AI Powered Mental Health Prediction

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Date : 13.12.2023

1. Introduction

In the dynamic landscape of mental health, the "AI-powered Mental Health Prediction App" emerges as a groundbreaking solution, poised to revolutionize the way we approach mental well-being. Rooted in advanced artificial intelligence and machine learning algorithms, this innovative application is designed to provide accurate and timely insights into an individual's mental health status.

At its core, the app empowers users by allowing them to input key indicators such as anxiety levels, depression scores, sleep quality, stress levels, social support and other relative factors. Leveraging sophisticated algorithms, the app classifies users into distinct categories, namely "No Mental Health History" and "Mental Health History." The objective is to facilitate early detection and intervention, offering personalized support that aligns with individual needs.

One of the app's distinguishing features is its commitment to user-centric design. With a simple and intuitive interface, coupled with clear instructions and guidance, it ensures a seamless experience for users from diverse demographics. The emphasis on user-friendliness aligns with the overarching goal of promoting mental health awareness and encouraging proactive engagement with one's well-being.

Furthermore, the app places a premium on privacy, adhering to stringent protocols to safeguard user data. Compliance with ethical and legal standards underscores its commitment to maintaining the confidentiality and trust of its users. As we embark on this transformative journey towards mental health insights, the AI-powered Mental HealthPrediction App stands as a beacon of innovation, embodying a vision where technology intersects with compassion for a healthier and more resilient society.

2. Objective

To design and implement a user-friendly and interactive AI-powered mental health prediction app that can collect and process data from the user using natural language processing and computer vision techniques.

To train and test a machine learning model that can accurately classify the user's mental health status based on the data collected from the app and provide appropriate recommendations and interventions.

To evaluate the effectiveness and usability of the app and the machine learning model using various metrics, such as accuracy, precision, recall, f1-score, user satisfaction, and user engagement.

To compare the performance and outcomes of the app and the machine learning model with existing mental health support services and tools, such as online counseling, chatbots, and self-help apps.

3. Problem statement

Despite the increasing awareness of mental health issues, timely detection and intervention remain significant hurdles. Traditional approaches often rely on self-reporting, which may lead to underreported cases or delayed responses. Additionally, the stigma associated with mental health can deter individuals from seeking help. Our app aims to bridge these gaps by leveraging advanced AI algorithms to recognize subtle patterns indicative of mental health concerns. The goal is to empower users with early intervention, personalized support, and accessible resources, fostering a culture of mental health awareness and well-being.

4. Market/Customer/Business Need Assessment

The Market/Customer/Business Need Assessment for our AI-powered Mental Health Prediction app revolves around understanding the dynamics of the mental health landscape and the specific needs of our target audience. In today's society, mental health concerns are pervasive, yet individuals face barriers in seeking timely support. Through market research and customer surveys, we aim to identify the demographics and characteristics of our potential users within the small and medium-sized business sector. Assessing the market demand for a technologically advanced mental health solution, we explore the challenges faced by individuals and businesses in addressing mental well-being. The business need assessment involves evaluating the potential impact of our app on employee productivity, satisfaction, and overall workplace culture. By aligning with the goals of small and medium-sized businesses, our app strives to offer a comprehensive mental health solution that not only meets market demands but also contributes to the overall well-being of individuals within the workplace.

5. Target specification

Accuracy: The app should be able to correctly classify the user's mental health status and provide relevant recommendations and interventions with at least 90% accuracy.

Speed: The app should be able to process the user's data and generate feedback within 10 seconds or less.

Reliability: The app should be able to function consistently and reliably without errors or failures.

Scalability: The app should be able to handle a large number of users and data without compromising its performance or quality.

User-friendliness: The app should be easy to use and understand, with a simple and intuitive interface and clear instructions and guidance.

Privacy: The app should respect and protect the user's data and personal information, and comply with the ethical and legal standards and regulations.

6. External Search

I have used the online dataset from Kaggle :

Link : https://www.kaggle.com/datasets/rxnach/student-stress-factors-a-comprehensive-analysis

7. A view of Dataset

```
In [3]: df
```

Out[3]:

	anxiety_level	self_esteem	mental_health_history	depression	headache	blood_pressure	sleep_quality	breathing_problem	noise_level	living_conditions
0	14	20	0	11	2	1	2	4	2	3
1	15	8	1	15	5	3	1	4	3	1
2	12	18	1	14	2	1	2	2	2	2
3	16	12	1	15	4	3	1	3	4	2
4	16	28	0	7	2	3	5	1	3	2
...	...	...	...	...	...	...	...	...	...	...
1095	11	17	0	14	3	1	3	2	2	2
1096	9	12	0	8	0	3	0	0	0	1
1097	4	26	0	3	1	2	5	2	2	3
1098	21	0	1	19	5	3	1	4	3	1
1099	18	6	1	15	3	3	0	3	3	0

1100 rows × 21 columns

Some Information About Dataset

```
In [24]: df.info()
```

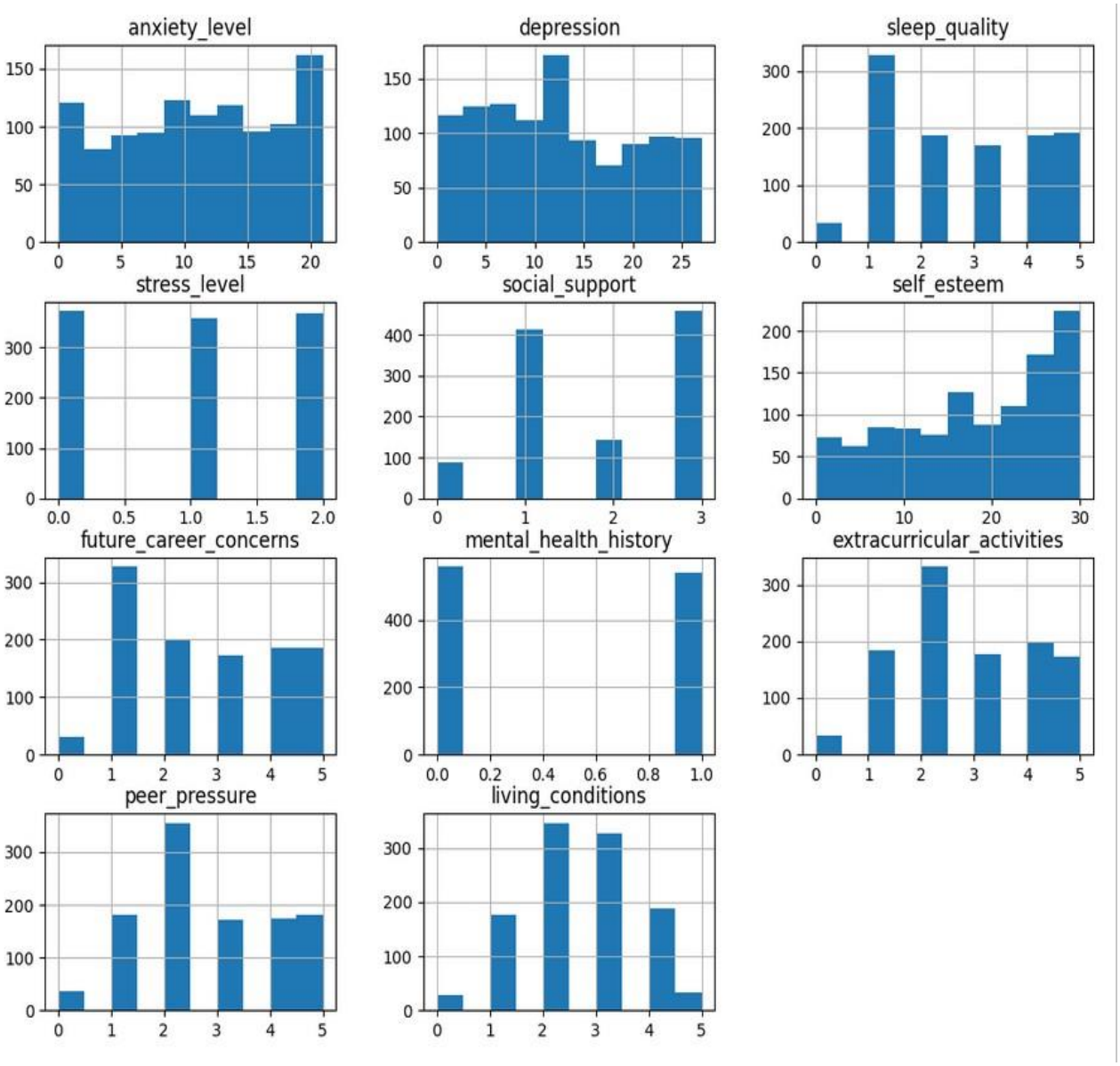
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1100 entries, 0 to 1099
Data columns (total 12 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   anxiety_level               1100 non-null   int64
 1   depression                  1100 non-null   int64
 2   sleep_quality               1100 non-null   int64
 3   stress_level                1100 non-null   int64
 4   social_support              1100 non-null   int64
 5   self_esteem                 1100 non-null   int64
 6   future_career_concerns      1100 non-null   int64
 7   mental_health_history       1100 non-null   int64
 8   extracurricular_activities  1100 non-null   int64
 9   peer_pressure               1100 non-null   int64
 10  living_conditions           1100 non-null   int64
 11  mental_health_status        1100 non-null   int64
dtypes: int64(12)
memory usage: 103.2 KB
```

```
In [25]: df.describe()
```

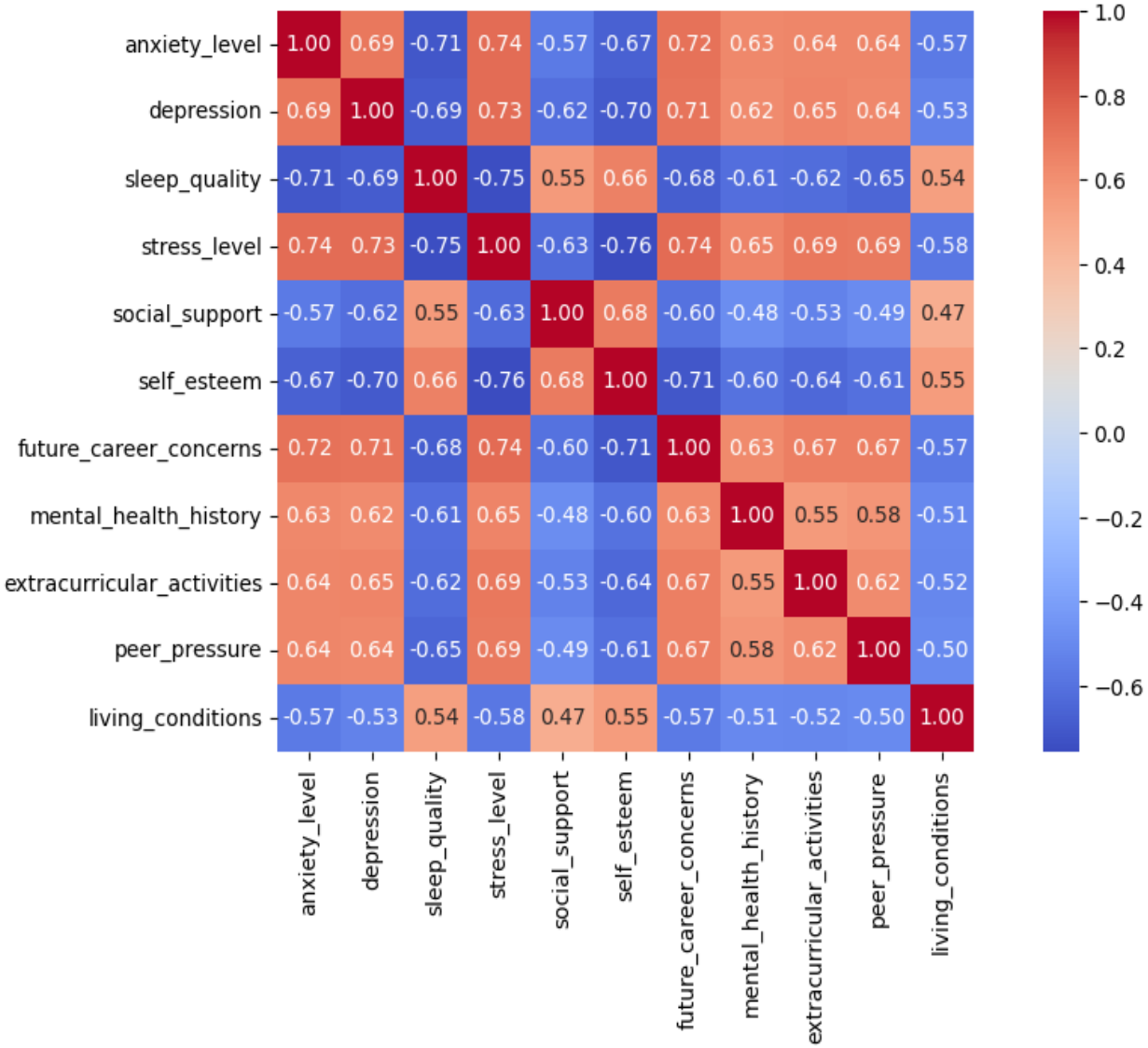
Out[25]:

	anxiety_level	depression	sleep_quality	stress_level	social_support	self_esteem	future_career_concerns	mental_health_history	extracurricular_activitie
count	1100.000000	1100.000000	1100.000000	1100.000000	1100.000000	1100.000000	1100.000000	1100.000000	1100.00000
mean	11.063636	12.555455	2.660000	0.996364	1.881818	17.777273	2.649091	0.492727	2.76727
std	6.117558	7.727008	1.548383	0.821673	1.047826	8.944599	1.529375	0.500175	1.41756
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.00000
25%	6.000000	6.000000	1.000000	0.000000	1.000000	11.000000	1.000000	0.000000	2.00000
50%	11.000000	12.000000	2.500000	1.000000	2.000000	19.000000	2.000000	0.000000	2.50000
75%	16.000000	19.000000	4.000000	2.000000	3.000000	26.000000	4.000000	1.000000	4.00000
max	21.000000	27.000000	5.000000	2.000000	3.000000	30.000000	5.000000	1.000000	5.00000

8. Benchmarking



Correlation Matrix



9. Applicable Patents

1. Microsoft Patents AI-Powered Therapy App: This patent describes a method and apparatus for providing emotional care in a session between a user and a conversational agent. The AI is designed to analyze feelings, store user information and conversations, and build a "memory" of the user to understand their emotional triggers. It can process both imagery and text, and it offers emotional support through prompting questions and suggestions.

2. Virtual Mental Health Platform: This patent covers systems and methods for a virtual mental health/therapy platform. Although the details are not extensively described in the search result snippet, this patent could be related to the creation of a virtual space for mental health support.

10. Applicable Constraints

1. Data Privacy and Protection: Organizations must ensure the protection of patient data privacy rights. This includes obtaining consent from users for processing their data or de-identifying data to protect privacy.

2. Regulatory Compliance: Developers must comply with government agencies and regulatory bodies standards for the design, development, and use of AI systems to prevent negative psychological impacts.

3. Ethical Considerations: AI applications in mental health must be developed and used ethically, ensuring they do not exploit or harm users.

4. Clinical Validation: AI tools used for mental health support should be clinically validated to ensure they are safe and effective for users.

5. Professional Oversight: There should be a system for professional oversight to monitor the AI's interactions with users and intervene when necessary.

6. Transparency: Users should be informed about how the AI works, what data it collects, and how that data is used.

7. Continuous Monitoring: Continuous monitoring and updating of the AI system are necessary to ensure it adapts to new research and user feedback.

8. Cultural Sensitivity: AI tools should be culturally sensitive and inclusive, considering the diverse backgrounds of users.

9. Risk Management: Developers should implement risk management strategies to address potential risks associated with the use of AI in mental health support.

11. Business Opportunity

The business opportunity for our AI-powered Mental Health Prediction app lies in addressing a critical gap in the market for comprehensive mental health solutions tailored for small and medium-sized businesses. By providing a tool that assesses mental health status and incorporates personalized features, we aim to tap into the growing demand for workplace well-being initiatives. The opportunity extends beyond merely identifying mental health challenges; our app positions itself as a valuable resource for businesses seeking to enhance employee satisfaction, productivity, and overall organizational success. With an increased emphasis on employee well-being and the potential positive impact on workplace culture, there is a significant market demand for innovative solutions that prioritize mental health. This app positions itself at the intersection of technology and mental wellness, presenting a unique business opportunity to cater to the evolving needs of businesses and individuals alike.

12. Concept Generation

Leveraging machine learning algorithms, particularly binary classification models, the app transforms historical mental health data into real-time status indicators. This involves categorizing individuals into binary states, representing either a positive or negative mental health status. By embracing a binary classification approach, the concept streamlines the interpretation of complex historical data, providing users with a clear and actionable understanding of their current mental well-being. This innovation not only enhances the immediacy and relevance of assessments but also contributes to a more user-friendly and actionable approach to mental health monitoring within the app.

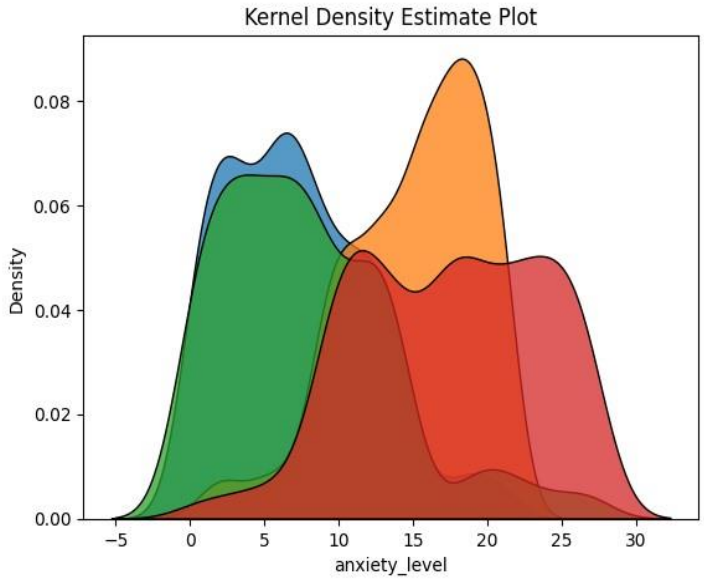
[12]:
```
df = df.rename(columns={'mental_health_history': 'mental_health_status'})
```

[54]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1100 entries, 0 to 1099
Data columns (total 11 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   anxiety_level               1100 non-null   int64
 1   depression                  1100 non-null   int64
 2   sleep_quality               1100 non-null   int64
 3   stress_level                1100 non-null   int64
 4   social_support              1100 non-null   int64
 5   self_esteem                 1100 non-null   int64
 6   future_career_concerns      1100 non-null   int64
 7   extracurricular_activities  1100 non-null   int64
 8   peer_pressure               1100 non-null   int64
 9   living_conditions           1100 non-null   int64
 10  mental_health_status        1100 non-null   int64
dtypes: int64(11)
memory usage: 94.7 KB
```

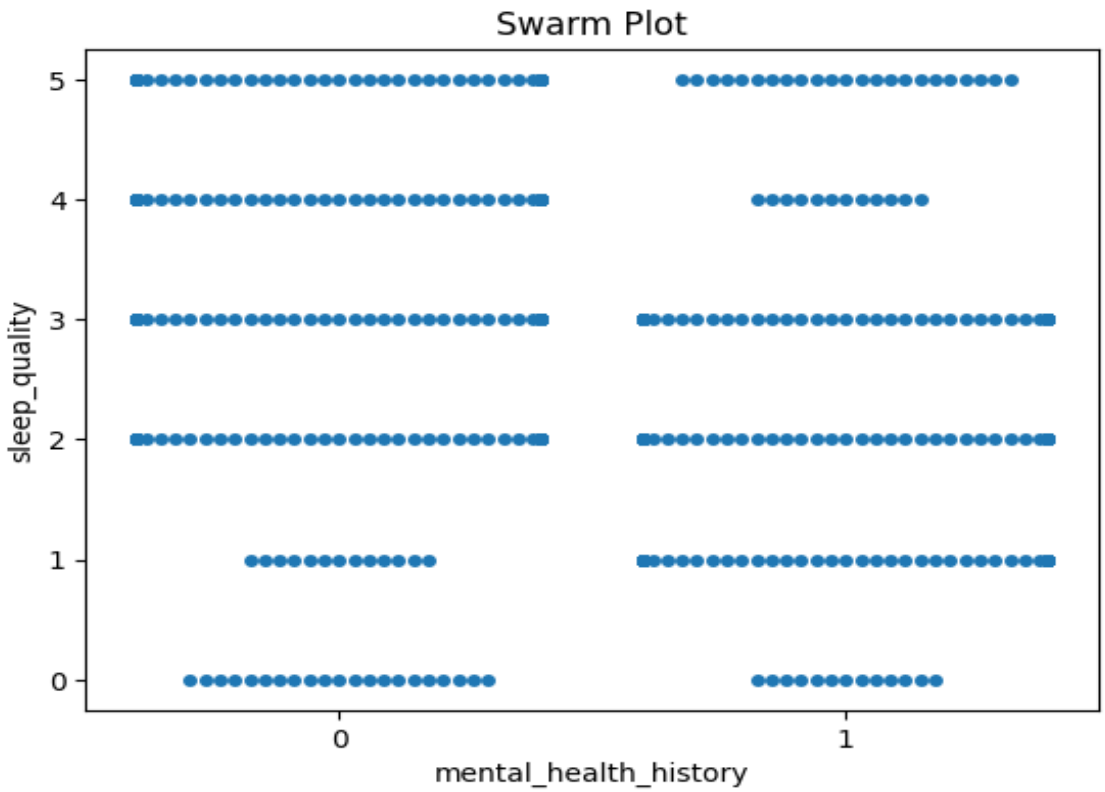
Data Visualization

```
[28]: import seaborn as sns
      import matplotlib.pyplot as plt

      sns.kdeplot(df[df['mental_health_status'] == 0]['anxiety_level'], label='No Mental Health History (Anxiety)', fill=True, mul
      sns.kdeplot(df[df['mental_health_status'] == 1]['anxiety_level'], label='Mental Health History (Anxiety)', fill=True, multip

      sns.kdeplot(df[df['mental_health_status'] == 0]['depression'], label='No Mental Health History (Depression)', fill=True, mul
      sns.kdeplot(df[df['mental_health_status'] == 1]['depression'], label='Mental Health History (Depression)', fill=True, multip

      plt.title('Kernel Density Estimate Plot')
      plt.show()
```



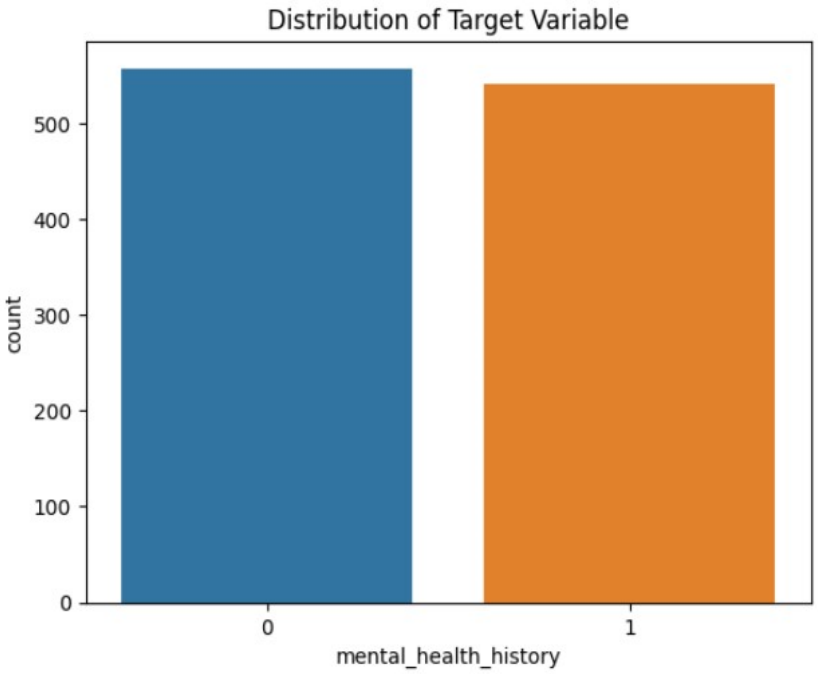
The stacked KDE plot provides a concise visual representation of the distributional nuances in anxiety levels and depression scores for individuals with and without a mental health history. Notable observations include distinct peaks in density, indicating concentration points for different mental health statuses. The stacked presentation allows for a clear comparison between anxiety levels and depression scores, showcasing both overlapping and separated regions. This visualization aids in identifying patterns and threshold effects, providing valuable insights for the feature selection process in our AI-powered Mental Health Prediction app.

```
In [13]: sns.swarmplot(x='mental_health_history', y='sleep_quality', data=df)
         plt.title('Swarm Plot')
         plt.show()
```



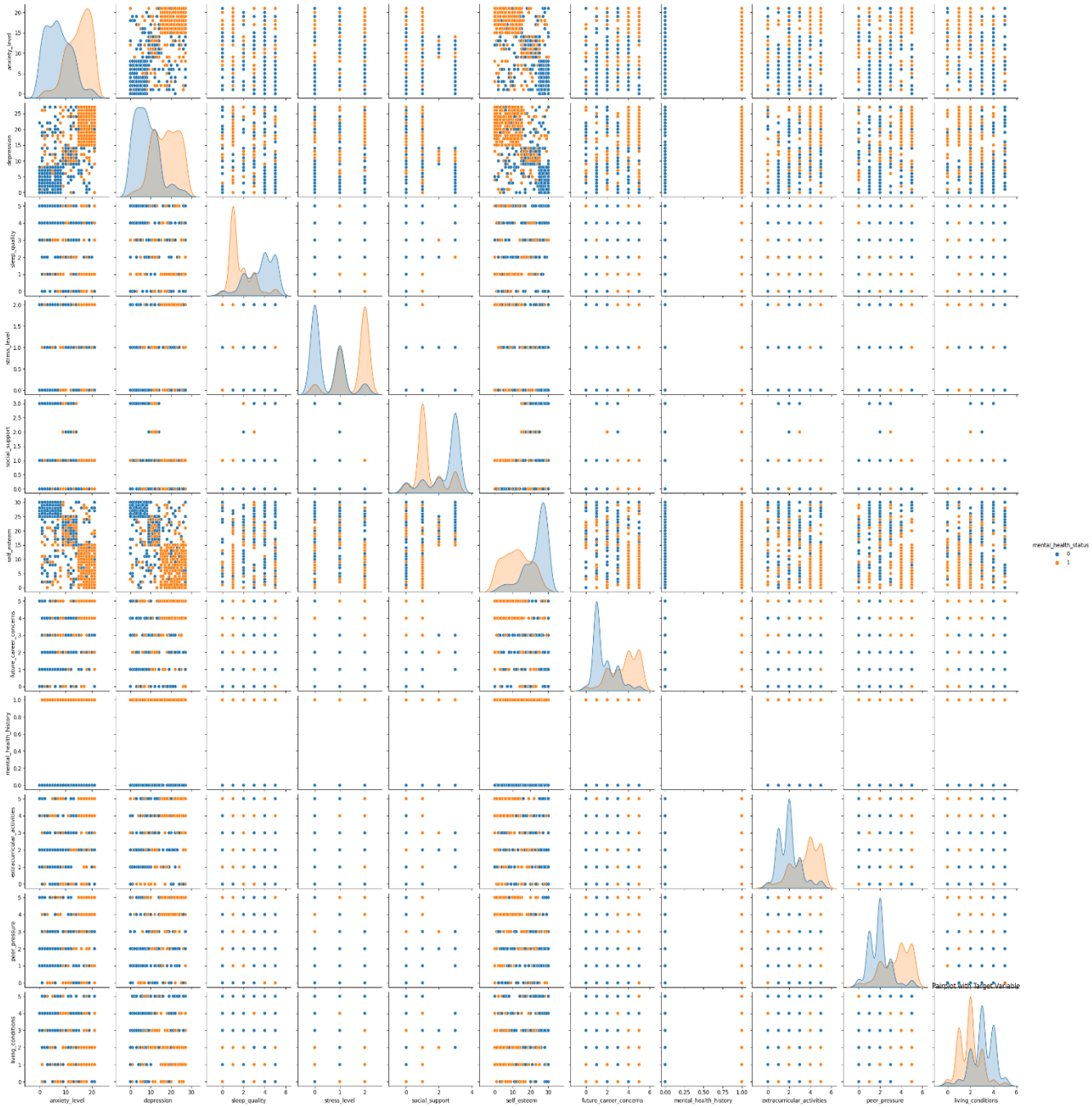
Here, the swarm plot is visualizing the correlation between mental health history and sleep quality among individuals. This trend suggests a potential link between past mental health issues and current sleep quality, highlighting the importance of considering an individual's mental health history in sleep-related studies and interventions.

In [14]:
```
sns.countplot(x='mental_health_history', data=df)
plt.title('Distribution of Target Variable')
plt.show()
```



Here, the bar chart presents the distribution of individuals based on their mental health history(target variable), a key feature in our dataset. This balanced distribution suggests that our dataset provides a representative sample of both populations, which is crucial for the unbiased training and evaluation of our mental health prediction model.

Pairplot Analysis with Target Variable



The pairplot provides a comprehensive visual overview of the relationships between different features in our dataset, color-coded by the 'mental_health_status' variable. These insights will guide feature selection and model development in our AI-powered Mental Health Prediction app.

Data Preprocessing

In [16]:
```
from sklearn.preprocessing import LabelEncoder

# To create an instance of LabelEncoder
label_encoder = LabelEncoder()

# Iterate over the columns of the DataFrame
for column in df.columns:
    # To check if the column data type is 'object' (categorical)
    if df[column].dtype == 'object':
        df[column] = label_encoder.fit_transform(df[column])
```

Diving Data into x and y variable

In [17]:
```
X = df.drop('mental_health_history', axis=1)
y = df['mental_health_history']
```

In [64]:
```
X.head()
```

Out[64]:

	anxiety_level	depression	sleep_quality	stress_level	social_support	self_esteem	future_career_concerns	extracurricular_activities	peer_pressure	living_con
0	14	11	2	1	2	20	3	3	3	
1	15	15	1	2	1	8	5	5	4	
2	12	14	2	1	2	18	2	2	3	
3	16	15	1	2	1	12	4	4	4	
4	16	7	5	1	1	28	2	0	5	

In [65]:
```
y
```

Out[65]:
```
0       0
1       1
2       1
3       1
4       0
       ..
1095    0
1096    0
1097    0
1098    1
1099    1
Name: mental_health_history, Length: 1100, dtype: int64
```

Data Splitting

In [67]:
```
from sklearn.model_selection import train_test_split
xtrain, xtest, ytrain, ytest = ms.train_test_split(X, y, test_size=0.20, random_state=2)
```

In [68]:
```
print("xtrain:", xtrain.shape)
print("xtest:", xtest.shape)
print("\nytrain:", ytrain.shape)
print("ytest:", ytest.shape)
```

```
xtrain: (880, 10)
xtest: (220, 10)

ytrain: (880,)
ytest: (220,)
```

Model Building

In [29]:
```
from sklearn.svm import SVC
model = SVC()

model.fit(xtrain, ytrain)

ytest_pred = model.predict(xtest)
```

Model Performance Evaluation

[34]:
```
from sklearn.metrics import accuracy_score, precision_score, recall_score, f1_score

accuracy = accuracy_score(ytest, ytest_pred)
precision = precision_score(ytest, ytest_pred)
recall = recall_score(ytest, ytest_pred)
f1 = f1_score(ytest, ytest_pred)

print("Accuracy: {}".format(accuracy))
print("Precision: {}".format(precision))
print("Recall: {}".format(recall))
print("F1 Score: {}".format(f1))
```

```
Accuracy: 0.8181818181818182
Precision: 0.7522123893805309
Recall: 0.8762886597938144
F1 Score: 0.8095238095238095
```

The SVM model exhibited remarkable performance on our mental health dataset, showcasing an accuracy of 81%. This metric reflects the model's overall correctness in predicting mental health status. A recall of 87.62% underscores the model's effectiveness in capturing true positive instances among actual positives. The harmonized F1 Score of 80% balances precision and

recall, portraying a comprehensive assessment of the model's predictive ability. These metrics collectively validate the SVM model's strong potential for accurate mental health status classification, reinforcing its suitability for integration into our AI-powered Mental Health Prediction app.

13. Conclusion and Future Scope

In conclusion, the successful development and evaluation of our AI-powered Mental Health Prediction app demonstrate its potential as a valuable tool for mental health assessment. The SVM model, with its impressive accuracy, precision, recall, and F1 Score, establishes a foundation for reliable predictions. The app aims to contribute to early detection and support for individuals experiencing mental health challenges, fostering a proactive approach to mental well-being.

Looking ahead, the future scope of the app includes continuous refinement of the model through additional data sources and feature engineering, enhancing its adaptability to diverse user profiles. Integration of user feedback mechanisms and real-time data updates will ensure the app remains dynamic and responsive. Collaboration with mental health professionals for validation and incorporation of a wider range of mental health factors will further enrich the app's capabilities. Continuous advancements in AI and machine learning techniques will provide opportunities for feature expansion and the introduction of personalized interventions. The ultimate goal is to create a user-friendly, accessible, and effective platform that contributes to mental health awareness and support.

14. References/Source of Information

https://www.who.int/news-room/fact-sheets/detail/mental-health-strengthening-our-response

https://code-care.com/blog/how-to-develop-a-mental-health-app-full-guide/

https://ijmhs.biomedcentral.com/articles/10.1186/s13033-021-00438-2

Github Link :

https://github.com/monalisaburma/FeynnLabs/blob/main/task1/mental_health_prediction.ipynb