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## Assessing and Responding to the Growth of Computer Science Undergraduate Enrollments

Computer science (CS) is currently experiencing a surge in undergraduate enrollments that is straining financial resources at many universities, causing concern among faculty and administrators about how best to respond. There is also significant interest in what this growth will mean for the future of academic computer science programs, the field as a whole, and U.S. society more broadly.

This report examines drivers behind the current computer science enrollment surge, possible institutional responses to it, and the impacts of those responses on students, faculty, and institutions. It offers recommendations for what colleges and universities, government agencies, and the private sector can do to manage the surge and plan for a strong and sustainable future for the field of computer science.

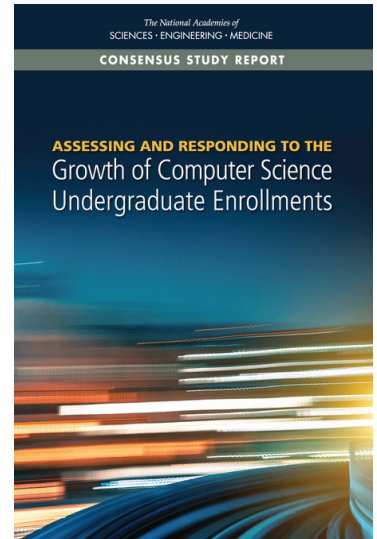
### THE CHANGING LANDSCAPE OF COMPUTER SCIENCE ENROLLMENTS

Data show that the number of computer science majors in U.S. colleges and universities has increased since 2006, rising at a steeper rate beginning in 2012. From 2006 to 2015, the average number of CS majors increased for large departments (25 or more tenure-track faculty) from 341 to 970, and for small departments from 158 to 499 majors. These data likely underestimate the actual demand, as some institutions cap the number of students who may major in a program.

The increasing demand for computer science courses is not limited to those majoring in the field; interest in CS courses has grown at a similar rate among non-majors, reflecting the increasing importance of computing skills across professional fields and in daily life.

Rising enrollments are straining program resources at many institutions. The most common challenges cited by departments include increased faculty workload; too few faculty, instructors, or teaching assistants; greater need for academic undergraduate advisers and administrative support; and increased need for classroom, lab, and office space. In recent years over half of new PhDs in computer science have taken jobs in industry, posing challenges to finding faculty. Recent data indicate that the average increase in tenure-track computer science faculty at research institutions was only about 10 percent of the increase in the number of computer science majors.

An important factor driving the CS enrollment surge is the labor market, where the number of jobs far exceeds the number of computer science graduates. According to the Bureau of Labor Statistics, employment in computer occupations outside of the technology sector grew by nearly a factor of 20 between 1975 and 2015 – almost twice as fast as the production of



bachelor's degrees in computer and information science and support services. In particular, expertise in cybersecurity, data science, and machine learning is in high demand.

## RESPONDING TO THE ENROLLMENT SURGE

Computing's deep and growing penetration into virtually all sectors of the economy, all academic disciplines, and all aspects of modern life will continue to drive increasing enrollments in undergraduate computer science, from both majors and non-majors. There will probably be fluctuations in the demand for courses, but the longer-term trend is that CS course demand will fluctuate, the long-term trend is that enrollments are likely to continue to increase for many years to come.

Because U.S. colleges and universities have various missions, priorities, and business models, there is no one-size-fits-all solution to rising enrollments. However, all institutions of higher education need to make strategic plans to realistically and effectively address the growing student demand for CS courses. How colleges and universities respond to the surge in student interest and enrollment will have a significant impact on the health of the discipline.

The report identifies a range of potential strategies that could be pursued alone or in combination, and the advantages and risks of each, along with key areas for self-assessment to inform institutional action. Examples of such strategies include using technology for teaching, such as video lectures and automated grading; creating new organizational structures, such as colleges of computer science; and hiring additional faculty in order to meet demand. Each approach has benefits and costs, and university leaders will need to select strategies and make trade-offs that are appropriate to their institution's mission and values.

## RECOMMENDATIONS

The report offers a series of recommendations for institutions, federal agencies, states, and industry, including the following:

- The leaders of the institutions of higher education that have experienced rapid increases in computer science enrollments should take deliberate actions to address this trend with a sense of urgency.
- A range of strategies should be considered as part of a comprehensive institutional strategy, from targeted controls on enrollments or resource additions to meet demand, to more extensive institutional changes that extend beyond the computer science department.
- Institutions experiencing a computer science enrollment surge should seriously consider an increase in resources to address the rising workload on faculty and staff in computer science and related departments, and the limitations arising from inadequate facilities.
- Some institutions may view the imposition of limits on enrollment in computer science and related courses as desirable or unavoidable. However, before imposing limits on course or major enrollments, the consequences of doing so should be considered comprehensively, and the benefits and cost weighed for the entire university community.
- Institutions should take deliberate actions to support diversity in their computer science and related programs. In particular, they should assess how computer science enrollment growth – and any actions or strategies for responding to it – affects the diversity of their student bodies, and deliberately align their actions and the culture of their programs with best practices for diversity and retention. Institutions should leverage the increasing interest in computer science and related fields, among both non-majors and intended majors, to engage, recruit, and retain more women and underrepresented minorities into the field.

The National Science Foundation (NSF) can be especially helpful in advancing undergraduate computer science education in the context of increasing enrollments, for both majors and non-majors. The agency should seriously consider actions such as:

- o using its convening power to bring computer science faculty and institutional leaders together to identify best practices and innovation in computer science education in times of limited departmental resources;
- o supporting research on how best to use technology in teaching large classes;
- o supporting research to advance the understanding of best practices for diversity in computing, including rigorous and longitudinal assessment of the efficacy of specific institutional practices, especially those taken or considered in times of high enrollment; and
- o creating an initiative to expand instructional resources in computer science.

- Computer science departments and the computing industry should develop new partnerships to help higher education meet workforce needs, continue to graduate well-prepared students, encourage industry to provide increased support for research funding, and allow a better exchange of PhD-level researchers between academia and industry.
- Public institutions produce a significant fraction of each state's workforce and the nation's computer science undergraduate degrees. States should provide sufficient support to their public institutions to enable them to support fully their academic missions, including with respect to computer science education.

A full list of recommendations can be found in the report.

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**For More Information...** This Report Highlights was prepared by the Board on Higher Education and Workforce, based on the Consensus Study *Assessing and Responding to the Growth of Computer Science Undergraduate Enrollments* (2018). The study was sponsored by the National Science Foundation. Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of any organization or agency that provided support for the project. Copies of the Consensus Study Report are available from the National Academies Press, (800) 624-6242; <http://www.nap.edu>.

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