Thesis Project Portfolio

PRODUCING INFORMATIVE CELL-SPECIFIC DATA USING GENERATIVE ARTIFICIAL INTELLIGENCE

(Technical Report)

A SOCIO-TECHNOLOGICAL ANALYSIS OF CHATGPT's EFFECTS ON INFORMATION SPREAD AND PERCEPTION

(STS Research Paper)

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Sociotechnical Synthesis

Introduction

Generative AI holds the potential to transform our lives and our perceptions of the world in unprecedented ways. In my technical project, I explore the applications of generative AI technology in the biomedical field. On the other hand, my STS project assesses the broader societal impacts of this technology, exploring its impact on communication and information dissemination.

Technical Project

Studying gene behavior is essential for understanding vital biological processes and diseases. Traditionally, this analysis was accomplished using bulk RNA sequencing (bulk RNAseq), a cheap and quick method that samples mRNA from a tissue sample. Single-cell RNA sequencing (scRNA-seq), a new method of genetic sequencing, provides a far more detailed and informative alternative. scRNA-seq data offers a much clearer picture of the genetic processes within tissues but is far more expensive and time-consuming. The availability of scRNA-seq data is limited due to its high cost. In contrast, a wide berth of bulk RNA-seq data already exists and is publicly accessible. Therefore, researchers often face a trade-off of using small amounts of high quality scRNA-seq data or larger amounts of lower-quality bulk RNA-seq data.

My technical project develops a powerful generative AI approach that uses existing bulk RNA-seq data and generates corresponding scRNA-seq data. Our bulk to single cell model, called bulk2sc, is trained to separate bulk RNA-seq data into its single cell components. Bulk2sc learns an accurate compressed representation of bulk RNA-seq data, then practices transforming this compressed data into high quality single-cell data. This method attempts to generate

synthetic scRNA-seq data that will closely mirror true scRNA-seq data in terms of its cell-type distributions and gene expression profiles.

Bulk2sc was trained and validated against known scRNA-seq datasets to ensure its accuracy and reliability. This model acts as a proof-of-concept of generating scRNA-seq data from bulk RNA-seq inputs. When completed, this will provide researchers with a viable alternative to true scRNA-seq data. This innovation expands access to high quality genetic data by reducing any time and resource costs associated with generating scRNA-seq data. Future work on this project will focus on refining the model's accuracy and further proving its applicability in the real world on diverse tissue types and disease states.

STS Project

My STS project analyzes the impact that ChatGPT has on the spread of information and its perception in our society. Large language models (LLMs) such as ChatGPT are extremely powerful tools that have shown remarkable abilities in tasks such as content creation, language translation, and question-answering. My STS project comprehensively analyzes the effects of ChatGPT using the Technopolitics framework by evaluating its context, purpose, scale, actors, and synchronization. This analysis combines information from previous research across Google Scholar and ProQuest provided by the UVA Library.

Studying the history of ChatGPT has revealed a consistent trend of growing repercussions and concerns as a direct result of the increasing capabilities of this tool. At first, these issues were broad and general, focusing on mitigating AI's unintended behaviors or ensuring its adaptability. However, the release of GPT-2 resulted in far more serious concerns, such as the

ability of researchers to extract personally identifiable information just from interacting with ChatGPT itself. Even more concerning, as future iterations of ChatGPT have been released, these issues have gone unaddressed. GPT-4 has been observed to have increasing vulnerabilities when given malicious prompts, hypothesized to be a result of the model's ability to follow the attacker's instructions more closely. Furthermore, ChatGPT's purpose is to act as a step in OpenAI's plan for creating a widely used artificial general intelligence capable of solving human-level problems. However, its widespread use may cause any repercussions due to unresolved privacy and security issues to be magnified across digital spaces.

ChatGPT's role can also be analyzed on two major political scales: the communal and national scales. On the communal scale, ChatGPT can enhance customer service roles and facilitate cross-cultural communication within local communities. On a national scale, the way ChatGPT impacts the spread of information is heavily dependent on the country it is used in. This is shown by the temporary ban of ChatGPT in Italy, as well as the investigations conducted into the legality and ethics of ChatGPT conducted by Canada, Germany, France, Ireland, and Spain.

In our society, ChatGPT's impact is heavily guided by its interactions within the realm of social media. Social media content creators are given resources to spread content generated by ChatGPT across the primary news source for 62% of adults - content that is largely considered untrustworthy with current events and is often indistinguishable from human-generated content by the average person. This is extremely alarming as the misinformation that can be spread across these platforms using generative AI can be extremely detrimental to our society.

In conclusion, generative AI is an extremely powerful technology that can completely change our perceptions of information in society. Whether it will be used to our benefit or not remains to be seen, but we have the power to determine its course in the future.