Thesis Portfolio

Wearable Cognitive Assistant Systems for Emergency Response

(Technical Report)

An Analysis of Morality in Autonomous Vehicles

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

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Spring, 2020

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Sociotechnical Synthesis

Introduction

I had the opportunity during my fourth year at UVA to plan and conduct two research projects of my choice. As a computer science major, I chose to investigate topics that would not only expand my interest in the subject which I would be immersed in for the rest of my life, but also show me some impacts of computer science on the real world. I chose ethics in autonomous vehicles (AVs) to be the focus of my STS research, not only because AVs were becoming more prevalent by the day, but also because I had a strong interest in learning more about how and why ethics matter in computer science. My technical research involved building a negation detector for use in medical contexts because I had a desire to learn more about natural language processing techniques, as well as potentially do some machine learning tasks. This negation detector would be used in a wearable device that can assist a first responder at the scene of an emergency. The wearable device provides the first responder with treatment suggestions based on the vital signs of the patient, as well as the verbal communication from the first responder. Hopefully, as AVs become smarter, safer, and more widely adopted on the road, wearable devices such as the one being developed by my technical research team will need to be used less and less often.

Wearable Cognitive Assistant Systems for Emergency Response

Detecting negations in a medical context is a very unique challenge for two reasons. Negations in a medical context are different from those in normal, conversational English because of where they are placed in relation to the verb. In a medical context, the verb itself is often a negative verb, whereas in conversational English, the verb is usually accompanied by a negative word. For example, the phrase “patient denies taking medication” has the negative verb

"denies," while in the phrase "patient does not take medication," the word "not" negates the verb "take." In many cases, sentences in a medical context take on the form with the negative verb. This makes negation detection in a medical context difficult, as searching for negative words in a sentence such as "no" or "not" will not yield all the negated concepts. In addition, only the concepts that were already determined to be of interest should be included in the list of detected negations. For example, in the sentence "the patient said they do not feel good, and denies chest pain," only the concept "chest pain" should be returned as negated. In order for a program to be good at negation detection in a medical context, it needs to address both of these challenges.

My approach to solving these challenges is a user-extendable program that uses a list of around 400 known regular expressions for different English modifiers commonly used in a medical context. The presence of these known regular expressions determines whether a given sentence contains a negative modifier describing a concept or not. If a given sentence contains a negative modifier, the program looks at the rest of the sentence to determine all the subjects that are related to that modifier. I am able to provide my program with a list of all the medical subjects of interest, such as "pulse rate," "headache," or "chest pain." The program uses this list to determine whether a negation pertains to a medical subject or not, thereby eliminating unwanted non-medical negations. This negation detector will eventually be integrated with a wearable device, to be used by a first responder at the scene of an emergency. The wearable device can provide treatment suggestions by listening to the first responder's words, and determining what symptoms apply and do not apply to a patient.

An Analysis of Morality in Autonomous Vehicles

There are hundreds of thousands of car crashes in the United States every year. Most of these accidents are caused by acts of human error, such as not paying attention to the road,

driving aggressively, or overcompensating on a turn. AVs have the potential to drastically cut down on this number by replacing the human driver with a faster-reacting computer that is constantly aware of its entire surroundings. However, AVs would require the computer inside the car to be responsible for everything a human driver would normally be responsible for, including what happens in an accident. In a situation where injury or loss of life is inevitable, inside the car or outside, the car must make what it considers to be the most moral decision. What are possible solutions to creating an ethical AV? In order to answer this question, utilitarian ethics and wicked problem framing will be used to support and justify claims and recommendations throughout the research. The study expects to find that autonomous vehicles should implement a policy to always prioritize the safety of the passengers inside the vehicle. It also hopes to show that the conventional way of discussing AV ethics using the trolley problem is unproductive and unfair, and that ethics for AVs outside of the inevitable trolley problem scenario should also be considered.

Conclusion

Working on both my STS research and technical projects together has been a valuable experience. I spent a year researching methods on how to create an ethical AV for my STS project, and developing a technical project that justified why it would be highly beneficial for AVs to become widely adopted. The technical project I worked on throughout this past year has a real potential to help first responders save the lives of victims from car accidents in the future. However, after countless hours of coding, frustration, and debugging, it can become very easy to forget about that real-world impact, and think of the project as just another mundane coding assignment. By concurrently working on my STS research with my technical project, I have been

forced to constantly consider how my work right now could potentially save thousands of lives in the future.