Current Trends in Computer Science Graduate Admissions:
A Survey of the Top 108 Programs

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Abstract

This article addresses some questions students have when completing applications to maximize their chances for admission to graduate school. We conducted a survey of the admissions process among the top computer science programs. Our study shows how admission committees weigh different sections of an application and overall trends of admission. The results are of interest to both applicants and computer science graduate faculty.

Introduction

As one of the fastest growing disciplines in the past two decades, computer science provides a very valuable degree. From 1971 to 1986, the number of master's degrees awarded rose 508%, the fastest growth among any discipline [2]. In only twelve years, from 1980 to 1992, the number of Ph.D.s awarded annually doubled [3].

Each year undergraduates inundate administrators of graduate programs in computer science with admission applications. The limited number of openings challenges administrators to differentiate meaningfully between applicants. They use both objective and subjective factors to predict who will be successful as a graduate student. Naturally, there is no guarantee that those admitted will be the most successful; the filtering of qualified students is an intricate problem.

Universities use many factors (only a few of which are quantitative) to evaluate an applicant. As confirmed by participants of this study, few use an explicit and precise formula for deciding admission. Therefore, a dilemma arises for undergraduates desiring admission to graduate school: where to exert the most effort in their application materials in order to make a good impression. Undergraduate students find themselves concerned with the following six questions.

- Which parts of an application do administrators consider important?
- What is required for a high probability of admission?
- How important are Graduate Record Examination (GRE) scores and grade point averages (GPA) compared to other criteria?
- What are average GRE scores and GPA of admitted students?
- What other criteria are important for admission?
- Which is the best school to which a particular applicant has the highest chance of acceptance?

Each computer science department may answer the first five of these questions differently. Current literature answers unsatisfactorily these questions. The current trends of application requirements and expectations for admission are useful to both undergraduate students and to admission administrators. Therefore, this study has sampled the current state of admissions among the top 108 computer science graduate programs in the United States.

Method

In the spring of 1998, we initiated this project. The target population was the top 108 doctorate offering computer science graduate programs (from more than 150 possible Ph.D. granting programs) as listed by a study conducted by the National Research Council in 1993 [3]. We located the email address of one individual dealing with computer science admissions from each institution and opened an email correspondence. The correspondents were typically graduate coordinators, members of admission committees, or department secretaries in charge of admissions.

The project proceeded in three phases:

1. The first phase investigated the importance of GRE scores, GPA, letters of recommendation, personal statement, work experience, and other measures of application materials.
2. The second phase investigated the rate of acceptance of applicants, the average GRE scores of admitted students and the percent of admitted students that are non-US citizens. It also investigated whether the GRE computer science subject test is required and whether the department publishes its minimum admission requirements.
3. The third phase investigated the increase in the number of foreign students admitted, the usefulness of the GRE computer science subject test scores, and the average GPA of admitted students.

We sent the questions via email with a response time of

Trends

three weeks for each phase. The second phase targeted the respondents to phase one; the third phase targeted the respondents to phase two. The response rates of the first, second, and third phases were 55%, 54%, and 53%, respectively. The distribution of the respondents among the rankings of the top 108 programs was uniform for each of the three phases.

Results

Admission administrators attempt to predict who will succeed in the graduate program. Since the selection criteria correspond to institutional objectives [5], different aspects of an application may be taken into consideration. In addition, each committee member has a different approach to reviewing applications and may focus on different aspects of an application [5].

Importance of Application Materials

The standard application requires four categories of data: GPA, GRE, three letters of recommendation, and a personal statement. We first measured the perceived importance of each of these four categories; each respondent assigned each category a number between zero and five (five being of most importance).
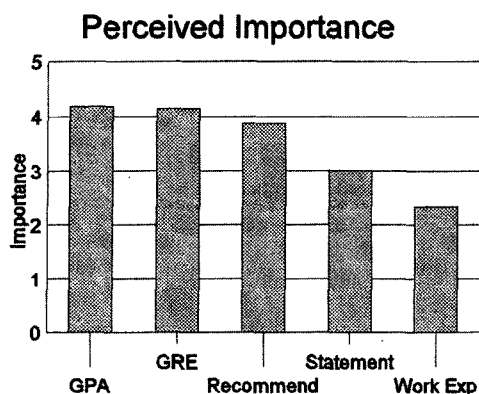

Perceived Importance

Figure 1 Average perceived importance of application materials.

Figure 1 gives the average perceived importance of each application part. In order of importance, figure 1 shows undergraduate GPA, GRE scores, letters of recommendation, personal statement, and work experience. Although both GPA and GRE scores tend to carry more weight than other portions of an application, their correlation with predicting completion of graduate school is low. A study of graduate admissions at RAND correlated GPA and GRE with completion of graduate school. The correlation with GRE verbal, quantitative, and subject scores, respectively, was 0.29, 0.31, and 0.44 for engineering related disciplines; the correlation with GPA was only 0.18 [5].

There is a significant correlation between the ranking of the admitting institution and the importance of letters of recommendation. Figure 2 shows that the higher the rank of an institution, the greater the importance placed on letters of recommendation. In addition, respondents from highly ranked universities placed greater emphasis on a

recommendation written by a reviewer known to them.

Table 1 lists other considerations in the admissions process. Research and publications are a great asset, followed by the strength of the student's computer science background.
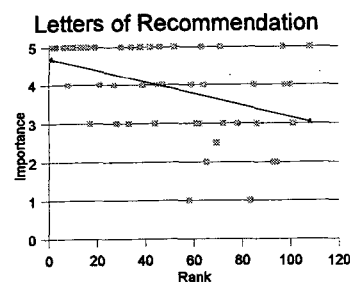

Letters of Recommendation

Figure 2 Importance of letters of recommendation by institution ranking. Correlation coefficient: -.42

# times mentioned	Other considerations by respondents
12	Research experience
7	Publications
5	Strength of undergrad program
5	CS / Mathematical strength
5	Match with faculty interests
3	Personal interview
2	Academic prizes and honors
1	Previous CS TA/RA experience
1	Other life experiences which indicate the self-discipline crucial to write a thesis or dissertation

Table 1

Students must remember that universities consider separately each part of an application. Each applicant is unique and accordingly, universities process applications in a special way. An application strong in research or with an exceptional letter of recommendation may override low GRE scores. An application with a negative letter of recommendation may nullify impressive GRE scores. In fact, five respondents stated that no part of the application is most important. In addition, respondents expressed the following four difficulties in determining an overall scale of importance. They are:

* GPA is not an accurate measure due to grade inflation (some schools maintain tables to "convert" a GPA by school)
* GPA does not measure the quality of the undergraduate college.
* GRE scores are not an accurate measure due to GRE preparation classes or temporary factors the day the student takes the test such as illness.
* Low GRE scores may reflect a student's deficiency with test taking rather than a lack of knowledge.

Applicants expect admission to be harder to a highly ranked program; figure 3, which confirms this truism, shows the substantial correlation between an institution's rank and its rate of acceptance.
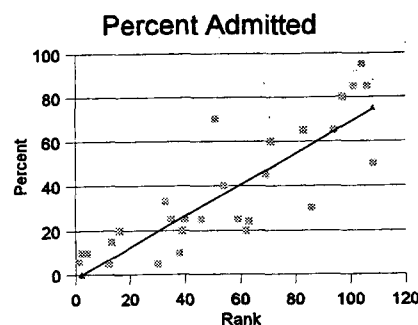

Percent Admitted

Figure 3 Percent of applicants accepted by institution ranking. Correlation coefficient: .82

Foreign Student Admission Rates

A large part of the inundation for computer science graduate admission comes from the growing number of foreign students applying to graduate programs in the United States. Figure 4 shows the strong correlation between percent of foreign students (in the population of accepted applicants)

Percent Foreign Admitted
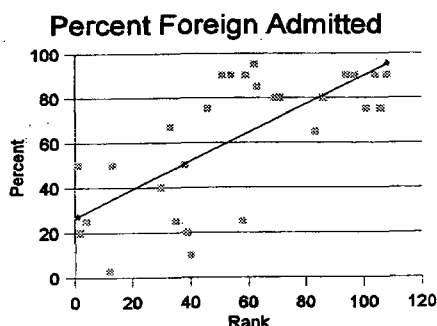
Figure 4 Percent of foreign students in the population of accepted applicants by institution ranking. Correlation coefficient: .71

and institutional ranking. A study reporting data from 1980 to 1990 [4] indicates "a very high and growing proportion of foreign students among Ph.D. graduates, and thus among graduate students and teaching assistants." The National Research Council reported in 1995 [3] the percentage of doctorates in computer science awarded to US citizens by institution. Almost two-thirds of the responses to our study indicated a much larger percentage of admitted foreign students than before.

When we asked our correspondents if they had noticed a significant rise in applications from foreign students in the past five years, 82% of them responded affirmatively and provided two distinct reasons:

- The United States economy's high demand for computer scientists in industry lures away U.S. undergraduates from graduate work
- A new policy in the People's Republic of China permits more graduate students to study abroad.

In combination, these have resulted in the significant growth of foreign applications. As an example of the rise in foreign applications, one mid-ranking school reported that 886 foreign students have requested applications as compared to only 20 U.S. students. Although there has been a rise in foreign applicants admitted, foreign students enroll less frequently than admitted U.S. students. One response indicated that 20% of admitted foreign students enroll, whereas 60% of admitted U.S. students enroll.

Quantitative Scores of Admissions

Quantitative scores are easiest for an institution to evaluate. Two-thirds of the respondents indicated their schools have set minimum GRE scores and GPA for admission, and that

without higher than minimum scores it is not realistic for a student to expect admission. In a study of master's programs in 1991, the average minimum acceptable GRE scores and GPA figures for admission were reported (see table 2) [2].

|	GRE				GPA	
	Verbal	Quant	Analyt	CS	Total	CS
Avg.	473	650	592	652	3.0	3.1
%ile	51	73	71	66		

Table 2 Average of minimum acceptable GRE and GPA figures for admission (Adapted from [3]).

As mentioned previously, GPA is a questionable measure for admissions because of varying quality of the undergraduate institution and grade inflation. The average GPA among responding schools was between 3.3 and 3.7 (on a 4-point scale) with higher-ranking institutions having a higher average (figure 5).

Figure 6 shows the average admitted student's GRE scores.
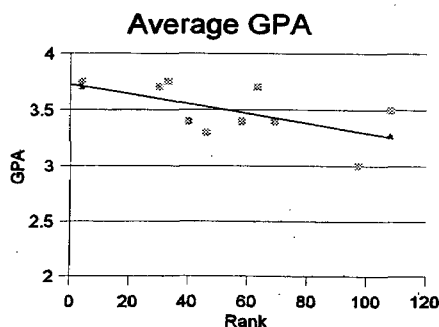
Average GPA

Figure 5 Average GPA of admitted students by institution ranking. Correlation coefficient: -.60

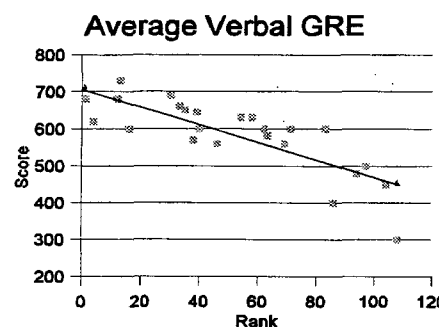### Average GRE Scores
Admitted Students
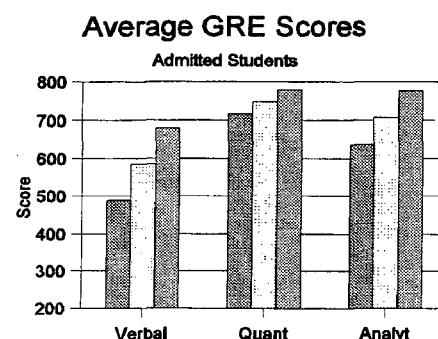
Figure 6 Mean GRE sub scores and corresponding scores within one standard deviation.

Typically, quantitative scores are higher than analytical scores, which are higher than verbal scores. An analysis of the average GRE scores, as reported in the ACM graduate assistantship directory, has yielded parallel results [1].

Our survey has found a slight difference between the verbal scores reported by our survey and the verbal scores contained in the ACM graduate assistantship directory. (Compare figures 7 and 8.) If we exclude scores from institutions ranking lower than 80 (there was no score in the ACM directory for such institutions) [1], the linear fit of the data matched closely. (Compare figures 8 and 9.)

The verbal score shows a distinct correlation to institutional ranking; institutions of higher

Average Verbal GRE

Figure 7 Average verbal GRE score by institution ranking. Correlation coefficient: -.80

ACM Verbal GRE

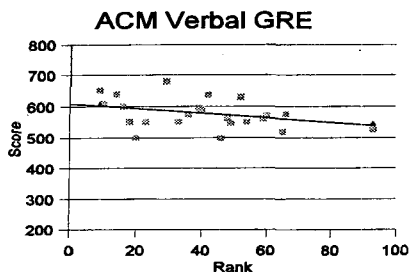**Figure 8** Average verbal GRE scores by institution ranking reported in [1]. Correlation coefficient: -.40
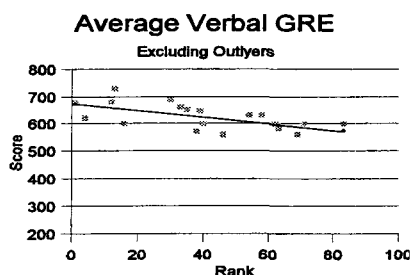
Average Verbal GRE
Excluding Outlyers

Figure 9 Average GRE Verbal score by institution ranking excluding outliers from figure 7. Correlation coefficient: -.65

rank tend to have a much higher GRE verbal average (figure 7). This phenomenon relates to the tendency for higher-ranking institutions to admit fewer foreign students as illustrated by figure 4. Nonnative English speakers struggle with the verbal section. At lower ranking schools where more foreign students are accepted, the GRE verbal average is lower.

Acceptance of the GRE Computer Science Subject Test

The most highly varying requirement between institutions is the GRE computer science subject test. Table 3 shows the difference of opinion regarding the significance of the examination. Almost 60% require or recommend the computer science GRE; only 40% do not require it.

Required	38%
Recommended	21%
Not Required	41%

Table 3 Percent of institutions requiring or recommending the GRE Computer Science subject test.

The importance of the GRE CS subject test has grown since 1991 when 25% of the Ph.D. institutions required it [2]. Increasingly, universities perceive the GRE computer science subject test as an essential part of the admissions process. Comments on the pragmatic use of the computer science subject test include:

- Helps evaluate the applicant's computer science background.
- Helps determine recipients of assistantships.
- Helps in borderline cases.

- Not helpful if the applicant has a non-computer science background.

Conclusion

What can U.S. computer science undergraduates do to better their chances of getting into a graduate school? They cannot change their GPA much by the senior year. However, students can prepare for the GRE general and computer science subject tests (which are weighted the same as the GPA). If students discover they have poor verbal test scores, they should probably apply to lesser-ranked schools. If students score well on the GRE subject test, they can send the score to a highly ranked school. If they score poorly on the GRE subject test, they can swallow the score and apply to the 40% of schools that do not require the subject GRE.

Additionally, students can approach faculty members at the beginning of their senior year and mention that they are going to ask them for a letter of recommendation. Attending graduate seminars and working gratis in a faculty member's research lab can help professors write better letters. The key is to have a letter writer who knows the student.

Many factors play a part in admissions decisions. Neither purely subjective means nor purely objective means can facilitate an accurate evaluation of an application. Commonly used quantitative measures may inaccurately predict success in graduate school. Yet, educators continue to rely on them more than any other section of an application. The National Research Council reported, "it is not possible to provide a valid description of the quality of program by any method that relies exclusively on a single number" [3]. If we cannot reduce a program to a single number, how much less can we reduce an applicant to numbers!

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*   *Editor's Note*
At the time of the writhing of this article, Travis Nielsen was an undergraduate student at Bringham Young University. He has recently graduated from its computer science program