

**THE
COMPUTER SCIENCE
PH.D. PROGRAM
AT
CARNEGIE MELLON**

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1 Introduction

Carnegie Mellon’s Computer Science Ph.D. program aims to produce well-educated researchers, teachers, and future leaders in Computer Science. The Ph.D. degree is a certification by the faculty that the student has a broad education in Computer Science and has performed original research in the area.

This document is an informal description of the Computer Science Ph.D. program; herein “we” refers to all the faculty and staff involved in the Ph.D. program. Currently, the Department Head is Jeannette Wing; the Director of Graduate Programs is Srinivasan Seshan and the Graduate Programs Administrator is Deb Cavlovich;

To complete the Ph.D. degree, we require that each student

- Participate in *directed research*
- Pass 96 university units worth of *graduate courses*, with certain distribution requirements
- Serve as a *teaching assistant* at least twice
- Demonstrate oral and written *communication skills*
- Write and orally defend a *thesis*, a significant piece of original research in a specialized area of Computer Science

We are committed to the principle that students may achieve competence through a variety of methods, including courses, seminars, projects, and independent study. We consider each student’s individual strengths, weaknesses, and interests in designing the best method for the student to fulfill these requirements. Our program is unique in that we encourage and expect students to engage in research from their first day in the Department.

To help students fulfill these requirements, we provide these educational opportunities:

- An active research environment
- The *Immigration Course*, intended to give an overview of the research interests of the faculty and to familiarize new students with the people and facilities of the Department
- A large number of *graduate courses*: regularly offered area courses in algorithms and complexity, artificial intelligence, computer systems, programming languages, and software systems; advanced graduate area courses; special topics courses; practicum courses; and reading seminars—together covering a broad range of areas in Computer Science
- The *Emigration Course*, intended to groom students for success in their post-graduate careers

The entire faculty meet twice a year to evaluate each student's progress. A student demonstrates progress by passing courses, doing directed research, teaching, fulfilling the skills requirements, and doing thesis work. While students are encouraged to shape an educational program to suit their needs, financial support and/or permission to continue in the Ph.D. program depends on satisfactory progress each semester along at least some of these categories.

2 Overview of the Program

Carnegie Mellon's Ph.D. in Computer Science is, above all, a research degree. When the faculty award a Ph.D., they certify that the student has a broad foundation in Computer Science, has advanced the field by performing significant original research, and has reported that work in a scholarly fashion.

Before embarking on original research, we expect students to acquire a body of technical knowledge that includes a familiarity with the breadth of Computer Science as well as a deep understanding of a specialized area. The Immigration Course is the first step in this process, exposing the student to the many ongoing research activities and projects in the Department and School. Next, through structured coursework the student gains a broad understanding of the fundamental research issues in major areas of Computer Science, and has the opportunity to gain a deep understanding in the student's area of specialization. Finally, the thesis work itself guarantees that the student understands the area well enough to advance the state of knowledge in the field.

Below we sketch the progress of a typical student through the program. Since the program is flexible, the careers of some students depart from this script at one or more points.

Around the start of October of the first year, each student is matched with a suitable advisor, who helps the student pursue directed research in an area of mutual interest. If the student's research interests change, he or she is free to change advisors at any time.

During the first two years of the program, the student begins to gain the foundation of knowledge that will allow him or her to go on and become an expert researcher in Computer Science, primarily through the following two ways:

- By mastering a body of graduate material, achieved by passing 96 university units worth of graduate courses. Ninety-six units is equivalent to eight full-time (12-unit) courses.
- By learning how to organize and begin to carry out original research, achieved by participating in directed research. What constitutes directed research is decided individually between the student and his or her advisor.

Twice, usually during the first three or four years, the student serves as a teaching assistant. While teaching or taking courses, we expect students to spend at least half their time doing directed research.

Our environment provides a myriad of opportunities for students to hone their writing and speaking abilities and to maintain their programming finesse. We expect students to satisfy their communications skills requirements within their first three years.

Each 12-unit course should require no more than a quarter of the student's time during any one semester. So, typically a student tries to complete all coursework by the end of two years, at which point the student becomes involved in full-time research and starts thinking about research directions for a thesis. As the student's thesis research direction becomes clear, the student writes a thesis proposal and assembles a thesis committee with help from the student's advisor. The student then completes and defends the thesis, and graduates.

Students, especially those who are about to finish, are encouraged to attend Emigration Course events. Participation is completely voluntary.

For students who have a strong desire to teach, we offer a special *Graduate Teaching Fellow* program. Students who opt to complete this program are rewarded with a special letter of commendation signed by the Department Head.

All requirements in the Ph.D. program must be fulfilled by work actually carried out at Carnegie Mellon University, with the exception of the dual degree program with several Portuguese universities. Work done elsewhere cannot be accepted for satisfying CSD requirements; rare exceptions must be approved by the Director of Graduate Programs.

The Ph.D. program provides each student with a periodic evaluation of his or her progress. Continuation in the Ph.D. program is contingent on making satisfactory progress.

3 The Immigration Course

The Immigration Course (IC) is intended to provide a common starting point for the entering Ph.D. students. It is organized as a short, intensive two to three week session at the beginning of the semester. The IC's goals are

- To orient students new to the Department, through introductions to people (faculty, staff, other students) and through social activities.
- To introduce students to various research and educational topics of current interest to the faculty.
- To give students an opportunity to find a suitable research advisor.
- To familiarize students with the computing facilities and environment at Carnegie Mellon.

These goals are fulfilled through a program of lectures, poster sessions, demonstrations, and tours of laboratories. Enough open hours are scheduled to allow students to meet with faculty individually to learn more about their research. Since all first-year graduate students are required to attend the IC, regular graduate courses for all CS Ph.D. students do not start till the intensive part of the IC is over.

4 Advisors

Except during their first month in the program, each student has a faculty advisor charged with guiding the education and monitoring the progress of the student through the program. This personal student-advisor relationship ensures that every student receives the necessary faculty mentoring. Throughout the program, the advisor is responsible for guiding the student's research and education. Early in the program, the advisor guides the student along some research initiative and helps with strategic planning for courses and other educational activities. Later, the advisor helps to focus the student's research interests towards a thesis topic. Toward the end of the program, the advisor chairs the student's thesis committee, and helps to select the other members of the committee. The advisor also provides the student with career advice.

How are advisors initially chosen? After a little over a month at CMU, entering students are matched with faculty advisors by the "handshake" process. Students list faculty preferences and faculty list student preferences; a committee then matches each student with a faculty member, taking into consideration each of their preferences and other factors. Students base their faculty preferences on research interests. They can learn about an individual faculty member's research interests by attending the faculty's research presentation during the IC, by reading the Department's annual Faculty Research Guide, and from meeting individually with different faculty members during their first month here.

There is flexibility in the kind of relationship a student has with his or her advisor. Some students work more closely with their advisors than any other faculty member, and some students work more closely with another faculty member on a particular research project. A few students have two co-advisors. While it must be approved by the Director of Graduate Programs, a request to switch advisors is routine and almost always granted for a student in good standing, especially during the early part of the degree program. It often results from an evolution of the student's research interests.

There are many faculty both within SCS and outside SCS who have advising privileges and can either function as sole advisors or co-advisors. Please see <http://www.cs.cmu.edu/~csd-grad/thesiscommittee.html> for a full list of people with advising privileges.

Suggested additions to the Approved List should be made by contacting the Department Head. A CSD faculty advocate is required for anyone wishing to be added to the list.

5 Directed Research

During a student's first two years, he or she should be doing directed research at least half time; once all coursework is completed and before doing thesis research, full time (except when teaching). Different students, and different advisors, have different ideas of what directed research means and how progress can be demonstrated. It is the responsibility of both the student and his or

her advisor to formulate for each semester a set of reasonable goals, plans, and criteria for success in conducting directed research.

At each semi-annual graduate student review meeting, the faculty assess the student's previous semester's research progress and the student's next semester's research plans to ensure that the student is making satisfactory progress. The evaluation of a student's progress in directed research often depends on the student having produced some tangible result; examples include the implementation of pieces of a software system, a written report on research explorations, an annotated bibliography in a major area, or, as part of preparation for doing research, a passing grade in a graduate course (beyond the required 96 required units).

Advisors are individually responsible for adequately supervising this portion of the Ph.D. program.

6 Course Requirements

The purpose of completing 96 university units worth of graduate courses is to cover breadth across many areas in and beyond computer science. By taking five *star* courses, one per five areas, students acquire breadth through exposure to basic knowledge, concepts, and skills in five different areas in computer science. Through the equivalent of three elective courses, students typically choose to gain more depth in the student's particular area of research. Some students use electives to gain more breadth by specialized exposure to an area outside of the student's research area and even outside of computer science.

Syllabi for all courses are monitored by the Doctoral Review Committee (DRC). Homework and exams in each course are limited to its prerequisite material and topics covered by its syllabus.

6.1 Five Area Star Courses

Each student must pass one star course from each of these areas:

- Algorithms and Complexity
- Artificial Intelligence
- Computer Systems
- Programming Languages
- Software Systems

Each area lists from one to three star courses offered for the year. Each star course is 12 university units.

Star courses differ from non-star courses in that (1) they assume an undergraduate background in the relevant area—no more and no less; (2) they are meant to be accessible to all Computer Science graduate students, not just

those in the area; and (3) they are offered on a regular basis so students can plan ahead.

Through these star courses we expect students not only to learn a breadth of technical material in Computer Science, but also to learn about and appreciate the different areas' research styles. The problems of interest, approaches to solving them, and analyses of their solutions differ across areas; often someone working in one area can be inspired by following an approach from a different area.

We attempt to schedule these courses so that students can complete all five in a one-year period; however, since we expect students to be engaged in directed research at least half-time, a typical student should plan to complete their five star courses over a two-year period.

Below is a list of the star courses we offer; this list is subject to change over time and may not always reflect current status.

- Algorithms and Complexity
 - * Algorithms
 - * Complexity Theory
- Artificial Intelligence
 - * Advanced AI Concepts
 - * Machine Learning
 - * Planning, Execution, and Learning
- Computer Systems
 - * Computer Architecture
 - * Optimizing Compilers for Modern Architecture
- Programming Languages
 - * Type Systems for Programming Languages
 - * Semantics of Programming Languages
- Software Systems
 - * Advanced Operating Systems and Distributed Systems
 - * Networking

6.2 Thirty-Six Elective Units

Students must also take 36 university units worth of elective courses, at least 24 of which are from graduate courses offered by the School of Computer Science (not just the Computer Science Department); the other 12 may be from graduate courses offered by the rest of the University. These graduate courses must be level 700 or above.

There is no explicit breadth or depth requirement. Students may use electives to gain additional depth of knowledge in the student's research area, e.g., to complement their directed research or to prepare them for choosing a thesis topic. Students may also use electives to gain additional breadth of knowledge in an area outside of the student's research area.

Though students typically take courses to satisfy the elective units requirement, there are three other means of passing these units: doing an internal project, carrying out an external project, or teaching a graduate course. For students in some areas such as algorithms, it might make more sense to take advanced courses; for students in other areas such as software systems, it might make more sense to do a project. For those who like to reinforce knowledge by teaching, we provide the opportunity to obtain elective credit by being a teaching assistant.

We strongly advise students to choose electives in consultation with their advisor. The student and his or her advisor are both responsible for making sure that through these 36 elective units the student gains new knowledge, perhaps to fill gaps or to prepare for thesis research. They are also responsible for balancing how a student fulfills these units (through courses, projects, or teaching), taking into consideration the student's career goals, and the student's strengths and weaknesses in research, teaching, communication skills, and programming ability.

Students are free to take more than the required number of elective units.

6.2.1 Project Unit

One way to obtain elective unit credit is through a faculty-directed project. Doing a project has the same primary goal of taking a course: the acquisition of knowledge. As a side benefit of doing a project a student often learns new research skills.

Here are some rules-of-thumb for considering what qualifies as a project which may be used for elective credit:

- The scope of the material learned should broaden the student's education; it should not be too narrow.
- The work should be something other than that which would otherwise be done as part of the student's directed research or as part of the research project run by the student's advisor.
- A student should be able to complete the project working full time for no more than one month (or quarter time for one semester). The time frame for doing the project does not have to respect semester boundaries, but a deadline for completion should be set.
- The project should have a written component resulting in a paper or technical report that demonstrates a high quality of writing.

- The project should also have an oral component requiring that the student present a brief (seminar length) description of the work performed. The student is responsible for scheduling the talk, and the project advisor is required to attend. The talk may be given externally.

To get a project approved for elective credit, a student submits a short (1-2 page) description of the project, written with the guidance of the project advisor. The proposal should clearly explain how the proposed work addresses the educational goals of the student.

Every project must be approved by two faculty members and the Director of Graduate Programs. The two faculty members are the project advisor and the student's regular advisor. In the case that the regular advisor is also the project advisor, the student and advisor need to select some other appropriate faculty member to evaluate the proposed work independently.

6.2.2 Fahlman Teaching Unit

Another way to get elective unit credit is by being a teaching assistant for one of the Ph.D. star courses. We call such elective credit a "Fahlman Unit," named after its proposer. To qualify, a student must have already taken and passed the course for which he or she plans to be a teaching assistant. Again, in the spirit of the educational objectives of coursework, doing a Fahlman Unit should broaden the student's education. Students who wish to do a Fahlman Unit should contact the Director of Graduate Programs who coordinates with the student's advisor and course's instructor in approving the credit.

The two teaching assistant (TA) requirements (see below) are completely separate from Fahlman Units. A student may not use one course to satisfy simultaneously elective units and a TA requirement.

6.2.3 V Unit

A third way to obtain elective unit credit is to carry out an external project, exploring, for example, the role of computer science in society, or articulating a vision for new multi-disciplinary research involving computer science. A V Unit must be preceded by a proposal, to be approved by a faculty advisor and the Director of Graduate Programs. More information on the V Unit can be found at <http://www.cs.cmu.edu/~vunit>.

6.3 Placing Out

There are two kinds of placing out: substitutions and waivers. Either can be done on the basis of previous graduate coursework. There might be exceptional cases, for example, students with extensive work experience.

Substitution is when a student takes a non-star Ph.D.-level course instead of a star course. For example, if a student took courses in advanced operating systems, distributed systems, databases, and networking already, instead of taking one of our Software Systems star courses, he or she might wish to use the

Mobile Computing course to satisfy the Software Systems area requirement. In essence, substitution gives the student another free elective, where the choice is somewhat limited (to courses within the area).

The mechanism for substitution is to obtain approval from the relevant instructors in charge of both courses and from the *Area Advocate*. Each year the DRC identifies an Area Advocate, someone who is not the course instructor, for each of the five areas. We use the term “Advocate” because, like a lawyer, he or she speaks on behalf of the student who desires to place out. Requests for substitution should mostly be granted. Currently, the area advocates are

- Artificial Intelligence: Tuomas Sandholm
- Algorithms: Danny Sleator
- Computer Systems: Seth Goldstein
- Programming Languages: Frank Pfenning
- Software Systems: Peter Steenkiste

Waiving a course requirement implies reducing the total number of units a student must take. For example, a student transferring to Carnegie Mellon from another Ph.D. program might be able to get waivers for two star courses already taken elsewhere. However, the department requires that a minimum of 24 university units be taken at Carnegie Mellon.

The mechanism for the waiver of a course requirement is for the student to contact the Director of Graduate Programs or the responsible Area Advocate with the course syllabus and other supporting materials used in the course taken already. The final decision made by the Director of Graduate Programs, in consultation with the Area Advocate and relevant Carnegie Mellon course faculty, may be immediate or conditional, based on having the student either (1) take and pass an oral exam (conducted by the Area Advocate and the instructor(s) of the course to be waived), or (2) take and pass its final exam. Doing a side project is not a possible condition for waiving a course requirement. Since we take a lot of pride in our graduate courses and try to provide unique educational experiences, and also because our overall course load is quite light, we expect outright waivers (as opposed to course substitutions) to be relatively rare.

7 Teaching Requirement

The ability to teach is an important skill for all scientists, not only for those who plan to teach after completing their degrees. Teaching skills include the ability to communicate technical material ranging from elementary to advanced, and to communicate technical material to audiences ranging from general to specialized. Thus, we expect students to develop and exercise teaching skills as part of their graduate education.

Students have ample opportunities to present advanced material while working on research projects, by participating in research seminars and by giving practice conference talks. To gain experience in presenting more elementary material, we require that all graduate students help teach two courses. The norm is for students to teach one introductory-level undergraduate course and one advanced-level undergraduate course. Current policy (which is subject to change from semester to semester) is that graduate star courses in the Computer Science Department with an enrollment of 20 or more are also eligible for TA credit. *In particular, star courses in other units in the School of Computer Science, or advanced graduate courses are **not** eligible for satisfying the teaching requirement.*

It is important that **all** teaching that is to count towards the teaching requirement must be assigned and approved **in advance** by the responsible administrator, which is the Assistant Dean for Undergraduate Education for undergraduate courses (currently Mark Stehlik), and the Director of Graduate Programs for graduate courses (currently Mor Harchol-Balter). Students' preferences will be taken into account, but cannot always be honored.

We encourage students to teach more than twice. At the semi-annual evaluation of students the faculty give special recognition to those who do an outstanding job as a TA and to those who teach beyond the required load. The School of Computer Science offers a TA workshop which we encourage students to take advantage of.

8 Written and Oral Communication Skills

To be a well-rounded computer scientist each student should have not just basic knowledge, but also the abilities

- To communicate technical ideas clearly in writing
- To communicate technical ideas clearly orally

We also expect students to be able to program, but there is no formal checkpoint to certify programming skills. It is left up to the advisor and student to make sure the student has the necessary skills.

8.1 Writing Skills

To satisfy the written communication skill requirement each student must write a scholarly document, as either its sole author or its primary author (if co-authored), that is at least the quality of a Carnegie Mellon technical report. The student obtains written final approval of the document from at least two faculty members and one Ph.D. graduate student. A co-author on a paper can not be a reviewer of that paper to satisfy the writing requirement, and one of the reviewers must be a member of the Department of Computer Science.

This document must be a scholarly paper with references to the literature that could be sent for peer review. It can be

- A technical report
- A submitted, accepted, or published conference or journal paper (rejected papers may count since sometimes conference program committees and journal editorial boards have their own agendas)
- A document written to satisfy a course requirement (e.g., a course project's final report)
- A comprehensive survey paper, e.g., suitable for *ACM Computing Surveys*

Annotated bibliographies, user manuals, and reference manuals do not qualify because they do not require the same kind of explication, organization, and summarization skills needed to write a conference- or journal-like publication.

It cannot be

- The thesis proposal
- The thesis

The student should iterate with at least one faculty member, not necessarily the advisor, in writing this document. To determine whether the writing requirement has been satisfied, the student eventually must get at least two faculty members and one graduate student to read the document, to provide written feedback by filling out a Writing Review Form (available from the Graduate Program Administrator or at <http://www.cs.cmu.edu/~csd-grad>), to meet and discuss this feedback, and to give final approval by signing the form accordingly. The student then gives these three (or more) signed forms to the Graduate Program Administrator who keeps copies in the student's file and indicates in the student's records that the requirement has been satisfied.

Students are responsible for asking the appropriate faculty members and graduate student to help them with satisfying their writing requirement.

We expect students to be able to satisfy this requirement within their first three years and prior to their thesis proposal.

Computer Science Ph.D. students are welcome to enroll in the undergraduate communications course, required of undergraduate majors, to enhance their writing skills; however, taking it does not serve to satisfy the written communication skills requirement.

8.2 Speaking Skills

The Department and School provide many opportunities for students to practice their speaking skills. Here are just a few:

- Research area seminar series (AI, CS, Logic, POP, PS, Theory)
- Research unit seminar series (MLD, HCII, LTI, Robotics)
- Regular lunchtime talks (e.g., SDI lunch, Graduate Student Seminar Series)

- Research area group meetings (e.g., Machine Learning, SSSG, Multicomputer)
- Oral presentations in regular graduate courses or as part of a project course (see Section 6.2.1)
- Recitations, tutorials, and guest lectures (as a teaching assistant)

To satisfy the oral communication skill requirement each student should give a public talk at Carnegie Mellon. The talk is scheduled so that members of the standing committee, the *Speakers Club*, can attend, evaluate the student's talk, and provide oral and written feedback to the student.

This talk must be accessible to a general Computer Science audience. It should be advertised as "In Partial Fulfillment of the Speaking Requirement" so the audience knows what kind of feedback the student is seeking and so all interested and available Speakers Club members can mark their calendars accordingly.

Students should be able to use existing forums (e.g., those listed above) to give their talk, and thereby avoid having to schedule a special talk. Of course it is acceptable if the student wants to schedule a special time and date, but the student should take care to ensure that an audience beyond the three required members of the Speakers Club (two faculty and one student) is present at the talk. The Speakers Club "robot" helps students schedule their talks, ensures a quorum of Speakers Club members is met, and reminds Speakers Club members of their responsibility and commitment to attend talks. Due to contention for popular times (especially the Student Seminar Series), talks must be scheduled at least three weeks in advance.

All Speakers Club members are welcome to attend the advertised talk. Immediately after the talk, those members in attendance confer among themselves (with the student absent) about the talk. They also each fill out a Speaking Review Form, available from the Graduate Program Administrator. If at least two faculty members and one graduate student member of the Speakers Club grade the student's talk to be "Good" or better, then the student passes. If not, the student will be required to give another talk. After a decision has been made, one of the attending faculty members volunteers to discuss the feedback and outcome privately with the student.

After the talk, whether the student passes or not, he or she takes all signed forms to the Graduate Program Administrator who keeps copies in the student's file and marks in the student's records the attempt or the completion of this requirement. Much of this part of the process is like what happens after a thesis proposal presentation or thesis defense; the focus here, however, is on oral communication skills.

As with writing, speaking well takes practice. Satisfying this requirement might take a few tries on the student's part. For students who are naturally good speakers or are already experienced speakers, one try may suffice. No stigma is attached to those who have to try more than once.

9 The Thesis Process

The thesis must describe a significant piece of original research work. It is evidence of proficiency, high attainment, and ability to do research in a specialized area of computer science.

A more extensive checklist with specific information on the thesis proposal and thesis defense is available at <http://www.cs.cmu.edu/~csd-grad>. Every student must read and adhere to these more detailed process rules.

9.1 Thesis Proposal

The student submits a written proposal to the Faculty. The student also orally presents the thesis proposal to interested faculty and students in a public colloquium.

A thesis proposal should

- Explain the basic idea of the thesis topic (e.g., the problem to be solved and the approach to solving it)
- Argue why that topic is interesting (e.g., what contributions to the field would be made in carrying out the proposed work)
- State what kind of results are expected
- Argue that these results are obtainable within a reasonable amount of time
- Demonstrate the student's personal qualifications for doing the proposed work

The main purpose of the thesis proposal is to convince the faculty that the chosen thesis topic is significant and that the student's approach has a reasonable chance of success. A thesis proposal gives the faculty the opportunity to pass such judgment at the start of the work and not at the end. We want to minimize the chance that a thesis will be turned down when almost completed. We expect students to present their thesis proposals as early as possible, not halfway through writing the thesis. A thesis proposal should be short, about 15–20 pages.

A thesis proposal should *not* be

- A dry run for the thesis
- A summary or abstract of the thesis
- The first chapter or part of the thesis
- A technical report
- A survey of the field

- An annotated bibliography

Any included list of references or bibliography should serve the purpose of supporting the assessment of the state of the art and the student's personal qualifications.

To provide ample notice to the public, at least one week in advance of the oral presentation, students should provide the Graduate Program Administrator with one hardcopy of the thesis proposal, an on-line copy of the proposal's abstract, and a list of the thesis committee members, including the external member. The Graduate Programs Administrator posts the public announcement of the thesis proposal presentation.

Please remember that at least three thesis committee members (including the Chair) must be physically present for the thesis proposal.

Upon completion of the thesis proposal the student must complete a Doctoral Candidate Contractual Agreement Form provided by the Graduate Programs Administrator.

9.2 All But Dissertation (ABD) Policy

After the presentation of an acceptable thesis proposal, and satisfying all other requirements except for the dissertation and its oral defense, students are regarded as all but dissertation.”

Time to Degree: Once students achieve ABD status, students who began in the PhD program prior to June 1, 2011 must complete all requirements for the PhD within a maximum of seven full academic years, unless terminated earlier by conferral of the degree or by academic or administrative action.

Students who began in the PhD program after June 1, 2011 must complete all requirements for the PhD within a maximum of ten years from original matriculation as a doctoral student, unless terminated earlier by conferral of the degree or by academic or administrative action.

Once this time-to-degree limit has lapsed, the person may resume work towards a doctoral degree only if newly admitted to a currently offered doctoral degree program under criteria determined by that program.

An ABD candidate may choose to continue as a regular student *In Residence*, or to be *In Absentia* (ABS).

Please see the University policy: <http://www.cmu.edu/policies/DSS.html>

An ABD candidate may choose to continue as a regular student, or to be *in absentia* (ABS).

ABS - Off Campus: Students who leave CMU but plan to continue working on the thesis will be classified as ABS. These students should not require substantial use of university resources, but are permitted use of the libraries and consultation with faculty or students as necessary. While a candidate is ABS are required to pay the university technical fee each semester. No formal enrollment or payment of tuition is required, with the exception of the academic semester in which the degree requirements are completed. A candidate who is ABS is required to enroll for a minimum of five units during the academic semester in

which the degree requirements are completed. Charges for these units are the responsibility of the candidate.

Since an ABS candidate will not be certified by the University as a “student” for immigration purposes, non-resident alien students who become ABD should not choose to become ABS.

ABD - On Campus: Students who are self-supporting and are in ABD status may remain on campus to complete the thesis. They must register and pay for a minimum of five units each semester. However, students who receive a stipend predicated on their status as a graduate student and paid by or administered by the university will be required to register for a minimum of 36 research units. Nearly every ABD student in CS falls into this latter category.

9.3 Thesis Committee

The student’s advisor chairs the thesis committee. All other committee members, including the external member, should be agreed upon before the thesis proposal presentation. Members of the student’s committee must accept the responsibility of meeting with the student regularly to ensure that the research is progressing in the right direction. The Thesis Committee must consist of at least one Computer Science Department faculty, two members of SCS faculty, and/or other approved faculty and an external committee member. Please see <http://www.cs.cmu.edu/~csd-grad/thesiscommittee.html> for a full list of people with advising privileges. All thesis committees are subject to departmental approval.

Please remember that at least three thesis committee members (including the Chair) must be physically present for the thesis proposal and defense.

9.4 Thesis

The thesis must describe a piece of original research work and must describe it well. It is on this basis that the Department certifies the qualifications of the new Ph.D. Furthermore, it is the most important basis on which the scientific community judges the initial achievement and potential of that individual.

9.5 Thesis Defense

The student’s thesis committee decides whether to accept the thesis based on its content and the outcome of the *thesis defense*, which is a public presentation describing the contributions of the thesis. At least one week in advance of the oral presentation, students must provide the Graduate Programs Administrator with one hardcopy of the thesis abstract, an on-line copy of the abstract, and a list of all thesis committee members. The Graduate Programs Administrator posts the public announcement of the thesis defense.

Before the thesis defense, the entire thesis committee is expected to have read the entire thesis, to have given comments to the candidate, and to have given approval for scheduling the public defense. This means that a copy of the

complete thesis document should be provided to the whole thesis committee a minimum six weeks in advance of any proposed date for the defense. Significant deviations from this rule must be approved by the Director of Graduate Programs. Committee members should meet briefly before the thesis presentation to discuss any issues.

The presentation by the candidate is normally about 45 minutes, followed by a question-and-answer period which may be as long as needed. Please remember that at least three thesis committee members (including the Chair) must be physically present for the thesis defense. The thesis committee chair (advisor) determines who may ask questions and in what order and brings the discussion to a close at the appropriate time. The question-and-answer period is followed by a closed-door session attended by only the members of the thesis committee and any interested faculty members. The options of the committee are:

- To approve without corrections
- To approve subject to minor changes, to be approved later by the thesis chair only
- To require a resubmission after major changes and reapproval of the entire committee
- Not to approve the thesis

All members of the committee are required to sign a Final Oral Examination card, indicating that the student has passed the thesis oral examination. In addition, the thesis committee chair, the Department Head, and the Dean sign a final certification sheet when the student submits the final version of the thesis.

9.6 Graduation Certification

The Graduate Programs Administrator maintains a checklist of procedures for scheduling the thesis oral presentation and completing the other requirements for graduation. The Graduate Programs Administrator certifies fulfillment of requirements for graduation only when the final version of the thesis has been approved by the thesis committee, the Department Head, and the Dean. Students are not allowed to participate in commencement exercises unless final certification has been made.

If the final copy of the thesis is not submitted within one year of the thesis defense, the faculty may require a second defense before making a final certification.

10 The Emigration Course

In addition to doing research and taking courses, students also learn leadership and survival skills as part of their education in the Ph.D. program. Most directly, they obtain these skills through their advisors. To supplement this personal

mentoring, we offer the *Emigration Course*. Whereas the Immigration Course prepares entering students for their graduate career while at Carnegie Mellon, the Emigration Course grooms finishing students for their career afterward. The Emigration Course is structured as a series of talks offered throughout the year and focuses on five topics: Jobs, The Real World, Money, Ethics, and Communication. These talks cover nuts-and-bolts issues like how to job interview, how to apply for grant money, and how to write a technical paper. They also expose students to traditional and non-traditional career paths in academia, industry, and government.

Participation is open to the entire SCS community and is completely voluntary. More senior students, especially those planning to finish in any given year, are encouraged to attend sessions offered that year; however, even junior students can benefit from attending, to prepare for a smooth transition from life as a student to life in the real world.

11 Community Spirit

Our sense of community is well-known as a distinguishing aspect of doing computer science at Carnegie Mellon. It is one of the reasons many students choose to come here. The Computer Science Department is proud of our strong community spirit, which we foster through close working relationships between students and advisors, among faculty, and among students. Many working relationships turn into friendships for life.

Luckily, our community works. People volunteer their time, energy, intellect, talent, and other skills to do many of the things that keep our environment running smoothly. These efforts include organizing seminars, maintaining software packages, serving on departmental committees, grading for a graduate course, planning and running social activities, giving tours, and hosting visitors.

We are initiating a new web-based mechanism to provide a way for students to volunteer for activities they enjoy doing and to inform the community of the activities that need volunteers. See <http://www.grad.cs.cmu.edu/>. This “SCS Community Page” serves the entire School of Computer Science and is open to all graduate students in the school. This service is run entirely by students.

12 Graduate Teaching Fellow Program

To encourage and recognize exemplary activities in teaching and education by Ph.D. students, we offer the Graduate Teaching Fellow program as part of the Computer Science Ph.D. program. Students who successfully complete this program are rewarded with a letter that documents the teaching accomplishments of the student and explains the requirements that were satisfied to complete the Teaching Fellow program. The letter is written and signed by the Department Head. There is no special designation on the Ph.D. diploma itself.

Any CSD Ph.D. student in good standing is eligible to enter the Teaching Fellow program, and may remain as long as good standing is maintained. Participation in the Teaching Fellow program does not in any way reduce or replace any of the usual Ph.D. requirements. Progress through the Teaching Fellow program is monitored by a faculty member appointed for this purpose (henceforth referred to as the Teaching Fellow Monitor) and the DRC. The Ph.D. student is responsible for lining up the Teaching Fellow Monitor, who may or may not be the student's advisor.

The following are the requirements for completion of the Graduate Teaching Fellow Program:

1. Completion of at least six teaching seminars at the University's Eberly Center for Teaching Excellence.
 2. At least one semester-long teaching experience involving significant responsibility for course *content*, *delivery*, and *management*. This teaching experience may take the place of one semester of the normal teaching requirement, though in many cases it is expected that this experience will be carried out as an additional semester of teaching.
 - (a) For course content, the Teaching Fellow should be personally involved (typically jointly with a Lecturer or Professor) in the creation of a significant number of the course topics and materials, including elements such as the syllabus, lecture notes, homework assignments, projects, and exams. Any materials written by the Teaching Fellow may be submitted to the Monitor for review.
 - (b) For course delivery, the Teaching Fellow should give a significant number of lectures/recitations in the course. At least two of the lectures/recitations must be observed and reviewed by the Center for Teaching.
 - (c) For course management, the Teaching Fellow should be involved in a significant number of management activities, e.g., organizing and directing of other teaching assistants and graders, calculating mid-semester or final grades, and arranging for special classroom or laboratory facilities. If the Teaching Fellow is acting as a teaching assistant to an instructor, the instructor will be asked to comment on the management activities of the Teaching Fellow, for review by the Monitor.
- Any teaching experience, if it is to be used to satisfy this requirement, must be approved in advance by the DRC.
3. Submission and review, by the Teaching Fellow Monitor, of a "tangible contribution" to education. Typically, this material would include course notes, syllabi, exams, homework, and course-related software. Other possibilities include outcomes from participation in curriculum and course design efforts.

Opportunities for significant teaching responsibility may be hard to find, so we encourage students to seek help from the Director of Graduate Programs, the Teaching Fellow Monitor, and the DRC. We also strongly encourage faculty to consider co-teaching arrangements with prospective Teaching Fellows. The Director of Graduate Programs has a separate document that contains a detailed rationale for having the Teaching Fellows program.

13 Masters Degrees

Although the CSD does not technically offer a Masters Degree, we are happy to grant any student a Masters Degree once they have passed all 96 course units, passed at least one of the two communication skills requirements, and taught at least once. You must make your request in writing or via email to the Graduate Programs Administrator.

14 Student Support

14.1 Academic Year Support

The Department aims to allow students as much freedom as is possible in choosing research directions, subject to the interests and expertise of the faculty who are available to oversee the work. Thus, the Ph.D. program generally decides which funding source to use to support a student *after* the student has chosen an advisor or research area. On occasion, the Ph.D. program is able to obtain an individual fellowship for a student through external sources. We also encourage students to seek their own external funding since often the award is prestigious (e.g., NSF or Hertz) or the source provides an opportunity to make professional connections (e.g., an industrial fellowship).

If a student receives an external fellowship/scholarship, they must notify the Graduate Programs Administrator. The Department supplements the stipends of students with an outside fellowship to meet (and usually exceed) the stipends of students with internal funding. To any student whose spouse or qualifying domestic partner earns less than \$200 per month, the Department pays a dependency allowance that is 10% of the student's SCS monthly stipend per dependent.

14.2 Summer Support

There is summer support available for many students, particularly for those working on their dissertation. However, we believe it is also good for students to gain experience in industry for one or two summers during their career here at Carnegie Mellon. Faculty and staff will provide help in finding suitable summer employment.

14.3 Travel Support

The department encourages students to travel to conferences and workshops to enhance their professional and career development.

If a student wants to attend a conference or workshop, the student's advisor or research sponsor should support the trip through either a research contract or a discretionary account.

If no such funding is available to the student, then limited departmental funds may be available upon request from the Graduate Programs Administrator. Since departmental funds are limited, some requests may not be approved, and some may not receive full funding; however, the department will try to support a student's travel as much as possible. Funding is usually available to a student for no more than one departmentally-sponsored trip per year.

To obtain travel support, the student and his or her faculty advisor/research sponsor must first agree that the student should take the trip. Then *in advance of the trip* the student should get a Student Travel Authorization Form from the Main Office, and then the advisor/research sponsor's signature (on the Faculty Research Sponsor line). The faculty member must either (i) indicate the amount of support the student may receive and its source (be sure the charge number is filled in!), or (ii) state that no funds are available from any research or discretionary account.

If no faculty support is available, the student should submit the signed form to the Graduate Programs Administrator for approval of departmental sponsorship. The maximum to be reimbursed will be \$200 plus the registration fee, if only attending the conference or workshop; \$600 plus registration fee, if presenting a paper.

14.4 Consulting and Outside Employment

Consulting is a privilege, not a right. We grant this privilege for one of two reasons:

- The consulting task is relevant to the student's thesis work or a Carnegie Mellon research project.
- The student has exceptional financial obligations.

Consulting is normally limited to a maximum of one day per week.

A student who wishes to consult should obtain permission from his or her advisor and the Director of Graduate Programs, and fill out an approval form, available from the Graduate Programs Administrator.

We may require that students limit outside employment in order to be in compliance with university and government rules.

15 Leave of Absence

Students who wish to leave the program temporarily may request a leave of absence by submitting a request to the Graduate Programs Administrator. Leaves are initially granted for a period of no more than one year, but an extension of up to one additional year may be granted under exceptional circumstances. When an extension is granted, the conditions for return must be negotiated with the advisor and the Director of Graduate Programs prior to returning to the program. Students must be in good standing in order to be granted a leave of absence.

Students on leave of absence should contact the Graduate Programs Administrator two months prior to the end of the leave to indicate their plans. While a leave can in principle start at any time, university regulations allows students to return only at the beginning of a semester (usually late August or January).

16 Evaluation of Students' Progress

Evaluation and feedback on a student's progress are important both to the student and to the faculty. Students need information on their overall progress to make long-range plans. The faculty need to make evaluations to advise students, to make support decisions, and to write recommendations to potential employers.

The faculty meet at the end of each semester to make a formal evaluation of each student in the Ph.D. program. For historical reasons this meeting is called "Black Friday." The purpose of having all the faculty meet together to discuss all the students is to ensure uniformity and consistency in evaluating across all the different areas, by all the different advisors, throughout the years of the Ph.D. program in CSD as it inevitably changes. The meeting consists of two parts, one in which subsets of the faculty from different research areas (Artificial Intelligence, Computer Systems, Programming Languages, Software Systems, and Theory) meet, and the other in which the entire faculty meet.

The faculty measure each student's progress against the goal of completing the Ph.D. program in a reasonable period of time. The evaluation considers all components of the program using indicators and information sources described below. Through a Black Friday letter the faculty inform students of the results of this evaluation, which may include specific recommendations for future work or requirements that must be met for continued participation in the program.

16.1 Components and Indicators

In their evaluation, the faculty consider the following components, though naturally only some of these components will be applicable in any given semester; they are not equally important at every stage of a student's career.

- *Courses taken*: Evaluated by the course instructor—brief prose evaluation/summary grade.

- *Directed research*: Evaluated by research supervisor and other collaborating faculty.
- *Teaching*: Evaluated by the course instructor and two different teaching evaluation forms (one filled out by the course instructor and the other filled out by students, where appropriate).
- *Skills*: Writing and speaking, by relevant faculty and forms.
- *Thesis*: Status summarized by the thesis advisor and comment by members of the thesis committee.
- *Other*: Lectures given, papers written, etc. Evaluated by cognizant faculty.

The faculty's primary source of information about the student is the student's advisor. The advisor is responsible for assembling the above information and presenting it at the faculty meeting. The student should make sure the advisor is informed about participation in activities and research progress made during the semester. Each student is asked to submit a summary of this information to the advisor at the end of each semester—the *Student Statement for Black Friday* at <https://blackfriday.cs.cmu.edu>. This statement is used as student input to the evaluation process and as factual information on activities and becomes part of the internal student record. It is strongly recommended that the student and advisor meet prior to the faculty meeting to review the information provided in this statement.

16.2 Recommendations

Based on the above information, the faculty decide whether a student is making satisfactory progress in the Ph.D. program. If so, the faculty usually suggest goals for the student to achieve over the next semester. If not, the faculty make more rigid demands of the student; these may be long-term (e.g., finish your thesis within 1-1/2 years) or short-term (e.g., select and complete one or more specific courses next semester; prepare a thesis proposal by next Black Friday).

Ultimately, permission to continue in the Ph.D. program is contingent on whether or not the student continues to make satisfactory progress toward the degree. If a student is not making satisfactory progress, the faculty may choose to drop the student from the program.

The faculty also decide whether support should be continued for each student. Termination of support does not always mean termination from the program.

16.3 Grades

Since the Ph.D. program is not based solely on conventional academic courses, it is difficult to associate grades with a student's accomplishments. Also, for students who complete the program, grades are largely irrelevant. However,

passing grade for graduate courses is B- or better. Graduates are judged primarily on their professional achievements and the experience they have gained during the program, and on the basis of recommendations from members of the faculty.

The Ph.D. program keeps an internal record of various information about a student's performance, such as final grades given in some graduate courses. This information is used at the Black Friday meeting. This information does not go on the student's university transcript.

Once the required coursework is completed, students register only for a blanket course (e.g., "Reading and Research") covering all their program activities for that semester, for which they receive a Pass/No Pass grade.

CSD Ph.D. students may formally register for graduate or undergraduate courses in other departments, in which case they are subject to the grading policies of the University and the department offering the course. A form to request pass/fail grading is available from the Graduate Programs Administrator.

17 Problems?

17.1 Points of Contact

Students and advisors enjoy a close working relationship in our program. If students have problems, whether related to their research or not, they should feel free to speak to their advisors. If doing so is awkward or if students simply want a second opinion, they should feel free to discuss their problems with either the Director of Graduate Programs (currently Mor Harchol-Balter) or the Graduate Programs Administrator (currently Deb Cavlovich).

17.2 The Doctoral Review Committee

The Doctoral Review Committee is the official advisory committee to the Graduate Programs Administrator for the Ph.D. Program and the Department Head. While the structure and contents of the Ph.D. program are still discussed by the faculty and students as a whole, the DRC makes sure that the program's design is implemented and rules abided by properly. In this sense the DRC is also an oversight committee.

The DRC monitors all courses. It regularly asks students to evaluate courses and their instructors. It keeps statistics and data about all past and present CS Ph.D. students, discusses issues and problems that are specific to CS Ph.D. students, and makes minor policy decisions that do not require the attention of all the faculty and students.

The DRC is also something like a senate since the student representatives speak for all the students and the faculty representatives speak for all the faculty.

17.3 The Ombudsperson

If a student feels that none of the above avenues are appropriate for hearing about his or her problem, the student can turn to the Ph.D. program's *ombudsperson*. The ombudsperson's role and responsibilities are:

- To meet with students and listen to their problems
- To give advice, perhaps suggesting someone else to talk to or suggesting the next step to take
- To keep conversations confidential

The ombudsperson is supposed to be friendly, approachable, mature, a good listener, in his or her third year or higher (i.e., should “know the ropes” so to speak), and reasonable (of course!).

An ombudsperson is different from student DRC members since the DRC is an official committee. So, if a student has a personal problem (e.g., with his or her advisor), it may not be appropriate to talk to a student DRC representative about it (unless as just a friend). If the student feels uncomfortable approaching either of the Graduate Programs Administrators about it, then the ombudsperson would be the perfect person to turn to.

Currently, the ombudsperson is Michelle Goodstein.

18 University Policies

All policies not explicitly covered in this document adhere to university policies as stated in the Graduate Student Handbook. These policies include the status of All But Dissertation (ABD) and In Absentia students, academic disciplinary actions, and grievance procedures.

A Prerequisites to the Area Star Courses

Although there are no formal prerequisites for admission to the doctoral program, the area star courses make certain assumptions about a student's prior knowledge. Each topic listed below is accompanied by an indication of the level of proficiency that is assumed. In general, this amounts to the ability to use fundamental concepts and techniques in technical discussions.

A student deficient in one or more of these subjects could take or audit undergraduate courses to learn the material.

- **Programming ability:** Fluency in C or C++, with the ability to code efficient algorithms from high-level abstract descriptions. Some knowledge of assembly language programming.
- **Programming Languages:** Enough fluency in a high-level imperative language such as Pascal, Modula, Ada, or Java, and a functional language such as LISP, Scheme, or Standard ML to read examples and program exercises. Basic language concepts at the level of Parts 1 and 2 of *Programming Languages: Concepts and Constructs* by Sethi, or Chapters 1-9 of *Principles of Programming Languages* by Tennent.
- **Program Design:** As in Chapter 1 of *Structured Programming* by Dahl, Dijkstra, and Hoare, and Chapters 9, 13, and 14 of *Abstraction and Specification in Program Development* by Liskov and Guttag.
- **Algorithms and Data Structures:** At the level of the non-starred sections of *Algorithms* by Cormen, Leiserson, and Rivest.
- **Compilers:** At the level of Chapters 1-5, 7-8 of *Compiler Design* by Aho, Sethi, and Ullman.
- **Operating Systems:** Familiarity (as a user) with one or more interactive operating systems, e.g., Unix. Understanding of basic concepts in the design and implementation of operating systems, e.g., concurrent processes, semaphores. At the level of *Modern Operating Systems* by Tanenbaum or *Operating System Concepts* by Silberschatz, Peterson, and Galvin.
- **Database Systems:** At the level of Chapters 1-5, 8-11 of *Database Management Systems* by Ramakrishnan and Gehrke (that is, the relational data model, algebra, and calculus, basic SQL storage, files, tree- and hash-based indexing).
- **Computer Architecture:** Processors, registers, indexing, indirect addressing, interrupts, simple machine language programming, primary memory, secondary memory, peripherals.
- **Discrete Mathematics:** Basic concepts of sets, relations, functions, mathematical induction, and algebra as in Chapters 2-4 and 7 of *Discrete Mathematics in Computer Science* by Stanat and McAllister.

- **Logic:** Including propositional calculus, quantifiers, and the ability to manipulate and evaluate logical formulas, as in Chapters 1, 2, and 4 of *The Science of Programming* by Gries.
- **Probability and Statistics:** Basic probability and statistics as in Chapter 6 of *Algorithms* by Cormen, Leiserson, and Rivest, Chapters 1-7 of *Probability and Statistics* by Morris de Groot, or Chapters 1-7 of *Introduction to Probability* by Grinstead and Snell.
- **Formal Languages:** Regular sets, finite automata, regular expressions, nondeterminism, push-down automata, context-free languages, Turing machines, polynomial-time (P and NP) to the level of *Introduction to Automata Theory, Languages, and Computation* by Hopcroft and Ullman.

B Time Estimates

The following table indicates estimates for approximately when students should have finished each requirement. Overall, we expect students to complete the program within 5–6 years, depending on background, research area, and dissertation research.

These figures are meant to be suggestive, not prescriptive. We present them so that all faculty and students can develop a shared image of the expectations of the program.

COMPONENT	INTENSITY	COMPLETION TIME
Immigration Course	full time	2 + 2 weeks
Star Courses	each 1/4 time	by end of year 2
Elective Courses	each 1/4 time	by end of year 3
Writing Skills	variable	by end of year 3
Teaching	1/2 time	by end of year 4
Speaking Skills	variable	by end of year 4
Thesis Proposal	1/2 time	by end of year 4
Thesis	full time	by end of year 5 (or 6)

Students are expected to be working on research every semester with intensity at least 1/2 time throughout their time at CMU. In addition, it is expected that students volunteer within the department and school throughout their time at CMU.

C Ph.D. Specializations

Students admitted to the Ph.D. Program in Computer Science may choose to further specialize in one of three tracks: Algorithms, Combinatorics, and Optimization (ACO); Neural Basis of Cognition (NBC); and Pure and Applied Logic (PAL). These students must also be separately admitted to those programs; they fulfill the same basic requirements as regular Ph.D. students in Computer Science but have additional requirements to fulfill.

C.1 Algorithms, Combinatorics, and Optimization

The Ph.D. Program in Algorithms, Combinatorics and Optimization is an interdisciplinary program administered jointly by the department of Computer Science, the department of Mathematical Sciences, and the Operations Research group in Tepper School of Business (TSB). The purpose of the program is to bring together the strengths of the participating departments in topics such as algorithm design, graph theory, combinatorial optimization, integer programming, polyhedral theory, analysis of heuristics, and number theory. Participating faculty from the Computer Science Department include Guy Blelloch, Avrim Blum, John Lafferty, Anupam Gupta, Bruce Maggs, Gary Miller, Steven Rudich, Danny Sleator and Manuela Veloso.

Course of Study: Students in the ACO program take the equivalent of three courses each in Computer Science, Math, and TSB (technically, students take six mini-courses in TSB), and one course in probability theory. Students participate in a weekly ACO seminar and work with a research advisor who may be in any of the participating departments. For more details, see the ACO web page at <http://www.cs.cmu.edu/~ACO> or ask for a copy of the ACO brochure.

The Ph.D. in Computer Science also offers a “minor” in ACO for those students who wish to have a formal involvement with the ACO program but still receive a Ph.D. in Computer Science. Students receiving a “Ph.D. in Computer Science with minor in ACO” must take (a) the CS requirement of 5 area star courses, (b) 2 elective courses in CS, and (c) 3 courses from the union of Math and TSB (minis counting as 1/2 of a course) with the condition of at least one course in each. Students are also expected to actively participate in the ACO seminar. Any student in the CS Ph.D. program may elect to pursue a minor in ACO at any time during their graduate studies.

C.2 Neural Basis of Cognition Training Program

The CNBC Training Program is an interdisciplinary Ph.D. and postdoctoral training program operated jointly with several academic departments at Carnegie Mellon and the University of Pittsburgh. Participating Computer Science faculty are Tai-Sing Lee, Michael Lewicki, James McClelland, David Plaut, and David Touretzky. Other affiliated departments at CMU are Biological Sciences, Machine Learning, Psychology, Robotics, and Statistics. Affiliated departments

at the University of Pittsburgh are Mathematics, Neurobiology, Neuroscience, and Psychology.

The CNBC option for Computer Science Ph.D. students allows them to combine intensive training in CS with a broad exposure to cognitive science, neural computation, and other disciplines that touch on problems of higher brain function.

Course of Study: CS/CNBC students are admitted through their home department (Computer Science) and fulfill the normal CS Ph.D. program requirements. In addition, they take a sequence of CNBC core courses in neurophysiology, systems neuroscience, computational neuroscience, and cognitive neuroscience. The CNBC core courses take the place of the three elective course unit requirement in CS. CS/CNBC students also participate in a research seminar series and experience a lab rotation.

Because of the extra time required to complete the CNBC requirements, students may apply for one year of financial support from the CNBC. In addition, CS/CNBC students are given an annual travel allowance to help them attend conferences and workshops.

Completion of all degree requirements earns the student a Ph.D. in Computer Science plus an additional certificate in the “Neural Basis of Cognition.” More information about the CNBC option is available at <http://www.cnbc.cmu.edu/>.

C.3 Pure and Applied Logic

The Pure and Applied Logic Program is joint with the Carnegie Mellon Mathematics and Philosophy Departments. Carnegie Mellon has a large and active group of faculty whose research and teaching interests span all aspects of logic, with a particularly strong concentration in foundational aspects of computing. This Logic Community has an established record of collaborations in pursuing theoretical research, conducting major implementation projects, and running colloquia and workshops. Participating faculty from the Computer Science Department include Stephen Brookes, Edmund Clarke, Robert Harper, Peter Lee, Frank Pfenning, and John Reynolds.

Course of Study: CS/PAL students are admitted through their home department (Computer Science). They may choose to specialize in Pure and Applied Logic any time after their first year, though the expectation is that a mutual decision is reached by the end of their first year. CS/PAL students fulfill all the normal CS Ph.D. program requirements; however rather than take the equivalent of just three elective courses, they must take five. CS/PAL students should choose their elective courses from a list of regularly offered courses in Pure and Applied Logic. Since some of these courses are taught in the Mathematics or Philosophy Departments and CS students are restricted to taking the equivalent of at most one elective course outside of SCS, in special cases students may petition to have a second elective course chosen from outside of SCS. CS/PAL students are also expected to participate in the activities of the Carnegie Mellon Logic Community, such as relevant seminars and colloquia.

Completion of all degree requirements earns the student a Ph.D. in Computer Science plus an additional certificate in “Pure and Applied Logic”. More information about the PAL program is available at <http://www.cs.cmu.edu/~pal>.

D Dual Degree Program with Portugal

Since Fall 2007 the department also offers a dual degree program in cooperation with several Portuguese universities. The regulations are essentially the same as given in this document, except that some requirements can be fulfilled in an affiliated program in Portugal. For more information, see <http://www.csd.cs.cmu.edu/education/phd/portugal.html>.

E Self-Defined Interdisciplinary Ph.D. Programs

We encourage students to follow their interests and to pursue interdisciplinary contacts as appropriate for their program of research and study. The doctoral program is broad and flexible, so usually we can find ways to accommodate these interests. However, there are times when a student's research goes so far afield that an interdisciplinary Ph.D. would be more appropriate. The department accommodates these students by allowing a self-defined interdisciplinary Ph.D. program.

A student interested in a self-defined Ph.D. sets it up between Computer Science and another academic department. The student must draw up a description of the area in which he or she wishes to work and a proposed academic plan, which typically includes coursework, a description of the qualifier (if any), and how the thesis will be approved. The student then must put together a program committee consisting of people from both departments who will agree to oversee the student's progress through the program; this committee acts as the student's department. Finally, the program must be approved by the DRC and by the equivalent committee of the other department.

The process of setting up an interdisciplinary Ph.D. is not easy and can easily take a year or two. The process by which an interdisciplinary Ph.D. is created is unfamiliar to most other departments and is not well-defined by the university itself, so it may take significant effort to define an interdisciplinary degree and have it be recognized in all participating departments. It is therefore in most students' interests to stay within the Computer Science program; once coursework is done, there are few limitations on a Computer Science Ph.D. student's course of study, thereby giving the student nearly the same flexibility achievable through a self-defined program.