CS Mid-Term Response to the External Review

Fall 2017; revised Spring 2017

Chair's Foreword

In order to better understand the challenges and opportunities facing the computer science department, it is useful to first consider its history in recent years in the broader context of the campus, and of the surge of interest in computer science nationally and worldwide. The history is one of diminishment first, and of partial growth later that is beginning to bear fruits.

Diminishment

In the last five years, from July 2012 to July 2017, the number of filled faculty positions in computer science fell by 5.5. This is the largest decrease of any department on campus in absolute terms, and at 23.4%, also in relative terms with the exception of the department of education, which shrank by 31.25%, from 16 to 11 (see this table). The computer science department was one of the few to shrink; overall, in the same period the number of filled faculty positions on campus increased by 10.6%.

This diminishment of the computer science department is particularly unfortunate, as it occurred in concurrence with two phenomena.

First, in the same period, the interest in computer science nationwide and worldwide exploded, and the number of students in computer science at UCSC swelled eightfold (see Figures 1 and 2). The computer science department has been declared as impacted in 2018, and has had to throttle steeply the number of students that are admitted to UCSC to study computer science.

Second, and most ominously, the years from 2012 to 2017 were supposed to be the "fat" years, the years in which the rebenching funds coming from the central UC administration would be used to expand, and in particular, expand UCSC's capacity to advise graduate students. The rebenching funds largely bypassed the one department on campus that has the greatest number of graduate students (almost half of the total campus) and that was receiving the greatest increase in interest from students. Having squandered the opportunity of using the rebenching funds to increase the computer science department's capacity to advise graduate students, the computer science department is now faced with the challenge of trying to grow in the leaner years that we are entering.

The loss of filled positions in computer science occurred mainly due to two reasons: several computer science faculty left to become the kernel of the founding faculty of the computational media department; and several other faculty decided to separate from the department. The report will contain details on the latter, as the former left before the period covered by the report.

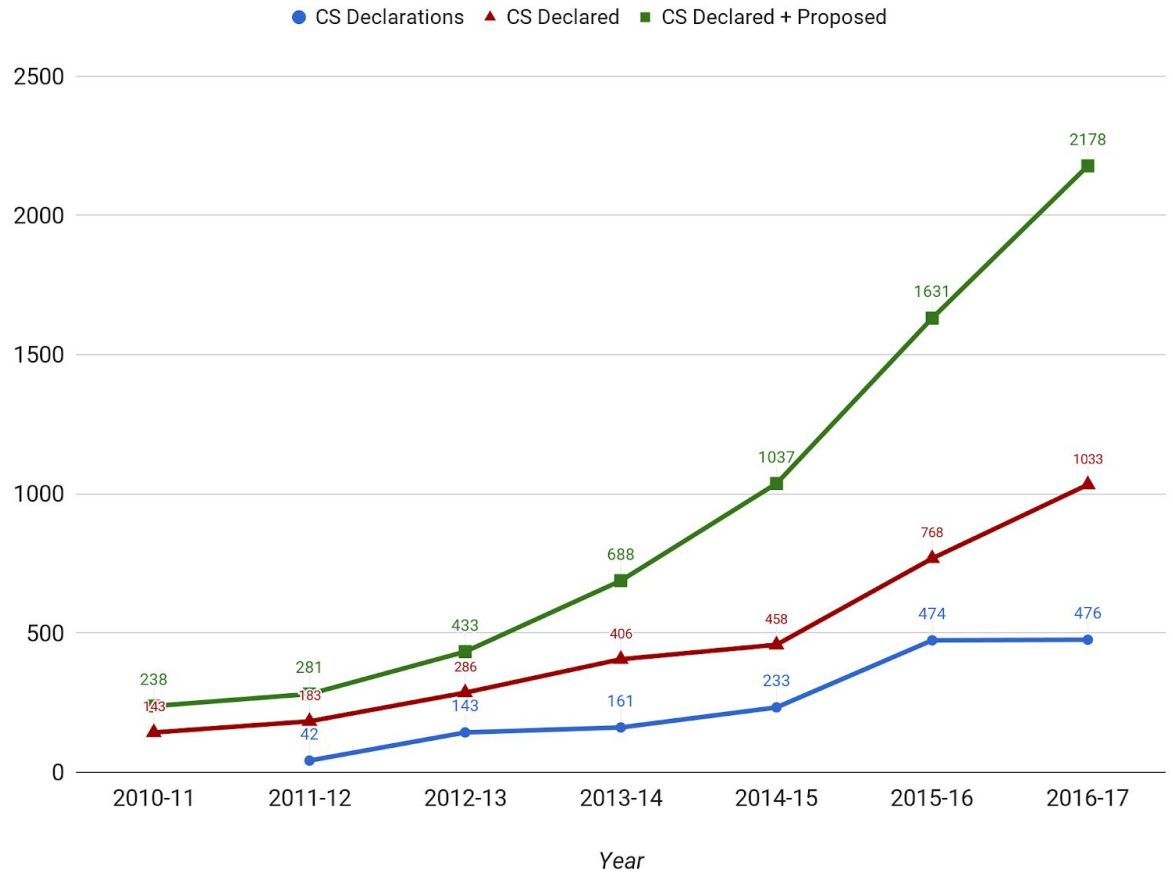


Figure 1: Number of yearly CS major declarations (blue, includes both BS and BA), number of total enrolled CS declared (red, includes BA, BS and transfers), and CS declared or proposed (green) majors, 2010 to 2016 (data from SOE data analysts based on the Student Universe of the Data Warehouse; see source).

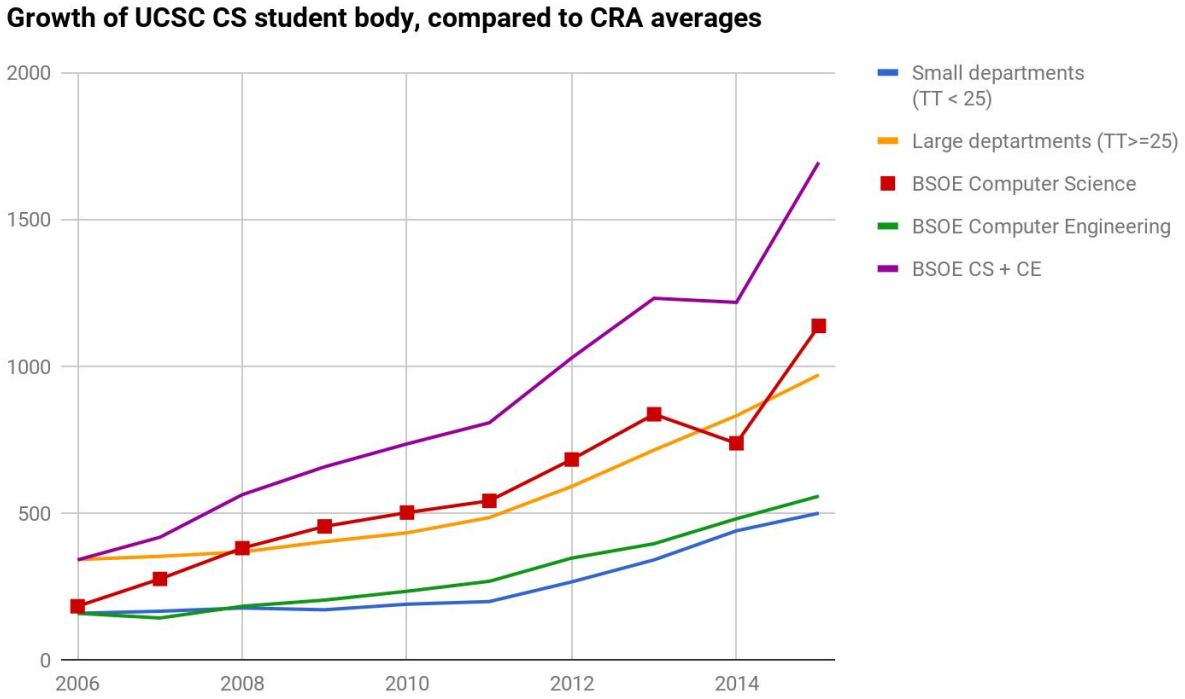


Figure 2: Undergraduate student growth of BSOE CS and CE departments, compared to averages for small and large CS, CE, and I departments in the United States and Canada. BSOE majors include both proposed and declared majors; the data are averages over the three quarters. TT is an abbreviation for tenure-track faculty.

Partial Growth

Since about 2015-16, the department has started again growing, and we have seen the start of encouraging signals from the central administration of the university. Specifically, the number of new FTEs allocated from the central university to the computer science department has begun increasing, and since 2015, more new FTEs have been allocated to CS than to any other department (see this table). This is an extremely positive signal, and we hope it is the harbinger of a full realization by the rest of campus of the pre-eminent role that information technology plays in our society, and in the interest of the California students the university was established to serve.

We note that the two tables, of total filled positions (see this table) and new FTEs (see this table) seem in disagreement in the trends they portray, but the disagreement is only apparent. Divisions other than SOE hold many positions in reserve, “hollowed” of their funding and authorizations to be filled; these divisions can grow without requiring new FTEs, simply by obtaining authorizations to hire under their currently allocated FTEs. In the School of Engineering, much fewer positions are kept in such fashion, so that the growth in filled positions is more closely dependent on the allocation of new FTEs from the central campus.

Detailed Response

What is the current chair succession plan? Are there strategies under consideration to ensure that the next chair serves a multi-year term?

There currently is a chair who is planning to serve a three-year term. As this is the first year of the term, there is no succession plan in place yet; we hope to have a successor determined in the third year of the current chair's service.

How has the instructional workload policy been revised?

The CS department now has a formal workload policy, which comprehensively tracks the activity of each faculty, from undergraduate and graduate teaching, class sizes, to MS and PhD students being advised, to grant writing, and more. The first year for which data was collected under the new workload policy is 2016-17. The new workload policy is based on measured parameters (classes taught, class sizes, number of PhD advisees, and so on), and replaces a policy that was more reliant on judgement. We attach the workload policy.

What new faculty have been hired, and what is the hiring plan for the next two years?

The following faculty has been hired since 2014:

- SVN Vishwanathan (hired 7/1/14, resigned 6/1/2017; machine learning).
- Sesh Comandur (hired 1/1/15; algorithms and data mining).
- Peter Alvaro (hired 7/1/15; distributed systems and verification).
- Alex Wolf (hired 1/1/16; Dean: not serving in the department).
- Owen Arden (hired 6/30/16; security and programming languages).
- Abhradeep Guha-Thakurta (hired 1/1/17; privacy and security in machine learning).
- Narges Norouzi (hired 7/1/17; LSOE).
- Faisal Nawab (hired 1/1/18; distributed cloud computing).
- Snigdha Chaturvedi (hired 4/1/18; machine learning and natural language processing).

The following separations have occurred:

- Alkis Polyzotis (databases and crowdsourcing, resigned 2015).
- Wang-Chiew Tan (databases and data mining, resigned 2017).
- SVN Vishwanathan (machine learning, resigned 2017).
- Darrell Long (systems, transferred to CE 2017).
- Ethan Miller (systems, transferred to CE 2017).

Two more retirements are expected to occur in 2017-18.

Hiring plan:

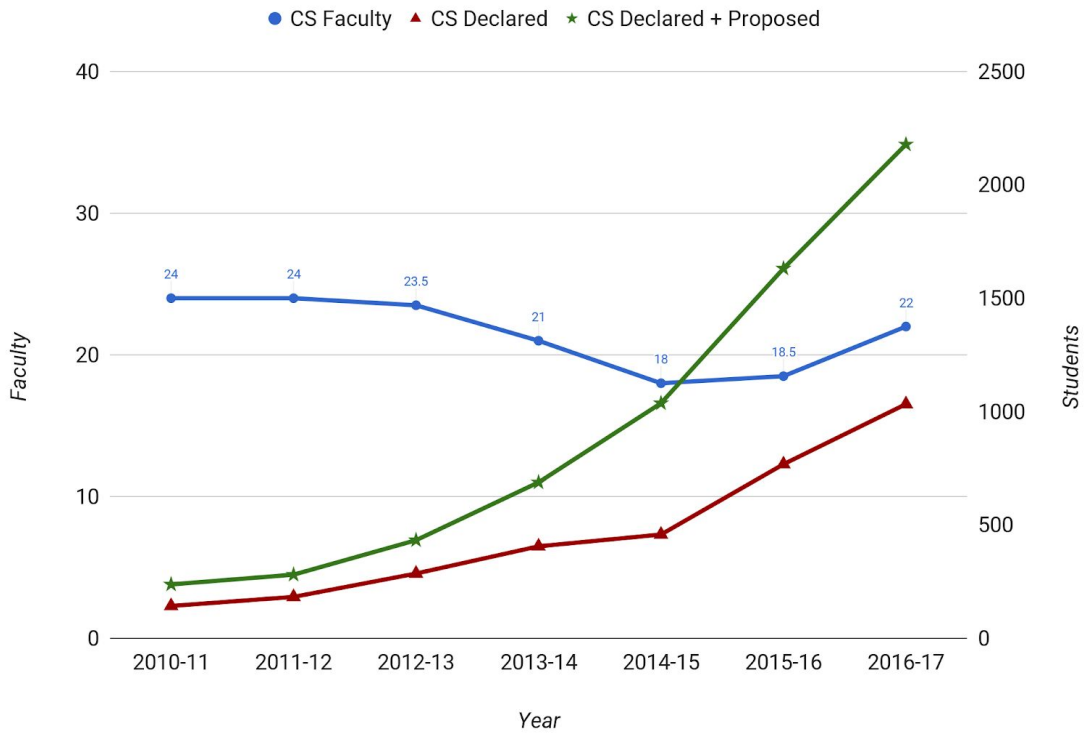
In 2017-18, we are hiring under two provisions:

- Foundations of data science
- Distributed systems

In 2018-19, we hope to be able to hire at least under the following two provisions:

- Software foundations (already approved to the division)
- One divisional position under a topic that is still under discussion.

As there are some separations that are planned, we will re-assess in 2018 the needs of the department and we will formulate a full plan for 2018-19 and for 2019-2020. In spite of the separations, the computer science department is finally on a trajectory of modest growth, after many years in which the number of faculty has remained substantially the same while enrollments have grown nine-fold.



Faculty size and enrollment since 2010-11.

Has there been any change concerning a potential merger with the Computer Engineering Department?

The School of Engineering is going through a "reshaping" study, which may advise changes to the structure of several departments. Among these changes, it is possible it will advise to split the computer engineering department into two portions; one which would join electrical engineering, the other which would join computer science.

To the computer science department, this reshaping process is bringing both opportunity, and concern. We are embarking in extensive re-examinations of the curriculum, especially at the undergraduate level; this is a multi-year process, and the uncertainty on the future shape of the department makes the process somewhat more complex and of uncertain outcome.

Graduate Program

Has the department developed guiding principles for the M.S. program and if not, is there a plan to do so?

The CS department is enthusiastically supportive of MS program growth and has unparalleled opportunity to do so, but we find that the current MIP program structure, combined with our flood of undergraduates and limited faculty FTE growth, has left us with too few resources to do so. We would welcome an opportunity to discuss changes that would enable us to help achieve this important campus goal.

Two years ago, the department tried to accommodate the campus goal of increasing graduate enrollment by increasing its MS cohort almost 4 fold. There was a corresponding increase in MIP funds that was used towards making multi-year offer packages for PhD students. However, the large number of MS students also changed the nature of some of our graduate courses. And there was no other corresponding increase in resources to the department in terms of FTE. The department has since pulled back to its previous capacity of MS students. In the meantime, the number of applicants to our MS program accounts for almost half of the total number of MS applicants for the entire campus. We have been extremely selective with our MS applicants (more competitive than the PhD program). This has allowed us to target those that have previous research experience with the hope that they will convert to our PhD program. Indeed, some have done so.

The goal of most MS students is to get an advanced degree to improve their marketability in the job market. We have a huge unmet need in this regard, which represents a missed opportunity for UCSC. Clearly, the MIP funding model, especially with the low MIP funds, does not work if we are to scale up to meet such a demand. The department is exploring the SSP funding model instead. While other UC campus such as Riverside has been very supportive and

successful with developing new SSP programs, we would be breaking new grounds on this campus with this model.

What is the strategic role M.S. students play in the Department, especially in view of recent large increase in M.S. enrollments, and what is the optimum balance between M.S. and Ph.D. enrollments?

CS has a very large number of MS applicants; about 900 per year. Currently, it admits very few: about 40 per year. The number is dictated by a balance:

- MS students allow us to "fill in" graduate classes up to their optimal size of about 30 students, and to generate MIP funds.
- MS students allow us to fill TA positions that are left unfilled by PhD students who are mostly supported by GSR.
- Given the drastic selection, the quality of many MS students tends to be very good, and many of them do interesting research projects with faculty, with some even converting to the PhD program. That is, the MS program is a recruitment avenue for the PhD.
- If MS students were to increase further, they would outnumber PhD students in many graduate classes, influencing the quality of those classes in ways that may not be fully desirable.

In general, as the MIP funds per students are much lower than in other UC campuses, there is little incentive for the CS department in admitting more than about 40 MS / year, which is the number that can be accommodated in the current graduate classes. The large number of MS applicants, compared to the small number who are admitted, represents a large missed revenue for UCSC. To tap into this potential, a scheme where faculty lines can be created in response to increased MS enrollment would be needed. The department is currently examining the possibility of starting large SSP or PDST MS programs, that could generate enough revenue to justify faculty lines, either paid on "soft" SSP funds, or preferably, regular faculty lines justified by the tuition revenue. This is a topic that will require discussions at many levels within UCSC. We note that UC Riverside has been able to develop a number of large and successful (both financially, and in terms of faculty lines) SSP MS programs.

What is the current level of interactions between the CE and CS graduate programs, especially on course requirements? Is the CS Department considering a revision of the graduate curriculum, especially including graduate requirements, and in synergy with the CE graduate program?

In terms of required graduate courses, the set is fairly minimal. There is CMPS/E 200 which is co-taught with a CE faculty member, and the majority of the students are from CS and CE. The other required courses for CS are: CMPS 201 (algorithms), CMPS 203 (programming languages), and an architecture requirement which can be satisfied by either CMPE 202 or CMPE 110. The rest of the courses are either independent study, seminar courses, or electives.

Is a joint graduate applications portal in the works?

Yes, there is already a system for applying and reviewing applications, and the review system is common to all SOE; faculty can flag and forward for review any applicant to any other faculty. Currently, students can apply to only one program at a time, and as mentioned earlier, CS would favor a system in which students can apply to more than one program if they so wish (perhaps paying a fee for each program they apply to discourage over-applications).

What efforts has the department undertaken on specific initiatives to market and advertise to improve the graduate applicant pool?

There are a number of key factors that influence where a student applies and where they ultimately attend. A subset of these are things that a department can influence to some extent.

- Reputation and ranking. In this regard, the department, is hiring in strategic areas to address current needs but also to build strength and prestige in the longer term.
- Word of mouth. About 75% of our graduate applicants are foreign. Schools like UCSC that are not among the top 10 schools benefit from word of mouth of their alumni's especially in foreign. In this regard, growing the MS program will improve the visibility of our PhD program.
- Outreach. Faculty members throw up an extra slide advertising our graduate program when they give a presentation at conferences. SOE is also organizing faculty to be more involved with programs such as SACNAS and recruiting from Cal State campuses to improve our diversity.
- Targetting. CS has obtained approval from campus for off-cycle admission of PhD students. This is particularly useful when a faculty member receives a grant mid-year and need to find a GSR as soon as possible. Advertisement on our web page about Open PhD Positions as well as at conferences help fill these positions.

Undergraduate Program

What has the department learned from looking at other CS departments in the UC for potential guidelines on dealing with increasing enrollment?

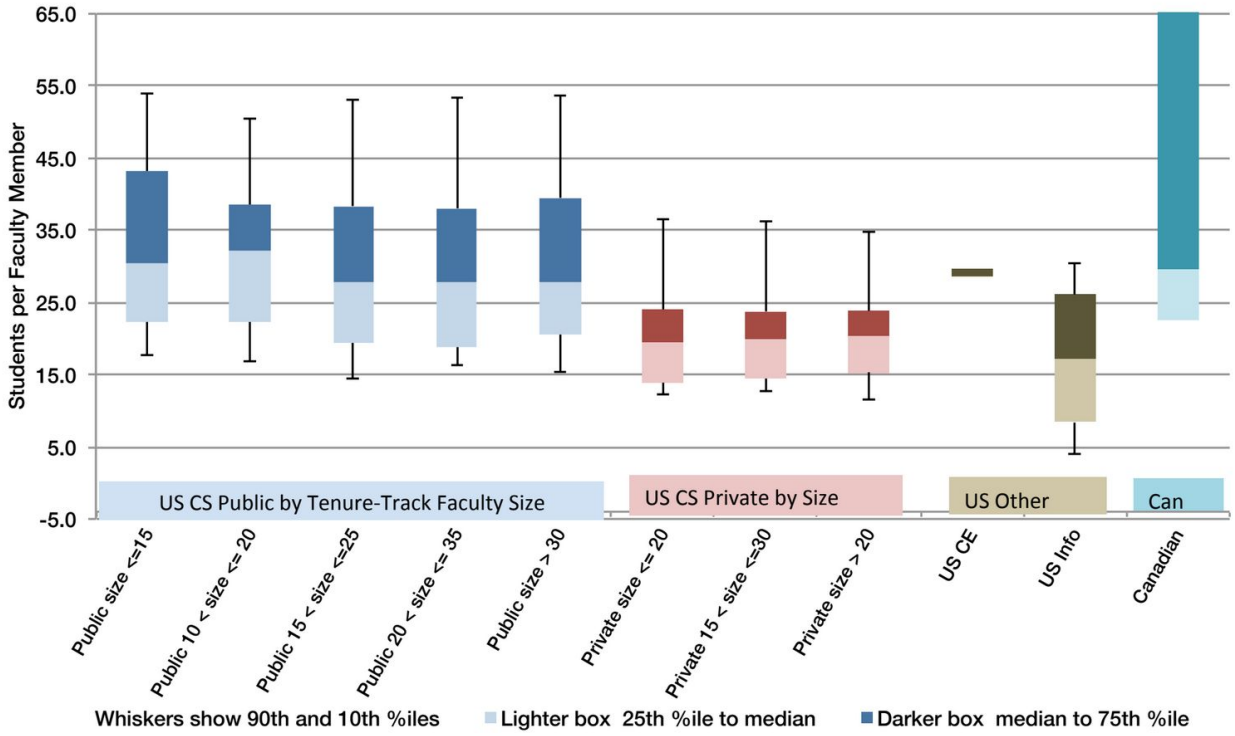
One of the things we have learned is that UCSC CS is at **twice the 90% student-to-faculty ratio** compared to other CS departments in North America.[1] CS is thus in uncharted waters, and there are few departments we can look at that compare with us. Most other UC campuses where CS has been under similar pressure have put in place enrollment management long ago. The Chair has participated in the Fall in a large gathering of CS Chairs from hispanic-serving

[1] Data from the 2016 CRA Taulbee Survey (http://cra.org/resources/taulbee-survey/), the main survey of enrollment, graduation, and department statistics for computer and information sciences, conducted since 1974 in North America. The survey covered 266 PhD-granting departments, and received response from 178 of them; the response rate from US CS departments was 77%.

institutions, and it was depressing to note how in most of the other institutions, the CS departments were aggressively hiring. UCSC seems to be one of a small group of institutions that has been unwilling to grow the CS department faculty size, and this in spite of the clear leading role campus-wide that CS has not only in undergraduate enrollments (where it is now the largest or the second largest major), but also in attracting international students and transfer students, and in having by far the largest graduate program. We can only hope that the situation will change with the new administration.

Figure B4. Bachelor's Enrollment Normalized by Tenure-Track Size

CRA Taulbee Survey 2016



In this figure, data from the 2016 CRA Taulbee Survey (the most recent available) shows the student-to-tenure-track-faculty ratios at North American CS Departments. The ratio for UCSC CS is 100:1, entirely off the chart.

What is the current status on the curriculum reform? (i.e., what modes of teaching have been changed to address larger classes? What are the streamlined requirements for lower and upper division courses? Has the physics requirement been revisited?)

We are in the process of doing a deep redesign of the lower-level undergraduate curriculum, including 5J, 5P, 11, 12A, and 12B. The goal is to develop one sequence of classes (tentatively called 20, 30, 40) that can replace these five, so that we can streamline and modernize the curriculum and the teaching, and focus on teaching fewer classes more homogeneously and better. Further, we have plans for streamlining the Math requirements.

This is part of a large set of program changes that we are developing this year, and that we are going to propose in the Fall of 2018. This is the first year in which we have had sufficient continuity in department leadership to embark on such a plan. Our main concern is that the reshaping of the School of Engineering may result in a change to the composition and leadership of the CS department, complicating the execution of the plan.

The requirement for a two-course sequence in physics (or chemistry) has been dropped: in discussions following the external review, the two-course sequence was seen as non-essential for CS.

Has there been more coordination with CE on the introductory curriculum?

Yes: CE is introducing new operating system classes, and CS will propose to use them as alternatives to its own classes for satisfying the major requirements. As far as the introductory curriculum goes, we do not think that the CS-CE coordination is lacking or particularly needing improvement.

Are there significant bottlenecks in the curriculum or other barriers that restrict students' ability to qualify for the CS majors or progress to degree? What steps will be taken to identify these constraints and increase the capacity of these courses to promote student success?

We have markedly increased the number of offerings and the capacity of all of our main classes, from CMPS 12A, 12B, 101, 102, 109, 121, 183, 115, 116, 117, and more.

There are some remaining bottlenecks:

- Availability of project classes for capstone projects. We are improving this by doubling the number of sections of the CMPS 116-117 track next year.
- Availability of DC (disciplinary communication) classes. There is currently a dearth of classes that enable to satisfy the DC requirement, and compounding the problem, the ones we have cannot be scaled to much larger size, in part precisely because grading papers does not scale well (this is why many classes in the humanities are limited to sub-50 enrollment; unfortunately, we cannot afford to do the same). We are currently trying to see whether, with the help of peer-grading, more classes can be made to satisfy the DC requirement.
- Chain of prerequisites for CMPS 111. The current chain of prerequisites for CMPS 111 is rather long. As part of our curriculum revision, we plan to propose CMPE 105 as an alternative to CMPS 111, leading to a shorter chain, as CMPE 105 does not require CMPE 110 as prerequisite.

What steps will be taken to address student concern for more opportunities to engage in research with the CS faculty?

Faculty attention to individual students cannot scale, and with student to faculty ratios, involvement in research will be something that only a very small percentage of students will be able to do. The real step CS has taken to address this concern consists in putting forward an enrollment management proposal aimed at reducing the number of incoming students.
We note that all external signals, from undergraduate interest, to transfer students, to international students, to size of doctoral program, point to the need for *more* capacity in CS. We hope that the campus and the new administration will heed these clear external signals, and that the enrollment management will be needed only temporarily.

Further, we are improving our project sequence, consisting of CMPS 115, 116, 117, assigning a dedicated lecturer to teach two sections of each of these classes. While this will not enable more students to work alongside faculty, at least it will allow more students to work on projects, some of which are sponsored by industry.