Utilizing Multi-threading in Order to Optimize Processing
(Technical Paper)

An Analysis of Social factors in High Stress Situations
(STS Paper)

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Chi Min Jung
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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

Signature ______________________________ Date __________
Chi Min Jung

Approved ______________________________ Date __________
Henning Mortveit, Department of Systems and Information Engineering

Approved ______________________________ Date __________
S. Travis Elliott, Department of Engineering and Society

Introduction

Computer science is deeply entrenched in our everyday lives. There isn't a day that goes by where most of us in the Western world aren't interacting with a piece of technology that is dependent on this field. Computational ability has proven extremely powerful in filtering through huge amounts of data and speeding through complex calculations. Pooling all of these together allows for some smart predictions and simulations. Take the project I am involved in for example. I am working on a project that takes a series of different points of travel on a map. Each point is connected to another via modes of travel, such as walking, driving, and traveling by train. A simulation is then run to calculate all possible routes of travel, in the shortest amount of time. This is part of a larger project that can take this data and simulate travel routes in the event of a disaster. This is to predict routes that might become too congested and to help better plan for emergencies. This is all well and good, and these preventative measures could help reduce casualties. But one has to wonder if people would actually trust this system. In such a state of panic, would people be willing to trust the results of a simulation over their own instinct? Let's ignore the implications of the human condition and ask a more general question: What is the likelihood that people would trust in technology, even in high stress situations?

STS Framework

When talking about the relationship between people and technology, it is important to look at the different stakeholders that are involved in this. The situation that is being analyzed is the public's trust in these simulations in states of panic. The area that is being specifically being examined is Richmond, Virginia. There are two stakeholders here. One, obviously are the citizens of Richmond, the ones whose lives may depend on these simulations if some disaster level should occur. The other stakeholder is the Public Safety Committee or more generally the government and policy makers. One would assume that those depending on these simulations would want them to be accurate and dependable in routing out emergency travel options. Both these groups have an interesting relationship with the technology in that there must be a maintained level of trust in different situations. There are a number of different factors that may impact how this relationship of trust is affected. Has it been put into practice before? Has there been extensive testing done to verify the results of the simulation? And one of the most important, has there been any instances that this simulation failed to protect the safety of people? Even with the perfect combination of factors, how people may react during an actual emergency, may differ completely. It is these different situations that this paper seeks to look deeper into.

As we have established in the above paragraph, a relationship of trust must be built in order for the acceptance of this technology into the lives of the people. There is an STS theory that highly correlates with this idea. SCOT or Social construction of Technology is a constructivist theory of technological innovation that successful theories are as much as a product of their social context as unsuccessful ones. The idea being that social reception and acceptance hold important weight in determining whether or not a society adopts the relevant technology ("Social construction of technology (SCOT)," 2009). This theory comes is inspired from SSK or Sociology of scientific knowledge which, "considers the social factors that may impact or affect scientific development relative to rational empirical and other factors" ("Sociology of scientific knowledge (SSK)," 2009). Again, essentially the argument is made that social factors are an important component of the scientific development of ideas. It considers that it may have an impact with respect to the actual empirical data that is produced from the relevant scientific work. Some of the key tenants of this theory is the idea of relevant social groups. Essentially, the theory goes into detail that there will be different social groups that have different social priorities and their own ideas of the problem that the technology is being made for. Due to this, each group will try their hand at getting their interpretations and designs across, trying to overcome the designs of other groups. There are two possibilities that might occur, either one group presides over the other, or multiple groups come together and reach a compromise. In either case, the process is called stabilization (2006). Basically, the theory holds that the interpretation of the results of scientific or technological advancements are more important than the facts themselves.

How this might relate to this topic is quite simple. Panic and fear are real social responses that occur in stressful situations. While this technology is well and good, what really matters is if people decide to opt into following the simulation models during a state of emergency and high stress. The trust aspect is the social adoption in this case. Do these theories appear appealing and something that will prioritize a person’s safety? Or does the newness of the technology present uncertainties that lead to decisions based more on instinct. All of these have less to do with the actual performance, nor empirical data than it has to do with one might feel about the technology. Knowing this, we can examine the stakeholders of this technology and pin them as our social groups. The biggest group, the public, is concerned for their own individual safety and for those around them that they themselves have a stake in, for example family and friends. The government or committees putting these ideas into place is concerned about efficiency and is concerned over maximizing the safety of all individuals. These two ideas sound similar, but one is concerned over individuals and the other is concerned about a group. Individualism versus utilitarianism. It is because of these reasons that SCOT has been decided as the leading STS framework in which the thesis will continue to investigate.

STS Research

One of the methodologies of investigating the behavior of people during high stress situations. Because this technology is concerned with a mass amount of people, it would be most appropriate to research Mob mentality or herd mentality. This is the idea that the way people operate and think change within group settings (Editor, 2004). In high stress situations, where a mass of people are trying to get away, the question is how likely are people to follow a precautionary implementation that came from a simulation? Alongside looking at mob mentality, it would be best if the idea of self-preservation was also looked into. Natural disasters and large-scale emergencies could have people fearing for their lives. Now let's have hundreds of thousands of people with the same sort of fear. How will mob mentality and herd mentality affect their thinking? How will fear of death also affect their thinking? With these questions in mind, a framework can be set up in investigating how people will respond to this technology. This is another interesting question as we have a microcosm of the SCOT theory working in this very specific situation. When people's lives aren't in danger and the public isn't in a panic, people may very be more accepting of these ideas. But in the actual situations of emergency, how will people's willingness to adopt this technology change? Real life examples can also be cross examined and compared to build a working understanding of how people might behave. By looking at this psychological aspect of a particular social phenomenon, answers may be reached for these questions.

Another methodology is looking at the ethical and moral side of things. Mentioned earlier, it was stated that the two main stakeholders have similar but very different goals in these emergency situations. Individualism versus Utilitarianism, for the benefit of one versus the benefit of the entire group. It would be interesting and useful to see what these ideologies are and looking at how it is they are related in people's decision making. It would also be interesting to investigate the presiding ethical theory in such a society. If a society was more utilitarian, would the adoption of this technology go more smoothly? The city of Richmond is the real-life example that is being used in research and development of this technology. Studies on typical Western behavior could give a very general view of the kind of society Richmond represents. All of this would be done in order to investigate the kind of groups that would be willing to adopt this technology if at all. It would allow for an examination of creating a sort of litmus test of the success rate by having a general analysis of the typical societal behaviors.

Once both the psychological, ethical, and general social ideas are presented, the final step in attempting to answer this question would be to synthesize an idea of how all these factors play together. A discussion of how the typical behaviors of people change during emergencies and using example of how things play out would be done. An argument can then be made about how say if a simulation was done for the city of Richmond and an emergency actually occurred, how willing people would be to trust in the simulation, and the likelihood of whether or not their own survival instincts kick in. With all of this research combined, a suitable answer can then be reached. Another discussion of what could be done to improve the likelihood of successful adoption could also be discussed when all is said and done. A final connection to the STS theory and its relation to the thesis could then be made to tie the paper together.

Technical Portion

In the summer of 2019, I conducted research under the Network Systems Science and Advanced Computing Division under Biocomplexity Institute & Initiative. The group specializes in the patterns of networks in large scale applications, such as tracking disease transmission, and large crowd movement. The project I was working on was specifically involved the different paths of travel people would take in the event of an emergency. There were two components to this project. The first being structuring physical locations by using a data structure known as a graph, which is basically points connected together with lines that have a certain value, this value being the distance between two points. There was also another value which dictated the kind of connections that were made between these points and they represent the kind of travel modes that could be done between them such as walking or going by car. This connects to the second portion of this project which contained something called an NFA (nondeterministic finite automata). Basically, it dictates how people can travel, for example one can walk and take a car and walk, but they cannot take a car and walk somewhere and drive again, since it is assumed their car is inaccessible at this point. All of this was used to find the shortest paths between different nodes. A user could input a text file of requests and the program could calculate the shortest distance and way to travel, keeping these parameters in mind.

The main contribution I had to this project was making the project parallelable. In Computer science, there is a concept called parallel computing that is effectively doing multiple tasks at the same time. This is done through multithreading, where the multiple cores of a computer's processor are utilized to do different tasks. Each "thread" is a singular process that operates on its own and lives on one of these processor cores. How multithreading was utilized in this project was by building functionality to allow for processing multiple requests at the same time. This was done, by using the native thread library in C++ 11. In the program, the normal request processing was put into a thread-able method and prior to processing everything, different sets of requests can be put through to different cores to optimize in the best way possible. The advantages of processing the requests in this way is speed. When there are hundreds of thousands of different points and as many requests, it can take a lot of time to finish. The other advantage is also memory. This program is also paired with UVA's research computing server Rivanna, where users can virtually allocate sets of computing cores to be used called nodes. Not only will this speed up the process, but it will save memory. The main challenge in approaching this was that the original tools designed to run on a per node basis and would create instances to run on the cores of the node. The problem with this is that each instance would have to create its own copy of the network. This is redundant and not space efficient. By having this new multi-threaded design, the program not only solves the issue of redundant copies, but also allows for representing larger networks and more core utilization per computing node.

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