

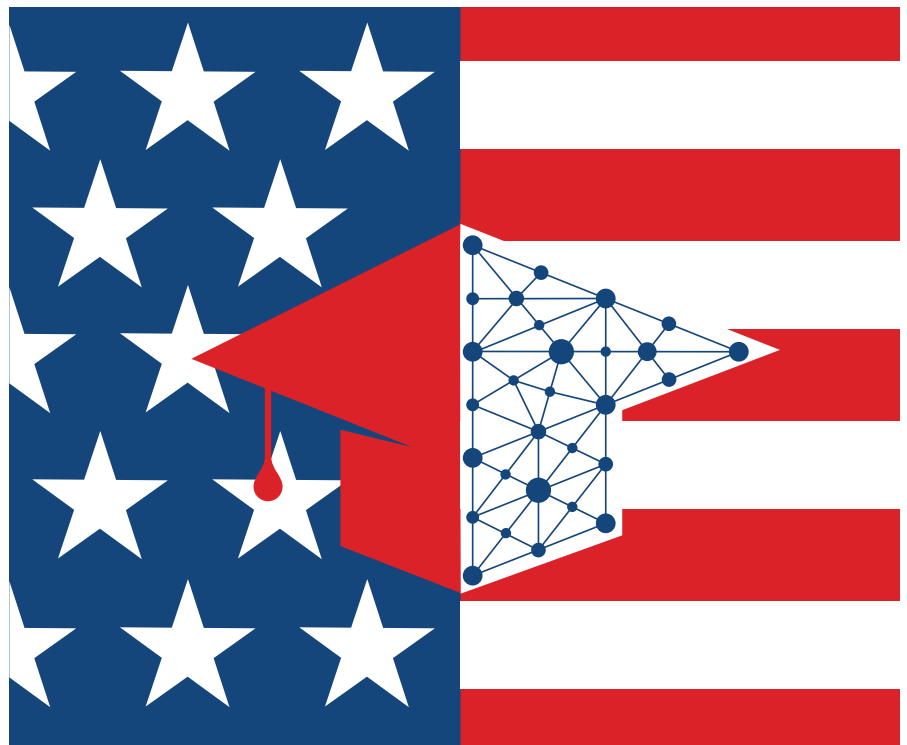
Viewpoint

The Domestic Computer Science Graduate Students Are There, We Just Need to Recruit Them

Proven practices to recruit domestic computer science graduate students.

IN THE “VARDI’S INSIGHTS” column, “Where Have All the Domestic Graduate Students Gone?”, in September 2020 *Communications* (p. 5), Moshe Vardi stated: “Graduate programs admit so many international students not only because they have strong international applicants, but mainly because they do not have qualified domestic applicants.” The authors of this Viewpoint agree with the points Vardi made in his column that the U.S. should welcome international computer science (CS) graduate students. However, we believe it is important to try to convince qualified domestic CS undergraduate (UG) students to attend graduate school as it can be beneficial to both the students and the nation to do so. In this Viewpoint, we share the approaches we have successfully utilized in the Florida State University (FSU) Department of Computer Science to increase the number of domestic CS graduate students.

In the past it had been the policy in the State of Florida that the State would provide a tuition waiver to all graduate students at Florida public state universities who were supported by a teaching or research assistantship. Between 1995 and 2005, the State of Florida made a sequence of changes



to the way it would fund the state university system. One consequence of those shifts was that each university would need to take responsibility for providing tuition waivers. FSU decided it was important to not require any FSU graduate student on support to pay tuition even without the funding support from the State of Florida and decided

to use its own funds to provide free tuition to these students. FSU was faced with a dilemma since many of its graduate students were international. Unlike domestic students, international students cannot qualify for in-state residency after 12 months and out-of-state tuition is much more expensive than in-state tuition. At FSU, this



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quickly led to a necessary balancing of tuition liability by optimizing the mix between domestic and international graduate assistants, an action that would require increasing the fraction of funded domestic graduate students.

The FSU Computer Science Department in the 1990s and early 2000s had a very large fraction of CS graduate students who were international students. Most of the domestic CS UG students in the U.S. have employment options after graduation that are not available to many CS UG students in developing countries. Most of FSU's CS international graduate students are from three countries: China, India, and Bangladesh. We have very few FSU CS international graduate students from Western Europe. From our discussions with our European colleagues, they face the same challenge of convincing their CS UG students to obtain a graduate degree.

We decided that we needed to educate our CS UG students about the merits of attending graduate school in order to recruit them into our graduate program. Our initial attempts included sending email to the CS UG students, having individual faculty talk to students about graduate school in senior classes, and holding advertised meetings where we provided pizza to encourage students to attend and learn about the merits of going to graduate school. These efforts had little success as they did not significantly increase the number of domestic applicants to our graduate program.

Conventional methods of distributing graduate school information to domestic CS undergraduate students are ineffective.

Effective Solutions

The next strategy we attempted was to have the FSU CS department chair individually meet with qualified CS UG students. The chair sends individual email messages to each FSU CS or computer engineering (CE) senior who meets a specified GPA requirement that is indicative of likely success in the FSU CS graduate program. The chair instructs each of these students to contact the department secretary to set up an appointment to meet with him/her and does not inform them of the reason for the meeting. Very few UG students will refuse a request to meet with the department chair. When the student arrives at the meeting, the chair and often one other faculty member (for example, the CS Director of Graduate/Undergraduate Studies) would together meet with each student. We compliment the student on his/her performance in their UG studies and ask the student about their plans after graduation. Most of the students will reply that they plan on getting a job. We ask them if they have considered going to graduate school. Most of the students reply that they had not considered this option. We then describe the merits of obtaining a CS graduate degree, including:

- CS graduates with an MS or Ph.D. can be hired by companies or government agencies that would normally not consider hiring BS CS graduates. One of us describes his own experience of the types of jobs that he was offered when completing his BS CS degree versus the types of jobs he was offered when completing his MS CS degree.

- MS CS graduates receive significantly higher pay on average than BS CS graduates and we provide the statistics on average salaries for FSU CS student graduates to show that getting an MS degree makes financial sense. If a student expresses any interest in getting a Ph.D., we point out that salaries at academic institutions tend to be lower than the Ph.D. salaries in industry and are often significantly lower for academic institutions with only UG students.

- MS CS and Ph.D. CS graduates obtain positions that often provide more fulfilling and enjoyable work. For instance, many companies will hire a BS CS graduate to be a test engineer while an MS CS graduate hired at that same company will develop software and/or

hardware for a product. We mention that many Ph.D. graduates decide to take academic positions despite receiving lower salaries because they find teaching and research more fulfilling than supporting the development or maintenance of a product in industry.

► We also describe the types of support that are offered by the FSU CS Department for graduate students, which include fellowships, research assistantships, and teaching assistantships. We explain that they will not have to pay any tuition if they are on support from the department. While we point out that a CS graduate student will not get wealthy from their graduate stipend, we show them that their pay is enough to support themselves without assistance from their parents or a student loan. We also point out that each FSU CS graduate student who is on support is assigned a desk in an office where they can study and perform their assigned duties.

► The FSU CS Department also established combined BS/MS programs, where a student can take up to four CS graduate courses and have these courses also count as CS undergraduate electives. We encourage all of the qualified CS UG students to enter these combined BS/MS programs to see how they would like taking graduate courses. The FSU CS faculty member who is the Director of Graduate Studies meets individually with these UG students in the combined BS/MS CS program each semester to provide advice about which graduate courses they should consider taking. Students who successfully complete one or more CS graduate courses gain confidence in their ability to obtain a CS graduate degree. We also point out that students who have taken three or more CS graduate courses by the time they complete their BS CS degree will very likely reduce the time they spend in their CS graduate studies by one semester.

Many CS faculty assume CS UG students are knowledgeable regarding the benefits of getting a graduate degree. Our experience with these individual meetings taught us that this is far from the truth: Many CS UG students, including high-achieving students, have very little knowledge about graduate school, including the benefits of getting a graduate degree, the typical activities of a graduate student,

Recruiting domestic CS graduate students is possible, but it does take time and effort.

financial aid for graduate students, as well as the application process. For some reason, conventional methods of distributing graduate school information to domestic CS UG are ineffective. We suspect that some of these students may be the first in their family to attend a university and very often are the first in their family to enroll in a CS UG degree program. Given that CS domestic students usually have employment options when they graduate with a bachelor's degree, many of them will not even consider applying to a graduate program.

Over the years, these meetings with individual prospective graduate students have enjoyed great success. We believe these meetings not only benefited our department, but also the students. Note we are not advocating for recruiting UG students into the graduate program of the same school. Rather we emphasize that there are untapped qualified potential domestic applicants and that we must do a better job in reaching this group. If all U.S. universities can find effective methods to reach these potential applicants, the nation may not be in the situation of lacking domestic CS graduate students.

The FSU CS Department has also attempted to recruit domestic graduate students from other institutions. One approach that we have taken is to provide a travel reimbursement to visit the department for any admitted student with financial aid (fellowship, teaching assistantship, or research assistantship) to our CS graduate program that is currently residing in the lower 48 U.S. states. Most of these students are domestic students. We set up a schedule where the student will individually meet with FSU CS faculty during half-hour time slots. In contrast, many other departments will arrange a

single time for all prospective students to visit their department. We have had many students state they were very impressed that our faculty spent the time to individually meet with them. Most of our CS faculty members are willing to spend the time to meet with these students as they realize that it is to their benefit to recruit as many well-qualified students into the FSU CS graduate program as possible.

One Step at a Time

We have found it is often difficult to convince CS UG domestic students to directly enroll in a Ph.D. program as that is a significant commitment of both time and effort. Obtaining an MS CS degree is viewed as much less formidable than obtaining a Ph.D. CS degree to the average CS UG student. We encourage our MS CS students to choose the MS thesis option so they can get some experience with CS research. A number of our FSU CS faculty members are willing to work with MS CS students on research projects as it is possible to get these students to accomplish some good research, and some of our best MS CS students do decide to stay for a Ph.D.

The FSU CS Department has also obtained grants from the NSF Cybercorps Scholarship for Service (SfS) program, which provides a number of scholarships for MS CS students. These SfS scholarship students are required to work for a government agency or a federally funded research and development center (FFRDC) after they graduate for a number of calendar years that is equivalent to the number of academic years of support they received from their scholarship. This SfS scholarship program requires the student either be a U.S. citizen or a U.S. permanent resident. We find the financial benefits of the SfS program are an excellent incentive for our students to obtain an MS CS degree. We do encourage students to not enroll in the SfS program if they are considering getting the Ph.D. degree as the service requirement may delay them from enrolling in a Ph.D. program.

The FSU CS Department also encourages our faculty members to actively recruit CS UG domestic students, often the top performers in their classes, into the FSU CS graduate

program. Many of the FSU CS faculty members apply for an NSF Research Experience for Undergraduates (REU) supplement after obtaining an NSF grant or apply for other types of UG research grants. Few CS UG students will turn down an opportunity to get paid for working on a CS research project. CS UG students who become excited about working on a research project are much more likely to enroll in a CS graduate program and eventually get a Ph.D. degree.

FSU CS Domestic Graduate Student Data

We realize the number of CS domestic graduate student applications can be affected by many factors. During recessions, domestic students are more likely to apply to graduate school as there are fewer employment opportunities. The economies in other countries can have an indirect impact on the number of domestic students who are awarded financial aid. In recent years, there has been a significant decline in the number of FSU CS graduate student applicants from India, which we believe is due,

in part, to the improved employment opportunities in their economy. The timeliness of processing the graduate student applications to admit students and award financial aid can vary depending upon the efficiency of the CS graduate student admissions and financial aid committee and the office staff member who processes the CS graduate student applications. Both the composition of this committee and the CS staff member who processes the graduate student applications can change over time. Graduate student stipends can affect whether or not an applicant decides to enroll in a graduate program. The number of CS UG students affects the number of domestic CS graduate applicants, as we can get more applicants when there is a larger pool of CS UG students qualified to enter a CS graduate program. We found it became easier to recruit CS domestic students over the years as role models are important. Once a CS UG domestic student's friends start to attend a CS graduate program and these CS UG students are exposed to more domestic CS graduate teaching assistants, then they are much

more likely to apply and attend a CS graduate program themselves.

Despite the effects of these various other factors, we believe we can still show that our efforts to recruit CS domestic graduate students has had a positive impact. The accompanying figure shows the FSU CS domestic graduate student data for each calendar year from 2012–2020, which had similar improving economic conditions each year. We decided to report this information in calendar years as we tend to have individual meetings with prospective CS domestic graduate students in the Fall semesters. Note that the number of FSU CS UG students has been significantly increasing from 2012, but has become more stable since 2016. Similar increases in CS UG students have been seen across the nation. Having more CS UG students affects the number of prospective graduate students. From 2012–2015, the numbers of FSU CS graduate students applied and enrolled are significantly lower than those in more recent years. We believe this was in part due to the individual meetings with prospec-

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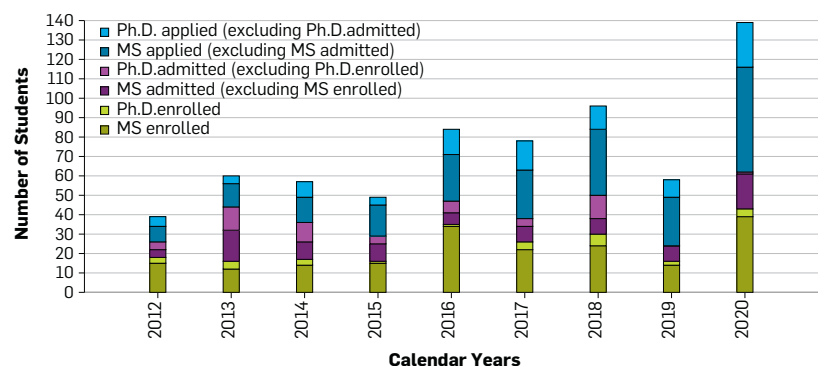
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tive graduate students from our own department being suspended in Fall semesters 2011–2013, which affected the number of FSU domestic CS graduate applicants from 2012–2014. From 2014–2020, we resumed our normal individual meetings with prospective graduate students from our own department. However, in 2014, the current graduate coordinator staff member to process the graduate student applications resigned and a replacement was not hired for several months, which resulted in some applications not being processed on time and caused some students to not complete the application process or enroll for the 2015 cycle. Thus, we also had a lower number of domestic CS graduate student applicants in 2015. One can see a significant improvement in applications and enrolled CS domestic graduate students from 2016 to 2018, which demonstrates the effectiveness of individually meeting with prospective graduate students. In fall 2018, the FSU CS department chair decided to indicate to the students he wished to discuss the benefits of attending graduate school rather than not revealing the reason for the meeting in his email message to each prospective CS graduate student. This resulted in a significant decline of the number of students meeting with the FSU CS department chair. This decline in meetings directly correlates to the decline in the number of FSU domestic CS graduate student applications and newly enrolled students in 2019. The FSU CS department chair did not reveal the reason for meeting with prospective CS graduate students in his email message in fall 2019, resulting in a large increase in the number of CS domestic graduate students in 2020. We believe this increase was also in part due to fewer job opportunities during the COVID-19 pandemic leading to more FSU CS domestic graduate student applicants. We also had fewer FSU CS graduate students enrolled from other countries as many U.S. embassies and consulates were closed during the pandemic causing our international graduate student applicants being unable to obtain a student visa. The indirect impact was that there was less com-

FSU CS domestic graduate student enrollment, admission, and application data.



petition for teaching or research assistant positions for FSU CS domestic graduate student applicants.

We recognize the data shown in figure here is not perfectly correlated with our efforts to recruit CS domestic graduate students due to the effect of other factors previously described in this section. However, we know from our individual meetings with prospective graduate students that many of the students tell us they never considered going to graduate school and do eventually enroll in our CS graduate program or other CS graduate programs in the U.S.

Conclusion

Through these efforts previously described in this Viewpoint, the FSU CS Department for many years has been able to recruit a majority of students that are domestic among the supported graduate students that enter the FSU CS graduate program each year. While the majority of our domestic CS graduate students are MS students, a reasonable fraction is Ph.D. students. We believe we need to do a better job of convincing our MS CS domestic students to stay for the Ph.D. program.

We usually have the CS department chair and one other faculty member individually meet with our CS UG students to discuss the merits of attending graduate school. It takes approximately 20–30 minutes to meet with each of these students to discuss their plans and to describe the merits of attending graduate school. Viewpoint authors David Whalley and Xin Yuan were FSU CS department chairs previously and Xiuwen Liu is the current FSU CS department chair. All three

of these department chairs made the commitment to meet personally with FSU CS UG students to discuss the merits of attending graduate school. This is quite a time commitment given we typically meet with 50+ students each year.

Recruiting domestic CS graduate students is possible, but it does take time and effort. We feel it is not only beneficial to the FSU CS department to recruit domestic CS graduate students, but it is also very beneficial to these students and the nation that we convince qualified domestic CS undergraduate students to attend a CS graduate program to help them reach their potential.

Engineering, mathematics, and the physical sciences are also fields that have a high fraction of international graduate students in the U.S. We believe the strategies we have utilized could increase the number of domestic graduate students in these other fields as well since our strategies are not specific to CS students.

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