

Graduate Study Manual

Computer Science Program
2020 –2021

Department of Computer Science

Effective Fall 2020 – Summer 2021

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Welcome!

We thank you for pursuing your graduate study with us in the Department of Computer Science (CS).

The goal of this manual, updated annually, is to provide a reliable, clear authoritative guide to all CS Dept requirements and policies for our graduate degree programs. We all work together to make the Department a supportive and enthusiastic community for world-class research and scholarly advancement, augmented by strong support from the McCormick School of Engineering and Applied Sciences (MEAS), one of the largest of the twelve schools and colleges that comprise Northwestern University (NU).

(<https://www.northwestern.edu/academics/colleges-and-schools.html>).

But sometimes a manual simply isn't enough; in addition to your academic advisor and other faculty members please don't hesitate to contact the CS Department's Director of Graduate Studies, or the Director of Graduate Admissions, or our Graduate Affairs Coordinator. Whenever you need clarifications, advice, referrals, or just a sympathetic ear, please let us help you; don't be a stranger! 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.

Sincerely,

the CS Dept. Graduate Studies Team:

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Diversity Statement

A diverse student population is a key element of the educational experience of students in The Graduate School (TGS). Diversity presents itself in many different forms such as: socioeconomic status, race or ethnicity, religion, gender, sexual orientation, nationality or place of origin, disability, unique work or life experience, etc. It is the goal of TGS to cultivate an environment that values diverse backgrounds, approaches, and perspectives — all essential ingredients for true academic excellence.

Nondiscrimination Statement

Northwestern University does not discriminate or permit discrimination by any member of its community against any individual on the basis of race, color, religion, national origin, sex, pregnancy, sexual orientation, gender identity, gender expression, parental status, marital status, age, disability, citizenship status, veteran status, genetic information, reproductive health decision making, or any other classification protected by law in matters of admissions, employment, housing, or services or in the educational programs or activities it operates. Harassment, whether verbal, physical, or visual, that is based on any of these characteristics is a form of discrimination. Further prohibited by law is discrimination against any employee and/or job applicant who chooses to inquire about, discuss, or disclose their own compensation or the compensation of another employee or applicant.

Northwestern University complies with federal and state laws that prohibit discrimination based on the protected categories listed above, including Title IX of the Education Amendments of 1972. Title IX requires educational institutions, such as Northwestern, to prohibit discrimination based on sex (including sexual harassment) in the University's educational programs and activities, including in matters of employment and admissions. In addition, Northwestern provides reasonable accommodations to qualified applicants, students, and employees with disabilities and to individuals who are pregnant.

Any alleged violations of this policy or questions with respect to nondiscrimination or reasonable accommodations should be directed to:

Northwestern's Office of Equity
1800 Sherman Avenue, Suite 4-500
Evanston, Illinois 60208
847-467-6165
equity@northwestern.edu

Questions specific to sex discrimination (including sexual misconduct and sexual harassment) should be directed to:

Northwestern's Title IX Coordinator in the Office of Equity
1800 Sherman Avenue, Suite 4-500
Evanston, Illinois 60208
847-467-6165
TitleIXCoordinator@northwestern.edu

A person may also file a complaint with the Department of Education's Office for Civil Rights regarding an alleged violation of Title IX by visiting www2.ed.gov/about/offices/list/ocr/complaintintro.html or calling 800-421-3481. Inquiries about the application of Title IX to Northwestern may be referred to Northwestern's Title IX Coordinator, the United States Department of Education's Assistant Secretary for Civil Rights, or both.

1. Overview

This manual specifies the official academic plans, curricula of required and recommended courses, degree requirements and policies for graduate study in the Department of Computer Science (CS). Its degree programs include the Masters of Science (MS) and Doctor of Philosophy (PhD) degrees in Computer Science, Computer Engineering, and in transformational collaborations available through the CS+X program that may spark entirely new fields of study.

This manual is produced and maintained by the Director of Graduate Studies (dgs@cs.northwestern.edu) of the Department of Computer Science which also cooperates with the Department of Electrical and Computer Engineering for the Computer Engineering graduate degree programs. All our departmental policies are guided by our parent school, the McCormick School of Engineering and Applied Sciences (MEAS) and with Northwestern's governing body for all graduate studies, The Graduate School (TGS). We also collaborate with and rely upon the Northwestern Univ. Division of Student Affairs (to help enrich graduate-student life beyond the academic rules and policies contained in this manual).

Resource Links:

- CS Dept: <https://www.mccormick.northwestern.edu/computer-science/graduate/>
- ECE Dept: <https://www.mccormick.northwestern.edu/electrical-computer/>)
- CS academics: <https://www.mccormick.northwestern.edu/computer-science/academics/graduate/>
- ECE academics: <https://www.mccormick.northwestern.edu/electrical-computer/academics/graduate/>
- McCormick Graduate Pgms: <https://www.mccormick.northwestern.edu/academics/graduate/>
- The Graduate School (TGS): <https://www.tgs.northwestern.edu/>
- Northwestern Student Affairs: <https://www.northwestern.edu/studentaffairs/index.html>

1.1 Where can I find the “Computer Engineering (CE) Department”?

No such department exists! Computer Engineering is not a department, but a joint program between the Department of Computer Science and the Department of Electrical and Computer Engineering. The CE program combines students, faculty, and courses from these two departments, guided by:

- The Director of Graduate Studies (DGS) for Computer Engineering: Professor Nikos Hardavellas (nikos@northwestern.edu), <https://www.cs.northwestern.edu/~hardav/>
- The Graduate Study Manual for Computer Engineering: <https://www.mccormick.northwestern.edu/electrical-computer/documents/graduate/ce-graduate-manual.pdf>.
- The Computer Engineering web site: <https://www.mccormick.northwestern.edu/electrical-computer/research/areas/computer-engineering.html>

Each CE degree program student is admitted and enrolled by their ‘home’ department, either:

- The Department of **Computer Science (CS)**, covered by this manual, and in particular by the Computer Engineering track described in Section 4.2 and by these sites:

(MS): <https://www.mccormick.northwestern.edu/computer-science/academics/graduate/masters/>
(PhD): <https://www.mccormick.northwestern.edu/computer-science/academics/graduate/phd/> , or

- The Department of **Electrical and Computer Engineering (ECE)**:
(MS): <https://www.mccormick.northwestern.edu/electrical-computer/graduate/masters/computer-engineering.html>
(PhD): <https://www.mccormick.northwestern.edu/electrical-computer/graduate/phd/computer-engineering.html>)

Your ‘home’ department provides advising, facilities, support, and general administrative services.

1.2 I’m New Here -- How Do I Get Started? What’s Happening? When? Where? And How?

The sheer size of Northwestern University (NU) can be bewildering.

It offers to its students so many large sets of opportunities, services, and novel programs that some may slip past you entirely unnoticed, despite our best efforts to publicize them. In addition to a wealth of deadline-driven scholarships, fellowships, research internships and award programs, you will find numerous ongoing student organizations and communities of all sorts, and always-available assistance and supports for any difficulties (public, private, or personal) throughout your time with us as a graduate student.

Fortunately, staying well-informed isn’t difficult with a good start online.

Everything is carefully organized and reachable (with some effort) from the top-level NU home-page:

<https://www.northwestern.edu/> and it’s always a good starting place in a search for anything

(be sure to explore tabs at the top of the pages, too!).

Graduate students in CS should also visit:

- the CS Department home: <https://www.mccormick.northwestern.edu/computer-science/>
- the McCormick School of Engineering home: <https://www.mccormick.northwestern.edu/>
(note its News and Events tab: <https://www.mccormick.northwestern.edu/news-events/>)
- The Graduate School home: <https://www.tgs.northwestern.edu/>
(note its News & Events tab: <https://www.tgs.northwestern.edu/about/news-events/index.html>)
- and The Division of Student Affairs home: <https://www.northwestern.edu/studentaffairs/>
(note many useful departments: <https://www.northwestern.edu/studentaffairs/departments/index.html>)
- PhD students should also make regular visits to:
 - the CSPAC website: <https://cspac.cs.northwestern.edu/> and wiki <https://github.com/nu-cspac/nu-cs/wiki>
 - and join the CS PhD student slack: <https://nucsphd.slack.com/>

1.3 On-Campus Essentials:

Access? When you arrive on campus,

- Get your **NetID**; (<https://www.it.northwestern.edu/netid/>) for access to all NU online services;
then
- Get your **WildCard**; (<https://www.northwestern.edu/wildcard/>) for access to all NU physical services;
then
- Get your **keys & office assignments** (PhD students) at Student Services, Mudd Hall, Rm. 3.546
<https://www.mccormick.northwestern.edu/computer-science/resources/>
then
- Get your mailbox (PhD students) from Student Services office (Mudd Rm. 3.546) and

- Get **transportation** help here: <https://www.northwestern.edu/transportation-parking/> (NU shuttle bus, city bus & train service(CTA, U-Pass), and all parking info).

Where? Who?

- Online NU maps of all sorts: <https://www.northwestern.edu/campus-life/visiting-campus/maps.html>
- The CS Dept. is located on the 3rd floor of Mudd Hall. <https://maps.northwestern.edu/facility/91>
- The CS Dept. administrative offices are in **Room 3.546**, where you will find Graduate Affairs Coordinator Judi Hernandez and other helpful CS Dept. staff
see: <https://www.mccormick.northwestern.edu/computer-science/people/staff.html>
- CS Dept faculty (offices, email, mailing addresses, etc.)
see: <https://www.mccormick.northwestern.edu/computer-science/people/faculty.html>
- CS Dept course listings for the entire year (name, number, instructor, what, when & where)
see: <https://www.mccormick.northwestern.edu/computer-science/academics/courses/>
- Search for any active student, staff, faculty member, department, or building at NU:
see: <https://www.northwestern.edu/> see 'search web or people', top-right side...

What? When?

- Official NU Academic Calendar:
<https://www.registrar.northwestern.edu/calendars/academic-calendars/>
- Official University-wide Events listings: <https://www.northwestern.edu/campus-life/events.html>
- McCormick News & Events: <https://www.mccormick.northwestern.edu/news-events/>
- CS Dept News & Events: <https://www.mccormick.northwestern.edu/computer-science/events/>

Housing? Food? Pantry? Urgent?

- Always start with the NU Division of Student Affairs: <https://www.northwestern.edu/studentaffairs/>
- which includes their Residential Services office: <https://www.northwestern.edu/living/index.html>
- and all available dining halls & vending machines: <https://www.dineoncampus.com/northwestern>
- and help with food access at any time:
<https://www.northwestern.edu/enrichment/resources/food-accessibility.html>

Doctors & Health? Insurance?

- 633 Emerson Street (Searle Building) On-campus infirmary:
<https://www.northwestern.edu/healthservice-evanston/> .
- TGS regulations legally require every graduate student to have health insurance coverage:
<https://www.northwestern.edu/student-insurance/>
- TGS and the CS Department fully cover the cost of our insurance coverage for all of our PhD students, and offer partial coverage for MS students. Graduate students may opt out of this school-provided coverage if you supply your own insurance and proof that this alternate insurance provides full coverage for the entire duration of graduate studies.
- Stress, well-being, and overall mental health:
(CAPS) Counseling and Psychological Services (847-491-2151) call anytime, all 24 hrs / all 7 days
<https://www.northwestern.edu/counseling/>

Welcoming Communities? How can NU and CS dept 'Feel like my Home'?

The Division of Student Affairs offers a vast array of diverse activities, communities, organizations and encouragements to enrich all aspects of student life. To find them all:

- Home Page: <https://www.northwestern.edu/studentaffairs/> home page
- Departments: <https://www.northwestern.edu/studentaffairs/departments/index.html>
- Community Resources: <https://www.northwestern.edu/studentaffairs/community/index.html>

- Norris Center: <https://www.northwestern.edu/norris/>
- AccessibleNU (works to ensure equal access to all) <https://www.northwestern.edu/accessiblenu/>
- Watsup CS: <https://watsup.cs.northwestern.edu/index.html>

Personal Safety? -- Be Sure You Already Know This:

- Dial '911' for help with any emergency at any time.
- Stay aware of your surroundings.
Avoid areas that appear poorly lit such as walkways and alleys at night).
- Try to walk home in the evenings with a friend.
- No friend around? Want a walking buddy? Try SafeWalk which is housed in the NUhelp app.
<https://www.northwestern.edu/offcampus/resources/getting-around/walking-safety.html>
- Limit distractions such as texting or listening to music loudly when walking alone.
- All the blue-light poles hold a phone connected to police – everywhere on campus.
- Northwestern Police will help you & protect you: <https://www.northwestern.edu/up/index.html>
Location: 1200 Davis St. in Evanston. **Non-emergency help: 847-491-3456**
- Worried? **Don't hesitate to call for a 'safety escort'** 847-491-3456 (Evanston; NU Police svc.)
<https://www.northwestern.edu/up/community-services/safety-escorts.html>
- For all NUPD Compliments, Complaints, and Comments:
https://cm.maxient.com/reportingform.php?NorthwesternUniv&layout_id=125

Personal Distress or Crisis? --24/7 help--

What Everyone Should Know:

- For medical assistance, call or visit campus infirmary: 633 Emerson Street (Searle Building):
<https://www.northwestern.edu/healthservice-evanston/>. **Medical Emergency? 847-491-8100**
- For personal crisis/stress help, counseling, an understanding listener, and/or mental health assistance:
(CAPS) Counseling and Psychological Services (847-491-2151) call anytime—all 24 hrs / 7 days
<https://www.northwestern.edu/counseling/>
- For help from NU authorities-- **Dean on Call: 847-467-3022 call anytime**—all 24 hrs / 7 days
- TGS Legal Service: <https://www.tgs.northwestern.edu/services-support/legal-services/>
- For a longer list of on-campus supports, check:
<https://www.northwestern.edu/care/get-help/get-help-now/are-you-in-crisis/index.html>
- **RAINN: National Sexual Assault Hotline: 800 – 656- 4673**

1.4 Graduate Study Essentials:

We expect every graduate student to know or learn about these essential services and basic procedures:

The Graduate School (TGS)? <https://www.tgs.northwestern.edu/>

TGS works throughout the university to ensure uniformly high standards for all graduate degree programs. TGS policies apply to all graduate degree programs at Northwestern, and we require TGS approval on most of the official forms that regulate CS Department graduate degree programs.

In addition to your CS Dept. advisor, each graduate student is assigned a TGS counselor to monitor overall academic progress. The TGS counselor inspects the students' coursework and GPA, enforces TGS policies for timely completion of degree requirements (milestones), and works to ensure compliance with all TGS standards.

International Office (IO)? <https://www.northwestern.edu/international/>

The IO is available to all the international students and its primary two roles are:

(a) to provide guidance/advise for maintaining proper immigration status consistent with the laws of the United States;

(b) to ensure compliance with those laws and help the students with various forms, such as OPT (Optional Practical Training) and CPT (Curriculum Practical Training).

The IO is located at 630 Dartmouth Place, and the regular hours of operations are M-F, 10AM-5PM.

Help with English Language Proficiency (ELP) Requirements?

<https://www.elp.northwestern.edu/english-proficiency-testing/>

All graduate students must satisfy the English Proficiency Requirement to gain eligibility for any TGS - supplied funding such Teaching Assistantships.

The Graduate School (TGS) offers extensive assistance to graduate students to ensure suitable proficiency in both spoken and written English for study, teaching, and research. These services include online software training, graduate student courses in English (*e.g.* LING_480), teaching demonstration assessments, group and individual tutoring, assistance with editing written works, and English language proficiency testing (TOEFL, Versant, and SPEAK).

The Graduate Student Tracking System (GSTS)? <https://gsts.northwestern.edu>

This online portal records and manages the student's progress through the graduate program. GSTS lists the TGS program milestones and deadlines (always consult this manual for additional info), completed coursework and unofficial transcripts, course plans, advisor and committee members, milestones, annual evaluations, and more.

Students should use GSTS to formally invite faculty members to serve in the student's committee, provide concise descriptions of the student's research, participate in annual self-evaluation, submit milestone forms, request admission to PhD candidacy and thesis examinations. We strongly recommended using GSTS for formal communications with any student's advisor, committee members, program administration, and for all program-related form submissions and petitions.

How do I pay for a Graduate Degree?

- PhD students receive funding that covers tuition, fees, health insurance, and a living stipend. The CS department supplies funding for new PhD students for up to 1 year (4 quarters) while they familiarize themselves with CS department faculty, join a research group, and pick a PhD advisor/mentor. After the end of that first year of study the PhD advisor is responsible for securing the student's funding source. <https://www.tgs.northwestern.edu/funding/fellowships-and-grants/index.html>

- Typical PhD funding sources include:
Research Assistantships (RA) funded by research grant support for advisor’s research;
Teaching Assistantships (TA) funded from university sources for teaching activities;
Fellowships usually funded from trusts or endowments, for the student’s research.
Students must apply and win these fellowships for themselves,
but NU offers help from many sources including:
 - the Computer Science department:
(see: <https://www.mccormick.northwestern.edu/computer-science/students/national-fellowship-calendar.html> and <https://www.mccormick.northwestern.edu/computer-science/academics/graduate/financial-aid.html>)
 - the McCormick School of Engineering:
(see: <https://www.mccormick.northwestern.edu/students/graduate/fellowships-internships/>)
 - the TGS ‘Office Of Fellowships’ (see: <https://www.northwestern.edu/fellowships/>)
CSPAC also hosts a list on their wiki: <https://github.com/nu-cspac/nu-cs/wiki>
- MS students are *not* eligible for TA or RA funding. Typical MS funding sources include: Personal funds, student loans, scholarships or fellowships, possibly supplemented by paid work as Peer Mentors in large classes in a few quarters of study.
- MS students seeking funding should consult with faculty – start with your initial academic advisor, and you may also wish to talk with faculty guiding the MS program (MS director Chris Riesbeck; Steve Tarzia, others), the CS Dept. Graduate Affairs Coordinator (Judi Hernandez), the CS dept. Director of Graduate Studies: dgs@cs.northwestern.edu (Peter Dinda), and the Director of Graduate Admissions gradadmissions@northwestern.edu (Fabian Bustamante).

Choosing Courses? Class Registration?

Get help -- Let us help you find wiser choices...

- First, review the course requirements for your degree in this manual, make a plan, and then confer with your academic advisor (or if a new PhD student, your initial academic advisor). Together you can plan out a schedule of courses to make the best use of your time here at NU.
- Our online catalog lists all NU courses (not all are taught each quarter or each year) <https://catalogs.northwestern.edu/>
- To understand the NU course-numbering system, see: <https://catalogs.northwestern.edu/undergraduate/requirements-policies/courses-credit/>
- Our CS department ‘courses’ webpage lists all CS courses taught this year, including instructor’s name: <https://www.mccormick.northwestern.edu/computer-science/courses/> Consult this page regularly with your advisor.
- For best results, plan ahead; map out courses for the entire academic year.
- Ideally, make and maintain your own whole-degree study plan. This plan should list *all* the courses you’d like to take while here at NU, and organize them into a schedule of classes that meets all the degree requirements described in this manual.
- Once you have your plan, you can register for courses online: <https://caesar.northwestern.edu/>

Degree Milestones?

Petitions? Qualifiers? Proposals? Prospectus? Defense? Graduation? Exceptions?

- Graduate students are expected to discuss all academic issues with their advisors first, in an open and constructive manner. For further help with any administrative aspect, both the students and advisors work closely with the CS Dept. Graduate Affairs Coordinator.
- All staff in the Student Services office (Room 3.546) are your allies – stop by, say hello, and get to

know them – they can help you with *everything*! Start with:

Judith (Judi) Hernandez, judith.hernandez@northwestern.edu

Graduate Affairs Coordinator

in the CS Dept Student Services office:

Mudd Hall Rm. 3.546, (847) 491-8174.

details: <https://www.mccormick.northwestern.edu/computer-science/people/staff.html>

- The Graduate Affairs Coordinator helps you meet every major milestone that your degree program requires. Contact the Coordinator when you need to submit a petition for course substitutions, for transfer credits, and for coursework completion. The Coordinator oversees each step for your qualifying exam, prospectus, proposal, defense, submission of completed thesis or dissertation, degree petition, graduation processes and more.
- The CS dept. and TGS both rely on ‘Graduate Student Tracking System’ (GSTS):
<https://www.tgs.northwestern.edu/academic-policies-procedures/gsts.html>
or just: gsts.northwestern.edu to monitor your degree progress, coursework, advising, committees, and timelines to graduation.
Check GSTS to see upcoming milestones and their deadlines, and enter data into GSTS to record current degree progress.

Every Student’s General Responsibilities?

Every graduate student is an adult, and we expect everyone to act sensibly, maturely, and responsibly. Accordingly, we expect you to be reliably self-directed; to be alert to mistakes, and to correct those mistakes as you find them. Your course instructors, your advisor, and the CS Dept. staff will help, but we cannot detect and alert you to all possible problems and mistakes, nor should you wait for us to tell you to fix them. We will all work to help you, but you must take the lead in ensuring that:

- You meet all the requirements of The Graduate School (TGS), of the CS Department, and of your chosen degree program. Requirements include timely and proper scheduling of all examinations, meeting all milestones and deadlines; scheduling, finding and following the deadlines and dates on the official academic calendars of Northwestern University (e.g. <https://www.registrar.northwestern.edu/calendars/academic-calendars/index.html>), and the current procedures and degree requirements of the CS Graduate Programs in this manual.
- **Ask the Graduate Affairs Coordinator (judith.hernandez@northwestern.edu) in CS Department Student Services Office (Mudd Hall, Room 3.546) first to execute procedures, confirm requirements, and obtain forms and paperwork for exams and various other tasks and concerns (e.g. visa related issues).**
We also strongly urge students to confer and plan with their academic advisors.
- Students are responsible for checking their official Northwestern <name>@u.northwestern.edu email accounts on a regular basis, no less than once a week. **Email is important – don’t ignore it. Email is the method used to send all official notices, warnings and alerts on degree program progress, on financial aid, payroll and tax matters, and all the important notices from the CS Department, TGS, McCormick, and the university.**
- Students are responsible for checking their official department mailbox on a regular basis, no less than once per month. **Some official notices or items are not suitable for email (e.g. ID cards, parking tags, paycheck records) and go to the student’s official CS dept. mail boxes instead.**
- **All students in all degree programs at Northwestern University are responsible for knowing and complying with the University’s policies on academic integrity.**
The principles, requirements and possible consequences of academic misconduct are documented at:

<https://www.northwestern.edu/provost/policies/academic-integrity/principles.html>

Students found guilty of academic misconduct, such as cheating on coursework, or plagiarizing research, by definition are failing to make satisfactory academic progress, and hence may be placed on academic probation.

(<https://www.tgs.northwestern.edu/about/policies/satisfactory-academic-progress.html>)

Students must be particularly vigilant in programming courses. Unless the instructor for the course has explicitly documented otherwise in the course syllabus:

- Code you submit must be your own.
- Copying and adapting someone else's code is not allowed.
- Studying someone else's solution for a specific assigned problem is not allowed.
- This includes code from a friend, an online article, or online code repository.
- Letting another student study your solution is not allowed.

If an instructor concludes that cheating has occurred, he or she will submit the evidence to your Dean for investigation and adjudication. Penalties for cheating will depend on the specifics of the case. They can range from letters of reprimand included in your academic records, loss of points on the assignment in question, a reduction letter grades earned for the course, failure of the course, suspension of enrollment, or even dismissal from the University in extreme circumstances.

- **‘Exception Handling’:**
the CS Department Student Services staff all work together as a formidable problem-solving team. Together, they know all the people and all the processes that make the university work. The CS Student Services team can always find or devise a good solution to just about any kind of problem that any kind of student might have to confront while here at Northwestern.

1.5 Graduate Admissions: General Requirements

The primary objective of the graduate admission process in the CS Department is to determine an applicant's qualifications, and to judge the applicant's prospects for success in his/her desired program of study and track. Typical applicants for either the PhD or MS degree programs are expected to have a BS in computer science or computer engineering, or a related discipline from a recognized institution. Highly qualified candidates with other academic backgrounds may also be considered.

The specific undergraduate preparation required for graduate study depends on the degree program and the area of specialization. An applicant with insufficient undergraduate preparation in any particular area, but well qualified in every other respect, may be required to take a selected set of undergraduate-level courses as soon as possible after enrolling at Northwestern. We inform students of these additional requirements at the time of admission, along with expectations for course grades.

To maintain a proper balance between department resources and the size of the graduate student population, we must limit offers of admission to the most qualified applicants. Thus, our admission process is highly selective and competitive in nature.

- To apply, please read and follow all the instructions on our Graduate Admissions website: <https://www.mccormick.northwestern.edu/computer-science/academics/graduate/admissions/> as well as those on the Graduate School (TGS) website: <https://www.tgs.northwestern.edu/admission/index.html>
- Importantly, note that all applicants for graduate study in the CS Department must submit verbal, quantitative, and analytical scores from the Graduate Record Examination (GRE). If an applicant has already obtained an MS degree from a U.S. institution, then GRE scores are not needed for PhD admission. However, GRE scores are required for all applicants who wish to be considered for any university fellowship.
- **PhD applications deadline: Tuesday December 15, 2020** to enroll in Fall Quarter 2021.
- **MS applications deadline: Monday March 1, 2021** to enroll in Fall Quarter 2021.
- All graduate degree programs begin in Fall Quarter, and no PhD student may delay the start of their enrollment to Winter, Spring, or Summer quarter unless granted permission by the department under exceptional and rare emergency circumstances.
- Admissions decisions for all CS graduate degree program applicants are made on a rolling basis, starting in mid-January and concluding by early April.
- All PhD applications and financial aid requests are reviewed and evaluated during Winter Quarter. During this evaluation period, a select group of PhD applicants may be asked for an interview with faculty member by telephone, Skype or Zoom. Some applicants may be invited to visit our campus to gain a better understanding of how they might fit into our PhD programs and research groups.
- The CS department and TGS provide all new PhD students with initial financial support for up to four (4) quarters while students find and obtain a committed primary academic advisor among the CS Department faculty. Upon arrival, every new PhD student begins regular meetings with their initial academic advisor, and during Fall and Winter Quarter gets acquainted with all CS department faculty to get involved in research work in at least one group.
- Before the end of Winter quarter, every PhD student must formally obtain a CS faculty member as their primary academic advisor. The new academic advisor must formally notify the Department in writing (through the GSTS) as advisor is committed to guide, advise, and financially support the student through completion of their degree program. Students who still lack an advisor at the end of Spring quarter may be placed on academic probation by The Graduate School, and may be excluded

from their degree program after two quarters of probation (See: ‘Satisfactory Academic Progress’: <https://www.tgs.northwestern.edu/academic-policies-procedures/policies/satisfactory-academic-progress.html>).

1.6 Financial Aid

PhD Students

The policy of the McCormick School of Engineering allows us to admit only those students for whom financial support is assured from either internal or external sources. Suitable internal sources include fellowships from Northwestern (e.g. Cabell and Murphy Fellowships), research assistantships (RA), and teaching assistantships (TA). Suitable external sources that students can supply include graduate fellowships, scholarships, or grants from institutions, companies, or government programs (see: <https://www.tgs.northwestern.edu/funding/about-graduate-funding.html>).

If financial support cannot be provided, then the CS Department will not recommend admission of the student to The Graduate School.

The Northwestern Office Of Fellowships (<https://www.northwestern.edu/fellowships/>) offers substantial help and guidance for those seeking suitable external funding sources, and online searches (e.g. ‘graduate fellowship computer science’) can yield many suitable fellowship opportunities.

MS-Only Students

The CS Department encourages MS-only students, especially those from industry, to apply. However, the Department does not provide financial support to MS-only students. Such students can be supported by external sources such as grants or fellowships from a company, government, or external institution, or the student may be self-supported. While some MS students may be eligible for paid, part-time work as ‘Peer Mentors’ for large classes for some quarters while enrolled,

MS students are not eligible for teaching assistantships or research assistantships.

1.7 Academic Integrity – How to Avoid Misconduct

All students in all degree programs at Northwestern University are responsible for knowing and complying with the University's policies on academic integrity.

The principles, requirements and possible consequences of academic misconduct are documented at:

<https://www.northwestern.edu/provost/policies/academic-integrity/principles.html>

Students found guilty of academic misconduct, such as cheating on coursework, or plagiarizing research, by definition are failing to make satisfactory academic progress, and hence may be placed on academic probation.

<https://www.tgs.northwestern.edu/about/policies/satisfactory-academic-progress.html>

Students must be particularly vigilant in programming courses.

Unless the instructor for the course has explicitly documented otherwise in the course syllabus:

- All code you submit must be your own.
- Copying and adapting someone else's code is not allowed.
- Studying someone else's solution for a specific assigned problem is not allowed.
- This includes code from a friend, an online article, or online code repository.
- Letting another student study your solution is not allowed.

If an instructor concludes that cheating has occurred, he or she will submit the evidence to your Dean for investigation and adjudication. Penalties for cheating will depend on the specifics of the case. They can range from letters of reprimand included in your academic records, loss of points on the assignment in question, a reduction of letter grades earned for the course, failure of the course, suspension of enrollment, or even dismissal from the University in extreme circumstances.

1.8 Graduate Internships & OPT for Post-Graduation Employment

MS students who wish pursue opportunities for off-campus internships, service-learning projects, and engineering research projects can obtain assistance from the Engineering Career Development program within McCormick School of Engineering:

<https://www.mccormick.northwestern.edu/career-development/for-students/>

A graduate student wishing to combine research work with industrial experience may, with the permission of their advisor, elect to participate in the Crown Family Graduate Internship Program. This experience permits the student to gain a broader understanding of some problems that eventually could serve as the background for a thesis or project. For more information on the Crown Family Graduate Internship Program, see [Section 3.2.e](#) of this Manual.

The US ‘OPT’ or ‘Optional Practical Training’ program can provide temporary work authorization for international students or recent graduates living in the United States on a current F-1 visa for a full academic year. Students who apply must be in good academic standing, and have a valid passport, a valid I-20, have NOT had more than 12 months of full-time CPT, have NOT previously had 12 months of post-completion OPT for the same level of degree. For the latest information, please visit the website for the Office of International Student and Scholar Services (OIS):

<https://www.northwestern.edu/international/index.html> , which includes detailed OPT instructions: (<https://www.northwestern.edu/international/living-working/student-employment/optional-practical-training/post-completion-opt.html>).

!WARNING! Processing ‘OPT’ Applications takes several months!

You must complete & submit your OPT application 3-4 MONTHS BEFORE GRADUATION!

Without submitting this application in advance, you will not be able to transition smoothly from the F-1 student status to the OPT visa status, and any such interruption may delay or prohibit your employment with a US employer. The International Office (IO) assists students with collection and submission of the required documents. In addition to consulting with your advisor, you should also schedule a meeting at least one month in advance of the OPT submission deadline to ensure you have enough time to collect the needed documentation.

2. MS Program In Computer Science

This section discusses all academic aspects of the process of obtaining an MS degree in Computer Science from the Computer Science department. The MS degree in Computer Engineering, conferred by the Department of Electrical and Computer Engineering, is described in the Graduate Study Manual for the CE program: <https://www.mccormick.northwestern.edu/electrical-computer/documents/graduate/ce-graduate-manual.pdf>

Each MS degree option requires students to submit a quarterly study plan to their academic advisor for review before registering for classes. Incoming MS students should submit a first-quarter study plan for review by the MS Degree Program Director for CS, and may continue this practice until they find a more suitable academic advisor. We also encourage MS students to assemble their own informal whole-degree study plans early – to find all courses you'd like to take, and then fit them into the time you have available.

2.1 MS Degree Options

Most MS students must maintain full-time study (3-4 units) throughout their Computer Science degree programs (defined by The Graduate School <https://www.tgs.northwestern.edu/academic-policies-procedures/policies/general-registration-policies.html#fulltime>). See Section 2.7 for part-time options.

Each full-time student pursuing an MS degree in Computer Science (CS) must declare his/her intention to follow one of the degree plans (A, B, or C) summarized below, and get the approval of this choice from his/her advisor. We recommend an early declaration, usually in the 2nd quarter of enrollment or after completing 3-4 courses. Most full-time MS students who began their studies in Fall quarter should declare their Degree Plan (A, B, or C) during Winter quarter.

To ensure timely completion, we require all MS students to declare their Degree Plan at least a month before the end of their 3rd quarter of enrollment. For MS students who begin classes in Fall, the deadline is May 1. For other quarters, the deadlines dates are August 1, November 1, and February 1. An MS student who does not meet this completion deadline, and does not successfully petition the CS Department for an extension, will be placed on academic probation for a maximum of two academic quarters. At that point, the Department retains the option to dismiss the student in question.

Committees:

Any MS student who chooses Plan A (Thesis) or Plan B (Project) must form an examination committee to evaluate their work. In accordance with TGS requirements, at least two committee members must be part of the Graduate Faculty (<https://www.tgs.northwestern.edu/about/for-faculty/graduate-faculty-membership.html>). For Plan A (Thesis), a CS faculty member must either be the primary (academic) advisor, or an equal co-advisor with an affiliated faculty member. For Plan B (Project), a Post-Doctoral Associate working with the student is acceptable as the 'affiliated faculty member'.

Use GSTS entries (<https://www.tgs.northwestern.edu/academic-policies-procedures/gsts.html>) to build your committee; it can send formal invitations and record accepted members as part of the progress-recording needed by the CS Department and TGS.

We encourage, but do not require, that MS students invite members into their committees as soon as they establish clear goals for their research or project topic. With more time for your committee to help, an MS student can gain build lasting connections to industry and research communities, get more guidance on good habits in research, design, writing and publications, and establish broader collaborations through conferences, journals, scholarships, and employment opportunities.

Plan A (Thesis MS Degree)

In this plan, a student declares their intent to earn the MS degree by completing a formal thesis that reports substantial original research results. Under this plan, a maximum of three units of COMP_SCI 590 research credit can be counted toward the 12-unit requirement for the MS degree.

All requirements for the thesis MS, including coursework and final approval of the thesis by the student's MS Examination Committee, must be successfully completed before the end of the fifth academic quarter (typically Fall quarter of the second year). In extraordinary circumstances, a student may, if their advisor approves, submit a petition to the CS Department to request more time to complete their Thesis MS Degree. The department is very unlikely to approve any MS degree program extension request that would extend a student's enrollment beyond seven (7) quarters of enrollment.

Thesis Requirements

A successful thesis has two components: a written document and an oral defense of the research. These are judged by a committee, headed by the thesis advisor, who is the committee head. One week prior to the oral defense, the student must provide a complete draft of the thesis to the committee. The defense should take between 30 minutes and 1 hour. Upon a successful defense, the committee will suggest edits to the document, if any are required.

The minimum MS thesis committee size is two people: the thesis advisor and at least one other faculty member. All MS thesis committees must also contain two (2) faculty that are members of the Graduate Faculty (see: <https://www.tgs.northwestern.edu/about/for-faculty/graduate-faculty-membership.html>), and a CS faculty member must either be the primary advisor, or an equal co-advisor with either an affiliated faculty member or a CS post-doctoral fellow.

Format of thesis document:

The MS thesis must conform to the formatting guidelines of a doctoral thesis, as specified by The Graduate School: <https://www.tgs.northwestern.edu/about/policies/phd-degree-requirements.html>

Length of project document:

There is no specified minimum or maximum length for a thesis. Historically, they tend to be roughly 30 pages in the double-spaced graduate school thesis format. The MS thesis committee evaluates the thesis contents for completeness and decides if the submitted work is of adequate length.

After the committee approves the final version of the thesis, the student must submit the thesis as an CS Department technical report. The thesis is not considered complete until this step has been taken.

Instructions: <https://www.mccormick.northwestern.edu/computer-science/research/tech-reports>

IMPORTANT: Please allow ample time for thesis revisions your committee or advisor may require after the defense to ensure timely completion. The Registrar's academic calendar lists thesis defense deadlines for each quarter (<https://www.registrar.northwestern.edu/calendars/>). These deadlines vary: in Spring term, the Graduate School requires **all thesis defenses to be completed ONE MONTH before the quarter ends** to enable graduation at the end of Spring quarter. Deadlines in other quarters are not as early, but be ready!

Plan B (Project MS Degree)

In this plan, a student declares their intent to earn the MS degree by completing a project and writing a project report that contains results based on existing theory and techniques or experimental verifications. A maximum of two units of COMP_SCI 590 research credit can be counted toward the 12-unit requirement for the MS degree.

All requirements for the Project MS degree, including coursework and final approval of the thesis by the student's MS Examination Committee, must be successfully completed before the end of the fifth

academic quarter (typically Fall quarter of the second year). In extraordinary circumstances, a student may, if their advisor approves, submit a petition to the CS Department to request more time to complete their Thesis MS Degree. The CS Department is very unlikely to approve any MS degree program extension request that would extend a student's enrollment beyond seven (7) quarters of enrollment.

Project Requirements

A project requires a written final report, approved by a project examination committee.

The minimum MS project examination committee size is two people: the thesis advisor and one other faculty member. Committees for Plan B projects must have at least one CS faculty member as advisor or equal co-advisor, and at least one additional member who may be either CS faculty, affiliated CS faculty, or CS post-doctoral fellow.

We recommend, but do not require, that the written project report conforms to the formatting guidelines of a doctoral thesis, as specified by The Graduate School:

<https://www.tgs.northwestern.edu/about/policies/phd-degree-requirements.html>

There is no specified minimum or maximum length for a project report. The MS project committee evaluates the thesis contents for completeness and decides if the submitted work is of adequate length. Once the advisor approves the final project report, the CS Dept recommends but does not require the student to submit the project document as an CS Department technical report. Instructions:

<https://www.mccormick.northwestern.edu/computer-science/research/tech-reports>

Plan C (Course MS Degree)

In this plan, the student must satisfactorily complete 12 courses approved by the student's advisor. The choice of courses must represent a coherent program of study that prepares the student for advanced work in a specific field. All requirements for the course MS degree must be satisfactorily completed before the end of the fifth academic quarter (typically Fall quarter of the second year).

Note that COMP_SCI 590 cannot be counted as a credit for a course-only MS degree. The purpose of COMP_SCI 590 is to get students involved in research beyond the traditional course experiences.

Hence, COMP_SCI 590 can only be applied towards the project MS degree or the thesis MS degree.

MS Degree Time Limits:

All requirements for the thesis MS, including coursework and final approval of the thesis by the student's MS Examination Committee, must be successfully completed before the end of the fifth academic quarter (typically Fall quarter of the second year). An MS student who does not meet a degree program deadline, and who does not successfully petition the CS Department for an extension of that deadline, will be placed on academic probation. Academic probation acts as a strong official warning within the Department, and should prompt students to take immediate action to leave probationary status. The Department retains the option to exclude (dismiss) any student who completes two or more sequential academic quarters on probation. Note that TGS policies and requirements can also impose probation

(see: <https://www.tgs.northwestern.edu/about/policies/satisfactory-academic-progress.html>).

2.2 Advising and MS Course Requirements

Advising:

All MS students must consult their academic advisor before registering for courses on CAESAR. At a minimum, MS students must file a 'study plan' of proposed courses before the quarterly course registration. Failure to do so could result in selecting courses that fail to meet the requirements of the MS degree.

The MS Degree Program Director is the default initial academic advisor for all MS students.

A student may elect at any time to change to a different academic advisor by these steps:

- (1) The student notifies the current advisor, and
- (2) In the Graduate Student Tracking System (GSTS), the student issues an 'invitation' message to the potential new advisor (purple menu bar at top; select 'Committee' tab, then visit the white/gray 'Committee/Advisor' tab and the 'Send Committee Invitations' tab with instructions), and
- (3) If the faculty member clicks the 'accept' link in the invitation email then the GSTS will formally record the new advisor. If necessary, the CS Graduate Affairs Coordinator can assist with any GSTS difficulties.

Course Requirements for CS degree programs:

Earning each unit of credit requires you to take a course, but not all courses will earn a unit of credit for you. We distinguish between COMP_SCI classes, with lectures and assignments, from project courses such as 499 and 590.

Twelve (12) units of graduate-level credits are required for the CS MS degree.

At least six (6) of the 12 units must be COMP_SCI classes.

COMP_SCI 499 (independent study) and
COMP_SCI 590 do not count as COMP_SCI classes, as noted above.

At most six (6) of the 12 units can be courses other than COMP_SCI classes.

Such courses must be approved in advance
by both the student's advisor and by the MS Degree Program Director for CS, if different.

At least three (3) of the 12 units of credit must be at the 400-level or above.

COMP_SCI 499 can be used to satisfy this 400-level requirement, but not COMP_SCI 590.
Advisor - approved non-COMP_SCI 400-level courses can also satisfy this requirement.

Master's students engaged in research may enroll in COMP_SCI 499 or in COMP_SCI 590:

COMP_SCI 499 and COMP_SCI 590 courses are appropriate for research work by MS students.
COMP_SCI 499, if taken for a grade, can be applied to any MS degree plan.
COMP_SCI 590 can be applied only to the project MS and thesis MS plans.

The maximum allowable credits for COMP_SCI 499 and COMP_SCI 590 are:

- Thesis Plan MS (Plan A): up to three (3) credits of COMP_SCI 499,
and up to three (3) credits of COMP_SCI 590.
- Project Plan MS (Plan B): up to three (3) credits of COMP_SCI 499,
and up to two (2) credits of COMP_SCI 590.
- Course Plan MS (Plan C): up to three (3) credits of COMP_SCI 499,
and zero (0) credits of COMP_SCI 590.

Additional Course Notes

All courses that **can** be taken on a letter-grade basis (L/G) **must** be taken on a letter grade basis (L/G) to be counted towards the MS degree.

All coursework for the MS degree must be taken within The Graduate School (TGS) of Northwestern University.

Coursework must be completed with a composite grade-point average of B (3.0) or higher.

MS students must consult with their academic advisor before enrolling in courses. Advising helps students avoid bad choices such as inapplicable or inappropriate courses, and courses that do not meet degree requirements.

Courses completed for undergraduate credit at Northwestern or elsewhere cannot be repeated for graduate credit.

Only these following courses may be applied to MS degree requirements more than once:

COMP_SCI 497 (Design, Technology, and Research), COMP_SCI 499, COMP_SCI 590, and TGS 512.

Internships:

MS students who wish pursue opportunities for off-campus internships, service-learning projects, and engineering research projects can obtain assistance from the Engineering Career Development program within McCormick School of Engineering:

<https://www.mccormick.northwestern.edu/career-development/for-students/>

An MS student engaged in these activities can maintain full-time registration with no tuition by enrolling in one of the following courses (requires advisor approval):

- **CRDV_411 Engineering Internship Program**
- **CRDV_412 Projects in Service Learning**
- **CRDV_413 Engineering Research Project**

These zero-unit (0) courses carry **no tuition cost, maintain full-time enrollment status** at the University during these approved activities, and allow only the S/U grade basis (Satisfactory/Unsatisfactory) grade basis. Full-time status is usually required for international students to maintain US visa status and for some scholarships. Registration in CRDV courses helps Northwestern administration, including TGS, record graduate student progress and track our students' efforts in external research collaborations.

International students who chose to take an off-campus internship must also apply and obtain Curricular Practical Training (CPT) authorization. "Off-campus" is defined as any internship that takes place outside of Northwestern University. For more information on applying for CPT, please visit the International Office's website: <http://www.northwestern.edu/international/living-working/student-employment/curricular-practical-training.html>

COMP SCI Course Credit Waivers

An MS student may petition to have at most three course credits waived, based on graduate level courses taken previously at another program. Only coursework that has **not** been applied to a completed graduate degree will be considered for transfer credit for a MS degree. A petition for such a waiver must include complete documentation (*e.g.* syllabus, assignments, projects) of the content of the graduate level course the student wants to transfer. The student must also provide an official transcript, sent directly to the department that shows the grade received for each course used for transfer credit.

The coordinator of this CS Department course will review the petition and make a recommendation. All such waivers are ultimately subject to the approval of the advisor, the MS Degree Program Director (Prof. Chris Riesbeck for CS, Prof. Steve Tarzia for CE) and the CS Director of Graduate Studies (Peter Dinda).

2.3 Computer Science MS Prerequisites

All MS Students in Computer Science (including BS/MS students) must provide evidence of having sufficient background in the field in one of 3 ways:

- **Northwestern BS/MS and BA/MS students:**
Must have completed the undergraduate CS core sequence (COMP_SCI 111, COMP_SCI 211, COMP_SCI 212, COMP_SCI 213, COMP_SCI 214) **prior to beginning** their Master's studies. Students who have not completed the core sequence will not be allowed to matriculate into the MS program in CS. No course taken at another university can substitute for a core class, unless it is accepted as transfer credit towards an undergraduate degree program at Northwestern University.
This is the only option allowed for Northwestern BS/MS students.
- **MS students newly admitted to Northwestern:**
Preliminary Exam
Prior to their first quarter of study, MS students in Computer Science must take a preliminary exam covering topics in our undergraduate CS core sequence (COMP_SCI 111, COMP_SCI 211, COMP_SCI 212, COMP_SCI 213, COMP_SCI 214). The preliminary exam is offered only once per year in the week before *New Graduate Student Fall Registration* begins.
It is the responsibility of the students to arrive on campus in time to take this exam.
This exam is not available to BS/MS students or to transfers from another degree program.

Intensive Program Design (IPD) Course:

Those who do not pass the preliminary exam must enroll in "COMP_SCI 295 Intensive Program Design" during their first quarter of study at Northwestern University and receive a grade of B or higher. This is a 2-credit course that teaches remedial skills that CS students should have prior to beginning a MS program. It is offered only in the fall quarter of each year and does not count towards the 12 required credits for the MS degree. This option is not allowed for BS/MS students. This option is not allowed for BS/MS students or to transfers from another program.

2.4 General Registration Courses – help to complete your Project or Thesis

Choosing courses for the last quarter or two can be difficult. Some MS students must balance the need to maintain full-time enrollment against a small set of remaining courses, while also minimizing enrollment cost as they complete an MS project or thesis. These 'general registration' courses from TGS: <https://www.tgs.northwestern.edu/about/policies/general-registration-policies.html> can help MS students apply time and funds most effectively.

To enroll in any of these 'general registration' courses you must first get the formal approval from your academic advisor, and if necessary, consult with the CS Graduate Student Services staff:

- **TGS 500 – Advanced Doctoral Study:**

MS students cannot enroll in this course. This course is for advanced doctoral research and is not available or applicable to the 12 units needed to complete any CS MS degree. Instead, consider TGS 512.

- **TGS 512 - Continuous Registration:**

This low-cost course enables MS students extra time to complete their thesis (Plan A) or their project (Plan B) yet still maintain full-time enrollment (3 or 4 units). Most students will not need this course, but those who have completed 9 or 10 courses (excluding 590), who plan to enroll in COMP_SCI 590 to complete their required 12 units, and have obtained written permission from their academic advisor may enroll in COMP_SCI 512 in one term and COMP_SCI 590 in others. TGS 512 course units do not apply to the 12 units of coursework required by our MS degree programs.

Students taking TGS 512 cannot enroll in any other courses, but must make steady progress towards degree completion in collaboration with their advisor. Students taking TGS 512 are not eligible for the TGS Activity Fee nor any of its attendant services, but they pay quarterly tuition of only \$100, maintain their student visa status, defer their student loans, continue their NetID, WildCard and email accounts, and retain access to most university facilities.

2.5 Degree Completion

To complete the MS degree, students must complete the following steps:

- Complete the Application for Degree (AFD) in CAESAR. This form can be found by navigating to For Students > TGS Forms > Application for Degree (AFD).
- Complete the Master's Degree Completion (MDC) form in CAESAR. This form can be found by navigating to For Students > TGS Forms > TGS Master's Completion. Note: students may see other TGS forms related to Prospectus and Final Exam. These forms are only for PhD students: Master's students should ignore them.
- **For ALL students:** students should send a list of the 12 courses they intend to use toward their MS degree to Christopher Riesbeck c-riesbeck@northwestern.edu, the CS Dept. MS Degree Program Director. For BS/MS students, please note that these 12 courses must NOT be counted toward the undergraduate degree.
- **For Coursework-only (Plan C) MS degrees:** in the section for Committee Members, students should enter the name of their CS academic advisor as the Chair. In either the Co-Chair or Member box, students should enter the name of the MS Degree Program Director (for CS or for CS).
- **For Thesis (Plan A) and Project (Plan B) degrees:** students should enter the names of their committee members, and then enter the name of the MS Degree Program Director (for CS or for CS).
 - At least one week prior to defending their thesis (Plan A) or completing the written report for their project (Plan B), students should complete the CS Examination Request Form: <https://www.mccormick.northwestern.edu/computer-science/graduate/forms-documents.html> and return it to the **CS Graduate Affairs Coordinator** (Judi Hernandez, judith.hernandez@northwestern.edu) in CS Department Student Services Office (Mudd Hall, Room 3.546) in the CS Dept. Student Services office (Mudd Hall, Rm 3.546).
 - Administrators will then check the student's file for any missing documents, grades, *etc.* The committee chair will need to collect the checked file and the CS Examination Request Form from the CS Graduate Affairs Coordinator prior to the defense. After the student completes a successful defense, the committee members and committee chair must sign the CS Examination Request form and return the completed paperwork and file to the CS Graduate Affairs Coordinator.
 - Once the advisor and the committee has approved the thesis or project and any revisions they require, the student must submit the thesis in its final form as a CS Department Technical Report. The thesis is not considered complete until this step has been taken. Instructions here:

- Project students are encouraged but not required to submit their project report as a CS Dept. Technical Report as well.

2.6 Transfers into the CS Department

Our MS program has limited capacity. We can only accept a small percentage of applicants. We cannot accept most requests to transfer into CS from other MS programs at Northwestern.

Any petition to transfer into the MS degree program in CS must be approved by both the Director of Graduate Studies for the student's current degree program and the Director of Graduate Studies for the CS Department. The student will need a strong recommendation from the current advisor, and we will confer with this advisor during the evaluation of the request.

Transfer is not guaranteed.

If approved, **transfers may require one or more additional quarters of study**, and we will require evidence of good progress already made in the original degree program as we consider the transfer request.

Transfers to Computer Science must meet the program requirements for establishing appropriate background described in Section 2.3 of this Manual.

Transfer requests are accepted for review after the student has demonstrated success as evidenced by **at least one quarter of letter-graded work** in the current degree program and, at the earliest, transfer requests may be placed in the 2nd (typically Winter) quarter - to be effective starting in the 3rd (typically Spring) quarter of their first year.

A student should request a program transfer no later than the date by which the students declare their degree plan: May 1 of the academic year of their admission, at the latest. In exceptional cases, requests for transfers will be considered after this date, however, they will be subject to extra review by the student's advisor, the Graduate Committee, and the Director of Graduate Studies.

Students will not be considered for transfer until after they complete at least one quarter of letter-graded work in the program to which they were admitted.

Requests for program transfer should be signed by the students' academic advisor and submitted to the CS Graduate Student Affairs Office. It will be forwarded to the DGS for evaluation. The DGS will take various factors into account, including, but are not limited to:

- Success in the original program of study or track to which the student was admitted.
- The expected ability of the student to successfully complete graduate work in the desired program of study or track. Relevant evidence includes transcripts and work experience.

The justification provided by the student for requesting a transfer. This justification must be based on something more substantial than a simple desire to change the title of the degree.

2.7 Ad-Hoc Combined MS / PhD Degree

The Graduate School allows students in one PhD degree program to pursue a secondary MS in another program. The details are given here:

<https://www.tgs.northwestern.edu/academic-policies-procedures/policies/ad-hoc-combined-degrees.html>

Note that this must be applied for and approved by both departments in advance.

2.8 Part-time Enrollment: Limited or Prohibited

All PhD students and most MS students must maintain full-time study throughout their Computer Science degree programs (**no fewer than three and no more than four course units of credit per quarter**, as defined by The Graduate School <https://www.tgs.northwestern.edu/academic-policies-procedures/policies/general-registration-policies.html#fulltime>).

Only USA citizens and permanent residents in the CS Master's degree programs be enrolled part time, because the United States government does not grant student visas for part-time graduate study. For more information, consult your academic advisor and Christopher Riesbeck (c-riesbeck@northwestern.edu), the CS Dept. MS Degree Program Director.

2.9 Pursuing a PhD After Being Admitted to the MS Program

Students admitted to the MS degree programs in CS at Northwestern generally cannot enter the PhD programs in CS. The surest, most sensible path for entry into the PhD program is to apply to the PhD program itself rather than entering through the MS program. However, sometimes a faculty member may decide to formally invite a successful MS student to transfer into the PhD program. The faculty member must notify the CS Director of Graduate Admissions of this invitation before the CS department will consider a student's petition to transfer.

MS students are required to complete at least 2 quarters of classes in the MS-only program before they can be considered for a transfer into the PhD program. If a student is planning to apply to continue with the PhD program he/she should first contact the CS Department Student Affairs Office (csgrad@northwestern.edu) to learn the correct process for this unusual transfer. Each student's case will be evaluated subject to the same procedures and standards that apply to external PhD applicants, but MS-to-PhD transfer students are ineligible for the first-year fellowships that ordinarily support new PhD students.

2.10 Probation, Exclusion, and Appeal Processes

The Graduate School (TGS) may place a graduate student on probation for failure to meet academic integrity standards (*e.g.* cheating on coursework), failure to meet all the requirements for academic progress (*e.g.* maintaining a minimum of 3.0 GPA), or for failure to reach milestones related to project or thesis work. Students placed on probation by TGS receive an email or letter to formally notify them of probationary status, the reason for that status, the actions the student must take to leave probationary status, and specific deadline dates for those actions.

Despite its dire implications, probation is meant to be a strong motivation rather than a punitive action. It is a formal, top-priority alert that you must take immediate corrective actions to continue in your degree program. Most probation notices allow a student only one or two quarters to resolve the problem before dismissal, but a student may formally petition TGS for an extension by supplying suitable and convincing reasons. Failure to remove probationary status before the deadlines given may ultimately result in exclusion from The Graduate School and the respective degree program.

Once a MS student is placed on probation, the CS department reserves the right to review the student's case and subject the student to additional requirements and penalties during probation as relates to their standing in the CS degree program including, but not limited to, loss of funding and/or exclusion from the CS graduate program. For more information on probation and appeal processes for probation, please refer to The Graduate School requirements for satisfactory academic progress:

<http://www.tgs.northwestern.edu/about/policies/satisfactory-academic-progress.html>

3.0 PhD Program in Computer Science

This section covers the official **Milestones (3.1)** in a PhD student career and the **Registration (3.2)** requirements mandated by Northwestern University and the CS Department for each year. In addition to the requirements outlined below, each PhD student and advisor will declare and follow a ‘track’ with its own additional requirements. [See Section 4](#) (Doctoral Degree Tracks) of this manual for details.

3.1 Milestones

This section outlines the set of milestones that must be passed in the Computer Science doctoral degree programs. Any student not meeting the milestones will be considered not in good standing and therefore will be ineligible for fellowships, traineeships, teaching or research assistantships, and scholarships. Students who do not meet published requirements of satisfactory academic progress may be excluded from The Graduate School (TGS). Students who have taken time off for family or other approved leave will have appropriate accommodations made to adjust their milestones.

Student may view these milestones and the deadlines for completion in the Graduate Student Tracking System (GSTS). After logging into the GSTS Dashboard, the list of milestones can be viewed under “Show Profile > Milestones.”

For additional information, see TGS PhD Degree Requirements webpage and TGS Satisfactory Academic Progress webpage:

- <http://www.tgs.northwestern.edu/about/policies/phd-degree-requirements.html>
- <http://www.tgs.northwestern.edu/about/policies/satisfactory-academic-progress.html>

3.1.a Selecting an Academic Advisor for the PhD Dissertation:

PhD students are required to have a permanent academic advisor by the end of their third quarter (typically spring quarter). Every PhD student must have an academic advisor that is willing to serve as their advisor and who has an approved plan for funding. **The advisor must have an academic appointment** in CS and may include co-advising with faculty with a courtesy appointment in CS.

Each new incoming PhD student is assigned an initial academic advisor (a CS faculty member) at the time of admission. This initial academic advisor assists with planning the first academic quarters of study, and help acquaint the new student with active research groups within the department. This initial is most likely a faculty member with research interests closest to those stated in the student’s application, and therefore a strong candidate for serving as the student’s eventual academic advisor, **but** the student is **not required** to select the initial advisor as their permanent academic advisor.

The student’s academic advisor will serve as the primary contact with the CS Department, and should be chosen to match the student’s academic program of study and doctoral degree track (see Section 4).

If a PhD student decides to change advisors at any point in time during his/her studies, the student must first consult with his/her current advisor, and confer with the CS Dept. Director of Graduate Studies () for assistance.

Prior to course registration each quarter, each PhD student should obtain their academic advisor’s approval for the study plan for the list of courses they will request from the Registrar. Conferring with your advisor in this way helps ensure all courses are appropriate for your research and degree requirements for your ‘track’ in the PhD program.

All students receiving financial aid in the form of fellowships, research assistantships, or teaching assistantships must register as full-time students. The normal full-time program of graduate study is three units per academic quarter, and the maximum permitted is four units.

3.1.b Admission to Candidacy:

Admission to candidacy requires meeting the **academic requirements** of the chosen doctoral degree track, **and passing the Qualifying Exam** of that track as described in Section 4 of this Manual.

As stated in the TGS PhD Degree Requirements webpage noted above, a PhD student must be admitted to candidacy **by the end of the third year of study**, which falls on the last date of the **12th academic quarter**. A student failing to meet this milestone will be considered not in good academic standing, and therefore will be placed on academic probation, as per TGS Satisfactory Academic Progress webpage noted above.

3.1.c Qualifying Examination:

When you and your advisor believe you are ready to take the Qualifying Exam for your chosen doctoral track, let **Graduate Affairs Coordinator (judith.hernandez@northwestern.edu) in CS Department Student Services Office (Mudd Hall, Room 3.546)** help you to schedule an exam time, to reserve a room if necessary, and to complete and submit the qualifying exam forms to TGS. The course requirements and the content of qualifying exams will vary across different Programs of Study within the department, as specified in Section 4.

3.1.d Prospectus (Dissertation Proposal):

Students must have a prospectus (or equivalently, a dissertation proposal) approved by the student's faculty 'proposal/prospectus committee' (details below) **no later than the end of the fourth year of study**, which falls on the last date of the **16th academic quarter**. A student failing to meet this milestone will be considered not in good academic standing and therefore will be placed on academic probation, as per TGS Satisfactory Academic Progress Guidelines (see link in [Section 3.1](#)).

When you and your advisor are ready to schedule your Prospectus / Proposal for your chosen doctoral track, let **Graduate Affairs Coordinator (judith.hernandez@northwestern.edu) in CS Department Student Services Office (Mudd Hall, Room 3.546)** help you to schedule an exam time, to reserve a room if necessary, and to complete and submit the Prospectus / Proposal forms to TGS.

Prospectus / Proposal Committee: The department recommends forming the proposal / prospectus committee well ahead of the prospectus / proposal exam date, as the committee can guide the student in sensible preparations and help minimize missteps and aimlessness.

Please use committee-formation as an opportunity to build ongoing research discussions with professors in your research area (<https://www.mccormick.northwestern.edu/computer-science/research/>), including those in other departments and universities world-wide. A strong committee can focus and accelerate a PhD students research interests in the most promising and productive directions. Reach out to research colleagues; read their work, build professional conversations by email, at conferences, and in person. Ideally, your prospectus / proposal committee members will continue as your PhD defense committee members as well.

Use GSTS entries (<https://www.tgs.northwestern.edu/academic-policies-procedures/gsts.html>) to build your committee; it can send formal invitations and record accepted members as part of progress-recording needed by the CS Department and TGS.

The ‘proposal/prospectus committee’ consists of a minimum of three individuals with expertise in the research work the student will present. At least two members of this committee, including the committee chair, must be members of the Northwestern University Graduate Faculty, as explained here: <http://www.tgs.northwestern.edu/resources-for/faculty/>).

In addition, at least two members, including the committee chair or at least one of a pair of co-chairs, must be full-time faculty (not courtesy appointments) in the CS Department. See [Section 4](#) of this Manual for any additional committee requirements for the chosen doctoral degree track.

3.1.e Dissertation and Defense

Every PhD candidate is required to prepare a dissertation that presents substantial evidence of original and significant research supported by citations, in full compliance with TGS PhD Requirements (<https://www.tgs.northwestern.edu/academic-policies-procedures/policies/phd-degree-requirements.html>), and the “Dissertation Formatting Guidelines” available here: <http://www.tgs.northwestern.edu/documents/policies/dissertation-format-guidelines.pdf>

Students must schedule and prepare for their Dissertation Defense (also known as PhD Final Exam) by duplicating much of the same procedure used for their Prospectus/Proposal (above), including: agreement with advisor, and conferring with the **Graduate Affairs Coordinator (judith.hernandez@northwestern.edu) in CS Department Student Services Office (Mudd Hall, Room 3.546)** help you to schedule an exam time, to reserve a room if necessary, and to complete and submit the Dissertation/PhD Defense forms to TGS. Specifically:

--Four weeks prior to the PhD Final Exam date, the student submits the CS Examination Request form signed by all members of the committee. The student and advisor must confirm completion of all the degree requirements of the chosen doctoral degree track, of the CS Department as detailed in this manual, and all TGS requirements: <https://www.tgs.northwestern.edu/academic-policies-procedures/policies/phd-degree-requirements.html>)

--The Graduate Affairs Coordinator posts and advertises a formal announcement of the student’s Final Exam / Dissertation Defense, encouraging public attendance. The Registrar, TGS, and CS check the student’s records for any missing documents, grades, *etc.*, that need to be completed for the Final Exam and awarding of the PhD degree in Computer Science. This file and the *Report of the Committee on Examination of Candidate form* is given to the student’s advisor prior to the Final Exam and must be in the examination room for reference (or by e-mail for online-only defenses during COVID-19 restrictions). Upon conclusion of the Final Exam, this *Report* must be signed by all of the committee members (or e-signed during COVID-19 restrictions). Then, the advisor immediately returns the completed and signed paperwork to the Graduate Affairs Coordinator in CS Student Services Office.

Once the PhD dissertation has been approved by the dissertation committee, and the student has completed all subsequently required edits and revisions, then the student must submit the dissertation online via the ProQuest website: <http://www.etdadmin.com/cgi-bin/home>.

At this point, a TGS Student Services representative reviews the formatting and confirms via email that the dissertation is acceptable or notifies the student if changes need to be made before granting the PhD degree.

3.1.f Teaching Requirement

In February 2014, the McCormick School of Engineering approved the following PhD teaching requirement effective with the PhD class matriculating in Fall 2014:

- (1) All students earning a PhD degree from a McCormick program must meet

one of the following requirements:

- (a) Serve as an instructor of an undergraduate course, or
 - (b) Serve as a full-time teaching assistant (20 hours a week) in an undergraduate course for at least one quarter, or
 - (c) Serve as a part-time teaching assistant (6-8 hours a week) in an undergraduate course for at least three quarters, or
 - (d) Meet a Departmental teaching requirement that has been approved by The Graduate School.
- (2) Teaching assistant positions must involve some face-to-face contact with students (office hours, lab or problem session, lecturing) in addition to grading.

In addition to options (1a), (1b), and (1c) listed above, PhD students in the CS Department can choose to satisfy the teaching requirement by registering for two quarters of *Teacher Trainee* (TT) duties. Each TT quarter's work assignment involves a half-time teaching assistantship with some additional class involvement beyond grading homework or staffing a help desk. Typically, during the academic quarter, the TT prepares and presents one class lecture or designs one new homework assignment.

First-time TT students should register for GEN_ENG 545 (Teaching Experience) to receive credit for their effort. Second-time TT students should register for GEN_ENG 546, which is zero credit but does place on their transcript recognition of their contribution.

Note that a PhD student cannot be both a teaching assistant and a TT in the same academic quarter. Also, registrations in GEN_ENG 545 and GEN_ENG 546 are only for TT students.

Also note that a student **will not be able to graduate until one of the teaching requirements listed above is fulfilled**. When a student files his/her thesis proposal, the student must also file a form listing what part of the teaching requirement has been fulfilled at that point and what, if any, teaching requirement has yet to be fulfilled.

3.2 Registration and Course Requirements

3.2.a The Graduate School Requirements

Starting in 2019, detailed TGS requirements for PhD degrees are easily available online at:

<https://www.tgs.northwestern.edu/academic-policies-procedures/policies/phd-degree-requirements.html>

Students receiving financial support (assistantships or fellowships) must be registered as full-time students (3-4 units), including summer quarters. Such students must also maintain satisfactory academic progress, as per TGS Satisfactory Academic Progress Guidelines (<https://www.tgs.northwestern.edu/academic-policies-procedures/policies/satisfactory-academic-progress.html>)

Key requirements include:

- GPA: PhD students must maintain a cumulative grade point average of B (**3.0 GPA**) or higher.
- Full Time Registration
 - Full-time registration is no less than three (3) units (courses) per quarter and no more than four (4) units per quarter. Typically, students in most Programs of Study will take three courses per academic quarter, with an optional 4th 'Independent Study (COMP_SCI 499 Projects)' or TGS 590 Research course.

- Although TGS requires a minimum of 9 letter-graded graduate level courses, **the PhD program in Computer Science requires a minimum of 15 letter-graded graduate level courses**).
- Students who have not completed the CS program’s coursework requirements and need to maintain a full-time registration but register for fewer than 3 credits of coursework in one quarter, should register for COMP_SCI /COMP_ENG 590 Research for the remaining credits.
- --Students that are not enrolled full-time in letter-graded coursework should instead register for COMP_SCI 590 *Research* to maintain full-time study.
Refer to the TGS General Registration Policies webpage for details:
<http://www.tgs.northwestern.edu/about/policies/general-registration-policies.html>
- After meeting the requirement for 15 letter-graded graduate-level courses, students receiving funding should begin registering for TGS 500 and not COMP_SCI 590. TGS 500 carries a lower tuition rate.
- PhD students staying at NU in the summer and are receiving funding can also register for TGS-500 regardless of whether they have completed all coursework requirements.
- Doctoral students who have met both the graduate-level courses requirements but are not receiving funding during a quarter may register for TGS 512.
This is a low-cost course designed to maintain student’s full-time enrollment status.
- **‘Continuous Registration’**: All PhD students must be registered at Northwestern University in each of the Fall, Winter and Spring terms until all degree requirements have been completed, including dissertation submission to The Graduate School, as specified in the TGS General Registration Policies link above.

Students unable to maintain continuous registration can submit petition TGS to be granted Leave-of-Absence for any sensible reasons including: Medical Leave, Family Leave, and General Leave:

<https://www.tgs.northwestern.edu/academic-policies-procedures/policies/leaves-of-absence.html>

NOTE: The Graduate School (TGS) has **removed its “residency” requirements** effective Fall 2019:

<https://www.tgs.northwestern.edu/about/news/2019/10/change-to-tgs-residency-policy.html>

3.2.b Common CS Course Requirements

The CS Department requires 15 letter-graded units of graduate coursework for the PhD. Coursework includes COMP_SCI 499, but not COMP_SCI 590 (Research). At least 6 units should be at the 400 or 500 levels, not counting GEN_ENG 545 or GEN_ENG 546 (credits PhD students can earn for teaching (see Section 3.1f Teaching Requirement)).

A PhD student’s advisor or CS doctoral degree track may require more than the minimum number of courses. In such cases, the number of COMP_SCI 590 research units will be reduced correspondingly.

COMP_SCI 499 is not intended to replace or augment the required units of COMP_SCI 590 research for either the MS or PhD degrees. Computer engineering students are limited to two units of COMP_SCI 499.

GEN_ENG 519: The National Science Foundation (NSF) requires everyone being paid on NSF grant money to complete **Responsible Conduct of Research (RCR) training**. For doctoral students, this requirement is satisfied by enrolling in GEN_ENG 519. All PhD students are required to complete this training in their first year.

3.2.c Meet Requirements of one Doctoral Degree Track

Each doctoral student must complete all requirements imposed by their chosen doctoral degree track ([Section 4](#)), in addition to all requirements of the CS Doctoral program itself ([Section 3](#)).

3.2.d Petitioning for Course Credit or Substitution

A PhD student may petition to have at most six (6) CS Department course credits waived, based on graduate level courses taken previously elsewhere. This petition must include complete documentation (e.g. syllabus, assignments/projects) of the content of the course from the student's previous institution that most closely matches the CS Department course credit to be waived. The student must provide an official transcript, sent directly to the department, that shows the grade received for each course used for transfer credit.

The coordinator of this CS Department course will review the petition and make a recommendation. All such waivers are ultimately subject to the approval of the advisor and the CS Director of Graduate Studies.

3.2.e Internships during Graduate Study: The Crown Family Graduate Internship

Students who wish to take advantage of an internship opportunity are encouraged to sign up for The Graduate School General Curriculum course **CRDV 510 Crown Family Graduate Internship** (or CRDV 411 for MS students – see Section 2.2 Advising and MS Course Requirements). Written approval from the student's PhD advisor(s) is a pre-requisite for registration for this course. Students may register for this zero (0)-unit course for no more than three academic quarters and no more than two consecutive academic quarters.

Enrolling in CRDV_510 when doing an internship maintains the student in full-time status at the University and **carries no tuition cost**. Registration for CRDV_510 allows students to maintain their health benefits, permits continued deferral of student loans, enables international students to maintain full-time status required by many US visas, and helps Northwestern administration, including TGS, record graduate student progress and track our external research collaboration efforts.

For more details about the Crown Family Graduate Internship Program, contact the McCormick School's Associate Dean for Graduate Studies and Research or visit the following URL:

<http://www.mccormick.northwestern.edu/students/graduate/fellowships-internships/crown-family.html>

International students who chose to do an off-internship must also apply for Curricular Practical Training (CPT) authorization. "Off-campus" is defined as any internship that takes place outside of Northwestern University. For more information on applying for CPT, please visit the International Office's website: <http://www.northwestern.edu/international/living-working/student-employment/curricular-practical-training.html>

3.3 Probation, Exclusion, and Appeal Processes

Each quarter, students are expected to make satisfactory academic progress. Satisfactory academic progress is defined, in part, as meeting the requirements set by The Graduate School:

<http://www.tgs.northwestern.edu/about/policies/satisfactory-academic-progress.html>

Students are also expected to meet additional CS requirements for satisfactory progress, as follows:

- Students found to be guilty of academic misconduct (*e.g.* cheating on coursework, or plagiarism of research) are defined as failing to make satisfactory academic progress.
- PhD students are required to have a permanent advisor by the end of their third quarter (typically spring quarter). To continue as a student in the CS doctoral program beyond the third quarter of study, every PhD student must have an academic advisor with an appointment in CS and an approved plan for funding.

If a doctoral student has no advisor by the last day of a given quarter, or if the current advisor has notified the student and the Director of Graduate Studies of unsatisfactory research progress during a given quarter, this will constitute failure to make satisfactory academic progress, as defined by the program.

- Students are required to make satisfactory progress towards their thesis as evaluated by their thesis advisors.

Failure to meet requirements for satisfactory progress may result in The Graduate School placing a student on probation.

Students may petition to The Graduate School for an extension of a milestone's deadline if a convincing reason and evidence is provided, but cannot petition to defer probation due to missed milestones or other concerns. Note that 'probation' is not meant to be punitive, but instead as a loud and insistent warning. The purpose of Probation is to compel the student and advisor to action, to correct the undesirable situation promptly (typically within 2 quarters), return the student to good academic standing, and preclude any punitive actions by TGS or the Department. Failure to remedy the problem that keeps a student on Probation for two quarters or more may ultimately result in exclusion from The Graduate School and the respective CS degree program.

For more information on probation and appeal processes for probation, please refer to The Graduate School's guidelines here: <https://www.tgs.northwestern.edu/academic-policies-procedures/policies/satisfactory-academic-progress.html>

Once a PhD student is placed on probation, the CS department reserves the right to review the student's case quarterly, and to subject the student to additional consequences during probation as relates to their standing in the CS degree program including, but not limited to, loss of research assistantship (RA) funding, loss of departmentally funded support such as teaching assistantships (TA), loss of and/or exclusion from the CS graduate program.

Students who fail to make satisfactory academic progress according to the CS Program requirements in a given quarter will be put on probation for the following quarter. The student must use the probationary quarter to resolve the problem; to seek an alternate advisor or improve progress to receive a report of satisfactory progress with their current advisor. At the end of the probationary quarter, if the student has secured an advisor who can report satisfactory progress, the student will be removed from probationary status. Otherwise the department may make a recommendation of exclusion (dismissal) to The Graduate School. No further funding from the department or advisor will be provided to the student after the end of the probationary quarter.

4 Doctoral Degree ‘Tracks’

General PhD requirements for Northwestern University (*e.g.* graduate courses, grade requirements, deadlines to reach milestones) are discussed in Section 3 of this manual, and includes information on course requirements shared by all CS doctoral degrees.

In addition to these common requirements, every CS doctoral student and academic advisor must select a doctoral degree track leading to the PhD degree. Each track has specific requirements for the coursework, qualification exam, and dissertation prospectus required for the PhD.

In the years since these ‘tracks’ were formally organized, defined and approved by the entire CS Dept faculty, our depart has grown. Our current, enriched set ‘Research Areas’ (see:

<https://www.mccormick.northwestern.edu/computer-science/research/areas/>)

outnumber our degree ‘tracks’, but each research area requires its students to satisfy one of these tracks.

In 2020-2021 the CS Department offers:

- **Computer Systems track**
may include research areas of Systems and Networking, Security and Privacy, Programming Languages, and more.
Also collaborates closely with the Computer Engineering Program within the Electrical and Computer Engineering Department:
<https://www.mccormick.northwestern.edu/electrical-computer/academics/graduate/>
- **Computer Engineering track**
may include topics in Computer Systems, Computer Architecture, Internet of Things, and more listed in the Computer Engineering website: <https://www.mccormick.northwestern.edu/electrical-computer/research/areas/computer-engineering.html>
- **Theory track**
may include topics in Computing, Algorithms, and Applications and more.
- **Artificial Intelligence track:**
may include topics in Cognitive Systems, Machine Learning, Human-Computer Interaction. Robotics, and more.
- **Graphics and Interactive Media track:**
may include topics in Human-Computer Interaction, Graphics, Vision, Computational Photography, Robotics, assistive technologies and more.

Requirements of each PhD degree ‘track’ are described in one of the following subsections.

4.1 Computer Systems Track

This section outlines the specific procedures and requirements for a Computer Science (CS) PhD in this track. For requirements that apply to all doctoral students in CS (*e.g.* number of course credits and teaching requirements) see Section 3 of this Manual. For general requirements that apply to all Northwestern doctoral students (*e.g.* deadlines for achieving milestones, such as the qualifying exam and the prospectus), see: <https://www.tgs.northwestern.edu/academic-policies-procedures/index.html>.

Research Area Description

Research in [Systems and Networking](#), [Security and Privacy](#), and [Programming Languages](#) includes a broad range of topics, including (but not limited to) data mining, database systems, network security, programming languages, program development environments, network analysis; network protocols, peer-to-peer networks, resource virtualization and ubiquitous computing.

Affiliated Faculty

Fabian Bustamante, Simone Campanoni, Yan Chen, Alok Choudhary, Christos Dimoulas, Peter Dinda, Robby Findler, Nikos Hardavellas, Josiah Hester, Russell Joseph, Aleksandar Kuzmanovic, Gokhan Memik, Seda Memik, Eleanor O'Rourke, Jennie Rogers, Vincent St-Amour, Stephen Tarzia, Jesse Tov, and Xiao Wang.

Course Requirements

Breadth in Computer Science beyond this doctoral degree track: Before taking qualifiers, each should have taken at least one course in each of the following areas: Theory, Artificial Intelligence, and Interfaces. Courses that satisfy those requirements are listed below.

- Theory: COMP_SCI 335, 459, COMP_ENG 356, 357. We strongly recommend that students become familiar with algorithms at least to the level of COMP_SCI 336.
- Artificial Intelligence (AI): COMP_SCI 325, 337, 344, 348, 349. We strongly recommend that students become familiar with core AI and machine-learning topics as described in COMP_SCI 348 and COMP_SCI 349.
- Interfaces: COMP_SCI 330, ELEC_ENG 332, COMP_SCI 351-1, 351-2, 352, 370

Breadth in Computer Systems: The expectation for students is that they have deep knowledge of systems, in general. To that end, we expect that you will take at least **six courses in the following areas. Of these six courses, you must take at least one course in each of Operating Systems, Networking, and Compilers**, unless, for some reason, appropriate courses are not offered. Courses that satisfy the breadth requirement are listed below.

- Architecture: COMP_SCI 361, 452, 453
- **Compilers: COMP_SCI 322 (required)**
- Databases: COMP_SCI 339
- Distributed Systems: COMP_SCI 345, 455
- Languages: COMP_SCI 321
- **Networking: COMP_SCI 340, 440 (1 required)**
- **Operating Systems: COMP_SCI 343, 441, 443, 446 (1 required)**

- Parallel Systems: COMP_SCI 358, 368, 468
- Performance Analysis: COMP_SCI 410, 442, 486
- Security: COMP_SCI 350, 354, 450
- Sensor Networks: COMP_SCI 369

You need not have taken these specific courses, but you should be familiar with their concepts and content. There are often additional CS courses that may be appropriate for systems. Please consult online syllabi for these courses. With advisor approval, alternate graduate courses may be used to satisfy this requirement. Additionally, COMP_SCI 499 courses may be used with advisor approval.

Breadth Course Substitution: A student may already have satisfactory background in some area of general computer science or in computer systems, either through general knowledge or similar courses at another university. With advisor consent, one may substitute other courses. If the student feels they have satisfied any of these areas, they are encouraged to approach the relevant course coordinator for an assessment, or their advisor if the coordinator is unable to provide an assessment.

Depth in Systems: How to acquire depth in your area will be determined by your advisor. Generally, it takes the form of taking additional graduate-level courses and doing guided research and reading.

Qualifying Exam

The purpose of the Systems Qualifying Exam is to determine whether you have the essential prerequisites of being a doctoral-level researcher, namely:

- *Have you acquired a breadth of knowledge in computer science and computer systems?
Do you have a depth of knowledge in your research area?*
- *Can you do research?*
- *Can you present your research well, both in written form and orally?*
- *Can you defend your research?*
- *Can you think and discuss research extemporaneously?
In other words, can you think on your feet?*

If you do not meet these prerequisites, you will not pass the exam. In some cases, such as if you fail due to insufficient breadth or depth, you may be able to retake the exam. **The exam can be retaken only once.**

You should ask your advisor if you are prepared to take the systems Qualifying Exam. If he or she agrees, you should form a committee consisting of your advisor and at least two other Systems faculty members. Non-Systems faculty are also appropriate in some situations: you should ask your advisor. It is your 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. Exams are private: only your committee and you are in the room.

The Qualifying Exam begins with your presentation of a significant piece of research that you have done. One week before the exam, you must supply the committee with a paper about the work. A conference or workshop talk/paper is ideal. The committee will ask you tough questions about the content of the presentation and the work. The purpose of this part of the exam is to determine whether you are capable of doing research, presenting it, and defending it well.

In the next stage of the Qualifying Exam, each of your committee members will have the opportunity to ask you questions. Any technical question related to computer science is fair; however, the focus will be on

systems. Many faculty members prefer to start with a question designed to test your breadth or depth of knowledge in computer science. The committee may follow up on such questions, probing to find out what you know and what you don't know. The committee is particularly interested in how you respond to questions in areas you don't know or that you don't know the answer to. This is a common situation in doing research and the committee wants to know how you respond to it. It is appropriate and encouraged to ask questions of the committee. The committee also wants to see how you respond in an intellectual dialog.

After the exam, the committee will deliberate. Four outcomes are possible:

- **Pass.** The student successfully completed of the qualifying exam.
- **Conditional Pass.** While the student did well on the majority 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.
- **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 prior to The Graduate School's deadline.

The Qualifying Exam can be retaken only once.

A student cannot be admitted to candidacy without passing this exam.

Thesis Committee

The thesis is judged by a committee that is chosen by the student in consultation with the student's advisor. The committee commits to reading and commenting on the thesis proposal, attending the thesis proposal defense, providing guidance and advice as the thesis work progresses, reading and commenting on the dissertation, and attending the thesis defense.

The committee must consist of at least three faculty members in the CS Department that are also faculty in The Graduate School and at least one external committee member. This requirement is specific to Systems in Computer Science and supersedes the minimum committee required by The Graduate School.

The committee must include the student's advisor, who is generally the chair of the committee. In most cases, the faculty member should be drawn from the Systems Group, although exceptions can be made.

The external committee member should be from outside Northwestern and should hold a PhD.

Exceptions can be made in consultation with the student's advisor, but a member external to the CS Department is required.

It is the responsibility of the student to form the committee and to schedule it for the proposal and dissertation defenses.

Thesis Prospectus

The thesis prospectus is a document written by the student that describes the proposed thesis. The proposal is generally 10-15 pages long and prepared in consultation with the advisor. It must contain:

- Thesis statement. What is the specific research problem being addressed and what is the proposed solution?
- Related work. What have other people done in this area and why is the proposed solution new?
- Prior work. What work has the student done already that suggests that he is capable of addressing the problem?

- Work plan. What the student proposes to do. Of course, research often takes one in unplanned directions. The point of the work plan (and schedule) is to describe what path is currently expected.
- Expected contributions. What artifacts and results are expected?
- Schedule. When will the major elements of the work plan be completed? Notice that writing the dissertation is an important task.

The document must be given to the members of the committee **at least one week** before the proposal defense. It is not necessary to make the proposal available online.

The proposal defense is an open, advertised, public talk, given in front of the committee and any members of the CS Department who care to attend. The open segment of the proposal defense is followed by a closed segment with only the committee and the student.

The student must schedule the defense, making sure all his/her committee members are there physically or via phone conference. The student must assure that the proposal defense is advertised to the CS Department at least one week before it occurs. It will specifically be posted as a thesis proposal talk.

The talk is a summary of the thesis proposal and a defense of its ideas. It's the final sanity check before the thesis work begins and is very important.

Generally, proposal talks last about 50 minutes, although there is no set time. Only clarification questions are permitted during the talk. After the talk, each member of the committee, in an order determined by the chair, will ask in-depth questions. Once the committee is finished, further questions will be solicited from the audience.

After public questions have been exhausted, 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.

If the student passes the thesis proposal defense, we will immediately inform The Graduate School that the student's "thesis prospectus has been approved."

Thesis and Defense

The dissertation document must be complete, in draft form, before the dissertation defense can take place. It must be provided to the members of the committee at least one week before the defense is to take place. Generally, the advisor will read and comment on the dissertation draft well before then.

The procedures for the dissertation defense are similar to those of the proposal defense. The defense is an open, advertised, public talk, given in front of the committee and any members of the CS Department who care to attend. The open segment of the defense is followed by a closed segment with only the committee and the student.

The student must schedule the defense, making sure all the committee members are there physically or via phone/video. The student must assure that the defense is advertised to the CS Department at least one week before it occurs. It will specifically be posted as a thesis defense talk.

The defense talk is a summary of the thesis work and a defense of its ideas and results. Generally, a defense talk lasts about 50 minutes, although there is no set time. Only clarification questions are permitted during the talk. After the talk, each member of the committee, in an order determined by the chair, will ask in-depth questions. Once the committee is finished, further questions will be solicited from the audience. After public questions have been exhausted, 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 dissertation defense. In either case, the chair of the committee will inform the student describing the results of the committee's deliberation and what additional work, if any, is to be done.

If the student passes the thesis defense, we will report this to The Graduate School. At this point, the student needs only to deliver the final version of his/her dissertation in order to graduate.

Publishing a Technical Report of the Thesis

After a successful defense, the committee will, within 2 weeks, send comments on the dissertation draft to the student. The student will then complete any additional work and make the necessary changes to the dissertation. The student must deliver the final dissertation in two ways. First, he/she must turn it in to the library. Second, **the student is expected to publish the thesis as an CS Department technical report.** The purpose of publishing the dissertation as a technical report is to make the thesis widely available to the public.

Additional Expectations and Requirements

Systems research necessarily involves computers and networks, often many of them. This research infrastructure does not manage or configure itself, nor does the systems support group support all aspects of research computing. Systems students are expected to help in configuring, updating, and maintaining the infrastructure for the Systems Group's overall benefit.

Good systems researchers build systems; they don't just talk about or simulate them. You must know at least one low-level systems programming language such as C or C++. You must know at least one high-level application programming language such as Java, Perl, Python, Scheme, Lisp, ML, or Matlab.

If you haven't written a 1000+ line program in the language, you don't know it. If you haven't programmed on a multi-person project, you haven't programmed. You should look at the websites of the various labs that comprise the Systems Group to get a sense of the level of programming you should be able to implement.

By the end of your second year, we expect that you will have made significant research contributions that will also serve as a guide for the remainder of your time in the program.

4.2 Computer Engineering (CE) Track

This track is for CS PhD students interested in the research directions offered by Northwestern University's [Computer Engineering \(CE\)](#) program, a joint program between the Department of Computer Science (CS) and the Department of Electrical and Computer Engineering (ECE). CS students in the Computer Engineering track are admitted by CS, have CS as their home department, and can receive MS and PhD degrees in Computer Science under the advising of faculty affiliated with the CE program.

Research Area Description

Computer Engineering covers a diverse set of research areas in which our faculty are actively pursuing. These areas include, but are not limited to, computer architecture, computer systems, operating systems, compilers, parallel systems, distributed systems, high-performance and parallel computing, distributed computing, data mining, artificial intelligence, machine learning, big data science and applications, integrated circuits/VLSI, mixed-signal circuit design, design automation, formal methods, embedded and real-time systems, mobile and wearable computing, internet of things, cyber-physical systems, database systems, and reconfigurable systems. For more details please browse the web pages of individual faculty members.

Affiliated Faculty

Ankit Agrawal, Nabil Alshurafa, Simone Campanoni, Yan Chen, Alok Choudhary, Peter Dinda, Jie Gu, Nikos Hardavellas, Larry Henschen, Josiah Hester, Russell Joseph, Wei-keng Liao, Gokhan Memik, Seda Memik, Alan Sahakian, Stephen Tarzia, Chi-Haur Wu, Hai Zhou, Qi Zhou. For an up-to-date list please see <https://www.mccormick.northwestern.edu/electrical-computer/research/areas/computer-engineering.html>.

Degree Requirements

The requirements for this 'track' are specified entirely within the CE Graduate Study Manual (see: <https://www.mccormick.northwestern.edu/electrical-computer/documents/graduate/ce-graduate-manual.pdf>)

4.3 Theory Track

This section outlines the specific procedures and requirements for a Computer Science (CS) PhD in theory-related topics. For requirements that apply to all doctoral students in CS (e.g. number of course credits and teaching requirements) see Section 3 of this Manual. For general requirements that apply to all Northwestern doctoral students (e.g. deadlines for achieving milestones, such as the qualifying exam and the prospectus), see: <https://www.tgs.northwestern.edu/academic-policies-procedures/index.html>.

Research Area Description

[Theoretical Computer Science](#) looks at the fundamental questions of computation by creating formal models of computation and understanding the resources needed to solve general and specific algorithmic questions. TCS studies the design of efficient algorithms and the computational complexity of various computational tasks that arise in computer science, statistics, economics, and other sciences.

Affiliated Faculty

Anindya De, Jason Hartline, Ming-Yang Kao, Samir Khuller, Konstantin Makarychev, and Aravindan Vijayaraghavan.

Course Requirements

Each student in the CAA Group must earn at least a B+ in 3 courses from the following list:

- COMP_SCI 496 - Graduate Algorithms
- COMP_SCI 496 - Computational Complexity
- COMP_SCI 496 - Mechanism Design
- COMP_SCI 496 - Approximation Algorithms
- COMP_SCI 496 - Theoretical Machine Learning

The student can substitute one of these courses with a different graduate-level theory course, with the permission of the committee.

Qualifying Exam

The purpose of the CAA Group Qualifying Exam is to determine whether you have the essential prerequisites for being a doctoral-level researcher, namely:

- *Have you acquired sufficient breadth of knowledge in computing and algorithms?*
- *Do you have a depth of knowledge in your research area?*
- *Can you present your research (or survey a research topic) well, both in written and oral form?*

The Qualifying Exam Committee consists of your advisor and at least two other CS Department faculty (who can be substituted by faculty from other departments at Northwestern with the consent of your advisor). The Qualifying Exam will typically take two hours in total.

You have two options for the Qualifying Exam: (a) you can present the results of research you have done (a conference or journal paper is ideal); or (b) you can present an in-depth survey of a research topic assigned to

you by your advisor.

The topic of the presentation should be discussed with your advisor. Fourteen days before the exam, you must supply the committee with a document about the work you will present. In case you are presenting the results of your research, (option (a)) a full draft of the paper will suffice. The exam will begin with your presentation. This portion of your exam is open to the rest of the department. The committee will ask you questions about the content of the presentation and the work.

The next stage of the exam is closed, with only you and your committee members in the room. Each of your committee members will have the opportunity to ask you technical questions related to your research area or the core courses you have taken. After the exam, the committee will deliberate. Four outcomes are possible:

- **Pass.** The student successfully completed of the qualifying exam.
- **Conditional Pass.** While the student did well on the majority 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.
- **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 prior to The Graduate School’s deadline.

The Qualifying Exam can be retaken only once. A student cannot be admitted to candidacy without passing this exam.

Thesis Committee

There are no requirements beyond those specified by the CS department and The Graduate School.

Thesis Prospectus

The prospectus must be approved by a faculty committee. A minimum of three individuals must serve on the prospectus committee. Upon formation of the prospectus committee, the student should submit the PhD Prospectus form through The Graduate School forms.

The prospectus document should be submitted to the committee at least **one week before the presentation** to allow time to read and critique it.

The prospectus defense is an open public talk, given in front of the PhD thesis committee and any members of the Northwestern community who care to attend. The talk should last approximately 50 minutes. The student will be informed whether he/she has passed or failed on the day of the proposal defense. In either case, 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.

Thesis and Defense

The thesis document should be submitted to the committee at least **two weeks before the presentation** to allow time to read and critique it.

The procedures for the PhD thesis defense are similar to those of the proposal defense. The defense is an open public talk, given in front of the committee and any members of the CS Department who care to attend. The talk is a summary of the PhD thesis work and a defense of its ideas and results.

After a successful thesis defense, your committee will, within 7 days, send comments on the thesis draft to you. You will then complete any additional work and make the necessary changes to the thesis. You must deliver the finalized thesis to The Graduate School.

Additional Expectations and Requirements

You are expected to finish your PhD study in 4 - 5 years. Generally, you should make every effort to follow the following schedule:

1. Find a faculty member to be your PhD advisor no later than Spring Quarter of the first year;
2. Take the Qualifying Exam by Spring Quarter of the second year, and no later than the end of your third year;
3. Take the PhD thesis proposal defense by Spring Quarter of the third year of study.

In choosing an advisor, you should take the initiative to discuss with any faculty member who interests you upon your joining Northwestern University or even before then. You should engage in research as soon as possible, but the timing will depend on your academic background and should be decided in consultation with your advisor. In your first year or two, you will also be taking classes, but doing research will determine your success as a graduate student.

By the end of your 2nd year, you will take the CAA Group qualifying exam, which is described in detail below. The next step after the qualifying exam is to find a PhD thesis topic. A thesis proposal is presented after you have done substantial work, and the potential research contributions can be envisioned and defended. The final step is to write and defend a PhD thesis.

Students are encouraged to seek out summer funding of their own in the form of internships at quality research laboratories, if this is deemed to enrich their learning experience.

4.4 Artificial Intelligence Track (AI)

This section outlines the specific procedures and requirements for a Computer Science (CS) PhD in Artificial Intelligence (NOTE: formerly ‘Cognitive Systems’). For requirements that apply to all doctoral students in CS (e.g. number of course credits and teaching requirements) see [Section 3](#) of this Manual. For general requirements that apply to all Northwestern doctoral students (e.g. deadlines for achieving milestones, such as the qualifying exam and the prospectus),

see: <https://www.tgs.northwestern.edu/academic-policies-procedures/index.html>.

Research Area Description

Work in this area focuses on: understanding how minds work, from a computational perspective; Creating systems for helping people learn better and perform better using principles of Cognitive Science, [Artificial Intelligence and Machine Learning](#) techniques, [Robotics](#) and more.

Affiliated Faculty

Brenna Argall, Larry Birnbaum, Oliver Cossairt, Douglas Downey, Ken Forbus, Kristian Hammond, Thomas Hinrichs, Ian Horswill, Jessica Hullman, Han Liu, Bryan Pardo, Christopher Riesbeck, Michael Rubenstein, Sara Owsley Sood, and Haoqi Zhang.

Course Requirements

There are no specific coursework requirements beyond those specified by the CS department and The Graduate School.

Coursework will vary depending on 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.

While the following courses are not required, each student should be conversant with the material in these courses, as their content is assumed knowledge in the Artificial Intelligence 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

Qualifying Exam

The Artificial Intelligence Qualifying Exam is a one-day written exam, traditionally the Monday or Tuesday after Finals week of Spring Quarter. The exam is open-book, open-notes, and graded anonymously. Graduate students must take the exam at the end of their second year.

After the exam, the committee will deliberate. Four outcomes are possible:

- **Pass.** The student successfully completed of the qualifying exam.

- **Conditional Pass.** While the student did well on the majority 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.
- **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 prior to The Graduate School’s deadline.

The Qualifying Exam can be retaken only once. A student cannot be admitted to candidacy without passing this exam.

Thesis Committee

There are no requirements beyond those specified by the CS Department and The Graduate School.

Thesis Prospectus

All graduate students will write a thesis proposal before undertaking serious work on their PhD research. The written proposal must be approved by a AI Group-approved thesis committee. After approval, the student must give a public presentation of the thesis proposal.

The prospectus document should be submitted to the committee at least **one week before the presentation** to allow time to read and critique it. The oral component consists of a formal presentation of the proposed research to the thesis committee, as one might give at a departmental colloquium. You should plan the presentation for 45 minutes, with another 15 - 45 minutes for questions.

Thesis and Defense

Two presentations are required. The actual defense of the thesis is an oral presentation, open only to faculty and other members of the University with PhD degrees. A public presentation of the thesis is required after the defense is passed.

The required format of the final thesis is governed by The Graduate School. Please consult their website for details.

The thesis document should be submitted to the committee at least **two weeks before the thesis defense** to allow time to read and critique it.

Additional Expectations and Requirements

It is crucial to realize that, unlike undergraduate study, graduate school is primarily about research, not courses. We expect you to do well in your courses, naturally. However, we expect you to become involved in research starting in your first year. Independent-study projects are a good way to explore what kind of work you want to become involved in or just to wrap your head around something different if you are already involved in a project. Instead of a master’s thesis, we encourage students to publish research in conferences and journals, starting early in the graduate career.

4.5 Graphics and Interactive Media (GIM) Track

This section outlines the specific procedures and requirements for a Computer Science (CS) PhD in this track. For requirements that apply to all doctoral students in CS (*e.g.* number of course credits and teaching requirements) see Section 3 of this Manual. For general requirements that apply to all Northwestern doctoral students (*e.g.* deadlines for achieving milestones, such as the qualifying exam and the prospectus), see: <https://www.tgs.northwestern.edu/academic-policies-procedures/index.html>.

Research Area Description

This doctoral degree track can include [Human-Computer Interaction](#), [Computer Graphics](#), [Robotics](#), audio processing, human computation and social computing, collaborative and assistive robotics, and more.

Affiliated Faculty

Brenna Argall, Larry Birnbaum, Jeremy Birnholtz, Oliver Cossairt, Elizabeth Gerber, Darren Gergle, Nick Diakopoulos, Kristian Hammond, Michael Horn, Ian Horswill, Jessica Hullman, Eleanor O'Rourke, Bryan Pardo, Anne Marie Piper, Michael Rubenstein, Jack Tumblin, Sarah Van Wart, Uri Wilensky, Marcelo Worsley, and Haoqi Zhang.

Course Requirements

There are no specific required courses for our doctoral students. However, all are required to demonstrate proficiency in the subfields listed below.

- Fundamentals of Programming: COMP_SCI 111+ COMP_SCI 211+ COMP_SCI 214
- Theoretical Computer Science (1 course): COMP_SCI 335, COMP_SCI 336
- Systems (2 courses drawn from any of the following categories)
 - Computer architecture: COMP_SCI 361
 - Databases: COMP_SCI 339
 - Networking: COMP_SCI 340
 - Operating systems: COMP_SCI 343
 - Programming languages: COMP_SCI 321, COMP_SCI 322
- Graphics or media (1 course from any of the following categories)
 - Audio, visual or multimedia processing: COMP_SCI 351-1, COMP_SCI 351-2, COMP_SCI 352
 - Computer games: COMP_SCI 370, COMP_SCI 396
- Cognitive and social systems (1 course from any of the following categories)
 - Artificial Intelligence: COMP_SCI 348, COMP_SCI 349, COMP_SCI 371, COMP_SCI 474
 - Cognitive science: An advisor-approved cognitive science course

- Social science: An advisor-approved social science course
- Learning sciences: COMP_SCI 313

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 Director of Graduate Studies for Computer Science, be demonstrated through significant work experience in the software industry. Students entering the CS doctoral degree 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 should be resolved by taking the appropriate course at Northwestern University. Students should discuss with their advisors to identify appropriate courses to take. Course numbers shown are courses offered at Northwestern University that would satisfy the requirement, but other courses may also apply.

It is the responsibility of the student to make a case for how each course taken at a prior institution satisfies a requirement. This may include providing their transcript, the syllabus of each class in question. This case should be made to the student's academic advisor. If there is any question about the applicability of a course after discussion with the advisor, the case should be brought to the Director of Graduate Studies for Computer Science (dgs@cs.northwestern.edu).

Students entering with an undergraduate degree in computer science should complete this work in their first year, those with undergraduate degrees in other areas should complete this within two years.

Qualifying Exam

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

What the exam consists of:

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. The paper submitted to the committee should be a final version, approved by the student's advisor. In certain cases, a committee may agree to accept a dissertation proposal in lieu of a completed project paper. The paper should be submitted to the committee at least **two weeks before the presentation** to allow time to read and critique it.

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 probe the student's analytical and research skills, although the committee may ask whatever questions it feels are appropriate.

When to take the exam:

The expectation is that the qualifying exam will be completed prior to the start of the student's third year in the program. In exceptional cases, this may happen later, subject to the deadlines specified by Northwestern's Graduate School on how late in the degree the exam may be taken without being placed on academic probation or being excluded from the graduate program.

Outcomes:

After the exam, the committee will deliberate. Four outcomes are possible:

- **Pass.** The student successfully completed of the qualifying exam.
- **Conditional Pass.** While the student did well on the majority 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.
- **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 prior to The Graduate School’s deadline.

The Qualifying Exam can be retaken only once.

A student cannot be admitted to candidacy without passing this exam.

Thesis Committee

There are no requirements beyond those specified by the CS department and The Graduate School.

Thesis Prospectus

The written component of the thesis prospectus specifies:

- 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 prospectus length in GIM is roughly 15 to 20 pages.

The prospectus document should be submitted to the committee at least **one week before the presentation** to allow time to read and critique it. The oral component consists of a formal presentation of the proposed research to the thesis committee, as one might give at a departmental colloquium. You should plan the presentation for 45 minutes, with another 15 - 45 minutes for questions.

Thesis and Defense

The thesis document should be submitted to the committee at least **two weeks before the presentation** to allow time to read and critique it.

The procedures for the PhD thesis defense presentation are similar to those of the proposal defense. The defense is an open public talk, given in front of the committee and any members of the CS Department who choose to attend. The talk is a summary of the PhD thesis work and a defense of its ideas and results.

After a successful thesis defense, your committee will send comments on the thesis draft to you. You will then complete any additional work and make the necessary changes to the thesis. You must deliver the finalized thesis to The Graduate School.

Additional Expectations and Requirements

None.