Undergraduate Thesis Prospectus

Machine Learning in Cybersecurity: An Evolution of Virus Detection

(technical research project in Computer Science)

Influence by Design: Big Tech's Impact on Mental Health

(sociotechnical research project)

by

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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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General Research Problem

How can the relationship between technology and its users be improved?

Digital technology is ubiquitous and pervasive. According to Gartner, there are more than 20 billion internet of things (IoT) devices (Hung, 2017). However, this connectivity drives data collection that can be used to exploit consumers. According to Think with Google (2016), the average number of apps installed on a smartphone is 35. Every app can collect data specific to the user. With the user being a crucial part of technology development, the user-tech relationship must be monitored.

Machine Learning in Cybersecurity: an Evolution of Virus Detection

How can machine learning algorithms be used to improve computer virus detection?

The coevolution between viruses and anti-virus software constantly promotes innovation. Rad et al. (2011) highlights the development of metamorphic viruses, a type of virus that mutates between hosts. The mutation complicates identifying the virus based on a signature. Machine learning is a useful method for classification problems such as virus detection. Unlike signature-based detection, machine learning enables the possibility of zero-day detection, detection of a novel virus. Kaspersky, an antivirus software company, reported finding an average of 360,000 new malicious files per day in 2020 (Kaspersky, 2020). While most of these files aren't from unknown viruses, the fight against malware developers is certainly not won.

In terms of the state of the art, Bitdefender and ESET are both popular antivirus software that deploy machine learning techniques. In a 2020 test suite, Bitdefender was the only software to detect all 15 advanced persistent threats while ESET detected 14 threats (AV Comparatives,

2020). While effective, these programs don't answer what the best machine learning techniques are for virus detection. Likewise, how will they stop the next generation of malware?

The goal of the project is to synthesis the ideas of virus detection and machine learning. Methods include applying ideas from CS 4774 such as generative adversarial networks to virus detection methods mentioned in CS 4630. Daniel Graham of the computer science department is advising on the capstone project. At the end of the project, we will have a sophisticated understanding of the role machine learning has in detecting malware and ultimately innovating malware.

Influence by Design: Big Tech's Impact on Mental Health

How do tech companies strive to appear to take responsibility for the mental health costs of compulsive device use?

With the rise of the smartphone, there has been a social media boom. Apps like Facebook and Twitter allow users to stay up to date with all their relevant interests in real time. They also display endless content to the user referred to as the infinite scroll. The infinite scroll is a common feature in social media apps that causes increased screen time (Jovicic, 2021). With this increase, there has been a correlated increase in consumption of mental health services among college students (Lattie et al., 2019). Although just a correlation, with social media being popular among the younger generations, it begs the question as to what effect these apps are having on its users. And is that effect intended?

Research has been done on the effects on mental health from device use and particular software design decisions. Ferreira and Agante (2020) found that YouTube's recommended video algorithm favors videos with longer length than the current video. Likewise, Su et al.

(2021) found that TikTok's user personalized recommendations elicit brain activity that hinders self-control. They concluded that about 5.9% of TikTok users may have problematic use patterns. While this research identifies that these companies have designed their apps to maximize use, the direct mental health effects are not as clear. For instance, de Berail et al. (2019) concluded that users' parasocial relationships with YouTube content creators is a strong factor in YouTube addiction. These parasocial relationships may be a product of YouTube's design choices or perhaps the content creators create such an environment.

Based on the research, tech companies employ choice architecture by displaying choices that favor consumption. Besides longer recommended videos, YouTube has their autoplay feature on by default. Therefore, after finishing a video, the next video automatically starts playing. Netflix does the same thing for episodes of TV shows. The companies are hoping the user accepts the default and continues watching. TikTok designed their app to constantly be playing videos for the user. The first screen the user sees is their "for you" page that contain videos that the user might like. The user simply swipes up to see the next video. Dating apps like Tinder do something similar. On Tinder, the first screen the user sees are their potential matches. Once the user decides about one person, the next person is immediately presented for the user to make another decision. Choice architecture is a pivotal part of modern software design.

Some social groups of interest include groups against unnecessary device use, tech companies, content creators, and support groups. PAPAYA is a group of parents who argue that technology can have damaging effects on adolescents. They believe that social media apps have been created to "increase their persuasive technology and keep young people hooked" (PAPAYA, n.d.). However, their proposed solutions to combat addiction revolve around how to control their children's use of technology. For popular social media apps, they provide specific

steps to parents on how to restrict their kid's account to be private, have time restrictions, and limit inappropriate content. Conversely, End Child Surveillance is a participant that believes tech companies are to blame for compulsive device use among children. They argue that popular apps implement features such as YouTube autoplay and push kids towards harmful content to maximize profit (End Child Surveillance, n.d.). The organization provides multiple petitions to fight against the persuasive software.

Tech companies do have monetary incentive for keeping people on their apps, but some provide information about mental health. Instagram has a help page about steps that can be taken for someone experiencing thoughts of self-harm. One suggestion is "physically stepping away from social media for a while" (Instagram, n.d.). Likewise, they elaborate on how to control the content the user sees to create a healthier environment. Therefore, they seem to blame the content on the app for mental health struggles rather than their software design decisions. Along with tech companies, content creators gain revenue through the number of views they receive. There have been creators on TikTok that have put out videos urging people to take a break from the app (TikTok Tips, 2020). These videos are intended to show up on users' feeds when they have spent hours on the app. Similarly, some creators on YouTube have published videos addressing parasocial relationships with titles like "I Am Not Your Friend" (Ludwig, 2020).

Other groups that are involved include support groups. Internet and Technology Addicts Anonymous (ITAA) is an online support site that offers a 12-step program like Alcohol Anonymous. Therefore, their program is centered "around the concept of a power greater than ourselves" (ITTA, n.d.). Likewise, Foothills at Red Oak Recovery offer treatment programs to adolescents for social media addiction. They argue that while "a social media addiction treatment center may seem unnecessary, it can be quite useful for this condition" (Foothills at Red Oak

Recovery, n.d.). Both groups have separated the tech companies from the solution to addiction. Consequently, both groups gain monetary benefit through their guidance. ITAA provides a link for donations and Foothills at Red Oak Recovery charges for their treatment programs.

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