THERMO-STASIS, PELTIER-BASED VARIABLE TEMPERATURE PORTABLE BOX

ALGORITHMS, ARTIFICIAL INTELLIGENCE, AND THE HUMAN MIND

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By
Victor Xia

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Technical Team Members:
Diana Aleksieva
Eric Choi
Margaret Tran
Thu Nguyen

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.

ADVISORS

Joshua Earle, Department of Engineering and Society

Harry Powell, Department of Electrical and Computer Engineering

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Introduction

As technological solutions grow more complex and abstract, the public perception of what software can achieve grows closer to the realm of science fiction. We dream of artificial intelligence(AI) lifeforms with intelligence and adaptive learning rivaling the human mind's capabilities. We dream of virtual assistants that can answer any question and help you with any problems in life that you could think of, a capability AIs like ChatGPT seemingly come close to achieving.

In a way, recent developments in fields like cloud computing and AI reflect this push for abstraction. To the inexperienced, cloud computing gains an almost mythical quality, where you can send your calculations to some higher being in the clouds who will compute anything you ask of it. In reality, cloud computing just means sending off computing data to another server or computer to do the work your computer would've had to do ("What is Cloud Computing", 2022). Similarly, stories and media popularize AI as a computer capable of higher intelligence equal to humans, first coined by John McCarthy at the Dartmouth Summer Research Project on Artificial Intelligence in 1956 and continuing to capture the public imagination through stories like 2018's Detroit: Become Human ("The History of Artificial Intelligence", 2017). This promise of machine intelligence draws people to the field, where they quickly understand that AI is just a predictive model using large amounts of data to tune parameters and find patterns in the dataset. The answers generated by AI are not through higher intelligence thinking, but rather through predictions formed from training data.

Technology begins to embody human concepts and societal constructs, abstracting away the reality that everything is being implemented on the fundamental basis of logical 0's and 1's,

electric impulses and components that exist on a board residing in a device. This pursuit of abstract, near-human capabilities reflects a desire to push technology beyond its principal purpose of computation and data science into applications that traditionally reflect human tasks, like Starship Technology's autonomous food delivery robots that are slowly making their way around college campuses throughout the US (Grubhub Inc., 2022). This development reflects a trend towards technochauvinism, the belief that technology is the solution and can be used to solve any complex societal and technical challenge (Broussard, 2017).

The principal aim of this exploration is to understand why we have trended towards the belief that algorithms and technology has the capability to solve all technical and societal challenges, and how ongoing innovations in digital technology reflect this desire to match and surpass the human mind's capability. The technical project explores a different topic from the STS exploration, instead focusing on the engineering of a temperature-regulated portable box, constructed for food safety and drug transportation.

Thermo-Stasis, a Peltier-based Variable Temperature Portable Box

Solutions have existed for temperature-controlled environments for ages, with many solutions gravitating towards maintaining temperature through insulation and material construction. Very few address the concept of portability with the flexibility to heat and cool to a user-specified temperature, as our technical project does. My technical advisor is Harry Powell from the Department of Electrical and Computer Engineering. I am working on this project with Diana Aleksieva, Eric Choi, Margaret Tran, and Thu Nguyen. This technical report will document the design and testing of an alpha-stage prototype for a portable, variable-temperature box.

The box centers around the use of Peltier modules, or thermoelectric devices that generate a temperature differential when driving a current across the device, a phenomenon known as the Peltier effect. The Peltier module couples with both internal and external heatsinks and fans to effectively distribute the temperature of the Peltier module throughout the space of the box while dissipating heat generated from the device via fan cooling. Standard applications of Peltier modules focus on their capability to cool spaces, but flipping the direction of current through the Peltier module allows the module to also heat spaces, a characteristic used to keep the temperature constant across a wide range of temperatures.

The portability of the box requires the presence of batteries to support the operation of the device while disconnected from a power outlet. One particular trait of Peltier modules is that they require large amounts of power to run, resulting in needing a larger battery to keep the device running for a reasonable period of time. The high power draw of Peltier modules also results in significant heat loss, increasing requirements for how much heat the heatsinks and fans can dissipate from the system.

Aside from the electric requirements of the project, the box also requires a control algorithm loaded onto a microcontroller to effectively maintain the set temperature on the box. The control algorithm used to regulate the temperature of the space inside the box is known as a fuzzy logic controller. Conceptually, fuzzy logic simulates partial truths, where an input result can imply many different factors that all contribute in varying degrees toward the output. In a way, the fuzzy control in this project seeks to replicate the human decision-making process for how to tune a temperature device to achieve a stable temperature. With this algorithm, the box will react accordingly to both situations of insulation heat loss from the system and also changes to the set temperature by the user.

A portable temperature-controlled box can have many uses, in both medical applications in drug transport and food safety, in ensuring that food remains in safe temperature ranges hostile to bacterial growth. The aspect of portability adds a lot of utility to the device, allowing for the transport of contents within the box without concerns of temperature fluctuation, or having to pack thermal objects like ice or dry ice. Upon successful completion, the team will investigate further improvements to the design of the box to bring it closer to a production-ready level of polish. This project seeks to improve both food safety and drug safety by maintaining suitable environments for sensitive items.

The Pursuit to Surpass Human Intelligence

When did we stop thinking of machines and programs as a meticulously crafted collection of signals on a piece of hardware, but rather solutions to increasingly more complex societal systems? The STS-focused section of this portfolio will seek to establish a preliminary understanding of how algorithms and AI have grown from computational tools to concepts that capture the boundless potential of technology. At the same time, this paper will explore the fallacies that exist when thinking about technological solutions as alternatives to existing solutions to complex societal issues.

The promise of a technological utopia, where future technological advances will eliminate all societal issues, has captured the imagination of generations, inspiring them to enter the field of STEM and contribute to bringing about this techno-utopia. We expect algorithms to tell us what decisions we should make, which pieces of information are most pertinent to our understanding of a topic matter, and how we get exposed to the culture of our society and interact with others. There is faith in algorithms, that they contain intelligence and will provide the optimal solution to any societal problem that we design them to solve. The public perceives algorithms as embodiments of a certain societal concept rather than a collection of electrical signals on a circuit board exhibiting behavior intended by the designers.

AI, or the misconception of the capabilities of AI, lies at the pinnacle of the human pursuit for a digital analog of humans, a general intelligence capable of anything humans can do, and more. This faith in the capability of AI results in less oversight over how AI, ML, and other learning algorithms perform since people trust in the objectivity and superiority of the algorithm to at the very least outperform whatever a person could do. AlphaGo is commonly referenced when discussing the potential of AI, with less emphasis placed on the inconceivably large dataset

by which the algorithm trained to tune its parameters until it could reliably pick the move with the highest probability to win. AlphaGo can beat the best human Go players in the world. Does that capability represent that the AI has surpassed human intelligence, or does it represent the ingenuity of the designers and the collective wisdom of humankind in the 30 million games that went into training AlphaGo? (Broussard, 2017) As a whole, AI remains in the realm of predictive models from large and complex datasets where mathematical solutions prove too difficult to derive, a far cry from the promise of intelligence and a capability surpassing humans.

This faith in the performance of algorithms and AI, while a source of inspiration for generations of coders and techno-lovers, blinds people from the reality that improperly designed algorithms could contain inherent biases that serve to manifest societal issues, rather than eliminate them. Algorithms and AI, being designed by humans, can try, but not succeed completely, at being fair and objective in their results. Both training datasets used to evaluate the performance of algorithms, as well as the fundamental design of algorithms, can serve to perpetuate biases.

STS Methods and Frameworks

For this paper, I will utilize the STS methodologies of social construction of technology(SCOT) and literature synthesis. First, I will establish a base understanding of the history of AI by collecting and analyzing historical literature on the concept of AI, both socially and scientifically. These sources would range from the coining of the term AI by John McCarthy, to discussions on famous algorithms and proof of concept AI humans presented at tech conferences. Next, I will research sources to learn about the key stakeholders in the development of AI, primarily AI researchers, companies driving advancements in the technology, and the general public using the algorithms in their day-to-day lives. Finally, I will explore the concept

of a technological utopia, where technological advancements are seen as the solution to all problems in society. The technological utopia research will tie back into the discussion on AI through the public perception of AI being the breakthrough point for technology to match or surpass human intelligence.

The sources gathered will mostly be from books discussing the philosophies of the public when it comes to the impact of technology, as well as articles and historical references on events concerning the development of AI, and the rise of algorithms. The focus will be on sources with higher-level synthesis on the formulation of technology and the societal impacts associated with development of technology, rather than technical sources describing the specifics of the technology.

Foundational Texts and Primary Resources

A text that has greatly enhanced my understanding of the current state of technology as opposed to the concept of technology engrained in the public consciousness would be a book written by Meredith Broussard. This book, titled *Artificial Unintelligence*, tempers expectations and describes limitations of technology, refuting the ideology of technochauvinism, where for all problems, there exists a solution that could be implemented through technological means (Broussard, 2017). She asserts that innovations in digital technology don't appear out of nowhere, with every piece of software having a logical precedent and months of work leading up to the creation of the piece of software. She also asserts the power of digital technology in bringing convenience to daily life, but refutes the idea that everything in society can be replaced by digital alternatives — a promise that true AI, with the full capabilities and adaptability of the human mind, can theoretically bring to reality. Broussard ultimately concludes that the digital solutions developed over the half century of technological advances has not resulted in a better

form of society, merely reflecting the same issues that have plagued human society, just in a different form. Broussard draws from various historical sources to paint a narrative of computational history, from the first computer dubbed ENIAC to the coining of the term artificial intelligence by John McCarthy.

Another text that sheds light on the current state of technology versus the public perception of technology is Ed Finn's book on the role of algorithms in today's society, *What Algorithms Want*. Finn explores how algorithms have been abstracted away into concepts by companies and society, where people grow to trust in the accuracy and validity of the algorithm rather than staying critical and understanding the shortcomings and issues inherent in algorithms. Many algorithms are taken for granted; we trust that Netflix will give us accurate recommendations based on shows we've watched previously, that Uber's feedback system will encourage drivers and riders to behave and protect riders from rude or dangerous drivers (Finn, 2017). He argues that consumers treat algorithms as a black box, where it can be trusted to give the right results for people, almost like the algorithm has an intelligence of its own rather than being the design work of engineers, fine tuned to work exactly as the designers expect. Finn concludes that algorithms are culture machines in today's society that abstracts away complex interactions, and that this importance lends an urgency to redefine how we create and use algorithms to enhance, rather than govern, our lives.

Cathy O'Neil's book, *Weapons of Math Destruction*, digs deep into the fallacies by which faith in the superiority of software and technological systems can result in societal impacts, on both the beliefs of people and economic livelihoods of others. She conducts case studies on the power of big tech to govern how we learn and process information online, through their algorithms that govern our search results and news feeds. O'Neil also analyzes how lack of

oversight on the design of algorithms and technological solutions can result in people losing their jobs, i.e. the layoff of 206 teachers from the results of a teacher assessment tool developed by a single designer. Her book reinforces the idea that technological solutions are not exempt from the issues present in society, and that societal issues manifest in digital solutions just as they do with pre-existing solutions, due to inherent biases in both data collection and how designers design their algorithms.

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