Thesis Project Portfolio

Medical Fraud Detection: Network Graphs on Shared Patients

(Technical Report)

Social Media's Inherent Ties with Dark Patterns and Artificial User Engagement

(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

Byron Xu

Spring, 2024

Department of Computer Science

Table of Contents

Sociotechnical Synthesis

Service providers in the medical and social media sectors make a total of over hundreds of billions of dollars of profit yearly. However, these record-breaking profit margins often place company and financial interests over those of their clients. In the medical world, a sizable subset of providers collaborate in fraud schemes in order to garner more money from their patients, while in the social media landscape, major social media companies earn enormous profits through their user engagement and retention. Service providers, especially those that are integral to human wellbeing and social functioning, have an ethical duty to not violate the trust that their clients vests in them, and should always act with the client's best interests in mind.

For the technical research, I focused on combating medical fraud schemes between providers through the development of a graph network model linking known fraudulent providers and their hidden associates. Over $100 billion is lost yearly due to medical fraud. While various fraud schemes exist, one type of fraud scheme involves multiple medical providers "bouncing" patients between each other, unnecessarily giving treatment that the patient does not need. By primarily tracking the shared patient ratio between non-suspicious providers and suspicious providers, I generated a small-scale network of the patients that visited the most suspicious providers in a year and drew variable links between all related providers. My team was able to locate the top 10 most suspicious providers related to this patient filing more than $50,000 of medical claims over the course of the year.

On another hand, the focus of the STS research was centered on another type of service provider: social media companies. According to one study, teenagers spend more than 7 hours per day using social media, with over 50% of teenagers claiming that they feel addicted to their phones as a result of their excessive usage of social media. Similarly, many other studies have also demonstrated the negative impacts of social media towards its user base. In order for social media companies to provide a free service, they must maintain some sort of revenue stream—but at the expense of their users. Modern social companies implement specific algorithms and design decisions such as an "endless scroll" functionality or personalized content in order to increase user engagement and thereby provide better metrics for financial stakeholders like third-party advertisers. According to some former developers at major social media companies like Meta, the goal of the company is to "grow", "engage", and "advertise", all of which are currently being done through unhealthy means at the expense of the user (The Social Dilemma).

In both sectors, service-providers are not always acting in the best interest of their clients, but often pursuing personal profit in lieu of the physical or mental wellbeing of their client. For the technical research, while my project was successful in narrowing down potential hidden collaboration between fraudulent providers, it was unable to provide a certain answer as to whether fraud was being committed or not. The model is only able to predict the likelihood of fraud, as misclassifying a non-fraudulent provider as fraudulent can have disastrous consequences. The major limitation of the STS research is in its lack of tangible, numerical data to explain the specific impacts of algorithmic design choices and dark patterns on its users. While many studies focus on the general overarching impacts of social media on users, few focus on how specific design functionalities may impact their users. Future research should focus on

isolating these functionalities to determine the key contributing features in social media design resulting in addiction among its user base. This could be done through A-B testing, creating one social media application with certain functionalities (e.g. endless scroll), and a second with the alternative, and then tracking user metrics to empirically understand how each function affects the user.

Special thanks to Professor Wylie from the University of Virginia for their assistance with reviewing the numerous draft iterations of this work. In addition, I would like to thank my peers in the course who were able to help me peer revise earlier drafts