PAUL G. ALLEN SCHOOL
OF COMPUTER SCIENCE & ENGINEERING

10-Year Self-Study

DRAFT

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Section I: Overview of the Organization

I.A. Mission of the Paul G. Allen School

The Paul G. Allen School of Computer Science & Engineering seeks to be at the forefront as a national and global leader in research, education, and impact in our field. That's a tall order. Computer science (CS) is among the most vibrant and dynamic of all fields — a field in which, if you're not moving forward rapidly, you're falling behind. We strive to educate our students so that they will reach their full potential in practice and in research through a deep understanding of both the fundamentals of the field and the application of those fundamentals in solving important problems and creating products. We strive to imbue students with an affinity for lifelong educational renewal. We strive to exemplify through our research and teaching an expansive 21st century vision of the role of CS in the region, the nation, and the world, and of the societal responsibilities of computer scientists and engineers. We strive, through partnerships, to strengthen the UW and our region. We strive to create a diverse, equitable, inclusive, and accessible environment where everyone is supported and thrives.

I.B. Culture of the Allen School

An important strength of the Allen School is its culture and a continual focus on improving that culture — a culture based on a highly collegial, collaborative, non-hierarchical structure. Interdisciplinary collaboration is highly valued. This is even reflected physically in the layout of our buildings, in which spaces are arranged to maximize interaction and mixing across disciplines and seniority levels. We strive to be collegial and non-competitive internally, acting as a coherent unit where individuals support each other and act for the good of the whole community. We have a growing collection of peer-group, mentorship, and professional development activities.

I.C. Role of the Allen School in the University

Computer Science has grown from its roots in mathematics and electrical engineering into a broad and deep field of its own. CS has expanded to become a socio-technical field whose impact is deeply intertwined with every aspect of our world, with connections to the arts, humanities, social sciences, law, business, and many other fields beyond STEM. Innovation and leadership in CS are essential to innovation and leadership in the broadest imaginable range of other fields. In short, CS lies at the heart of the modern university and the modern world.

We embrace the pervasive role of CS in society at large, in the modern university, and at the UW. We embrace the responsibilities that accompany this pervasive role. We view ourselves as central to the UW of the present and future. We view ourselves as a unit of the entire university rather than of any one school or college. We view ourselves at the heart of increasingly deep intellectual partnerships with disciplines ranging from architecture to zoology, with art, astronomy, biology, business, engineering, global health, law, medicine, and many others, leading to a transformation of these disciplines, and a transformation of CS as well. This view is reflected in the wide variety of campus-wide multidisciplinary initiatives that we have launched or co-launched but explicitly *not* sought to “own,” including the eScience Institute (data science), DUB (human-computer interaction and design), Change (technology for developing regions), the Tech Policy Lab (led by the Allen School, the Law School, and the Information School), CREATE (assistive technology), and most recently CS4Env (Computing for the Environment). Initiatives such as these, and others, are transforming research and education across the campus.

This attitude is not new — it goes back decades. The members of our 10-year review committee in 2000 saw it clearly, writing in the Executive Summary of their report:

> “This department, like no other here, lies at the core of nearly every imaginable future of the University of Washington. This is not just a general reflection of the role of CS and information technology for any institution of higher learning; rather we see this as particularly germane to the University of Washington … Consider this a department of the University.”

I.D. History of the Allen School

What is today the University of Washington's Paul G. Allen School of Computer Science & Engineering was established by the UW Board of Regents as the CS Group — a graduate program reporting to the Dean of the Graduate School — in 1967.
In 1974, the Regents approved the transition to a Department of CS — an inter-college unit reporting to both the Dean of Arts & Sciences and the Dean of Engineering — and the addition of an undergraduate major that was launched at the start of the 1975-76 academic year.

In 1979, our reporting relationship was changed at the request of the Provost so that we became a unit of the College of Arts & Sciences exclusively. There we were nurtured by an extraordinary dean, Ernest Henley. Receipt of the first award in the National Science

Foundation’s Coordinated Experimental Research Program in 1980 launched the department into the first rank, reflected in the 1982 NRC “Assessment of Research-Doctorate Programs,” in which we were ranked among the top 10 in the nation (9th for quality of faculty, 10th for effectiveness of graduate program, and 2nd for improvement in the preceding five years).

In 1989, a different Provost decided that we should be a unit of the College of Engineering. A Computer Engineering undergraduate program was added at that time, and our name was changed to the Department of Computer Science & Engineering. (More than 30 years later, 90% of our undergraduate students are Arts & Sciences students enrolled in our Bachelor of Science in Computer Science program offered through the College of Arts & Sciences. Although housed in the College of Engineering, we truly are a unit of the entire university.)

A Professional Master's Program — a part-time, evening program for fully-employed professionals — was added in 1996. A five-year combined bachelor’s/master’s program in which roughly 10% of our undergraduates participate was added in 2008.
In 2017 — our 50th anniversary year — the Board of Regents voted to create the Paul G. Allen School of Computer Science & Engineering, elevating the status of CSE within the university and linking us in perpetuity with the internationally renowned investor, philanthropist and computing pioneer. (The Allen School is not fully independent, however: We continue to be a unit of the College of Engineering.)

Between 1975 and 1999, undergraduate enrollment grew from 40 degrees per year to 160 degrees per year, where it remained until 2012 despite massive changes in student demand, employer demand, and the role of the field. At that point, a sequence of legislative provisos — line-item appropriations — grew our undergraduate capacity to 550 degrees per year and our total capacity to 720 degrees per year. This dramatic increase still falls far short of meeting demand. (We must rely on legislative appropriations to grow — in-state tuition would fall far short of covering our costs even if it flowed through to us, which it does not.)

I.E. Organization and Governance of the Allen School

The Allen School’s leadership consists of the Director (Magda Balazinska), the Vice Director (Dan Grossman), five Associate Directors — for facilities (Paul Beame), graduate studies (Anna Karlin), diversity, equity, inclusion and access (Yoshi Kohno), development and outreach (Ed Lazowska), and research and innovation (Shwetak Patel) — and an Executive Committee comprised of these seven plus five elected members (currently Hanna Hajishirzi, Justin Hsia, Rachel Lin, Rajesh Rao, Amy Zhang).

The Director is appointed by the Dean of Engineering for a five-year term with the potential for extension and/or renewal. The Vice Director and Associate Directors are appointed by the Director for duties that correspond to current needs. Additional members of the Executive Committee are elected for one-year terms with a gap of at least one year after two consecutive terms. The general duties of the Executive Committee are to be “in the loop” on all issues, to deal with straightforward issues (and others that are delegated in accordance with the UW Faculty Code), to ensure that the faculty as a whole is engaged on important issues, and to serve as a two-way communication channel. An analogous Staff Executive Committee works with the Director on matters pertaining to the staff; staff directors are members of Staff Exec.

In terms of numbers, the Allen School has:

- 88 FTE faculty (73 tenure-track, 14 teaching-track, one research), counting all faculty members currently in the Allen School or who will be starting on or before January 1, 2023. We also have four additional incoming faculty members who are planning to start by January 1, 2024. Of course, by then, we may have had additional retirements too, and hopefully additional hires.
- 112 staff (19 finance, administration, operations; 9 development, outreach, communications, events; 16 student services; 8 diversity, equity, inclusion and access; 18 technical support; 19 administrative support for faculty clusters; 23 technical support hired by specific research projects). This does not count 10 eScience Institute staff nominally housed in the Allen School.
- Students as of Fall 2021 (Fall 2022 numbers will only be available in late October):
    - 1,906 bachelor’s majors
    - 325 Ph.D. students
    - 164 part-time Professional Master’s Program students
    - 74 5th-year B.S./M.S. students

Despite our size and future growth plans, we have chosen not to “departmentalize” — we attempt to preserve a “one school” culture. As a result, we have large, school-wide committees that bring all research areas together. Three committees in particular — the tenure-track and teaching-track faculty search committees and the graduate admissions committee — are each co-chaired by two faculty members who play significant leadership roles in the school. Other faculty members hold important roles by overseeing our various degree programs as well as faculty and postdoc career development.

Appendix A provides more details on the Allen School organizational structure.

I.F. Relationship of the Allen School to the College of Engineering

By measures such as bachelor's degrees awarded, student credit hours, research awards, and philanthropy, the Allen School ranks among the top four to six of UW's 16 independent Schools and Colleges (see Appendix B.3). We remain, though, a unit of UW's 10-department College of Engineering, where we constitute between roughly 40% and roughly 60% of those measures. Despite lacking budgetary autonomy (allocation of tuition revenue, indirect cost return, etc., is at the discretion of the Dean of Engineering), we operate independently in many ways, due to our size and due to the extraordinary presence of technology companies in the Seattle area and our close partnership with those companies. We have our own undergraduate admission pathway; we have our own student services staff; we have our own technical support staff; we have our own career fairs; we have our own diversity, equity, inclusion and access staff and activities; we have our own communications and alumni relations staff; we have our own human resources staff; we have our own representative on the UW Foundation Board.

I.G. Unusual Characteristics of the Allen School

- The quasi-independence noted in the preceding subsection is one unusual characteristic of the Allen School. (Berkeley, Cornell and MIT also have structures that are "neither fish nor fowl," but each benefits from budgetary autonomy that we lack.)
- Like most undergraduate majors at UW, we are capacity-constrained. We can grow only when the legislature provides us with funding to grow. (Even if tuition flowed down to the units offering instruction, which is not the case at UW, it would fall far short of covering the costs of education in a technology field.)
- We offer two Bachelor of Science degrees: Computer Science, offered through the College of Arts & Sciences, and Computer Engineering, offered through the College of Engineering. The degree requirements are similar, and we admit students to the Allen School by a holistic process without regard to which major they desire.
- As a result of this "major-blind" admission process based on a holistic assessment of student quality, roughly 90% of our undergraduates are in our A&S Computer Science program. These students have a strong allegiance to the Allen School, but understandably do not view themselves as College of Engineering students. (Oddly, the current Dean of Arts & Sciences is reluctant to view them as A&S students.)
- The focus of our graduate program is Ph.D. students. We do not have a full-time master's program, with the exception of our small 5-year combined bachelor's/master's program. We have the part-time, evening Professional

Master's Program for fully-employed professionals noted above, and we contribute to several multi-department master's programs as we will discuss in the education section of this self-study.

- We have been blessed to grow up alongside and in close partnership with Seattle's tech community. This partnership represents a unique competitive advantage for us in many ways. One response to capitalizing on this advantage is an arrangement negotiated with the Provost that allows our faculty to have extended partial leaves — essentially, "dual hatted" positions (see Appendix F.3). This causes stresses and strains, but we feel that it is a net win that offers significant advantages to the companies, the university, the region, and the individuals.

I.H. Budget and Funding

The Allen School has two major sources of funding: Washington state funds and research grants. In addition, we have income from gifts, two major endowments (the Innovation Endowment and the Allen Endowment), and endowed professorships, scholarships, and fellowships. We further have income from our Professional Master's Program (PMP) and, to a lesser extent, the Data Science Master's program (joint with five other units) and the MHCI+D program (joint with three other units).

The following are the key points related to our budgetary status. The graphs and details follow in the next subsections as well as in the Appendix:

- As we mentioned above, we are a large unit! By most measures — including overall budget (see Appendix B.1 and B.3) — the Allen School ranks among the top half dozen of UW's 16 independent Schools and Colleges. Due to our scale, we operate mostly autonomously with our own strategic plans and staff.
- Overall, the Allen School is in a healthy financial situation. Responding to extraordinary student demand and extraordinary workforce demand, a series of legislative provisos in the past decade has funded our growth. When proviso funding is provided, we immediately enroll the students. However, faculty and staff hiring lags (see Section I.J on Faculty Hiring below). This results in temporary savings, which we must accumulate to cover start-up expenses for future hires. As a result, we presently have substantial "reserves," but these are committed and projections show reserves shrinking rapidly in the next few years. (Lags in hiring also result in excessive class sizes and use of temporary instructors.)
- Due to huge demand for computing education and, in particular, data science and artificial intelligence/machine learning education, we have also grown our

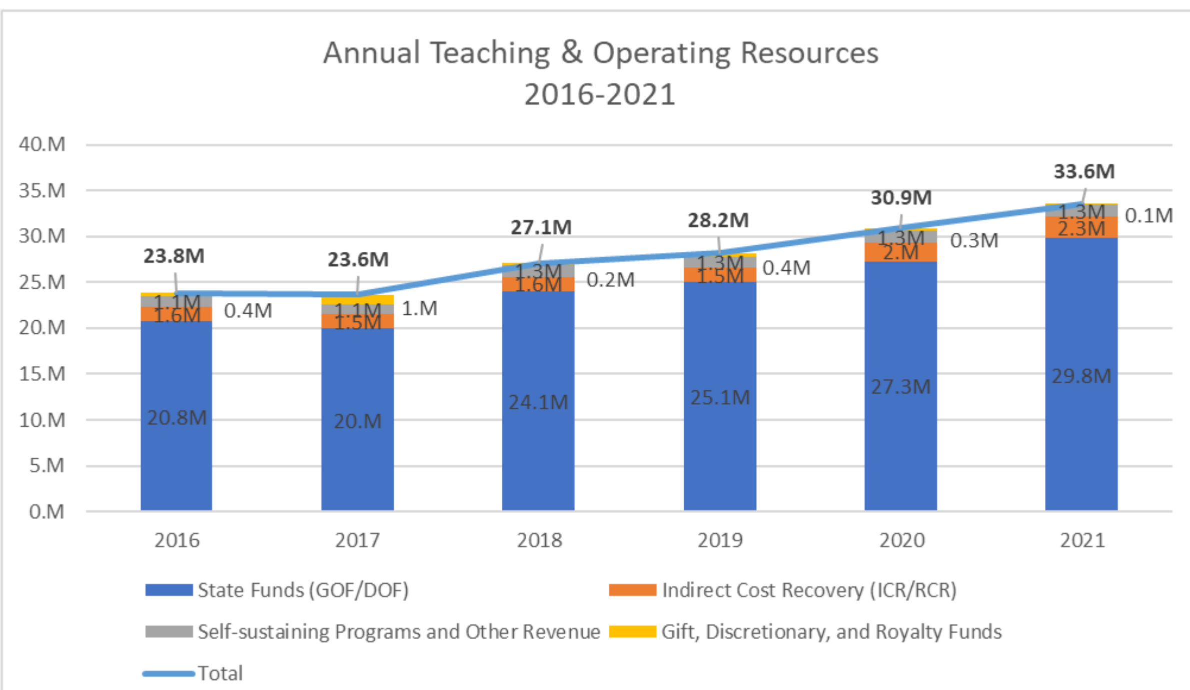
non-major courses, which should be paid for by UW's Activity-Based Budgeting. However, proportional distribution of ABB revenue stops at the level of the Dean — the College of Engineering in our case. We further discuss non-major courses in Section II on "Teaching & Learning."

- Due to our size, we must plan for churn in faculty as our older faculty retire and as some other faculty occasionally depart for other reasons. Such churn is expensive since each new faculty member costs us approximately $750K in startup expenses (a number that is growing rapidly due to competition from other institutions — many faculty candidates this year had competing startup offers in excess of $1M). We currently do not have any income to specifically help cover startup expenses due to churn. Legislative provisos fund us only for the steady-state that results from growth and the provisos do not even include automatic future inflation adjustments.

In the next few subsections, we break down our budget and expenses into (1) teaching and operations; (2) research; and (3) endowed funds.

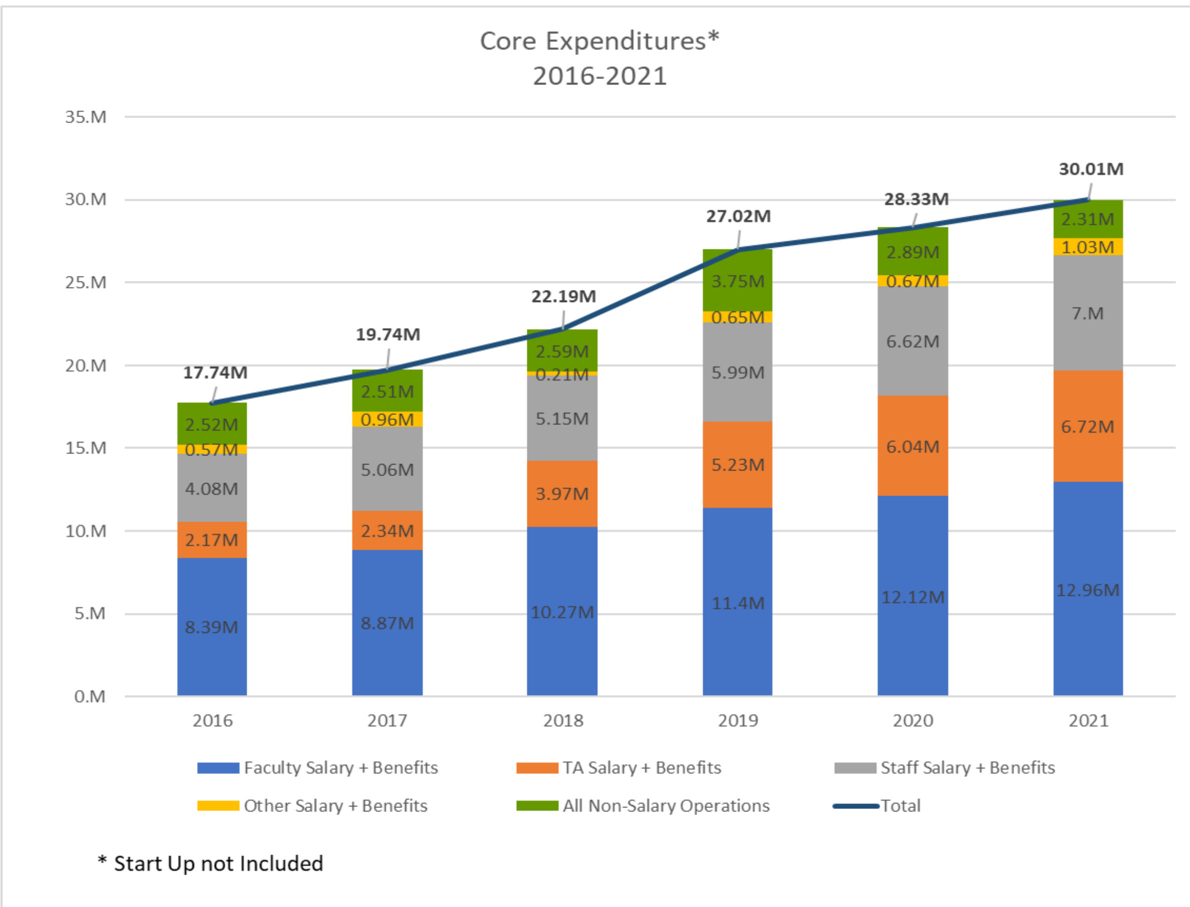
I.H.1. Teaching and Operations Revenues & Expenditures

For our teaching activities and overall school operations, which support teaching and research, the major sources of funding are state funds, indirect cost recovery from research grants, revenue from self-sustaining master's programs, and gift funds. The following figure shows these major sources of revenue for the last six years.



As the figure above shows, Allen School revenue has significantly increased in recent years. Much of this increase came from the legislative provisos that, starting in 2012, funded the Allen School to significantly grow the number of degrees that we produce. The number of awarded degrees went from 289 in 2011-12 to 738 in 2021-22 — a 2.6X increase over the decade. We further discuss degree production in Section II.C**.** For the six years in the figure above, the number of awarded degrees grew from 354 to 635 — a 1.8X increase. In the same period, our state funds increased from $20.8M to $29.8M (a 1.4X increase). Revenue from our self-sustaining programs increased by about 20% and indirect cost recovery from grants increased by about 44%. We note that the number of degrees produced is a lagging indicator of the total number of students in our programs (and thus the expenses that we incur).

The following figure shows our expenditures for teaching and operations. This figure does not include our commitment to faculty start-ups, which we discuss next.



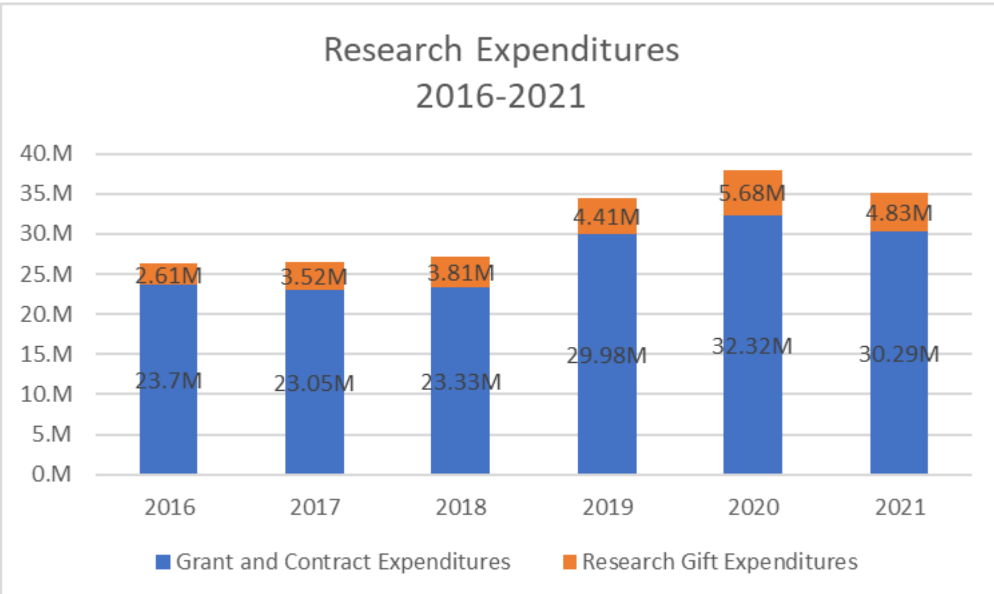
Our teaching-related expenditures have seen a dramatic increase, in particular due to the cost of teaching assistants. This increase comes for the most part from growing our course enrollments. In 2020-21, we spent about $19.7M on faculty and TAs and produced 635 degrees (bachelor's, master's, and doctoral combined), or $31K/degree compared with 2015-16, when we spent $10.6M and produced 354 degrees, or $30K/degree. So our overall cost per degree has grown only modestly; in fact, it decreased after accounting for inflation. However, this cost is expected to increase because faculty hiring has lagged behind our growth: The number of degrees per tenure-track faculty member increased from 6.7 in 2015-16 to 10.0 in 2021-22 (the full graph is in Section I.J on Faculty Hiring below). As faculty hiring catches up, this ratio should drop and costs per degree will grow. Our TA costs have grown significantly faster than our degree production in recent years. We spent $11K/degree in TA costs in 2015-16 and $18K/degree in TA costs in 2020-21. This increase is due to a significant growth in more expensive, upper-division courses and in unfunded, non-majors courses, as we discuss further in Section II on Teaching & Learning. For non-CS majors, we provide courses on basic programming, data science, and AI/ML skills. We consider this an important aspect of our mission for the university, but we observe that we are currently primarily responsible to cover the associated expenses from our savings instead of receiving the associated activity-based budgeting revenue. Finally, our staffing expenses have been stable with staff salaries remaining at about 23% of all expenses between 2016 and 2021. As we grow our programs and hire more faculty, we need to continue to grow our staff proportionally. As staff grows, we need to improve our organizational structures to ensure scalability of the services that staff provide.

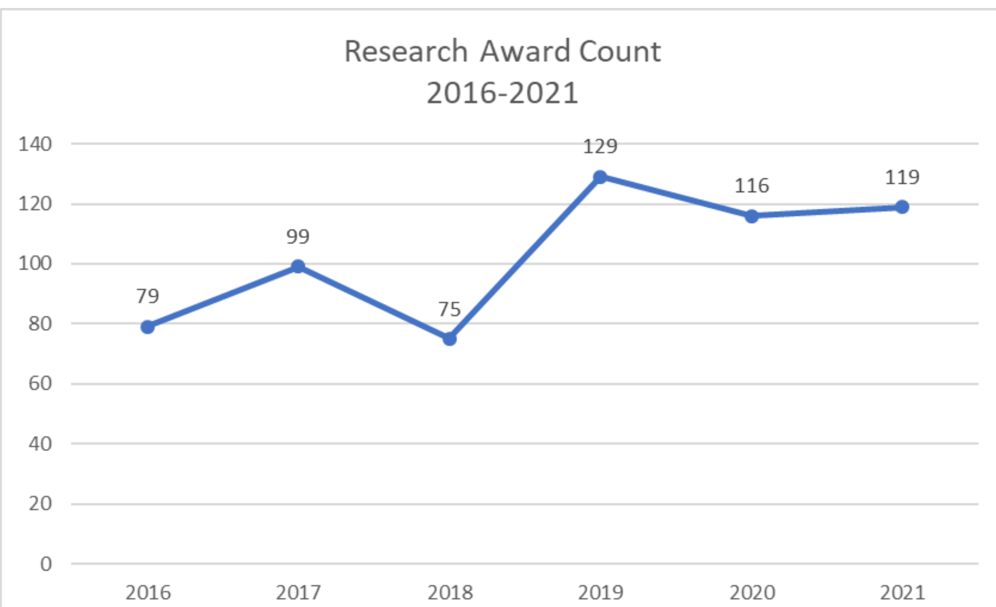
If we compare our overall revenue and expenditures, we are doing well. However, the expenditures do not include our spending on faculty start-ups. Between 2016 and 2021, we spent between *$1M and $4.5M each year* in new start-up commitments for faculty members (figure in Appendix B.1). We currently have approximately $25M in "carryforward" or "reserves," but as our faculty hiring has been catching up with our growth, we are now dipping into those reserves to fund operations. Current projections for growth, without significant additional resources, have us exhausting operating reserves by FY28. Because of the significant demand for CS, we continue to work diligently to receive funding for growth from the state legislature.

Non-salary operations typically represent between 7% and 15% of all expenses and include office supplies and services, travel, events, facilities maintenance, and software and equipment purchases.

I.H.2. Research Awards & Expenditures

As we enrolled a larger number of students, we also hired new faculty members, both teaching-track and tenure-track. Between 2016 and 2021, our total tenure-track faculty FTE went from 52.5 to 70.83, counting fractional appointments as such (the full graph is in Section I.J on Faculty Hiring). This represents a 1.35X increase. In the same time period, as shown in the figure below, research expenditures increased from $26.31M to $35.12M, a 1.33X increase. The number of research awards shown in the following graph had a similar increase. We note that the most recent two years (2020 and 2021) were during the pandemic when much of our faculty had their productivity significantly disrupted due to school closures and other personal factors, switching both instruction and research to be online, impossibility to travel, and other pandemic-related factors.





I.H.3. Fellowships, Scholarships, and Professorships

In addition to the above sources of revenue and expenses, we actively fundraise for scholarships, fellowships, professorships, and our two school endowments. Current Allen School endowments are:

- School-wide endowments (Allen Endowment, Innovation Endowment): $88.5M
- Faculty Endowed Chairs: 4 funds totaling $12.4M
- Faculty Endowed Professorships: 17 funds totaling $29.0M
- Graduate Student Fellowships: 19 funds totaling $16.5M
- Undergraduate Student Scholarships: 33 funds totaling $13.2M

Because the UW endowment spins off only 3.6% per year (additional gains are reinvested to grow the principal), the total available annually from our $160M in endowments is only roughly $5.75M. Importantly, though, and in contrast to most private institutions, Chairs and Professorships do not support base salary — base salary is provided by state funds. So the yield from Chairs and Professorships is available to the holder of the position for discretionary purposes.

I.I. Space

In 1974, when departmental status was conferred and an undergraduate program was authorized, the 11 faculty members and several dozen graduate students in CS were consolidated in Sieg Hall. By the mid-1980s, as the field moved in a more laboratory-intensive direction, we were increasingly limited by space constraints: We had a total of less than 40,000 ASF (less than 1/3 the average per FTE of peer departments); we had no amenities (e.g., we had only one conference room, which also doubled as a lab); and we had only two “real” research labs.

A private fundraising effort beginning in 1999 enabled us to build, and in 2003 to move into, the Paul G. Allen Center for Computer Science & Engineering — UW’s first largely privately funded building — which provided approximately 75,000 ASF. (In addition, we still occupied a portion of one floor of Sieg — roughly 8,000 ASF.) The Allen Center roughly doubled our space, and provided numerous instructional and research labs, high-quality amenities, office space, etc.; it allowed us to grow, and to modernize our research and education in a variety of ways.

By 2015, expansion in response to explosive enrollment demand had caused us to outgrow the Allen Center. We launched another private fundraising effort for an additional building, and in 2019 we dedicated the Bill & Melinda Gates Center for Computer Science & Engineering, roughly doubling our space once again and providing vastly improved facilities for our undergraduate students who had received short shrift in the Allen Center. Sieg Hall is, blessedly, in the rearview mirror — the only space that we occupy beyond the Allen Center and the Gates Center is wet lab space for research on the interface between CS and biology. (We included a small wet lab in the Gates Center but we underestimated the need.)

Both the Allen Center and the Gates Center were community efforts rather than having a single individual write "the big check": Each had more than 300 donors, with Paul Allen providing just a bit more than 20% of the funding for the Allen Center, and the Gates Foundation providing less than 15% of the funding for the Gates Center (and this after the building had already, in confidence, been named for the Gateses by Microsoft and a dozen couples who were long-time friends). Thanks to the generosity of friends and alumni, and strong support from the state legislature, we are blessed with outstanding facilities — facilities are not currently the limiting factor for our continued ascent.

I.J. Faculty Hiring

Faculty hiring is a crucial way in which we define our future. In the last five years (since we became a school), we have hired 39 faculty members: 30 tenure track, eight teaching track, and one research track (counting academic year 2017-18 through 2021-22).

Our hiring strategy has four components:

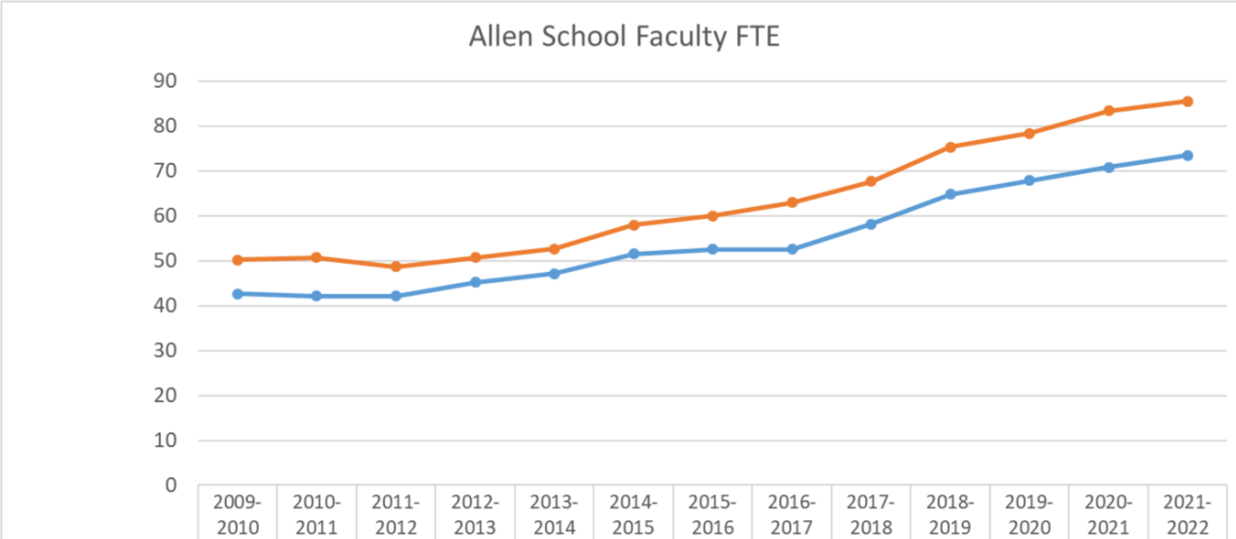
1. **We hire to strengthen existing areas and to expand into new areas**. In the last five years, we have continued to focus on broadening ourselves and hiring more interdisciplinary researchers. We started new research groups in data science, quantum computing, cryptography, computational fabrication, and CS education research. We have also hired to strengthen our core including machine learning (including AI fairness and core AI), natural language processing, software engineering, robotics, human-computer interaction (including social computing), computational biology, molecular programming, system security, data visualization, data management, computer vision, wireless sensors, systems, cloud computing, computer graphics, and neuroscience. Most of those new faculty members have collaborations with researchers across the UW campus, in industry, and at other institutions. Many participate in large interdisciplinary centers as we discuss later in the document. Appendix C includes a detailed list of our hires in the last five years.
2. **We hire at both the junior and senior levels**. Of the most recent 39 hires, 31 have been assistant professors and eight have been associate professors. However, five of the assistant professors were already employed elsewhere as tenure-track faculty and relocated to the Allen School. While our focus is on new graduates and postdocs, more advanced hires enable us to start a new area or

rapidly move an area forward in prominence. We have used this strategy to catapult several groups to be among the best in the world, including natural language processing, robotics, data visualization, computational biology, and cryptography. We also leveraged senior hires to dramatically strengthen our systems, machine learning, and software engineering groups. Most recently, we hired a senior faculty member who is a research leader in CS education. Senior hires put us on the map immediately and help us build out new groups.

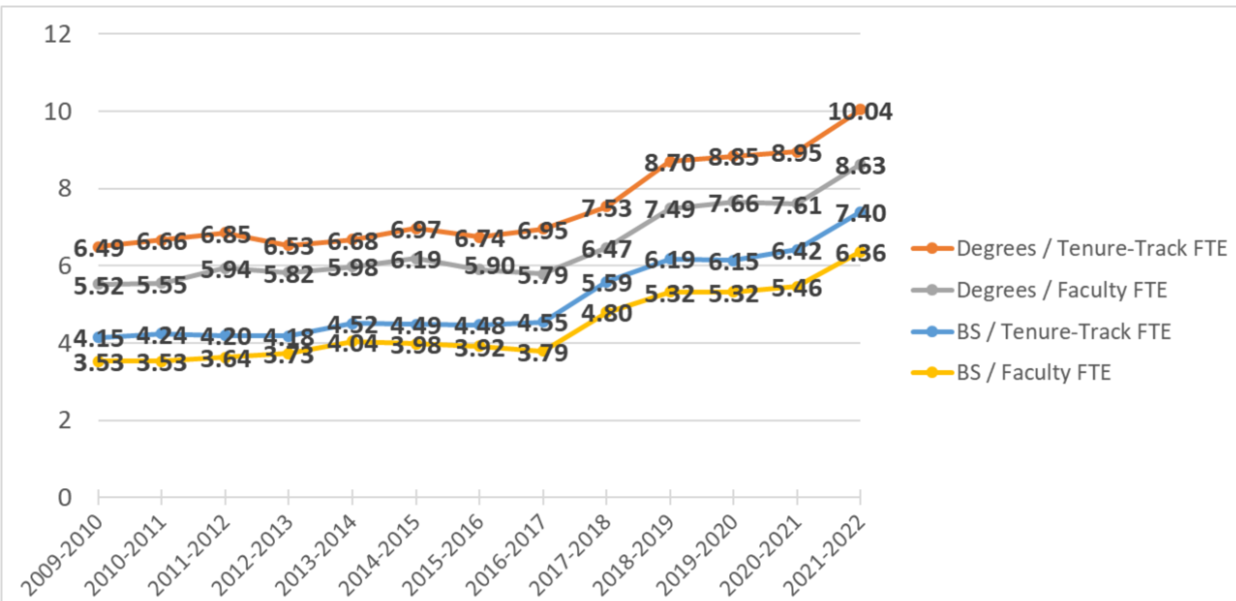
3. **We conduct broad searches.** In order to hire candidates of the highest caliber, we simultaneously search across multiple priority areas each year, as well as considering truly extraordinary candidates in any area. This strategy enables us to hire “best in N years” types of candidates, and directly translates to the high caliber of research that comes out of the Allen School.
4. **We hire both tenure-track and teaching-track faculty**. As our school has grown, our need to teach large numbers of students has also expanded. To address this need, we adopted a more balanced approach to hiring both tenure-track and teaching-track faculty members. In the last five years, we hired eight teaching-track faculty. Those teaching-track faculty have created a rich and supportive community. We now have seminars about CS education and are preparing a curriculum and a certification for Ph.D. students who seek to pursue teaching careers after graduation. Teaching-track faculty also engage deeply in pedagogical innovation and K-12 outreach, significantly strengthening our school. They are first-class faculty members hired for long-term careers and, as of two years ago, the university gives them professorial titles. We do not require a Ph.D.; three of the eight recent hires (and six of our 14 total teaching-track faculty) do have a Ph.D. Six of the 14 teaching-track faculty have a degree from our unit.

Over that same five-year period, we had a number of losses as well — most at the senior level. Five tenure-track faculty members retired. Seven tenure-track faculty members relocated to another department, academic institution, or startup. Three teaching-track faculty members also left the school either to retire or to pursue other opportunities (we list arriving and departing faculty members in Appendix C).

Altogether, in the last five years, we hired 30 tenure-track faculty members but lost 12, for a net increase of 18. We hired eight teaching-track faculty members but lost three, for a net increase of five. Research faculty members are expected to stay only for a limited period. The following two graphs show the growth in tenure-track FTEs, carefully taking into account fractional positions, and not counting faculty who were recently hired but did not yet join the school. As the following graphs show, in spite of this growth, our hiring on the tenure track has not kept pace with the growth of our program and we continue to have a large ratio of degrees to tenure-track faculty.



	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022
All faculty	50.17	50.67	48.67	50.67	52.67	58.00	60.00	63.00	67.67	75.33	78.33	83.33	85.50
Tenure-Track	42.67	42.17	42.17	45.17	47.17	51.50	52.50	52.50	58.17	64.83	67.83	70.83	73.50



I.K. Academic Unit Diversity, Equity, and Inclusion

The Allen School has a long history of attention to gender diversity in our undergraduate and graduate programs. We were granting roughly 1/3 of our bachelor's degrees to women at a time when the average among CRA schools was less than half of that. Based on our achievement of tangible results and our continuing commitment, we were recognized in 2015 with NCWIT's inaugural NEXT Award Grand Prize for Excellence in

Promoting Women in Undergraduate Computing. In the commendation accompanying the award, NCWIT observed:

> *The University of Washington has grown an inclusive, welcoming community that spans beyond the walls of the university and has demonstrably advanced women's meaningful participation in computing.*

We had paid far less attention to other aspects of diversity: students who belonged to other traditionally underrepresented groups (racial, ethnic, economic, educational), and most aspects of faculty/staff diversity. Additionally, we had failed to make further progress in the gender diversity of our student body — our lead began to erode. In fairness, we face some special headwinds — for example, Washington's Initiative 200, analogous to California's Proposition 209, prohibits any consideration of race or gender in admissions or hiring. But the truth is that we had not focused.

Our focus and efforts have now expanded — dramatically. This is demonstrated through changes in our population. In the past few years we have approached the campus average for first-generation, Pell-eligible, and African American students — a result of heavy investments in programs and practices to recruit a more diverse class of students and ensure that all students, regardless of background, have the tools and the environment that they need to succeed. Membership as one of seven schools in the Hopper-Dean Foundation Collaborative has had a significant impact on undergraduate program diversity in areas beyond gender. Membership as one of 11 schools in the initial cohort of the LEAP Alliance has had a significant impact on graduate program diversity in areas beyond gender. (We are also a member of the newly formed 11-school LEAP Alliance Cohort 4, focused on engaging traditionally marginalized undergraduates in research.) Support from the Center for Inclusive Computing is assisting a complete redesign of our introductory course sequence with an explicit goal of making it more welcoming and inclusive. Interaction with colleagues at other universities through the collaborations just noted have hugely informed and shaped our efforts. Signature practices include:

- Significant investment in joint faculty-staff Diversity, Equity, Inclusion, & Access (DEIA) leadership. We have appointed a faculty member who serves as our Associate Director for DEIA. We have expanded our dedicated staff who work on DEIA initiatives, including hiring a Director for DEIA Strategy and Operations, expanding our undergraduate Diversity & Access team (seven professional staff members), and expanding DEIA staffing at the graduate student level. Faculty are committed and engaged, of course, but dedicated staff ensure that things actually happen. This has been crucial.

- We have transitioned our outreach programs from “broad and shallow” to “narrow and deep” — investing in significant relationships with K-12 partners and community-based organizations that are carefully selected for their ability to channel students from specific demographics to the Allen School. Much of the horsepower for these activities comes from the Allen School Ambassadors, a group of undergraduates who are funded to conduct K-12 outreach and recruitment activities for middle and high school students who are underrepresented in computing.
- We have launched a new summer program called Changemakers in Computing (CIC). The CIC program is a four-week summer program for rising high school juniors and seniors to learn about technology, society, and justice. The program serves Washington state students from systematically marginalized backgrounds and provides a $2,500 stipend to each student. (Stipends enable students to participate without missing out on wages they would accrue if they were working during the summer program). We have partnered with Microsoft to expand the number of students in the program and to expose students to additional opportunities in the tech industry.
- We have always had a single introductory course sequence in order to avoid “dead end” pathways: Much of our gender diversity has arisen from converting women who enroll for other reasons into CS majors. We have completely redesigned the sequence — length, pacing, assignments, encouragement of collaboration, TA training (all TAs are undergraduates) for inclusiveness, etc. — to better accommodate the range of prior experience and otherwise make the sequence, and the first course in particular, more welcoming to those with no or limited background. (The process is complex because our course sequence is used by many UW departments and our curriculum is used by a number of the state’s high schools and community colleges.)
- We have multiple cohort-based programs that provide dynamic support to incoming freshmen who have limited programming experience and/or are from low-income, first-generation, and underserved communities. At the aggressive extreme, the STARS program is a two-year cohort program with a specialized curriculum designed to build learning skills and strengthen academic preparation for core math and science courses. The less aggressive Startup program is a one-year cohort program that involves a pre-autumn course and freshman year support including supplementary sections of key courses and “intrusive advising.” Our “Rising into 300s” program provides a preparatory supplement to the material presented in the first majors-only post-intro-sequence course, and fosters the formation of a social and academic network among students.
- We have augmented our graduate admission process to identify applicants who have taken maximum advantage of the opportunities afforded them as

undergraduates, even if cutting-edge research was not among them. Faculty have conversations with these applicants early in the review process. We also are reaching out and actively encouraging students in this demographic to apply.

- We have recognized that an overall climate of inclusion is paramount. The cohort-building activities noted above reflect this. We also actively support a constellation of student groups, including Ability (for students with disabilities), Women in Computing (for women and non-binary students), Gen1 (for first-generation college students), Q++ (for LGBTQ+ students), and Minorities in Tech (for students who identify as African American/Black, Latinx, American Indian, Native Hawaiian or Native Pacific Islander).
- Faculty, staff, postdocs, and graduate and undergraduate students actively participated in a two-year process that yielded a substantive DEIA Strategic Plan with broad ownership and buy-in. Our entire community is committed to increasing DEIA across identity groups in such a way that all members of our community are safe, included, and equitably supported. Our commitment is focused on improving the Allen School along three key dimensions: (1) the diversity of our community and each cross section; (2) the quality and equity of one's experience at the Allen School; and (3) the capacity of our community to produce technology that is just, equitable, and socially aware.
- And — *mirabile dictu* — we have recruited our first Black faculty member. (Twenty-five percent of our faculty are women. As with many aspects of DEIA, we are not where we need to be, but our commitment is strong and we are making progress.)

See our DEIA webpages for additional information (please see the various tabs on that page). We also include an executive summary of our DEIA strategic plan in Appendix D.

Section II: Teaching & Learning

Nothing is more fundamental to the Allen School than our educational mission: *To educate students to become responsible leaders in the design and implementation of the computing systems that touch every aspect of modern society*. Our view of computing is broad, including hardware, software, theory, applications, interactions with humans, and interactions with society. While our commitment to this mission at all levels, from introductory programming through our doctoral program, has not changed, nearly every aspect of our educational programs has transformed over the last decade — with growth and innovation still ongoing.

II.A. Key Takeaways for Teaching and Learning

1. Our bachelor's and doctoral programs have grown significantly in the last decade, more than tripling and doubling in size, respectively.
2. Service courses have grown to over 7,000 non-major student course enrollments per year, including multiple new high-demand courses related to data science.
3. We have worked toward the greater campus good by partnering with other units on three new interdisciplinary master's degree programs.
4. Our educational role extends not only across the UW campus, but also across the state through relationships with K-12 institutions and community colleges.
5. Despite all this growth, we still turn away a heartbreaking number of highly qualified students. More growth is needed because admissions is unacceptably competitive.
6. Despite the increased class sizes due to our growth and the inherent lag in faculty hiring, we continue to achieve excellence in effective teaching, student outcomes, and student satisfaction. We embrace continuous evaluation and improvement.
7. Key structural changes we made to enable this success include:
    a. A substantial change to undergraduate admissions to our majors
    b. Many new courses as we lead the expansion of the computing field
    c. More flexible, modernized course requirements for our Ph.D. degree
8. We have several key ongoing efforts. (We discuss some of them in Section IV Future Directions.)
    a. Reinventing our main introductory programming sequence to better serve more students with a range of prior experience (will deploy in 2022-23)
    b. Better integrating technology, ethics, and professional responsibility in curricula
    c. More structured support for undergraduate research experiences
    d. Expanding early-college support for students with underprivileged academic preparation

II.B. High-Level Overview of Programs

1. **Undergraduate majors:** As of Fall 2021,[1] we had 1,900 undergraduate majors. We awarded 544 B.S. degrees in 2021-22, up from 171 in 2010. We offer a B.S. in Computer Science in the College of Arts & Sciences (with an option to specialize in Data Science) and a B.S. in Computer Engineering in the College of Engineering.[2]

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[1] Fall 2022 enrollment numbers will only become available after the due date for this report.

[2] We are also one of four departments that jointly run the Applied and Computational Mathematical Sciences (ACMS) major, which awards ~100 B.S. degrees/year. We contribute to, but do not lead, this program and do not receive "credit" for its degrees. It uses our upper-division service courses.

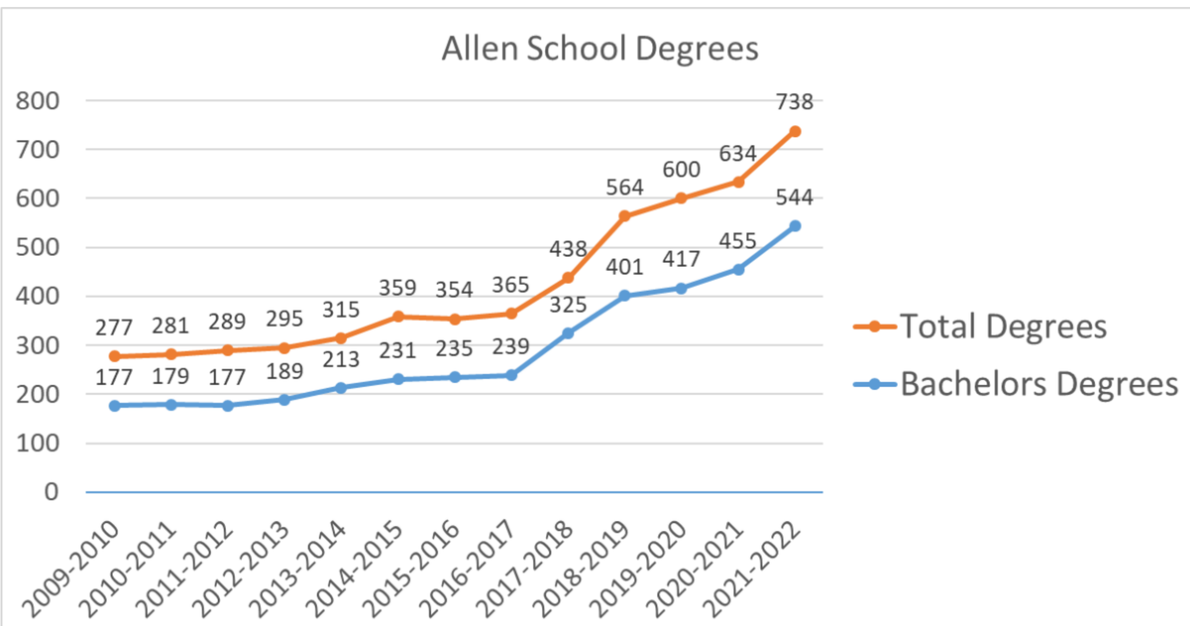
The CS degree has more flexible requirements. While ~90% of our students choose the Computer Science degree, we operate a unified undergraduate program with essentially no distinction in the student experience; our students identify as *in the Allen School* and *studying CSE*.

2. **Ph.D. students:** As of Fall 2021, we had 325 Ph.D. students, with entering classes of approximately 50-60 students and graduating cohorts of ~40. We are one of the top computing doctoral programs in the nation; see Section III on Scholarly Impact.
3. **Postdocs:** We have a small, but active and growing postdoc program. As of September 1, 2022, we have 26 active postdoc appointments across 19 faculty members. About half of our postdocs get jobs in academia after completing our program. We discuss our postdoc program in more detail in Section II.J Postdoctoral Researchers.
4. **Allen School master's programs:** We have no conventional full-time master's program. Instead, we have:
   a. A part-time evening **Professional Master's Program** for full-time software engineers: Established in 1996 to meet a regional need and have regional impact, it attracts more applicants than ever, has a current enrollment of ~170, and produces ~50 degrees per year.
   b. An **integrated B.S./M.S. program** through which roughly 10% of our undergraduate majors "stay for a master's." Established in 2008, the program admits students before senior year so they can plan their last undergraduate year and graduate year together. Students take a mix of additional advanced undergraduate courses and graduate courses, with opportunities for research and teaching.
   c. Substantial participation, including annual teaching obligations, in three **interdisciplinary programs**, all new in the last decade and involving several departments: Data Science (MSDS), Human-Computer Interaction & Design (MHCI+D), and Science in Technology and Innovation (MSTI).
5. **Service courses:** We proudly shoulder an enormous service load, from introductory programming up through graduate courses, totaling over 7,000 course-enrollments per year from UW students who will never receive an Allen School degree. Roughly 75% of these enrollments are at the freshmen level.
6. **Outreach and state leadership:** While not a program *per se*, key to our educational mission is collaborating across the state to enable access to high-quality computer science education. This includes outreach work on student access, teacher professional development, dual credit (UW in the High School), and more.

II.C. Enrollment Growth

Meeting substantially more student demand without compromising educational excellence has been a major focus pervading all aspects of teaching and learning. Because student growth has far outpaced faculty growth, we have learned how to teach larger classes and meet other challenges of scaling up to impact more students.

Our **degree growth** has been significant, although we still represent a small fraction of the UW as a whole. UW has 125 distinct undergraduate majors and dozens of sub-majors, and awarded 8,893 bachelor's degrees in 2021-22; we represent only 6% of the total. When we receive resources to grow, we enroll the students immediately even though faculty hiring lags, so we have met every new degree target well ahead of schedule. We are currently funded to reach 720 total degrees and have already reached that level. (The pandemic accelerated the completion of students at all degree levels; we did not anticipate reaching 720 total degrees for another year or two, and our total is likely to drop a bit next year.)



Our enrollments have grown even faster, because degrees are a lagging indicator and because changes to undergraduate admissions, discussed below, mean more of our majors are in the Allen School for four years rather than two to three. Compared to a decade ago, our undergraduate majors have more than tripled and our Ph.D. students have doubled.

Student-credit hours (SCH) are another important measure because they include our service courses, which account for ~40% of our total SCH. Total 2021-22 SCH was 92,400, up from 39,000 in 2010-11. By comparison, the rest of the College of

Engineering taught 135,000 SCH in 2021-22. We have the most SCH of any UW department: A decade ago, Mathematics offered over twice as many SCH as we did. We passed them in 2019 and now exceed them by 20%. To run at such a scale, we hire roughly 350-400 TAs each quarter, both undergraduates and graduate students. Some departments on campus have as many *students* as we have *TAs.*

As discussed in the budget section, our degree growth was almost entirely funded by new legislature-appropriated funds rather than tuition or internal reallocation, and our service course increases have essentially not been funded. Two of the new interdisciplinary programs are profitable, but consume limited faculty teaching cycles.

The top-level numbers can underemphasize the actual impact "on the ground," so consider one specific example: our databases courses. Up until 2010, we had one undergraduate databases course (CSE 444), and in 2009-10, we taught two offerings of it to a combined 126 majors. For pedagogical reasons, we split the course into a junior-level majors course (CSE 344) focusing on the client side with CSE 444 focusing more on implementation. Then in 2013, we adapted CSE 344 to create a new service course, CSE 414, for non-majors. Then in 2017, we adapted the material again for the Data Science Master's program (DATA 514). In 2020-21, we offered:

- CSE 344 to a combined 443 students across four offerings
- CSE 414 to a combined 547 students across four offerings
- CSE 444 to a combined 159 students across two offerings
- DATA 514 to 50 students in one offering

Overall, this is now 11 course offerings instead of 2, with an 8x increase in students.

II.D. Curriculum Expansion

In addition to periodically revamping our curriculum as we describe in Section II.E, we have often added new classes based on the interests and expertise of new faculty hires as well as those of our students. While our foundational classes remain, many courses we teach today are interdisciplinary, including molecular computing, ethics, and computational biology. New course offerings reflect the rapidly expanding nature of our field. For the service courses, notice the focus on courses relevant to data science and data analysis. In the last several years, we have created the following new courses:[3]

- Ten undergraduate-major courses: Interaction Programming, Domain Specific Languages, Natural Language Processing, Robotics, Deep Learning, Cryptography, Data-Center Systems, Modern Algorithms, Wireless Systems, Computer Ethics

[3] Not all courses listed in this section have permanent numbers yet, but they are in process and we are committed to teaching them long-term. We have not included many more new special-topics and capstone-design courses.

- Four undergraduate service courses: Introduction to Data Science*, Intermediate Data Programming, Data Visualization, Machine Learning* *Joint with other units
- Ten graduate major courses: Theory of Optimization, Cryptography, Mobile Systems, Computational Fabrication, Deep Learning, Interactive Learning, Reinforcement Learning, Computing for Social Good, Computing Ethics, Computational Genomics
- Two graduate service courses, not including interdisciplinary master's programs: Machine Learning for Big Data,* Software Engineering for Data Science. *Joint with other units

In addition to creating new courses, we have adjusted the content of core courses to connect to real-world scenarios (e.g., drawn from our connections to the tech industry) and to include discussions of ethics and diversity-related topics. For example, our software engineering and machine learning classes focus on core technical skills, but also include discussions of societal implications of technology and students' responsibilities to anticipate and address potential negative impacts of the technology they build. Feedback from undergraduate and graduate students suggests that they much appreciate these modules, in addition to focused courses on ethics and related topics that we have added.

II.E. Undergraduate Major: Goals and Outcomes

Our undergraduate major curriculum helps students reach their full potential with a thorough understanding of computing fundamentals, and how our field can help solve humanity's biggest challenges. As our field continues to broaden, our curriculum does too. We prepare students for lifelong learning and a range of career outcomes by keeping our curriculum big and flexible.

A majority of undergraduate and B.S./M.S. graduates start in software engineering positions at large technology companies, predominantly in Washington state, but our graduates also work at many small companies including startups, join top Ph.D. programs, and occasionally pursue careers outside the tech industry. We collect the institution, job title, and geographic location of our graduates — see Appendix E.1.

Our student-retention and time-to-degree data are excellent. Among majors who take at least one upper-division course from us (a good proxy for starting the major in earnest as opposed to finding another interest during freshman year), ~95% graduate with a degree from us, far higher than the university's graduation rate. Attrition is too low to notice any demographic skew. Attrition is lower than a decade ago despite our growth.

Our “core curriculum” of 300-level courses was reinvented in 2009 and has withstood the test of time with some evolution. Our 400-level has broadened significantly, with many new courses and capstones. A variety of student surveys (see Appendix E.2) demonstrate consistent high marks from students with what they learn in our curriculum and the overall student experience, though this data also informed our DEIA Strategic Plan for where we can improve. Student course evaluations are also very high — see Appendix E.3. In fact, for academic year 2021-22, on a 0-5 scale, over half of our course offerings had a combined median of 4.5 or higher, and half of our instructors had at least one course with a combined median of 4.7 or higher!

We have several mechanisms for evaluating instructors and TAs summarized in Appendix E.4, with most of them new in the last decade. The ABET accreditation of our Computer Engineering degree (2019 self-study) requires substantial assessment of learning outcomes. We have also added mechanisms designed to improve teaching, including “teaching buddies” for all new faculty, teaching professional development at faculty meetings two to three times per year, and support for relevant educational technology (e.g., Edstem, Gradescope). Subjectively, the pandemic has had the silver linings of (a) strengthening our teaching community via shared challenges and (b) helping instructors understand the importance of accommodating students facing hardship.

Our undergraduate experience is much more than our courses. Some key aspects we have focused on in recent years have been essential to our success. In particular:

- Our undergraduate student services team (program advisers) are full-time advising professionals who help students navigate any challenges and much more. Explosive student growth has required growing this team, which allows for more structure and specialization within the team.
- We have several new co-curricular seminars and workshops to help students at all program stages: on-ramping into the major (190B, 390T), preparing for internships (492J), and learning from alumni how to succeed post-graduation (492L). We also have new workshops and courses to help students with less academic preparation succeed in the major (190Y, 390B).
- We have substantial support for career services and interfacing to companies, including the over 100 members of our Industry Affiliates Program. We regularly have alumni provide resume reviews, mock interviews, advice presentations, etc.
- Undergraduate community and student leadership: A decade ago, we had two student organizations, one general and one for women. Now we also have an undergraduate Student Advisory Council that liaises with school leadership and several new affinity groups.

- We revamped our TA training, with a new training for upper-division course TAs led by two faculty members.

We also provide a wide range of both academic and nonacademic support structures for students at all levels. To give a recent example, to combat isolation during the pandemic, we developed faculty cohorts for undergraduate CSE majors, in which groups of 10-20 students would each meet a few times per quarter with a faculty member over zoom to converse informally. We also created a fund to support activities and programs designed to aid Ph.D. student morale during this difficult period.

II.F. Undergraduate Admissions and Unmet Demand

Undergraduate admissions to the Allen School is complicated because there are pathways for freshman applicants to UW, community-college transfers, and students who discover computing after enrolling at UW. Appendix E.5 is a primer on admissions pathways and Appendix B.2 is a legislative proposal including data on unmet demand.

We turn away hundreds of highly-qualified applicants each year, with each pathway forced to turn away many students who deserve an Allen School education. For example, for Fall 2022, more than 600 Washington residents applying to be freshman Allen School students were denied despite UW Office of Admissions ratings that would have resulted in admission to the rest of the College of Engineering. While our capacity has increased 3x in the last 10 years, demand from freshman applicants has increased by 7x, far outpacing any other UW program. The extreme and unacceptable difficulty of gaining admission to the Allen School as an undergraduate is all too well known across the state and beyond.

Four years ago, to stop having UW bring ~1,000 students to campus to “compete” for a fraction of that many spots in our major, we transformed our admissions to accept more students before entering as freshmen, telling others to attend UW only if they understood it was unlikely they would later gain Allen School admission. This was a necessary step that dramatically improved the campus experience, improved the Allen School’s diversity, and (perhaps counterintuitively) modestly improved the capacity in the major for students who discover computing while at UW. But this change does not reduce the amount of student and workforce demand we fail to meet.

II.G. Service Courses: Highlights and Needs

CS in general, and computer programming, data science, and AI in particular, are an essential part of a 21st-century general education, rightfully alongside mathematics, natural sciences, social sciences, and the humanities. We embrace this role and have expanded capacity and offerings dramatically, as well as taken key campus leadership roles on shared initiatives: Starting in 2013, and thanks to an NSF IGERT grant, we led the creation of data science specializations at the undergraduate and graduate levels now offered in 22 units on campus. We co-led and co-offer the new Data Science Master's program. We similarly co-led the creation of a Data Science Minor. In support of the growing need for data science education, we created a suite of 400-level courses for non-CSE-majors in data management (CSE414), visualization (CSE412), and ML (CSE416/STAT416, co-created with Statistics). We co-created an Introduction to Data Science course (CSE180/STAT180/INFO180 with Statistics and the Information School). We created alternate introductory programming courses (CSE160-CSE163) that uses data-science projects and Python. We are now similarly bringing the campus together to define what AI education should mean and what campus-wide AI education programs should be created.

A key next step is reinventing our main introductory programming sequence for the first time in over 15 years. This is a massive effort with ramifications across the campus and the state (due to courses approved-for-transfer at many community colleges and high schools) affecting many thousands of students per year. The main structural change is moving from a two-quarter to three-quarter sequence to better support students arriving with differing amounts of prior experience. Appendix E.6 has our rationale document. In 2021-22, we designed the high-level curriculum, engaged stakeholders across campus and throughout the state, and completed the university's curriculum-approval process. In 2022-23, we will deploy the new courses.

II.H. Outreach and Statewide Leadership Highlights

Our external educational impact extends well beyond the campus boundaries. We have invested significantly in outreach and recruitment to ensure we use our unique expertise in the state to make high-quality computing education accessible to everyone in Washington state. We list here a few highlights:

For teachers:

- Students in 13 high schools can receive dual credit for our first programming course. We visit each school annually and provide other resources and infrastructure for these courses. We are now working to make CSE 163, a follow-on data programming course, available in high schools too.
- Our faculty member Lauren Bricker has kept the Puget Sound Computer Science Teachers Association thriving.
- Starting in Spring 2022, we teach a course annually in the College of Education for K-12 teachers earning a certificate in CS education.

For students:

- Our student Outreach Ambassadors do outreach and recruitment for high school and community college students.
- We run the targeted Changemakers in Computing summer program.
- We have many other programs throughout the year, including during CS Education week, etc. We refer the reader to Appendix D, which includes links to our DEIA webpages and 5-Year Strategic Plan for DEIA, for additional details.

II.I. Graduate Program

In nearly every respect, our graduate program is thriving. Highlights include the following:

High-quality research output and excellent post-Ph.D. outcomes: Our Ph.D. students are producing cutting-edge research in all areas of CS and engineering, as well as interdisciplinary work involving biology, neuroscience, the environment, social science and psychology. They win a variety of best paper awards, prestigious fellowships, and dissertation awards. For more on this, see Section III on Scholarly Impact. Post-Ph.D. outcomes over the last 10 years are summarized in Appendix E.7.

Community across research groups: While we are a large Ph.D. program, with approximately 325 students across 15+ research groups, we are not siloed by research area. Rather, we work hard and are successful at fostering a global graduate student (and faculty) community, both socially and in terms of collaborative research. Steps we take to this end include: office assignments that mix students and faculty across diverse research areas, mentoring pods for first-year Ph.D. students, weekly school-wide breakfast and happy hour events, multiple annual school-wide parties, a fund for students to organize community-building events both on and off campus, and autumn quarter school-wide colloquia from students and faculty in all research areas.

Strong commitment to advising and student support: The vast majority of our faculty are dedicated advisors and mentors to their Ph.D. students, and many students are co-advised by two faculty (in a number of cases, across departments and colleges). We have also ramped up mentoring of junior faculty on the topic of Ph.D. advising. Our staff advisers are highly dedicated and available. For example, Elise DeGeode, our Director for Graduate Student Services, recently won a UW College of Engineering Award for her tireless dedication to the students. We are working hard to make sure that those students that are not ultimately going to complete a Ph.D. at the very least leave the program with a master's degree in hand, and preferably after at most two to three years. (Our Ph.D. graduation rate is roughly 70%.) We review all students annually, with individual follow-up whenever advisor and advisee accounts differ or reveal problems. Our staff and faculty Ph.D. program directors also meet with larger groups of students regularly to identify and resolve systemic problems as they arise in individual research areas or labs. We provide additional support to students from underrepresented groups, including help with funding and fellowships, community building opportunities, etc. As with undergraduates, we conduct multiple student surveys each year regarding student satisfaction and success. We summarize these reports in Appendix E.2. Finally, we have increased our student services support for our Ph.D. program, from a single staff adviser a decade ago to a synergistic four-person team today.

In recent years, we have been focusing on further improving our advising and mentoring and on reducing the time-to-degree; currently, the median time to completion is 6.25 years. To this end, we have recently made several structural improvements including:

- The introduction of a formal requirement that each Ph.D. student have a dedicated and committed permanent advisor at the first program milestone, which should be reached by the end of year two. We see this as an important step towards improving our graduation rate and ensuring that those students that will not ultimately get a Ph.D. figure that out earlier.
- Revamp of the Ph.D. course requirements, requiring fewer courses and organizing courses into larger groups, thereby enabling greater specialization while still ensuring breadth.
- The offering of an annual seminar for first- and second-year Ph.D. students titled "The Tao of Ph.D.: Thriving in the Allen School Graduate Program" to help them develop camaraderie, skills, and purpose. The seminar covers topics such as the advisor-advisee relationship, how to choose research topics, presentation and writing skills, how to read/review research papers, handling feedback, time management, work-life balance, impostor syndrome and mental health.
- The creation of a document "How to get good advising" providing basic guidance on how to develop a positive and productive advisee-advisor relationship.

Ph.D. admissions: We have revamped admissions processes requiring interviews and research-group discussions, while also identifying students with unconventional backgrounds who have maximized their opportunities. For the 2023 admissions cycle the faculty have voted to permanently remove the GRE requirement, which was temporarily suspended during the COVID-19 pandemic. While our total application numbers have more than doubled (from 1,051 in 2012 to 2,469 in 2021) we have continued to manage a high-touch Ph.D. admissions review process where each application receives at least one human review. The demographics of our admitted students have also changed in the last 10 years; in 2012, 27% of the applicants we offered admission to identified as women and in 2021, 39% of the applicants we offered admission to identified as women. In 2012, we offered admission to zero students from underrepresented backgrounds and in 2021, we offered admission to 11 students from underrepresented backgrounds.

Expanded course offerings: As described in Section II.B., we have significantly expanded our course offerings at the graduate level, including courses on HCI, ethics, and societal implications. Ph.D. students with diverse backgrounds often choose our program for this reason. As we have grown our courses and the diversity of our student body (in terms of both their demographic diversity and their educational backgrounds), we have also added "for all" classes, especially at the graduate level, that provide broad and introductory-level skills to incoming students and those in related disciplines.

LEAP Alliance at the doctoral level: In 2017, the Allen School partnered with 10 other leading CS programs (Berkeley, Carnegie Mellon, Cornell, Georgia Tech, Harvard, Illinois, MIT, Princeton, Stanford, and UT Austin), under the leadership of CMD-IT (the national Center for Minorities and People with Disabilities in IT), to establish the LEAP Alliance. The LEAP Alliance addresses the challenge of increasing the diversity of the professoriate in computing at research universities as a way to achieve diversity across the field. The approach is to increase the diversity of the Ph.D. graduates at the institutions that are the top producers of faculty at research institutions. The focus is on people who identify as African American/Black, Hispanic, Native Americans/Indigenous Americans, and people with disabilities — groups that are severely underrepresented in computing, especially in the professoriate at research universities. The Allen School's efforts associated with the LEAP Alliance have led to our population of underrepresented minority students enrolled in the Ph.D. program increasing from three in 2016 to 15 in 2021. Thus far, two of our LEAP Alliance students are headed to faculty positions after graduation.

II.J. Postdoctoral Researchers

While postdoctoral researchers are not part of a specific program, we strive to make them feel supported and included in the Allen School. Our mentoring follows best practices for improving the postdoctoral experience[4], inspired by the structure of the Computing Innovation Scholars program of the Computing Community Consortium, institutionalized at UW and several other schools by follow-on awards from CCC/CRA, and consistent with guidance from the National Academies. A key focus has been to assume the same sort of "school-wide responsibility" for postdocs that we assume for our Ph.D. students — assuming collective responsibility for our postdocs, rather than

[4] https://www.cs.washington.edu/postdoc/proposal

relying entirely on individual faculty members. We have a staff postdoc adviser; annual progress reporting and planning; funds that provide a degree of independence (for example, funds to hire undergraduate RAs to provide mentoring experience); and support for career development and job placement.

Postdoc numbers have grown considerably since 2012. As of September 1, 2022, there will be 26 active postdoc appointments across 19 faculty sponsors, compared to 18 active appointments across 14 sponsors on September 1, 2017.

In support of postdocs' career exploration and development, the Allen School offers annual panel discussions on industry, academic, and teaching careers and maintains an online suite of career development resources. We ensure funds are available to support postdocs' travel to conferences or workshops not covered by their PI or when the postdoc is not presenting a paper, as we do not want the lack of funding to preclude the postdoc from participating. Funding is also available for individual research awards for postdocs, in which the postdoc serves as PI of their own truncated (typically 9-12 month) research project and gains experience managing a complete grant lifecycle and mentoring undergraduate research assistants.

The Allen School tracks first-destination employment outcomes of our departing postdocs. Of 114 postdocs who have completed appointments since 2012, 58 (51%) have entered academia (51 into tenure-track positions) at 40 institutions across the world; 46 (40%) have taken positions in the industry as practitioners or researchers or at startups, at 25 separate employers; and eight (7%) have continued to another postdoc position.

Section III: Scholarly Impact

The Allen School is firmly established as one of the premier programs in the nation, prominence that is driven in large part by the quality and commitment of our faculty. This is (partially) illustrated by the volume of professional honors and awards that have accrued to faculty members in recognition of their research, mentorship and service:

- Current faculty have been recognized a combined 100 times for their early-career scholarship and potential for future leadership, including 27 Sloan Research Fellowships, 49 Presidential/NSF Young Investigator or NSF CAREER awards, and eight Technology Review TR35 awards.
- Senior and emeriti faculty have been elected to the National Academies and/or the American Academy of Arts & Sciences 10 times.

- Current faculty have been recognized 31 times with election to distinguished ranks in major professional societies such as Fellows of the ACM, Fellows of the IEEE, Fellows of the Association for Computational Linguistics, and others.
- In addition, current faculty have been honored 14 times with some of the most prestigious awards in our field such as two ACM Grace Murray Hopper Awards, the ACM Prize in Computing, the USENIX Lifetime Achievement Award, and the IEEE Koji Kobayashi Computers and Communications Award.
- Our faculty have received accolades for their service leadership and for engaging underrepresented groups in computing 7 times, including multiple ACM and CRA Service Awards and CRA-W Anita Borg Early Career Awards.
- Faculty and students across the Allen School regularly win “best paper” (and other “best of”) awards. Jeff Huang’s tally[5] has us as the top-ranked university in authorship of Best Paper Awards (and second only to Microsoft Research overall) at the 30 top research conferences spanning the field.

For a full list of faculty awards, see https://www.cs.washington.edu/people/faculty/awards.

III.A. Impact of Research and Creative Work

The Allen School produces world-class research in virtually all subdisciplines of computer science and engineering. The positive arc of our research over the last 10 years, as measured by quality, depth, breadth, productivity and impact, has been significant. In areas where we were traditionally strong, we have maintained and further built our strength. In areas where we had become somewhat weak a decade ago, such as theory of computation, programming languages and software engineering, we have since become one of the top programs in the world. In the last decade, we have also built outstanding research groups in important emerging areas such as data visualization, computational fabrication, molecular programming, natural language processing, and computing for social good (including computing for health and for the environment, ethical AI, and accessibility). A major source of our research strength is the extensive collaboration within and between research groups, as well as with other units across campus and industrial partners.

We have serious research efforts in the following areas (see Appendix F.1 for more details on each of these areas):

- Artificial Intelligence
- Computational Biology
- Computational Health

[5] https://jeffhuang.com/best_paper_awards/institutions.html

- Computer Architecture
- Computer Graphics, Computer Vision, Game Science, and Augmented & Virtual Reality
- Computing for Development
- Computing for the Environment
- Cryptography
- Data Management
- Data Science
- Data Visualization
- Ethical AI
- HCI, Accessibility, and Fabrication
- Machine Learning
- Mobile and Ubiquitous Computing
- Molecular Programming and Synthetic Biology
- Natural Language Processing
- Programming Languages and Software Engineering
- Robotics
- Security and Privacy
- Systems and Networking
- Theory of Computation

In the rest of this section, due to space constraints, we highlight only a few of these research groups and specific research projects.

A small sampling of research topics covered in the Allen School:

Theory of Computation: The group studies a wide range of fundamental problems in algorithms and complexity and, over the last decade, has become one of the premier theory programs in the world. This is reflected in external recognition including two Packard Fellowships, two Simons Investigator awards, six Sloan Research Fellowships, a Fulkerson Prize, a Tucker Prize, a Pressburger award, a Kanellakis Theory and Practice award, a member of the American Academy of Arts and Sciences, the National Academy of Sciences and the National Academy of Engineering, and 12 best paper awards at the premier conferences in theoretical computer science since 2014. A small sampling of exciting results from the last decade includes: (1) the first improvement in the approximability of the Traveling Salesperson Problem (TSP) in four decades, (2) a proof that semidefinite programs cannot be used to efficiently solve NP-complete problems, (3) the design of algorithms that achieve optimal convergence rates for optimizing non-smooth convex functions in distributed networks, and (iv) foundational work launching the field of information complexity.

Accessibility and Assistive Robotics: Researchers in the Allen School are leading the field in developing technology that does not depend on a certain set of abilities, limit customizability, or fail to include people with disabilities as creators of technology. Much of this work is done under the auspices of CREATE, the Center for Research and Education on Accessible Technology and Experiences (discussed in Section III.C below). Recent research has included (1) work on mobile and wearable accessibility, and using mobile and wearable devices to increase access to the world, (2) using fabrication to make access and to make "making things" (e.g. craft, 3D printing) accessible, (3) using technology to make urban spaces such as sidewalks and indoor areas accessible, (4) improving the accessibility of tools for creativity, presentation, interface design and data visualization, (5) creating a programming tools and environments for including blind students and professionals at all levels of programming, (6) assistive robotics, and much more. For this research, the group has received nine best paper awards, 10 honorable mention awards, and three best artifact/demo awards and is the top-published academic institution at the leading accessibility conference, ASSETS. In addition, CSE faculty and graduates have been awarded two SIGACCESS paper impact awards for impactful work at least 10 years old, two SIGCHI Social Impact Awards for accessibility-related research and service, a SIGACCESS Award for Outstanding Contributions to Computing and Accessible Computing, and a National Science Board Public Service Award. The practical impact of the work is also significant: For example, Project Sidewalk has mapped real-world accessibility issues across 7,000 miles in seven cities to improve inclusive urban design policies, received more than 100K routing requests for customized accessible navigation, and the group's research to improve the accessibility of mobile phones ships on every modern device.

Natural Language Processing (NLP): The Allen School NLP group's research spans all aspects of language processing, including semantics, knowledge, reasoning, social good, NLP for all (high quality language technologies across cultures and language boundaries) and theory. Exciting projects include the development of AI systems with genuine common sense: Comet, a "common-sense transformer," and Atomic, an "atlas of machine common sense." These systems have achieved remarkable results, exhibiting common sense at a level never before seen. This is done by combining symbolic reasoning (or "good old-fashioned AI") with the latest advances in deep learning (neural language models). The quality of the NLP group's research is reflected in external recognition, including 23 best paper awards in the last 10 years, two 10-year test-of-time paper awards, two Allen Distinguished Investigators, two ACL Fellows, an Anita Borg Early Career Award, an "IEEE AI's top 10 to watch" award, a PECASE award, a Longuet-Higgins Prize, and two Sloan Research Fellowships, among others.

Computational Health: Research out of this group covers a variety of interdisciplinary and collaborative research topics ranging from AI and health diagnostics, to health sensing solutions using mobile technology, to health informatics. The group's papers are published in the top computing journals as well as Science, Nature, The Lancet, and the New England Journal of Medicine, and involve meaningful collaborations with multiple departments at UW's world-class School Of Medicine, the Fred Hutchinson Cancer Research Center, the Allen Brain Institute, and more. Mobile health technologies created at UW are in use by millions of people, and its faculty and students have produced a number of venture-backed health startups and technology licenses to industry. Exciting projects include the use of techniques from signal processing and machine learning combined with the sensing capabilities in a phone to monitor health, e.g., turning a phone into a device for measuring lung function, for detecting jaundice or tuberculosis, and for measuring hemoglobin levels in the blood, among others. In another example, researchers have developed smart speaker apps that can detect if a person has irregular heart rhythms or is experiencing a cardiac emergency. External recognition for faculty in the area includes multiple best paper awards, a MacArthur Fellowship, the ACM Prize in Computing, an ACM Fellow, a PECASE award, two Sloan Research Fellowships, a Forbes "30-under 30" All-Star Alumni, two TR35 awards, a Popular Science "Brilliant Ten," an ACM Grace Murray Hopper Award and a Moore Inventor Fellowship, among many others.

Programming Languages and Software Engineering: Research in this area ranges from practical program verification, to program synthesis, to software testing, in addition to the application of foundational techniques to other areas such as verifying distributed systems and optimizing machine-learning kernels. In the last decade, the group has been recognized with 12 best paper awards in the top conferences of the field, and also has had significant real-world impact (e.g., their type-system-definition tools are used at Amazon and their mutation-testing framework has been rolled out company-wide at Google). Other awards in the last decade include two ACM Fellows, an ACM SIGSOFT Outstanding Research Award, and an ACM SIGPLAN Milner Young Researcher Award.

Computer Graphics, Computer Vision, Game Science, and Augmented & Virtual Reality: Research in this area includes animation, games for scientific discovery, games for education, object recognition, medical image analysis, computational photography, and 3D reconstruction from images. The flagship UW Reality Lab is focused on advancing the state of the art in virtual and augmented reality technologies. The group publishes at the very top computer graphics and vision conferences, and in the last decade has received four best paper awards, a Helmholz Prize, an ACM SIGGRAPH Distinguished Educator Award, and a TR35, among others. Research successes in the past 10 years have also led to huge impact through tech transfer, such as the technology behind Google's Jump VR

Camera, several startups, and research groups at Apple and Google led by CSE graphics and vision faculty. Research in game science has had broad impact beyond traditional CS, resulting in crowdsourcing tools for scientific discovery in protein folding and design, crystallography, and neuroscience and in educational tools for teaching fractions and algebra at scale in K-12 settings.

Robotics: Researchers in this group are performing groundbreaking research across all areas of intelligent robotics including sensing, perception, learning, planning, control, and human-robot interaction. The group's work is regularly published in the flagship robotics conferences and journals and has resulted in over 25 best paper awards, including 11 in the last seven years. Other external recognition includes an IEEE RAS Pioneer Award, an ICRA Milestone Award, a Sloan Research Fellowship, three Robotics Science and Systems Early Career Awards, an Allen Distinguished Investigator, two AAAI Test of Time Awards, a Ubicomp "10 Year Impact" Award, a DARPA Young Faculty Award, an ACM Fellow, three IEEE Fellows and an AAAI Fellow. Faculty in this area have also demonstrated leadership outside the university, e.g., Dieter Fox is Senior Director of Robotics Research at NVIDIA, Siddhartha Srinivasa is Director of Robotics AI at Amazon, and Joshua Smith has co-founded several companies including Jeeva Wireless, WiBotic, and Proprio.

A small sampling of recent research highlights:

In a school with roughly 500 researchers, we can't possibly list all research highlights from the past decade, or even the past month. Below are only three examples that we picked from each of systems, theory, and one novel research area (molecular information systems) as illustrative of the kind of research that we do.

Ambient Backscatter (wireless communication out of thin air): In 2013, a team of researchers led by Shyam Gollakota and Joshua Smith created a wireless communication system that allows devices to interact with each other and with users without relying on batteries or wires for power. The new technique, known as "ambient backscatter," produces power by harvesting television, WiFi, and other wireless signals to enable battery-free computation and communication. The team later refined and expanded their work to enable transmissions over greater distances and via embedded devices with long-range backscatter, and even produced a prototype of the world's first battery-free cellphone. Gollakota also showed how backscatter communication could be accomplished without electronics with the introduction of 3D-printed smart objects. The researchers started a venture-backed company, Jeeva Wireless, to commercialize their work. The team has been highly decorated for this and other accomplishments, with accolades including a Best Paper Award at SIGCOMM 2013, a Best Paper Award at

IMWUT 2017, an ACM Grace Murray Hopper Award, and a Moore Inventor Fellowship for Gollakota and induction into the National Academy of Inventors for Smith.

Indistinguishability Obfuscation: A long-standing goal in the field of cryptography has been to securely implement indistinguishability obfuscation (iO). This is a powerful cryptographic method for securing computer programs by making them unintelligible to would-be hackers while still retaining their functionality. The original concept was posed back in 1978, and more than 100 research papers since then were devoted to showing that iO*, if it could be built*, would give a sort of cryptographic master tool from which nearly every other cryptographic protocol could be built. However, the attempts at constructing iO relied upon assumptions that were either broken through subsequent cryptanalysis, or had not been studied sufficiently to generate confidence in them. All of this changed with Rachel Lin and coauthors' recent breakthrough work, which finally put iO on terra firma. Their work shows that provably secure iO is constructed from four well-founded assumptions, all of which have a long history of study well-rooted in complexity, coding, and number theory. This result has had explosive impact in the field: It was featured in a two-day workshop at the Simons Institute of Theory of Computing at Berkeley, was the subject of an invited tutorial at FOCS 2020, and won a Best Paper Award at STOC 2021, in addition to extensive media coverage (see, e.g., Quanta).

DNA-based Digital Data Storage; In a series of exciting breakthroughs, researchers in the Molecular Information Systems Laboratory (MISL), including Luis Ceze and Karin Strauss, have shown how to use synthetic DNA as a scalable solution for digital data storage and computation. Their fully functioning, automated, end-to-end system for DNA data storage incorporated the equipment required to encode, synthesize, pool, sequence, and read back the data — all without human intervention. After demonstrating it was feasible to automate DNA data storage, they moved on to showing how it could be practical too, unveiling a full-stack automated digital microfluidics platform to enable DNA data storage at scale. As part of this work, the lab designed a low-cost, general-purpose digital microfluidics device for holding and manipulating droplets of DNA, dubbed PurpleDrop, which functions as a "lab on a chip." The science behind this feat has been published in Nature Biotechnology, Nature Communications, and other venues, and for this work, Ceze and Strauss won the prestigious 2020 ACM SIGARCH Maurice Wilkes Award.

III.B. Impact by Students and Postdocs in the Program

The Allen School attracts extraordinary students at both the undergraduate and graduate levels. In the past decade our undergraduates have included a Rhodes Scholar finalist, a UW Gates Cambridge Scholar, and a Putnam Fellow honorable mention. Seven undergraduates have won Goldwater Scholarships, and three more were nominated. Each year, the UW awards four “high scholarship” medals to the top student (out of 5,500-7,500) in each class. In the past decade, Allen School undergraduates have won two Freshman Medals, one Sophomore Medal, one Junior Medal, and two President’s Medals (the Senior Medal for the top graduating student). The Dean’s Medal recognizes the top senior in the College of Engineering, and the top senior in each of the College of Arts & Sciences four divisions. In the past decade, Allen School undergraduates have won four Dean’s Medals in Engineering and three Dean’s Medals in the Sciences. Our team placed first in the National Collegiate Cyber Defense Competition two years in a row, and were finalists five times. In the past decade, 33 Allen School undergraduates have been recognized in the CRA’s Outstanding Undergraduate Researcher Award competition, six were named Levinson Emerging Scholars, and one was recognized as an EIP Presidential Scholar. Twenty-three of our undergraduates have been featured in the Husky 100 since the award began in 2016.

Our graduate students have also thrived over the last decade. For example, 69 Allen School graduate students have held NSF Graduate Fellowships; five have held NDSEG Fellowships; three have held NSERC Fellowships; 19 have received competitive fellowships from the UW College of Engineering; and 32 have received competitive fellowships from the ARCS (Achievement Rewards for College Scientists) Foundation. An additional 56 graduate students have been recognized by highly competitive industry fellowship programs for Ph.D. students (e.g., Qualcomm, Google, Microsoft, Facebook, IBM, Intel, JP Morgan and Apple). Two have been recognized with TR35 awards for work done while in our graduate program, and more have received significant national or international awards for their research including the NSF Postdoctoral Fellowship, the American Association of University Women International Fellowship, and the Ruth L. Kirschstein National Research Service Award[6] from the National Institutes of Health.

In addition, over a dozen of our Ph.D. students have won their SIG’s premier Doctoral Dissertation Award (see Appendix F.2, Section B), and our graduate students and postdocs have placed into a variety of excellent positions in academia and industry (see Appendix E.7). For an overview of grad student and postdoc successes by research area, see Appendix F.2 (Section A).

Alumni of our Ph.D. program have achieved remarkable success as well. For example, Chris Ré (associate professor at Stanford, Ph.D. UW 2009) and Stefan Savage (full professor at UCSD, Ph.D. UW 2002) have both received MacArthur Genius Awards in recent years.

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[6] The Kirschstein-NRSA, also known as the F30, was created to enhance research and clinical training of promising predoctoral students who are enrolled in a combined M.D.-Ph.D. training program and plan to pursue careers as physician-scientists.

In the rest of this section, we present a small sampling of the award-winning research projects led by our Ph.D. students and postdocs:

Smartphone based medical applications: As part of her Ph.D. research, Rajalakshmi Nandakumar (Ph.D. 2021, now faculty at Cornell Tech), and her collaborators developed a set of powerful health screening and monitoring tools. These include a non-invasive app for detecting fluid in the ear (a symptom of ear infection) and an app for detecting obstructive sleep apnea. Another exciting project uses smartphones to tackle the opioid epidemic, using sonar to monitor a person's breathing and movements for signs of a potential opioid overdose. For her work "creating an easily-deployed technique for low-cost millimeter-accuracy sensing on commodity hardware, and its bold and high-impact applications to important societal problems," Rajalakshmi won the SIGMOBILE Doctoral Dissertation Award and a number of other awards.

Security and machine learning: Ivan Evtimov's Ph.D. research (Ph.D. 2021, now research scientist at Meta) makes significant contributions to the security of adversarial machine learning, focusing particularly on the vulnerabilities of convolutional neural networks that allow maliciously crafted inputs to affect both their inference and training. For example, Ivan found that the image detecting algorithms reading traffic signs in autonomous cars could be tricked by an object as simple as a sticker on a stop sign. The sticker could fool the cameras into reading the stop sign as a speed limit sign. In the case of autonomous driving, it is critical to identify anything that could be exploited by malicious parties in such a safety-critical setting. For this and his other contributions, Ivan won the William Chan Memorial Dissertation Award.

Markov Chain Monte Carlo (MCMC): Finding ways to efficiently understand, process, manipulate and sample from high-dimensional, complex probability distributions is a central problem in modern statistics and data science. One of the most ubiquitous and simple-to-implement families of algorithms for sampling is the MCMC method, which is widely used to solve problems in quantum and statistical mechanics, machine learning, privacy and fairness, epidemiology and social sciences, among many others. However, in the vast majority of its applications, there had been no accompanying theoretical analysis that would guide its use. In his Ph.D. thesis, Kuikui Liu (Ph.D. 2022, soon to be faculty at MIT), developed new theoretical techniques that revolutionized this field, enabling him and his collaborators to resolve fundamental problems that had been open for 30 years. This work received a Best Paper Award at the STOC 2019 conference, was the subject of an entire week-long research workshop this summer, and is already being taught in graduate randomized algorithms courses around the world.

TVM: Motivated by the need to bring machine learning to a wide diversity of hardware devices, a team of Allen School researchers led by then Ph.D. student Tianqi Chen (Ph.D. 2019, now faculty at CMU) joined forces to develop TVM. The open-source TVM framework bridges the gap between deep learning systems, which are optimized for productivity, and the hardware they run on, enabling researchers and developers to quickly and easily deploy and optimize deep learning systems on a multitude of hardware devices without sacrificing battery power or speed. This ML compiler and optimization system has been transferred into a spinoff company OctoML, which now employs over 80 people and has commercial partnerships with most hardware vendors and cloud providers.

Assistive robotics: Tapomayukh (Tapo) Bhattacharjee's postdoctoral research (UW, 2017-20, now faculty at Cornell) focused on the problem of designing robots that can assist people that have mobility limitations with important activities of daily life. Such tasks are highly complex, requiring physical and social interactions between robots and their surroundings in unstructured and/or cluttered environments. As an example application, Tapo and his collaborators developed an autonomous feeding system that can be attached to people's wheelchairs and feed them whenever they want to eat.

III.C. Collaborative and Interdisciplinary Efforts

The Allen School has an outstanding record of collaboration both within and external to the UW, and an outstanding record of activities that bridge and strengthen the university and the region. Particularly within the College of Engineering, we are sometimes viewed as self-centered. We will not offer here an explanation for this perception; we will simply assert that there is a long and clear track record to the contrary. Here are just a few examples:

In 2008, we launched the **UW eScience Institute** — what is now called Data Science was called eScience back then. With support from the state of Washington, the Moore Foundation, the Sloan Foundation, the Washington Research Foundation, the Schmidt Foundation, the National Science Foundation, and the university, the eScience Institute has made UW a national and global leader in data science education and research. At its inception, the eScience Institute was governed by an executive committee of eight individuals representing eight departments in four schools and colleges. This broad-based ownership — as opposed to "grabbiness" — has been instrumental to its success and is a hallmark of other interdisciplinary efforts that we have launched or co-launched. Today, the eScience Institute is home to 15 data and research scientists, has a permanent annual budget of $1.7M, and has 150+ affiliates representing more than 65 departments across campus. Research awards involving eScience staff exceeded $98M in 2020-21, and in that same period, programs supported by eScience resources included partnerships with more than 35 departments and centers across all three UW campuses.

DUB (Design, Use, Build) is UW's cross-campus effort for research and education in human-computer interaction and design, launched by faculty in the Allen School but never "owned" by us. DUB brings together faculty and students from multiple units (principally the Information School and Human Centered Design & Engineering, in addition to the Allen School, but also many others), as well as corporate partners. Today, weekly DUB seminars regularly draw 100+ attendees. DUB led UW's rapid emergence as one of the world's top centers for HCI and Design research, evidenced by the quantity and quality of work appearing at elite HCI venues (e.g., DUB had over 50 papers at CHI 2022, and four DUB members are winners of the SIGCHI Social Impact Award — two of them from the Allen School). DUB has also taken the lead in cross-campus educational efforts, including the design of an undergraduate HCI concentration and the interdepartmental MHCI+D master's program.

Change is a cross-campus group launched by Allen School faculty and students working on information and communication technologies for development (ICTD). Change brings together participants from academia, government, industry, and nonprofits to share knowledge and jumpstart collaborations. Change has had a number of successes: Open Data Kit (http://opendatakit.org), developed by Allen School faculty and graduate students in collaboration with Google, is the most widely used data collection and data sharing platform in the developing world. Recently, community networks have been deployed in Indonesia, the Philippines, Hawaii, Seattle, Tacoma, Mexico, and the Canadian Arctic to provide connectivity to thousands of formerly disenfranchised people; mobile applications have been deployed with ODK-X for humanitarian activities and immunization logistics around the world; and an exchange program including visiting graduate students has been established with Makerere University in Uganda.

The **Tech Policy Lab**, a joint undertaking of the Allen School, the Information School, and the School of Law that was originally funded by Microsoft, bridges the gap between technologists and policymakers to help generate wiser, more inclusive tech policy.

CREATE, the Center for Research and Education on Accessible Technology and Experiences, was launched in 2020 to unite faculty and students active in accessibility from the Allen School, the Information School, the School of Medicine, and the College of Engineering's Departments of Human Centered Design & Engineering and Mechanical Engineering — making the whole far bigger than the sum of the parts. The Allen School's emphasis on accessibility has been amplified by several recent faculty hires, but goes back nearly 40 years with Richard Ladner's research, education, and outreach focused on deaf, deaf-blind, hard-of-hearing, and blind people.

We have put a great deal of energy into supporting **GIX, the Global Innovation Exchange**. GIX is a partnership between UW and Tsinghua University, based on a concept initially advanced by Microsoft's Brad Smith: to offer project-based master's degrees combining technology, design, and entrepreneurship in a global setting. GIX got off to a somewhat rocky start, and in a discussion with Brad we agreed to dramatically increase our commitment to supporting it. Shwetak Patel led the team that devised the original master's program and continues to serve as the curriculum lead, designed and equipped the laboratory floor of the GIX building in Bellevue, Washington, serves as the Chief Technology Officer of GIX, and served as interim Executive Director between the tragic death of Vikram Jandhyala in 2019 and the recent onboarding of a permanent replacement. During his time as interim Executive Director, he extended GIX to include the concept of just-in-time training for industry by offering short courses for industry looking to up-level their workforce.

We have broad and deep activities in an area to which we refer as **Computational Health**, all of which involve collaborations with faculty in UW's outstanding School of Medicine. We roughly cluster these activities into the following categories: new sensing systems for health and remote monitoring; AI diagnostics, imaging, and computational biology; neuroinformatics and neurotechnology; personal health informatics; data science for health and wellness; digital fabrication and health; assistive technologies and robotics; and synthetic biology. In addition to outstanding research, in the past five years these collaborations have produced seven venture-backed startup companies, multiple licensed technologies, and multiple open-sourced tools. At our urging, Computational Heath has been adopted as the inaugural stream of UW's new Creative Destruction Lab–Seattle.

Allen School faculty are involved in major new multidisciplinary **NSF Institutes in Data Science** (the $12.5 million TRIPODS Phase II Institute for Foundations of Data Science, with UW PIs from the Allen School, Electrical & Computer Engineering, Mathematics, and Statistics, and partners at the University of Wisconsin–Madison, the University of California at Santa Cruz, and the University of Chicago) **and in Artificial Intelligence** (the $20 million AI Institute for Foundations of Machine Learning led by UT Austin with UW PIs from the Allen School and Statistics and additional partners at Wichita State University and Microsoft Research, and the $20 million AI Institute for Future Edge Networks and Distributed Intelligence led by The Ohio State University with 10 partners including the Allen School).

Justice-focused K-12 computer science education is the theme of a joint project with the College of Education and the Information School supported by the National Science Foundation, which supports UW researchers as they partner with practicing K-12 teachers to write a new curriculum that reframes CS content knowledge in the Computer Science Teachers Association standards in justice terms. The team also will co-design four new teacher education courses on CS teaching methods, assessment, justice and equity, as well as a teaching field experience.

Engagement with the regional tech community is a hallmark of the Allen School, and a major competitive advantage. The Allen School and the tech community have evolved together, in synergistic partnership. In 1978, UW's Department of Computer Science had 13 faculty members, and Microsoft was 13 20-somethings in Albuquerque. Since Paul Allen and Bill Gates brought Microsoft home to Bellevue in 1979, the region has spawned hundreds of homegrown companies ("from Amazon to Zillow"), complemented by nearly 150 engineering centers of companies headquartered elsewhere (led by Facebook and Google, each of which employs nearly 7,000 software professionals here). Increasingly, these companies are engaged in research in addition to development. Microsoft Research goes back a long way, of course — it celebrated its 30th anniversary last year. But the Allen Institute for AI (AI2), Amazon, Apple, Facebook, Google, NVIDIA, and even Zillow conduct research here at a serious scale.

The Allen School engages broadly and deeply with Seattle tech companies. Microsoft remains our closest partner, with 31 affiliate professors (many of whom are closely involved in our activities), multiple collaborative activities, deep engagement by faculty and students, and extraordinary levels of financial and political support and advocacy. But we have close ties to many dozens of other companies with a regional presence and with the Washington Technology Industry Association, the region's tech trade organization. An unusual arrangement, which deserves greater attention than it will receive in this brief section, is an agreement with the Provost that Allen School faculty can have extended-duration external relationships that go beyond normal 20% consulting (see Appendix F.3). Faculty currently are engaged in this way with the Allen Institute for AI, Amazon, Apple, Facebook, Google, and NVIDIA. While this causes stresses and strains, we feel that it is a net win that offers significant advantages to the companies, the university, the region, and the individuals.

As one of many examples, in 2017, NVIDIA CEO Jensen Huang approached Dieter Fox about joining the company to establish and lead a robotics research lab in the San Francisco Bay area. After some negotiation, the eventual arrangement was that Dieter would establish and lead a lab in Seattle on 80% leave from UW for two years, followed by 50% for several additional years, followed by 20% (one day per week) consulting.

Dieter is now in his third year of 50% leave (one more is allowed under our policy exception), and the NVIDIA AI Robotics Research Lab in Seattle is a permanent presence adjacent to the UW campus with 20 Ph.D. researchers. As with most of these relationships, students are also involved. Intellectual property and conflict of interest management has not proven to be an obstacle — conflict of commitment is the principal challenge. Overall, however, the engagement was a win-win for NVIDIA, the UW, and the Seattle area. Similar win-win situations came out of other engagements. For example, Luke Zettlemoyer's lead of a new Facebook AI Research Lab enabled the recent establishment of a "Meta AI Mentoring Program" that funds some of our students who can spend a year or two working in a co-advising relationship with Meta and UW (and the goal is to expand the program beyond the Allen School). Similarly, Sidd Srinivasa's engagement with Amazon as their Director of Robotics AI enabled us to recently establish a UW Amazon Science Hub.

In the 1980s, we transitioned our Industry Affiliates Program from a focus on "fund raising" to a focus on "friend raising": Rather than focusing on a small number of major national companies (IBM, HP, Digital, Intel, etc., at the time), we decided to use the program to build mutually beneficial relationships with Seattle's emerging tech ecosystem. This has paid tremendous dividends — our recruiting fairs and our research symposium draw from a broad range of companies, both national and regional. We are widely viewed not just as a partner with, but as a member of, Seattle's tech ecosystem.

We are in the process of envisioning how the Allen School's Industry Affiliates Program can better support various research groups whose goal is to establish and run smaller, more focused, and more lucrative programs involving corporate partners. We envision a "service-oriented architecture" in which redundant effort and expertise can be reduced. This is a work in progress.

Section IV: Future Directions

The Allen School finds itself at both an exciting and a challenging place.

As we described in the previous sections, over the past decade we have significantly grown our undergraduate and graduate programs. We have been successful at hiring amazing faculty members who have been producing high-impact, high-visibility research with their students and collaborators, have been recognized with a wide variety of significant awards, and have been successful through startups and industry collaborations in translating their research into practice. Our students have similarly been doing outstanding work and have been recognized with significant awards and top job opportunities. We have led many interdisciplinary centers and initiatives. In addition to their university roles, our faculty members also frequently take on national leadership roles. In practice, when hiring faculty or recruiting graduate students, our significant competition is MIT, Berkeley, Stanford, and CMU — candidates may occasionally decide to join another institution, but that is typically due to personal circumstances.

At the same time, we also face several challenges: (1) Student and employer demand has risen faster than we have been able to grow, so we urgently need to continue to grow, and we need UW's support in doing so; (2) Our internal structures no longer work at our large size, but we are challenged to devise structures that are more scalable while preserving essential aspects of our culture; (3) The vibrant tech ecosystem in Seattle is a blessing but also a challenge, with a number of senior faculty members focusing significant attention on industry opportunities; (4) We lack the institutional visibility and autonomy of the quasi-independent schools of computing at Berkeley, Cornell, and MIT, and of the fully independent schools of computing at many other universities, which severely limits our ability to respond with clarity and agility to opportunities; bluntly, the university has not lived up to the letter or the spirit of the agreement made with Paul Allen at the time the Allen School was created; (5) We must continue to work toward diversity, equity, inclusion, and access in the Allen School and the computing field as a whole.

This section discusses our goals and how we plan to achieve them given the above successes and challenges.

IV.A. Continued Program Growth

As we discussed in Sections I.H and II above, we have significantly grown our programs in the past decade. Because demand from students and employers continues to outpace our growth, we have further plans to grow our school. We describe the detailed case for growth (and some of its history) in Appendix B.2.

One challenge that we are currently facing is that the Allen School can only grow so far and so fast when it is embedded in a college rather than being a quasi-independent school or college. By various measures (bachelor's degrees awarded, student credit hours, research awards, fundraising, etc.), the Allen School already represents between roughly 40% and roughly 60% of the 10-unit College of Engineering, and already ranks between 4th and 6th in comparison to UW's 16 independent schools and colleges (see Appendix B.3). It is not healthy for the College of Engineering to be dominated by one program. (As an example, the Allen School was asked to leave the College of Engineering's "Direct to College" freshman admission program because our combination of extreme student demand and limited capacity "broke" the program —

students who cannot be accommodated in the Allen School's Computer Engineering program typically desire our A&S Computer Science program, not another Engineering major. As a result, there is now a "Direct to Allen School" freshman admission path that considers students desiring either Computer Science or Computer Engineering.) The Dean of Engineering understandably wants to grow other units of the College in preference to the Allen School, but this does not best address the needs of the state and its students.

IV.B. Growing Our Research Impact

As we discussed previously, the Allen School has a history of launching (or co-launching) interdisciplinary initiatives at UW that we choose not to "own" but rather turn into shared UW initiatives (e.g., eScience, CREATE, Change, Tech Policy Lab). Because computing and data science (including AI) continue to be the tide that lifts all boats, we see it as both an opportunity and a responsibility to leverage our expertise for campus-wide interdisciplinary initiatives.

One of our goals is to expand our footprint in the "Computing for Good" area. We have recently launched the "Computing for the Environment" initiative with the College of the Environment, the Department of Civil and Environmental Engineering, and the eScience Institute (which is UW's Data Science Institute). This initiative is funding projects that address issues from air pollution monitoring to wildfire tracking, climate model compression, wildlife conservation, and more. We plan to continue to grow this initiative and also expand it to include collaborations with local institutions that work in this space, including AI2, Microsoft, and Google.

Beyond the environment, "Computing for Good" has been an important goal of the Allen School for a long time, and we have recently renewed our efforts to grow in this area. We are strong, growing, and plan to continue to grow along four key pillars of CS4Good:

- **Computing for Health:** In collaboration with health scientists and clinicians, our faculty and students are applying computing innovation to transform medical science and patient care — from leveraging advances in artificial intelligence and machine learning to cultivate a deeper understanding of diseases such as Alzheimer's and cancer, to devising new approaches to diagnosis and treatment that harness the sensing capabilities of smartphones and other smart devices. Our researchers are also applying data science techniques to gain insights into how various factors impact people's well-being at a larger scale. And when COVID-19 emerged as a public health threat, we rapidly turned our expertise to aiding the public health response — work which will have an enduring impact beyond the current pandemic.

- **Computing for Sustainability:** Our faculty and students are taking inspiration from nature and developing innovative solutions to address the world's sustainability challenges while reducing the carbon footprint of computing itself. Some of our work focuses on untethering computation from traditional power sources to support a variety of real-world applications, from smart agriculture, to green buildings, to disaster response. Our researchers are also reimagining how we manage the world's rapidly expanding trove of digital data by developing novel storage capabilities using synthetic DNA as a potential alternative to power-hungry datacenters — and designing other systems and hardware that will optimize performance while minimizing environmental impact across a variety of domains, from artificial intelligence to manufacturing.
- **Computing for Society:** Our increasing ability to connect instantly with people around the globe and to access, translate, and disseminate content online has had a dramatic positive impact on society. However, this easy connectivity also has a downside; it can be misused to stoke political and social divides, rapidly spread misinformation, target vulnerable groups, and exploit weaknesses in privacy and security. The positive impacts of technology can also be unevenly distributed, particularly in low-resource communities. Our faculty and students work on analyzing and mitigating adverse impacts of emerging technologies and giving users the tools they need to protect themselves and others while enjoying the benefits of a more connected world through computing.
- **Computing for Everyone:** Technology can be a great equalizer for people with diverse abilities and experiences — as long as users' diverse needs and preferences are considered. Our faculty and students are leading the way when it comes to the development of new tools and techniques for improving how people interact with technology and the world around them. From making it easier for people to navigate their communities, to ensuring emerging technologies are inclusive of diverse cultures and languages, to assisting those with mobility impairments to complete everyday tasks — and much more — we produce innovations that will have a tangible, positive impact on people's lives and extend the benefits of computing to all.

One important initiative that we are working on with the Information School and the Department of Human Centered Design & Engineering is titled the "Technology, People, and Computing Innovation Initiative." This recent initiative is ambitious and seeks to raise substantial philanthropic funding. It has also bubbled up as a top-level UW initiative. The goal of this initiative is to bring together the key units on campus with expertise in computing technology and its implications. Here, "innovation" refers to the development of novel computing technologies through research (e.g., sensing, social media, theory, AR/VR, quantum); technologies with applications in health and medicine, education, accessibility, global development, social and civic engagement, and much more. The purpose of this initiative is to make UW a regional, national, and international leader in *reimagining how the world pursues technological change, ensuring that the greatest needs of communities around the world drive innovation at all stages of research and development, and do so while continuing to revolutionize computing technology and its applications*. While the initiative is starting from the Allen School, the iSchool, and HCDE, it seeks to bring together and be led by diverse experts from across UW's three campuses — experts from Social Sciences, Law, Policy, Medicine, Population Health, and elsewhere. This initiative will also serve as an umbrella and amplifier for the centers and institutes that engage in various aspects of this work.

The above are some of the initiatives we plan to focus on, as a school, as we expand the research impact of the Allen School in the near future. Those are not the only ones. We also plan to grow our research impact in other areas. Here, our focus is to support and build on initiatives that our faculty members and research groups initiate.

IV.C. Evolving Successful Models of Industry Engagement

As we discussed in the previous sections, our school exists in a powerful technology ecosystem from which we benefit, and which provides potential for strategic initiatives.

One of our goals has been to develop creative ways to enable our faculty to be dual-appointed and have an impact in academia, industry, and across the boundary. We want the faculty, the region, and the UW to benefit from such industry engagement. Toward this goal, we worked with UW Academic HR to create a unique extended leave policy that enables our faculty to be on 80%-100% leave for four years, 50% leave for six years, or 33% leave permanently and still retain their full, tenure-track position. We also have options for our faculty to reduce their tenure to 50% and remain permanently in a 50/50 position. See Appendix F.3 for details. In order to ensure that the faculty don't neglect their UW duties, we have instituted rigorous annual reviews for faculty on extended leaves. Leaves are approved for one year at a time. This approach has been helpful, but we are still struggling with ensuring deep faculty engagement with the broad set of needs in the school while on partial leave, and our plan forward is to continue to explore different approaches. This coming academic year, we will be assessing our extended leave policy. Each year, we change and adjust our processes (e.g., changes to the annual review process, changes to student review of progress) to maximize faculty engagement at the university, while supporting their dual engagement with industry.

Another area of potential growth is to explore expanding Allen School connections with nonprofit organizations, foundations, and communities. While we have connections in some areas — e.g., with larger nonprofits (e.g., Wikipedia, the Bill & Melinda Gates Foundation, PATH) and smaller ones (e.g., VillageReach, the Local Connectivity Lab), working with more could further expand our impact.

IV.D. Faculty Recruiting/Retention

An important concern is our ability to recruit and retain top faculty, especially in high demand subfields. We have lost several faculty to other universities over the past decade, and as noted have a number of faculty on partial leave with industry because of the research opportunities that this affords (including access to funding, to data, to vast compute resources, to engineering talent, etc.). A related challenge is the generally low salary of our faculty. We appear to have fallen behind our peers, which has been complicating faculty recruiting. This is an open problem that we are facing. It affects faculty recruitment, retention, and leadership at the senior faculty level.

IV.E. Diversity, Equity, Inclusion, and Access

As we discussed in the DEIA section earlier, we have been making great strides in this area. We are deeply committed to DEIA. We have a ways to go to get where we want to be, but we have an extensive and action-oriented strategic plan, and we are building on decades of experience. Our goal is to continue to put time and resources toward DEIA in the school, as summarized in our strategic plan (see Appendix D) and the DEIA section. Today, DEIA permeates all that we do. It is not a side activity — it has become part of our fabric.

IV.F. Improvements to our Education Programs

As we grow our education programs, we also continue to improve them.

Undergraduate Program: We identify two focus areas for improvement to our undergraduate majors' experience in the years ahead. These are complementary to reinventing our introductory sequence and the need for more growth, both discussed above.

- More thorough inclusion of **technology ethics and professional responsibility**, addressing head-on the dangers of technology misuse and unintended consequences. We have created an undergraduate discussion seminar (CSE 480) and are now growing its enrollment — a total of 125 students across three offerings in 2021-22. We are also encouraging instructors to do more in technical courses. Finally, we should better leverage relevant expertise on campus.

- Better structure for **undergraduate research**, which will lead to more student participation and more students pursuing research careers. We send a number of students to top Ph.D. programs each year, we have the most CRA Outstanding Undergraduate Researcher Awards over time of any program, and we have many undergraduate alumni now in top faculty positions. But the *percentage* of students pursuing a research path has been a victim of our rapid growth and the vibrancy of Seattle's tech ecosystem. We are developing a significant program with faculty leadership to increase undergraduate engagement in research:
    - We now have a faculty committee that maintains a webpage with research experiences offered by faculty and provides advice on how to best connect with faculty. That faculty committee also developed a new seminar for undergraduate students interested in research and is working on building additional structures to support undergraduate research.
    - We actively support undergraduates in finding research opportunities, and work to promote undergraduate researchers for awards, such as for the CRA award.

  However, despite many faculty, graduate students, and postdocs working extensively with undergraduates, demand for research experiences still outpaces these offerings. How can we scale the number of research experiences we provide to accommodate all undergraduates who are interested? Should we integrate research skills into our core curriculum, and if yes, how could we do this to address students' interest in getting in-lab experience?

Graduate Program: The greatest issue that has affected graduate student success over the last decade is the large number of faculty (especially those in high demand areas such as AI, ML, NLP, computer vision, and robotics) that have been on part-time or full-time leave in industry or at startups. As a consequence, some students have suffered from insufficient advising. This has also resulted in the occasional conflict of interest between faculty and their advisees. This is an area of improvement for us, and we continue to work on new approaches to improving the situation.

Postdocs: Just like for our graduate students, postdocs have occasionally received insufficient attention from their faculty mentors who were on part-time or full-time leave. Not being part of a specific degree program, and being a small minority in the school, has also meant that postdocs sometimes do not feel as included as would be desirable in school decisions (e.g., hiring) and social/collaborative activities. This is another area where we have already been increasing our efforts but plan to continue to do so in the future.

PART B: UNIT-DEFINED QUESTIONS

1. What is the role of computer science in the modern university? Core computer science research and education is transformative for society. Additionally, computer science can be "a rising tide that lifts all boats," making a university and its region stronger through collaborative research, interdisciplinary teaching, and other interactions. To what extent does the Allen School fulfill this dual role? How can we improve? What potential partnerships are we taking insufficient advantage of, and how might we grow these?

We discuss:

- "Mission of the Paul G. Allen School" in Section I.A.
- "Role of the Allen School in the University" in Section I.C.
- "Service Courses: Highlights and Needs" in Section II.G.
- "Outreach and Statewide Leadership Highlights" in Section II.H.
- "Collaborative and Interdisciplinary Efforts" in Section III.C.
- "Future Directions" in Section IV.

2. There is an increasing trend toward independent (CMU, Georgia Tech, UC Irvine, UMass, Northeastern, etc.) or quasi-independent (Cornell, MIT, Berkeley, etc.) schools/colleges of computing. What are the benefits of this to the universities? Would UW potentially benefit if the Allen School had greater (quasi-)independence?

Carnegie Mellon University and the Georgia Institute of Technology were ahead of the curve: the CMU School of Computer Science and the Georgia Tech College of Computing each were established in 1988. In both cases the impact was significant. CMU's SCS has become by far the largest program in the nation and has retained its top-four *US News* ranking despite what is, at best, a modest halo effect from CMU and Pittsburgh. Georgia Tech's CoC has grown tremendously and has risen from the middle of the pack to #8 in the *US News* rankings.

What had been a trickle — 14 years passed between 1988 and the establishment of the third independent school/college of computing, UC Irvine's School of Information and Computer Science — has recently become a tsunami. In the past two years, MIT has established an independent College of Computing, Cornell has created and then elevated its School of Computing and Information Science, and Berkeley has created a Division of Computing, Data Science, and Society, which will become an independent College in the near future. More than a dozen other public and private universities have made similar moves recently, including Indiana, Northeastern, Penn State, Pitt, UMass

Amherst, and Wisconsin. The magnitude of this trend is emphasized by national organizations echoing the value in creating such independent schools and colleges; for example, the Computing Research Association published a white paper in 2019 on "Creating Institutional Homes for Computing: Transforming a Department into a School or College."

Most importantly, five of the top 10 programs in computing (according to *US News*) — and four of the top six, with which we compete most directly (MIT, Berkeley, Carnegie Mellon, and Cornell) — are independent or quasi-independent schools or colleges led by Deans. While major donations accompanied some of these transitions, in most cases the academic decision to elevate the prominence of computing preceded, and in some cases stimulated, the donation. For example, at MIT, a decision was made to create an independent College of Computing, at which point President Rafael Reif sought a naming donor as the top institutional priority. That donor provided $350 million, but MIT as an institution undertook to raise a total of $1 billion in new funding to support the College.

The University of Washington is at risk in this tsunami. We recognize that full independence from the College of Engineering would have undesirable repercussions: It would damage the ranking of the College.[7] This is why Berkeley, Cornell, and MIT are quasi-independent. Their faculty still "count" toward their schools/colleges of engineering. However, in addition to an independent identity (which we also possess), they have Dean-level prominence, operational autonomy, and budgetary autonomy (all of which we lack). This allows them to be far more agile, responsive, and competitive — elevating not only themselves, but their schools/colleges of engineering and their universities. They have their own dedicated advancement staff, enhancing alumni and corporate relations. Their Dean-level prominence facilitates the establishment of broad and deep partnerships both within and beyond their universities, growing the excellence, impact, and reputation of their universities across a broad range of fields. They handle their own hiring, promotion, and tenure processes, reducing the burden on the schools/colleges in which they were previously housed. Strategic planning can proceed collaboratively but independently, yielding better, more coherent outcomes for each. Budgetary autonomy enables them to grow appropriately in response to student demand, employer demand, and intellectual opportunity. They and their universities are part of national conversations and national perceptions regarding universities' responses to the evolving role of computing (e.g., as part of CRA's Deans Group).

[7] *US News* ranks schools/colleges of engineering based upon reputational and quantitative factors, but does *not* rank schools/colleges of arts and sciences. All of the CS programs that have become fully independent in recent years had previously been housed in schools/colleges of arts and sciences.

3. As we have grown, we have struggled to adapt. We seek to preserve coherence (avoid creating silos) and maintain or even improve our climate and culture. What is your assessment of our faculty mentoring and retention? What is your assessment of our climate in terms of diversity, equity, inclusion, and access? What is your assessment of our sense of community and our internal collaborations? How can we improve in these and related areas?

The Allen School has always prided itself on its culture of collaboration, support, mentorship, and inclusiveness. Over the last decade, we have tried to foster an atmosphere of continuous improvement by taking the following actions:

Faculty: We have significantly improved our faculty mentorship in recent years. For new faculty, we offer expanded onboarding and assign three mentors: one in the same research area, one in a different area, and a "teaching buddy." We provide those mentors with a list of topics they should cover with their mentees and encourage them to meet at least monthly. For all faculty, we offer a variety of opportunities for professional and personal development. For example, over the last two years, we have had presentations on such diverse topics as career paths, fundraising, accessible teaching, mental health, and bystander training. We have also developed systematic procedures for nominating faculty for both cross-cutting and in-area awards, and are working to ensure that we provide *all* faculty with opportunities to be nominated for appropriate awards (as opposed to falling into a "rich get richer" trap).

We have also continued less visible practices to maintain our collaborative and cohesive culture. For example, it has been our practice since our early days in the 1970s to not respond to external offers. This is to avoid a destructive culture and salary disparities that often disproportionately negatively affect minoritized populations and those with families. We also do not differentiate salaries based on research area within our school to support everyone feeling treated fairly. Finally, we work hard to give all incoming faculty members a fair start-up package and avoid salary inversions.

Organizational structure: To address issues of scale, we have streamlined a number of our administrative processes and restructured our committees. We now have rotating co-chairs for each major committee, providing continuity and reducing the workload. We have created new leadership roles, such as the roles of co-chairs of Faculty Mentorship and Career Development. We have created new committees. For example, we now have separate committees for teaching-track and tenure-track faculty hiring. We seek to give our committees and their two chairs maximal agency in making changes and driving their processes to encourage faculty buy-in, leadership, and to avoid creating decision-making bottlenecks. Nevertheless, we still struggle with our growing size. We want to avoid splitting into departments or divisions to avoid creating silos and any feeling of competition or friction between those silos, but we are fast approaching the size of 100 faculty members. At that scale, it’s all too easy for faculty to feel like their voice is unimportant and it won’t be noticed if they don’t engage, don’t show up to faculty meetings, and don’t speak up. We have been working on addressing these issues, but we also welcome advice on this topic.

Students: We discuss our support of students and our educational programs in Section II above on “Teaching and Learning” and in particular Section II.E on “Undergraduate Major: Goals and Outcomes.” We also discuss our ongoing and planned improvements to our programs in Section IV on “Future Directions.”

In terms of climate specifically, to help us better understand our own strengths and weaknesses, we commissioned the UW Center for Evaluation and Research on STEM Equity (CERSE) to conduct a climate study in 2019. CERSE did a survey of all students associated with the Allen School, from those in our introductory programming sequence to Ph.D. students, and then analyzed the results. Overall, the conclusions of their study were quite positive, with the vast majority of CS majors and Ph.D. students reporting that they feel supported by their advisors, prepared for and optimistic about their future, and positive about the quality of education they are receiving. On the other hand, the climate survey revealed that more work has to be done to improve the feeling of belonging for minority and minoritized students, and those in our introductory programming courses. We further discuss how we regularly survey our students in Appendix E.2.

DEIA: Allen School Director Magda Balazinska, together with Yoshi Kohno, Associate Director for DEIA, co-led a significant effort over the past two years to develop our DEIA Strategic Plan. Working on this plan provided us with a big picture view of the numerous activities already going on, clarifying the synergies, overlaps and gaps. For example, we noticed that our DEIA activities were not fully addressing the needs of our B.S./M.S. students or our staff. We have come out of this process significantly better organized and energized. We further discuss our DEIA strategic plan in Appendix D.

We seek the committee’s help with understanding where we should focus our efforts going forward to further improve the climate in the school. Of particular concern is our ability to maintain cohesion in light of our rapid growth. In addition, as we have educated ourselves on issues of DEIA, it has become increasingly clear that there is still much work to do (though we are optimistic that our activities and strategic plan will bear fruit).

4. Seattle has a rich technology industry, and a rich technology research community. These represent nearly unique competitive advantages for us. How can we achieve even greater synergy? How should we support faculty in maximally leveraging the opportunities afforded by the regional tech industry in ways that complement their faculty responsibilities?

We discuss:
- "Engagement with the regional tech community" at the end of Section III.C.
- "Growing Successful Models of Industry Engagement" in Section IV.B.
- "Faculty Recruiting/Retention" in Section IV.C.

5. As our programs for majors and the rest of campus grow, and as computer science continues to evolve, how should we best serve our undergraduate and graduate students (as well as students from all of the UW) through courses, research experiences, affinity groups, and other activities?

We discuss:
- "Academic Unit Diversity, Equity, and Inclusion" in Section I.K.
- "Teaching & Learning" in Section II.
- "Future Directions" related to our educational program in Section IV.F.

6. What are the budgetary/financial constraints and opportunities toward fulfilling the Allen School's mission?

We discuss:
- "Budget and Funding" in Section I.H.
- "Relationship of the Allen School to the College of Engineering" in Section I.F.
- "Unusual Characteristics of the Allen School" in Section I.G.
- "Future Directions" in Section IV, including challenges related to program growth, industry engagement, and salaries and faculty retention.
- Appendix B includes important budget, size, and growth documentation.

PART C: APPENDICES

Appendix A: Organizational Chart

Faculty Leadership

Magdalena Balazinska, Director of the Allen School
Dan Grossman, Vice Director of the Allen School
Paul Beame, Associate Director, Facilities
Anna Karlin, Associate Director, Graduate Studies
Tadayoshi Kohno, Associate Director, Diversity, Equity, Inclusion & Access
Ed Lazowska, Associate Director, Development & Outreach
Shwetak Patel, Associate Director, Research & Innovation

Note: We currently do not have an associate director for undergraduate studies. This role is shared between the vice-director and the undergraduate program chair listed below.

Executive Committee: Comprises the above individuals as well as five elected faculty members. Elections take place each summer. An elected faculty member can serve up to two years in a row before a required break of at least one year. As of Fall 2022, elected members are Hanna Hajishirzi, Rachel Lin, Raj Rao, Amy Zhang, and Justin Hsia.

Additional significant leadership roles (as of Fall 2022):

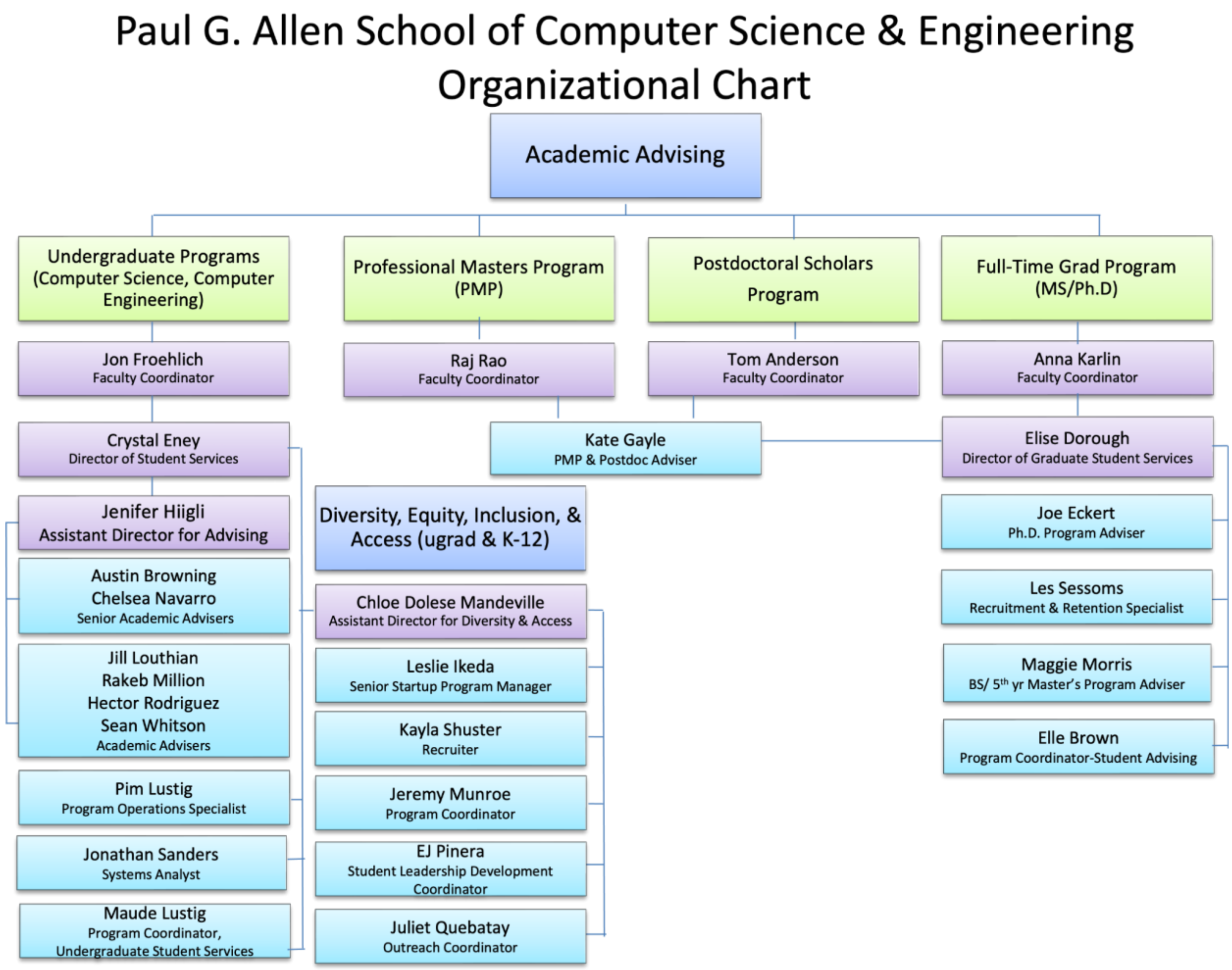
- **Co-chairs of the tenure-track FRC:** Jeff Heer and Zach Tatlock
- **Co-chairs of the teaching-track FRC**: Justin Hsia and Kevin Lin
- **Co-chairs of faculty mentorship & career development**: Josh Smith & James Fogarty
- **Undergraduate program & admissions chair:** Jon Froehlich
- **Undergraduate research co-chairs:** Maya Cakmak and Franzi Roesner
- **Undergraduate curriculum chair:** Ruth Anderson
- **5th year masters & admissions chair:** Richard Anderson
- **Professional master's program chair:** Raj Rao
- **Co-chairs of graduate admissions:** Stefano Tessaro and Anup Rao
- **Postdoc program chair:** Tom Anderson
- **Faculty awards chair:** Anna Karlin

Staff Leadership

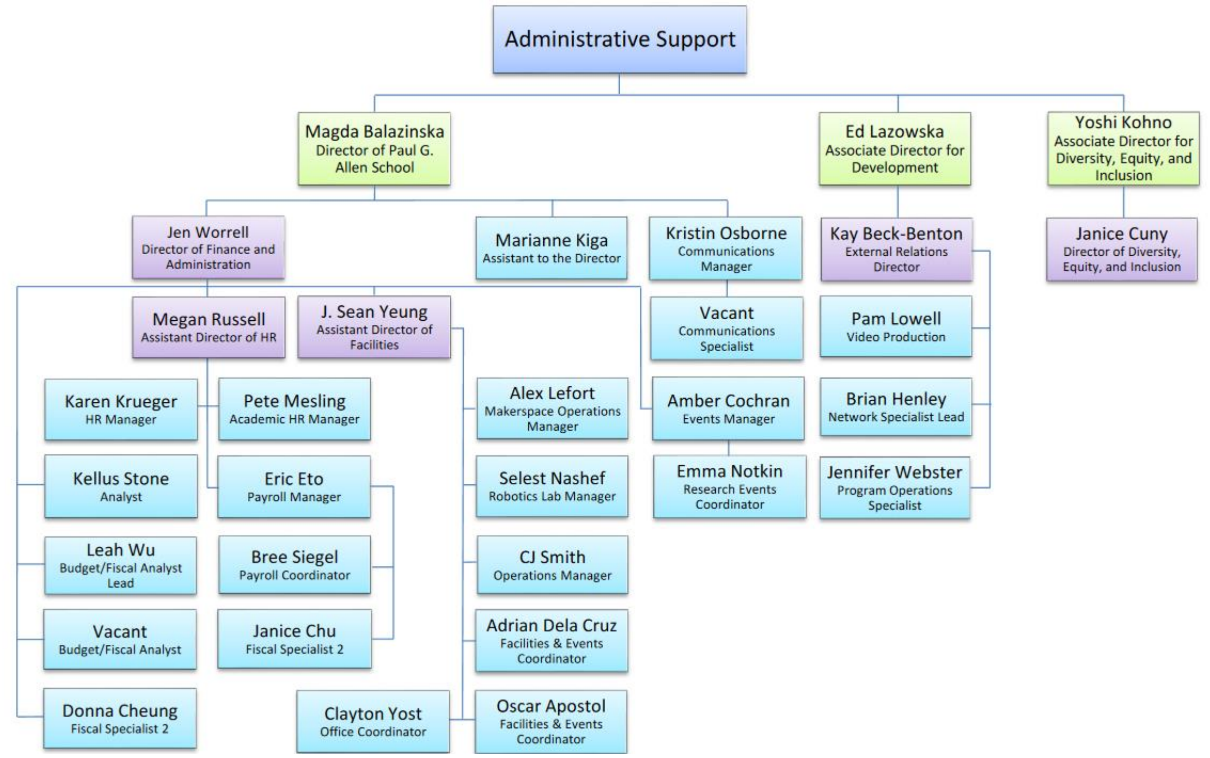
Kay Beck-Benton – External Relations Director
Elise Dorough – Director of Graduate Services
Crystal Eney – Director of Student Services (undergraduate students)

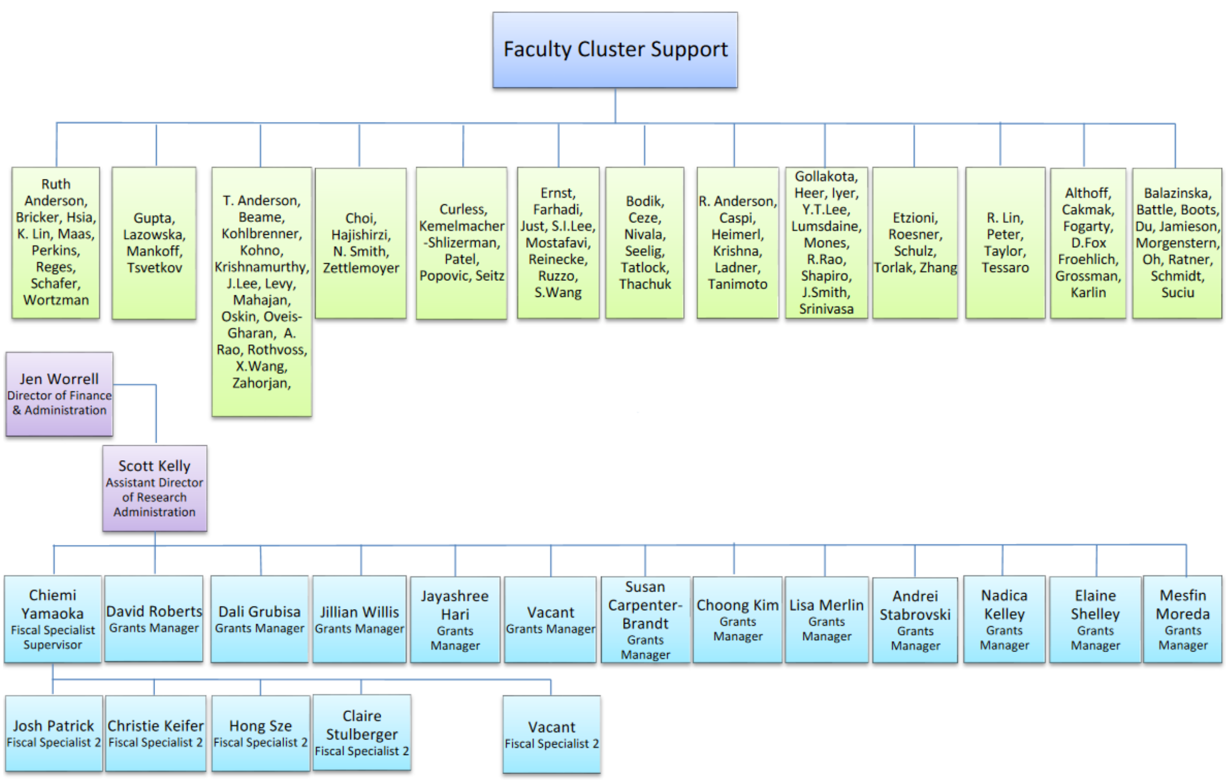
Scott Kelly – Assistant Director of Research Administration
Megan Russell – Assistant Director of Human Resources
Aaron Timss – Director of Computing
Jennifer Worrell – Director of Finance & Administration
J. Sean Yeung – Assistant Director of Facilities

Academic Advising

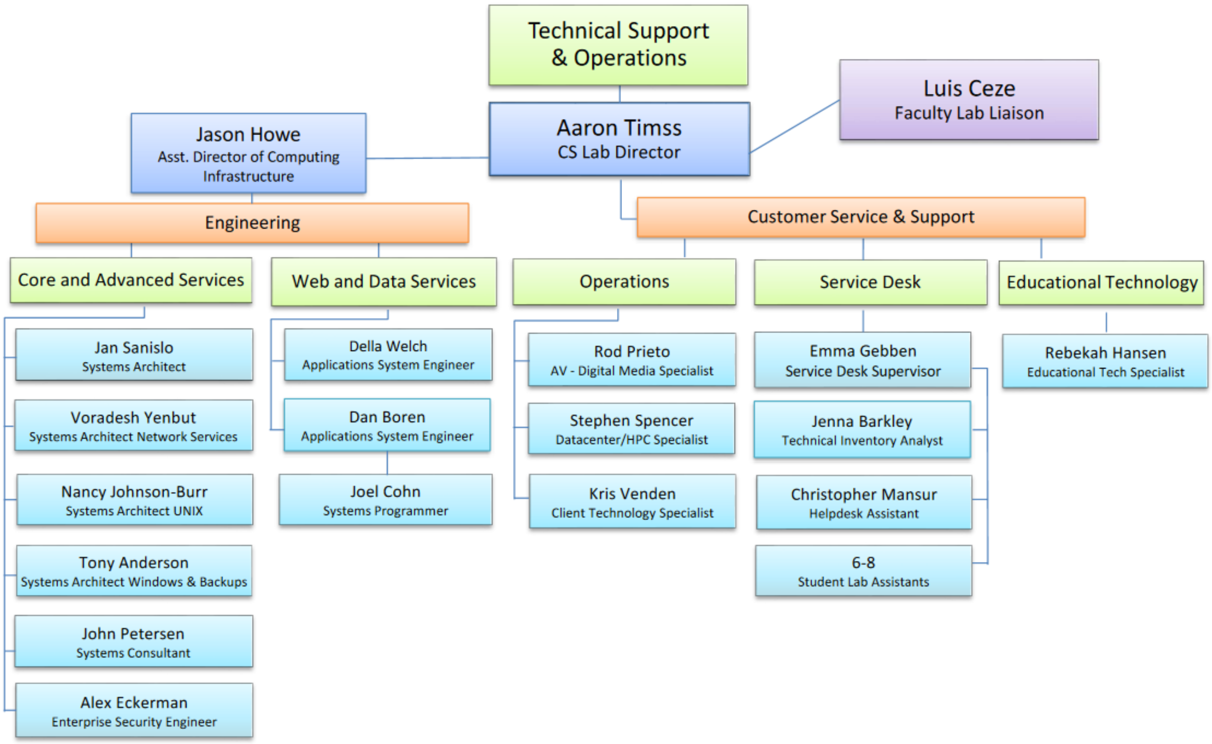


Administration and Grants Management Support

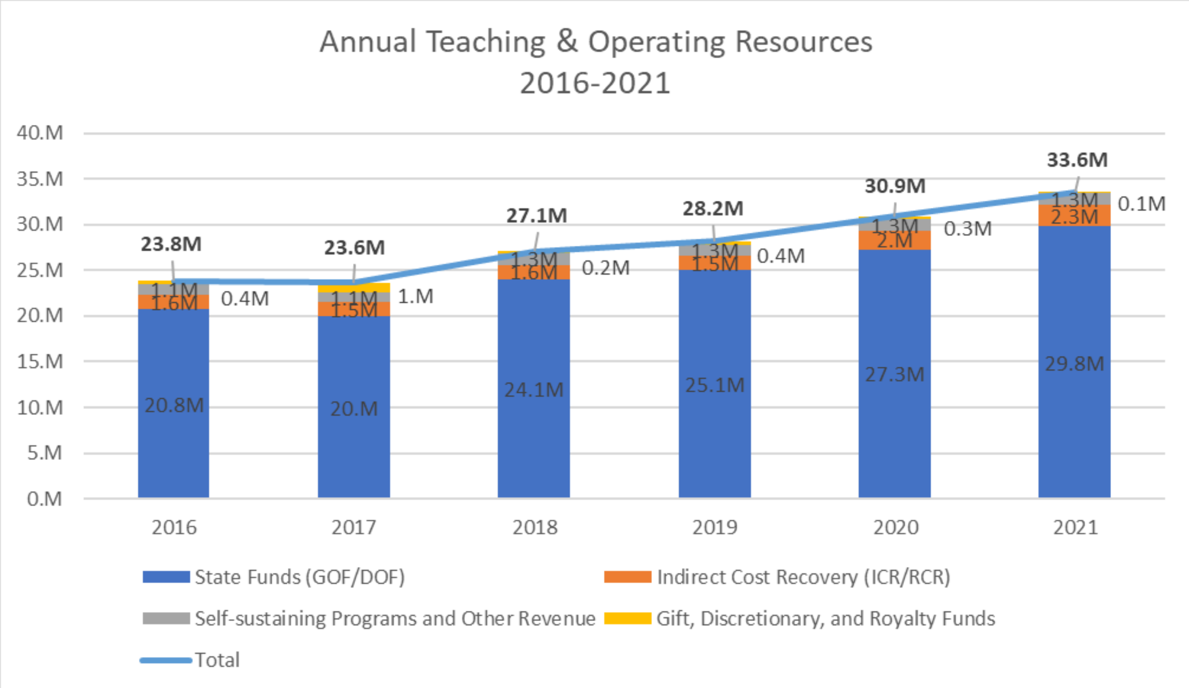


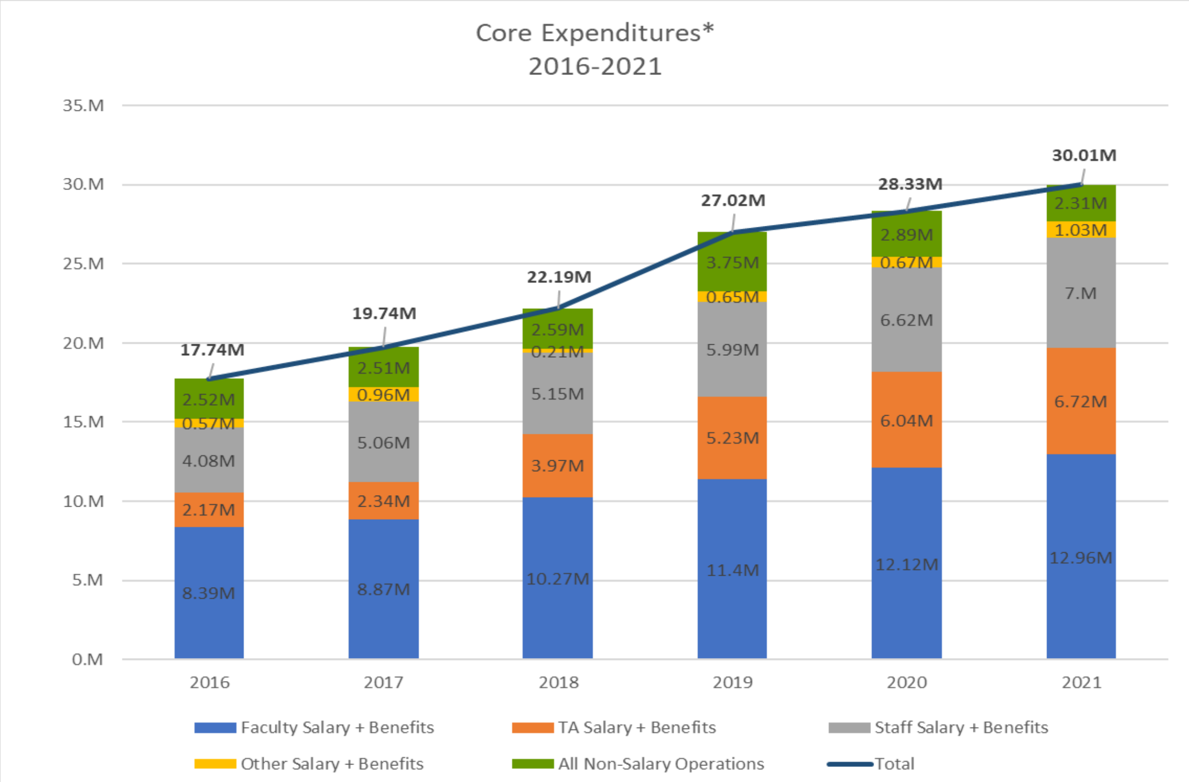


Technical Support

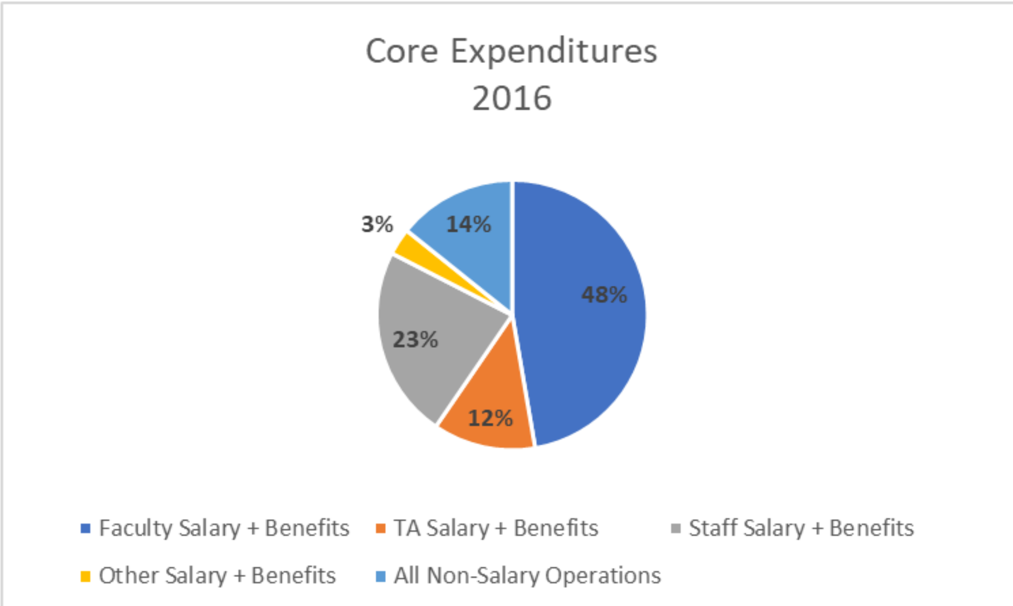


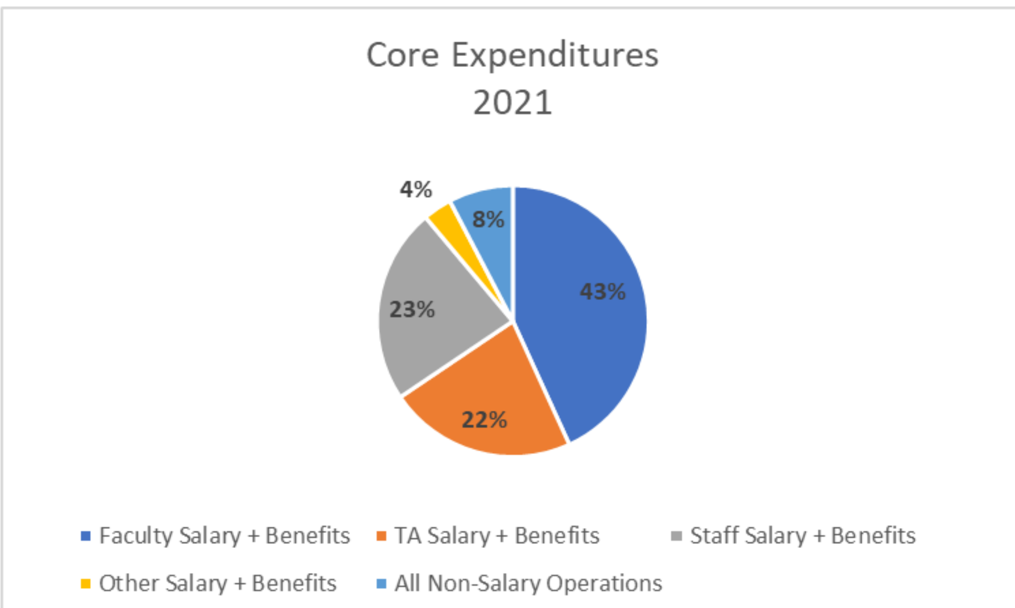
Appendix B.1: Budget – Budget Summary

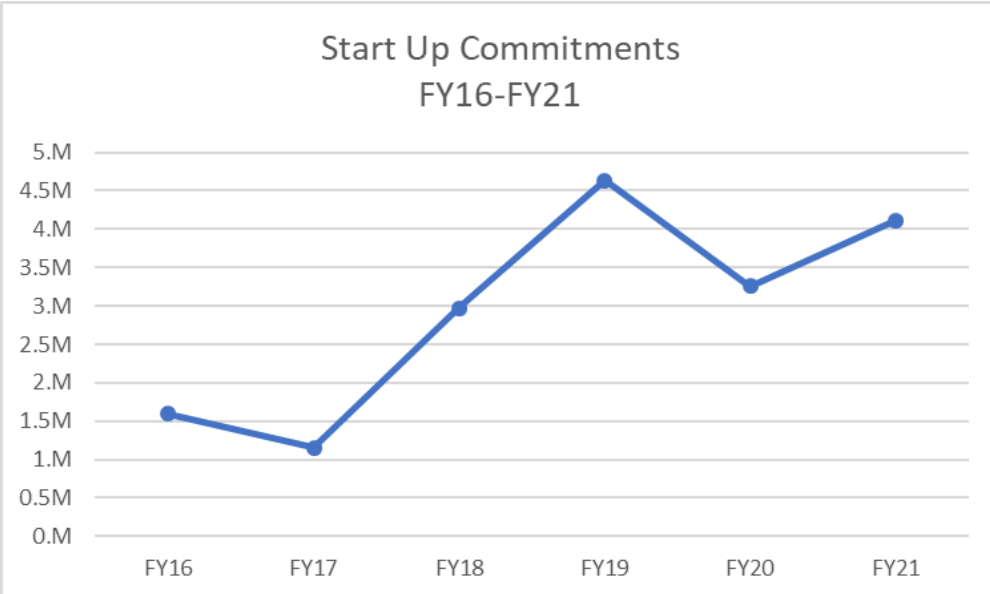


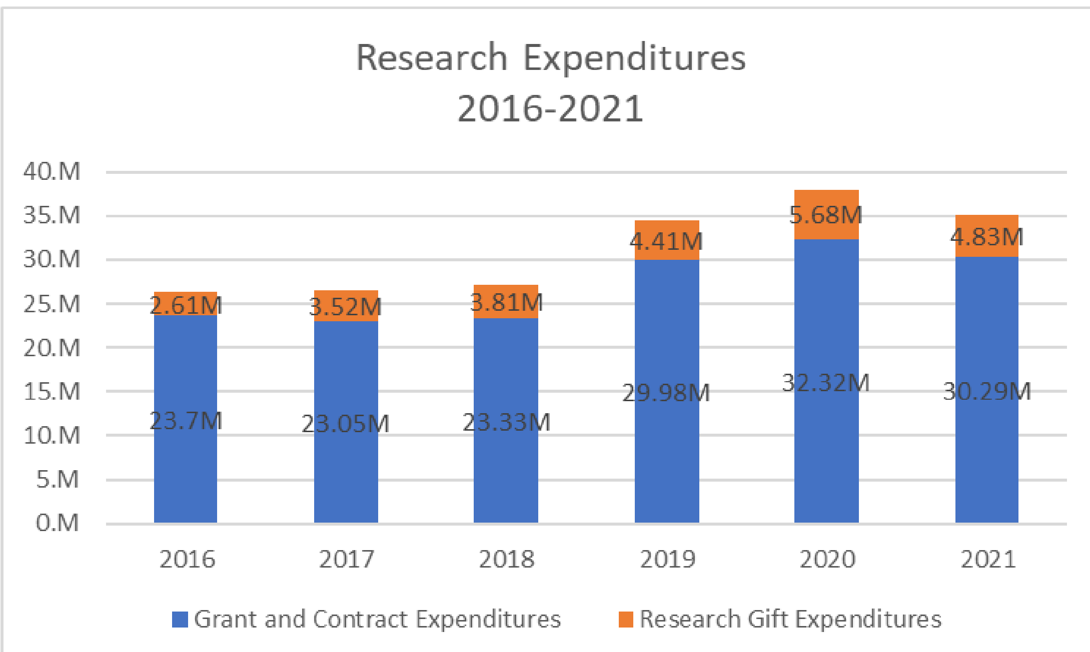


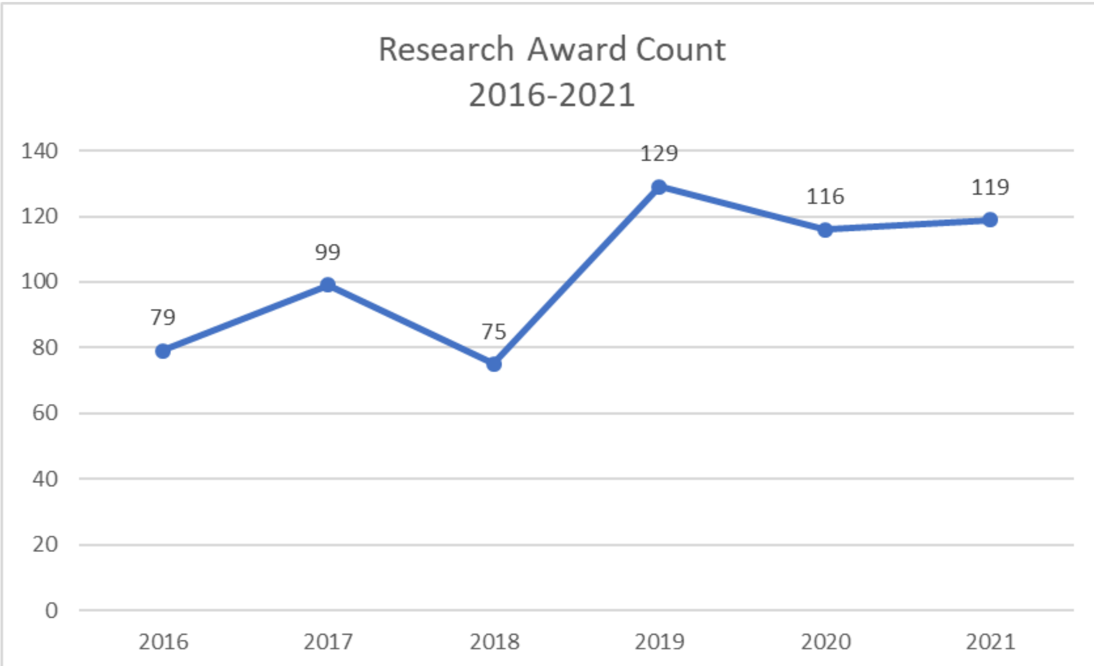
* Start Up not Included


Core Expenditures
2016
3%
14%
48%
23%
12%
Faculty Salary + Benefits
TA Salary + Benefits
Staff Salary + Benefits
Other Salary + Benefits
All Non-Salary Operations


Core Expenditures
2021
4%
8%
43%
23%
22%
Faculty Salary + Benefits
TA Salary + Benefits
Staff Salary + Benefits
Other Salary + Benefits
All Non-Salary Operations


Start Up Commitments
FY16-FY21
5.M
4.5M
4.M
3.5M
3.M
2.5M
2.M
1.5M
1.M
0.5M
0.M
FY16
FY17
FY18
FY19
FY20
FY21


Research Expenditures
2016-2021
40.M
35.M
30.M
25.M
20.M
15.M
10.M
5.M
0.M
2.61M
3.52M
3.81M
4.41M
5.68M
4.83M
23.7M
23.05M
23.33M
29.98M
32.32M
30.29M
2016
2017
2018
2019
2020
2021
Grant and Contract Expenditures
Research Gift Expenditures


Research Award Count
2016-2021
140
120
100
80
60
40
20
0
79
99
75
129
116
119
2016
2017
2018
2019
2020
2021

Appendix B.2: Budget – Allen School Growth

Proposal for the 2023–25 Biennium and Beyond

Version of 5/9/2022

History

Between July 2012 and July 2018, the Allen School was able to expand enrollment thanks to multiple legislative provisos that funded growth from 160 Bachelor's degrees per year (260 total degrees per year) to 450 Bachelor's degrees per year (620 total degrees per year).

Over this period, growth in student demand vastly exceeded even this substantial growth in capacity. As a result, in Fall 2020, at the request of House Higher Ed leadership, we presented "a new multi-year initiative to grow from 620 to 1,020 degrees per year, including growing Bachelor's degrees from 450 to 770 per year, with a particular focus on ensuring that our undergraduate student body reflects the many dimensions of diversity in Washington State." Specifically, we proposed to add 400 annual degrees at a rate of 100 in each of the 2021-23, 2023-25, 2025-27, and 2027-29 biennia, funded by adding $4M to our annual budget during each biennium.

The first 100 degrees and $4M in annual budget were added during the just-concluded 2021-23 biennial budget process. ***We strongly urge that the University's request for the 2023-25 biennium and beyond include this rate of growth for the Allen School in terms of degrees and funding.***

Student Demand

For Fall 2022, **7,587 UW freshman applicants, including 2,062 Washington residents**, listed the Allen School as their first-choice major. This continues a steep growth in student demand that goes back more than a decade (Figure 1).

The total demand of 7,587 freshman applicants represents nearly 60% of the combined demand for the College of Engineering and the Allen School.

Capacity Relative to Student Demand

Allen School Direct-to-Major Admission and College of Engineering Direct-to-College Admission are similar: each seeks to enroll roughly 50% of capacity, biased strongly toward students from Washington (90% in the case of the Allen School). For Fall 2022, the College of Engineering was able to offer Direct Admission to **52%** of applicants. The Allen School, in contrast, was able to offer Direct Admission to only **7%** of applicants – *an enormous disparity, and an enormous disservice to students*. (Overall, UW was able to offer admission to 47% of applicants.)

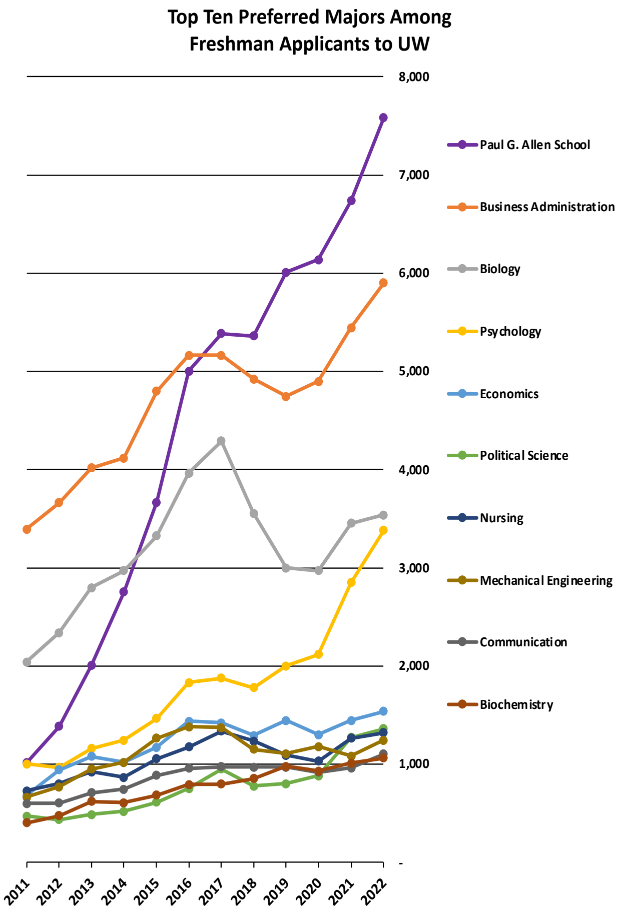


Figure 1

Focusing on students from Washington, the Allen School was *unable to accommodate* a minimum of **723 well-qualified Washington students** who, based upon their Academic Score assigned by the UW Office of Admissions, would have received College of Engineering Direct-to-College Admission (Figure 2).

Number of Washington-resident freshman applicants for 2022 denied Direct Admission (Pre-appeals, so will change somewhat)			
Academic Score	WA Applicants Denied College of Engineering Direct-to-College Admission	WA Applicants Denied Allen School Direct-to-Major Admission	Running Total of WA Applicants Denied Allen School DTM Admission
18	0	0	0
17	0	180	180
16	0	304	484
15	0	239	723

Figure 2

A broader view: Consider all Fall 2022 freshman applicants (not just Washington students), and include programs in the Natural Sciences Division of the College of Arts & Sciences (in addition to programs in the College of Engineering). The Allen School represents nearly **30% of Fall 2022 freshman demand** for this group, but only **15% of total capacity** (Figure 3).

	Fall 2022 Freshman Applicants	Annual Capacity	Percent of Total Applicants	Percent of Total Capacity
Natural Sciences Division of College of Arts & Sciences	12,615	2,000	49%	56%
College of Engineering other than Allen School	5,752	1,000	22%	28%
Allen School	7,587	550	29%	15%
Total	25,954	3,550	100%	100%

Figure 3

Freshman Direct-to-Major Admission has become the most common path to the Allen School, accounting for 50%-60% of our annual intake. However, the demand among current UW students who apply to the Allen School also vastly exceeds capacity. These applicants are increasingly "interest changers" who discover our field during college. (By intent, students exclusively focused on computer science but not receiving Direct-to-Major admission increasingly choose to attend college elsewhere.) In the past 3 years, the Computer Science major received a total of 2,120 applications from current UW students. We were able to offer admission to only 518 of them. **Of the 518 students offered admission, 517 enrolled – *all but one***. UW students "hedge their bets" by applying to multiple majors, but the Allen School is the first choice of essentially all who apply.

Our third admission path accommodates transfers from Washington's community and technical colleges. In a typical year we receive 400-500 applications for 70 spots with a yield (the proportion of admitted students who actually enroll) of well over 90%.

(The Allen School's yield is unusually high for freshman admission as well: **roughly 67%, vs. roughly 30%** for the College of Engineering and for UW overall – roughly 80% vs. roughly 60% among students from Washington.)

Employer Demand and Workforce Gap

Employer demand is reflected by the workforce gap in our state (the gap between annual jobs available in the state, and annual degrees granted in the state) as reported in the biennial *Skilled and Educated Workforce* report.[1] The most recent version of this report (2019) projects 11,702 annual Bachelor's-level job openings in "Computer and Information Science" vs. 2,015 in-state degrees

[1] Authored by the Washington Student Achievement Council, the Washington State Community and Technical Colleges, and the Workforce Training & Education Coordinating Board.

(Figure 4) and 6,378 annual graduate-level job openings vs. 393 in-state degrees (Figure 5). The gap between jobs available and degrees granted in computer and information science is far greater than in any other field.

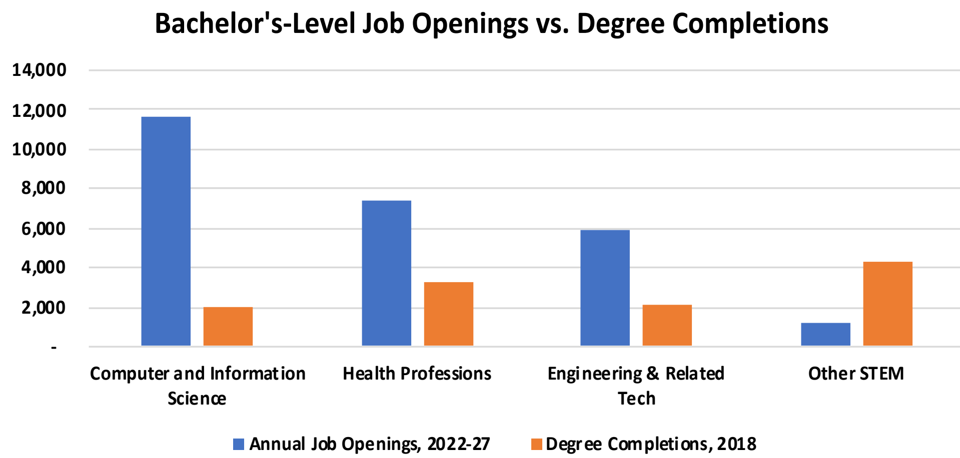


Figure 4

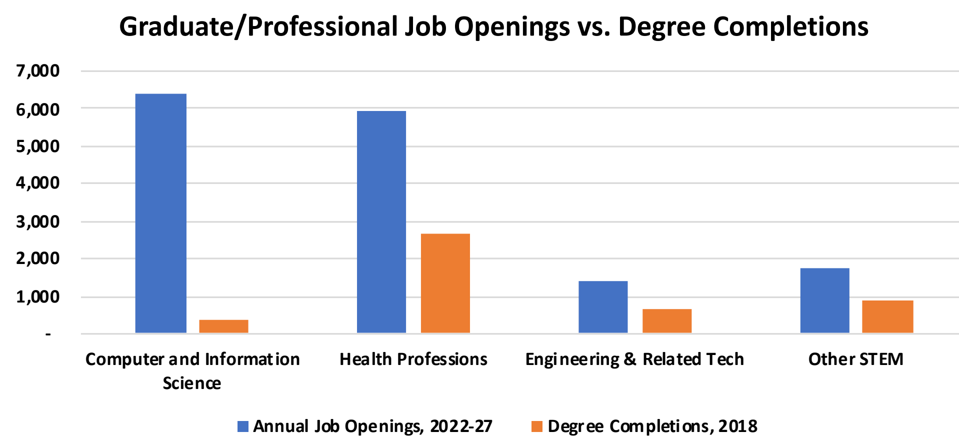


Figure 5

The technology sector powers our region's economy. The technology sector creates a diversity of jobs for a diversity of people with a diversity of backgrounds. However, *it is the software engineers who power the sector* – theirs are the jobs that create the other jobs.

The majority of these people have bachelors or graduate degrees in Computer Science or Computer Engineering from the nation's top programs – the degrees that are offered at UW by the Allen School. A powerful illustration appears in data regarding Amazon's tech workforce in Seattle, assembled by the Commonwealth of Virginia in their successful effort to attract Amazon's HQ2 (Figure 6). 49% of Amazon's tech workforce in Seattle has degrees in Computer Science, and 7% has degrees in Computer Engineering. The next largest contributor was Electrical Engineering, at 4%.

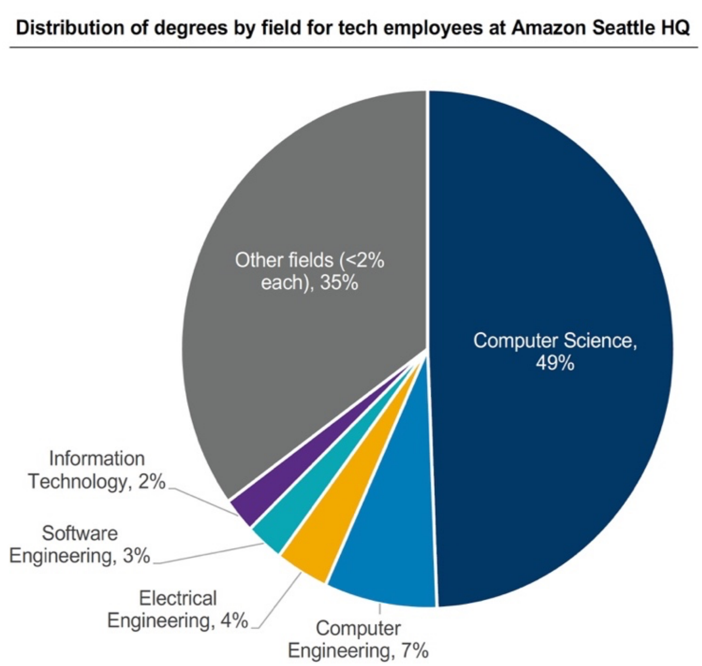


Figure 6

The Allen School is, *by far*, the state's leading educator of these people. Of our 2020-21 graduates, at least 59 took positions at Amazon ("at least" because we do not have 100% response), 52 at Microsoft, 23 at Facebook, 17 at Oracle, 11 each at Expedia and Google, and smaller numbers at nearly 100 other companies. Roughly 90% remained in Washington.

Continuing to grow the Allen School is an essential investment in our region's future.

Our Ability to Meet Our Growth Targets

We have successfully grown at a rate of 100 annual degrees per biennium (or more) multiple times. As a recent example, during the 2017-19 biennium we were funded in two steps to grow from 505 to 620 degrees per year, with 3/4ths of the funding provided in the 2018 supplemental session. We achieved that target in the 2020-21 academic year – only 3 years after the funding was secured. When funding is provided, we immediately enroll sufficient students to meet the target. Our success with the legislature is based on straight talk: we make specific commitments, and we deliver on those commitments.

What Motivates Students to Study in the Allen School?

Some people assume "they're after the money" or "their parents told them to do it." Independent surveys of Allen School students tell a very different story.

More than fifteen years ago – in 2006 – the Allen School produced a video aimed at high school students, featuring interviews with a dozen current undergraduates. The title of this video was *Power to Change the World*. The Allen School has led the nation in this positioning of computer science. We continue to innovate at the core of the field, but the goal of this innovation – and the focus of much of our education and research – is to create life-changing, world-changing advances that address society's most pressing challenges.

Our students hear this, they experience this, and they embrace this. In the most recent annual climate survey of our students, conducted by the Center for Evaluating the Research Pipeline, the two most often mentioned answers to the question "Why did you choose your degree program?" (respondents were allowed to select as many as 3 of 10 suggested answers) were "I like learning about this field" (83% of respondents) and "The program will allow me to make an impact on society" (56% of respondents – the average for similar institutions was only 34%). Only 13% of Allen School respondents chose "My family influenced my decision," and only 29% chose "This program will allow me to make a lot of money" (versus 38% at similar institutions). (See Figure 7.)

Table 1.2.1 Why did you choose your degree program?
Choose up to 3 responses.

	Your Institution (%)	Similar Institutions (%)
I like learning about this field	83%	78%
My friends are enrolled in this program	4%	6%
The courses required of this program are interesting	40%	36%
Professors/faculty at my institution influenced my decision	2%	4%
The program will allow me to make an impact on society	56%	34%
This program will enable me to make a lot of money	29%	38%
The job market for this field is promising	55%	62%
My family influenced my decision	13%	12%
I will be successful completing the coursework required of this program	7%	11%
Another reason	2%	3%
None of the above	0%	0%

Figure 7

We documented earlier that our matriculation rate (the percentage of students offered Allen School admission who actually enroll – our "yield") is exceptionally high. In addition, our attrition rate (the percentage of Allen School students who switch to other majors) is exceptionally low. Our attractiveness and our retention both are extraordinary.

Progress Toward Diversity Goals

We have received national recognition for our success with undergraduate women. (We are far short of where we need to be, but we are significantly outperforming our peers.) In recent years we have dramatically increased our focus on other populations whose representation is important; our goal is to meet or exceed UW-Seattle percentages, and we are making real progress (Figure 8).

Impact on the University of Washington

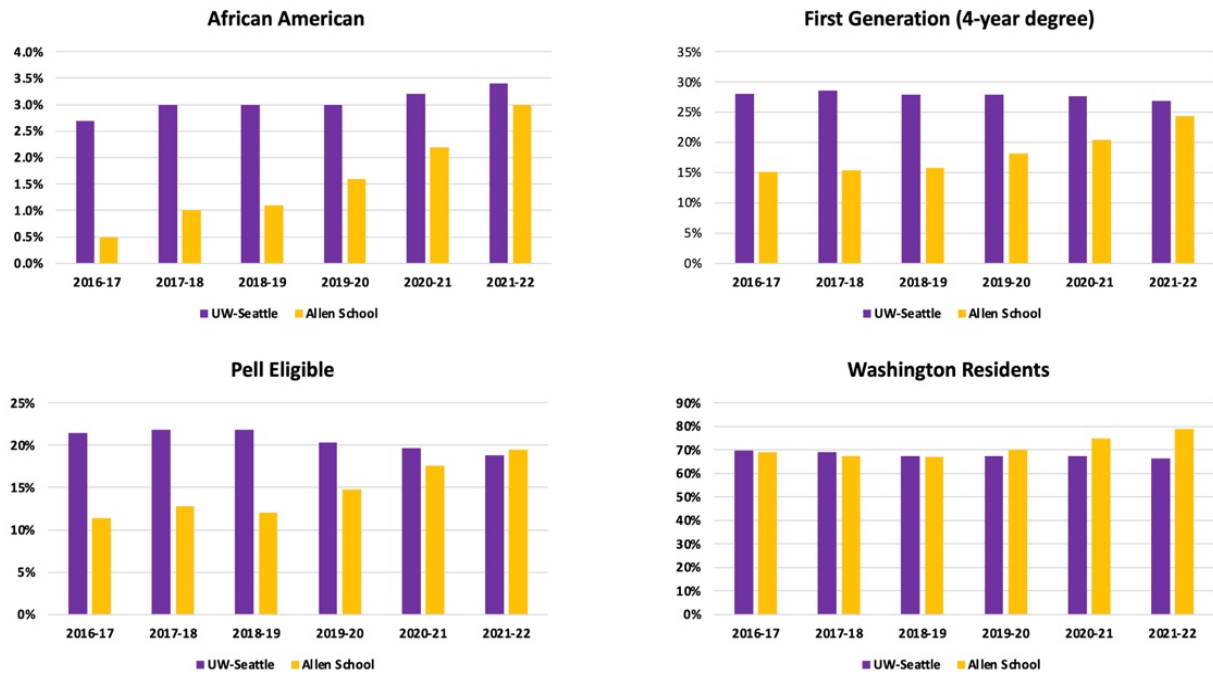


Figure 8

As a field, computer science is the rising tide that lifts all boats. This is especially true of the Paul G. Allen School at the University of Washington. As just one example, we have a long record of interdisciplinary initiatives that involve multiple units and that we are scrupulous not to "own." Examples include the eScience Institute (data science), CREATE (accessibility), the Tech Policy Lab (led by Law, the iSchool, and the Allen School), dub (human-computer interaction), and Change (technology to improve the lives of underserved populations).

The Allen School uniquely bridges the College of Arts & Sciences and the College of Engineering. We spent our formative years as a unit of the College of Arts & Sciences before being force-moved to the College of Engineering in 1989. Our College of Arts & Sciences B.S. in Computer Science awards roughly 90% of our Bachelor's degrees, our College of Engineering B.S. in Computer Engineering roughly 10%.

A discussion of research horizons is beyond the scope of this document. We will simply note that national and regional research priorities such as quantum computing and all aspects of artificial intelligence (robotics, natural language processing, computer vision, machine learning) have computer science at their core, and that many of today's and tomorrow's most exciting research opportunities – for example, in biomedicine – lie at the interface of computer science and other fields.

In Conclusion

We strongly urge that the University's request for the 2023-25 biennium and beyond continue the four-biennium growth plan for the Allen School that we presented to legislative leadership in Fall 2020 and that the legislature supported during the just-concluded 2021-23 biennial budget process: request an additional 100 annual Allen School degrees in each of the next three biennia, funded by adding $4M to our annual budget during each biennium, with a continued focus on ensuring that our undergraduate student body reflects the many dimensions of diversity in Washington State.

In addition, we strongly urge that the University seek to make permanent the $455K per year funding for staffing of our Startup program that was included in the 2022 supplemental budget as a one-year appropriation. The Startup program provides crucial support for Washington students with high potential whose academic backgrounds may not have fully equipped them for early success in an intensive STEM Bachelor's program.

We strongly urge that the University be data-driven in prioritizing enrollment growth. Where is the greatest student demand? Where is the greatest gap between demand and capacity? Where is the greatest workforce gap (the gap between annual jobs available and annual degrees granted)? Where is the greatest program attractiveness measured by yield (the percentage of admitted students who enroll – whether as freshmen, or as community college transfers, or as current UW students)? Where do investments in growth result in the hiring of world-class faculty and the growth of world-class programs that lift the entire University? Where is the greatest intellectual opportunity, and the opportunity for the greatest impact?

Washington state needs to grow many programs, particularly in computer and information science. The Allen School's growth plan is an essential component of this broader strategy. It is unconscionable that Washington residents with academic admission scores of 17 must be denied Direct Admission to the Allen School due to capacity constraints. We strongly urge that we be allowed to grow in order to right this wrong on the trajectory that we have outlined. The University of Washington's support for this growth will be received with tremendous enthusiasm by students, parents, legislative leaders, and the business community. It will be highly beneficial to the University. It will still leave us far below meeting the demand by well qualified Washington students – demand that will persist because of changes in the world around us.

Appendix B.3: Budget — Allen School Size

Allen School Scale Compared To UW's Independent Schools and Colleges

2021-22 Bachelors Degrees Awarded

Source: UW data warehouse https://bitools.uw.edu/#/views/15-DegreeSummary/15V-DegreeSummary?:iid=1	2021-22 Bachelors Degrees Awaded	Allen School % of College of Engineering total (incl. Allen School)
1 College of Arts & Sciences	4,832	
2 College of Engineering (without Allen School)	918	
3 Foster School of Business	662	
4 Paul G. Allen School of Computer Science & Engineering	544	37%
5 School of Public Health	472	
6 College of the Environment	353	
7 College of Education	259	
8 The Information School	248	
10 College of Built Environments	210	
9 School of Medicine	203	
11 School of Nursing	141	
12 School of Social Work	51	
13 Evans School of Public Policy & Governance		
14 School of Dentistry		
15 School of Law		
16 School of Pharmacy		
17 The Graduate School		

2021-22 Student Credit Hours

Source: UW data warehouse https://bitools.uw.edu/#/views/20-TrendsinStudentCreditHours/20T-TrendsInSCH?:iid=1	2021-22 Student Credit Hours	Allen School % of College of Engineering total (incl. Allen School)
1 College of Arts & Sciences	928,253	
2 School of Medicine	145,940	
3 College of Engineering (without Allen School)	134,991	
4 Foster School of Business	133,552	
5 College of the Environment	96,631	
6 Paul G. Allen School of Computer Science & Engineering	92,853	41%
7 School of Public Health	80,191	
8 College of Education	76,790	
9 The Information School	62,403	
10 College of Built Environments	57,929	
11 School of Nursing	29,663	
12 School of Pharmacy	27,433	
13 School of Law	27,416	
14 School of Dentistry	24,202	
15 School of Social Work	23,580	
16 The Graduate School	18,829	
17 Evans School of Public Policy & Governance	16,921	

FY 2022 Research Awards

Source: UW data warehouse https://bitools.uw.edu/#/views/30-ResearchAwardsDashboard/30-SummaryofResearchAwardCountsandAmounts?:iid=1	FY 2022 Research Awards	Allen School % of College of Engineering total (incl. Allen School)
1 School of Medicine	846,000,000	
2 School of Public Health	190,000,000	
3 College of the Environment	132,000,000	
4 College of Arts & Sciences	119,000,000	
5 College of Engineering (without Allen School)	93,000,000	
6 Paul G. Allen School of Computer Science & Engineering	56,000,000	38%
7 College of Education	22,000,000	
8 School of Pharmacy	15,000,000	
9 School of Nursing	15,000,000	
10 School of Social Work	14,000,000	
11 The Graduate School	14,000,000	
12 School of Dentistry	8,000,000	
13 The Information School	6,000,000	
14 Evans School of Public Policy & Governance	5,000,000	
15 College of Built Environments	2,000,000	
16 Foster School of Business		
17 School of Law		

"Be Boundless" Campaign Total, 7/1/2010 - 6/30/2020

Source: Karine Raetzloff 12/28/2020	"Be Boundless" Campaign Total, 7/1/2010 - 6/30/2020	Allen School % of College of Engineering total (incl. Allen School)
1 School of Medicine	2,516,218,043	
2 College of Arts & Sciences	590,542,554	
3 College of the Environment	413,421,215	
4 School of Public Health	362,114,561	
5 Paul G. Allen School of Computer Science & Engineering	270,147,895	54%
6 Foster School of Business	256,675,911	
7 College of Engineering (without Allen School)	226,310,438	
8 School of Law	127,296,938	
9 College of Education	102,782,419	
10 School of Social Work	75,845,276	
11 School of Pharmacy	74,330,355	
12 Evans School of Public Policy & Governance	50,453,543	
13 School of Nursing	49,322,866	
14 The Information School	48,088,603	
15 School of Dentistry	45,384,212	
16 College of Built Environments	44,093,128	
17 The Graduate School		

FY 2022 Fundraising To Date (as of 3/31/2022)

Source: April 2022 UW Foundation Board Book	FY 2022 Fundraising To Date (as of 3/31/22)	Allen School % of College of Engineering total (incl. Allen School)
1 School of Medicine	239,086,775	
2 College of Arts & Sciences	39,693,239	
3 College of the Environment	23,475,843	
4 Paul G. Allen School of Computer Science & Engineering	21,910,919	59%
5 School of Public Health	19,097,512	
6 College of Engineering (without Allen School)	15,258,613	
7 College of Education	14,150,159	
8 Foster School of Business	12,084,875	
9 College of Built Environments	6,609,294	
10 School of Social Work	3,550,672	
11 School of Pharmacy	3,348,882	
12 School of Nursing	3,001,017	
13 School of Law	2,545,156	
14 School of Dentistry	2,283,256	
15 The Information School	2,160,996	
16 Evans School of Public Policy & Governance	631,603	
17 The Graduate School		

Appendix C: Information about Faculty

Current Faculty (as of September 1, 2022)

Name	Rank	Other Affiliations	Link to webpage
Althoff, Tim	Assistant Professor	*Adjunct - iSchool*	http://www.timalthoff.com/
Anderson, Richard	Professor		https://www.cs.washington.edu/people/faculty/anderson/
Anderson, Ruth	Associate Teaching Professor		http://homes.cs.washington.edu/~rea
Anderson, Tom	Professor		http://www.cs.washington.edu/people/faculty/tom/
Balazinska, Magdalena	Professor		http://www.cs.washington.edu/people/faculty/magda/
Battle, Leilani	Assistant Professor		https://homes.cs.washington.edu/~leibatt/bio.html
Beame, Paul	Professor		http://www.cs.washington.edu/people/faculty/beame/
Bodik, Rastislav	Professor		https://homes.cs.washington.edu/~bodik
Boots, Byron	Associate Professor		https://www.cc.gatech.edu/~bboots3/
Bricker, Lauren	Associate Teaching Professor		https://homes.cs.washington.edu/~bricker/
Cakmak, Maya	Associate Professor	*Adjunct HCDE*	http://www.mayacakmak.com/
Ceze, Luis	Professor		https://homes.cs.washington.edu/~luisceze/
Choi, Yejin	Professor	*Adjunct - Linguistics*	http://homes.cs.washington.edu/~yejin/
Curless, Brian	Professor		http://www.cs.washington.edu/people/faculty/curless
Du, Simon	Assistant Professor		http://simonshaoleidu.com/
Ernst, Michael	Professor		http://www.cs.washington.edu/people/faculty/mernst/
Farhadi, Ali	Professor		http://www.cs.washington.edu/people/faculty/ali/
Fogarty, James	Professor	*Adjunct - iSchool*	http://www.cs.washington.edu/people/faculty/jfogarty/
Fox, Dieter	Professor		http://homes.cs.washington.edu/~fox
Froehlich, Jon	Associate Professor		https://jonfroehlich.github.io/
Garza, Elba	Assistant Teaching Professor		https://www.elbagarza.com/
Gollakota, Shyam	Professor	*Adjunct - ECE; Mechanical Engineering*	http://www.cs.washington.edu/people/faculty/gshyam/
Grossman, Dan	Professor		http://homes.cs.washington.edu/~djg/
Gupta, Abhishek	Assistant Professor		https://abhishekunique.github.io/

Hajishirzi, Hanna	Assistant Professor	*Adjunct - ECE*	https://homes.cs.washington.edu/~hannaneh/
Heer, Jeffrey	Professor		http://homes.cs.washington.edu/~jheer/
Heimerl, Kurtis	Assistant Professor		https://kurti.sh/
Hsia, Justin	Associate Teaching Professor		http://homes.cs.washington.edu/~jhsia/
Ichikawa, Scott	Associate Teaching Professor and Associate Director - MHCI+D Program		https://www.sumiostudio.com/
Iyer, Vikram	Assistant Professor		https://homes.cs.washington.edu/~vsiyer/
Jamieson, Kevin	Assistant Professor	*Adjunct - Statistics*	https://homes.cs.washington.edu/~jamieson/about.html
Just, Rene	Assistant Professor		https://homes.cs.washington.edu/~rjust/
Karlin, Anna	Professor		https://homes.cs.washington.edu/~karlin/
Kemelmacher-Shlizerman, Ira	Associate Professor		https://www.irakemelmacher.com/
Kohlbrennner, David	Assistant Professor		https://davidkohlbrenner.com/
Kohno, Tadayoshi	Professor	*Adjunct - ECE & iSchool*	http://homes.cs.washington.edu/~yoshi/
Krishna, Ranjay	Assistant Professor		https://ranjaykrishna.com/index.html
Krishnamurthy, Arvind	Professor		http://www.cs.washington.edu/people/faculty/arvind/
Lazowska, Ed	Professor		http://www.cs.washington.edu/people/faculty/lazowska/
Lee, James	Professor		http://www.cs.washington.edu/homes/jrl/
Lee, Su-In	Professor	*Adjunct - ECE; Biomedical Informatics; Genome Sciences*	http://suinlee.cs.washington.edu/
Lee, Yin-Tat	Assistant Professor	*Adjunct - ECE*	http://yintat.com/
Levy, Hank	Professor		http://www.cs.washington.edu/people/faculty/levy/
Lin, Kevin	Assistant Teaching Professor		https://kevinl.info/
Lin, Huijia (Rachel)	Associate Professor		https://homes.cs.washington.edu/~rachel/
Maas, Ryan	Assistant Teaching Professor		https://homes.cs.washington.edu/~maas/
Mahajan, Ratul	Associate Professor		https://ratul.org/
Mankoff, Jen	Professor	*Adjunct - HCDE & iSchool*	https://make4all.org/portfolio/jennifer-mankoff/

Mones, Barbara	Teaching Professor		https://homes.cs.washington.edu/~mones/index.html
Morgenstern, Jamie	Assistant Professor		http://jamiemorgenstern.com/
Mostafavi, Sara	Associate Professor		http://saramostafavi.github.io/
Nivala, Jeff	Research Assistant Professor		https://www.jeffnivala.com/
Oh, Sewoong	Associate Professor		https://homes.cs.washington.edu/~sewoong/
Oskin, Mark	Professor	*Adjunct - ECE*	http://www.cs.washington.edu/people/faculty/oskin/
Oveis Gharan, Shayan	Associate Professor		http://homes.cs.washington.edu/~shayan/
Patel, Shwetak	Professor		https://homes.cs.washington.edu/~shwetak/
Perkins, Hal	Associate Teaching Professor	*Joint with ECE; CSE 100%*	http://www.cs.washington.edu/people/faculty/perkins/
Peter, Simon	Assistant Professor		https://homes.cs.washington.edu/~simpeter/
Popović, Zoran	Professor		https://homes.cs.washington.edu/~zoran/
Rao, Anup	Associate Professor		https://www.cs.washington.edu/people/faculty/anuprao/
Rao, Rajesh	Professor	*Adjunct - ECE & Bioengineering*	https://www.rajeshpnrao.com/
Reges, Stuart	Teaching Professor		http://www.cs.washington.edu/people/faculty/reges/
Reinecke, Katharina	Associate Professor	*Adjunct - HCDE*	http://www.cs.washington.edu/people/faculty/reinecke
Roesner, Franziska	Associate Professor	*Adjunct - ECE; HCDE; iSchool*	https://www.franziroesner.com/
Rothvoss, Thomas	Associate Professor	*Joint Math*	http://www.cs.washington.edu/people/faculty/rothvoss
Ruzzo, Walter (Larry)	Professor	*Adjunct - Genome Science*	http://www.cs.washington.edu/people/faculty/ruzzo/
Schafer, Hunter	Assistant Teaching Professor		https://homes.cs.washington.edu/~hschafer/
Schmidt, Ludwig	Assistant Professor		https://people.csail.mit.edu/ludwigs/
Schulz, Adriana	Assistant Professor		https://homes.cs.washington.edu/~adriana/
Seelig, Georg	Professor	*Joint ECE & Adjunct Bioengineering*	http://www.seeliglab.org/
Seitz, Steven	Professor		http://homes.cs.washington.edu/~seitz/
Shapiro, Linda	Professor	*Joint ECE; Adjunct Biomed Informatics*	http://homes.cs.washington.edu/~shapiro/
Smith, Joshua	Professor	*Joint ECE*	https://www.cs.washington.edu/people/faculty/jrs/
Smith, Noah	Professor	*Adjunct Linguistics*	https://homes.cs.washington.edu/~nasmith

Srinivasa, Siddhartha (Sidd)	Professor		https://homes.cs.washington.edu/~siddh/
Suciu, Dan	Professor		http://www.cs.washington.edu/people/faculty/suciu/
Tanimoto, Steven	Professor	*Adjunct ECE*	http://www.cs.washington.edu/people/faculty/tanimoto/
Tatlock, Zachary	Associate Professor		https://ztatlock.net/
Taylor, Michael	Associate Professor	*Joint ECE*	http://darksilicon.net/
Tessaro, Stefano	Associate Professor		http://homes.cs.washington.edu/~tessaro/
Thachuk, Chris	Assistant Professor		https://thachuk.com/
Torlak, Emina	Associate Professor		http://homes.cs.washington.edu/~emina/
Tsvetkov, Yulia	Assistant Professor		https://homes.cs.washington.edu/~yuliats/
Wang, Sheng	Assistant Professor		https://homes.cs.washington.edu/~swang/
Wang, Xi	Associate Professor		https://www.cs.washington.edu/people/faculty/xi
Weber, Robbie	Assistant Teaching Professor		http://weberrobbie.com/
Wilcox, James	Assistant Teaching Professor		http://jamesrwilcox.com/
Wortzman, Brett	Assistant Teaching Professor		https://homes.cs.washington.edu/~brettwo/
Zettlemoyer, Luke	Professor	*Adjunct linguistics*	http://www.cs.washington.edu/people/faculty/lsz/
Zhang, Amy	Assistant Professor		https://homes.cs.washington.edu/~axz/

Recent Tenure Track Faculty Hires (last 5 years, from 2017-18 through 2021-22)

The "Hire Date" is the date when faculty candidates received and signed their offer letters, typically at the end of Spring of the indicated year. Many then chose to defer their start date by 6 to 12 months, occasionally longer.

Name	Hire Date	Level	PhD Research Area		Prior Position or Postdoc	Joint Dept
Gilbert Bernstein	2022	Assistant	Stanford	Graphics+PLSE	Postdoc - UC Berkeley	
Andrea Wei Coladangelo	2022	Assistant	Cal Tech	Quantum	Postdoc - Simons Institute (Berkely)	
Matthew Golub	2022	Assistant	CMU	Neuroscience	Postdoc - Stanford	

Name	Hire Date	Level	PhD Research Area		Prior Position or Postdoc	Joint Dept
Natasha Jaques	2022	Assistant	MIT	AI+Robotics	Research Scientist - Google; Postdoc-UC Berkeley	
Baris Kasikci	2022	Associate	EPFL	Arch, Systems, Networking	Asst. Prof - U Michigan	
Pang Wei Koh	2022	Assistant	Stanford	Machine Learning	Research Scientist - Google	
R. Ben Shapiro	2022	Associate	Northwestern	CS Education	Asst. Prof - U Colorado Boulder; Apple Learning Sciences, Lead	
Leilani Battle	2021	Assistant	MIT	Data management, Data Science, HCI, data visualization	Asst. Prof.- U Maryland	
Abhishek Gupta	2021	Assistant	UC Berkeley	Robotics, Machine Learning	Postdoc - MIT	
Vikram Iyer	2021	Assistant	UW-ECE	Wireless sensors, microbots, bio-hybrid systems		
Ranjay Krishna	2021	Assistant	Stanford	Computer Vision, HCI	Research Scientist - Facebook AI	
Simon Peter	2021	Assistant	ETH Zurich	Systems	Asst. Prof.-UT Austin	
Sara Mostafavi	2020	Associate	U Toronto	Computational Biology, Statistics, Machine learning	Asst. Prof.-UBC	Adjunct-Genome Sciences; eScience Fellow
Simon Du	2020	Assistant	CMU	Theoretical Machine Learning	Postdoc - IAS Princeton	
David Kohlbrenner	2020	Assistant	UC San Diego	Security, Privacy, Systems, Architecture	Postdoc- UC Berkeley	
Ludwig Schmidt	2020	Assistant	MIT	Machine Learning	Postdoc - UC Berkeley TRI - Visiting Scientist	
Chris Thachuk	2020	Assistant	UBC	Molecular programming	Sr. Postdoc - CalTech	
Yulia Tsvetkov	2020	Assistant	CMU	NLP	Asst. Prof.-CMU	
Sheng Wang	2020	Assistant	UIUC	ML/NLP, Computational biology	Postdoc - Stanford	
Byron Boots	2019	Associate	CMU	Machine learning, AI, robotics	Asst. Prof.- Georgia Tech	

Name	Hire Date	Level	PhD Research Area		Prior Position or Postdoc	Joint Dept
Jamie Morgenstern	2019	Assistant	CMU	Machine learning, game theory	Asst. Prof.- Georgia Tech	
Alex Ratner	2019	Assistant	Stanford	Data Science, DB, ML		
Amy Zhang	2019	Assistant	MIT	HCI, social computing	Postdoc - Stanford	
Huijia (Rachel) Lin	2018	Associate	Cornell	Security, Cryptography	Asst. Prof. - UCSB	
Sewoong Oh	2018	Associate	Stanford	Machine Learning	Asst. Prof. - UIUC	
Stefano Tessaro	2018	Associate	ETH Zurich	Security, Cryptography	Asst. Prof. - UCSB	
Tim Althoff	2018	Assistant	Stanford	Data science, NLP, HCI		Adjunct - Information School
Hanna Hajishirzi	2018	Assistant	UIUC	NLP, Machine Learning, AI	Research Asst. Prof - UW-ECE	Adjunct - ECE
Rene Just	2018	Assistant	University of Ulm	Data Science, Software Engineering, Security	Asst.Prof. - UMass Amherst	
Adriana Schulz	2018	Assistant	MIT	Computational design, computer graphics		

Recent Teaching Track Faculty Hires (last 5 years, from 2017-18 through 2021-22)

Name	Hire Date	Level	PhD/ Research Area		Prior Position
Scott Ichikawa	2022	Associate & Assoc. Director MHCI+D	UW (Masters)	Design	UW- UX Design Director & Lecturer
Elba Garza	2022	Assistant	Texas A&M	Computer Architecture	
James Wilcox	2022	Assistant	UW-CSE	Programming languages	Allen School - Temporary Lecturer
Ryan Maas	2020	Assistant	UW-CSE (Masters)	Database Systems	Allen School - Lecturer
Robbie Weber	2020	Assistant	UW-CSE	Theory	
Kevin Lin	2019	Assistant	UC Berkeley (Masters)	CS Ed	
Hunter Schafer	2018	Assistant	UW-CSE		

			(Masters)		
Brett Wortzman	2018	Assistant	UW (Masters)	Education	Allen School - Lecturer

Recent Research Track Faculty Hires

Name	Hire Date	Level	PhD Research Area		Prior Position or Postdoc
Jeff Nivala	2021	Assistant	UC Santa Cruz	Biomolecular Eng.	Research Scientist - UW Allen School

Recent Faculty Departures (last 5 years)

Over that last five years, we had a number of losses as well – most at the senior level. Five tenure-track faculty members retired: Dan Weld, Pedro Domingos, Oren Etzioni, Martin Tompa, and John Zahorjan. Seven tenure-track faculty members relocated to another department, academic institution, or start-up: Emily Fox (Stanford), Carlos Guestrin (Stanford), Sham Kakade (Harvard), Alvin Cheung (UC Berkeley), Emo Todorov (startup), Matt Reynolds (moved from being joint with to being 100% in the Dept. of Electrical & Computer Engineering, retaining an adjunct position in the Allen School), and most recently Alex Ratner (to his own, very successful, start-up). Three teaching-track faculty members also left the school either to retire (Bruce Hemingway) or to pursue other opportunities (Zorah Fung and Adam Blank). Yuliang Wang, research track faculty member, left to pursue other opportunities.

Appendix D: Diversity Plan

We provide a brief overview of our Strategic Plan for DEIA here and refer the reader to the full document for details: 5-Year Strategic Plan for DEIA.

We also refer readers to our DEIA web pages for additional information including school demographics, student groups, etc.

Our DEIA strategic plan is focused on improving the Allen School along three key dimensions:

1. The diversity of our community and each cross section;
2. The quality and equity of one's experience at the Allen School
3. The capacity of our community to produce technology that is just, equitable, and socially aware

To accomplish the above, the Allen School is utilizing six imperatives. Each imperative is a vehicle for change, and together, these imperatives enable us to achieve our objectives. Each imperative is further defined by a set of goals. The six imperatives are:

1. **Curricula and Programs.** This imperative has three elements: the first is to significantly revamp our introductory course sequence (currently CSE142/143) in order to make it more accessible and engaging to students with a range of interests and prior preparation, the second is to deploy a variety of academic supports reaching students at a number of different levels, and the third is to add education on DEIA, justice, and the societal implications of technology in a range of new and existing courses.
2. **Professional Development.** The first goal for this imperative is to increase awareness in all members of our community of the importance of DEIA and current mechanisms for addressing it within the Allen School, in the field of computing, and in the technology that we produce. The second goal is to raise awareness and adoption of best practices for inclusive teaching and presentations.
3. **Policies and Procedures.** This imperative aims to ensure that equitable, inclusive, and consistently used policies and procedures are in place for school-wide hiring, evaluation and promotion, admission, and allocation of resources and opportunities. In addition, it aims to improve procedures for reporting and responding to incidents that violate DEIA principles.
4. **Internal Community Engagement & Support.** This imperative engages members of the Allen School in DEIA activities, including increased access to

peer groups with a focus on better supporting diverse students/postdocs in the Allen School, mentorship programs for faculty, staff, and graduate students/postdocs, and mechanisms for participation in community celebrations and other DEIA events and activities.

5. **Outreach.** This imperative builds effective pipelines for entering the Allen School as undergraduate, B.S./M.S., and Ph.D. students, faculty, and staff with a focus on increasing diversity. It also includes efforts to expand professional development opportunities for teachers in Washington who seek to bring computer science to K-12 schools across the state, and to strengthen the Allen School's participation in and contributions to national consortia and alliances that work to improve DEIA in undergraduate and graduate programs.
6. **Budget Management.** This imperative aims to ensure a sufficient, persistent, and effectively managed budget that allows us to achieve our DEIA strategic goals.

Each imperative is further defined by a set of goals, which are listed in the strategic plan. Each goal for an imperative is associated with a set of tactics or concrete activities that will be undertaken to achieve that goal (and in many cases have already been undertaken), and a set of objective measurements that will enable us to assess our progress. Overall accountability is ensured by the Allen School's Associate Director for DEIA and Director for DEIA Strategy and Operations (currently Professor Yoshi Kohno and Dr. Jan Cuny, respectively). They oversee supervisors for each goal, who in turn ensure that the goals are being effectively implemented with appropriate measurements. Although numerous people may work on any individual tactic, for accountability, each tactic has an identified lead or co-lead, who report to the goal supervisor. The names of everyone involved are listed in an internal document. The document posted on our website omits those columns.

Appendix E.1: Career Outcomes

One of several important ways to understand educational outcomes is to consider the career outcomes of graduates – the job or next educational experience they pursued after graduation. We summarize in this section the data we have in this space. Our data-collection methods continue to improve and evolve – while our data is incomplete (e.g., we have information for almost 90% of 2021-2022 bachelor's graduates while still trying to collect more), we have more complete data than central-UW efforts because we work hard to collect it. The approximate numbers below are balancing between the most recent numbers (2021-2022 graduates) and the fact that the pandemic may make the most recent numbers less indicative of normalcy.

Here are the high-level takeaways:

For our bachelor's graduates:

- Roughly 10% continue in our integrated B.S./M.S. program, 4% pursue other graduate programs (both master's and Ph.D., maybe half of each depending on the year), 85% take software engineering positions in industry, and the last 1-2% pursue other paths. Since most of the BS/MS students also join industry after completing their master's, the effective number "going to industry" is even higher than the 85% figure suggests.

  Increasing the number of students going on to Ph.D. programs is an important goal going forward — the students pursuing Ph.D. programs do very well; we just want more of them. We have recently taken steps in this direction by creating a new program for undergraduate research led by two faculty co-chairs. We should start to see its impact in the upcoming years.
- A very high percentage of our graduates going to industry stay in the state of Washington — this has been as high as 85-90% in the recent past with the most recent year somewhat lower probably due to the pandemic but still around 75%.
- A high percentage of our graduates going to industry join large companies with a substantial Seattle presence, in particular Amazon, Google, Meta, and Microsoft. This percentage changes by the year, but is often around 40% for just these four companies and can be even higher. These are great companies where our graduates can learn, grow, and thrive and they often then head to other companies over time, but the percentage is still very high.
- Conversely, there is a very "long tail" where our industry-bound graduates report first-employment at over 100 distinct companies in a given year.

- Roughly 90% of our graduates, probably more but we do not have complete data to be sure, have taken a full-time position in industry or a graduate program within a couple months of graduating.
- For Ph.D. and postdoc career outcomes, see Appendix E.7.

In addition to our own data, which we collect via graduation surveys and follow-up emails and store in spreadsheets, https://careers.uw.edu/outcomes/ provides an elegant interface for the entire campus. The data on this site is currently a couple of years old and for other programs is often based on a low response rate. The UW Career Center, which maintains this site, has, in the past, taken data we have provided them in order to improve the accuracy for the Allen School.

Appendix E.2: Student Surveys and Feedback

We regularly survey our students about their overall Allen School experience as a complement to student evaluations for individual course offerings. Allen School leadership and our student services teams read and act on the results. We also provide the results internally (so not public URLs, but available to anyone with a CSE account) out of transparency.

The reports are too long to include in the self-study or even to try to summarize, but we can make copies available for the review committee. At the very highest level, the vast majority of our students report a positive Allen School experience and a sense of belonging in our field, but we still have work to do to eliminate a gap in which minoritized groups (women, racial minorities) feel less belonging. Our faculty, but even more so our student-services teams (academic advisors and more), get high marks for their contributions to the student experience.

We have the following surveys:

1. Each year we participate in the CERP Data Buddies project. The Data Buddies surveys are designed to assess experiences of students engaged in the computing community. This substantial survey of our undergraduate majors and graduate students covers a wide range of topics related to belonging, interactions with faculty, TAs, and fellow students, and much more, including breakdowns by gender and racial-minority status, comparison to peer departments at other institutions, and statistical analysis. One limitation is that for graduate students, it combines the Ph.D. students and the Masters students in the integrated BSMS program even though these are largely distinct communities.
2. In 2019, we worked with UW's Center for Evaluation & Research for STEM Equity (CERSE) on a large-scale student experience survey of all our majors and graduate students as well as students in our introductory courses. The survey captured information on students' academic experience, sense of inclusion, perceptions of the Allen School, career preparedness, and research environment. Open-ended items captured qualitative responses. We intend to do another survey in 2023. Faculty leadership worked with CERSE to refine demographic questions including aspects specific to the Allen School (e.g., admissions pathway) as well as questions about the student experience. CERSE analyzed the data and prepared a comprehensive report, including a 50-page summary and a complete set of statistics and free-form comments (the full report is over 400 pages). A CERSE set of slides is also available.

   Allen School Student Experience Survey Results (2019) and presentation slides
3. Our Ph.D.-student leadership conducts their own surveys in most years (the pandemic slowed them down recently).

    a. A “Graduate Student Happiness” survey was conducted annually 2014-2020 and will likely happen again. Questions have sometimes been tailored to the issues of the day and allow for free form responses like, “I wish the Allen School offered more ___.” Students summarize and present anonymized responses on a range of topics related to advising, courses, funding, career preparation, happiness, department culture, and more.
    b. Every few years Allen School Ph.D. students conduct a survey about housing in Seattle. This is meant to help guide new grads in finding housing as well as inform the school about average rents and other issues related to housing. Results are posted to the Allen School Graduate Student Housing Webpage.

4. We used to conduct more thorough graduation surveys of undergraduates, but between “survey fatigue” (the surveys above), the pandemic, and focusing on getting career data from them, it has been a few years since we have done this and the program has expanded significantly since then. One particular reason to bring back this survey is it used to have questions about courses and the curriculum that are often best answered around the time students graduate (i.e., asking about sophomore-level courses a couple of years later).

5. Ph.D. advisor changes used to be handled very informally via an email to the director of graduate-student services. In 2019 we moved to a slightly-more-formal Google Form that included optional qualitative questions regarding the reason for the switch. The hope was that the questions, developed in collaboration with PhD-student leadership, would help us learn about where advising issues occurred. A 2019-2020 report analyzed responses and is available. However, response rate for the qualitative questions was low and did not identify problems, so we retired these questions as a worthy experiment that did not need to continue.

   Report to make available

Appendix E.3: Student Course Evaluations

All of our courses conduct student course evaluations at the end of the term, using the standard UW forms and infrastructure. The Vice Director reviews the numeric results quarterly; free-form comments go only to the instructor who can choose whether to share them. While the forms can differ for different courses (one for large lectures, one for seminars, etc.), a representative example is included below. We can make available any student course evaluations the review committee wishes to see.

Student course evaluations, what they do or do not measure, and how biased they are in various dimensions is a complex topic. Given our enormous heterogeneity in terms of course sizes, course topics, teaching approaches, etc., we do not consider it valid to compare "evaluation numbers" across different courses nor do we think small differences in aggregate statistics are meaningful, nor do we think students are necessarily accurate in measuring instructional effectiveness and how much they learned.

However, we *do* think that student course evaluations carry some important signal in whether courses are interesting, well organized, offered fairly, and motivating to students who seek a rigorous, challenging, and well-structured education. We expect faculty to consider student feedback and to improve over time. "Lower numbers" can indicate a problem that mentoring can help address and/or worthy experiments that need adaptation. Student evaluations are one of several sources of data we consider regarding educational excellence — see also the other appendices.

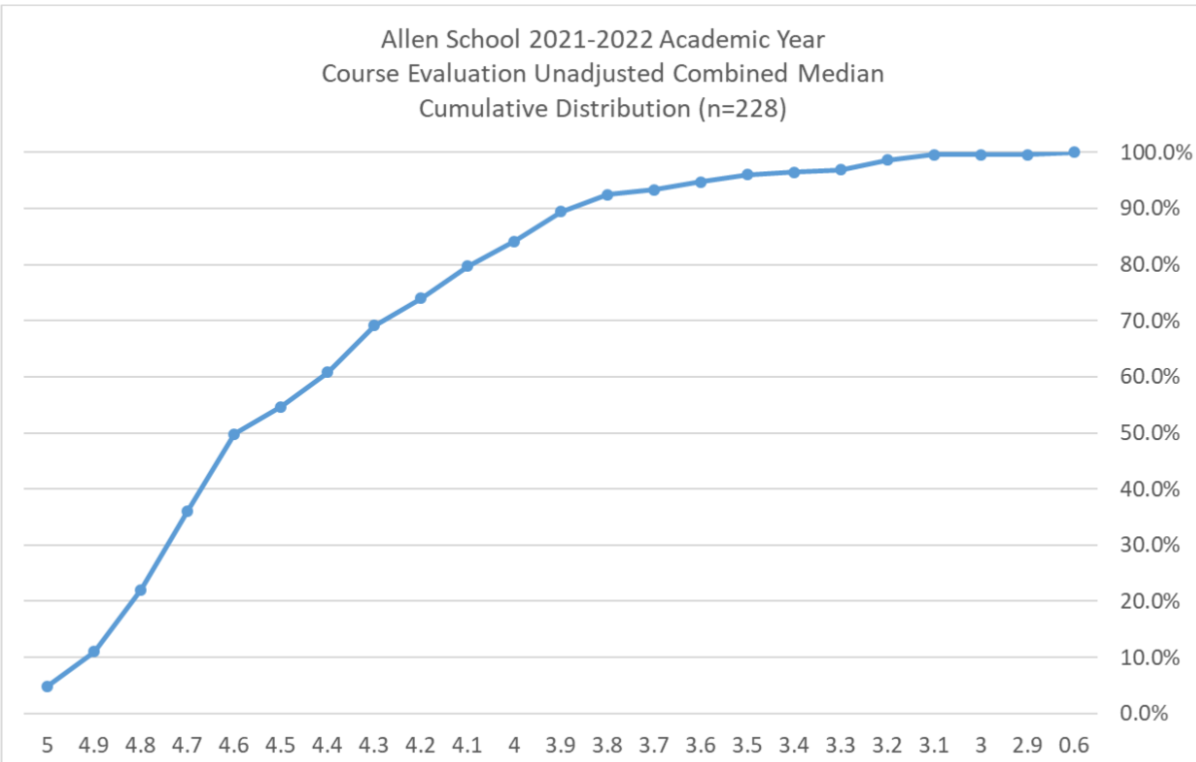
With that context, it is not clear how to summarize over 200 course evaluations each year, which fundamentally amounts to taking averages of averages of averages. **Yet the vast majority of our student evaluations are *extremely high*.** To get this down to a couple charts, we have taken this approach:

1. We started with academic year 2021-2022 course evaluations, removing some very small seminars (but still including graduate special-topics courses) and removing cross-listed courses taught by faculty in other departments. In the end, we had 228 data points.
2. The UW system already takes the four "summative items" and computes a *combined median*.[8] These four items are:
   - "The course as a whole was:"
   - "The course content was:"

[8] Median is a slight misnomer. As described in detail here, it is the method used most commonly for calculating the median of grouped data and is not the "ordinal" median.

- "The instructor's contribution to the course was:"
- "The instructor's effectiveness in teaching the subject matter was:"

3. While the UW system presents an "unadjusted" median and an "adjusted" median, with the latter taking into account course size and perceived course difficulty, we use only unadjusted numbers here since we are already aggregating across all our courses without trying to compare some courses with others.
4. This unadjusted median is from 0 (Very Poor) to 5 (Excellent) where 4 is "Very Good" and 3 is "Good." It is reported to one decimal place.
5. We graph a cumulative distribution function with 5 on the left and 0 on the right. So, for example, this shows that 36% of our courses received a combined unadjusted median of 4.7 or higher. (Notice we omit 0.7-2.8 from the x-axis; there are no courses in this range.)



Consistent with the graph above:

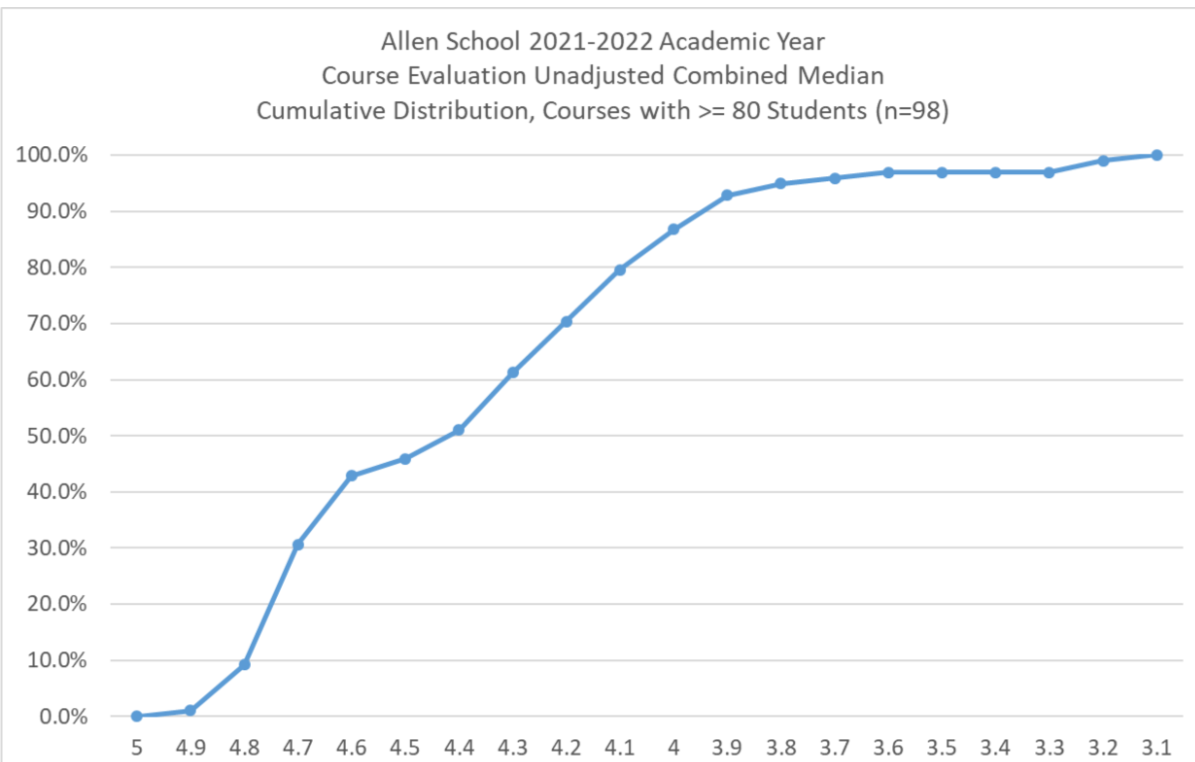
- Over half of our course offerings had a combined median of 4.5 or higher.
- Only 6% of our course offerings had a combined median of 3.5 or lower.
- Only 4 of the 228 courses in this data set had a combined median of 3.1 or lower.

Qualitatively, even of the "bottom" dozen or so course offerings by this measure, only two were known problems where a new instructor (in both cases a one-time instructor rather than a permanent faculty member) had significant problems with course execution.

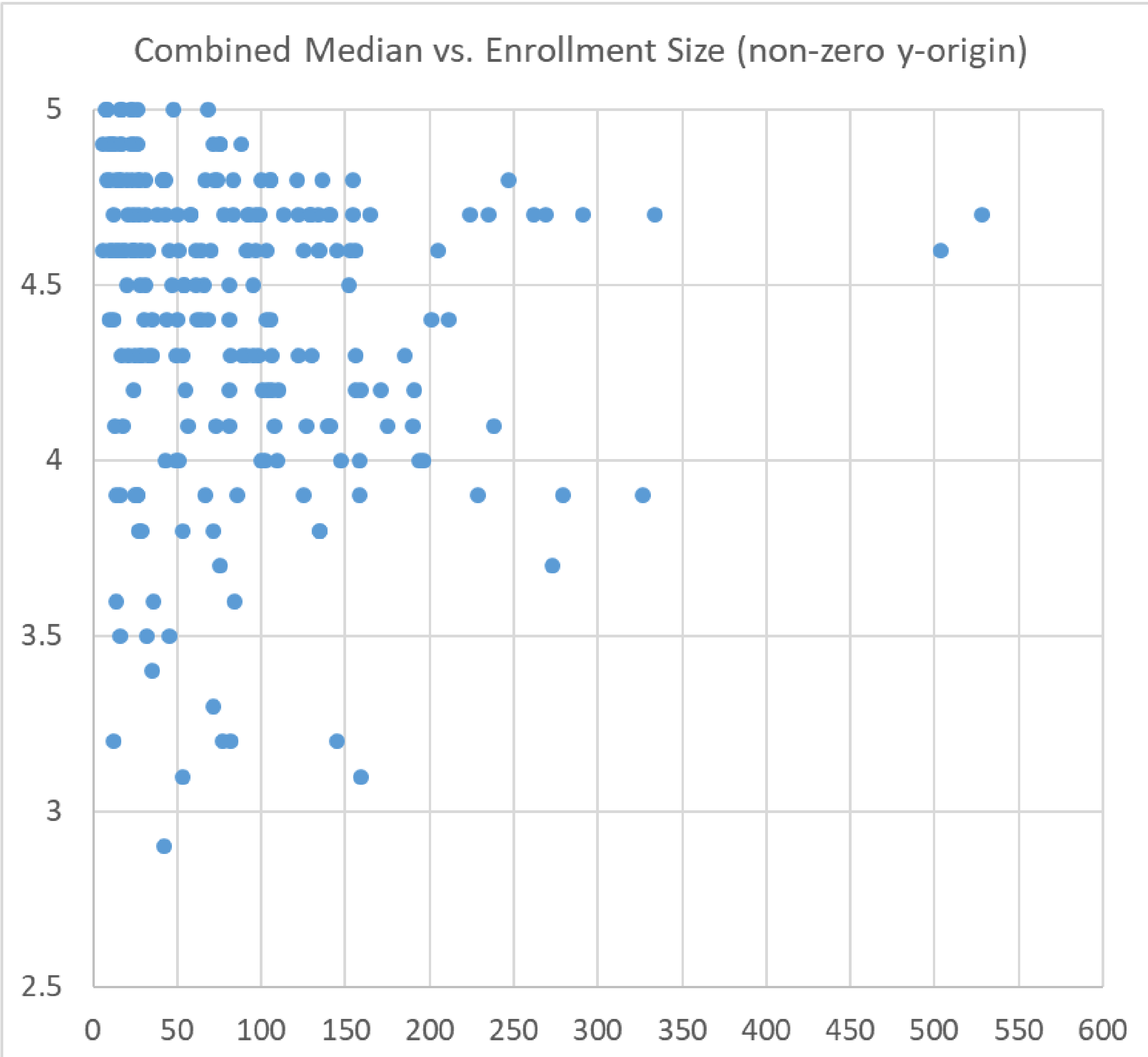
It is also worth noting that the non-faculty instructors are not a particular problem outside of these isolated examples. Overall, 43 of the 228 evaluations are for non-faculty instructors, though many have taught for us for several years. Thirty-three of the 43 have combined medians of 4.0 or higher and 10 of the 43 have combined medians of 4.8 or higher.

It is also the case that “very high evaluations” are not limited to a small subset of our instructors. The 228 courses were taught by 101 distinct individuals and 50 of them, *just* under half, had at least one course with a combined median of 4.7 or higher.

A final question we consider in this rough analysis is whether student evaluations are lower for larger courses. We can set an arbitrary threshold of 80 students for “large class” and consider just the subset of large courses. There are 98 such course offerings and the cumulative distribution function for these courses does show that while only one of them had a median of 4.9 or 5.0 (a ridiculously high threshold for a large course), many still had very high medians — 51% at 4.4 or above and 87% at 4.0 or above.



We can also present a scatter plot of combined median versus enrollment size to “eyeball” little correlation with class size. (For clarity, we omit a single combined median below 2.5; its class size was 58.)


Combined Median vs. Enrollment Size (non-zero y-origin)
5
4.5
4
3.5
3
2.5
0
50
100
150
200
250
300
350
400
450
500
550
600

Appendix E.3.1: Example Course Evaluation

IASystem
The Course Evaluation Standard

COURSE SUMMARY REPORT
Numeric Responses

University of Washington, Seattle
College of Engineering
Computer Science & Engineering
Term: Winter 2022 (COVID)

CSE 341 A
Programming Languages
Course type: Face-to-Face

Evaluation Delivery: Online
Evaluation Form: A88
Responses: 27/67 (40% moderate)

Taught by: Dan Grossman
Instructor Evaluated: Dan Grossman-Professor

Overall Summative Rating represents the combined responses of students to the four global summative items and is presented to provide an overall index of the class's quality:

Combined Median	Adjusted Combined Median
4.8	5.0

(0=lowest; 5=highest)

Challenge and Engagement Index (CEI) combines student responses to several *IASystem* items relating to how academically challenging students found the course to be and how engaged they were:

CEI: 4.9
(1=lowest; 7=highest)

SUMMATIVE ITEMS

	N	Excellent (5)	Very Good (4)	Good (3)	Fair (2)	Poor (1)	Very Poor (0)	Median	Adjusted Median
The course as a whole was:	26	58%	19%	12%		8%	4%	4.6	5.0
The course content was:	26	58%	15%	15%	4%	4%	4%	4.6	4.9
The instructor's contribution to the course was:	26	81%	4%	12%	4%			4.9	5.2
The instructor's effectiveness in teaching the subject matter was:	26	73%	12%	4%	12%			4.8	5.1

STUDENT ENGAGEMENT

Relative to other college courses you have taken:	N	Much Higher (7)	(6)	(5)	Average (4)	(3)	(2)	Much Lower (1)	Median
Do you expect your grade in this course to be:	26	8%	8%	15%	42%	15%	8%	4%	4.0
The intellectual challenge presented was:	26	23%	12%	50%	15%				5.2
The amount of effort you put into this course was:	26	23%	19%	27%	19%	12%			5.2
The amount of effort to succeed in this course was:	26	23%	27%	27%	23%				5.5
Your involvement in course (doing assignments, attending classes, etc.) was:	26	15%	27%	31%	19%	4%	4%		5.2

On average, how many hours per week have you spent on this course, including attending classes, doing readings, reviewing notes, writing papers and any other course related work?

Class median: 11.2 Hours per credit: 2.8 (N=24)

Under 2	2-3	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22 or more
		8%	8%	8%	29%	17%	12%	4%		12%	

From the total average hours above, how many do you consider were valuable in advancing your education?

Class median: 9.2 Hours per credit: 2.3 (N=23)

Under 2	2-3	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22 or more
4%	4%	9%	17%	17%	30%	13%				4%	

What grade do you expect in this course?

Class median: 3.5 (N=22)

A (3.9-4.0)	A- (3.5-3.8)	B+ (3.2-3.4)	B (2.9-3.1)	B- (2.5-2.8)	C+ (2.2-2.4)	C (1.9-2.1)	C- (1.5-1.8)	D+ (1.2-1.4)	D (0.9-1.1)	D- (0.7-0.8)	F (0.0)	Pass	Credit	No Credit
18%	32%	27%	5%		9%			5%					5%	

In regard to your academic program, is this course best described as:

(N=25)

In your major	A core/distribution requirement	An elective	In your minor	A program requirement	Other
76%		16%		4%	4%

STANDARD FORMATIVE ITEMS

	N	Strongly Agree (5)	Agree (4)	No Opinion (3)	Disagree (2)	Strongly Disagree (1)	Median	Relative Rank
Overall, I am comfortable with the climate in this course. (Climate is defined as attitudes, behaviors, and standards of staff and students concerning the access for, inclusion of, and level of respect for individual and group needs, abilities, and potential.)	26	73%	19%	8%			4.8	
I feel valued and respected by the instructor(s) in this course.	26	73%	15%	12%			4.8	
I feel valued and respected by the TA(s) in this course.	26	58%	23%	15%	4%		4.6	
I feel valued and respected by other students in this course.	26	65%	23%	12%			4.7	
Students help each other succeed in this course (to the extent permitted by academic integrity policy).	26	46%	35%	12%	8%		4.4	

	N	Excellent (5)	Very Good (4)	Good (3)	Fair (2)	Poor (1)	Very Poor (0)	Median	Relative Rank
Course organization was:	26	50%	27%	15%	8%			4.5	14
Clarity of instructor's voice was:	26	81%	15%	4%				4.9	7
Explanations by instructor were:	26	65%	15%	15%	4%			4.7	5
Instructor's ability to present alternative explanations when needed was:	26	69%	4%	19%	8%			4.8	4
Instructor's use of examples and illustrations was:	26	69%	4%	23%	4%			4.8	3
Quality of questions or problems raised by the instructor was:	26	69%	12%	12%	8%			4.8	1
Student confidence in instructor's knowledge was:	26	88%		8%		4%		4.9	2
Instructor's enthusiasm was:	26	85%	4%	8%	4%			4.9	6
Encouragement given students to express themselves was:	26	69%	12%	19%				4.8	12
Answers to student questions were:	26	69%	12%	15%	4%			4.8	8
Availability of extra help when needed was:	26	54%	15%	19%	8%		4%	4.6	16
Use of class time was:	26	58%	19%	15%	8%			4.6	9
Instructor's interest in whether students learned was:	26	65%	12%	15%		8%		4.7	13
Amount you learned in the course was:	26	54%	31%	4%	4%	4%	4%	4.6	11
Relevance and usefulness of course content were:	26	58%	15%	12%	4%	4%	8%	4.6	15
Evaluative and grading techniques (tests, papers, projects, etc.) were:	26	42%	35%	8%	12%	4%		4.3	18
Reasonableness of assigned work was:	26	46%	23%	19%		8%	4%	4.3	17
Clarity of student responsibilities and requirements was:	26	62%	23%	8%	4%	4%		4.7	10

CSE 341 A
Programming Languages
Course type: Face-to-Face

Evaluation Delivery: Online
Evaluation Form: A88
Responses: 27/67 (40% moderate)

Taught by: Dan Grossman
Instructor Evaluated: Dan Grossman-Professor

STANDARD OPEN-ENDED QUESTIONS

Please use this space to provide details explaining your answers to the five agreement questions about course climate above.

1. Professor Grossman was incredibly detailed and willing to answer all questions. He’s a great lecturer and made sure to accommodate any and all requests students had

2. Don't have much to say about the climate of the course. Dan seemed welcoming to students' questions, and I do not think that anybody felt unwelcome in the classroom.

3. I truly appreciate how flexible the instructor/staff were in accommodating remote options. While I tried to attend as many lectures/quiz sections as I could, having the remote option was extremely beneficial.

5. Always felt included and never felt like I was left out. I do wish there was more activity among students.

6. The coarse climate was great, the TAs and instructor were incredibly friendly and helpful, however the other students were very reserved and if I did not have a friend I was taking this course with I would have not talked to anyone in the class.

7. The instructor was awesome, he is super smart and loves this topic. I simply had a hard time absorbing it and there were no external resources to help me supplement the course when I needed it explained from different angles. There was just something about it that was really hard for me to learn. It didn't help that the documentations for the languages were far less than the languages I have learned in the past. I don't regret taking the class, I just wish I took it later on when I had a better foundation for the material.

9. Some of the TAs obviously didn't want to be there and acted as if I was bothering them when I came to office hours to get help on assignments. Honestly, that one interaction with the TA is probably the reason that I stopped attending and felt really demotivated.

18. Course climate in lecture was excellent. There was very low attendance in lecture and Dan seemed a little frustrated by that, but I found the jokes much funnier in person. There was zero wasted time + I always felt comfortable asking questions if I was confused.

Was this class intellectually stimulating? Did it stretch your thinking? Why or why not?

1. It was, it opened me to a part of CS I had no idea existed in dynamic vs static and I now can better weigh which languages to use in each situation

2. This class was intellectually stimulating. I felt that the concepts introduced me to ideas that I had not considered before and provided me with new and useful insight into programming languages.

4. It really was. I did not expect this class to change my perspective as much as it did. I came in thinking I would just get better at picking up new programming languages. However, the in-depth comparisons of dynamic/statically typed languages, function vs objected oriented programming, and how everything is framed was perspective shifting. I genuinely feel like a much more well-rounded and solidly founded software engineer than before I took this class, something I cannot state as confidently about all CSE courses I have taken.

5. Yes. This course really got me thinking into how languages work.

6. Yes this class did stretch my thinking a lot, it showed me new way to view programming that is very different than how I previously did. I believe this made me a better programmer because I understand more fundamentally how programming languages function.

7. Everything was very interesting and the topics were very useful. It stretched my thinking about how languages work and why they are implemented the way that they are.

8. This class helped give context and form to the art of programming languages that we easily take for granted. I think I definitely came out of it with a much greater appreciation and a deeper understanding that not only makes me a better programmer practically, but makes me more excited and interested about programming languages and how we use them to make those practical applications.

9. Yes, the concepts are definitely new and very different from what I've done before.

11. This class was definitely insightful into looking at the design and features of programming languages, something I had previously not thought about

12. Yes! It helped me make connections to topics in other classes and understand them more concretely.

13. This class was a looooot harder than I expected it to be, but I learned so much! I think it's just challenging concepts that I've never had to dig down deep and explore. It has made me a better programmer and I've learned a ton, even if it's not reflected in my grade.

14. Yes the course material was really different compared to other programming courses I had taken before and it was intellectually stimulating since I had to practice these new ways of programming

15. I think this class's content is definitely useful for learning programming languages, but I also think too much of this class was spent on learning specific languages for the sake of homework instead of learning abstract, broad concepts of programming languages.

17. - excellent course content

18. I really enjoyed this class! I wasn't sure what to expect going in, but the content was very valuable and cemented a lot of concepts that I had floating around from 331 and 333.

What aspects of this class contributed most to your learning?

1. The homeworks were very practical and helpful and aligned well with the lectures

2. The Lectures were phenomenal at providing a general overview of concepts with examples. Dan speaks clearly and concisely about what he is presenting, and always has useful concrete examples to back himself up. The readings were well-written and were a good way to prepare for Lecture or review. The homework always had direct connections to concepts discussed in lecture, and the challenge problems were a good way to further explore those topics. Overall, the components of this course were well-organized and complemented each other in a way that made it difficult not to learn at least a bit.

3. The readings - they were incredibly helpful and were sometimes more valuable then lecture itself. I know I probably read like 90% of the reading notes and believe that future students would benefit greatly to having reading notes for the last 2 units.

4. Lecture was great. Dan is a great instructor and gives very engaging and informative presentations.

5. The slides and codes. They provided helpful explanations and examples.

6. The lectures and homeworks contributed most to my learning, as they taught me new things and made me apply them in ways that forced me to internalize them. I also really liked how every homework had 2 late days, so in effect no homeworks had any late days but it felt like the timeline was much more manageable for some reason.

7. The lectures.

8. The class is meticulously designed and crafted. The content certainly isn't easy, but the way it is taught, the way the assignments are designed, and the way resources are provided all make it feel like a delight and not a chore to learn it. Dan, in teaching this course, may be the most excellent instructor I've ever had! Not just for how well he has designed the course curriculum (because for real, this is probably the most organized class I have ever taken at UW), but in the incredible enthusiasm and energy he brings to every lecture, even to a computer screen or a nearly empty lecture hall. The lessons and insights of the class were extremely well articulated, reflecting Dan's passion and deep knowledge of the subject.

9. The projects helped me practice the more theoretical aspects of lecture. I think they were pretty good projects.

10. Definitely Dan's wonderful lecturing skills. I really enjoyed all the jokes and analogies; they kept me really engaged and made sure I didn't get lost. I'm walking away from 341 with such a big interest in PL, an interest that wouldn't have had if the lectures weren't structured so well. Thanks!

12. Lectures, code examples, written resources

13. The lectures were top notch. Truly everything I need to know is in them if I know what to look for.

14. I found that using lecture time to walk through examples was most helpful and I would watch them again when doing homework, I really like the live coding

15. Engaging with the lecture code significantly helped me understand how to navigate the tasks presented in the homework.

16. I really appreciated the addition of the section recording. I was really struggling this quarter to get to class and once classes became in person again, I wasn't able to get to section. So having one section be recorded every week helped me make sure I could actually watch all of the course material.

17. - lenient late policy - lecture and section recordings - organized class website with lectures, slides, code, etc. - fast Ed responses, clear communication from instructor - online midterm

18. I felt like the back half of the class had more interesting and unintuitive concepts - a lot of the OCaml content felt pretty natural, but Racket was wild.

19. 1) The course website is amazing. It's very easy to find lecture materials. 2) Dan is a great instructor who's very passionate about PL and is very good at explaining it. 3) Although I didn't enjoy doing the homework, now that I look back, the homework really helped me understand the course content.

What aspects of this class detracted from your learning?

1. The challenge problems were interesting problems but were so little points they weren’t often worth the time required

2. The fact that some concepts were taught solely in Quiz Sections and not expanded upon in Lecture. One of my TAs was awful (consistently answered questions incorrectly, seemed to have no grasp on the fundamentals of OCaml and Racket), so I feel like a missed out on learning about a few concepts directly from Section. The AB Section videos were of far better quality, so I ended up not going to my regular Section and instead watched those. Also, I understand that some things are squeezed into Section because there is not enough time in Lecture with the quarter system, so perhaps providing TAs with a bit more guidance on what to present and how would be beneficial.

4. The assignment specs can be a bit confusing to parse at times.

5. The timing of homeworks. Put too much pressure on trying to learn multiple things at the same time.

6. Nothing comes to mind.

7. There was just too much too fast. I took this too early in my CSE schooling for me to get the most out of it.

9. I think there are too many assignments-- one should be removed. It's crazy that we have an assignment due Friday (many students will turn in Sunday because we are all so overwhelmed with work and this quarter has been depressing) and then we have a few hours until the final on Monday morning. There is barely any time to study, even if you turn in the assignment Friday night. I understand that the final time was not decided by the course staff, but the spacing and quantity of the assignments could've been adjusted. Overall, I feel like the course was rushed and it was hard to grasp concepts when it moved so quickly. 341 feels like a semester system course crammed into 10 weeks when it really shouldn't be. I don't know if I'm just not as smart or if I just experienced a lot of burnout and stress from the pandemic/shifting online and then back/life but I did not have the "easy and fun" class experience that everyone talks about.

12. TAs sometimes gave confusing/contradicting explanations so I ended up confused on some things like augment/pubment and subtypes.

13. Really nothing

15. While I appreciate the instructor's enthusiasm about the course content, I think the enthusiasm ended up hindering the teaching somewhat. Primarily, content presented in the slides came off as way too casual and conversational, which resulted in a lot of "well, technically, such and such" that confused me, and too much usage of quotes around words that helped explain nothing about a particular topic (e.g. this code evaluates at "just" the right time -- what does "just" mean in this context? Can you elaborate in the slides, or just say it outright?).

17. - gradescope grading and feedback somewhat difficult to understand - guidelines and spec for writing unit tests extremely unclear - inconsistent workload for homeworks

18. I was a little frustrated with the section content - I started by attending regularly up until week 5, but felt a little condescended to by my TAs.

19. Dan jumped around some topics, which confused me a ton. For instance, in the middle of our OOP discussion, we had a lecture on Static vs. Dynamic typing, then we came back to OOP afterward. I was very confused during our discussion on Static vs Dynamic typing because I was trying to figure out how it's related to OOP. Turns out it's a separate topic.

What suggestions do you have for improving the class?

1. Keep the hybrid sections

2. Provide TAs with a bit more guidance, since the topics discussed in Section are new and important concepts.

3. Personally, I felt as if I understood Ocaml very well but never felt like I had a solid grasp on racket. I wish more time was spent on focusing on the semantics of racket and how parentheses change things. I also wish there was some instructor-guided time (in a quiz section) where students got practice coding in both languages during the first week each language was introduced. In past classes, I've always found it useful when instructors sent emails from gradescope when HW was graded with statistics regarding mean, median, max/min scores. I think future students would appreciate this in 341 as well.

5. Try to be careful of placing when homeworks might be due and how much time people have for studying exams.

6. Nothing comes to mind.

7. I have heard it said it is a logical progression from 143. I think it should be suggested that students take it later in their schooling.

8. Keep being excited and ready to blow our minds.

11. Dan is very passionate, expressive, and easy to pay attention to. With that said, I feel like a way to improve the class would be to make certain ideas more concise to learn within a lecture. Atleast for me sometimes it was hard to grasp the main points of what Dan said versus less important words since he does talk a bit fast. A suggestion might be to take some even longer pauses for points that should be emphasized. Could just be me though, interesting and well designed course with great teacher!

12. It would be nice to have written notes for the last two units

13. I'm not a fan of exams because no matter how hard I study and understand the material I always blank under pressure. I understand that that's a necessary evil sometimes. Wish this class didn't have it though.

15. Being more precise, professional, and direct in the course content presented in the slides could help future students understand the course material much easier. Also, it would be nice if all of the course material was presented during lectures, instead of delegating some parts of the course material to section content, as I feel like quiz sections should be used to reinforce learning by presenting exercises to test understanding of course content rather than teaching completely new and significantly important content in sections, because students' understanding of that content will end up being considerably uneven and dependent on the ability of TAs to explain the content.

19. - Maybe consider re-organizing the order of lectures/introduction of these topics. - The homework spec is not always very clear sometimes (For instance, I still don't know what the expected behavior is when you press "c" twice for the Tetris homework. The TA's answer seems to contradict Dan's answer.) Providing some examples of expected behaviors would be great.

IASystem Course Summary Reports summarize student ratings of a particular course or combination of courses. They provide a rich perspective on student views by reporting responses in three ways: as frequency distributions, average ratings, and either comparative or adjusted ratings. Remember in interpreting results that it is important to keep in mind the number of students who evaluated the course relative to the total course enrollment as shown on the upper right-hand corner of the report.

Frequency distributions. The percentage of students who selected each response choice is displayed for each item. Percentages are based on the number of students who answered the respective item rather than the number of students who evaluated the course because individual item response is optional.

Median ratings. *IASystem* reports average ratings in the form of item medians. Although means are a more familiar type of average than medians, they are less accurate in summarizing student ratings. This is because ratings distributions tend to be strongly skewed. That is, most of the ratings are at the high end of the scale and trail off to the low end.

The median indicates the point on the rating scale at which half of the students selected higher ratings, and half selected lower. Medians are computed to one decimal place by interpolation.[1] In general, higher medians reflect more favorable ratings. To interpret median ratings, compare the value of each median to the respective response scale: *Very Poor, Poor, Fair, Good, Very Good, Excellent (0-5); Never/None/Much Lower, About Half/Average, Always/Great/Much Higher (1-7); Slight, Moderate, Considerable, Extensive (1-4).*

Comparative ratings. *IASystem* provides a normative comparison for each item by reporting the decile rank of the item median. Decile ranks compare the median rating of a particular item to ratings of the same item over the previous two academic years in all classes at the institution and within the college, school, or division. Decile ranks are shown only for items with sufficient normative data.

Decile ranks range from 0 (lowest) to 9 (highest). For all items, higher medians yield higher decile ranks. The 0 decile rank indicates an item median in the lowest 10% of all scores. A decile rank of 1 indicates a median above the bottom 10% and below the top 80%. A decile rank of 9 indicates a median in the top 10% of all scores. Because average ratings tend to be high, a rating of "good" or "average" may have a low decile rank.

Adjusted ratings. Research has shown that student ratings may be somewhat influenced by factors such as class size, expected grade, and reason for enrollment. To correct for this, *IASystem* reports **adjusted medians** for summative items (items #1-4 and their combined global rating) based on regression analyses of ratings over the previous two academic years in all classes at the respective institution. If large classes at the institution tend to be rated lower than small classes, for example, the adjusted medians for large classes will be slightly higher than their unadjusted medians.

When adjusted ratings are displayed for summative items, **relative rank** is displayed for the more specific (formative) items. Rankings serve as a guide in directing instructional improvement efforts. The top ranked items (1, 2, 3, etc.) represent areas that are going well from a student perspective; whereas the bottom ranked items (18, 17, 16, etc.) represent areas in which the instructor may want to make changes. Relative ranks are computed by first standardizing each item (subtracting the overall institutional average from the item rating for the particular course, then dividing by the standard deviation of the ratings across all courses) and then ranking those standardized scores.

Challenge and Engagement Index (CEI). Several *IASystem* items ask students how academically challenging they found the course to be. *IASystem* calculates the average of these items and reports them as a single index. *The Challenge and Engagement Index (CEI)* correlates only modestly with the global rating (median of items 1-4).

Optional Items. Student responses to instructor-supplied items are summarized at the end of the evaluation report. Median responses should be interpreted in light of the specific item text and response scale used (response values 1-6 on paper evaluation forms).

[1] For the specific method, see, for example, Guilford, J.P. (1965). Fundamental statistics in psychology and education. New York: McGraw-Hill Book Company, pp. 49-53.

Appendix E.4: Instructor and TA Evaluation and Improvement Mechanisms

For completeness' sake, we describe here a range of mechanisms and processes in place to help ensure our instruction is high quality and continually improving. Both the assessment mechanisms and the training/improvement mechanisms are complementary — no single mechanism is sufficient. While most of these mechanisms are fairly straightforward and designed to be lightweight and adaptable to our vast range of courses, it is worth noting that most of them are new in the last decade — we have annotated those as *New*. We don't claim particular novelty, but the point is we have filled in important gaps and actually do all these things.

- TA selection and training:
    - TAs for our introductory courses are undergraduates who took the courses themselves and who are selected via a very competitive process involving interviews and sample presentations. They also participate in an introductory-course-specific training during their first quarter as TAs.
    - *New:* Several of our teaching faculty also run interview processes for selecting TAs for our larger upper-division courses.
    - *New:* Several years ago we launched a CSE-specific TA training for new TAs in upper-division courses that they take during their first quarter as a TA. We continue to refine the content. It is led by two of our teaching faculty.
- TA evaluation:
    - TAs who lead recitation sections can have student course evaluations for their section.
    - *New:* We have a very simple evaluation form for instructors to give feedback to their TAs — areas of strength, areas of improvement, and a 1-5 score. This feedback is also available for future TA-selection decisions and, for PhD students, as part of their annual review process.
- Instructor selection and training:
    - *New*: Each new faculty member is assigned a teaching mentor, typically a teaching professor.
    - *New:* Our summer-quarter instructors are typically graduate students. We now select them via a transparent application process the preceding Fall, giving them to "on-ramp" into the course by TAing it before summer, and we have a faculty summer course coordinator who meets with them multiple times before and during their course offering.

    - *New:* We aim to have one professional-development activity/presentation per quarter at a faculty meeting and these are often teaching related.
    - *New*: For our temporary instructors who are not faculty members, we have instituted a quarterly lunch they attend with teaching faculty to create community and share best practices.
    - *New:* Our instructors Slack channel is active and welcoming, helping all instructors work together on unusual challenges, best practices, and wrestling with educational technology.
    - *New:* We have rewritten and expanded our guides, resources, and best practices for teaching in the Allen School. For example, see the [New Quarter Teaching Guide] (probably not available externally, but easy to provide a copy).

- Instructor evaluation:
    - All courses have student evaluations at the end of the term. These have two parts: Numeric results (mostly Likert-scale questions) and free-form answers to questions. The Vice Director has access to the numeric results and reviews them each quarter to identify any potential problems.
        - *New:* Starting about one year ago, we include a set of questions on inclusiveness and being respected by course staff developed by the College of Engineering.
    - The College of Engineering Center for Teaching and Learning makes available mid-quarter assessments where the director does an in-class exercise to collect student feedback and prepares a report for the instructor. We encourage faculty, particularly new faculty, to participate.
    - *New:* As part of the faculty review process, faculty complete a self-evaluation for each course, identifying what went well in the course and what they would improve next time.
    - *New:* We ask TAs to complete a survey about their experience each quarter where they provide positives, negatives, and recommendations for the course they TAed. We also ask how enthusiastic they would be to TA for the course again and for the instructor again. The Vice Director reviews all these answers and, with attribution by name, shares the feedback with the instructors.
    - As part of the faculty review process, we complete peer observations and reports.
        - *New:* This was typically focused on watching a lecture. We expanded the scope to also consider the quality of course structure and organization as well the opportunity to review a homework assignment, the syllabus, etc., better reflecting that in-classroom teaching is only one aspect of instructional excellence.

- Program-wide evaluation (activities that transcend evaluation of an individual course):
  - The ABET accreditation of our Computer Engineering degree requires a large-scale assessment process with respect to educational objectives.
  - See also the student-experience and student-satisfaction surveys and reports provided in other appendices.

Appendix E.5: Undergraduate Admissions Process

The high-order bit is that we are capacity-constrained, but students are admitted to the major through a truly holistic assessment rather than any sort of GPA cutoff.

We have three streams: students admitted to the Allen School directly from high school at the same time they are admitted to the university; current UW students who apply to the Allen School; and students who transfer from the state's community college system. These presently comprise roughly 57%, 31%, and 12% of each graduating class. (These percentages are politically charged — each stream feels that their percentage is too low, and they are correct in that we must deny highly qualified students from all three streams.)

We have many goals: gender diversity, racial diversity, socioeconomic diversity, Washington residency, potential. It is a hugely complex balancing act. For example:

- Because of Washington Initiative 200 (the equivalent of California Proposition 209), race and gender cannot be considered in admission decisions. If we do this, we are breaking the law.
- For the first and third streams above (students admitted to the Allen School at the same time they are admitted to the university, whether from high school or a community college), we are allowed to consider Washington residency as a criterion. But for current UW students we are not — decisions for this stream must be residency-blind. And in this stream, students who are not Washington residents predominate. Residency is a significant issue because our growth is funded by line-item appropriations for our program, and legislators and taxpayers intend to create capacity for students from Washington, vs. students from other states or from other countries in the world.

As the highest profile program at the University of Washington, we are under scrutiny by legislators, taxpayers, newspapers, and other programs at the UW. Thus we must strictly adhere to these and other constraints.

The first stream (nearly 60% of our students) is handled by the UW Office of Admissions, although we interact with them regarding criteria. The second and third are handled by us. The criteria are similar for each stream. The process is roughly:

- Each student's application is read twice.
- On each reading, the student receives two scores: an academic score, and a personal score.
- The personal score considers a range of factors including their non-academic accomplishments, hardships overcome, future goals, and writing quality. Factors such as being a first-generation college student or economic hardship can be considered.
- The two academic scores are added, and the two personal scores are added. At this point, each score ranges from 2-18. So you can imagine a matrix: academic

score from 2-18 on the y-axis, personal score from 2-18 on the x-axis, 17x17, 289 cells.

- Our approach is to place significantly increased weight on the personal score as the academic score decreases from 18.

Because of the scale involved, admission decisions for the first stream are more “rubric driven” and less “personalized” than admission decisions for the second and third streams, but the holistic criteria are similar.

Diversity implications:

- The first stream (students admitted to the Allen School directly from high school at the same time they are admitted to the university), relative to the other streams, is vastly higher for Washington residents (because this is an allowable criterion for this stream and also used for decisions on admission to UW), moderately higher for women, and much higher for underrepresented minorities.
- The second stream (current UW students who apply to the Allen School) is much lower for Washington residency and also for underrepresented minorities. It is usually lower for women than the first stream. (An important detail regarding this stream: in the academic aspect of the holistic assessment, we explicitly *disregard* performance in our first programming course, and have publicized this fact, in order to improve the environment in the course and in order to avoid disadvantaging students who may be new to computing.
- The third stream (students who transfer from the state’s community college system) is high for Washington residency (although significantly below the first stream), high for underrepresented minorities (although only by a bit over the first stream), and the same as the second stream (behind the first stream) for women.

Given our leadership position in the state, outreach is essential: outreach to high school students, outreach to community college students, and outreach to current UW students, particularly those in our introductory courses. This outreach is not “recruiting” in the traditional sense of convincing a student to attend the University of Washington in lieu of some other college or university — it is outreach that grows the pool by convincing a diverse set of high potential students to consider computer science and engineering as a major. This outreach serves all of the state’s higher education institutions, and beyond. Not every student who we interest in computer science will end up at the University of Washington, and this is fine with us - we are vastly over-subscribed.

Two final notes:

- We have two degree programs: a Computer Science degree offered through UW’s College of Arts & Sciences, and a Computer Engineering degree offered through UW’s College of Engineering. Students are admitted to the Allen School without regard to which box they check. Roughly 90% of our students are in the Computer Science program, but this percentage can move depending on the applicant pool – all streams consider applicants to both majors as a single pool.

As it happens, the percentage in Computer Science has increased steadily for 30 years.

- A natural question is “Wouldn’t you have more room for ‘interest-changers’ if you were to increase the size of the second stream?” We work hard in our introductory courses to create interest-changers, particularly students who start with misperceptions of our field including traditionally under-represented groups. But the most important thing we can do is to make it clear to students who are determined to get a Computer Science or Computer Engineering degree that if they are not admitted directly to the Allen School they should choose a different college, rather than attending UW, applying to the Allen School as a UW student, and crowding out the interest-changers as well as bringing a competitive, zero-sum dynamic to our introductory (and other prerequisite) courses. Somewhat counter-intuitively, by expanding the first stream, we can send the above message more forcefully than is currently possible, and admit a greater number of targeted interest-changers to the major.

Appendix E.6: Three-Quarter Intro Sequence Rationale

Last Updated: 8/7/2021

Background

In May 2019, a working group convened by the Allen School issued a report detailing numerous recommendations for evolving and improving the school's 100-level courses. Among the report's findings and conclusions were several notes related to the pace of CSE 142 and CSE 143, the Allen School's primary introductory programming courses, as well as the structure of the curriculum and the suitability of both CSE 142 and CSE 143 as "entry points" for incoming students. Based partially on this report and its findings, discussions began on how the introductory programming sequence could be updated to reflect changes in both the state of computing and the students the courses served.

As a result of these discussions, **the decision was made to investigate restructuring CSE 142 and CSE 143 into a three-quarter sequence**. This is clearly a massive change with many far-reaching ramifications which will be explored over the course of the project. This document is intended to explore and explain the reasoning behind beginning this project, as well as lay out some high-level goals and expectations. We assume that additional questions will be raised as the project progresses and that additional benefits and drawbacks will be uncovered. However, this document should serve to provide a baseline set of arguments for why this project is worth undertaking and what it can be expected to achieve.

This document will be updated occasionally as goals or motivations change throughout the project.

Slower Pace

Many students report struggling with the pace of our existing introductory courses, on both a macro (the amount of material in the course) and micro level (the amount of time spent practicing and engaging with material before assessment). A majority of students eventually develop comfort with most content from the courses, and most students who progress to upper-division courses are also successful. However, the discomfort many students feel with the pace of the course is at best creating a hostile environment and at worst causing many students who could otherwise succeed to give up.

Moving to a three-quarter sequence *without* introducing significant new material will allow more time for students to establish a deeper understanding of course concepts through increased exposure and development of additional supplementary programming skills (See Added Focus on Skills). Furthermore, a slower pace provides more flexibility for additional, lower-stakes assessments, giving students multiple opportunities to demonstrate mastery as well as more time to assign larger cumulative assignments or collaborative projects.

Added Focus on Skills

Due to the pace of the existing courses, minimal time is spent on helping students develop key programming skills such as design, testing, debugging, and documentation. These skills are not only vital to students becoming effective programmers, but can also directly lead to improved student understanding of other topics and concepts covered in the courses.

Though these skills are typically assessed (either directly or indirectly), there is little explicit instruction or guidance on these skills, with students instead being expected to develop them naturally while working on programming assignments. Students frequently comment that they feel as though they are forced to learn these skills on their own, and instructors of future courses have observed that students have not developed these skills to the extent that they expect.

Though we want to avoid adding significant new material to the courses (see above), some of the additional time gained from expanding to a three-quarter sequence can be used to provide more explicit instruction, guidance, and practice with these skills outside of the primary assessments. As these skills are fundamental to writing software, the room to teach them is intended to improve success without increasing workload.

Updated Entry Points

Over the last several years, the number of incoming students with previous computing experience has increased significantly. While some of these students will benefit from a UW course that covers material they have already encountered (potentially as a review or to adjust to college-level coursework), the best choice for many is a first course that builds off of their existing knowledge. Unfortunately, for many of these students, none of the existing course choices are a good fit. CSE 142 will include a great deal of review for most students. However, because CSE 143 was designed as a direct follow-up to CSE 142, it assumes that students are familiar with procedures and guidelines established in the prior course. Jumping straight into CSE 143 deprives students of the introduction to these requirements, putting them at a disadvantage. In addition, the curriculum for CSE 142 does not directly align with the most common high school curricula (e.g. AP Computer Science A or IB Computer Science), so students who begin with CSE 143 will likely not have seen some topics they are expected to have (e.g. file I/O).

Moving to a three-quarter sequence, explicitly designed to allow any of the three courses to be a student's first course at UW, will create a better set of entry points for the wide range of previous experiences we are seeing in recent years. Specifically, the first course will continue to assume no significant prior experience. However, the second course will assume some previous experience with certain CS content, but specifically will *not* assume that students have taken the UW version of the previous course, and thus will explicitly (re)introduce program policies, expectations, etc. The third course will be most appropriate for students with significant programming experience. The curriculum will also be designed to align as closely as possible to the most common previous courses our students may have taken to minimize the likelihood of students needing to learn material on their own when beginning with a course other than the first.

Improved Culture

Because of the misalignment between students' experience levels and the curriculum of our existing courses, it is not uncommon for students with significant programming backgrounds to be enrolled alongside students with little to no previous experience. In fact, roughly half of CSE 142 students enter the course with prior experience. This mismatch creates an environment in which, despite these being introductory courses, students feel as though previous experience is necessary or expected to succeed. Creating a sequence with entry points that are better aligned with students' backgrounds will reduce the frequency of students with significantly different experience levels enrolling in the same course, thereby helping all students feel as though they are in the correct course and are set up for success.

Increased Diversity, Equity, and Inclusion

The Paul G. Allen School is committed to providing an inclusive environment for students of all backgrounds, including in its introductory programming sequence. We believe a three-quarter sequence will provide a better learning environment for all students, and particularly students from underrepresented groups who may enter the courses with less prior exposure and therefore lower confidence. While not solely sufficient to create a more inclusive and equitable pathway to the computing field, the aforementioned changes are necessary toward supporting students of all backgrounds.

In particular, there is significant evidence that students from minoritized and underserved backgrounds are less likely to have previous programming or computing experience upon entering UW, and thus are more likely to be susceptible to the classroom culture issues described above. Creating a program in which students without previous experience are less likely to be in a course alongside peers who have programmed before, especially in the first course, will improve the inclusivity of the entire sequence, and provide disproportionate benefit to these underserved students.

In addition, we anticipate making updates to the course materials and assignments to support students bringing their full selves to class and creating authentic experiences for all students. There will be many elements to this, but the details are beyond the scope of this document and will be determined later in the process when we start designing and evaluating specific lessons and materials.

Better Alignment with Partner Programs

For many years, several Washington community colleges have taught three-course sequences of introductory programming. Historically, only two of these courses have been eligible for transfer credit at UW, causing potential issues both for students who take these sequences at community college and for the institutions themselves who are attempting to align with the UW curriculum. Moving to a three-quarter curriculum will allow us to more easily align with our community college partners and create a smoother transition for students transferring from these schools.

In addition, many on-campus partner programs and departments struggle with whether to require both CSE 142 and CSE 143, or only CSE 142. In reality, many of these programs would prefer their students to learn *some,* but not all, material from CSE 143. While no curriculum can perfectly fit the needs of all of the wide variety of programs and students that our introductory courses serve, moving to a three-quarter sequence will provide additional flexibility to other programs in deciding how much programming to require of their students. In particular, we expect that many programs will choose to require only the first two courses in the new sequence, and some may require only the first course.

Potential Drawbacks

While we strongly believe that these changes are for the benefit of both students and the Allen School, there are potential drawbacks to a three-quarter introductory sequence. Firstly, adding an additional course to the introductory sequence effectively creates a deeper prerequisite chain for all subsequent courses. This could result in students' progression into upper-division courses (both in CS and other departments) being delayed by a quarter. It could also create scheduling complexities if some relevant courses are not offered every quarter.

Furthermore, while credit counts for the new courses have not yet been determined, it is likely that the total credits for the three-quarter sequence will exceed the current nine credits in the two-quarter sequence. This can have ramifications for student status and tuition, as well as for various departments' graduation requirements.

Note that we expect a significant portion of students to not take the full sequence, skipping either the new first course-- based on previous experience-- or the new third course-- based on the requirements of other programs. The impact of both of the above issues will be minimized for students who only take two of the three new courses. Nevertheless, some students *will* take the full sequence, and these complications will need to be addressed for that population.

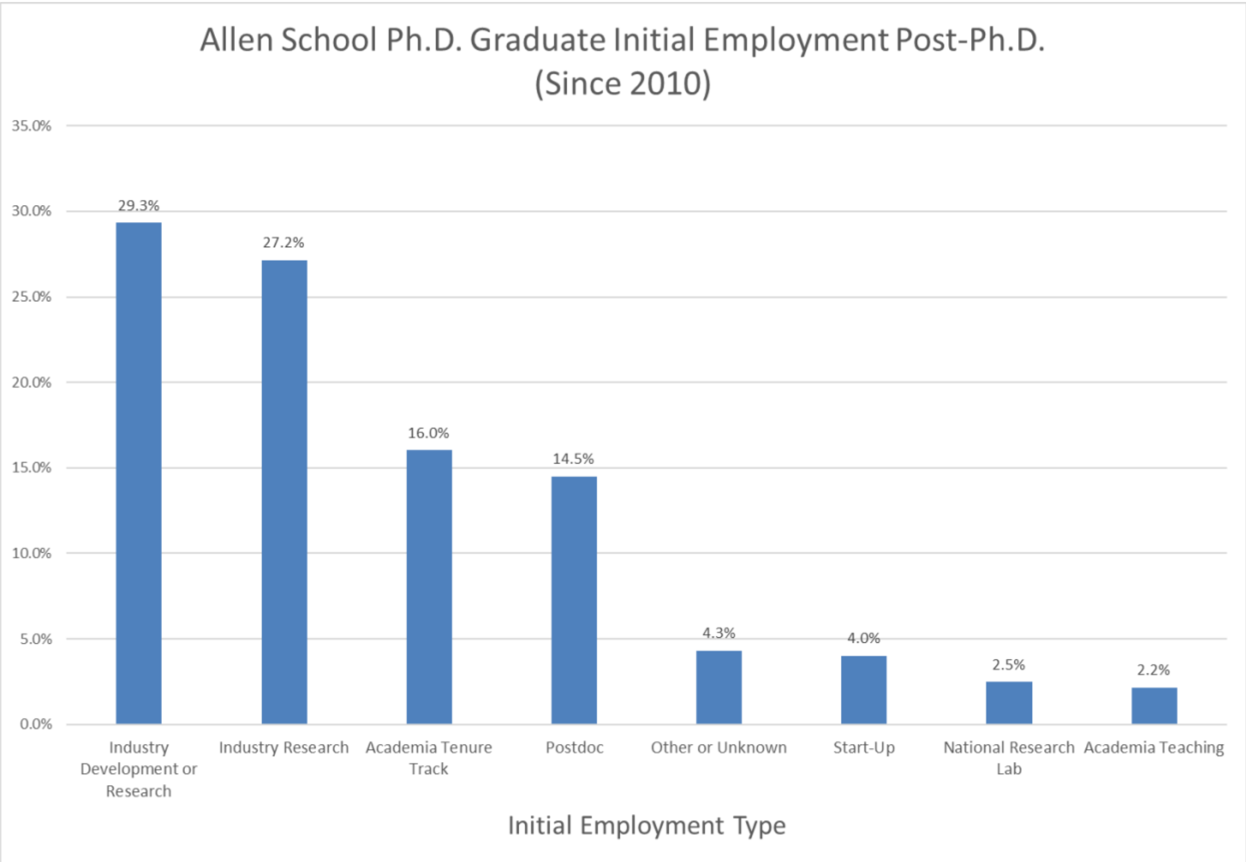
Non-Goals

In contrast to the motivations and goals stated above, the following are changes or updates that we explicitly *do not* expect to make during this process.

- Adding significant new technical content
- Creating a CS0 or pre-CS style first course
- Creating separate tracks for majors/non-majors or those with/without previous experience
- Moving to an introductory sequence that is not programming-focused

Appendix E.7: Ph.D. and Postdoc Placement

Ph.D. Placement

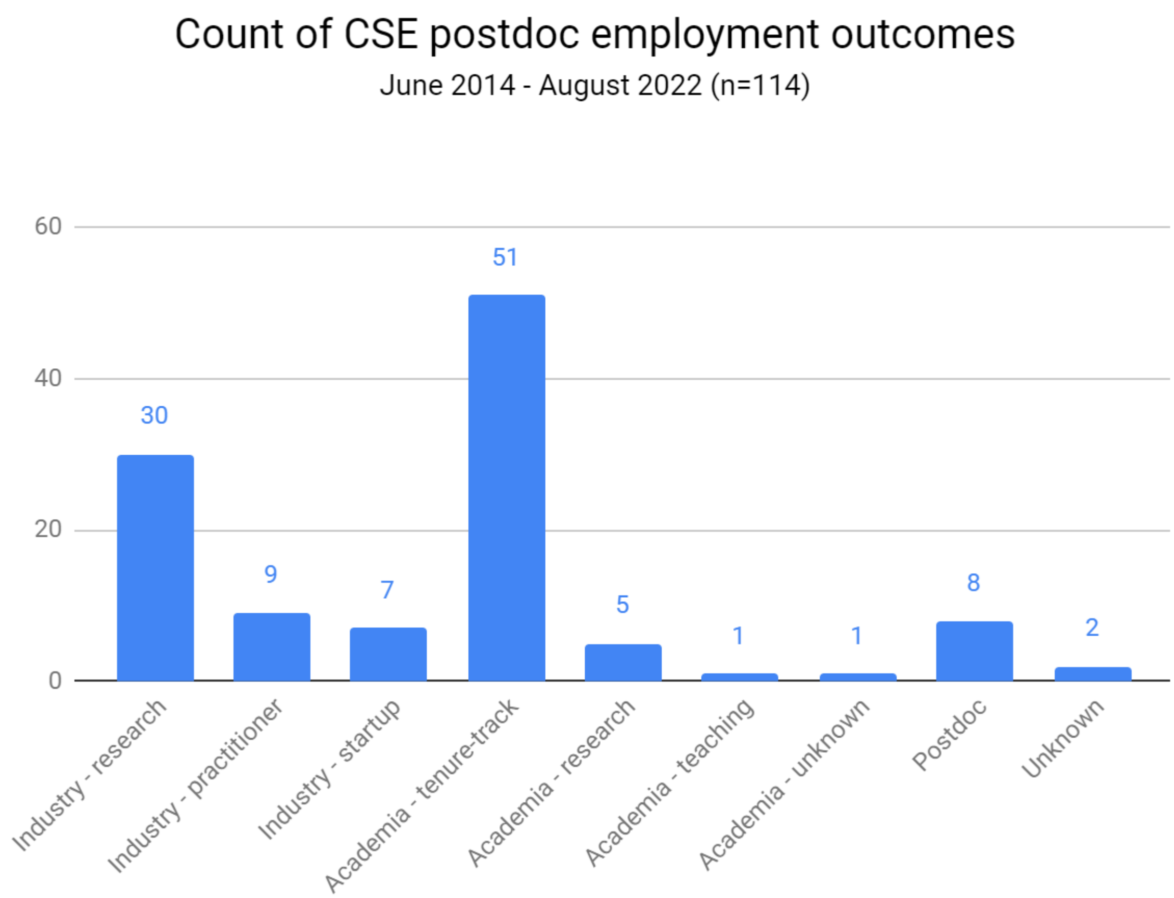


The Allen School tracks initial post-Ph.D. employment for all graduates. Of 325 Ph.D.s granted since 2010, about 60% have gone to industry positions (either research, development or type unknown. Pre-2014 data on the type of industry position was not collected.) and about 18% have gone to faculty positions (both tenure-track and non-tenure track). Another 15.5% have taken postdoctoral research positions, the majority of which have been postdocs in academia. Academic institutions our graduates have joined or will be joining as faculty or postdocs include:

- Brown University
- Bucknell University
- CalTech
- Carleton College
- Carnegie Mellon School of Computer Science
- Columbia University
- Cornell University
- Creighton University
- CWI Amsterdam

- Duke University
- ETH Zurich
- Georgia Institute of Technology
- Korea Advanced Institute of Science and Technology (KAIST)
- Kyoto University
- Macalester College
- Massachusetts Institute of Technology
- National University of Singapore
- Northwestern University Computer Science & Learning Science
- Singapore Institute of Technology
- Stanford University
- Swiss Federal Institute of Technology (EPFL)
- University of Capetown
- University of British Columbia
- University of California, Berkeley
- University of California, Irvine
- University of California, Santa Barbara
- University of California, San Diego
- University of Hawaii at Hilo
- University of Illinois Urbana-Champaign
- University of Iowa
- University of Maryland - Baltimore County
- University of Maryland College Park
- University of Massachusetts - Manning College of Information & Computer Science
- University of Michigan
- University of Pennsylvania
- University of Southern California
- University of Texas at Austin
- University of Tokyo
- University of Utah
- University of Washington, Computer Science & Engineering
- University of Washington, Information School
- University of Washington, Mechanical Engineering
- University of Wisconsin - Madison
- Wellesley College
- Yale

Postdoc Placement



Academic institutions our postdocs have joined as faculty include:

- Ben-Gurion University (Israel)
- Cornell University
- Duke University
- Georgia Tech
- Heriot Watt University (Scotland)
- Israel Institute of Technology (Israel)
- National Tsing Hua University (Taiwan)
- New York University
- Ohio State University
- Peking University (China)
- Pohang University of Science & Technology (South Korea)
- Purdue University
- Rutgers University
- San Pablo Catholic University (Peru)
- Shanghai Jiaotong University (China)
- Stony Brook University

- University of California, Irvine
- University of California, San Diego
- University of California, Santa Barbara
- University of California, Santa Cruz
- University of Cape Town
- University of Colorado
- University of Hong Kong
- University of Lisbon (Portugal)
- University of Maryland, College Park
- University of Massachusetts, Amherst
- University of Massachusetts, Lowell
- University of Minnesota
- University of Nevada, Reno
- University of North Carolina, Chapel Hill
- University of Southern California
- University of Texas, Austin
- University of Toronto
- University of Virginia
- University of Washington
- University of Wisconsin, Madison
- Weizmann Institute of Science (Israel)
- Western Michigan University
- Western Washington University

Appendix F.1: Overview of Research Groups

In this appendix, we provide a brief overview of the major research areas faculty in the Allen School are active in.

Computational Biology (Su-In Lee, Sara Mostafavi, Zoran Popovic, Raj Rao, Larry Ruzzo, Linda Shapiro, Sheng Wang): The group attacks central computational problems in molecular biology, computational medicine, and computational neuroscience. We publish regularly in premier scientific journals such as Cell and Nature, and have produced freely available software that is used regularly by scientists worldwide.

Computer Architecture (Luis Ceze, Mark Oskin, Michael Taylor, Hank Levy, Jean-Loup Baer (emeritus), Carl Ebeling (emeritus), Susan Eggers (emeritus), Larry Snyder (emeritus)): The group's research spans the entire stack, including architecture, OS, programming languages/compilers and VLSI. We publish regularly in the top conferences, and have multiple faculty in the hall of fame of ISCA, ASPLOS, etc, and multiple "top picks" awards.

Molecular Programming and Synthetic Biology (Ceze, Nivala, Seelig, Thachuk): In the past 10 years the Allen School established itself as a leader in molecular programming, with many visible results, media coverage, major awards and spin-outs. We publish in the premier scientific journals such as Science and Nature. Our work on DNA data storage led to the ACM Maurice Wilkes Award for Ceze and Strauss (affiliate), which was also notable for being an award for computer architecture, bringing more visibility of the potential of molecular data storage and computing to future computer systems.

Systems and Networking (Tom Anderson, Luis Ceze, Arvind Krishnamurthy, Ed Lazowska, Hank Levy, Ratul Mahajan, Simon Peter, Xi Wang, John Zahorjan (emeritus)): Our group studies problems that will shape future systems over multiple decades, such as developing automatic verification techniques for operating systems and enterprise-scale networks, and improving the performance of cloud computing with new hardware. We have won 20 best paper awards and multiple test-of-time awards from the premier conferences in our field. We have three members of the National Academy of Engineering, four ACM Fellows, a IEEE Koji Kobayashi and Usenix Lifetime Achievement award recipient and an ACM SIGCOMM Rising Star award recipient.

Programming Languages and Software Engineering (Ras Bodik, Michael D. Ernst, Dan Grossman, René Just, Zachary Tatlock, Emina Torlak): Our research ranges from practical program verification to program synthesis to software testing, in addition to the application of foundational techniques to other areas, such as verifying distributed systems, and optimizing machine-learning kernels. Our work is recognized with numerous best-paper awards in the top conferences of the field, and also has real-world impact (e.g., our type-system-definition tools are used at Amazon and our mutation-testing framework is used at Google). Awards include two ACM Fellows, an ACM SIGSOFT Outstanding Research Award, and an ACM SIGPLAN Milner Young Researcher Award.

Mobile and Ubiquitous Computing (Shyam Gollakata, Vikram Iyer, Shwetak Patel, Joshua Smith): Our research includes sensing, inference and the development of new interaction techniques. We publish regularly at the top conferences in our field and have received 14 best papers awards and nominations and four 10-year impact awards at Ubicomp/Pervasive in the last 10 years. Many of these projects have also led to impact in industry through numerous licenses and startups including Zensi (acquired by Belkin to form the WeMo IoT product line) and SNUPI Technologies (acquired by Sears). Other companies spun out and currently active include Jeeva, Wibotic, Proprio.

HCI, Accessibility, and Fabrication (Lauren Bricker, Anat Caspi, James Fogarty, Jon Froehlich, Jeffrey Heer, Richard Ladner, Jennifer Mankoff, Shwetak Patel, Katharina Reinecke, Adriana Schulz, Steve Tanimoto, Dan Weld, Amy Zhang): UW and the Allen School are widely recognized as one of the premier programs in HCI research and education with particular impact in accessibility, translation, and most recently fabrication and social computing. Efforts are organized around our DUB community, a cross-campus multidisciplinary alliance of faculty and students. UW is consistently the top-published academic institution in HCI and is active across all areas of HCI, with numerous best paper awards and other recognitions.

Computer Graphics, Computer Vision, Game Science, and Augmented & Virtual Reality (Brian Curless, Ali Farhadi, Ira Kemelmacher-Shilzerman, Barbara Mones, Zoran Popović, Adriana Schulz, Steve Seitz, Linda Shapiro, and, arriving in 2022, Ranjay Krishna): Research in this area includes animation, games for scientific discovery, games for education, object recognition, medical image analysis, computational photography, and 3D reconstruction from images. The flagship UW Reality Lab is focused on advancing the state of the art in virtual and augmented reality technologies. The group publishes at the very top computer graphics and vision conferences, and in the last decade has received 4 best paper awards, a Helmholz Prize, an ACM SIGGRAPH Distinguished Educator Award, and a TR35. Research successes in the past 10 years have also led to impact through tech transfer, such as the technology behind Google's Jump VR Camera, several startups, and research groups at Apple and Google led by CSE graphics and vision faculty.

Data Management (Tim Althoff, Magda Balazinska, Leilani Battle, Jeffrey Heer, Alex Ratner, and Dan Suciu): The data management group studies how to collect, organize, and query data easily and efficiently, and is best known for contributions to stream data processing, distributed and cloud data processing, probabilistic databases, storage of array structures, and for an innovative approach to pricing relational data. The group publishes actively in all top database conferences and has been recognized with multiple best paper awards, test-of-time awards and the 2022 SIGMOD Codd Innovations Award.

Machine Learning and Artificial Intelligence (Simon Du, Kevin Jamieson, Jamie Morgenstern, Sewoong Oh, Ludwig Schmidt): The last decade has been one of change with not one professor in the ML group that started it, ending it. The current ML faculty work on modern topics like the theory of deep learning, reinforcement learning, fairness, privacy, and the foundations of generalization. The group's accomplishments and promise have been recognized by NSF Early Career Awards; its members are serving as PIs on large, multi-institution NSF awards.

Robotics (Byron Boots, Maya Cakmak, Dieter Fox, Joshua Smith, Siddhartha Srinivasa): The group is performing groundbreaking research across all areas of intelligent robotics including sensing, perception, learning, planning, control, and human robot interaction. We regularly publish in the flagship robotics conferences and journals and have won over 25 best paper awards. Other accolades of the last decade include an IEEE RAS Pioneer Award, an ICRA Milestone Award, three Robotics Science and Systems Early Career Award, and a Ubicomp "10 Year Impact" Award. Faculty have also demonstrated leadership outside the university, e.g., Dieter Fox is Senior Director of Robotics Research at NVIDIA, Siddhartha Srinivasa is Director of Robotics AI at Amazon, and Joshua Smith has co-founded several robotics companies.

Natural Language Processing (Tim Althoff, Yejin Choi, Hannaneh Hajishirzi, Noah Smith, Yulia Tsvetkov, Luke Zettlemoyer): Our research spans all aspects of language processing, with strong bridges to other research disciplines. Research efforts focus on semantics, knowledge and commonsense, reasoning, social good, and NLP for all, among others. Recognition includes two Allen Distinguished Investigator awards, two ACL Fellows, a PECASE award, and two Sloan Research Fellowships. The group has received 22 paper awards in the last ten years, and two ten-year test-of-time paper awards.

Computing for Development (Richard Anderson, Kurtis Heimerl): UW is one of the top departments worldwide in the ICTD (Information and Computing Technology for Development) field with high-profile projects and many publications at the recent ICTD and COMPASS conferences. Recognition includes the 2020 ACM Eugene L. Lawler Award for Humanitarian Contributions within Computer Science and Informatics and a TR35 award.

Data Visualization (Leilani Battle, Jeffrey Heer): Research spans data visualization, data science, and scalable interactive data systems. The group publishes regularly and has received multiple best paper awards and two 10-year test-of-time awards at the top venues for data visualization and HCI.

Data Science (Tim Althoff, Magda Balazinska, Leilani Battle, Jeffrey Heer, Alexander Ratner, Dan Suciu): Our research is both interdisciplinary and multidisciplinary, spanning all aspects of data science. Recognition includes multiple best paper awards and a SIGKDD Dissertation Award.

Ethical AI (Jamie Morgenstern, Sewoong Oh, Kevin Jamieson, Tim Althoff, Ludwig Schmidt): As AI systems become increasingly pervasive in human-relevant decision making, so too do the social consequences of such adoption. The research questions studied by this group include understanding tradeoffs inherent in AI systems, privacy issues, robustness, and equitable machine learning.

Computing for the Environment (Richard Anderson, Shyam Gollakata, Kurtis Heimerl, Vikram Iyer, Shwetak Patel, Simon Peter): The Allen school has a growing presence in computing for the environment, including energy and water disaggregation, wildlife conservation and datacenter power efficiency. A notable project assisted the state of Washington in tracking “murder hornets”, an invasive wasp. The group’s research has led to multiple best papers awards and honorable mentions, two 10-year impact awards, and, for example, the integration of energy disaggregation algorithms into millions of smart meters in the U.S.

Computational Health (Shwetak Patel, Su-In Lee, James Fogarty, Shyam Gollakota, Jennifer Mankoff, Tim Althoff, Linda Shapiro, Sara Mostafavi, Sheng Wang, Yuliang Wang, Larry Ruzzo, Georg Seelig, Luis Ceze, Jeff Nivala, Chris Thachuk, Anat Caspi, Adriana Schulz, Rajesh Rao, Joshua Smith): The group does a wide array of interdisciplinary and collaborative research on topics ranging from AI and health diagnostics to health sensing solutions using mobile technology to health informatics. Our papers are published in the top journals including Science, Nature, The Lancet, and the New England Journal of Medicine. Mobile health technologies created at UW are in use by millions of people and our faculty and students have produced a number of venture-backed health startups and technology licenses to industry.

Security and Privacy (David Kohlbrenner, Tadayoshi Kohno, Franziska Roesner): Our small group is an international leader in several key areas of the field. We have produced award-winning and foundational research on automotive computer security (Test of Time Award and Golden Goose Award), wireless medical device computer security (Test of Time Award), security and privacy of augmented/virtual/mixed reality, IoT and smart homes, and web advertising security and privacy. Our work also addresses misinformation and security and privacy research for specific populations (e.g., children, journalists, refugees, activists during revolutions). We have had significant impact across industry and government, and our work has been covered widely in the media.

Cryptography (Rachel Lin, Stefano Tessaro): The crypto group has interests and expertise in a wide range of topics across theoretical and applied cryptography, as well as in the interaction of cryptography interaction with theory of computation and security and privacy. Some of our award-winning results in the last few years include the design of the first program obfuscation scheme, the resolution of two-round multi-party computation protocols from minimal assumptions, the design of privacy-preserving digital contact tracing methods (deployed at scale during the COVID-19 pandemic), the development of a theory of memory-intensive problems in cryptography, and the development of mathematical tools which have led to the validation of cryptographic protocols used at scale by billions of users.

Theory of Computation (Paul Beame, Anna Karlin, James Lee, Yin Tat Lee, Rachel Lin, Jamie Morgenstern, Shayan Oveis Gharan, Anup Rao, Thomas Rothvoss, Stefano Tessaro): The group studies a wide range of fundamental problems in algorithms and complexity and, over the last decade, has become one of the premier theory programs in the world. External recognition includes two Packard Fellowships, two Simons Investigator awards, six Sloan Research Fellowships, a Fulkerson Prize, a Tucker Prize, a Pressburger Award for Young Scientists, a Kanellakis Theory and Practice Award, a member of the American Academy of Arts and Scientists, the National Academy of Sciences and the National Academy of Engineering, and 12 best paper awards at the premier conferences in theoretical computer science since 2014.

Appendix F.2: Student Successes, by Research Area

In this appendix, we discuss graduate student success and placement (in Section A) and list some dissertation awards (in Section B).

A. We provide a sampling of student research success and placement in academia and industry, broken down by research area.

Computational Biology: Our computational biology group has been blessed with excellent students. These students, who must be experts in both computer science and biomedical science, have created several innovative methods that are used in the discovery of novel biological mechanisms or in medical decision processes. As an example, Scott Lundberg (now MSR) created the SHAP (SHapley Additive exPlanations) framework that provides explanations for the predictions of complex machine learning models and was presented in his highly cited seminal paper in the field of interpretable machine learning (a.k.a. explainable AI). His open-source SHAP software received the Open Source Data Science (OSDS) Award for impact on the data science community. In the past 10 years, the Allen School started to have Ph.D. students who are from the Medical Scientist Training Program (M.D./Ph.D.) — consisting of two years of M.D., four years of Ph.D. and two years of M.D. — absolute "genius" level students admitted through highly selective processes. Starting from the first M.D./Ph.D. student Gabe Erion (now in the M.D. program), we have three more M.D./Ph.D. students who will lead the field at the intersection between AI and medicine.

Computer Architecture: Our faculty have been extremely successful in the last 10 years at placing their graduate students into positions in academia, startups and industry, notably Joseph Devietti (2012, now at UPenn), Saturnino Garcia (2012, U. San Diego), Jack Sampson (2013, Penn State), Donghwan Jeon (2012, CTO MOLOCO), Hadi Emaeilzadeh (2014, now at UCSD), Brandlon Lucia (2013, now at CMU), Ben Wood (2015, now at Wellesley), Adrian Sampson (2015, now at Cornell), James Bornholt (2019, now at UT Austin), Meghan Cowan (2021, now at Microsoft Research), Jacob Nelson (2015, now at Microsoft Research), Liang Luo (2020, now at Facebook Research), Nathan Goulding (2020, Facebook Research), Eddie Yan (2021, now at NVIDIA research), Amrita Mazumdar (2021, now at NVIDIA research).

Systems and Networking: Our greatest successes continue to be our students. Over the last decade, many of our students and postdocs have taken faculty positions, including Harsha Madhyastha (Michigan), Roxana Geambasu (Columbia), Ethan Katz-Bassett (Columbia), Ivan Beschastnikh (UBC), David Choffnes (Northeastern), Aruna Balasubramanian (Stonybrook), Simon Peter (UT Austin), Vincent Liu (UPenn), Pedro

Fonseca (Purdue), Antoine Kaufmann (MPI), Tianqi Chen (CMU), Danyang Zhou (Duke), and Ming Liu (Wisconsin). Roxana Geambasu and Irene Zhang won the Dennis Ritchie award for the best dissertations in systems, while Mike Piatek and Ming Liu were runners-up for the SIGCOMM best dissertation award. Ethan Katz-Bassett recently won the SIGCOMM "Rising Star" award for his contributions to improving the reliability and performance of Internet services. Our current graduate students are developing novel approaches to verifying the correctness of real-world systems, devising new ways to improve the performance, reliability, and energy efficiency of cloud computing systems, and building systems artifacts that are of value to both academia and industrial practice. We also involve undergrads in our research who then go on to graduate school and even pursue academic careers, such as Amit Levy (faculty at Princeton via Stanford) who worked with us on extensible distributed storage systems and Justine Sherry (faculty at CMU via Berkeley) who devised new Internet measurement techniques. Many of our alumni have also made substantial contributions in the computing industry, e.g., Brad Calder (B.S. '91) is SVP and head of Google Cloud Engineering, Jeff Dean (Ph.D. '96) is SVP and head of Google Research, and Albert Greenberg (Ph.D. '83) is CVP and head of Microsoft Azure.

Programming Languages and Software Engineering: We have a decades-long track record of producing excellent students. Older UW Ph.D. alumni in our research area include Jonathan Aldrich (CMU), Jeff Dean (Google Fellow and member of the National Academy of Engineering), Michael Ernst (tenured at MIT before returning to our faculty), Bill Griswold (UCSD), Gail Murphy (UBC Vice-President of Research and Innovation), Miryung Kim (UCLA), Sorin Lerner (UCSD CSE Department Chair), Todd Millstein (UCLA Vice Chair for Graduate Studies), and Tao Xie (U. Illinois). More recent Ph.D. alumni include James Bornholt (U. Texas), Joe Devietti (U. Penn), Pavel Panchekha (Utah), Talia Ringer (U. Illinois), Adrian Sampson (Cornell U.), Benjamin Wood (Wellesley), and Doug Woos (Brown U.). We also regularly send multiple undergraduates per year to study at top Ph.D. programs.

Mobile and Ubiquitous Computing: The group has produced award-winning students who have gone on to have impact in academia and industry. These include Sidhant Gupta (MSR, Forbes 30 under 30, WAGS/UMI Innovation in Technology Award), Gabe Cohn (MSR, NSF Fellow, MSR Fellow, Yang Award), Mohit Jain (MSR), Hanchuan Li (MSR), Keyu Chen (Apple), Lilian de Greef (Apple, NSF Fellow, MSR Fellow), Eric Whitemire (Facebook, NSF Career, NDSEG Fellow), Ruth Ravichandran (Amazon), Eliot Saba (Julia Computing), Tien Lee (Google), Josh From (OctoML), Mayank Goel (CMU, MSR Fellow), Matt Kay (Michigan), Eric Larson (SMU), Alex Mariakakis (Toronto, NSF Fellow, Qualcomm Innovation), Edward Wang (UCSD, NSF Fellow, Heidelberg Laureate Fellow), Alanson Sample (Prof at U. Michigan), Ben Waters

(Wibotic Co-Founder CEO), Vamsi Talla (Jeeva Co-Founder CTO), Aaron Parks (Jeeva Co-Founder COO), Yi Eve Zhao (Facebook), Vaishnavi Ranganathan (MSR), Xingyi Shi (Synapse), Saman Naderiparizi (Apple via XNOR.AI), Jim Youngquist (Proprio Co-Founder)

HCI, Accessibility, and Fabrication: The depth of the Allen School and the breadth of DUB continue to be a powerful combination for our HCI students, for HCI students in other DUB-active programs, and for students in adjacent areas. Allen School HCI PhD students have been frequently recognized with highly-competitive national fellowships (e.g., from the NSF, Facebook, Google, Microsoft), with Best Paper awards and other recognitions, and with the UW Distinguished Dissertation Award (e.g., Nicola Dell, Saleema Amershi, Jon Froehlich). Allen School HCI PhD students are faculty at leading research institutions (e.g., Eytan Adar at University of Michigan, Shiri Azenkot at Cornell Tech, Jeffrey Bigham at Carnegie Mellon University, Lydia Chilton at Columbia, Nicola Dell at Cornell Tech, Daniel Epstein at University of California Irvine, Jon Froehlich at the University of Washington, Krzysztof Gajos at Harvard University, Mayank Goel at Carnegie Mellon University, Ravi Karkar at University of Massachusetts, Matthew Kay at Northwestern University, Eleanor O'Rourke at Northwestern University, Kyle Rector at University of Iowa), are faculty at teaching-focused institutions (e.g., Catherine Baker at Creighton University, Lauren Milne at Macalester College, Anne Spencer Ross at Bucknell University, Adrienne Slaughter at Northeastern University, Kyle Thayer at the University of Washington), and lead industry research groups (e.g., Saleema Amershi at Microsoft, Jeffrey Bigham at Apple, Mira Dontcheva at Adobe, Kayur Patel at Apple).

Allen School faculty also advise and co-advise students in other programs through collaborations with DUB faculty, and we helped launch and continue to help lead the Master of Human-Computer Interaction and Design, currently in its 9th cohort. This leading multi-unit multi-disciplinary program is a sibling to DUB, attracts students from around the world, and has served as a model for additional UW programs. Our undergraduates have gone on to leading graduate programs, and our leadership of the AccessComputing Alliance has helped to advance the representation of people with disabilities throughout computing.

Computer Graphics, Computer Vision, Game Science, and Augmented and Virtual Reality: Students graduating from our group have thrived over the years. Many undergraduates, after doing research in the group, have gone on to top graduate programs including Stanford, MIT, Berkeley, and CMU. The success of Ph.D. students has been significant, taking many faculty positions in the US (CMU, Stanford, Cornell, Princeton, Penn, Georgia Tech, Wisconsin, Northwestern, UC Santa Cruz, U Hawaii) and abroad (NTU Taiwan, KAIST Korea, SIT Singapore, NECTEC and VISTEC Thailand), as well as many jobs in top research labs including Adobe, Apple, Facebook, Microsoft, AI2, Amazon, and Google, and R&D positions at production companies such as Pixar and Industrial Light and Magic. A number of alumni have received major awards, among them: Hugues Hoppe (MSR and Google; SIGGRAPH Computer Graphics Achievement Award), Per Christensen (Pixar; Technical Academy Award), Seth Cooper (Northwestern; ACM Dissertation Award), Brett Allen (ILM and Google; Technical Academy Award), Aseem Agarwala (Adobe Research; ACM Dissertation Honorable Mention), Noah Snavely (Cornell; NSF PECASE, Sloan, ACM Dissertation Honorable Mention, ACM SIGGRAPH Significant New Researcher Award), Li Zhang (Wisconsin, Google; NSF CAREER, Sloan, Packard), Karen Liu (Georgia Tech, Stanford; NSF CAREER, Sloan, TR35), and Adrien Treuille (CMU; NSF CAREER, TR35). Finally, a number of postdocs have also gone on to faculty positions (Harvard, Toronto, UW, Hebrew University, TU Darmstadt, NTHU Taiwan, Simon Fraser) and top research labs (Adobe, Facebook, Google, Dropbox, AI2).

Data Management: The students and postdocs who graduated from the database group are highly sought after: they have been hired as faculty members at Duke, Northeastern, UPenn, Wisconsin, Stanford, UC San Diego, UC Santa Barbara, Technion, and at all major technology companies: Google, Microsoft, Facebook, Amazon and others. Some of our graduates received prestigious awards: the MacArthur Prize (Christopher Ré), the ACM Doctoral Dissertation Award (AnHai Doan), the ACM SIGMOD Best Dissertation Award (Gerome Miklau, Christopher Ré and Paris Koutris, and runner up Nilesh Dalvi), and Google Anita Borg scholarships (Kristi Morton and Julie Letchner).

Machine Learning and Artificial Intelligence: Our machine learning students and postdocs have become leaders at top universities and research labs. Tianqi Chen (CMU) created practical ML systems that are used by every major company and many researchers around the world, including XGBoost, Apache TVM and Apache MXNet. Marco Ribeiro (MSR) started a new research area in model-agnostic explanations in ML, receiving four awards at top conferences, leading to many thousands of follow-on papers. Abe Friesen (DeepMind) won the IJCAI-2015 Distinguished Paper Award for his work on non-convex optimization. Rob Gens (Google) and Hoifung Poon (MSR) won the NeurIPS-2012 Outstanding Student Paper Award and the UAI-2011 Best Paper Award, respectively, for their foundational contributions to sum-product networks, a deep learning architecture. Vibhav Gogate (UT Dallas) won the 2011 PASCAL Probabilistic Inference Challenge and was the UAI-19 Program Chair. Other recent former students and post-docs are thriving at universities like the University of Wisconsin-Madison (Ramya Vinayak), University of Washington (Lalit Jain), Columbia

University (Lydia Chilton), and research labs at Google (Weihao Kong), FAIR (Aravind Rajeswaran), and Amazon (Rahul Kidambi).

Robotics: Students and postdocs from the robotics faculty's labs are consistently amongst the top candidates for academic and industry positions. Multiple students have won NDSEG and NSF Graduate Research Fellowships, as well as many fellowships from industry. Our alumni are now on the faculty at top schools including UC Berkeley, Cornell, Imperial College London, UMass Lowell, UMBC, USC, and the University of Washington. They also have also taken highly visible roles in industry and government research labs including Amazon, Apple, Deepmind, Disney Research, Facebook AI Research, Facebook Reality Labs, Intel, Microsoft Research, NASA JPL, Toyota ITC, Waymo and others, and have spun off several startups in the Seattle area.

Natural Language Processing: Students and postdocs from the NLP faculty's labs are consistently amongst the top candidates for academic and industry positions. They have also received many prestigious awards, including NSF, Microsoft, Facebook (x2), Google, Apple, and IBM Fellowships. Our alumni are now on the faculty at Berkeley, CMU (x2), Cornell, Princeton, UT Austin, U Penn, Chicago, Edinburgh, EPFL, USC, U Maryland, and UMass Amherst, amongst others. They also have taken highly visible industry roles at all of the major tech companies, including Amazon, Deepmind, Facebook, Google, Microsoft, and more.

Computing for Development: Our graduates and post docs are having a major impact in the field, both at universities and through technology NGOs. Graduates have been placed at UC Berkeley, Georgia Tech, University of Cape Town, Cornell, and Cornell Tech, as well as multiple students at companies such as Google and Microsoft. Two graduates have received the TR-35 award, Tapan Parikh and Kurtis Heimerl (who received his undergrad degree from UW working on ICTD research projects.)

Data Visualization: Students and postdocs in our group have received significant accolades, in addition to the paper awards mentioned in the previous section. Dominik Moritz received the 2020 IEEE VGTC Outstanding Dissertation Award. Leilani Battle (former post-doc, now UW faculty) was named to the 2020 MIT Technology Review TR35 Innovators Under 35 list. Multiple students have received NSF Graduate Research Fellowships. Group alumni have gone on to hold prestigious positions in both industry and academia, including startup founders (Trifacta, Lilt, Observable), journalists (graphics editors at CNN and the New York Times), and tenure-track faculty at MIT (Arvind Satyanarayan), CMU (Dominik Moritz), Cornell (Yea-Seul Kim), and the University of Washington (Leilani Battle).

Ethical AI: The group's former students and postdocs have roles as faculty at UW (Lalit Jain) and University of Wisconsin (Ramya Vinayak), and in numerous research groups in critical industrial positions (at Amazon, Google, and Facebook, amongst others). Their undergraduate mentees have Ph.D. positions at Penn, CMU, CU Boulder, and more.

Computing for the Environment: Allen School students (Sidhant Gupta, now at MSR) founded Zensi (acquired by Belkin) which is responsible for the Phyn water sensing product line and the WeMo Conserve product line. Vikram Iyer, a student of Shyam Gollakota, won a Marconi award for his biology-based sensing technologies and has just joined the UW faculty. Other notable graduates include Jon Froehlich (faculty at UW), Eric Larson (faculty at SMU), Rajalakshmi Nandakumar (winner of SIGMOBILE Dissertation award and faculty at Cornell), and Vamsi Talla (winner of SIGMOBILE Dissertation award). Allen School student (Vikram Iyer, now at UW) has also been instrumental in creating Project Eclipse in collaboration with Microsoft to achieve hyperlocal environmental sensing and create a full stack – from sensors to analytics-sensing platform for cities. The goal is a radical increase (10x – 100x) in the geographic granularity of environmental sensing in cities in support of a variety of public health scenarios, starting with air quality. This project has deployed 100s of sensors in cities like Chicago that are currently being used to understand racial climate justice.

Computational Health: Some of our former students that are now in industry and academic conducting research in computational health include Keyu Chen (Google), Mayank Goel (Prof at CMU, MSR Fellow), Lilian de Greef (Apple, NSF Fellow, MSR Fellow), Mohit Jain (MSR), Eric Larson (Prof at SMU), Tien Lee (Google), Alex Mariakakis (Prof at Toronto, NSF Fellow), Rajalakshmi Nandakumar (Prof at Cornell Tech), Vaishnavi Ranganathan (Microsoft Research), Ruth Ravichandran (Amazon), Alanson Sample (Prof at U. Michigan), Edward Wang (Prof at UCSD, NSF Fellow), Jim Youngquist (Proprio Co-Founder), Amy Hurst (Director of the Ability Project at NYU), Sunyoung Kim (Rutgers)

Security and Privacy: One of our undergraduate students received the 2019 CRA Outstanding Undergraduate Researcher Award in 2019 (after being a finalist in 2017 and 2018). Security Ph.D. and postdoc alumni have obtained faculty positions at Columbia University, University of Illinois Urbana-Champaign, University of Utah, University of Washington, University of Wisconsin, Wellesley College, and Western Washington University. Graduated Ph.D. students have obtained positions at Facebook, Google, Intel, and NVIDIA. UW students have been co-authors on papers that received the USENIX Security '19 Distinguished Paper award, the IEEE Symposium on S&P '19 and '20 Test of Time awards; the USENIX ATC '16 Best Student Paper award; the IEEE

Symposium on S&P ‘12 Best Practical Paper; the USENIX Security ‘09 Best Student Paper award; the IEEE Symposium on S&P ‘08 Best Paper award. Multiple Ph.D. students have received NSF Graduate Research Fellowships. Since 2008 we have sent a team to the Pacific Rim Regional Collegiate Cyber Defense Competition; our team of eight students (at least six undergrads) won 1st place in 2008-2013 and 2017-2021; the team also won the national event in 2011 and 2012. Hundreds of undergraduate students have taken undergraduate computer security (CSE 484) or computer security capstone (CSE 481S) courses, preparing them to bring a computer security mindset into their subsequent careers; graduate students have been served with graduate computer security (CSE 564) and special topics (e.g., cryptography, misinformation) courses.

Cryptography: The UW cryptography group was established in 2019, and since then, students in the group have published at least 10 papers at top cryptography venues including Crypto, Eurocrypt, TCC, Asiacrypt. During this time, the group has also hosted three postdoctoral researchers (Joseph Jaeger, Marshall Ball, and Tianren Liu) who respectively secured tenure-track faculty positions at Georgia Tech, NYU, and Peking University. Joseph Jaeger also won the Best Paper by Early Career Researchers Award at CRYPTO ‘20. Marshall Ball was selected as a CI Fellow. Prior to the group's arrival at UW, Binyi Chen (PhD, 2019) won the best-paper award at EUROCRYPT ‘17. Also, Viet Tung Hoang (postdoc 2015-16) won the NSF CAREER award in 2021, and a best-paper award at ACM CCS ‘15.

Theory of Computation: There has been an exciting leap in the quality and impact of research by our theory students. Over the last few years, Ph.D. students in theory have published numerous exciting papers in the premier theory conferences (FOCS, STOC and SODA) and have received an NSF Graduate Fellowship, an MSR Research Ph.D. Fellowship and an NSERC Postgraduate Scholarship. Quantum computing Ph.D. student Ewin Tang was named one of the Forbes 30-under-30 and Ph.D. students Nathan Klein and Kuikui Liu each co-won a best paper award at STOC. Our students have also won best student paper awards at SODA, QIP, and EC, among others. Undergraduate students that did research with our faculty have gone on to top Ph.D. programs, and have become young stars in the field, e.g., Sam Hopkins (assistant professor at MIT), Mark Bun (Boston University) and Jerry Li (Microsoft Research). Prasad Raghavendra (Ph.D. alum, 2009) is a recipient of the Michael and Sheila Held Prize given by the National Academy of Sciences, the Sloan Research Fellowship, and best paper awards at STOC 2008 and 2015. Frank McSherry (Ph.D. alum, 2003) co-won the Gödel Prize for his groundbreaking research co-inventing and developing differential privacy. Most recently, for the first time, one of our students, Kuikui Liu, will be joining the faculty at MIT.

B. Here are some Ph.D. dissertation awards won by our graduate students and faculty in the last decade.

- Rajalakshmi Nandakumar - 2021 SIGMOBILE Doctoral Dissertation Award
- Tim Althoff - 2019 SIGKDD Doctoral Dissertation Award
- Ming Liu - 2021 SIGCOMM Doctoral Dissertation Award (Honorable Mention)
- Irene Zhang - 2018 Dennis M. Ritchie Doctoral Dissertation Award
- Vamsi Talla & Justine Sherry - 2016 SIGCOMM Doctoral Dissertation Awards
- Vamsi Talla - 2016 WAGS/UMI Outstanding Innovation in Technology Award
- Karl Koscher - 2016 SIGSAC Doctoral Dissertation Award (Runner-Up)
- Shayan Oveis Gharan - 2013 ACM Doctoral Dissertation Award (Honorable Mention)
- Roxana Geambasu - 2013 SIGOPS Dennis M. Ritchie Doctoral Dissertation Award (Runner-Up)
- Shyam Gollakota - 2012 SIGCOMM Doctoral Dissertation Award
- Shyam Gollakota - 2012 ACM Doctoral Dissertation Award
- Saleema Amershi - UW Graduate School 2013 Distinguished Dissertation Award
- Mike Piatek & Aruna Balasubramanian - 2012 Doctoral Dissertation Award of SIGCOMM (co-runners-up)
- Jon Froehlich - 2012 UW Distinguished Dissertation Award
- Peng Dai - ICAPS 2012 Best Dissertation Award
- Seth Cooper - 2011 ACM Doctoral Dissertation Award
- Aruna Balasubramanian (UW postdoc) - UMass Amherst 2011 Outstanding Dissertation Award
- Noah Snavely - 2009 ACM Doctoral Dissertation Award (Honorable Mention)
- Chris Ré - 2010 ACM SIGMOD Jim Gray Doctoral Dissertation Award

Appendix F.3: Allen School Extended Leave Policy Exception

Paul G. Allen School of Computer Science & Engineering
Policy Exception: Faculty Extended Leave Options

This document describes a Director-, Dean-, and Provost-approved exception to the University of Washington's general two-year limit to leaves of absence for the purposes of outside professional work for tenure-track and tenured professorial faculty in the Paul G. Allen School of Computer Science & Engineering.

Motivation

The Paul G. Allen School, the College of Engineering, and the University of Washington support high impact, translational research and entrepreneurship; in the modern world of computer science, both often require tight industrial relationships.

University faculty, especially in some areas such as Computer Science, have always had opportunities to engage fruitfully with industry through consulting, by creating startups, and through other collaborations. Faculty who have engaged in these types of experiences have ranged in their research expertise, from those who focus on basic science, to academics with a bent toward translational research and entrepreneurship.

Successful engagements with industry can bring many benefits to students, the Allen School, the College of Engineering, and the University of Washington:

- They can enhance the student experience by providing faculty with greater knowledge of the needs and research problems that arise in industry. Faculty who engage with industry can bring that experience back into their classrooms. They can provide students with recent and relevant industry examples and anecdotes. They can update the content of their courses to better reflect the state of the art in both academia and industry.
- They can enable access to resources beyond what academia can provide. Interesting datasets and large-scale or unusual computer resources can become available to faculty members and their graduate students for their research.
- They can strengthen collaborations with industry experts. Real-world problems can inspire faculty and graduate students to select research problems that have a direct practical impact. Industry experts can be co-advisors to students and even co-authors on papers.
- Faculty with engagement with industry frequently bring gift funds to the university in support of university research.

Over the past 5-10 years, however, there has been a growing trend in major technology centers such as Seattle and the Bay Area, but also others, where faculty have seen increasingly many opportunities to engage in "deeper than consulting", and longer than two year relationships with for-profit and nonprofit organizations. This shift creates both opportunities and challenges and a recent CRA Report [1] provides an excellent analysis of this new world. A key challenge is that these circumstances have set up a tremendous demand for high quality computer science professorial faculty members and retention is becoming increasingly challenging.

The Allen School and the College of Engineering support the University's limited leave policy because of the need for faculty to engage in the teaching and research mission of the school and college. Extended leaves beyond two years have the potential to impede the school's and college's ability to execute their mission by holding lines open that should be used for faculty fully engaged with students and research. However, given the multiyear growth of the Allen School and funding that is already in place, the school is at this time in a unique situation in which there is no immediate financial need to recover recurring faculty salary lines if a faculty goes on an extended leave to engage more deeply with an outside organization. With these special circumstances, there is reason to make an exception to institutional policy on a limited and structured basis.

There are several reasons to support *extended* leaves:

- **Access to Research Infrastructure, Data, People, and Research Ideas:** In many fields of Computer Science & Engineering, cutting-edge research requires unprecedented resources. Modern AI research, for example, requires extensive computing resources [2]. Those resources can take other forms too. For example, some resources take the form of data such as large-scale web crawls. Resources can also take the form of teams of researchers and software engineers. In all of these cases, a faculty member's research is accelerated by a deep and *continuous* engagement with industry. At the same time, these kinds of engagements can help spur new research questions that might not emerge solely from traditional scholarly activities.
- **Leadership Opportunity**: Seattle is a high-tech hub. As the talent-pool in Seattle grows, more companies move to our city and seek to establish new research groups and research centers. Those companies may reach out to faculty members to help them lead and establish those centers. In such cases, a faculty member may need to be on partial leave for several years to achieve impact and gracefully hand-off a functioning lab to a subsequent lead.
- **Startups:** Faculty members in the Allen School frequently found startups. When the startups are successful, they may get purchased. Such a purchase may require the faculty members involved to remain at the company that bought their startup for some number of years.
- **Other Impact:** There are many ways to demonstrate broader impact and translating research into practice often requires unique arrangements with industry.

The Allen School circumstances are similar to those of its peers. Traditional university policies are rigid with respect to extended leaves, which is causing some of the best faculty to leave academia and when they leave, it hurts students. A recent NYTimes article [3] discusses this problem, citing a recent study from the University of Rochester. Other articles [4] discussing the problem and potential solutions are also appearing. Opportunities outlined in this document will help address these unique retention and scholarship needs.

Policy Exception

Opportunities in industry are unlikely to disappear. In order to ensure that the Allen School, the College of Engineering, and the University of Washington continue to thrive and that our students receive a high quality education, a policy exception for extended leaves of absence for faculty in the Allen School is available. For the purposes of this policy exception, the term “faculty” refers to tenure-track and tenured professorial faculty with a primary appointment in the Allen School. Faculty who hold joint appointments with a 50% or more primary appointment in the Allen School, may be considered for eligibility for a policy exception on a case-by-case basis. Exceptions will require the approval of the director of the Allen School, the Dean of the College of Engineering, the chair/director/campus dean (or dean in an undepartmentalized school or college) of the faculty member’s secondary unit, the dean/chancellor of the secondary unit in a departmentalized school/college/campus, and the Provost or his/her designee. A memorandum of understanding would need to accompany any approved exception.

The following principles guide the policy exception:

- During any leave or partial leave, a faculty member's position in the Allen School and the University of Washington must remain their primary long-term employment commitment.
- Any leave or partial leave must respect our individual and collective commitments to our graduate students, who have themselves made long-term commitments in joining the Allen School to work with our faculty.
- Any extended leave option that is an exception to current policy must have conditions that ensure fairness with respect to the colleagues of any faculty members taking leaves or partial leaves.
- Only faculty members at the ranks of Associate Professor and Professor are eligible for extended leaves at or above the level of 34%.

Timing of Leaves: A faculty member may be eligible to engage with industry at a deeper level than one day per week consulting after a *minimum of three years* of full-time employment at the University of Washington. In exceptional circumstances, a 1%-33% leave may be approved before the three-year time-frame.

Annual Renewals: Consistent with existing UW policy, each request for a leave of absence will only be considered and approved one year at a time.

First Two Years: The existing UW policy related to leaves for outside professional work will continue to apply for leaves up to two years in duration. Note that these leaves are also approved on an annual basis.

Beyond Two Years: If a faculty member desires to remain on leave beyond two years, they can apply for an “extended leave”, following one of the options below. Importantly, each and every engagement requires the approval of the Director of the Allen School, the Dean of the College of Engineering, and ultimately of the Provost or his/her designee. Each extended leave request must articulate how the engagement will benefit the University of Washington and the Allen School. Positive impact on all is a requirement for extended leaves. Each request must include the required documentation (see next section), which includes a careful plan for graduate student advising, and it must be submitted in a timely fashion (the dates are discussed below). Extended leaves are further dependent on the outcomes of annual reviews (discussed below). All procedures regarding promotion, tenure considerations, regular conferences with the chair, merit-based salary reviews, and other Faculty Code and University policy provisions are to be followed while a faculty member is on an extended leave. Finally, the fact that a faculty member satisfies the criteria below does not ensure that a leave will be approved.

Total number of leaves: While the intent of the policy exception is to consider each leave request in isolation, the Allen School may need to limit the total number of faculty members who take a leave at the same time in order, for example, to ensure that it can cover instructional needs.

Leaves vs. one day a week consulting: Faculty members who are *not* on leave can engage in consulting no more than one day per seven-day week, provided that the outside consulting work does not impair the faculty member's ability to carry out regularly scheduled teaching or other work assignments or to complete terms of grants and contracts. This activity requires annual approval, as outlined in Executive Order No. 57.

When the desired outside work exceeds the one day per seven-day week limitation, a faculty member must be approved for a commensurate leave. The leave options below are inclusive of all outside work and account for these limitations.

Extended leave options:

- **1%-33% leave (beyond 2 years):** In the case where outside work is highly synergistic with a faculty member's research and directly accelerates that research, a tenure-track Assistant Professor or a tenured Associate Professor or Professor, may be eligible to take a 1/3 or less leave from UW without a predefined time-limit, so long as the faculty member can demonstrate that the leave continues to be beneficial to UW and while conditions in the Allen School can support such a leave. Note that this leave must include all of a faculty member's outside work for compensation (i.e., the faculty member cannot engage in additional consulting on top of that leave). This level of leave is equivalent to a faculty member taking a teaching release, except the faculty member engages with industry instead of paying their UW salary during the release quarter. The expectation for this activity level is the following:
    - Teach two courses / year (no additional releases). The two courses should be spread across two different quarters.
    - Continue to regularly teach undergraduate and quals courses as part of the teaching assignment in the same way other faculty members do.

    - Maintain a research output consistent with the level of activity in the Allen School.
    - Participate in other activities such as colloquia, industry affiliates day, and other school events at a percentage consistent with the percentage time that the faculty member remains active in the Allen School. Remain engaged in School life beyond immediate duties.
    - Continue a regular service load at a level consistent with the activity level.
    - Continue regular work with graduate students.
    - The faculty member is expected to spend ⅔ of their time on campus throughout the academic year. The faculty member should not plan to be completely gone for any extended period of time. The faculty member is also encouraged to spend adequate time on campus during the summer in order to ensure their students make good progress through the graduate program.
    - This leave option is not available to Assistant Professors in the year of their mandatory review for promotion and tenure.

- **34%-50% leave up to 6 years (2 years standard UW policy + 4 years extended):** A faculty member at the rank of Associate Professor or Professor may be eligible to take up to a 50% leave from UW for up to a total of, and not exceeding, 6 years. This level of leave means that the faculty member:
    - Teaches one and a half undergraduate or graduate quals courses every year, with the possibility to buy out of the one-half teaching. If a faculty member does not buy out, they should teach two courses in one year and one course in the other year.
    - Maintain a research output consistent with the activity level in the Allen School.
    - Engages in service at a level proportional to their activity level in the Allen School by participating in School committees such as the graduate admissions committee, the undergraduate admissions committee, the faculty recruiting committee, etc.
    - Participates in other activities such as colloquia, industry affiliates day, and other school events. Remains engaged in School life beyond immediate duties. Participation should be consistent with the activity level in the Allen School.
    - Participates in faculty meetings consistent with the activity level in the Allen School.
    - Or performs a different but equivalent set of duties as defined by an MOU that must be approved by the Executive Committee of the Allen School.

- **34%-50% leave beyond 6 years**: If a faculty member at the rank of Associate Professor or Professor desires to remain at a 34%-50% leave level beyond six years, the faculty member can request a permanent reduction of their appointment up to 50%, which will require the approval of the Director of the Allen School, Dean of the College of Engineering, and Provost or designee. It is possible to request a subsequent increase in appointment (i.e., return to 100%), but this process *requires a full review and vote of faculty,* and must be a part of the School's hiring plan. The faculty member must be in good standing, deemed meritorious in annual reviews while on leave, and meet performance expectations. Importantly, going back to 100% is not guaranteed. It is contingent on the School's budgetary situation, the School's hiring plan and growth priorities, the faculty review and vote, Director's support, and the Dean's support. The School is not obligated to provide any reason for declining to increase the appointment.

- **51% or more leaves up to 4 years (2 years standard UW policy + 2 years extended):** If a faculty member at the rank of Associate Professor or Professor desires to reduce their level of engagement below 50% beyond a typical two year leave, they can request up to an additional 2 years (total of 4 years). The responsibilities associated with this leave level include:
  - Co-advising graduate students.
  - Regular in-person meetings with graduate students.
  - Active academic research program.
  - Faculty hiring within the faculty member's area of expertise (i.e., review of faculty applicants, participation in onsite interviews, and participation in faculty discussions).

- **51% or more leaves beyond 4 years (2 years standard UW policy + 2 years extended):** Beyond four years, faculty members need to resign from their tenure-track or tenured position and seek appointment into a *"Distinguished Affiliate"* position. This is a courtesy appointment, with no guaranteed UW compensation, but is offered upon the basis of continued, distinguished engagement with the Allen School. This position has the important characteristic that a faculty member may request to be rehired by the Allen School into a tenure-track position at a 50% or higher activity level. Such reemployment requires a full review and vote of the faculty, but may be considered for a recruitment waiver during the hiring process (i.e., the faculty member may be reemployed without a competitive recruitment). The faculty member must be in good standing, deemed meritorious in annual reviews while on leave, and meet performance expectations. As above, the possibility to return is not guaranteed. It is contingent on the School's budgetary situation, the School's hiring plan and growth priorities, the faculty review and vote, Director's support, and the Dean's support. The School is not obligated to provide any reason for declining to increase the appointment.

Important Note: Faculty members on 34% leave or higher have lower priority for teaching advanced graduate courses. They get lower priority consideration for career-development and other professorships and chairs. They similarly get lower priority for other opportunities within the Allen School.

Annual Review: Continued leave should be granted only if the faculty member is deemed meritorious after completing their annual activity report and other merit-based performance expectations. In addition, the activities of a faculty member on 34% or higher leave must be reviewed annually. The annual review will consider their research output, the progress of their graduate students, their teaching performance at the undergraduate level, their impact on curriculum, their involvement in overall school activities, their mentorship of junior faculty, and their other commitments. Additionally, the Allen School graduate program coordinator will check-in with affected students every six months. The graduate program coordinator may recommend the addition of a co-advisor when appropriate. Faculty members at 33% leave or less will be reviewed on the same schedule as full-time faculty members.

Clock Reset: After being granted an extended leave, a faculty member must return to the Allen School at **100% for at least three consecutive academic years following the end of their extended leave** in order for their leave clock to reset. For example, consider a faculty member who takes a two-year leave at 80%, then switches to a 50% leave for three years, then comes back for one year, and then goes on leave again. The final year of leave will be considered a 6th year of leave.

Sabbatical Clock: If a faculty member takes a leave of absence at 34% or more for at least one year, the School considers the leave equivalent to a sabbatical in terms of subsequent sabbatical requests. This would be a locally implemented review criterion for sabbatical requests, and would be used at the time the School and College are considering and prioritizing such requests.

Additionally, if a faculty member takes a sabbatical, the faculty member must come back to UW at 100% for at least one full academic year following the sabbatical year before another leave request is granted. Failure to comply with this requirement shall trigger an obligation on the faculty member’s part to repay the University any and all remuneration received from the UW during the sabbatical leave.

By exceptional approval of the Dean of the College of Engineering, a faculty member may opt to meet their sabbatical payback by returning to the UW at 67% or more over two full academic years following the sabbatical year. If granted, failure to comply with this agreement shall constitute an obligation to repay the University *the full amount of remuneration* received from the UW during the period of sabbatical leave.

Leave Request Timeline: Initial leave requests for the next academic year must be communicated to the Allen School director no later than **March 15th** or as soon as the need for leave becomes known. The leave documentation should then be sent to the Assistant to the Director by April 15th to ensure that it can be approved by June 15th. If a faculty member fails to fill-out appropriate leave documentation on time or if they ignore any other email requests from the Assistant to the Director of the Allen School, their leave will automatically be denied. If a leave is denied, the faculty member is expected to fulfill the responsibilities and duties of their full appointment. Once a leave request is complete and reviewed and approved at the Allen School level, it will be submitted for review by the Dean of the College of Engineering and if approved, the Office of the Provost.

Logistics

Faculty members must obtain written approval prior to taking partial or full leave and will be required to submit the following materials:

1) **UW College of Engineering Leave Without Pay Form (full and partial leaves)**
2) **Professional Outside Work Form (Form 1460)**
3) **Concurrent Engagement Agreement** (where applicable)**:** This agreement is especially important for faculty members working in industry or at a startup where copyright or intellectual property assignments are required for their outside work. The agreement is also particularly important for determining how to counsel and advise students.
4) **The Allen School Leaves Questionnaire, which includes:**
    a) **Leave Plan:** Description of the scope of the leave, the location, the time spent on campus, the time spent outside of campus, and the general engagement plan with the School. There needs to be a convincing case made that the University of Washington is the faculty member's top priority in the long term, and that the external relationship has the potential to benefit the University of Washington. In the event a faculty member wishes to be considered for promotion during a proposed leave year, the request should be included in the leave plan.
    b) **Conflict of Interest Management Plan**
    c) **Teaching and Service Plan**: A list of seminars, courses, and service that will be maintained during the leave. It should address the impact on other faculty members in the area (e.g., how the requested leave would impact coverage of courses).
    d) **Student Advising and Mentorship Plan:** This document must include a detailed mentorship plan that includes the frequency and depth of advising for each student and postdoc. Please see the checklist below for details on how to prepare this plan.

Advising and Mentoring Checklist for Faculty on Extended Leaves
When you request a leave of 6 months or more:

- ❑ Submit to the School a detailed plan on how each of the Ph.D. students you advise and temp advise, as well as postdocs, will be handled. This plan should include
    - ❑ The student's name
    - ❑ Current status in the program (pre-quals, post-quals, post-generals, postdoc)
    - ❑ Plan for meetings (frequency, format, who the meeting will be with). *We expect that you will be available for weekly meetings with each of your students. (Being available for an hour a week seems to work for most students.) If this isn't possible, please arrange for a secondary advisor that they can go to on a weekly basis. For example, another faculty member in the group could be appropriate. We also expect that you will be able to respond to email requests in a timely fashion, ideally within 24 hours.*

    - ❏ Plan for funding
    - ❏ Concerns related to progress or anything else.
    - ❏ Plan for postdoc mentoring
- ❏ Provide the names, email addresses and home department for any students you are advising outside of the Allen School.
- ❏ A copy of the plan will be emailed to you, the individual student, and the graduate program advisor, graduate program coordinator, and the Director.
- ❏ The plan needs to be updated and resubmitted on a yearly basis.

Every 6 months during the leave:

- ❏ The School will check in with each Allen School student and advisor on leave to make sure that everything is going according to plan. This is an opportunity to assess and make adjustments to the plan.

At Review of Progress (May):

- ❏ Advisors are expected to fill in the form and have the usual Review of Progress meeting with their students regardless of leave status.

Policy Exception Review

The Allen School faculty will review this policy exception after 3 years, or sooner if the Allen School Director notices that extended leaves are creating problems for the School, the College, the UW, or if the conditions in the Allen School change. The outcomes of the review will be reported to the Dean and the Provost for exception continuation. The policy exception may also be reviewed at the direction of the Dean of the College of Engineering or the Provost.

____________________________ ____________________

Magdalena Balazinska Date
Professor and Director, Paul G. Allen School of Computer Science & Engineering
University of Washington

____________________________ ____________________

Nancy Allbritton Date
Frank & Julie Jungers Dean of Engineering
Professor, Bioengineering
University of Washington

____________________________ ____________________

Mark A. Richards Date
Provost and Executive Vice President for Academic Affairs
Professor, Earth and Space Sciences
University of Washington

FAQ

Q: Can a faculty member consult for a company one day a week in addition to being on an extended leave?
A: No.

Q: If I satisfy the criteria described above, am I guaranteed the ability to go on an extended leave?
A: No. There are no guarantees. The Allen School Director with the advice of the Allen School Executive Committee can decline leave requests if a leave is determined to be detrimental to the school or to the university, if too many faculty are on leave simultaneously, or for other reasons. Leaves can also be declined by the Dean and Provost.

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