Applications of Q-Learning in Coding with Snap!
(Technical Paper)

Analyzing Methods for Promoting Inclusion and Diversity in Computer Science Education
(STS Paper)

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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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The presence of technology around us every day is coupled with a problem with diversity among those developing this technology. This inequity can be attributed to the fact that several groups such as women, Black, and Hispanic do not continue on to upper level computer science courses at the same rate as other demographics (Ericson & Guzdial, 2014). There have been several different attempts at promoting inclusion in computer science education which have had varying levels of success.

Both my technical and STS projects focus on the issue of inclusion in computer science education. For my technical project, I will be working on Tunescope, a tool designed to integrate the arts into computer science education. Tunescope is built on Snap!, a programming language that is designed to be user friendly for students who do not have programming experience (Harvey & Mönig, 2020). I will be working with a team including two other undergraduate students on the Tunescope project with the help of Rich Nguyen, a machine learning professor, and Glen Bull, a professor in the Curry School of Education. My individual piece in this project is to create a Q Learning Agent capable of providing students live and accurate feedback when they are stuck on trying to solve a simple task using Snap!. For my STS project, I will be examining several case studies to determine the relationships between actors in each. I am analyzing three main types of studies that attempt to promote inclusion in computer science curriculum: a systematic approach to change all courses, an individualized approach to reach underrepresented students, and a mix of the two that examines single classes aimed at promoting inclusion at the individual level. After analyzing these three methods, I will make a recommendation on the best approach to promoting inclusion and diversity in computer science education.

Technical Topic

In today's society, technology is a part of everyday life for most people. As a result, it is a widespread belief that "different sectors should be represented in the process to define and develop technology" (Garcia-Holgado et al. 2019). While it would be ideal if there was interest in pursuing careers in technology from every person, that is simply not the case. According to a study by Tai, Liu, Maltese, and Fan, "students with expectations for a science related career were 3.4 times more likely to earn physical science and engineering degrees that students without similar expectations" (2006). After seeing this information, the question becomes one of how to engage students that are pursuing other fields so that people similar to them might be represented in the design and development of future technologies. There are currently some technologies with this in mind such as Arduino, a company that produces microcontrollers and microcontroller kits that enable users to do many different things such as create wearable technologies by sewing the microcontroller and sensors into fabrics (Beuchley et al., 2008). This concept can be expanded into other fields in the arts besides clothing design, such as drawing or creating music.

During the 2020-2021 academic year, I will be working on a capstone project in a team with two undergraduate students, Eric Stein and Yuxin Wu. Our technical advisor will be Rich Nguyen, a machine learning professor in the Department of Computer Science. In addition, Glen Bull, a professor in the Curry School of Education will be working with us at guiding the overall goals of our project. For our project, we are working on several different facets of a new educational tool for professors to teach computer science. It is built on an open source platform, Snap!, which was created at the University of California Berkley as a tool to simplify and teach the basics of coding to new computer science students (Harvey & Mönig, 2020). The project

we're working on is called Tunescope, and it aims to provide students a way to integrate computer science education with the arts. Using Snap! we have created our own custom blocks for students to use that allow them to code both music and art in an attempt to spice up computer science education.

Figure 1. Example Blocks Used by Students in Snap! (Harvey & Mönig, 2020)

Tunescope is currently used in a seminar taught by Glen Bull that focuses on learning how students can use coding to create music and art as two of the pieces of the course. This seminar also uses the Arduino devices mentioned before. My individual goal for this project focuses on a more specific feature: how students receive help and feedback for specific tasks. By the end of the fall semester, I hope to have completed a proof of concept for the applications of machine learning in our project for a simple assignment. The task my project focuses on consists of having the students draw a square using the Snap! framework provided. To achieve this goal, I am working on a creating a Q Learning Agent that takes in the current set of code blocks selected by a student and is able to suggest the best action for that student to take in order to complete their task of drawing a square. This functionality in our project for such a simple problem is designed to show that machine learning can be used to help not just students who are stuck but also professors who don't have the time and/or knowledge to give each student personalized feedback at any point in their work.

STS Topic

According to the U.S. Bureau of Labor Statistics, the number of computer science jobs available is expected to grow 15% from 2019-2029, much faster than the average compared to other fields (Computer and Information Research Scientists: Occupational Outlook Handbook, 2020). Given the presence of technology around us in nearly every aspect of life, it is essential that the future generations of computer be inclusive of a greater variety of people from different backgrounds. Despite the rapid growth of the field, the next group of students looking to study computer science is still extremely misrepresentative of the population (Ericson & Guzdial, 2014). A study conducted by Ericson and Guzdial examines the demographics of students taking the AP Computer Science A exam. They find that "the rates of participation among female, Black, and Hispanic students is quite low" when compared to each group's share of the population (2014). This disparity begs the question of how to promote diversity and inclusion for underrepresented groups in computer science.

For my sociotechnical topic, I will explore different examples and methods for inclusion in computer science education. I will also analyze the actor-actor interactions in each case study reviewed by applying Sismondo's Actor Network Theory, that any person or piece of technology forms connections with others in order to recommend the methods that I believe to be most effective at promoting diversity and inclusion (2010).

Systematic Approach to Inclusion

The problem of creating more diversity and inclusion in computer science can be approached in several different ways. One of the more common and widely studied approaches is a systematic one which aims to promote diversity at several different schools rather than one

individual program. One organization, Technology Education and Literacy in Schools (TEALS), connects schools with "trained technology industry professionals who volunteer their time throughout a school year" (Ibe et al., 2018). TEALS focus on adding actors in the form of professionals with relevant technological experience to the network of each school they work with. The TEALS program specifically created a Diversity, Equity and Inclusion Working Group (DEIWG) with the goal of identifying and assessing goals and changes they could make to the program to achieve those goals (Ibe et al., 2018). The DEIWG identifies five key program areas: school recruitment and selection, student recruitment and engagement, volunteer recruitment and placement, instructional support, and curriculum. Each of these areas centers around a different set of actors: school administrators, students, volunteers, teachers, and experts respectively; however, I plan on analyzing the interactions between all of the groups with one another and the overall effect of this strategy on diversity in the schools studied.

Individualized Approach to Inclusion

Another way that inclusion can be promoted in computer science is through a more individualized approach. Rather than attacking the ~~problem of a~~ lack of diversity by going through the underlying emphasis across all computer science courses, a single class or even a single person can be targeted in an attempt to increase diversity. A case study by Dennehy and Dasgupta in 2017 employed the tactic of one on one peer mentoring in order to study retention rates and self-efficacy for female students pursuing engineering degrees. The methods used in this study rely on human to human relationships as the method of promoting diversity directly rather than through organizational goals. The results of this study indicate higher levels of both retention and self-efficacy among students with female peer mentors. These increases make the

individualistic approach more appealing as there is a positive relationship between levels of self-efficacy in education and GPA for a diverse group of students (Majer, 2009).

One more method I will examine is the promotion of diversity through a combination of direct person to person communication within the more systematic setting of an individual computer science course. This method emphasizes the connection between a person and a piece of technology rather than other people or organizations. Many schools now have courses focused around student-technology interactions by using hands on tools such as LEGO Mindstorms robots or the LilyPad Arduino to promote interest from all different groups of students to enroll (Apiola, Lattu, & Pasanen, 2010; Beuchley et al., 2008).

Three different approaches to promoting diversity based on human-organization, human-human, or human-technology relationships and interactions will be analyzed, centering around each study's measured success in inclusion. The first half of the semester will be spent analyzing each method in depth, and the second half will consist of formulating a recommendation for the best practices in inclusion in computer science education.

Next Steps

The issue of diversity in computer science education can be approached in several different ways. For my technical project, I will be working on improving the accuracy of the machine learning agent I create in order to show that the concept of using artificial intelligence can help both students and teachers be more efficient and clearer while solving problems in the context of creating art with code. Once I have completed tuning the agent for accuracy, I will focus on adding its suggestions into the website for students to play with and for Professor Bull to use in his course.

For my STS project, I will be compiling some examples of each of the three methods I outlined to promote inclusion in computer science education. Once I've gathered sources for each, I will analyze the interactions between all people and technologies in each study along with the study's effectiveness at increasing diversity.

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