Thermoelectric Water Bottle Cooling Station
(Technical Paper)

Societal Implications From Racial Bias In Machine Learning and Artificial Intelligence
(STS Paper)

A Thesis Prospectus Submitted to
the
Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia
In Partial Fulfillment of the Requirements of the Degree
Bachelor of Science, School of Engineering

Everett Patterson Jr
Spring 2020

Technical Project Team Members
Mac Baskin
Micah Harris
Robin Watkins

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

Signature _____ Date _____
Everett Patterson Jr

Approved _____ Date _____
Harry Powell, Department of Computer & Electrical Engineering

Approved _____ Date _____
Thomas Seabrook, Department of Engineering and Society

Introduction

The growing interdependence between technological development and societal construction is becoming increasingly vital to our everyday lives whether we are aware of it or not. Today, humans and technology are more intertwined than ever before, with major corporations, public entities, and governments relying more and more on technology to influence and govern societies. However, a major issue is the underlying and often unforeseen consequences that arise from using machines to perform complex tasks and decision making that will be utilized to dictate and construct both individual lives and overall societal constructs. An example of this can be found in algorithms and data sets used for artificial intelligence and machine learning techniques more specifically, algorithms and data sets used as inputs for computing machines which are used to make decisions that affect individuals and societies oftentimes contain racial bias. As illustrated by Chris DeBrusk, humans and data sets that have biases will often pass those biases to machines in the form of code. "Since machine-learning models predict exactly what they have been trained to predict, their forecasts are only as good as the data used for their training" (DeBrisk, 2018).

Failing to properly mitigate racial bias in these technologies has had damaging consequences on communities especially those that consist of racial minorities. From government surveillance to healthcare, law enforcement, and other entities, there is an increasing reliance on artificial intelligence and machine learning. And, it is crucial that developers, corporations, and public institutions carefully take the necessary steps to mitigate bias or technological advancement could intentionally or unintentionally prove to be an oppressive force on racial minority groups, which is the main inspiration for this topic.

The technical topic will focus around a cooling water bottle station that will allow for a user to input a desired temperature to cool down their water bottle. The motivation behind this design is to find a way to reduce water waste since a big contributor of water waste is by people throwing out warm drinking water and refilling it with cold water. Therefore, designing a device that allows for someone to set their water bottle to a desired temperature will help resolve this issue.

Technical Topic

The majority of people find a cold bottle of water more refreshing than a warm bottle of water. However, a major inconvenience for carrying around a water bottle is that over time the water inside the water bottle warms up due to external temperature. Thus, unless there is a refrigerator nearby it is impossible to cool the water back down, and oftentimes the water will be dumped out and wasted as it is no longer considered to be drinkable. One of the most common causes of water waste in households is for people waiting for tap water from the faucet to turn cold. A standard faucet installed in the 1990's flows at a little over 2 gallons of water per minute (Faucets – Residential & Commercial, 2019), meaning if it takes just 15 seconds for the tap water in the faucet to become cool then over half a gallon of water will be wasted for just one glass of water.

Identifying this issue, our group has proposed a design to help alleviate this form of water waste by creating a water bottle cooling station which a user will be able to put in their water bottle and set a desired temperature with a lower threshold of 33 °F. The design includes the use of a Peltier, module which is a thermoelectric cooler, along with a ventilation system

and heat sink and an LED light that turns on once the device has finished cooling. The motivation behind this capstone design is to help alleviate water waste by creating a convenient and small scale cooling system specifically designed for single water bottles.

While there exists devices that cool down water bottles such as coolers or refrigerators, they are very large scale cooling systems and thus are not very portable. So when needing to cool down drinking water, it is not always guaranteed that there will be a cooler or refrigerator around. Our proposed device will be small enough to be able to easily carry around and will serve more as a kitchen utility as opposed to a kitchen appliance. By designing a small scale cooling system as the one proposed, our goal is to mitigate water waste from people dumping out warm drinking water by providing a convenient cooling system that will cool down the water itself.

The closest device to a self cooling water bottle that is available are insulating water bottles that are able to keep water at a certain temperature for a long duration of time. However, there was a device named the Self-Chilling Can designed in 2000 which utilized vacuum heat pump technology (Crown Cork & Seal Co. , n.d.). The vacuum pump would extract heat from the water and displace it into a heat sink. With this method, the Self-Chilling Can was capable of cooling water down to 30°F in just a few minutes. However today, there does not exist a self cooling water bottle or a similar cooling station mechanism available commercially, meaning that our design will hopefully pioneer a new method for water waste mitigation.

STS Topic

In STS theory, an artifact is defined as an object made by a human being, typically having cultural or historical interest. This idea can be extended to technology, since by definition, any sort of technology is an artifact. So, one can ask the question: does technology have politics? According to STS theorist Langdon Winner, technology can be political in two ways: the first way "are instances in which the invention, design, or arrangement of a specific technical device or system becomes a way of settling an issue in a particular community." (Samuel Taylor, n.d.) The second way in which technology has politics "are cases of what can be called inherently political technologies, man-made systems that appear to require, or to be strongly compatible with, particular kinds of political relationships" (Samuel Taylor, n.d.)

For my STS topic, I will explore how artificial intelligence and machine learning have politics as a result of the racial bias they inherit from datasets and algorithms. These technologies are not inherently political, but instead the politics of these artifacts derive from their technological development. When thinking of technology that contains or perpetuates racial bias or inequality, it is often technology that is inherently political in the sense that there exists a governing body or group using technology to directly control or exploit another group. However, this is often not the case; instead, technology that acts as an oppressive force against racial minority groups often has politics by means of its technological development. I argue that technology itself is rarely ever initially designed to purposefully perpetuate bias or oppress certain groups of people. Instead, it is during the process of its technological development where technology may inherit bias from the society using the technology or be directly

manipulated by a governing body or institution to oppress racial minority groups. In other words, the original purpose of a technology is often either intentionally or unintentionally perverted to harm racial minority groups despite not being purposefully designed to do so.

Artificial intelligence and machine learning technologies are an example of these phenomena. These artifacts are very rarely intentionally designed to have racial bias, however in many instances, artificially intelligent machines are shown to have racial biases. It is important to have an in-depth discussion regarding the effects of racial biases in technology; since these machines are not designed to have biases, the harm caused by their bias will go unnoticed until after they have negatively impacted minority groups or may go unnoticed indefinitely. For someone unknowledgeable about artificial intelligence, it is valid to assume that machines cannot be racist since they are incapable of experiencing human emotion. However, in reality, humans develop algorithms and input data sets used for artificial intelligence and machine learning so instead, computers actually inherit human biases. The underlying issue is that increasing computational power and accelerated deployment of artificially intelligent machines could further enhance the complex racial divides already deeply embedded within our society.

In my thesis I want to address the potential consequences of continuing to use artificial intelligence without sufficient bias training and how technology that actually intends on reducing bias may instead further increase racial inequality if not properly regulated. Additionally, I will explore the morality of using technology as a method of trying to resolve the very complex issue of removing racism and racial stereotyping from society. Even if we one day are able to develop bias free algorithms and data sets, is relying on technology to

remove bias from society an “easy way out?” And, should society instead work harder to address these issues by removing biases from people, not algorithms, instead?

Research Questions and Methods

The research question I will be analyzing for the thesis is how do biases appear in artificial intelligence and what methods are used to mitigate these biases? Several methods will be invoked in order to properly deconstruct and analyze this research question. The first method will be to use historical case studies. One example an investigation by ProPublica on a software algorithm created by Northpointe which exposed how bias within their software used to determine a defendant's likeliness to recommit a crime once released from jail mislabelled black defendants as future criminals at almost twice the rate as white defendants (Julia Angwin, Jeff Larson, Surya Mattu & Lauren Kirchner, 2016).

Secondly, I will draw inspiration from Horst Wittle’s and Melvin Webber’s work and apply Wicked Problem Framing to the issue of bias in artificial intelligence. Artificial intelligence is now being used within health medicine, law enforcement, and government surveillance, among other problems which are deeply complex and dynamic societal issues. Therefore, the consequences of applying artificially intelligent methods to these issues such as bias are often indirect and unforeseen. As a result, ethical issues arise and “Social roles may be filled by AI algorithms, implying new design requirements such as transparency and predictability. Sufficiently, general AI algorithms may no longer execute in predictable contexts, requiring new kinds of safety assurance and the engineering of artificial ethical considerations” (Keith Frankish, William M. Ramsey, 2014). When taking this into

consideration, using artificial intelligence to handle social problems no longer appears to be a simple technological fix.

Lastly, I will use policy analysis and investigate current policies and methods that corporations and public entities currently use to mitigate racial bias in algorithms and data sets. From this, I will seek to identify shortcomings that current policy has when mitigating biases and then propose potential alternatives that could be instead used to improve modern day standards.

Conclusion

To conclude, the technical deliverable for the capstone design project is a water bottle cooling station that will be able to cool a single water bottle down to a desired temperature with a lower threshold of 33 °F. The purpose of this design is to mitigate water waste resulting from people throwing out warm drinking water in the place of cooler drinking water by instead providing a convenient way to cool warm drinking water without the need of a refrigerator or other large scale cooling system. The STS deliverable is a thesis paper that discusses racial bias in machine learning and artificial intelligence. To guide this argument, I will highlight STS theory, that talks about how technology has politics and the way in which these politics influence societal constructs that negatively impact communities, especially those which consist of racial minorities.

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