

THESIS PROJECT PORTFOLIO

Computer Science Education: Synthesis of the Curricula of Data Structures and Algorithms

(Technical Report)

Analysis of Algorithmic Bias and its Interaction with Society

(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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ANALYSIS OF ALGORITHMIC BIAS AND ITS INTERACTION WITH SOCIETY

STS advisor: Kent Wayland, Department of Engineering and Society

PROSPECTUS

Technical Advisor: Rosanne Vrugtman, Department of Computer Science

STS advisor: Benjamin Laugelli, Department of Engineering and Society

Computer science and its auxiliary fields have numerous applications and the ideas discussed in the thesis highlight how two very different applications are valuable when combined in research. The topic of the technical work is the combination of two classes in the UVA curriculum that would enhance the learning experience for prospective students. The two classes are CS 2110 and CS 4102, essentially putting the general topics of data structures and algorithms together and creating a curriculum that synthesizes the information presented in that class. The STS topic addresses the idea of algorithmic bias in computer science and how algorithms can be trained to include unintentional biases. My technical and STS projects both address aspects of the socio-technical problem of how algorithms are taught and used and how they can have detrimental implications if done incorrectly. In what follows, I will demonstrate through both the technical project (changing how algorithms are taught) and the STS project (analyzing algorithmic bias through the lens of cases, socio-technical framework, journals) how the field of computer science can be improved in this specific aspect.

For the technical project, there are several problems in the current education path that are addressed by the proposed synthesis of the two courses. One of the issues is the lack of application by teaching the two courses together. For a brief description, the course CS 2110 is one of the earliest courses in the computer science path and is mainly a course based on teaching Java and some of its simple data structures. The course goes into depth about Java and its functionality but vaguely goes over algorithms as a small part of the course. CS 4102 is the course titled “Algorithms” and it is one of the last courses that Computer Science majors at the University of Virginia have to take. As can be seen in the name, the course goes into depth about several different types of computer science algorithms such as divide and conquer, graph algorithms, and Ford-Fulkerson. This course can either be completed in Java, Python, or C++. As

students explore the workforce and the computer science jobs that are available, a synthesis of these two courses could be more beneficial than having them taught separately. The technical project goes through all of the considerations with the combination of these two courses.

The STS project focuses on the severe issue of current bias in algorithms and how that can affect society and future technology. The argument for the STS research addresses how algorithmic bias can be addressed through the lens of several cases and socio-technical frameworks. This argument seeks to find resolutions and auxiliary concerning algorithmic bias while exploring the cases and evidence used. The major claims of this section of the thesis focus on how technology in the form of algorithms have been perpetuated by issues in society and suggestions on how that can be remedied. Using case studies dealing mainly with healthcare systems, melanoma research, facial recognition technology adds to the argument presented, with the analysis drawing further conclusions about possible issues and solutions. This concludes with new insights about algorithmic bias in CS today and a recommendation of next steps to further solve this problem.

The work that was completed throughout this year was valuable because of its possible applications in both the education-side of CS and the work-side as well. Some aspects of the technical project have already been adapted in the UVA CS curriculum, with the removal of courses like CS2110 and CS4102 coming in the near future. I also think that the use of project-based learning in the technical project's proposed curriculum could be a good addition to the new curriculum that is being developed. The possible applications and next steps of both of these projects make me proud of the results. I think that devoting time to compiling and analyzing information about these major topics was fruitful because it also helped me learn about future impacts and topics that I can address as I graduate as an engineer out of UVA. Future work

concerning the technical project would be analysis of teaching strategies with the new curriculum implementation and acquiring student data on the proposed curriculum. As for the STS research, I recommend that researchers conduct studies based on specific social trends directly interacting with algorithm bias to allocate primary data. There are endless approaches that can be used in light of completion of this thesis, all which would provide further insight to a field that is constantly evolving.