a written description of the envisioned work that should lay out the research problem that will be addressed, the student's planned approach to the problem, related work, the student's prior work, and a work plan and schedule. The schedule must make the student's expected completion date clear. Once the student and advisor agree the document is ready, the student will share it with the committee. The proposal does not need to be made publicly available online.

After the committee has had at least a week to review the thesis proposal, the next step is a thesis proposal defense. The talk is a summary of the thesis proposal and a defense of its ideas. This generally takes the form of a public talk followed by in-depth questions first from the committee and then from the other attendees. The student must schedule the proposal defense, making sure all the committee members are there physically or via phone/video. There is no set time limit for a thesis proposal defense, tracks might impose specific requirements.

Students must contact CS-PHD-STUDENT-HELP@NORTHWESTERN.EDU **no later than a week before** the proposal defense, so the CS program can formally announce it to the community. At the

end of the thesis proposal defense, the committee will either approve or reject the thesis proposal and inform the student. The committee's decision should be communicated to CS-PHD-STUDENT-HELP@NORTHWESTERN.EDU who will record it within CS and inform TGS as well.

Students should complete the thesis proposal and proposal defense no later than the end of the fourth year of study (more specifically, by the last day of the 16th quarter of study).

After successfully defending the thesis proposal, students must formally notify the CS program and TGS of the completion of this milestone. This is done by uploading in GSP a document in which the thesis prospectus committee members certify the student has successfully passed. Uploading an email chain with each committee member's certification is sufficient.

Additional requirements specific to each track are listed below.

Theory Track

The thesis prospectus defense is a talk open to the public and should last approximately 50 minutes. Following the thesis prospectus talk, the chair of the committee will write a formal letter to the student describing the results and what additional work, if any, is to be done.

Systems Track

The systems track **requires** that the committee has at least one external committee member. The external committee member should be from outside Northwestern and should hold a PhD. In most cases, the other three faculty members should be drawn from the systems group. Exceptions to these additional rules in committee composition can be made in consultation with the student's advisor, but a member external to the CS department is required.

The proposal presentations last about 50 minutes, although there is no set time. Only clarification questions are permitted during the talk. This part of the proposal defense is open to the public. After public questions have been exhausted, the open segment of the proposal defense is followed by a closed segment with only the committee and the student. The audience will leave, and the committee may ask further private questions or raise other private concerns. The student will then leave the room, and the committee will determine whether the student has passed or failed the proposal defense. The student will be informed whether they passed or failed on the day of the proposal defense. Given the multiple parts of the proposal defense, the exam should be scheduled for at least a 2-hour window.

Artificial Intelligence Track

The written proposal must first be approved by the thesis committee, before the student gives a public formal presentation of the thesis proposal, as one might give at a departmental colloquium. The expected format is 45 minutes for the presentation, with another 15–45 minutes for questions.

Interfaces Track

The thesis proposal document must specify the following:

- The topic to address.
- Why it's important.

- The relevant work that has been done before on the topic.
- How the student expects to improve upon existing relevant work.
- A schedule for the work to be done. This is intended as a planning tool for you to help ensure plans are practical.

A typical thesis proposal length is 15 to 20 pages, with a 45-minute presentation. Presentations are followed by another 15–45 minutes of time for questions.

Dissertation and Thesis Defense

The dissertation is a written, typically book-length work that addresses the problem and results outlined in the prospectus. It is not uncommon for the dissertation to integrate publications (for example as chapters), but the dissertation must be able to stand on its own. The dissertation should include an abstract, a statement of funding sources, and must include a list of the student's thesis committee members denoting the chair.

The student must schedule the thesis defense, making sure all the committee members are there physically or via phone/video. To allow time for the PhD thesis committee to ask questions and confer, the thesis defense should be scheduled for at least a 2-hour window. The dissertation document must be complete, in draft form, before the thesis defense can take place.

At least two weeks before the thesis defense, the student must submit a draft of their dissertation along with the CS Examination Request form signed by all members of the committee to CS-PHD-STUDENT-HELP@NORTHWESTERN.EDU or in person at the CS grad office. This signifies that the committee is ready to hear the defense and that they will have at least a week to review the dissertation draft. Generally, the advisor will read and comment on the dissertation draft well before then.

Students must also email CS-PHD-STUDENT-HELP@NORTHWESTERN.EDU at least one week prior to the defense with the following information, which will be used to create a formal public talk announcement, similar to a seminar talk announcement:

- The date, time, and location of the defense.
- The title and abstract of the talk, as well as the student's bio.
- The names of the thesis committee members, and their affiliations. The chair should be clearly designated.
- A link to the dissertation draft for interested parties.

The talk will then be advertised widely in the department and at Northwestern. Failure to meet the public announcement deadline will result in rescheduling the thesis defense at a later date.

The thesis defense begins with a public, well-advertised talk in which the thesis, dissertation, and primary results are summarized. This is followed by questions from the thesis committee and others. As with the thesis proposal defense, there is no set time limit for a thesis defense.

At least 3 members of the thesis committee must be designated as readers (in most cases, the external committee member is not a reader). At least three days prior to the defense, the readers must prepare

short reviews (at least 2–3 paragraphs) of the dissertation draft and send them to the student and the rest of the committee. All other members of the CS department are welcome to submit their feedback as well. Before the defense, the thesis committee chair should prepare a draft summary of all reviews. The summary can be edited and updated by committee members before and during the defense.

The defense minimally consists of four components:

- **Public talk**: The student will give their talk, presenting a summary of the thesis work and a defense of its ideas and results. Anyone may attend.
- **Public questioning**: Each member of the committee will ask the student in-depth questions. Once the committee is finished, further questions are solicited from the audience.
- **Private questioning**: After public questions have been exhausted, the audience will leave, and the committee may ask further private questions or raise other private concerns.
- **Private discussion and decision**: The student leaves the room, and the thesis committee continues the discussion and determines whether the student passed or failed the thesis defense.

Immediately after the defense, the committee chair will inform the student of their decision and provide a summary describing the results of the committee's deliberation and what required additional work, if any, is to be done.

After a successful thesis defense, the committee will send comments on the dissertation draft to the student. The student must then complete any additional work and make the necessary changes to the dissertation. The thesis committee chair is responsible for seeing that the required changes are completed, and verifying that the rest of the committee is also happy with them.

Once any revisions are completed, the student delivers the final version of their dissertation in two steps:

- First, the student submits it to TGS, specifically ProQuest. TGS will identify any formatting issues that need to be addressed. ProQuest makes the dissertation available via the library.
- Second, the student must create and publish a Northwestern CS technical report of their dissertation to make the thesis work widely available to the public. The dissertation, in both forms, must include a page documenting the thesis committee members who approved it.

Theory Track

After a successful thesis defense, the committee will send comments on the dissertation draft to the student within 7 days.

Systems Track

Generally, a defense talk lasts about 50 minutes, although there is no set time. Only clarification questions are permitted during the talk. After a successful defense, the committee will send comments on the dissertation draft to the student within 2 weeks.

Academic Probation and Dismissal by the CS Program

In addition to The Graduate School and McCormick's probation criteria, the CS PhD program places students in academic probation, with one quarter to remediate, if:

- The student receives an annual review evaluation of "Unsatisfactory."
- The student has violated Northwestern's academic or research integrity policy. Please see below for additional provisions regarding violations of these policies, including cases that result in immediate exclusion from the program.
- The student is on their fourth quarter of study or later, and does not have a thesis advisor.
- The student has not passed a qualifying exam within the first two years of study. PhD students who joined CS before Fall 2025 must pass the qualifying exam by the end of their third year.
- The student has not passed a PhD thesis proposal within the first four years of study.
- The student has not defended the PhD thesis within the first seven years of study. PhD students who joined CS before Fall 2021 must defend their thesis by the end of their ninth year. PhD students who joined CS in AY 2021-22 must defend their thesis by the end of their eighth year.

While on probation, the student may be required to report their progress to the Director of Graduate Studies (DGS) in regular intervals, to ensure progress is made toward remediation.

If the student does not satisfy the probation requirements within the remedial period, a committee formed by the DGS will convene and decide whether to dismiss the student from the program, or extend the probationary period by one quarter (in exceptional cases).

A second violation of Northwestern's academic or research integrity policy will result in dismissal of the student from the CS PhD program. Additionally, if a violation is deemed particularly serious by the student's advisor, the CS Director of Graduate Studies (DGS), or the Department Chair, then the DGS or Department Chair, along with a committee formed by the DGS, may dismiss the student from the program after a first violation. There are also cases where a violation of Northwestern's academic or research integrity policy may result in immediate exclusion from the program by McCormick or TGS.

Progress Checklist

Here is a list of required and recommended accomplishments students should be checking off during the program:

- ☐ Found an advisor
- ☐ Developed community within the department
- ☐ Conducted research with advisor and/or research group
- ☐ Held weekly one-on-one meetings with research advisor
- ☐ Completed Responsible Conduct of Research (RCR) Training
- ☐ Completed all other mandatory training to-date
- ☐ Passed any necessary English language tests to be qualified to TA
- ☐ Completed coursework
- ☐ Interned outside of Northwestern
- ☐ Provided service to the lab, group, or CS department
- ☐ Served as a TA
- ☐ Mentored or co-mentored an undergraduate, REU, or MS student
- ☐ Submitted a paper to a competitive venue as a co-author
- ☐ Had a paper accepted at a competitive venue as a co-author
- ☐ Submitted a paper to a competitive venue as an equal contributor
- ☐ Had a paper accepted at a competitive venue as an equal contributor
- ☐ Submitted a paper to a competitive venue as the lead author
- ☐ Had a paper accepted at a competitive venue as the lead author
- ☐ Attended a research conference
- ☐ Gave a talk at a research conference
- ☐ Completed the MS degree
- ☐ Passed the qualifying exam
- ☐ Seen a research proposal or received mentoring about research proposals
- ☐ Passed the thesis proposal (“prospectus”)
- ☐ Defended the thesis successfully
- ☐ Completed the dissertation document and had it approved
- ☐ Completed job application materials (“job packet”) for an academic or research lab position
- ☐ Completed job application materials for an industry or other position
- ☐ Received a job offer
- ☐ Received a job offer you like

Program Resources/Support

CS Resources

Computer Science resources and processes, including Travel; Purchasing, Procurement, and Vendor Payment; Expense Reimbursements; Department Operations and Facilities; and Student Resources, can be accessed at https://www.mccormick.northwestern.edu/computer-science/resources/. The CS Resources page has a subsection that caters specifically to CS PhD students. It includes resources such as PhD program handbooks, processes and documents for Qualifier and Thesis Prospectus exams, information on Conference CS Travel grants, etc. This subsection can be accessed directly at https://www.mccormick.northwestern.edu/computer-science/resources/student/phd.html.

CS PhD Student-led Organizations

CSPAC

The Computer Science PhD Advisory Council (CSPAC) has the mission of promoting the well-being of CS PhD students through advocacy and information-sharing. The council seeks to create and curate an accessible informational repository to connect CS PhD students with the resources they need for a healthy and productive graduate experience. It strives to elevate the voice and power of CS PhD students to address concerns that directly impact student life, including departmental policies and decisions. More information can be found in the following places:

- CSPAC Website: https://cspac.cs.northwestern.edu
- CSPAC Wiki: https://github.com/nu-cs-students/nu-cs/wiki
- CS PhD Student Slack Workspace: https://nucsphd.slack.com
- CS PhD Student WatsUp Site: https://watsup.cs.northwestern.edu/index.html

CSSI

The Computer Science Social Initiative (CSSI) pushes community-building efforts forward. Through the planning of informal and low-key events, CSSI aims to be a vector for students to know each other. CSSI actively collaborates with CSPAC and the CS Department to make these events part of our department's life and culture. More information can be found on the WatsUp Site.

Others

A range of other organizations or informal meetups can be found on the WatsUp Site. These include the AI Journal Club, the Databases and Security Reading Group, and the Graduate Women in Computer Science.

Teaching Development Resources

Teaching assistantship and teaching can be a valuable component of a student's professional development, particularly if they are considering a career that includes instructional responsibilities. A number of resources are available within the department and across the university to support students' growth as educators. Please check the departmental website for the full list.

Students on a TA assignment may refer to our practical guides for helpful advice and best practices:

- TA Tips: https://www.mccormick.northwestern.edu/computer-science/documents/undergraduate/ta-pm-position-guide.pdf
- Office Hours Tips: https://www.mccormick.northwestern.edu/computer-science/documents/undergraduate/tips-for-tutors-poster.pdf