

Dear Provost Mattson, Associate Provost Liben-Nowell, and Professors Anderson, Eblen-Zayas, Elflin, Farhart, and Narayan,

The department of computer science requests permission to undertake a tenure track search in 2023-2024. We believe this position is needed to address long waitlists, large classes, and an unsustainable ratio of majors to faculty. We have had to hire at least one visiting professor per year going back to the early 2010s, and as shown below, we project that this need to hire visiting faculty will continue with the current staffing levels. We recognize that addressing our enrollment pressures may not be solvable solely through increasing the size of our faculty, and as a department, we're committed to fostering the liberal arts at Carleton, as demonstrated by our involvement in campus and interdisciplinary initiatives. Yet, we believe at least one additional line is a necessary part of addressing these enrollment pressures: these pressures do not serve our students well, place a heavy workload on faculty to attempt to meet all students' needs, and significantly burden current faculty with finding short-term solutions, further impacting our ability to meet students' needs.

When talking to Provost Mattson about our enrollment pressure and this request, she suggested we might explicitly indicate whether we were likely to make additional requests for new tenure lines in subsequent years. We agree that an additional faculty member may not be sufficient to meet the pressures discussed below; we also value balance across departments and believe in a liberal arts education in which students take courses from a variety of disciplines and one major does not dominate.

We are currently undergoing a departmental review where we expect to engage in significant discussion about possible pathways for managing enrollment pressures in an equitable and sustainable way that is inclusive of all students and supportive of the mission of a liberal arts college, and we don't want to presuppose the outcome of that discussion and planning. In strategic planning discussions about the future of the department and in preparing our overview of the department for the reviewers, though, it was clear that we need at least one additional tenure-track faculty member, and we thus make this request now to try to move as quickly as possible towards improving the current state of affairs for students, faculty, and staff in the department.

Enrollments, majors, advising, and staffing the CS curriculum

The Carleton CS major requires 10 classroom courses in computer science: CS 111 (Introduction to CS), CS 201 (Data Structures), six core CS courses (CS 202, 208, 251, 252, 254, and 257), and two CS electives. CS majors also take a pre-comps seminar (CS 399), comps (CS400), and Math 111.

The number of CS majors has been consistently high and is increasing. For the ten most recently declared graduating classes (2015-2024), the median number of CS majors per year was 59.5 (mean: 63.8). For the five most recently declared classes, the median is 71 and the mean is 70.8. We have 85 CS majors in the junior class and 3 off-cycle sophomores declared.

CS is also very happy to serve a large number of students who are not CS majors. For the past decade, about 60% of all Carleton graduates have taken at least one CS course. Most of these students take CS111 (about 55%), but some place out of CS111 and instead begin in another course (typically, CS201). Like CS111, CS201 is also taken by a large number of students who do not go on to major in CS, including both students who are deciding whether to major in CS and those who would like to learn the material to help them achieve their other goals. These students are most commonly majoring in STEM areas, but also include multiple students per year majoring in a wide variety of departments across the college. Finally, our upper-level courses serve both majors and non-majors as well: for the last three years, 71 core-course

seats per year were filled by students who did not major in CS,¹ and an average of 41 elective seats per year were filled by non-majors.

Course number	Proportion of seats filled per year			
	2019-2020	2020-2021	2021-2022	2022-2023
CS.111	0.96	0.75	0.92	0.90
CS.201	0.93	0.87	0.86	0.78
CS.202	0.96	0.93	0.97	0.95
CS.208	0.96	0.97	0.98	0.97
CS.251	0.99	0.91	0.97	0.94
CS.252	1.06	0.95	0.99	0.86
CS.254	1.00	0.75	1.01	0.90
CS.257	0.99	0.95	1.02	0.98
All electives ²	0.85	0.76	0.88	0.89

Figure 1: Proportion of available seats that were filled in introductory courses (CS111, CS201), core courses (CS202-CS257), and electives for the most recent academic years. Enrollments are based on students enrolled at the end of the start of term one-week add/drop period; spring 2023 data may miss enrollment changes in the final day of that period. Orange indicates at least 85% of seats were filled, and red indicates at least 90% were filled. Some courses fill beyond 100% if a faculty admits students from the waitlist beyond the course capacity.

In 2019-2023, we filled almost all offered seats in all of our core courses: only CS254 in 2021-2022 averaged less than 90% filled (see Figure 1). In 2022-2023, all core courses have had average enrollment of at least 80% capacity. All core courses and electives were heavily waitlisted for spring 2023, with the majority of core and elective courses still having at least 15 students on the waitlist at the end of week 1. Because waitlists require manual processing and students may make changes to their courses relatively late in the week, some unfilled capacity in courses reflects seats that were occupied up until close to the end of the add/drop period, with insufficient time to grant another student permission to add. All core courses have capacity 34, and the average core course from fall 2019-spring 2023 had 32.5 students.

Elective enrollments are also consistently at 75% capacity or above, with all but one elective course since 2019 enrolling at least 50% of capacity. All electives, with the exception of an every-other-year interdisciplinary elective that is shared with Studio Art (CS / ARTS 232), have a capacity set to 34, and even including two offerings of that lower capacity elective, the average elective in CS from fall 2019-spring 2023 had 27.6 students.

We offer a range of elective courses, including some that may not be quite as popular as others, in order to represent the breadth of the field of CS. Eliminating electives that “only” fill to 70% capacity would leave our students with less of an understanding of the range of CS, as well as disproportionately harm students with less popular interests, and would negatively impact the capacity of the faculty to evolve the elective offerings based on changes in the field.

¹ Data is based on the three academic years from 2019-2022. Students are counted as not majoring in CS if as of summer 2022 (when data were received from the registrar’s office), they did not have CS as one of their declared majors. Students who took courses as first years in 2021-2022 are not included in these counts, as they may declare a CS major.

² Electives in the 2022 Summer OCS program on the History of Computing in England are excluded, as the notion of capacity does not apply in the same way for individual OCS courses as for on-campus courses.

Providing enough seats to allow our majors to graduate requires us to offer each core course an average of 2.5-3 times each academic year. This assumes 34-seat capacities and only assumes a handful of nonmajors in these courses, an assumption that is not always met. As we have talked about in our department review materials and in conversations with Provost Mattson, we do not believe that these 34 seat capacities are serving our students or faculty well. Capacities were raised from 28 to 34 over 10 years ago, and we believe this decision needs to be reevaluated. On the student side, larger courses make it easier for some students to fall through the cracks, failing to get the support they need to succeed or to get the more individualized experience that they expect when attending a college like Carleton. Because course sizes are consistently high, a student may major in CS and never take a major course with fewer than 30 students.

On the faculty side, we are concerned that we will face serious faculty retention issues given the workload imposed by the sustained need for larger courses and the limitations that enrollment pressures place on faculty's ability to engage in innovative and interdisciplinary teaching. Lowering course capacities to 28 students would require offering each course 3-4 times per year.

The situation is similar in our electives. Since many nonmajors take our electives and most of our majors want to take more than the two required electives (to prepare themselves for graduate school and technology-related careers), we would need over 250 elective seats per year to meet the current demand.

Our advising resources are also under pressure. During winter term this year, we had 6 on-campus CS professors able to act as advisors for our 169 majors (including 3 off-cycle sophomores). While we explored staff advisors for senior students, only 5 students opted into the staff advising program. That meant there were an average of 27.3 students per non-staff advisor.

Providing interested students with research opportunities has also been challenging: this summer we were only able to hire 10 of the 52 students that applied for summer research. When research opportunities are offered during the term, it's common for faculty to receive applications from five to ten times as many students as they intend to mentor.

We have taken several steps as a department to deal with our enrollment pressures:

- About 13 years ago, we increased enrollment caps from 28 to 34 students per course (not counting A&I seminars and the team-taught CS / ARTS 232). As noted above, we do not believe that this is serving our students well, and it significantly limits what we can do in our courses. The topic of course size is one we will be discussing with our external department reviewers this spring.
- Three years ago, we instituted the CS Match. This registration system was designed to enable us to guarantee one CS course to nearly all students who want one in any given term, while at the same time encouraging our majors to take courses outside CS since most of our classes fill up during the Match. While the Match has allowed us to allocate our scarce seats more efficiently, it cannot increase the number of seats. If more students are interested in a course than there are seats available, then not all interested students can take it. If all of the courses a student is interested in have more interested students than available seats, then we may not be able to guarantee that student any seat. These Match failures are becoming more frequent, indicating demand is outstripping capacity: 66 students failed to Match this spring, including 31 sophomores.
- As individual advisors, the CS faculty encourage our students in one-on-one conversations to take advantage of the wide range of disciplines available at Carleton, and we help them reflect on the importance of taking a wide range of courses both for their personal development and their future career paths.

Hiring visiting professors

As noted above, the college has approved CS to hire at least one full-time visiting professor in each of the past 13 years. We're very grateful for this institutional support, but continued reliance on visiting professors is extremely challenging. There is a very strong tech job market, with market salaries for those with advanced degrees in CS significantly outpacing visiting professor salaries. Finding candidates who wish to accept a short-term teaching position is challenging, with many of our strongest candidates being current graduate students who teach for us for 1-2 terms. In the past two years, we have expanded the way we recruit visiting faculty, with more outreach to local graduate institutions, colloquium speakers, and community college professors. Yet, this still typically nets a very limited number of qualified candidates, such that we are not always able to hire for all the courses for which we're approved.

Hiring and mentoring visiting faculty require significant resources each year, and hiring new visiting faculty each winter-spring complicates scheduling. Given the sustained need for visitors, we believe this time and effort could be better spent on activities that promote the long-term health of the department, rather than short-term solutions.

Supporting the liberal arts at Carleton

The CS department strives to promote a liberal arts mindset in all of our students, inviting colloquium speakers that emphasize interdisciplinarity, making connections to humanities and social sciences in both core courses and in electives like Data Visualization, and using advising as an opportunity to encourage students to help students recognize the importance of a variety of types of skills for their future lives and careers. We also see computational thinking as a crucial skill for all students, regardless of major, and the vast majority of our courses, including especially our introductory courses, emphasize how students can apply ideas from CS in a variety of fields.

We recognize increasing concern on campus about the number of computer science majors. Yet, the enrollment pressures on computer science and the limited number of faculty to meet those pressures has meant computer science is less able to contribute to interdisciplinary programs or to offer courses outside of major requirements that could provide students across majors with tools for thinking critically about technology and society.

This new faculty line would enable the CS department to better support students' liberal arts education in several ways:

- Begin a transition towards slightly smaller class sizes, allowing faculty to include a broader range of activities in their courses and enabling more meaningful feedback to individual students. Many faculty would like to incorporate more project-based learning in their courses, but need smaller course sizes to provide sufficient scaffolding for all students to be successful in these projects. Smaller course sizes would also enable more opportunities for students to work with community partners, which occurs in some courses like CS344: Human Computer Interaction but is difficult to scale.
- Enable CS faculty to contribute to cross-disciplinary initiatives that support the college more broadly. For example, CS faculty have contributed to the Summer Science Fellows program and STEM Board leadership, but such efforts typically strain the department, requiring more visiting hiring and thus more labor devoted to short term solutions. CS faculty would like to be more involved in programs like FOCUS, and we think it would benefit students to work with computer science faculty in a range of roles, rather than CS being siloed due to enrollment pressures.
- Enable CS faculty to contribute to courses in interdisciplinary programs outside the department and to develop courses in the department that have wide appeal for non-majors. The CS faculty has

connections to several interdisciplinary programs, including cognitive science and digital arts and humanities. We believe that we could offer courses in these programs that would help to absorb some of students' interest in CS without increasing our number of majors, and potentially allow students to see that an interest in topics related to CS can be fulfilled via a variety of majors. We believe that whoever we would hire for this position would likely have some interest in contributing to these efforts, and further, we know that there is significant interest in such efforts among current faculty - we simply are limited by the ratio of majors to faculty in being able to act on those interests.

CS at Carleton in 10-20 years

Computer science is a constantly evolving field: technologies like AI have become increasingly omnipresent, threats to privacy due to technology abound, and we increasingly live in a world infused with computational tools and careers that benefit from computational knowledge. We regularly publish articles and attend conferences in a variety of subdisciplines of computer science. As a faculty, we've developed new elective offerings as our field changes, and we adapt our core courses based on new advances. The content of our major is likely to evolve in the coming decades, but this request for a new hire is not in response to one particular curricular need. Instead, it comes from a need for additional FTE in order to make the work that the computer science department does sustainable and to enable us to equitably serve all students, without some students falling through the cracks.

In the department review document we recently prepared, we highlight the importance of interdisciplinarity to our faculty and students; our desire to strengthen the community of the department and support all students in feeling a sense of belonging in our courses; the immense amount of research mentoring that we do in the department and the value that has for students; and the need for realistic workload expectations to retain faculty. This hire would directly contribute to our ability to build on our strengths in these areas and address areas of weakness:

- As noted above, we want to increase the ties we have outside of CS, and to sustainably support interdisciplinary teaching and academic and civic engagement efforts. Enrollment pressures make this incredibly difficult without additional faculty.
- The current advising load cannot be maintained. Overloaded faculty advisors are likely particularly detrimental to first generation and URM students, who may already feel less of a sense of belonging in the department. While we are working to build community in other ways, we also think advising connections are critical and are a benefit of attending a small liberal arts college like Carleton. Advising connections are by necessity more shallow when each faculty member is advising 27 students.
- Research mentoring during the academic year is currently taken on by faculty members as an uncompensated overload, meaning the number of research opportunities for students is quite limited. We'd like to explore models like the psychology department has that more equitably recognize the work in mentoring these students and enable students to count research towards the major, making it easier for students who have work or other non-class responsibilities to incorporate into their schedules, and. Yet, at current staffing levels, this would further exacerbate enrollment pressures.
- Finally, as discussed above, we'd like the future of our department to include courses with smaller numbers of students to whom we can devote more individual attention, returning to the course capacities of 28 that were previously in place in the department. We need more faculty to do this effectively.

In the table below, we show current and projected staffing with and without another faculty member for the next three years, and the number of additional courses that would be needed under different possible assumptions about course capacities. Left out of these staffing projections is the fact that Jeff Ondich will

be moving towards retirement in the relatively near future; while he does not yet have a precise timeline, we're cognizant of the impact this will have on staffing even at 34 students per course.

	Expected number of sections taught		
Type of faculty member	2023-2024	2024-2025	2025-2026
Current permanent or tenure/tenure track	42	37 [includes several sabbaticals]	44
Visitor	6	6 [2 year visitor approved for 2023-2025]	None approved
Total expected sections	48	43	44
Total expected sections if approved to hire	—	48	49
	Needed courses by year		
	2023-2024	2024-2025	2025-2026
Expected number of sections needed, assuming current course capacities	Total: 48 CS111 - 9 CS201 - 6 Core - 17 Elective - 10 Senior seminar - 5 Other (A&I) - 1	Total: 46-50 CS111 - 8-9 CS201 - 6 Core - 18 Elective - 10 Senior seminar - 4-5 Other (A&I, FOCUS, etc.) - 0-2	Total: 46-50 CS111 - 8-9 CS201 - 6 Core - 18 Elective - 10 Senior seminar - 4-5 Other (A&I, FOCUS, etc.) - 0-2
Expected number of sections needed, assuming capacities of 28	Total: 56 CS111 - 10 CS201 - 7 Core - 21 Elective - 12 Senior seminar - 5 Other (A&I) - 1	Total: 56-57 CS111 - 10 CS201 - 7 Core - 21 Elective - 12 Senior seminar - 4-5 Other (A&I, FOCUS, etc.) - 1-2	Total: 56-57 CS111 - 10 CS201 - 7 Core - 21 Elective - 12 Senior seminar - 4-5 Other (A&I, FOCUS, etc.) - 1-2
Difference between needed sections and expected, assuming course capacity 34	—	3-7, if not approved 0-2, if approved	2-6, if not approved 0-1, if approved
Difference between needed sections and expected, assuming course capacity 28	—	13-14, if not approved 8-9, if approved	12-13, if not approved 7-8, if approved

Furthering our department and college-wide IDE goals

Computer Science as a field has long suffered from a lack of gender and racial diversity. One of the core goals of Carleton's computer science department is to find ways to promote diversity and equity within computer science.

Our efforts have been somewhat successful with respect to gender diversity. Of our 10 tenure-track faculty, 6 are female. This is impressive when compared to the most recent Taulbee survey which indicates that 19.9% of PhDs awarded in computer science are to women. For the last five graduating classes, 33% of our majors have identified as female (based on registrar data, which unfortunately does not allow for non-binary gender identification). This is also above the national average of 20.6% (also reported in the Taulbee survey). That said, we still have a long way to go towards achieving gender parity.

We have less information and a shorter track record on initiatives focused on racial diversity. (For example, the student organization *Love/ace* was founded about 12 years ago to focus on gender issues in computer science, but we have not had a corresponding student organization dedicated to racial diversity; in some years, *Lovelace* has a more intersectional focus.) Over the last ten years, the CS major has trended towards having somewhat more international students (16% of majors on average in 2018-2022 compared to 11% in 2013-2017) and maintaining about the same number of non-international BIPOC students (21% of majors on average in both 2018-2022 and 2013-2017; the classes of 2023 and 2024 have somewhat more non-international BIPOC students). For the past two years, we have participated in the Computing Research Association's Data Buddies survey to try to better understand the experiences of all students, and especially those who are underrepresented in computing.

We regularly pursue a number of other avenues for promoting diversity and inclusivity within our classes including, but not limited to: personally reaching out to individual students; providing support (both financial and logistical) for students to attend conferences such as the Grace Hopper Celebration of Women in Computing and the Richard Tapia Celebration of Diversity in Computing; hiring a diverse population of student course staff to provide near-peer mentors; teaching collaboration skills and monitoring and addressing group dynamics in our courses; and actively aiming to diversify our seminar speakers.

We know that students' past academic experiences can influence their success at Carleton, and that students vary widely in how much experience with computers and computer science they have prior to Carleton. In 2023-2024, we are piloting a version of CS201 that mirrors "with problem solving" courses in other STEM departments at Carleton. This version of the course will provide extra support to enrolled students, and we hope that it will help to level the playing field for students who currently struggle in CS201 or erroneously view it as a "weeder" course; evaluating the success of this new initiative and identifying further ways to support a diverse range of students in CS is a departmental priority.

An additional tenure-track faculty member will give us more capacity to address these IDE goals, and by helping to ease enrollment pressures, will also allow us to spend more time on community building and to contribute to interdepartmental efforts like FOCUS that serve the college's IDE goals more broadly. To the extent that a new faculty member enables us to move towards smaller class sizes, we believe that this hire will also contribute to college-wide goal of providing "an equitable environment for all students, staff, and faculty to thrive," as those students who are most hurt by larger class sizes are those who feel less of a sense of belonging at Carleton generally and in computer science specifically.

Developing a diverse applicant pool

Hiring in computer science is extremely challenging right now as there is huge demand (inside and outside academia) for the small pool of available applicants.

That said, for several previous searches, we have built our candidate pool in a variety of ways, including regularly attending the Grace Hopper Celebration (GHC) of Women in Computing and the Richard Tapia Celebration of Diversity in Computing Conference to make contact with potential applicants. We always alert our personal networks of our job opportunities, post on relevant discussion boards, and so on. In the

past hiring cycle, we also reached out to past speakers from our “CS Tea” speaker series regardless of their apparent current job status, asking them to alert their networks, and contacted a number of CS professional organizations that aim to support scientists with a particular identity (e.g., Black in AI; Networking Networking Women). When inviting CS Tea speakers, one of our goals is to ensure representation of speakers of a variety of different backgrounds, and we believe that fostering these connections helps to diversify our applicant pool in the long run.

Especially in the last year, we have worked to align our hiring practices with our IDE goals, particularly in recruiting a more diverse pool of applicants and focusing on the candidate experience during the hiring process (e.g., distributing questions to candidates prior to video interviews; rubrics in hiring that more explicitly consider candidates’ inclusive practices in the classroom). We will be attending the hiring workshop on June 9.

Mentoring

Good mentoring is essential for new faculty members and we have worked hard to support our new faculty in succeeding and thriving at Carleton. We have a long-standing tradition of internal mentoring within our department. All tenure-track and visiting faculty members are given an internal mentor in the department when they begin. We have found that our new faculty members find it helpful to have a default go-to person when they have questions. We also promote a culture of collaboration more broadly, with an active online departmental forum where faculty at all ranks post about teaching dilemmas, successes, and challenges. We believe it is important for our new faculty members to make connections across the college, too, so we provide introductions for our new faculty members to both faculty and staff across the campus. We intend to continue this mentoring model with all new hires.

Summary

We believe computer science is an essential participant in the modern liberal arts curriculum, and we are delighted with the enthusiasm for computer science shown by Carleton’s students. As a department, we’re eager to contribute to interdisciplinary efforts across the college, and within our classes, we aim to help students see computer science as one lens that they can apply in a variety of areas.

Enrollment pressures have been incredibly challenging for the department, and while we’ve tried to reduce these pressures by raising class sizes and experimenting with new registration mechanisms, we’re still struggling and the current state of affairs is not sustainable for retaining faculty or meeting students’ needs in the way they expect at a small liberal arts college like Carleton. We hope the FCPC will help us to manage enrollment pressures and enable us to experiment with ways of encouraging students to explore both their interest in computer science and their interest in other disciplines by approving our request for a new tenure-track colleague.

We appreciate the FCPC's care and thoughtfulness in considering this request.

Sincerely,

Eric Alexander
Amy Csizmar Dalal
Dave Musicant
Sneha Narayan

Layla Oesper
Jeff Ondich
Anna Rafferty (chair)
Any Vostinar