The Harvey Mudd Guide to Graduate School in Computer Science

1 Introduction

This guide is intended for Harvey Mudd students who are considering graduate school in computer science. The guide is intended to help you determine if graduate school is for you and, if so, how to prepare for graduate school and how to apply. *It's never too early to read this guide!* Some of our advice will be useful to you well before your senior year.

This guide is organized as follows: Section 2 addresses the question of what graduate school is all about and the difference between master's and doctoral programs. Section 3 examines what you can do before your senior year to help prepare yourself for graduate school. Section 4 is about choosing where to apply. Section 5 is about fellowships. Section 6 discusses the application process. Finally, Section 7 describes new procedures instituted by the Department of Computer Science which will help ensure that the application process proceeds as smoothly as possible.

2 What is Graduate School All About?

Graduate school provides an opportunity to pursue your academic interests in greater depth. Many people find it to be an exciting period in which they can immerse themselves in an intellectual pursuit with relatively few other obligations. There are two main types of graduate degrees to consider: a master's degree (M.S.) and a doctoral degree (Ph.D. or sometimes called a D.Sc.).

2.1 The Master's Degree

The master's degree typically takes 1 to 2 years to complete. This degree is intended to increase the depth of your knowledge of the discipline. Some master's degree programs require only course work (typically about 8-10 courses) while others require course work and a master's thesis. The master's thesis is a paper describing your results in a research project of limited scope. A master's degree is good preparation for working in industry or teaching at the junior college level. Some companies want their managers to have master's degrees, for example.

In many master's programs, the students pay tuition and get limited financial support. In others, partial or complete tuition waivers are available to some students. In addition, it

is sometimes possible to obtain a teaching assistantship or research assistantship that can also help defray your living expenses. Another option is to work for a company that will help pay for your master's degree.

You should be aware that some graduate programs are primarily Ph.D. programs and awards master's degrees to their Ph.D. students along the way. Other programs accept a large number of master's students. You should look at a prospective graduate school's web site carefully to determine what kind of master's program is available.

2.2 The Doctoral Degree

A Ph.D. typically takes 4 to 6 years to complete. This degree is intended to train you to perform original research. A Ph.D. requires some additional course work beyond the master's requirements, some oral or written exams (often called "general exams", "qualifying exams", or "comprehensive exam") to establish your proficiency in key areas of computer science as well as background in your intended area of research. The most significant component of the Ph.D. is the dissertation (or "doctoral thesis") which is a description of your original research. The research itself may take several years to complete.

Some people enter a Ph.D. program and decide after a year or two that graduate school is not for them. There is nothing wrong with this. Usually you will get a master's degree at this point and look for something else to do. In fact, if you are unsure if you want to pursue a master's or a Ph.D., it is generally advantageous to apply to a Ph.D. program. This allows you to participate in research earlier and obtain better funding.

A Ph.D. is generally required to obtain a faculty position at a 4-year college or university. Industrial research laboratories also hire people with Ph.D.'s to engage in research and development.

Ph.D. students typically do not pay any tuition and receive a teaching assistantship, research assistantship, or fellowship which pays a stipend sufficient to cover living expenses. Currently, Ph.D. stipends in computer science are in the $1300 to $1800 per month range.

If one of your primary reasons for considering graduate school is to earn a higher salary, think again. Although starting salaries generally increase with level of education, going to graduate school should not be primarily a financial decision. Graduate school takes time, and success in graduate school requires real enthusiasm and self-discipline. The long-term financial benefits of going to graduate school are unclear, since 4-6 years of working right out of college will lead you to a salary that may be comparable to one that you would earn after 4-6 years of studying for a Ph.D.

Deciding whether to go to graduate school is easy for some people but not so easy for others. If you are unsure, by all means talk to your advisor and other professors. We're very happy to talk to you and help you weigh the pros and cons.

3   How Should I Prepare for Graduate School?

First and foremost, do well in your classes. Graduate schools are particularly interested in your performance in computer science and mathematics courses. However, they also want

well-rounded and intellectually curious students. Doing well in *all* of your classes is a good indicator of intellectual promise.

In addition to doing well in your classes, get to know your professors. Your professors will ultimately write your letters of recommendation and a letter that can attest to your positive attributes, and not just your grade in the class, is the most useful kind. A letter that says "Joe got an A in my course" is not very useful. Your transcripts will indicate that. On the other hand, a useful letter is one that can say something like "Joe worked very hard in my class and demonstrated a real enthusiasm for the material. He occasionally came by my office to ask me questions about topics that I only mentioned briefly in class. He submitted a few bonus problems which showed real insight and creativity." Conversely, missing class, not paying attention in class, and turning in only partially completed homeworks are tell-tale signs that professors pick-up on very quickly. It will be hard for a professor to write a strong letter of recommendation under these circumstances.

Finally, participating in research is a great way to find out whether you really like it. Moreover, research experience can substantially improve your chances of being admitted to a graduate program. Undergraduate research experience demonstrates interest in research and allows your supervisor to comment about your research potential in the letter of recommendation. You can participate in research by either working with a Harvey Mudd faculty member during the year or during the summer or via a summer research opportunity such as the NSF REU (Research Experience for Undergraduates) program. See `www.nsf.gov/home/crssprgm/reu/start.htm`.

4   Choosing Where to Apply

If you have your sights set on one of the most competitive graduate schools (such as MIT, CMU, Berkeley, or Stanford), you should know that these schools have extraordinarily competitive admissions standards. In some years they have accepted less than 5% of their applicants. Most students admitted to these schools come from excellent undergraduate programs and have GPAs of 3.8 to 4.0. Most graduate schools know about Harvey Mudd's tough academic standards (and your letter writers will emphasize this in their letters of recommendation). Nevertheless, we have had very few students with GPA's under 3.7 get accepted to these most competitive schools. *However*, all graduate schools are looking for outstanding research potential. If your GPA is not as high as the norm at these schools but you have done exceptionally well in some upper-division courses, have had significant research experience, or other special experiences, you should still consider applying.

The good news is that there are outstanding graduate programs that are not as hyper-competitive in their admissions. There are over 200 Ph.D. granting computer science programs in the United States and Canada. Most schools in the top 15 or 20 are competitive, but much less so than the top 5. For example, many of our graduates have been admitted to top 20 programs with cumulative GPA's in the 3.0 to 3.6 range.

Talk to your advisor or other computer science faculty for help determining where you should consider applying. Some schools are strong in a few particular areas of computer science while others are strong in a breadth of areas. We can help you determine where to consider applying based on your interests and your academic record. It's generally wise to

apply to at least 2 schools that are safe bets for admissions, at least 2 that are good matches with your academic background, and at least 2 that are a bit of a stretch. You should note that most graduate schools charge an application fee of approximately $ 50.

To help you get a sense of which graduate schools are particularly strong, you may wish to look at rankings such as those published by U.S. News and World Report (`http://lazowska.cs.washington.edu/usnews2003/cs.htm`), the Gourman Report (`http://www-hkn.eecs.berkeley.edu/student/grad/top40.shtml`), or the National Research Council (`http://www.cra.org/statistics/nrcstudy2/rankcs.html`). However, you should take all such rankings with a large amount of salt! The HMC CS faculty do not endorse these rankings. The rankings should only be used to get a rough sense of which programs are particularly strong. A school that is ranked 20th may in fact be one of the best schools in a particular area of computer science. Conversely, a department that is ranked 1st may not be the strongest department in every area.

5   Fellowships

As mentioned earlier, if you are accepted to a Ph.D. program, you should expect that your tuition will be waived and you will receive a teaching or research assistantship which pays a reasonable monthly stipend.

There are, however, a number of fellowships and scholarships available that will pay for your tuition and pay an even nicer stipend than offered by most graduate schools. The other advantages to fellowships is that they are prestigious and afford you the flexibility of choosing what you want to work on without regard to whether your advisor has research funds from which to pay you. Among these fellowships are:

1. The National Science Foundation Graduate Research Fellowships.
   See `http://www.ehr.nsf.gov/dge/programs/grf/`.

2. The Fannie and John Hertz Foundation Graduate Fellowships.
   See `http://www.hertzfndn.org/`.

3. The National Defense Science and Engineering Graduate Fellowships.
   See `http://www.asee.org/ndseg/vvv`.

4. The Department of Energy High-Performance Computer Science Fellowships.
   See `http://www.krellinst.org/DOE_HPCS/DOE_HPCS.html`.

These fellowships are quite competitive. In particular, the NSF and Hertz fellowships are generally even more competitive than admission to a top 5 graduate school. Talk to your advisor to determine if you should apply for one of these.

6 The Graduate School and Fellowship Application Process

Applying to graduate schools and fellowships will take some time. You should plan to talk to your advisor about your interest in graduate school in September of your senior year. Together, you should identify where to apply by mid-October. You will also need to register and prepare for the GRE, arrange for letters of recommendation, and write a personal statement. These components are described below.

6.1 The GRE

You will need to register for the GRE (Graduate Record Exam) and obtain study guides for these exams in spring of your junior year or the early fall of your senior year. You can do this online at `www.gre.org`. There are two GRE exams that you will need to take: The general exam and the computer science subject exam. The general exam can be taken at a computer-based test center at your convenience or on paper on a scheduled test date. Consult the GRE web pages for more information. The subject exam can only be taken on paper on a scheduled exam date. In 2002, you should plan to take the subject exam on November 9. You must register by October 4.

The Harvey Mudd Computer Science Department will be offering a practice GRE subject test in the early fall. You should plan to take this practice exam. Our experience is that some practice and review can make a significant impact on performance on this exam. In the past, some students didn't take the GRE practice and preparation seriously and were unpleasantly surprised by their scores.

The GRE questions are classified approximately as follows with the relevant HMC courses next to them. It is highly recommended that you complete all of the CS courses in parentheses below before taking the GRE subject exam.

Software systems and methodology: 35% (CS 60, 70, 121, 131)

Computer organization and architecture: 20% (CS 110)

Theory: 25% (CS 80, 140, 142)

Mathematical background: 15% (Math 55 and CS 80)

Other topics: 5% (CS electives)

6.2 Letters of Recommendation

Letters of recommendation are a very important component of your application. Most graduate schools request 3 or 4 letters of recommendation. Letters from your professors and research advisors carry the most weight. If you did summer research with someone at Harvey Mudd or elsewhere, that person is an ideal letter-writer since they can speak to your research abilities. If you had a summer job working at a company, your supervisor their may be able to write you a useful letter depending on the nature of your work. Letters from

researchers at a company are often useful while letters from a non-research manager at a company are usually not so useful. Talk to your advisor about this.

Which professors should you ask to write your letters? The letter with greatest weight will be from a professor with whom you have done research. The next most valuable letters are generally from professors from whom you have taken at least one (and preferably more!) upper-division courses in which you have done particularly well. As mentioned earlier, you should take a real interest in your courses. Professors pick up on this very quickly and it makes a positive impression. This positive impression can then be distilled into a strong and useful letter of recommendation.

A good protocol is to ask a prospective letter writer if they feel that they know you well enough to write a supportive letter of recommendation. If they say "no", don't be offended. If the person doesn't know you well enough, their letter will not be useful to you. Try someone else. Again, consult your advisor for help with this process.

6.3   The Personal Statement

One of the most challenging parts of the application process is writing a good personal statement. The strongest kind of personal statement is one that addresses the research that you have already done and the research that you hope to do in graduate school. If you haven't done research yet, you should emphasize the research that you hope to do. Here is a good template for writing such a statement. Each "Part" in the following description should be one or two paragraphs. Try to keep your personal statement to a page in length if possible.

Part 1: Describe the areas of research that interest you most. It's wise to limit this to one or two areas. Be as specific as you can be. If you're interested in computer architecture, for example, mention that. If you you know that you're particularly interested in shared memory parallel architectures, that's more specific and indicates a more refined understanding of the area.

Part 2: Indicate the courses, research experiences, or other experiences which contributed to your background in this area. If you participated in research, indicate where, when, and with whom.

Part 3: If you have participated in research, describe the problem, the techniques applied, and the results. If publications or technical reports resulted from this research, mention them here!

Part 4: Explain why you want to you go to graduate school. Next, explain why you want to go to *this particular* graduate school. Finally, if you can identify a specific project or advisor(s) at this graduate school that look appealing to you, mention that here.

7   The Logistics

The Department of Computer Science has instituted some new procedures to help our students and faculty with the graduate school admission process. These procedures are intended

to ensure that every student gets their materials submitted on time and gets good advising and guidance along the way.

First, if you plan to apply to computer science graduate schools or fellowships this year, you should file a *Graduate School Form* with Joyce Greene in the CS Department's main office *no later than October 23, 2002 at 5 PM* . Your advisor can help you with the form. Joyce has copies of the form and it is on-line as well.

Next, you should prepare a folder for each of your letter writers and give them the folder by *October 23, 2002 at 5 PM*. The folder should contain the following:

1. A photocopy of your transcripts.

2. A copy of your personal statement.

3. A page containing a list of the schools and fellowships to which you are applying with the dates that the letters are due. Please list these in increasing order of deadline.

4. The letter of recommendation forms for each graduate school to which you plan to apply. Make sure that you have filled in all of the student part of each such form.

5. Self-addressed envelopes for each of the recommendation forms. (No stamps necessary - we can do that!)

8   Other Resources

There are a number of other graduate school guides that are available on the web and elsewhere. Dr. Mor Harchol-Balter at CMU has written a very nice guide on the application process for Ph.D. programs in computer science.
(See `http://www-2.cs.cmu.edu/~harchol/gradschooltalk.pdf`.)

Jason Hong constructed a web site entitled *Starting Out at Graduate School* while he was a graduate student at U.C. Berkeley. Looking at the various documents at his site may help you get a better sense of whether graduate school is appealing to you.
(See `http://www.cs.berkeley.edu/~jasonh/advice.html`.)