AI Powered Mental Health Prediction

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Mental health problems don’t define who you are. They are something you experience. You walk in the rain and you feel the rain, but you are not in the rain.

MATT HAIG

1. Introduction

In a world increasingly reliant on technology, the intersection of artificial intelligence and mental health emerges as a promising frontier. This report delves into the creation and implementation of an innovative Mental Health Prediction App, a tool designed for proactive self-assessment.
Developed as part of an internship project, this app leverages machine learning, specifically Support Vector Machines, to predict an individual's mental health status based on various self- reported features.

As mental health awareness takes center stage, providing accessible and user-friendly tools becomes paramount. Our app aims to empower individuals to gauge their mental well-being and prompt necessary interventions, fostering a culture of proactive mental health management. This report not only outlines the technical aspects of the model development but also provides insights into the market analysis, business model, and financial considerations, making it a comprehensive guide to our venture.

2. Problem Statement

Mental health is a critical aspect of overall well-being, and timely identification of mental health concerns is crucial for effective intervention and support. However, recognizing mental health issues based on subjective self-assessment can be challenging. The aim of this project is to develop an AI-powered mental health prediction tool. Leveraging machine learning techniques, the tool will analyze various personal attributes such as anxiety level, depression, sleep quality, and other factors to predict an individual's mental health status. By providing an accessible and automated means of mental health assessment, the tool seeks to empower users with valuable insights and foster early intervention, ultimately contributing to improved mental health outcomes.

3. Market/Customer/Business Need Assessment

The increasing awareness of mental health and its impact on overall well-being has elevated the demand for accessible tools that enable individuals to monitor and understand their mental health. With the rising prevalence of stress-related issues, anxiety, and depression, there is a growing need for a user-friendly AI-powered mental health prediction tool. This tool caters to individuals seeking a convenient and confidential means of self-assessment, providing insights into their mental health status based on a range of relevant factors. Additionally, businesses and institutions aiming to promote employee well-being can benefit from integrating such tools into wellness programs. The market demand aligns with the broader societal emphasis on mental health, making this AI-powered solution timely and relevant.

4. Some Information About Dataset

I have used the online dataset from Kaggle

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

The dataset used for developing the mental health prediction model comprises several key features related to individual well-being. Each row represents a participant, and the columns capture various aspects of mental health and lifestyle. The features include:

- "Anxiety Level"
- "Depression"
- "Sleep Quality"
- "Stress Level"
- "Social Support"
- "Self Esteem"
- "Future Career Concerns"
- "Mental Health History" (used as the target variable)
- "Extracurricular Activities"
- "Peer Pressure"
- "Living Conditions"

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

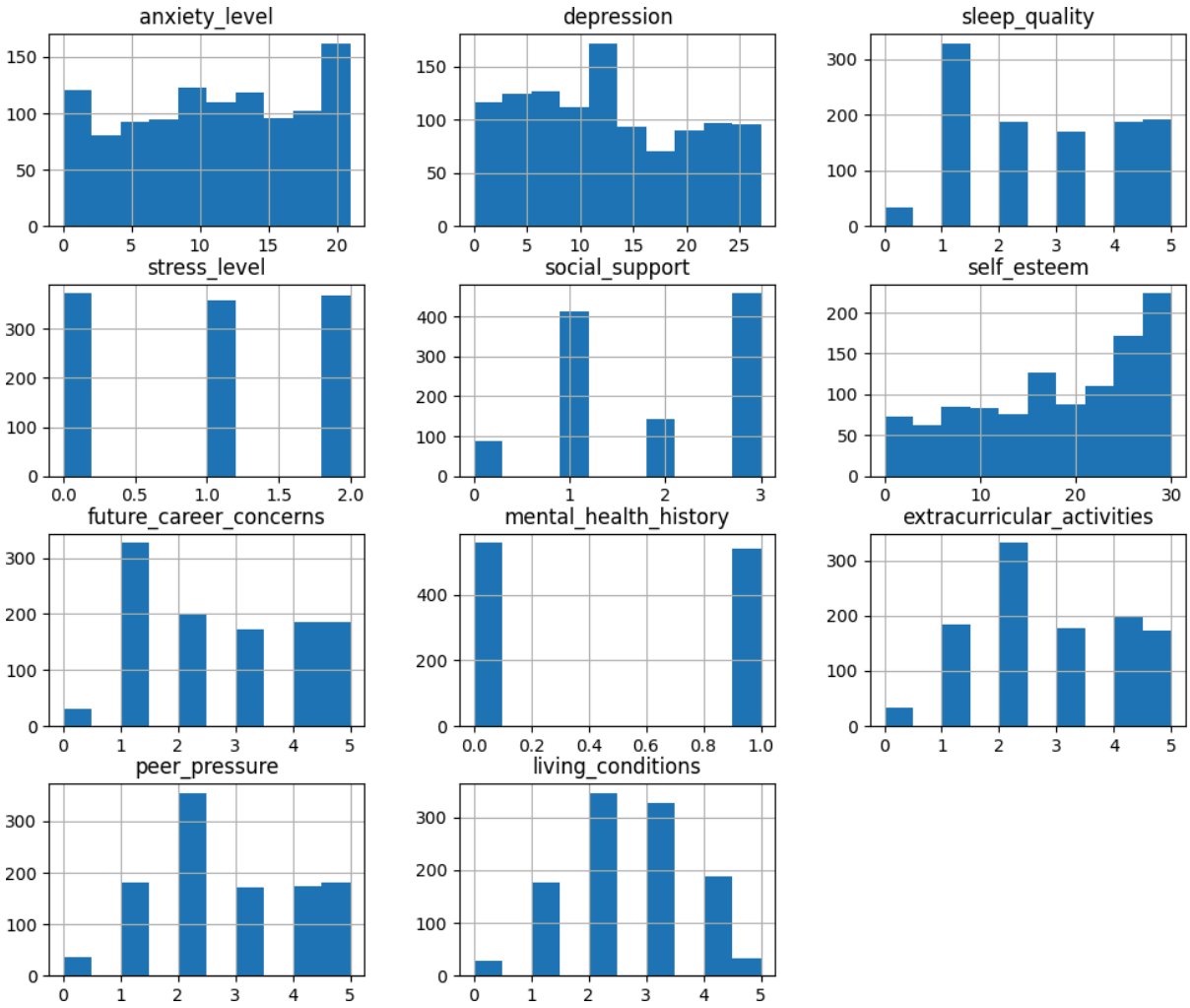
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1100 entries, 0 to 1099
Data columns (total 11 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   anxiety_level               1100 non-null   int64
 1   depression                  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   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
dtypes: int64(11)
memory usage: 94.7 KB
```

[8]:
```
df.describe()
```

[8]:

	anxiety_level	depression	sleep_quality	stress_level	social_support	self_esteem	future_career_concerns	mental_health_history	extracurricular_activities	peer_pr
count	1100.000000	1100.000000	1100.000000	1100.000000	1100.000000	1100.000000	1100.000000	1100.000000	1100.000000	1100.0
mean	11.063636	12.555455	2.660000	0.996364	1.881818	17.777273	2.649091	0.492727	2.767273	2.7
std	6.117558	7.727008	1.548383	0.821673	1.047826	8.944599	1.529375	0.500175	1.417562	1.4
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0
25%	6.000000	6.000000	1.000000	0.000000	1.000000	11.000000	1.000000	0.000000	2.000000	2.0
50%	11.000000	12.000000	2.500000	1.000000	2.000000	19.000000	2.000000	0.000000	2.500000	2.0
75%	16.000000	19.000000	4.000000	2.000000	3.000000	26.000000	4.000000	1.000000	4.000000	4.0
max	21.000000	27.000000	5.000000	2.000000	3.000000	30.000000	5.000000	1.000000	5.000000	5.0

Benchmarking



5. Applicable Patents

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

6. Business Opportunity

The Mental Health Prediction App presents a compelling business opportunity within the burgeoning digital health market. With the increasing societal emphasis on mental well-being, there exists a significant demand for accessible and proactive tools. This app uniquely positions itself by incorporating predictive analytics through machine learning, enabling users to gain insights into their mental health status. The market opportunity lies in offering a user-friendly, tech-driven solution that not only addresses the growing mental health awareness but also aligns with the trend of personalized health management. Leveraging this opportunity requires strategic marketing, collaborations with mental health advocates, and continual refinement based on user feedback, aiming to establish the app as an indispensable tool for those seeking an innovative and empowering approach to mental health assessment and management.

7. Concept Generation

The core concept involves the development of a robust AI model using Support Vector Machines (SVM) to predict mental health status. The choice of SVM is driven by its effectiveness in handling multidimensional data and its ability to discern patterns in complex datasets. The envisioned solution integrates seamlessly into a user-friendly web application, ensuring a smooth and engaging user experience.

8. Code Implementation

The target variable i.e. “Mental Health Status” for our model is derived from the "Mental Health History" column. This column has been transformed into a binary classification, indicating the mental health status of individuals. The goal is to predict whether an individual's mental health is considered healthy or unhealthy based on the provided features.

```
[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
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 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
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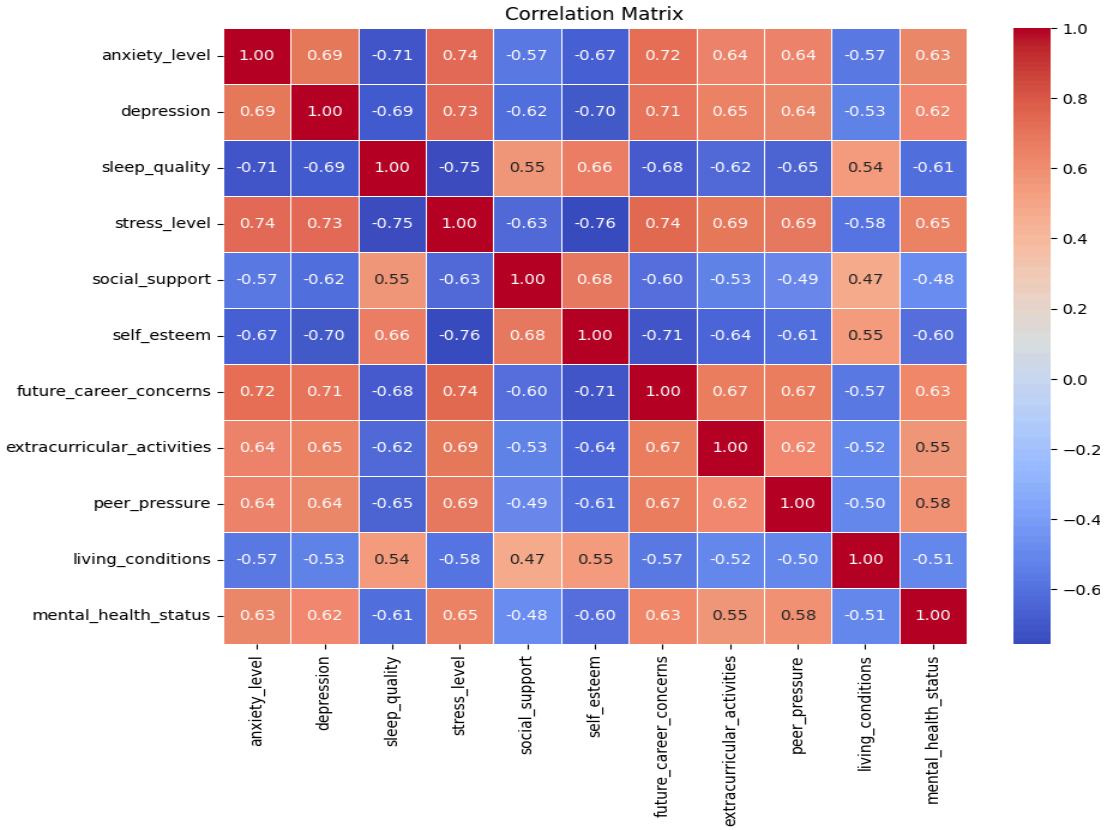


8.1. Dividing Data into X and y Variables:

The first step in developing the mental health recognition model involves separating the dataset into input features and the target variable. In our case, I am considering various features related to mental health, such as anxiety level, depression, sleep quality, etc. The target variable, denoted as "mental_health_status," is derived from the "Mental Health History" column, representing the overall mental health status of individuals.

[28]:
```
X = df.drop('mental_health_status', axis=1)
y = df['mental_health_status']
```

[29]:
```
X.head()
```

[29]:

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

[30]:
```
y
```

[30]:
```
0       0
1       1
2       1
3       1
4       0
       ..
1095    0
1096    0
1097    0
1098    1
1099    1
Name: mental_health_status, Length: 1100, dtype: int64
```

8.2. Training the SVM Model:

The dataset is then split into training and testing sets using the train_test_split function from the sklearn.model_selection module. The SVM model is instantiated and trained on the training set.

[33]:
```
from sklearn.svm import SVC
model = SVC()

model.fit(xtrain, ytrain)

ytest_pred = model.predict(xtest)
```

[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)

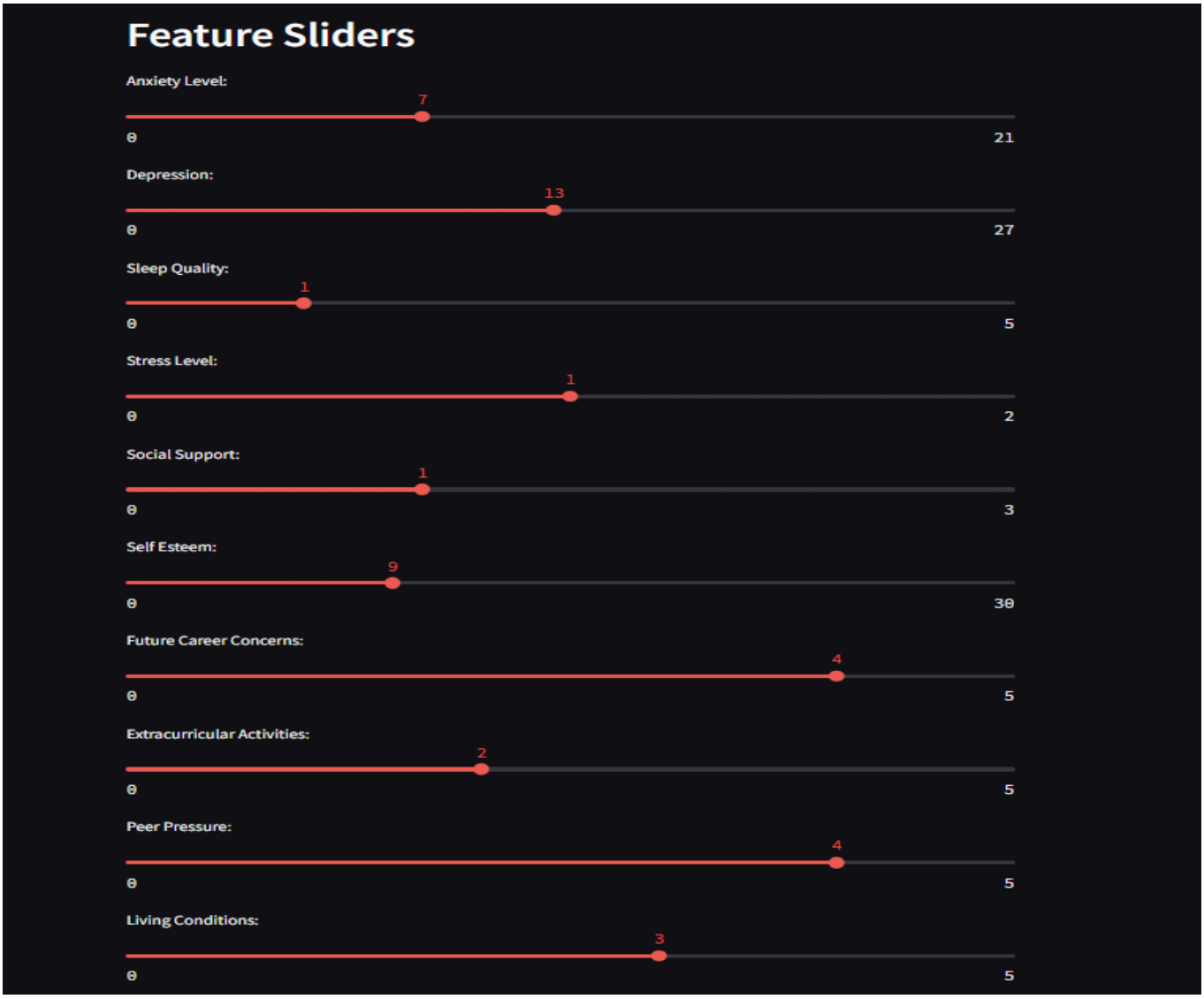
print("Accuracy: {}".format(accuracy))
print("Precision: {}".format(precision))
print("Recall: {}".format(recall))
print("F1 Score: {}".format(f1))
```

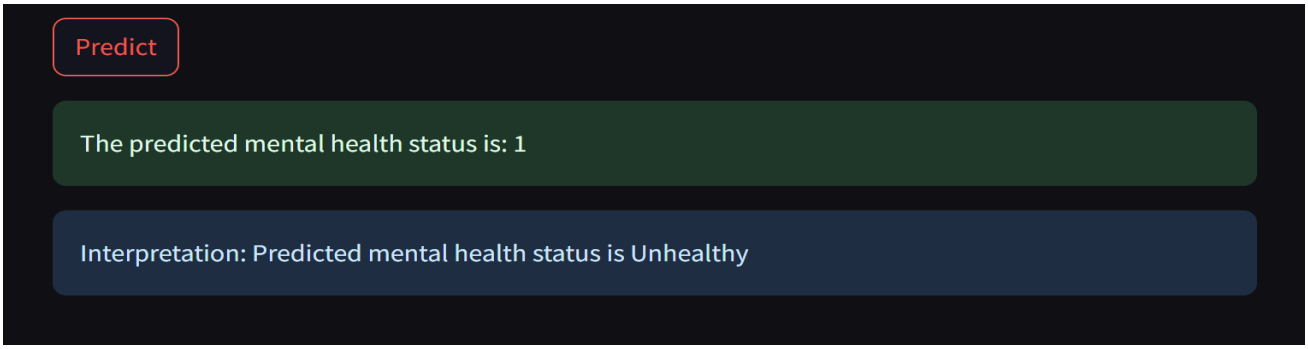
```
Accuracy: 0.8181818181818182
Precision: 0.7522123893805309
Recall: 0.8762886597938144
F1 Score: 0.8095238095238095
```

The model achieved an accuracy of 81.82%, indicating its capability to correctly predict mental health status based on the input features.

9. Final Product Prototype

The final product is an interactive Streamlit app allowing users to self-assess their mental health based on provided features. The user-friendly interface enhances accessibility and encourages proactive mental health awareness.





10. Product Details

Description:

The AI-powered mental health prediction app is providing users with a quick and easy way to assess their mental health status, promoting early intervention and self-awareness.

App link: https://mentalhealth-prediction.streamlit.app/

How to Use:

- Adjust Sliders: Users can interact with feature sliders representing different aspects of mental health, such as anxiety level, depression, sleep quality, and more.

- Predict Button: Clicking the 'Predict' button triggers the SVM model to analyze the user- input features and predict the individual's mental health status.

- Interpret Results: The app displays the predicted mental health status along with an interpretation label (Healthy or Unhealthy). Users can use this information as a tool for self-assessment.

Also, I have provided feature ranges and correlation matrix

Feature Ranges:

This provides a reference table showcasing the low and high ranges for each mental health feature. Users can refer to this table to understand the scale of their input and its potential impact on the prediction.

Correlation Matrix Heatmap:

The app visually represents the correlation between different mental health features using a heatmap. This allows users to gain insights into how various factors interrelate and contribute to the overall mental health prediction.

11. Consulting Business Model

Product Description:

The product is a web-based application designed for individuals seeking a convenient and private means of assessing their mental health. It goes beyond traditional survey-based approaches, utilizing advanced machine learning algorithms for accurate predictions.

Target Audience:

The primary target audience comprises individuals seeking a convenient and accessible tool for mental health self-assessment. This includes individuals from various age groups and backgrounds who are proactively managing their well-being.

Market Trends:

The mental health technology market has witnessed substantial growth in recent years, driven by a rising awareness of mental health issues and the increasing acceptance of technology in healthcare. Mobile applications, specifically those offering mental health insights, are becoming integral in the overall well-being strategy.

Competitive Landscape:

Several mental health apps and platforms exist, offering a range of features from mood tracking to meditation guidance. However, this app distinguishes itself by focusing on predictive analytics, empowering users with proactive insights into their mental health status.

Opportunities:

The growing demand for personalized mental health solutions presents a significant opportunity for the app. Additionally, the emphasis on destigmatizing mental health conversations and the increased adoption of telehealth services further augments the potential market.

Challenges:

Challenges in the market include maintaining user privacy and ensuring the accuracy of predictive models. Addressing these concerns is crucial for building trust and credibility among users.

Market Entry Strategy:

The market entry strategy involves targeted digital marketing campaigns, collaborations with mental health advocacy groups, and leveraging social media platforms. Building a strong online presence and emphasizing the app's user-friendly interface and predictive capabilities will be key in attracting users.

12. Conclusion:

In conclusion, the development and deployment of the Mental Health Prediction App mark a significant stride towards democratizing mental health insights. By seamlessly integrating advanced machine learning techniques into a user-friendly interface, the app aims to bridge the gap between technology and mental well-being. The app's predictive capabilities, as evidenced by robust model metrics, position it as a valuable tool for users seeking proactive mental health management.

The market analysis reveals a fertile landscape, with increasing demand for personalized mental health solutions. Leveraging opportunities, addressing challenges, and adhering to regulatory standards form the foundation of our market strategy. Also, the commitment to user privacy and the app's accuracy remains unwavering.

The app's purpose extends beyond prediction; it stands as a testament to the fusion of technology and empathy. By encouraging users to reflect on their mental health and fostering a culture of self-care, the Mental Health Prediction App aspires to contribute to a healthier and more resilient society.

13. Financial Equation

The financial equation involves careful consideration of development costs, maintenance, and potential revenue streams.

$$\text{Revenue} = \sum_{1} (\alpha_i y_i K(x, x_i) + b) \times Price\_Per\_User - (Development\_Costs + Maintenance\_Costs + Server\_Costs + Software\_Costs + Other\_Costs)$$

Where,

$\alpha_i y_i K(x, x_i) + b$: The decision function of the SVM model, representing the contribution of each support vector to the prediction.

- Price_Per_User: The cost associated with each user accessing the mental health recognition tool.
- Development_Costs: The total expenses incurred during the development phase, including model training, app development, and user interface design.
- Maintenance_Costs: The ongoing costs for maintaining and updating the machine learning model and the application.
- Server_Costs: The expenses related to server infrastructure for hosting the application and managing user data.

- Software_Costs: Costs associated with software licenses, third-party tools, and frameworks used in the project.
- Other_Costs: Miscellaneous costs that may include marketing expenses, administrative costs, or unforeseen expenditures.

Example Cost Estimation:

Let's assume the following hypothetical values for illustration

purposes: Number of Users: 10,000

Price Per User: $5

SVM Decision Function (Placeholder): Let's assume this value is 0.75 for illustration.

Development Costs: $50,000

Maintenance Costs: $10,000

Server Costs: $20,000

Software Costs: $5,000

Other Costs: $2,000

Now, let's calculate the revenue using the financial equation:

Revenue = (0.75 \times 10,000 \times $5) - ($50,000 + $10,000 + $20,000 + $5,000 + $2,000)

= (0.75 \times $50,000) - $87,000

= $37,500 - $87,000

= -$49,500

Conclusion from this Cost Estimation:

In this example, the calculated revenue is negative, indicating a financial loss. It's important to note that these are hypothetical values for illustration purposes, and the actual revenue would depend on various factors, such as the accuracy of the model, user engagement, and the effectiveness of the pricing strategy.

The negative revenue suggests that, in this scenario, the costs associated with development, maintenance, server, software, and other expenses outweigh the income generated from user subscriptions. This could prompt a reassessment of the pricing model, user acquisition strategies, or a review of cost-cutting measures to make the product financially viable.

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 Links:

Repository Link:

https://github.com/monalisaburma/Feynn-Labs/tree/main/task4

Streamlit code:

https://github.com/monalisaburma/Feynn-Labs/tree/main/task4/streamlit_code

Model creation code link:

https://github.com/monalisaburma/Feynn-Labs/blob/main/task4/mental_health_prediction.ipynb

Streamlit App link:

https://mentalhealth-prediction.streamlit.app/