

**UVA Computer Science Curriculum: Preparing Computer Science Students for the
Changing Technical Landscape**

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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ABSTRACT

The University of Virginia's computer science curriculum needs to evolve to ensure key skills are aligned with the changing landscape and prepare undergraduate students to become competitive job applicants and innovative contributors and leaders in the computer science industry. To accomplish this, I propose increasing the number of programming languages students learn, reformatting the curriculum to provide exposure to specialty areas beyond software development, and including a course to address non-technical skills such as interviewing techniques and networking. With these changes, UVA undergraduate CS students would be well-positioned to pursue internships and enter the competitive workforce. The success of these changes would be measured by establishing a baseline with past CS undergraduates, conducting follow-up surveys with students participating in the new program, and evaluating the degree to which the new undergraduate experience prepared them for the workforce.

1. INTRODUCTION

What do I really need to know for my job? What skills are employers looking for? Many undergraduate CS students find themselves asking these questions. While the UVA CS curriculum does a good job of covering the fundamentals they need to begin their career, students can feel intimidated and

underprepared to understand how to begin their job search and prepare for interviews. Given the wide range of focus areas in computer science, students are left wondering what technical skills they should pursue to enter the competitive job market.

Employers require a variety of skills and abilities due to the ever-changing landscape of technology and business focus areas. UVA students learn the basic principles of programming, data structures, algorithms, and computer systems, but have limited resources available to build interview skills or understand the types of computer science careers they would be most competitive for based on their curriculum focus.

CS has many specialty areas, yet the UVA curriculum only touches on software engineering, and classes covering other specialty areas are limited as they can only be taken as electives. This can be a disadvantage as some employers may seek applicants who have both a broad knowledge base and in-depth focus in a specialty area. Due to rapidly evolving technologies in computer science, many internships and jobs require knowledge of programming languages that were not part of the UVA curriculum.

2. RELATED WORKS

Lawrence-Fowler, et. al. (2015) discussed several issues college graduates face when

transitioning from college into the workforce, along with strategies to mitigate these issues. As faculty in the CS department at the University of Texas-Pan American, they posited that the main issues graduates face are learning everything they were not able to learn in college and professionalism in the workplace. They proposed having project-based courses to develop marketable skills such as the ability to adapt to changing characteristics of the field. These concerns formed the basis of my argument that undergraduates need to develop the necessary skills to help them acclimate to an ever-changing workplace. This leads to my proposal of expanding the curriculum to include a class on workplace readiness skills and increasing the number of programming languages learned to address the skill gap.

Maghsoudi (2023) analyzed the most essential skillsets in CS jobs by performing a Social Network Analysis on the LinkedIn social network. He found four distinct skill communities: Generalists, Infrastructure and Security, Software Development, and Embedded Systems. The analysis of critical CS skillsets influenced my proposal to call for the reformatting of the CS curriculum to address a need for a focus in specialty areas. The UVA curriculum mainly focuses on the Software Development skillset through learning Java, Git, and SQL, whereas other areas such as Generalists and Infrastructure and Security are barely touched on.

Lawrence-Fowler, et. al. (2015) and Maghsoudi (2023) inspired my proposal for changing the UVA CS curriculum to make it more applicable to real-world jobs. Lawrence-Fowler, et. al. (2015) showed that graduates often struggle with transitioning to the workplace when they are without proper guidance and experience. Maghsoudi (2023) demonstrated that the program needs to expand their required classes to be applicable

over a range of topics to have skills more reflective of the current environment.

3. PROPOSED DESIGN

Current CS courses can be modified to include a wider variety of programming languages prevalent in the industry, and the curriculum can be expanded to include a broader spectrum of CS specialties. The proposed changes to the UVA CS curriculum are separated into four parts: the difference in CS classes between the BS and BA curriculum, the restructured curriculum, a new Career Readiness course, and changes to select CS classes.

3.1 BSCS vs. BACS Classes

All students in the current BSCS and BACS curriculum programs are required to complete the following eight foundational CS courses: Introduction to Programming, Data Structures and Algorithms 1 and 2, Discrete Mathematics and Theory 1 and 2, Computer Systems and Organization 1 and 2, and Software Development Essentials. Additionally, BSCS students are required to take Advanced Software Development Techniques and 15 credits of CS electives at the 3000 level or higher. BACS students are required to take 9 CS elective credits at the 3000 level or higher and 12 CS integration elective credits. Integration electives are non-CS courses that apply computer science to fields in the arts and sciences.

3.2 Restructured Curriculum

The restructured UVA CS curriculum will keep the eight foundational CS courses and modify how students will select their CS electives at the 3000 level and above. In addition, the curriculum will require a one credit Career Readiness course. Currently, the CS curriculum mainly focuses on software engineering. To address this, CS electives will be separated into five categories: Cybersecurity, Software Engineering,

Computer Systems, Artificial Intelligence, and Digital Media. These specialty areas were constructed based on current course offerings at UVA. Below is a division of common CS electives in the previously listed categories:

Cybersecurity:

CS 3710 Introduction to Cybersecurity
CS 4630 Defense Against the Dark Arts

Software Engineering:

CS 3240 Advanced Software Development Techniques
CS 3250 Software Testing

Computer Systems:

CS 4457 Computer Networks
CS 4740 Cloud Computing
CS 4750 Database Systems

Artificial Intelligence:

CS 4710 Artificial Intelligence
CS 4774 Machine Learning

Digital Media:

CS 4720 Mobile Application Development
CS 4730 Computer Game Design

The restructured curriculum will require students to take a minimum of one course in any three of the five specialty areas. For BSCS students, 9 of their CS elective credits will be spread out across multiple specialty areas to establish a broad knowledge base, and six of their CS elective credits can be used to pinpoint a focal area they would like to pursue. Advanced Software Development Techniques will not count as a CS elective for BSCS students since it is already required.

The BACS curriculum will require students to take 12 CS elective credits and 9 integration elective credits. This adjustment will allow 9 of their CS elective credits to be in three specialty areas with three CS elective credits in a focal area of their choice.

3.3 Career Readiness Course

The current CS curriculum does not require students to take a class for job readiness, which can leave students unprepared for job interviews and the transition from school to the workplace. The Career Readiness course will be a required one-credit CS class to help prepare CS students for the workforce. This class will meet once a week on a pass/fail grading scale.

The Career Readiness Class will have the following topics: interviewing skills, career fields, networking opportunities, and job searching strategies. This course will help students develop their resume and will require students to attend at least one job fair. This class will feature interview workshops where students can practice interviewing each other and prep for technical interviews that are commonly required in the CS industry. In addition, representatives from companies can present and talk about their work during class, exposing CS students to the different specialty areas of CS and providing networking opportunities.

3.4 Changes to CS Classes

The current CS curriculum requires UVA students to learn the following programming languages: Python in Introduction to Programming, Java in Data Structures and Algorithms 1 and 2, C and x86 assembly in Computer Systems and Organization 1 and 2, and Java and SQL in Software Development Essentials. To help students learn more prevalent programming languages in the CS industry, such as JavaScript, C++, C#, and PHP, some of the programming languages used in these courses will be changed.

In Computer Systems and Organization 2, I propose that the assignments should be programmed by students in C++. Students learn C in Computer Systems and Organization 1, and the programming

language C++ uses C as the basis for its own language. C++ is commonly used for programming operating systems.

The Advanced Software Development Techniques course requires students to use Python, HTML, and CSS in their semester-long project to create a web application. I propose that JavaScript should be used to create the web application instead of Python because JavaScript is used to develop web applications similar to the course's semester-long project and it is a prevalent language required for many CS internships and jobs. Common programming languages in the workplace are also covered through students taking electives in multiple specializations, such as PHP in Database Systems and Kotlin in Mobile Application Development.

4 ANTICIPATED RESULTS

By adopting the proposed changes into the CS curriculum, we can expect that students will be aware of the computer science specialties they can focus on, have a grasp on multiple programming languages prevalent in the CS industry, and be prepared for job interviews. Taking classes within multiple specialties will provide students with a general understanding of the multiple focus areas of CS so they can concentrate on a specific specialty, which will prepare them for the type of field they would like to work in.

The changes in programming languages used in multiple courses will allow students to apply to more internships and full-time jobs that require those programming languages as a prerequisite. Additionally, the Career Readiness course will prepare students for interviews with companies, which will likely lead to UVA CS students having a job lined up for after they graduate. Students will be more competitive job applicants and feel more prepared for the workforce.

5 CONCLUSION

With the adoption of the proposed curriculum, CS undergraduates will feel better prepared for their transition from school to the workplace. The revised curriculum provides a variety of CS specialties and programming languages to solidify common knowledge needed in the CS industry, and the Career Readiness course encourages students to pursue internships and full-time jobs through building their resume and practicing interviewing skills. By fully developing undergraduates' CS foundation by making it applicable to future jobs, CS students will be prepared for the workforce.

6 FUTURE WORK

Colleges like the University of Virginia can adopt the proposed changes in the revised CS curriculum to better prepare undergraduates to enter the work industry. To fully measure the impact of the proposed curriculum changes, alumni from the former curriculum would be interviewed to set a baseline, and graduates from the new curriculum would be given follow-up surveys to determine how prepared they felt for the workforce with the new curriculum. To expand on this project, schools can implement an internship program where students work at an internship for a semester to gain job experience.

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