

# International versus US student enrollment into Graduate Programs in Computer Science

Sravanthi Munagala<sup>1</sup>, Sumanth Yenduri<sup>2</sup>, Louise A. Perkins<sup>3</sup>, Farnaz Zand<sup>4</sup>

**Abstract-** This paper discusses the variations in the international student enrollment in graduate programs in the recent years in universities in the United States. The focus is on the variations of enrollments in graduate programs in the fields of Science and Engineering with an emphasis on Computer Science. In a recent survey by the Council of Graduate Schools (CGS), it was noted that US graduate school enrollment increased by 12% since 2005. It was also noted that the biggest changes were in the fields of engineering and business. The survey also talked about the growing number of students from other countries such as China and India in the recent years. This paper discusses the survey data of CGS and Taulbee surveys with respect to variations in international student enrollment, particularly in Computer Science (CS).

**Keywords:** International Student Enrollment, Computer Science

## INTRODUCTION

In the US, graduate education has become a successful enterprise, serving the important needs of sustaining US leadership in various fields. It is an approximate \$13 billion dollar industry. Many Science and Engineering (S&E) programs in the US rely greatly on foreign students and skilled workers. Enrollment of international students has waxed and waned in the past decade.

The 2004 *CGS International Graduate Admissions* survey found sharp declines in both the number of applications and enrollment of international students in US universities. The 2005 survey reported a 5% decline in applicants and a 1% increase in first-time enrollment between 2004 and 2005. There was a 12% increase in both applicants and admission offers in the 2006 survey. The 2006 CGS survey suggests that US universities are beginning to see improvements in international admission and enrollment. Though the 1% growth in 2006 may seem little, it is a notable improvement over 2005 results, which showed a 3% decrease in total international students. The 25 institutions with the largest populations of international students had a 1% increase in total international enrollment this year, after a 2% drop in 2005. India, China, and Korea are the top three countries for providing international students in the US. This fall (2006), students from these three countries accounted for 53% of all non-U.S citizen graduates at various US universities that participated in the survey (see Table 1). This encourages focusing on these three countries which are hugely responsible for changes in international student enrollment over the years. Though students from countries in the Middle East were included, they only accounted for about 5% of total international enrollment. About 73% of international graduate students enrolled at the institutions that participated in the survey were in fields of business, engineering, social sciences, physical sciences, and life sciences. Engineering and business gained in total number of international graduate students in 2006 while other fields declined [1].

---

<sup>1</sup> Graduate Student, University of Southern Mississippi, Department of Computer Science, 730 East Beach Blvd, Long Beach, MS 39560, [Sravanthi.Munagala@usm.edu](mailto:Sravanthi.Munagala@usm.edu)

<sup>2</sup> Assistant Professor, University of Southern Mississippi, Department of Computer Science, 730 East Beach Blvd, Long Beach, MS 39560 [Sumanth.Yenduri@usm.edu](mailto:Sumanth.Yenduri@usm.edu)

<sup>3</sup> Professor, University of Southern Mississippi, Department of Computer Science, 730 East Beach Blvd, Long Beach, MS 39560 [Louise.Perkins@usm.edu](mailto:Louise.Perkins@usm.edu)

<sup>4</sup> Assistant Professor, University of Southern Mississippi, Department of Computer Science, 730 East Beach Blvd, Long Beach, MS 39560 [Farnaz.Zand@usm.edu](mailto:Farnaz.Zand@usm.edu)

|                          | Admissions,<br>2004 to<br>2005 | Admissions,<br>2005 to 2006 | First-Time<br>Enrollment,<br>2004 to<br>2005 | First-Time<br>Enrollment,<br>2005 to<br>2006 | Total<br>Enrollment,<br>2004 to<br>2005 | Total<br>Enrollment,<br>2005 to<br>2006 |
|--------------------------|--------------------------------|-----------------------------|----------------------------------------------|----------------------------------------------|-----------------------------------------|-----------------------------------------|
| International Total      | 3%                             | 14%                         | 1%                                           | 12%                                          | -3%                                     | 1%                                      |
| <b>Country of Origin</b> |                                |                             |                                              |                                              |                                         |                                         |
| China                    | -5%                            | 24%                         | 3%                                           | 20%                                          | -2%                                     | -2%                                     |
| India                    | 8%                             | 26%                         | 3%                                           | 32%                                          | -4%                                     | 8%                                      |
| Korea                    | 7%                             | 4%                          | 5%                                           | 5%                                           | -4%                                     | -3%                                     |
| Middle East*             | 12%                            | 6%                          | 11%                                          | -1%                                          | 1%                                      | 1%                                      |
| <b>Field of Study</b>    |                                |                             |                                              |                                              |                                         |                                         |
| Business                 | 0%                             | 15%                         | 7%                                           | 10%                                          | -3%                                     | 1%                                      |
| Education                | -3%                            | 9%                          | -15%                                         | 8%                                           | -8%                                     | -9%                                     |
| Engineering              | 3%                             | 27%                         | 3%                                           | 22%                                          | -6%                                     | 3%                                      |
| Humanities and Arts      | -1%                            | -6%                         | -2%                                          | -6%                                          | 1%                                      | -7%                                     |
| Life Sciences            | -2%                            | 4%                          | -1%                                          | 2%                                           | -5%                                     | -1%                                     |
| Physical Sciences        | 8%                             | 7%                          | 1%                                           | 5%                                           | -1%                                     | -4%                                     |
| Social Sciences          | -1%                            | 3%                          | -2%                                          | 3%                                           | -4%                                     | -2%                                     |

---

*Sources: 2005 & 2006 CGS International Graduate Admissions Survey III: Admissions and Enrollment.*

\*Middle East countries include: Bahrain, Cyprus, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestinian Authority, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates, Yemen

---

Table 1. Percentage change in International admissions and total enrollment into US institutions in 2004-2005 and 2005-2006 [1].

As noted above, both international graduate enrollment and undergraduate enrollment have undergone changes in the past couple of years. In the next section, the changes in international graduate enrollment based on the CGS and Taulbee surveys with respect to Computer Science (CS) are noted. Also, enrollments of US students in comparison with that of international students in graduate programs are discussed.

## DISCUSSION OF SURVEYS

Though graduate enrollment in science and engineering programs increased slightly in 2004, the number of first-time, full-time enrollment among international students decreased. Graduate enrollments in computer science declined as well (See figure 1). In 2003, CS was the only science and engineering field to see a decrease in enrollment. In 2004, it dropped further. The number of first-time, full-time graduate enrollments in CS fell by 6.2% among US citizens & permanent residents, and 3% among non-citizens [2].

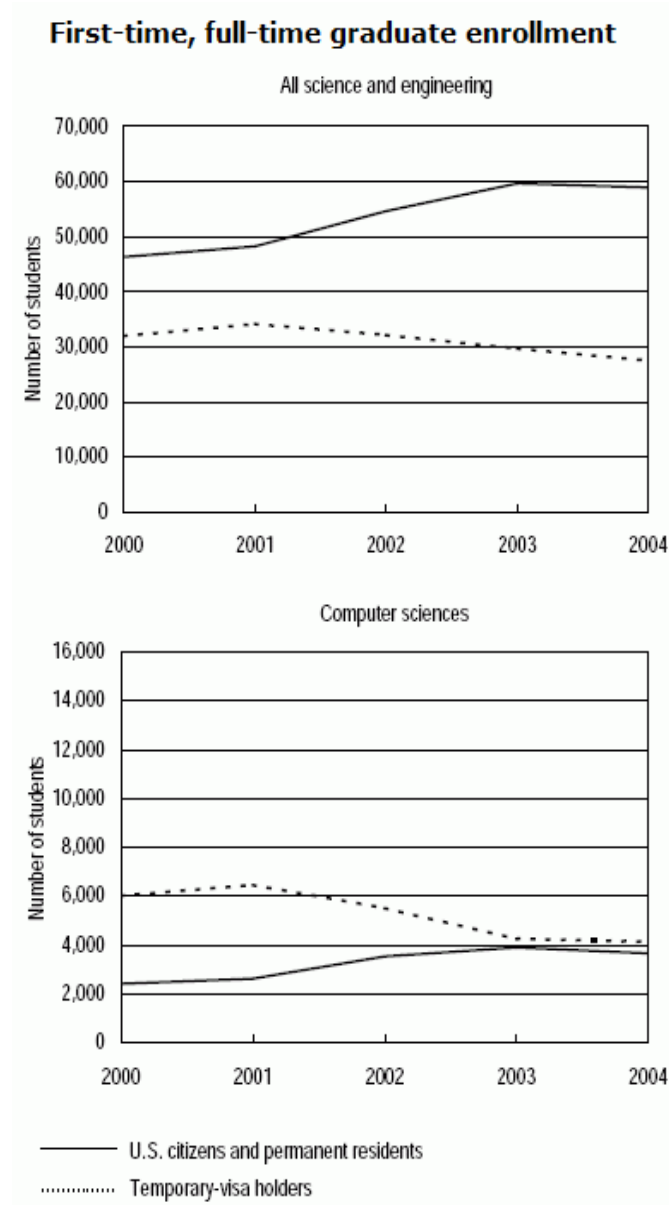


Fig 1. First-time, full-time graduate enrollment in CS [2]

S&amp;E graduate enrollment, by field: 1999-2004

| Field                                     | 1999    | 2000    | 2001    | 2002    | 2003    | 2004    | % change<br>2003-04 |
|-------------------------------------------|---------|---------|---------|---------|---------|---------|---------------------|
| All S&E fields                            | 411,182 | 413,536 | 429,242 | 454,892 | 474,694 | 476,331 | 0.3                 |
| Science                                   | 309,491 | 309,424 | 319,749 | 335,224 | 347,317 | 352,630 | 1.5                 |
| Computer sciences                         | 42,478  | 47,350  | 52,196  | 55,269  | 53,696  | 50,331  | -6.3                |
| Earth, atmospheric,<br>and ocean sciences | 14,083  | 13,941  | 13,841  | 14,240  | 14,620  | 15,110  | 3.4                 |
| Mathematical sciences                     | 16,257  | 15,650  | 16,651  | 18,163  | 19,465  | 19,873  | 2.1                 |
| Physical sciences                         | 30,691  | 30,385  | 31,038  | 32,341  | 34,298  | 35,772  | 4.3                 |
| Psychology                                | 51,727  | 50,466  | 50,467  | 51,165  | 52,211  | 54,052  | 3.5                 |
| Social sciences                           | 84,984  | 83,327  | 85,682  | 90,215  | 95,129  | 97,527  | 2.5                 |
| Engineering                               | 101,691 | 104,112 | 109,493 | 119,668 | 127,377 | 123,701 | -2.9                |

SOURCE: National Science Foundation/Division of Science Resources Statistics, Survey of Graduate Students and Postdoctorates in Science and Engineering.

Table 2. Graduate Enrollment, by field in numbers, during 1999-2004 in US institutions [2].

About 70 percent of full-time, first-time graduate students enrolled in CS were international students in 2000 and 2001. By 2003, however, it declined to 52 percent. Only CS saw a significant decline in 2002 and 2003. This indicator (first-time, full-time enrollment in graduate study) shows vital changes in the number of international students with numbers dropping between 2001 and 2003 [3]. The 2 year decline in mathematics & computer science was 28% and in engineering fields it was 17%. In the past two decades, two-third doctorates earned in Science and Engineering programs in the US were by international students from Asia. China accounted for 20%, Taiwan, India and South Korea accounted for 10-11% each. But, many other countries like Japan are now attracting these qualified students and engineers from Asia by creating immigrant-friendly policies [4]. Following several years of increases, the total number of bachelor's degrees granted in CS fell 17 percent during 2004-2005 (See Fig. 2). During 1980-1986, undergraduate CS production quadrupled but there was a swift decline in the 1990s. CS degree production surged in the late 90's but started to decline because of the economic recession and a weak job market since early 2000. Figure 3 depicts graduate enrollment in Computer Sciences by Citizenship, race/ethnicity during 1983-2003 [5]. The median annual salaries of computer and information sciences (CIS) graduates with bachelor's degrees earned a salary of \$45,000, and those with master's degrees earned a salary of \$60,000 in 2003 [6].

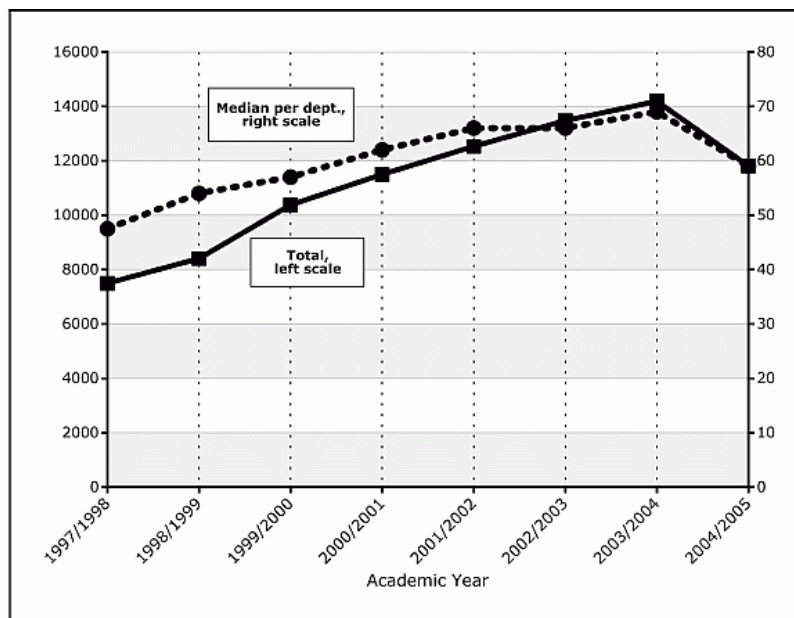


Fig 2. CS undergraduate degrees granted during 1997-2005 in US institutions, Source: CRA Taulbee Survey [5]

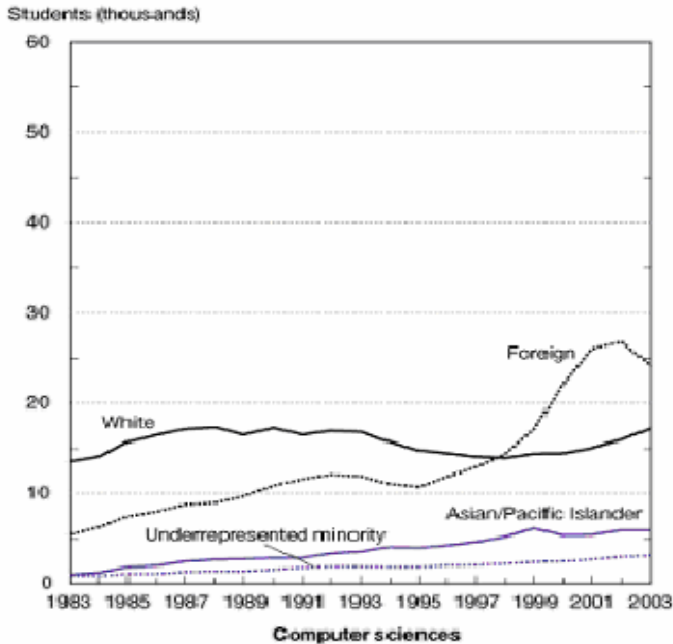


Fig. 3 Graduate Enrollment in Computer Sciences and in Engineering, by Citizenship, race/ethnicity 1983-2003 in US institutions [4]

While initial problems with communication in English language, unfamiliarity with American teaching/grading methods and policies, irregular course placement may be a few factors for low enrollment and admissions, the most important factors during 2000-2004 were economic recession and off-shore development. While economic recession tends to increase enrollment in schools (US citizens), international enrollment went the other way. Many international students (already enrolled in US institutions) did not graduate during the period, accounting to the lack of jobs. This resulted in departments not offering many admissions as they maintain policies on the number of international students in their graduate programs. The limit of international students in graduate programs arises from the availability of funds to support them.

The outsourcing of jobs in various fields, particularly to India and China, which have been the top countries to provide international students for graduate education in the US is a strong factor for low enrollments. Both the countries have been experiencing an economic growth of more than 8% an year. One of the reasons for this growth has been outsourcing of jobs. The sudden boom of jobs in these countries is making undergraduate to discontinue further studies. Economic recession in the US was at its peak during 2000-2004, which made it even worse. However, recent surveys have shown increases in both enrollment and admissions. This might be attributed to the end of recession and a growing job market within the US in recent years. Many graduate schools have also increased their direct recruitment of international students. The CGS survey results also show very strong year-by-year increases in offers of admission to international students seeking graduate-level studies in the US. During 2005-2006, the total number of graduate school admission offers to non-U.S. citizens rose 14% which is a significant increase over the 2004-2005. There were also large increases in admission offers by country also with offers of admission to students from China jumped 24% in 2006, versus a decline of 5% in 2005, offers of admission from India rose 26% in 2006 versus an 8% rise in 2005. The results suggest that there has been an improvement in the past few years when compared to the period during 2000-2004.

## CONCLUSIONS

The enrollment of graduate students in computer science has dropped since Sept. 11, 2001. CS has seen a further decline during the years 2002-04. Economic recession and outsourcing of jobs can be accounted to a large extent. Recent enrollments suggest a probable increase since 2004. Many universities are recruiting more students since

2004. This may be a prospect for the US software industry as more and more employers are relying on foreign born students and workers. Though the numbers from the past two years suggest improvement in the international student enrollment, there are chances that these improvements may not follow through in the coming years. Many countries are now realizing the potential of these foreign born students and employees who bring enormous knowledge and strength along with them, and are creating immigrant-friendly policies and the infrastructure in order to attract them. The current job market obviously encourages many students to opt computer science because of the high median annual salary when compared to many other science and engineering programs. Universities need to exercise new marketing programs overseas in order to recruit these students and the government has to support by making necessary amendments to immigration policies.

## REFERENCES

- [1] Kenneth and Emily, [http://www.cgsnet.org/portals/0/pdf/R\\_intlenrl06\\_III.pdf](http://www.cgsnet.org/portals/0/pdf/R_intlenrl06_III.pdf), "Findings from the 2006 CGS International Graduate Admissions Survey Phase III", "Council of Graduate Schools", Washington, DC, 2006.
- [2] Jay, <http://www.cra.org/wp/index.php?cat=18>, "Graduate Enrollments in S&E Rise Slightly in 2004, Drop in CS", "Computing Research Association", Washington, DC, July 2006.
- [3] Jay, <http://www.cra.org/wp/index.php?cat=42>, "Foreigners and Graduate-Level Computer Science in the US", "Computing Research News", Vol.18/No. 3, May 2006.
- [4] Jay, <http://www.cra.org/wp/index.php?cat=44>, "More International Students admitted to US Graduate Schools", "Computing Research Association", Washington, DC, September 2006.
- [5] Jay, <http://www.cra.org/CRN/articles/march06/vegso.html>, "Drop in CS Bachelor's Degree Production", "Computing Research News", Vol. 18/No. 2, March 2006.
- [6] <http://www.cra.org/wp/index.php?cat=31>, "Salaries of S&E Bachelor's and Master's Degree Recipients", "Computing Research Association", Washington, DC, December 2005.

### **Sravanthi Munagala**

Address: 730 East Beach Blvd, Computer Science Dept., USM, Long Beach, MS 39503

E-mail: [Sravanthi.Munagala@usm.edu](mailto:Sravanthi.Munagala@usm.edu)

Other Info: Sravanthi Munagala is a Master's student at University of Southern Mississippi, Gulf Coast Campus. She graduated with a Bachelor's in Computer Science in May 2006 from Nagarjuna University, India.

### **Sumanth Yenduri**

Address: 730 East Beach Blvd, Computer Science Dept., USM, Long Beach, MS 39503

E-mail: [Sumanth.Yenduri@usm.edu](mailto:Sumanth.Yenduri@usm.edu)

Other Info: Sumanth Yenduri is an Assistant Professor in the Computer Science Dept, at University of Southern Mississippi, Gulf Coast Campus. He graduated with a PhD in Computer Science from Louisiana State University in 2005. His research interests are Software Engineering and Programming Languages. He has published around 18 refereed journal and conference publications.

### **Arlene Louise Perkins**

Address: 730 East Beach Blvd, Computer Science Dept., USM, Long Beach, MS 39503

E-mail: [Louise.Perkins@usm.edu](mailto:Louise.Perkins@usm.edu)

Other Info: Louise Perkins is a Professor in the Computer Science Dept, at University of Southern Mississippi, Gulf Coast Campus. She has published over 60 refereed journal and conference publications.

### **Farnaz Zand**

Address: 730 East Beach Blvd, Computer Science Dept., USM, Long Beach, MS 39503

E-mail: [Farnaz.Zand@usm.edu](mailto:Farnaz.Zand@usm.edu)

Other Info: Farnaz Zand is an Assistant Professor in the Computer Science Dept, at Univ., of Southern Mississippi, Gulf Coast Campus. She graduated with a PhD in Computer Science from Univ., of Southern Mississippi in 2006.