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Letter to the Editor

Impact of COVID-19 on mental health in the US with generative AI

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ABSTRACT

This paper investigates the impact of COVID-19 on mental health in the US using a large CDC dataset and a new method with generative AI for automatically generating Python code. The generated code was used to investigate and visualize the time-series impact of COVID-19 on mental health by eight categories over time. The paper aims to activate research on mental health during COVID-19 and demonstrates the use of generative AI in psychiatry research for novice or non-programmer researchers.

1. Introduction

This paper challenges a new method using generative AI that allows novice and non-programmers to analyze, compute datasets, and visualize graphs for psychiatric researchers around the world. A brief tutorial on a set of recipes will help psychiatric researchers quickly conduct and advance their studies.

Psychiatric researchers are experts in understanding the contents of datasets, but not experts in how to work with them in Python programming code. With the advent of generative AI, even novices and non-programmers can generate the target code to achieve the desired computation and generate graphs.

The recent widespread use of large-scale language models for programming has been studied (Kashefi and Tapan, 2023; Tian et al., 2023; Surameery et al., 2023).

2. Relevance of AI technology and psychiatry

Although it is generally known that artificial intelligence can be applied to various fields, there may be a gap in mutual understanding between the readers of this journal and the specific subject proposed on mental health in this paper. Ray et al. wrote a review paper that proposes the use of artificial intelligence technology to reduce the burden of mental health care (Ray et al., 2022).

In generating the target code, users need to feed the necessary and sufficient information with a simple and correct query to the AI. The query plays a crucial role in generating the correct code in Python.

In the dataset, users must identify the important column names and how to use and calculate them. This paper demonstrates the latest mental health dataset released on May 17, 2023 from CDC in the US (CDC, 2023). The dataset is composed of 13203 instances and 14 columns.

The U.S. Census Bureau launched the Household Pulse Survey to produce data on the social and economic impacts of COVID-19 on American households. The survey from April 23, 2020 to May 8, 2023 was designed to gauge the impact of the pandemic on employment status, consumer spending, food security, housing, education disruptions, and dimensions of physical and mental wellness. It was conducted by an internet questionnaire, with invitations to participate sent by email and text message. The survey was designed to meet the goal of accurate and timely weekly estimates. Their dataset entitled "Indicators of Anxiety or Depression Based on Reported Frequency of Symptoms During Last 7 Days" is released and available in public[1].

According to the nih.gov database as of June 12, 2023, there are 1770 studies with Google phrase search of "COVID-19 impact on mental health". This paper briefly surveyed the impact of COVID-19 on mental health. Blanchflower et al. studied COVID and mental health in America (Blanchflower and Bryson, 2022). Their result showed that a variable based on daily COVID cases by county is positively associated with worse mental health. The effect declines in 2021 and 2022 as vaccination rates rise. For women and college educated men, having a vaccine improved mental health. However, being vaccinated worsens mental health among less educated men.

Li investigated impact of COVID-19 on children and adolescents (Li, 2022). The COVID-19 pandemic introduced physical distancing and social restrictions, greatly impacting students' lives and mental health. The study found that the pandemic adversely affected student mental health, leading to an increased prevalence of Major Depressive Disorder

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(MDD) and Generalized Anxiety Disorder (GAD).

Salanti et al. reviewed impact of COVID-19 on mental health of the general population (Salanti et al., 2022). The study assessed the trajectory of mental health symptoms during the first year of the pandemic. Relevant articles were identified from the COVID-19 Open Access Project. Longitudinal studies that reported data on the general population's mental health using validated scales were eligible. On average, depression and anxiety symptoms worsened in the first 2 months of the pandemic. There was a linear association of worsening depression and anxiety with increasing numbers of reported cases of SARS-CoV-2 infection and increasing stringency in governmental measures.

Duden et al. reviewed global impact of the COVID-19 pandemic on mental health services (Duden et al., 2022). 29 studies reporting on mental health services in 63 countries were included. Findings were organized according to nine major topics. Many services were closed or reduced while telepsychiatric services expanded. Face-to-face services decreased and many inpatient units restructured their services. The digitalization of services allowed for better access for some but hindered access for most. Staff experienced changes such as heightened impacts on their own mental health. This review suggests directions for policy and service development.

Kupcova et al. studied effects of COVID-19 pandemic on mental health, anxiety, and depression (Kupcova et al., 2023). 205 anonymous subjects participated in the study. A higher tendency to anxiety was exhibited by female participants and the age group under 30 years of age. The level of education was identified as a significant factor for changes in mental state. Summarizing two years of the COVID-19 pandemic, the mental state of people with higher levels of education tended to feel worse, while females and younger adults felt more anxiety.

This paper introduces a new method with generative AI for investigating the impact of COVID-19 on mental health in the US over three years, from April 23, 2020 to May 8, 2023. Unlike previous studies that relied on human-made software programs, the proposed method uses generative AI to automatically generate Python code for visualizing the impact of COVID-19 on mental health over time. The query from users to the generative AI is crucial in generating the correct code. The generated code must be carefully examined and verified by human experts. Detailed instructions will be provided for novice and non-programmers to navigate the generative AI and produce the desired outcome.

Recently, generative AI systems such as OpenAI's ChatGPT (OpenAI, 2023), Microsoft's Bing.com with ChatGPT-4 (Bing, 2023), and Google's Bard (King, 2023) have been introduced as essential and valuable tools for reducing the time and cost of human labor. According to Stokel-Walker, AI chatbots are being introduced to search engines (Stokel-Walker, 2023). However, new technologies are often presented without any guidance or educational framework for their appropriate use. This paper provides a brief guide on how to use the generative AI system to achieve the desired solution. When interacting with a generative AI through dialogue, error-prone queries will result in more conversations. On the other hand, error-free or error-less queries require fewer conversations. In order to achieve error-free or error-less queries, users must remove noises from the datasets and identify the important determinants and calculations between determinants, as well as specifying error-free API if possible.

The following links show access to three generative AI systems:

1. ChatGPT-3 via any browser: https://chat.openai.com/
2. Bing.com via Edge browser using ChatGPT-4: https://bing.com/chat
3. Bard via any browser: https://bard.google.com/

This paper demonstrated an example with Bing.com with ChatGPT-4. The goal of this example is to use the CDC dataset[1] and to generate the target code in Python for plotting time-series symptoms of anxiety disorder or depressive disorder by eight categories. A new finding is revealed by sexual orientation.

The generated code examined by human expert was used to investigate and visualize the time-series impact of COVID-19 on mental health by eight categories such as by age, by sex, by race/hispanic ethnicity, by education, by state, by disability status, by gender identity, and by sexual orientation over time. This paper demonstrates the use of generative AI in psychiatry research for novice or non-programmer researchers. It presents findings that bisexual individuals have higher rates of anxiety and depression compared to gay, lesbian, or straight individuals.

3. Results

When accessing to Bing.com/chat, the following query should be given in dialog box.

Query: With rows.csv, print unique values of "Indicator", "Group", "State" and "Subgroup" determinants respectively to user in terminal. User is allowed to enter four values for four determinants of "Indicator", "Group", "State" and "Subgroup" to draw the first line of the graph and the second line with the same values of three determinants "Indicator", "Group", "State" and with the second new value of "Subgroup" for comparison. "Time Period End Date" determinant is used as x-axis for time-series data. Four determinants are used in each graph line to select right values of "Value" determinant with ANDed operation of four determinants. The code can generate a graph of two lines of values in "Value" with given four determinant-value conditioned as y-axis and "Time Period End Date" determinant as x-axis. x-axis tick is with 10 labels with 90-degree rotation. Show the full code in Python. Beautify title named with "Indicator" and "State". Use black-and-white solid and dotted lines. Save the final png file named with the first and second Subgroup. Pack title and figure in the range correctly.

Answer:

The generated code is in Appendix.

The final code was examined by human experts and used for investigating symptoms of anxiety disorder or depressive disorder by eight categories in the CDC dataset such as 'By Age', 'By Sex', 'By Race/Hispanic ethnicity', 'By Education', 'By State', 'By Disability status', 'By Gender identity', and 'By Sexual orientation' from April 23, 2020 to May 8, 2023.

Bing.com with ChatGPT-4 can successfully generate the requested code in Python for comparing by Sexual orientation with three subgroups such as 'Gay or lesbian', 'Straight', and 'Bisexual'. Fig. 1 shows the comparison of three sexual orientations. The graph in Fig. 1 revealed that bisexual people are more likely to experience symptoms of anxiety and depression than gay or lesbian people, who are in turn more likely to experience symptoms than straight people.

4. Discussion

Bing.com with ChatGPT-4 was used to investigate symptoms of anxiety and depressive disorders across eight categories: age, sex, race/Hispanic ethnicity, education, state, disability status, gender identity, and sexual orientation. The query to generative AI plays a key role in automatically generating the desired code in Python. This paper briefly shows the query example and new finding. Researchers can use this code or generate different codes with new queries for their own investigation via generative AI.

In the query, users must provide the necessary and sufficient information for computing the desired outcome. In other words, users must identify key column names and show how to calculate the result with values in the key column names. In the graph visualization, x-axis and y-axis labels and the number of tick labels of x-axis must be addressed in the query. As much as possible, simplify the query for reducing the number of conversations with the AI.

"Indicator" column includes three symptoms such as 'Symptoms of Depressive Disorder,' 'Symptoms of Anxiety Disorder' and 'Symptoms of Anxiety Disorder or Depressive Disorder'. Four columns "Indicator",

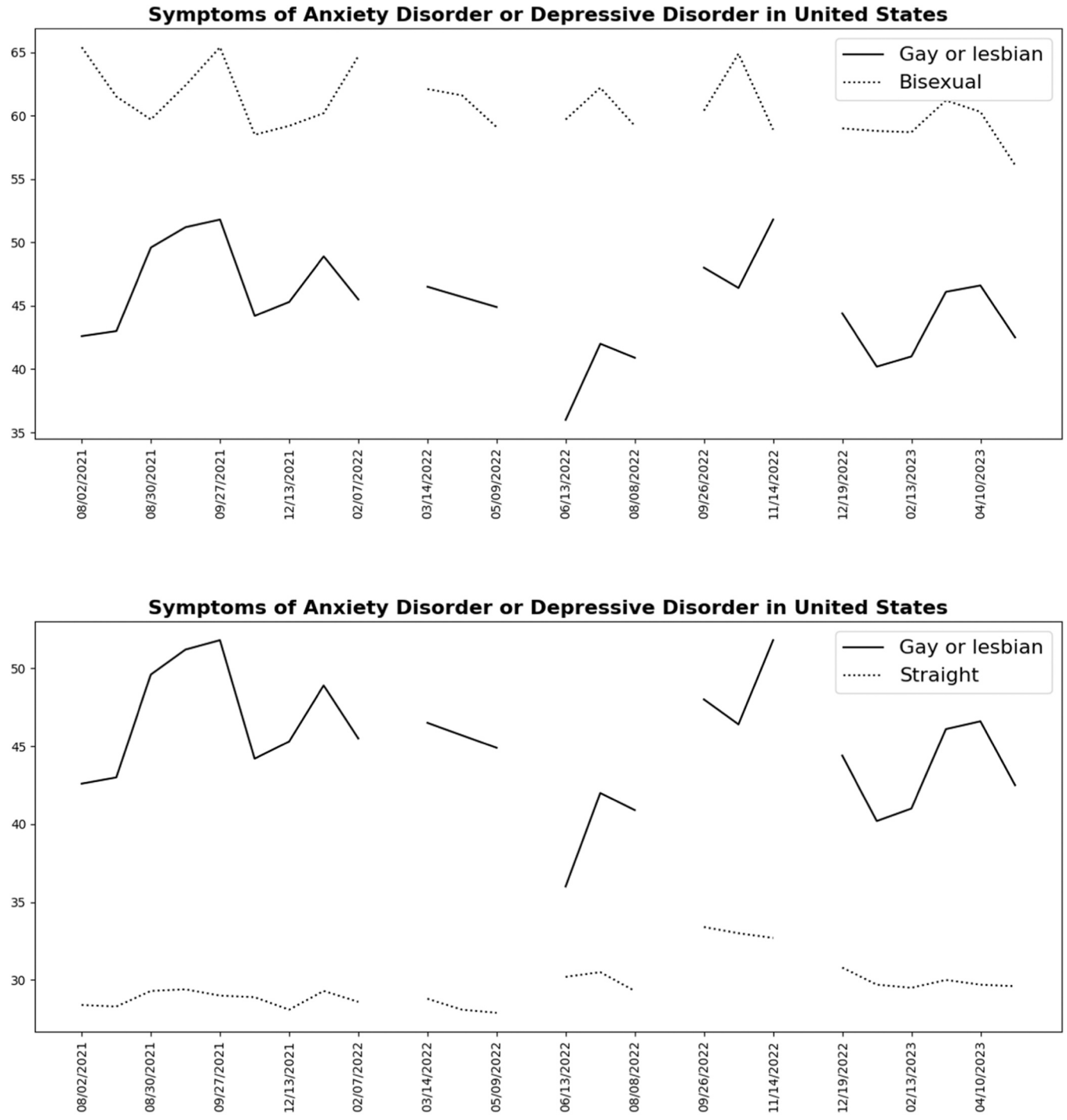

Fig. 1. symptoms of anxiety disorder or depressive disorder by sexual orientation.

"Group", "State" and "Subgroup" can determine values in "Value" column. User is allowed to enter four values for four determinants to draw the first line of the graph and the second line with the same values of three determinants "Indicator", "Group", "State" and with the second new value of "Subgroup" for comparison. "Time Period End Date" column is used as x-axis for time-series data. Four determinants are used in each graph line to select right values in "Value" for comparison. Generative AI can generate the desired code in Python and revealed the new finding that bisexual people are more likely to experience symptoms of anxiety and depression than gay or lesbian people, who are in turn more likely to experience symptoms than straight people.

Thornton et al. addressed that the use of generative AI such as ChatGPT in scientific publishing is a new challenge that raises concerns about inaccurate assertions and plagiarism. Some journals have prohibited its use, but this is impractical and unethical. The Asian Journal of Psychiatry recommends that authors acknowledge ChatGPT use in the acknowledgement section of the manuscript and specify the tasks and how it was utilized. The author argues that generative AI can be used effectively if its limitations are understood, such as the potential for incorrect responses due to insufficient training or incorrect data.

3. Online methods

The query mentioned in this paper was fed to Bing.com with

ChatGPT-4 to generate a code in Python as shown in APPENDIX. To run the code, install Python on your system and run the generated code in the terminal. The same graphs should be printed on the screen. The current generative AI faces a reproducibility problem. In other words, the same query may not generate the same code in Python due to the use of pseudorandom numbers.

4. Future work

For a generative AI based on large-scale language models, the ability to chat and the programming practiced in this paper is only a part of its vast applications. In light of the development of large-scale language models, ChatGPT-4 can perform versatile natural language processing, such as automatic translation of multiple languages, summarizing long sentences, and correcting and proofreading sentences (Zhou et al., 2023).

Given these factors, various uses of generative AI based on large-scale language models, building on existing research, may be expected in the field of Psychiatry (Corcoran and Cecchi, 2020; Patel et al., 2018).

On the other hand, many issues have been pointed out in the use of large-scale language models, including bias in the data used, ethical concepts, safety issues, lack of reproducibility, etc. For better use of generative AI in the field of Psychiatry, it is necessary to take into account the characteristics of generative AI (Ray, 2023).

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Not applicable.

Appendix. : Answer from Bing.com

```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
df = pd.read_csv('rows.csv')
print("values for Indicator: ", df['Indicator'].unique())
print("values for Group: ", df['Group'].unique())
print("values for State: ", df['State'].unique())
print("values for Subgroup: ", df['Subgroup'].unique())
indicator = input("Enter value for Indicator: ")
group = input("Enter value for Group: ")
state = input("Enter value for State: ")
subgroup1 = input("Enter first value for Subgroup: ")
subgroup2 = input("Enter second value for Subgroup: ")
line1 = df[(df['Indicator'] == indicator) & (df['Group'] == group) & (df['State'] == state) & (df['Subgroup'] == subgroup1)]
line2 = df[(df['Indicator'] == indicator) & (df['Group'] == group) & (df['State'] == state) & (df['Subgroup'] == subgroup2)]
plt.figure(figsize=(12, 6))
plt.plot(line1['Time Period End Date'], line1['Value'], color='black', linestyle='solid', label=subgroup1)
plt.plot(line2['Time Period End Date'], line2['Value'], color='black', linestyle='dotted', label=subgroup2)
x = np.arange(len(line1['Time Period End Date']))
step = max(1, len(x)//10)
plt.xticks(x[::step], rotation=90)
plt.legend()
title = f"{indicator} in {state}"
plt.title(title, fontdict={'fontsize': 12, 'fontweight': 'bold'})
plt.subplots_adjust(top=0.95)
filename = f"{subgroup1}_{subgroup2}.png"
plt.tight_layout()
plt.savefig(filename)
plt.show()
```

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