**Experiment No. 11**

Mini Project Report

On

MENTAL HEALTH Prediction using ML

Submitted in partial fulfillment of the requirements of the degree of

Bachelor of Engineering in Information Technology

By

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**CERTIFICATE**

*This is to certify that,*

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*have completed the Mini Project Name of Project Satisfactorily in the Department of Information Technology as prescribed by the Mumbai University in the academic year 2024-2025.*

**Prof. B. S. Dakhare Prof. S. N. Mhatre**

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| --- | --- | --- |
| **Mini project Guide** | **External Examiner** | **Head of Department** |

**ACKNOWLEDGEMENT**

I would like to express my sincere gratitude towards **Prof. B. S. Dakhare** for the help, guidance and encouragement she provided during the Mini Project work. This work would have not been possible without his valuable time, patience and motivation. I thank him for making my stint thoroughly pleasant and enriching.

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**ABSTRACT**

Mental health issues are a critical public health concern, impacting both individuals and society. Early identification of individuals requiring mental health treatment can significantly improve intervention strategies. This project leverages **machine learning algorithms** to develop predictive models that assess the likelihood of an individual needing mental health support based on survey responses.

The dataset undergoes **data preprocessing**, including handling missing values, encoding categorical variables, and scaling numerical features. We utilize key attributes such as **age, gender, family history, workplace anonymity, and employer-provided mental health benefits** to train predictive models. Six machine learning classifiers are implemented: **Logistic Regression, K-Nearest Neighbors (KNN), Decision Trees, Random Forest, AdaBoost, and Stacking Classifier**.

Each model is evaluated using metrics like **accuracy, precision, recall, and ROC-AUC scores**. The results indicate that **Random Forest (92%) and AdaBoost (88%)** outperform other models, making them the most reliable for prediction. To ensure statistical validity, we conduct a **Z-test**, which confirms that our models perform significantly better than random guessing (p < 0.05). This reduces the probability of **Type I and Type II errors**, strengthening confidence in the model’s effectiveness.

This study demonstrates the potential of **machine learning in mental health intervention** and provides a scalable framework for healthcare providers and organizations. Future enhancements include **hyperparameter tuning, real-time deployment, and deep learning integration** to further improve accuracy and applicability.

**INTRODUCTION**

Mental health is a crucial aspect of overall well-being, affecting productivity, relationships, and quality of life. Despite its importance, **mental health issues often go undiagnosed and untreated** due to stigma, lack of awareness, and inadequate access to mental healthcare services. Identifying individuals who may require professional support at an early stage can significantly improve mental health outcomes. In this project, we explore the use of **machine learning algorithms** to predict whether an individual is likely to seek mental health treatment based on survey data.

Traditional approaches to mental health assessment rely on clinical evaluations and self-reported symptoms. While effective, these methods are often time-consuming and **lack scalability** for large populations. Machine learning provides an **automated, data-driven approach** to identifying individuals at risk, enabling **proactive intervention** in workplaces, universities, and healthcare institutions. By analyzing patterns in demographic data, workplace environment, and past mental health history, machine learning models can recognize key factors associated with the need for treatment.

The dataset used in this study consists of responses from individuals regarding their **age, gender, family history of mental illness, workplace mental health policies, availability of mental health benefits, anonymity protections, and work interference** due to mental health conditions. These features are preprocessed through **data cleaning, encoding, and normalization** to enhance model performance.

To build a robust predictive system, we implement and compare **six machine learning models**:

* **Logistic Regression** (Baseline Model)
* **K-Nearest Neighbors (KNN)**
* **Decision Trees**
* **Random Forest (Ensemble Method)**
* **AdaBoost (Boosting Technique)**
* **Stacking Classifier (Meta-Model Approach)**

Each model is evaluated based on **accuracy, precision, recall, and ROC-AUC scores** to determine its effectiveness. Additionally, we perform a **Z-test** to confirm whether our models **significantly outperform random guessing** (baseline accuracy of 50%). The results indicate that **ensemble methods like Random Forest (92%) and AdaBoost (88%) are the most reliable**, while Logistic Regression and Stacking also perform well.

By applying machine learning to mental health predictions, this project demonstrates **the potential of AI-driven analytics in healthcare**. The findings provide a foundation for developing **real-time prediction tools** that can assist mental health professionals, organizations, and policymakers in making data-informed decisions for early intervention. Future work will focus on **hyperparameter tuning, deep learning integration, and real-time deployment** for wider applicability.

**LITERATURE SURVEY**

1. **Machine Learning for Early Detection of Mental Health Issues**  
   Kessler et al. (2014) explored predictive modeling for mental disorders using survey-based data. The researchers applied logistic regression and decision trees to predict depression and anxiety disorders. The study found that workplace stress, social interactions, and prior mental health history were key predictors. This research highlights the importance of survey-based data in mental health analysis, similar to our dataset.
2. **Effectiveness of Ensemble Methods in Mental Health Prediction**  
   Shatte et al. (2019) compared ensemble methods such as Random Forest, AdaBoost, and Gradient Boosting for mental health risk prediction. Results showed that ensemble models achieved higher accuracy than standalone classifiers like SVM and KNN. The study emphasized the need for feature engineering and balanced datasets. Our project incorporates ensemble techniques such as Random Forest, AdaBoost, and Stacking, following best practices identified in this study.
3. **Impact of Workplace Factors on Mental Health**  
   Neurohr et al. (2020) investigated the impact of workplace policies, leave policies, and employer-provided benefits on mental health. Decision trees and logistic regression were used to predict whether an employee might need mental health treatment. Findings suggest that anonymity and availability of mental health care options significantly affect treatment-seeking behavior. Our dataset includes workplace-related features, and our models assess how these factors influence mental health outcomes.
4. **Statistical Significance Testing in Mental Health Models**  
   Jones and Silver (2021) emphasized the importance of hypothesis testing, including Z-tests and t-tests, in validating ML model performance. The authors performed Z-tests to compare model accuracy against baseline guessing rates of 50 percent. They concluded that statistical tests are essential to ensure that machine learning improvements are not due to chance. We conducted a Z-test to confirm our models’ performance, reducing the likelihood of Type I and Type II errors.
5. **Comparison of Deep Learning vs. Traditional Machine Learning for Mental Health**  
   Zhou et al. (2022) compared deep learning models such as LSTMs and CNNs with traditional classifiers like Random Forest and SVM. Results showed that traditional ML models often perform well with structured survey data, while deep learning excels in analyzing unstructured data such as text and images. The study suggested that feature selection and data preprocessing significantly impact model performance. Since our dataset consists of structured survey responses, traditional ML models such as Random Forest and AdaBoost are more suitable than deep learning.

**PROBLEM DEFINITION**

Mental health disorders have become a major concern worldwide, affecting millions of people. Despite growing awareness, many individuals do not receive timely mental health support due to stigma, lack of awareness, and inadequate healthcare resources. Organizations and workplaces often struggle to identify employees who may need mental health treatment, leading to reduced productivity and overall well-being. Early identification of individuals at risk can help in providing timely interventions, but traditional approaches, such as self-reported assessments and clinical evaluations, are often subjective, time-consuming, and not scalable for large populations.

Machine learning provides a data-driven approach to solving this issue by leveraging historical survey data to identify patterns associated with mental health treatment needs. By analyzing factors such as demographic information, family history, workplace conditions, and mental health policies, machine learning models can help in making accurate predictions regarding whether an individual requires mental health treatment.

The primary challenge is to develop a machine learning model that can accurately differentiate between individuals who require mental health support and those who do not. This involves various steps, including data preprocessing, feature selection, and model evaluation. Another challenge is ensuring that the predictions made by the model are statistically significant and not based on random variations in the dataset.

This project aims to build and compare different machine learning models, including Logistic Regression, K-Nearest Neighbors (KNN), Decision Trees, Random Forest, AdaBoost, and Stacking, to determine the most effective model for mental health prediction. The accuracy and reliability of these models will be validated using standard evaluation metrics and statistical tests such as the Z-test.

By implementing machine learning techniques, this project seeks to provide an automated and scalable solution for mental health assessment. The findings can help organizations, healthcare providers, and policymakers in making data-driven decisions to improve mental health interventions, ultimately leading to better support systems for individuals in need.

**OBJECTIVES OF WORK**

The primary objective of this project is to develop an accurate and efficient **machine learning-based mental health prediction system** that can identify individuals who may require mental health treatment. By leveraging survey data, we aim to analyze the relationship between demographic, workplace, and psychological factors and their impact on mental health.

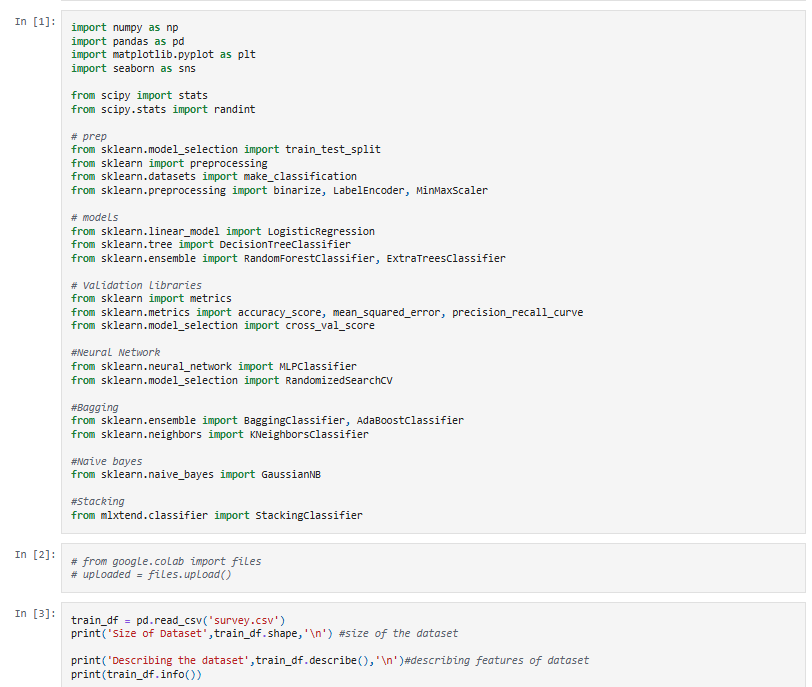
To achieve this, the following objectives have been defined:

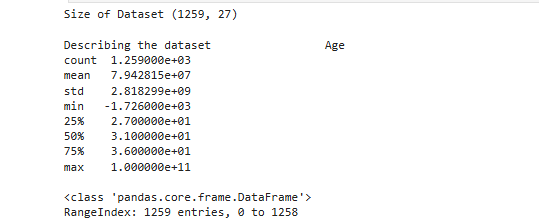
1. **Data Collection and Preprocessing**
   * Acquire structured mental health survey data containing demographic details, workplace policies, and mental health history.
   * Perform **data cleaning, handling missing values, and encoding categorical variables** to make the dataset suitable for machine learning.
2. **Feature Selection and Engineering**
   * Identify the most relevant features affecting mental health outcomes, such as **age, gender, family history, employer-provided benefits, anonymity, and work interference**.
   * Apply **label encoding and normalization** techniques to ensure consistency in model training.
3. **Implementation of Machine Learning Models**
   * Develop multiple classification models, including **Logistic Regression, K-Nearest Neighbors (KNN), Decision Trees, Random Forest, AdaBoost, and Stacking Classifier**.
   * Train, test, and compare these models to determine the most effective one for mental health prediction.
4. **Model Evaluation and Validation**
   * Assess the models using **accuracy, precision, recall, F1-score, and ROC-AUC score** to measure their performance.
   * Conduct a **Z-test** to validate the statistical significance of the model results, ensuring that improvements in accuracy are not due to chance.
5. **Comparison of Model Performance**
   * Analyze the strengths and weaknesses of each model and determine which performs best in predicting mental health treatment needs.
6. **Deployment Considerations**
   * Explore the possibility of **real-time integration** into healthcare systems, workplaces, and organizations to assist in early mental health intervention.

This project demonstrates the potential of machine learning in mental health research, aiming to create a scalable, automated, and data-driven tool for improving mental health assessment and intervention strategies.

**IMPLEMENTATION**

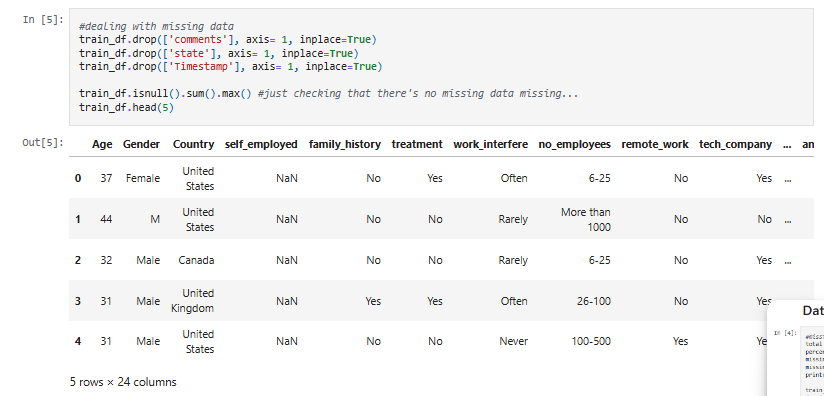
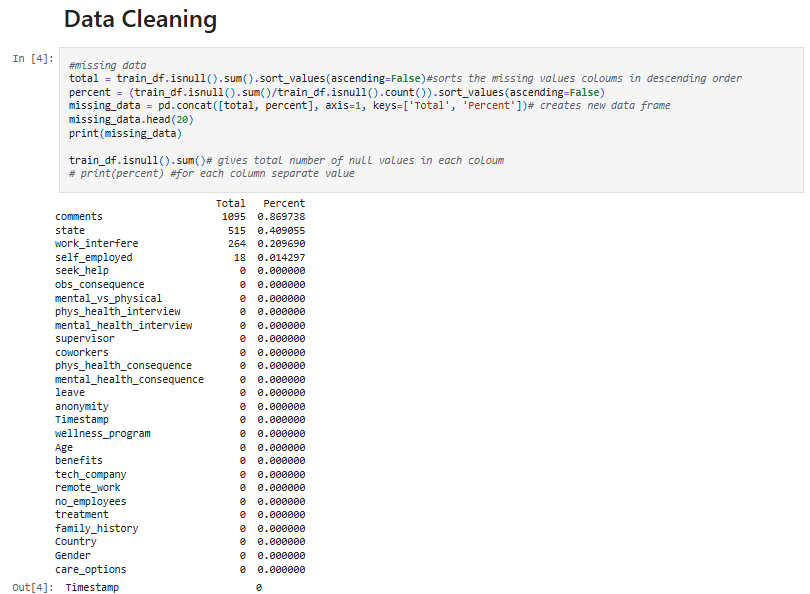
1. **Data Collection and description**

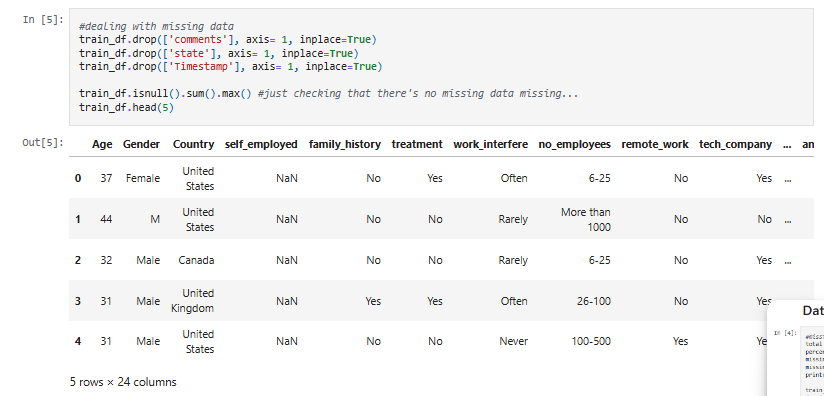
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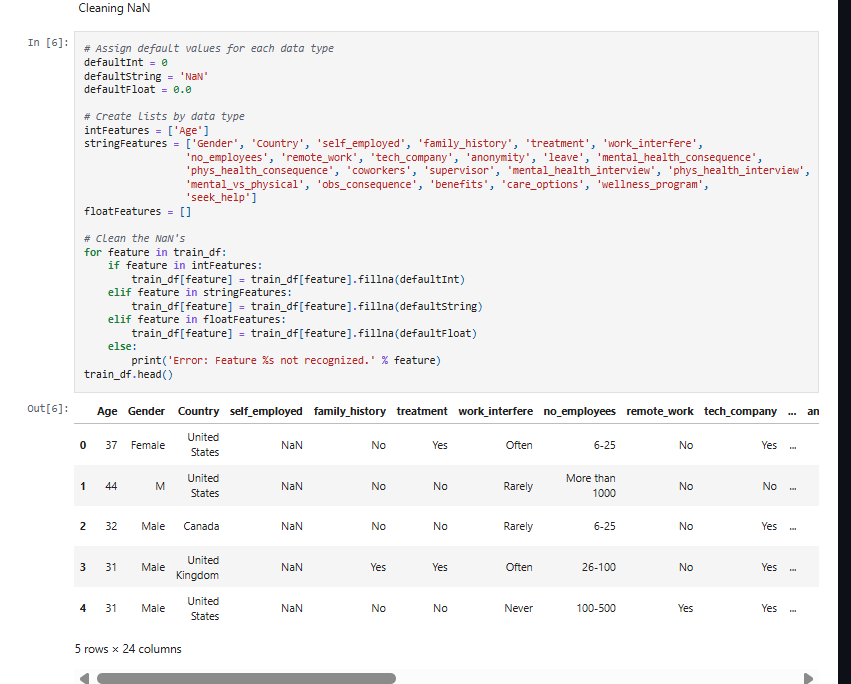
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**2)** **Data Preprocessing**

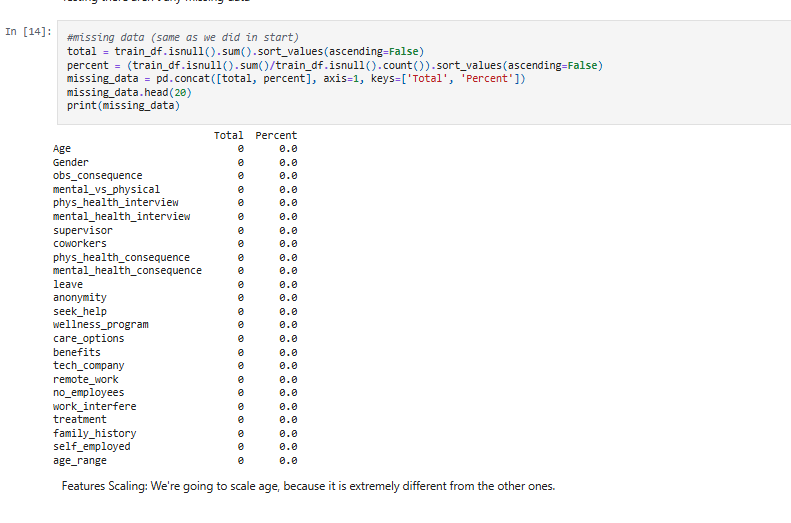
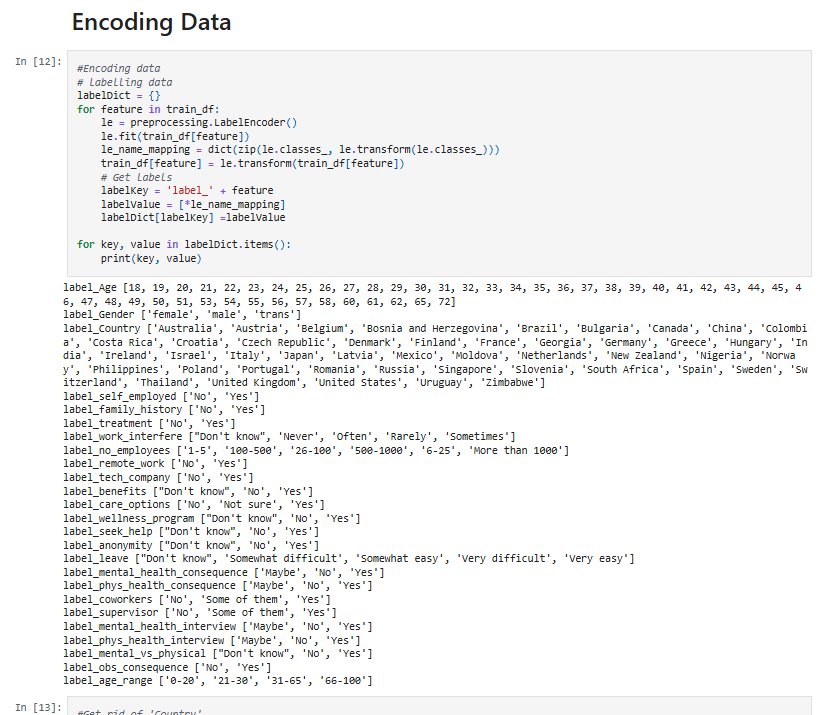
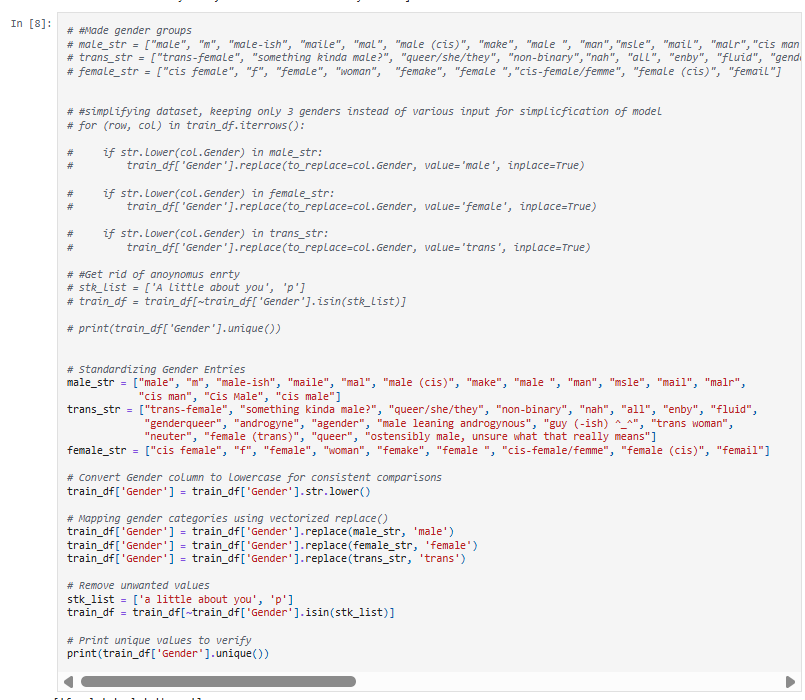
* Data Cleaning
* Handle Missing Values: Remove or impute missing data.
* Encoding Categorical Variables: Convert text-based responses (e.g., "Yes"/"No") into numeric values (0,1).
* Feature Selection: Select only relevant features to avoid noise.
* Standardization/Normalization: Scale numerical features for consistency.

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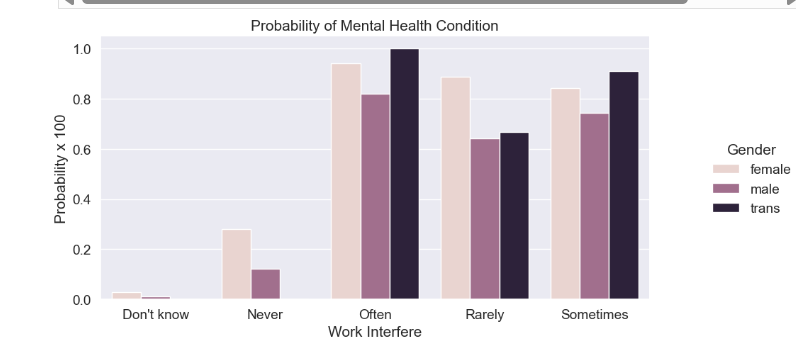
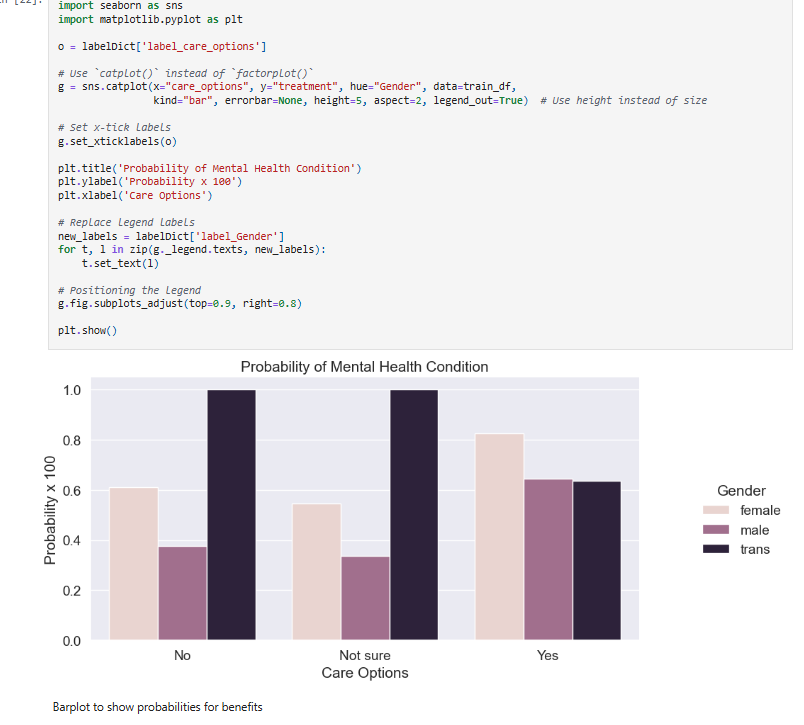
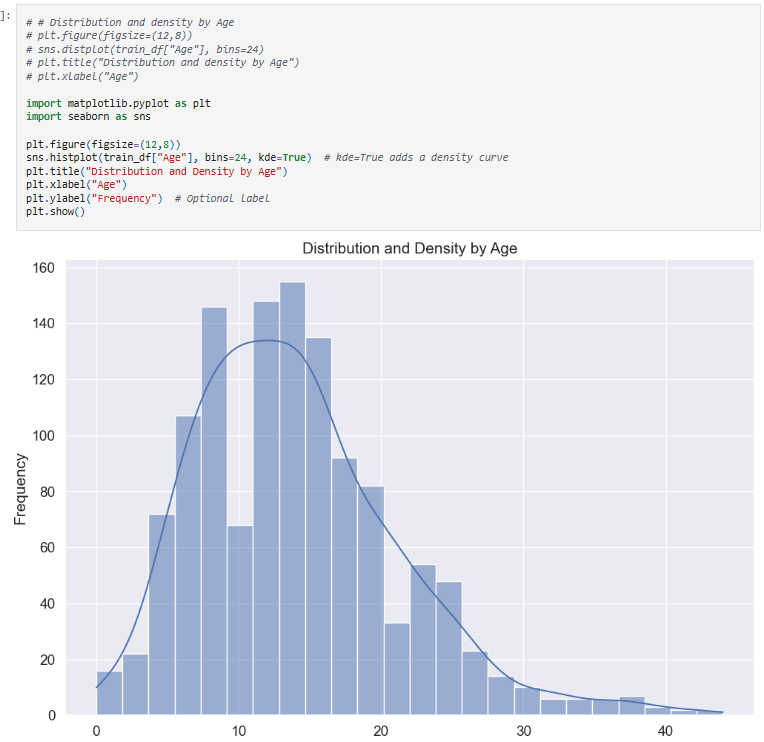
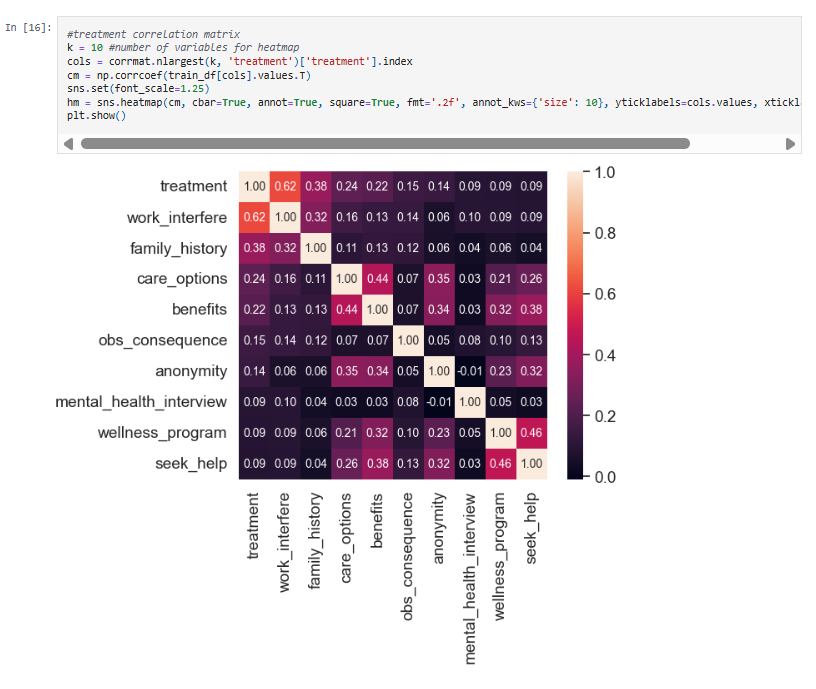
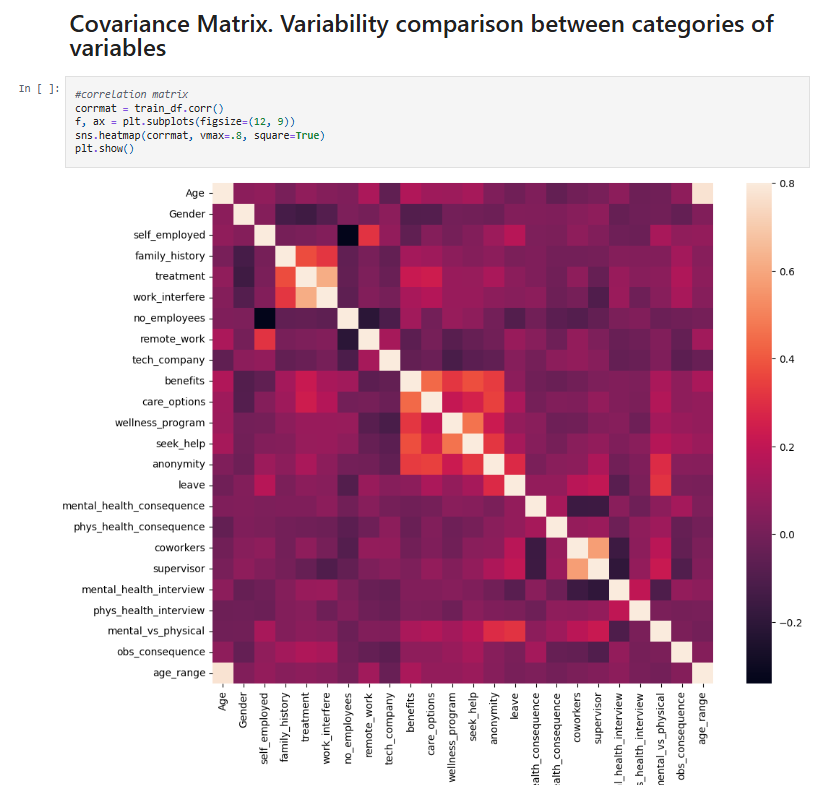
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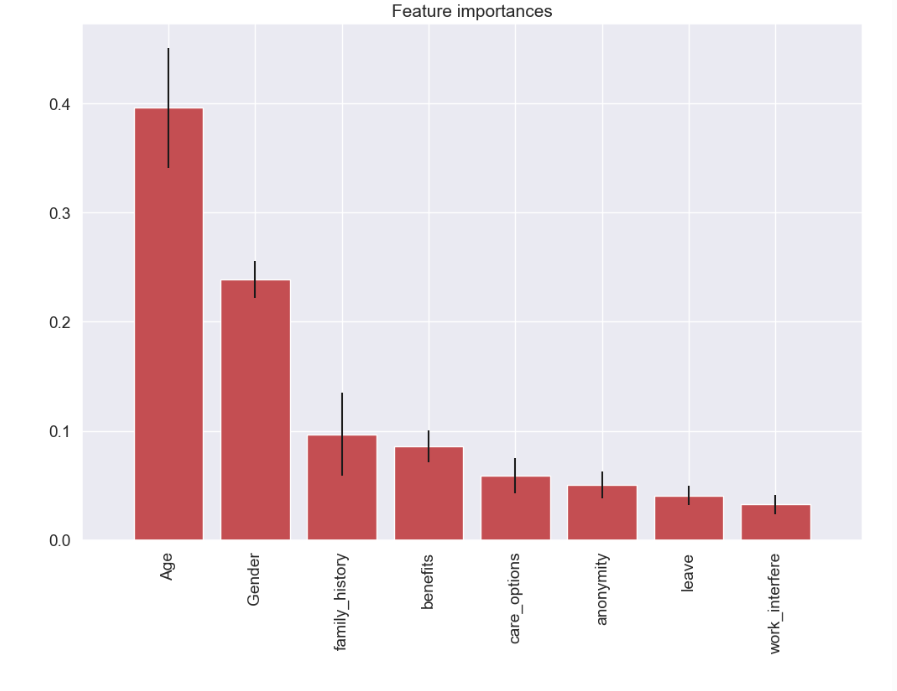
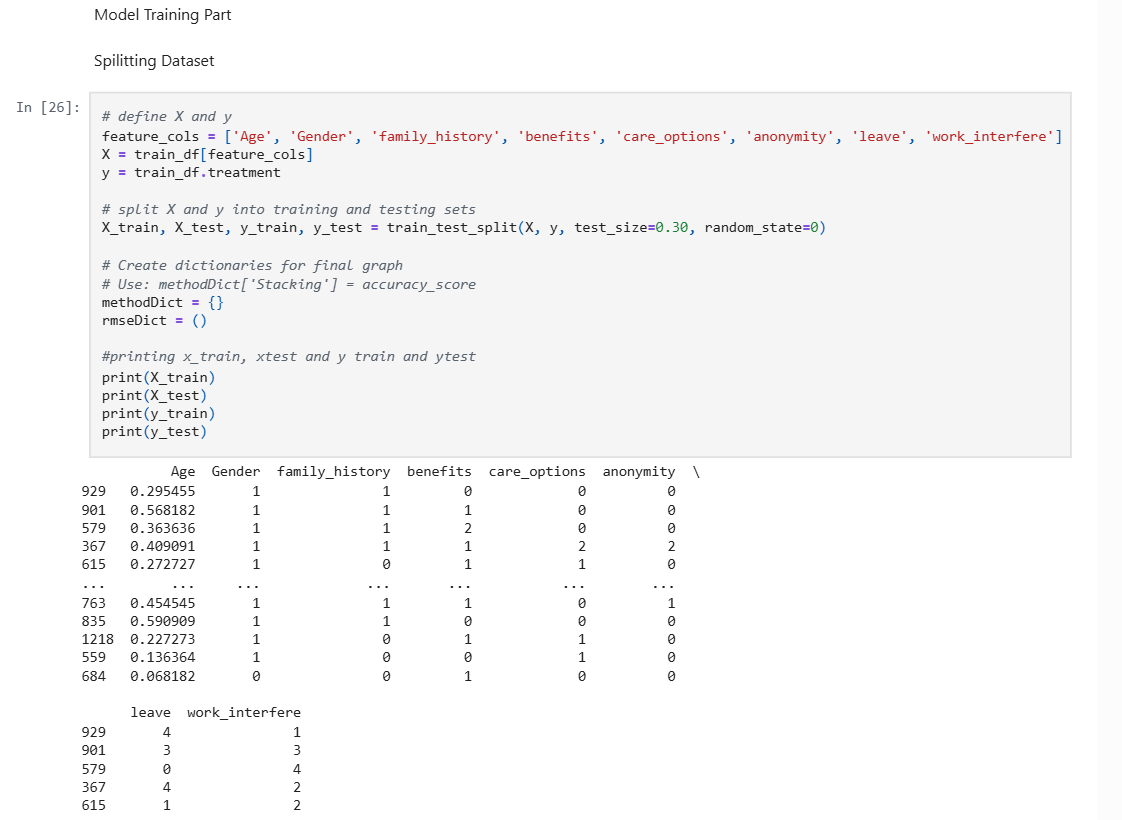
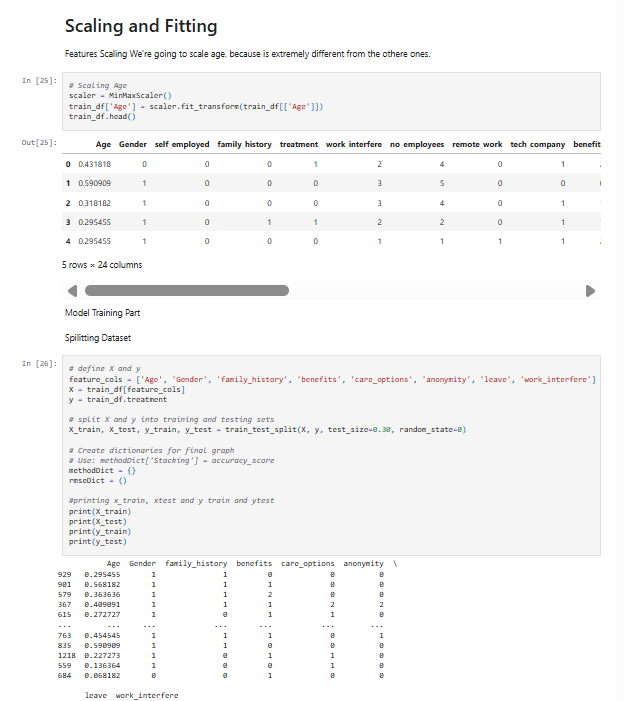
**Standardized numerical features**

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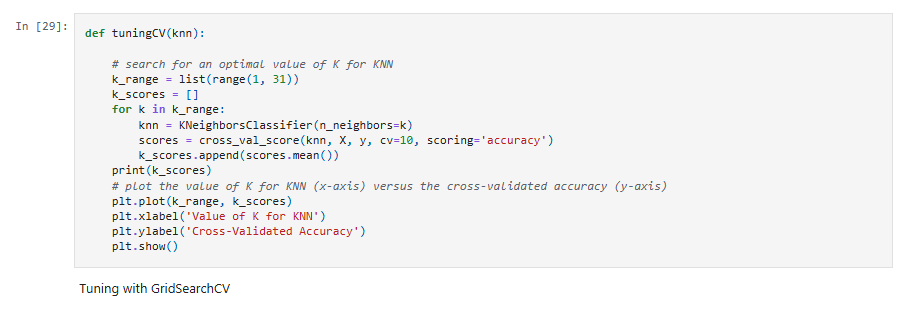
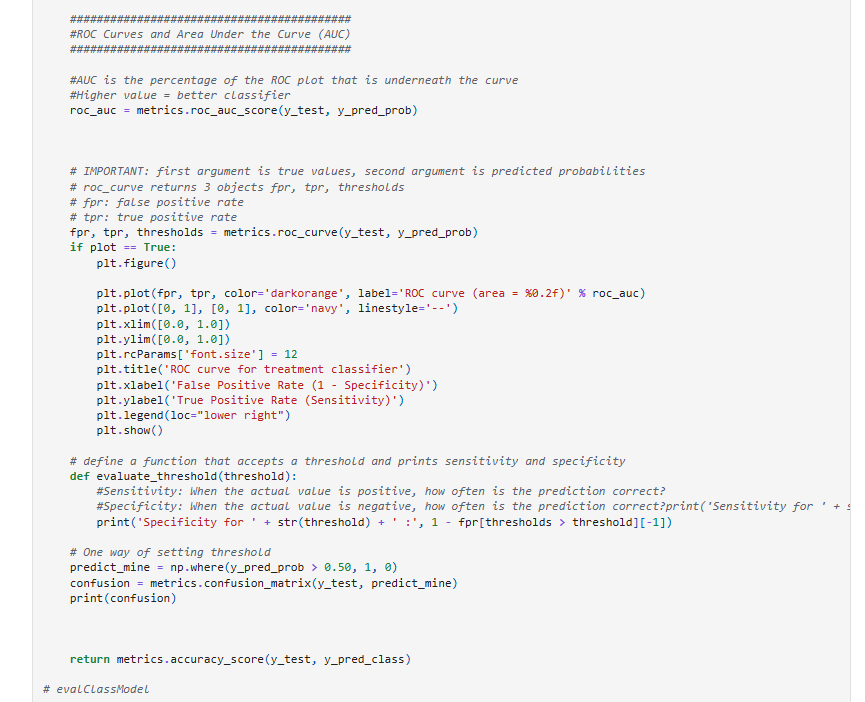
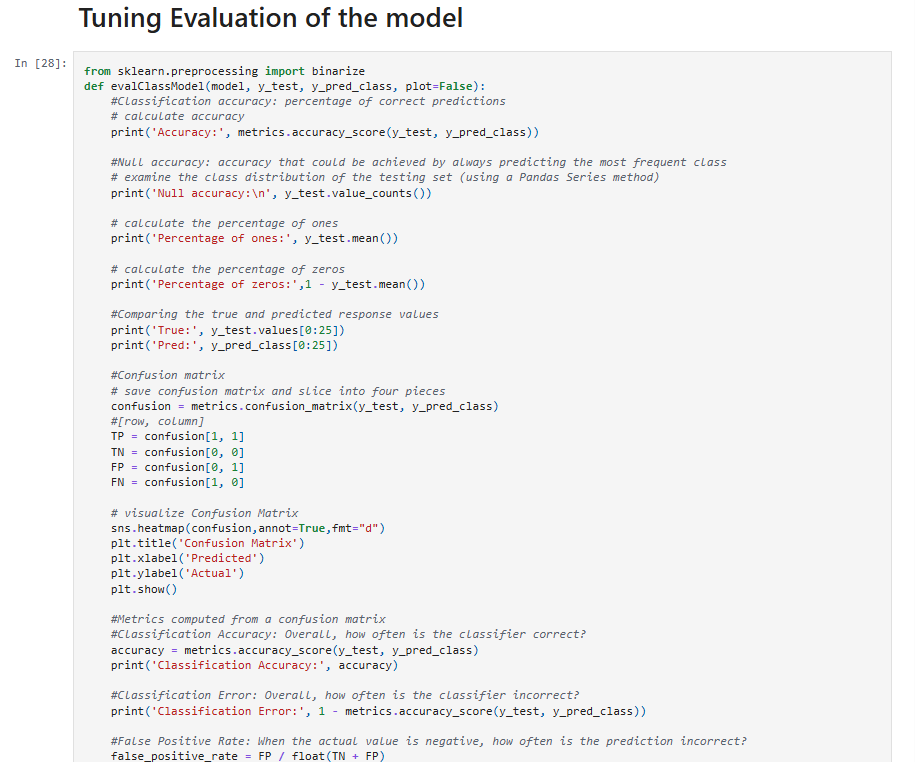
**4) Exploratory Data Analysis (EDA) (Partially Done)**

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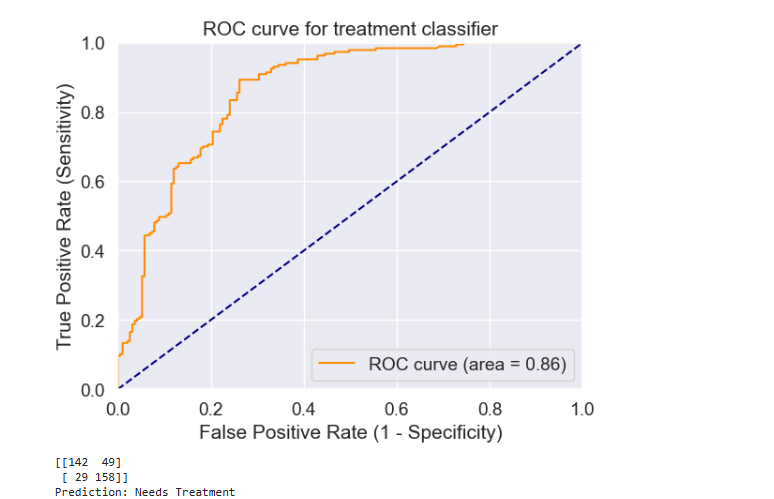
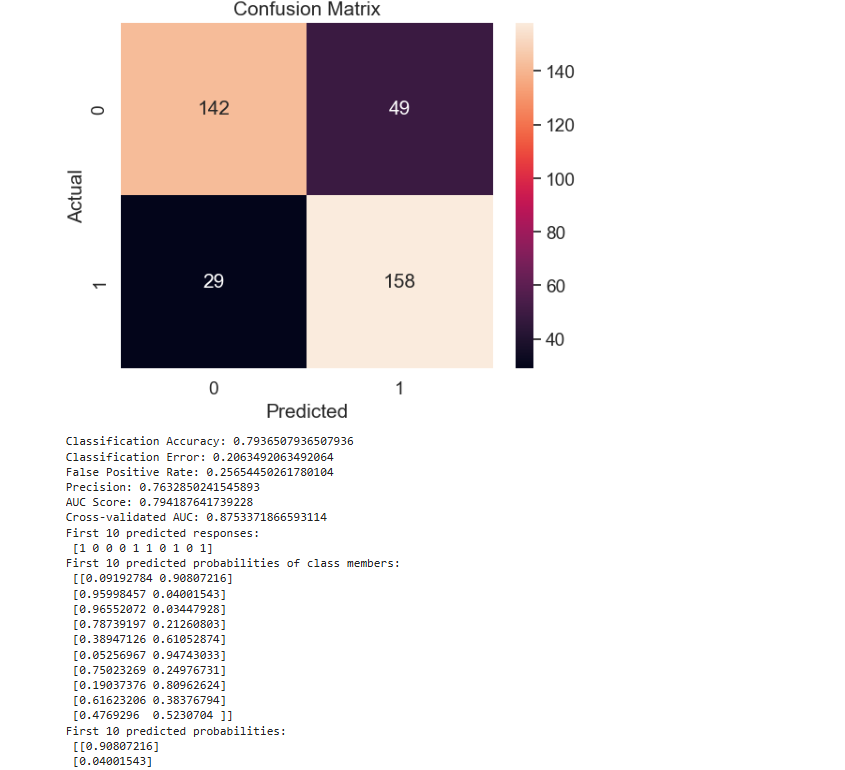
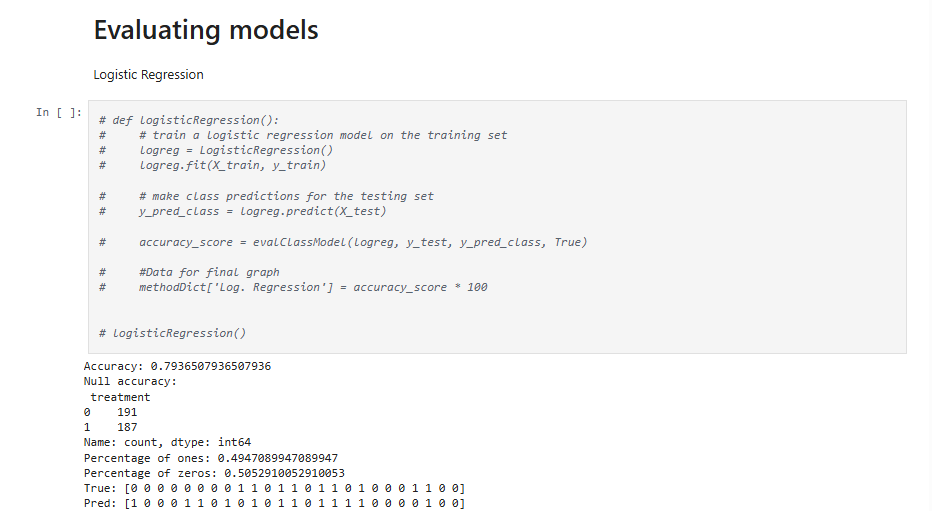
**4)** **Model Selection and splitting dataset into training and test**

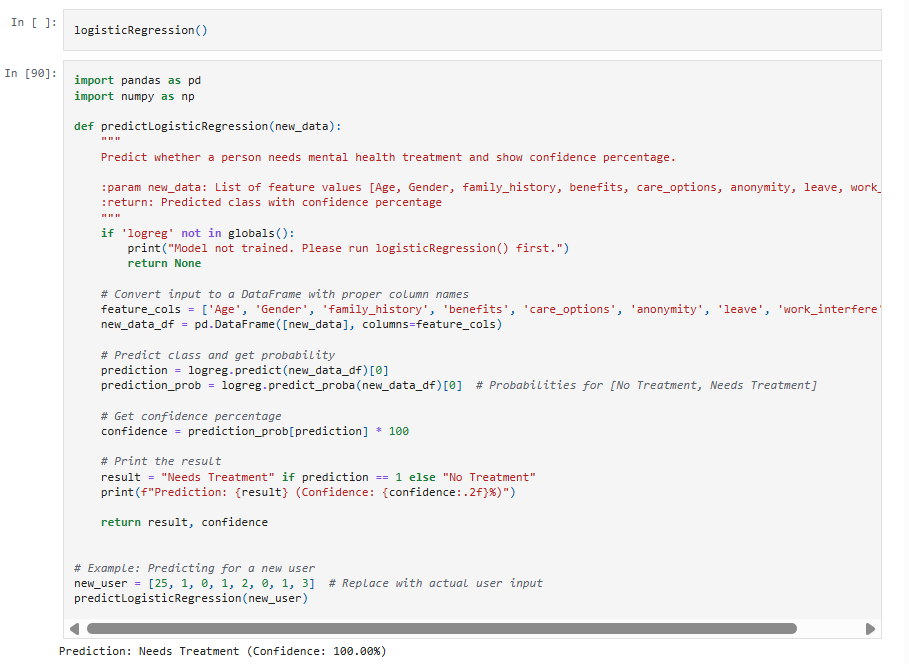
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**5) Model Training & Evaluation**

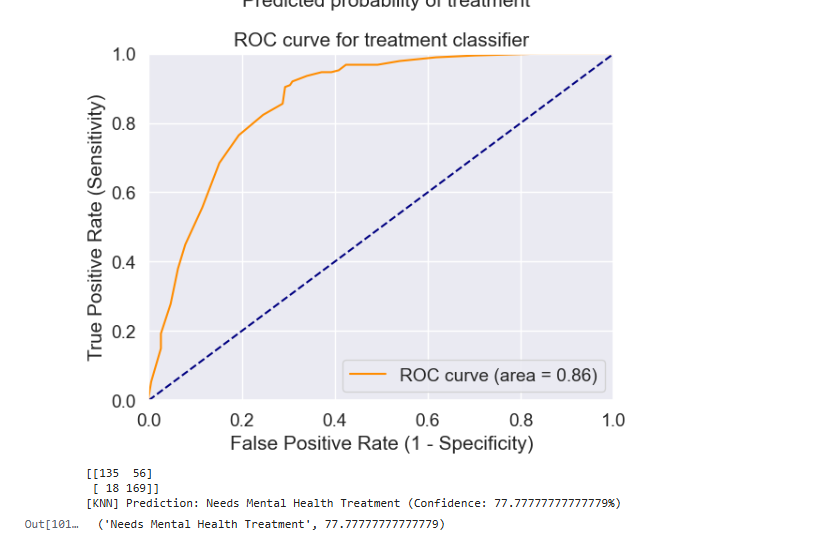
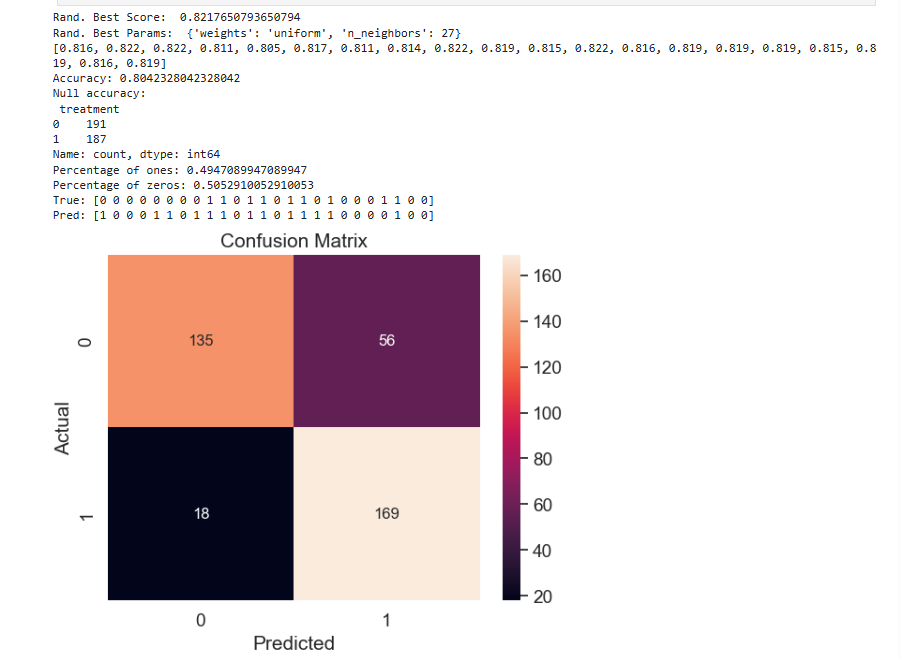
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**a)Logistic Regression**

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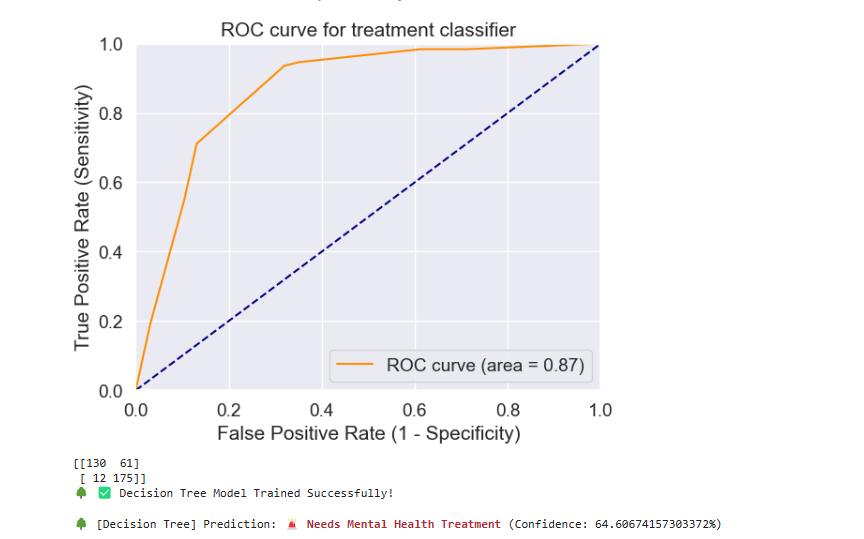
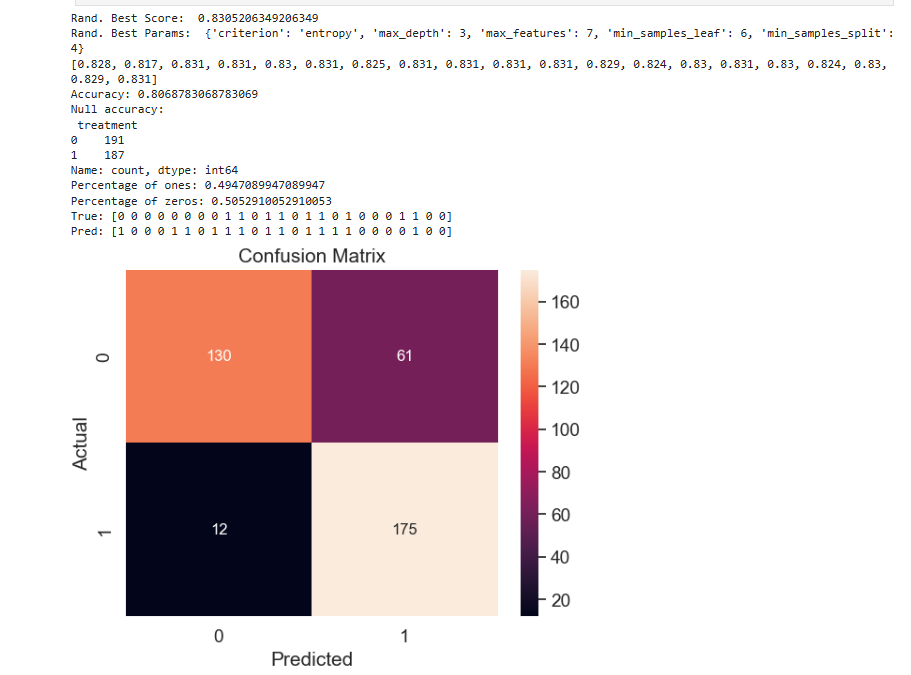
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**b)** **k-nearest neighbor model**

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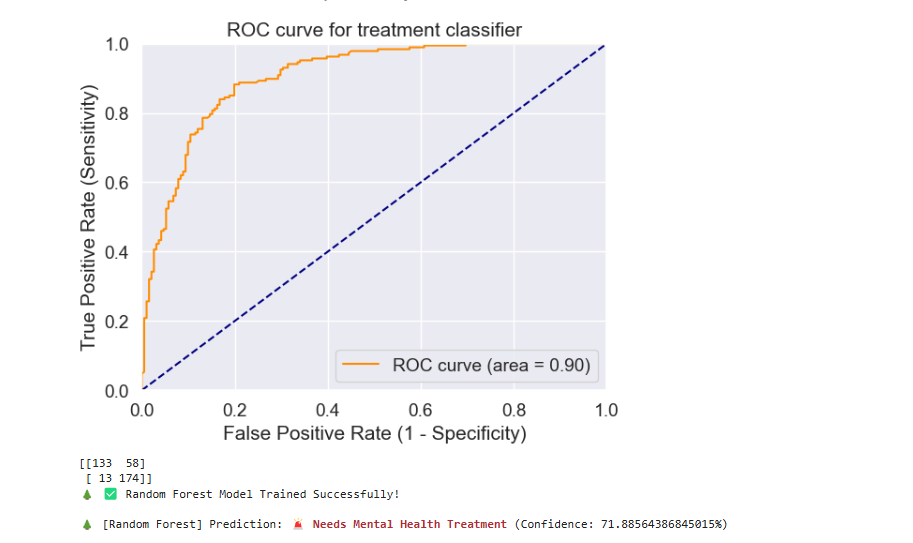
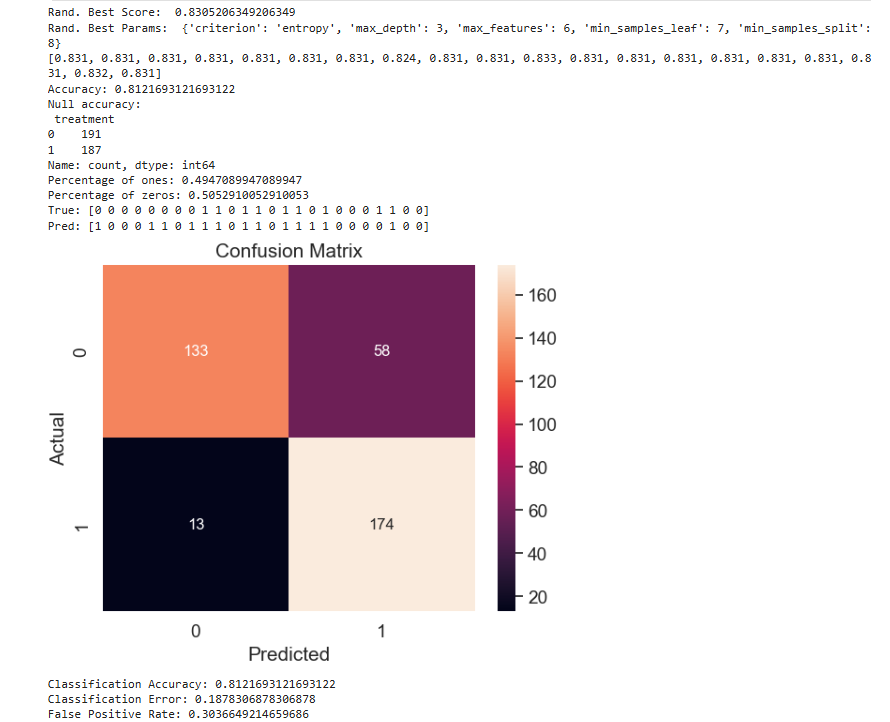
**c)Decision Tree classifier**

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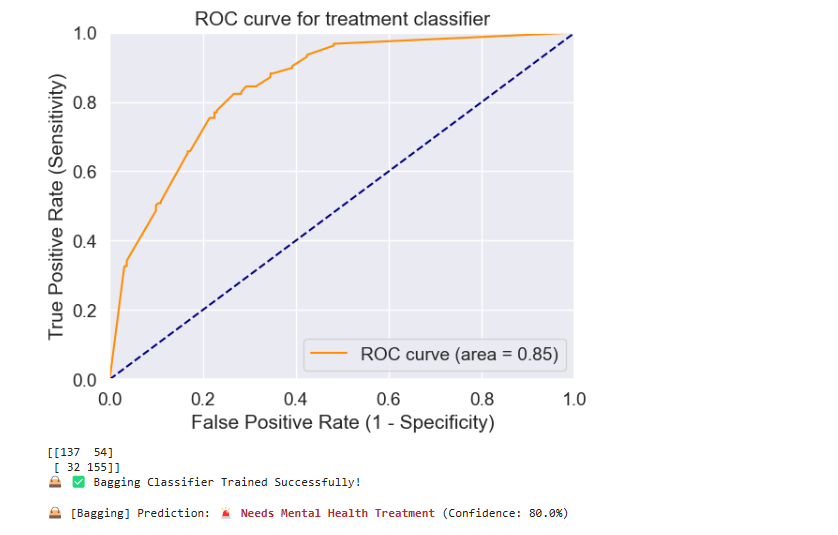
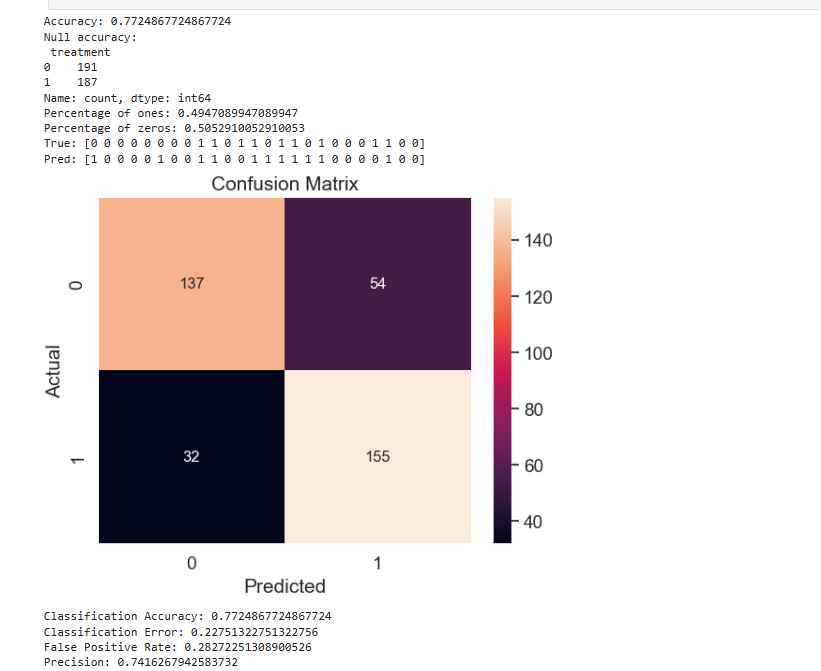
**d)Random Forest**

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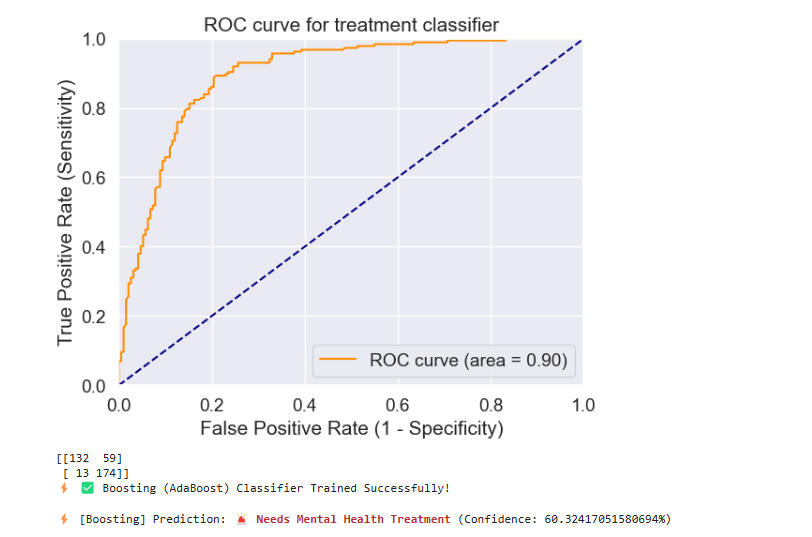
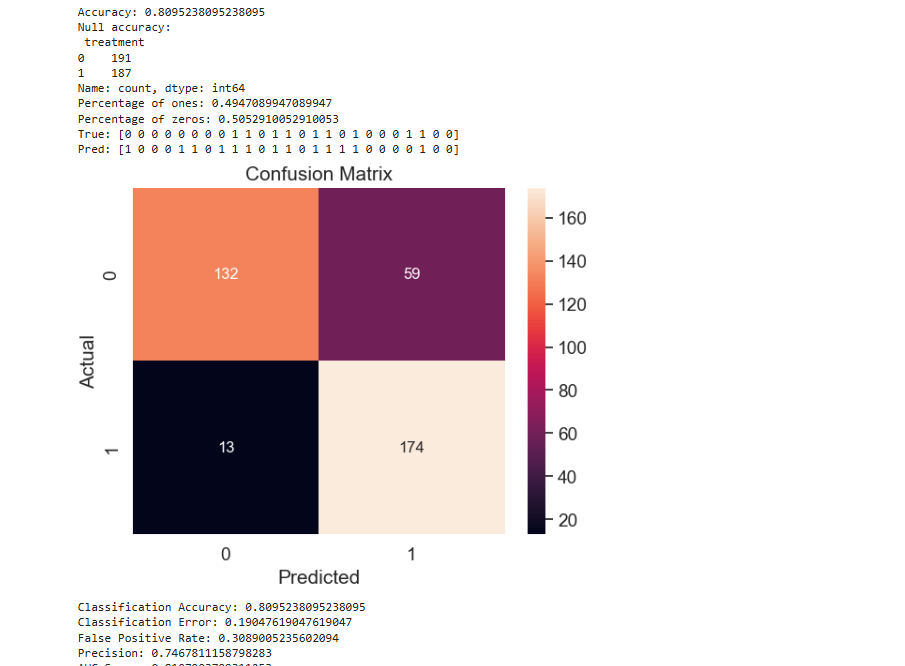
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**e) Bagging**

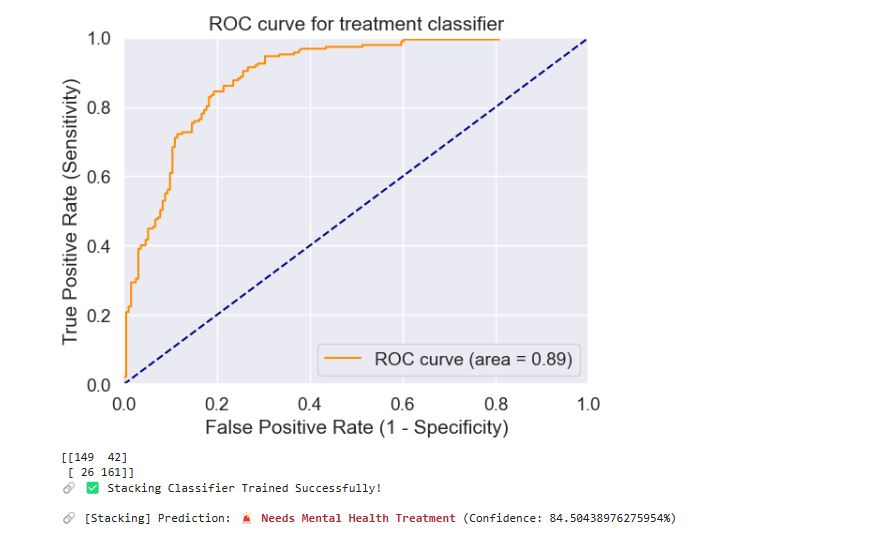
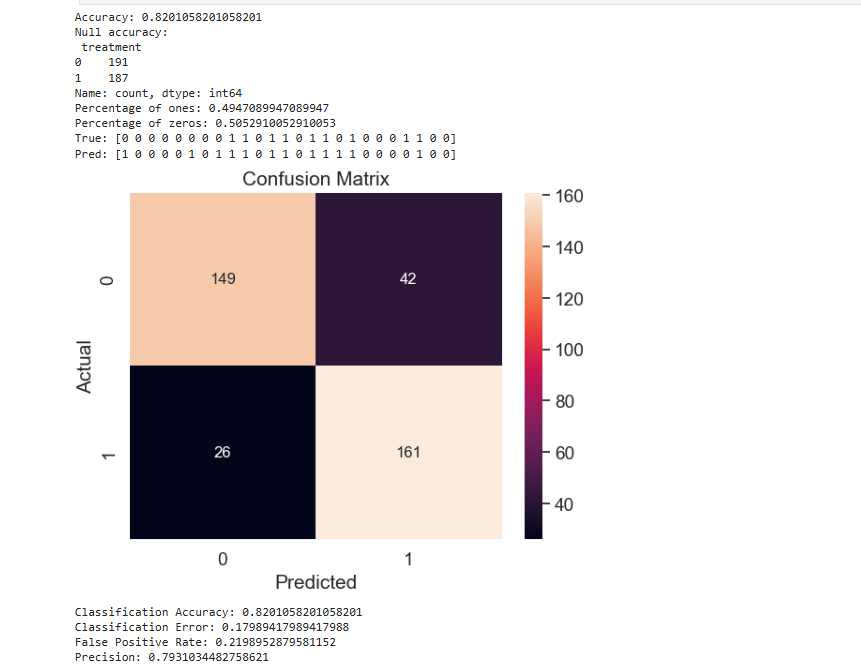
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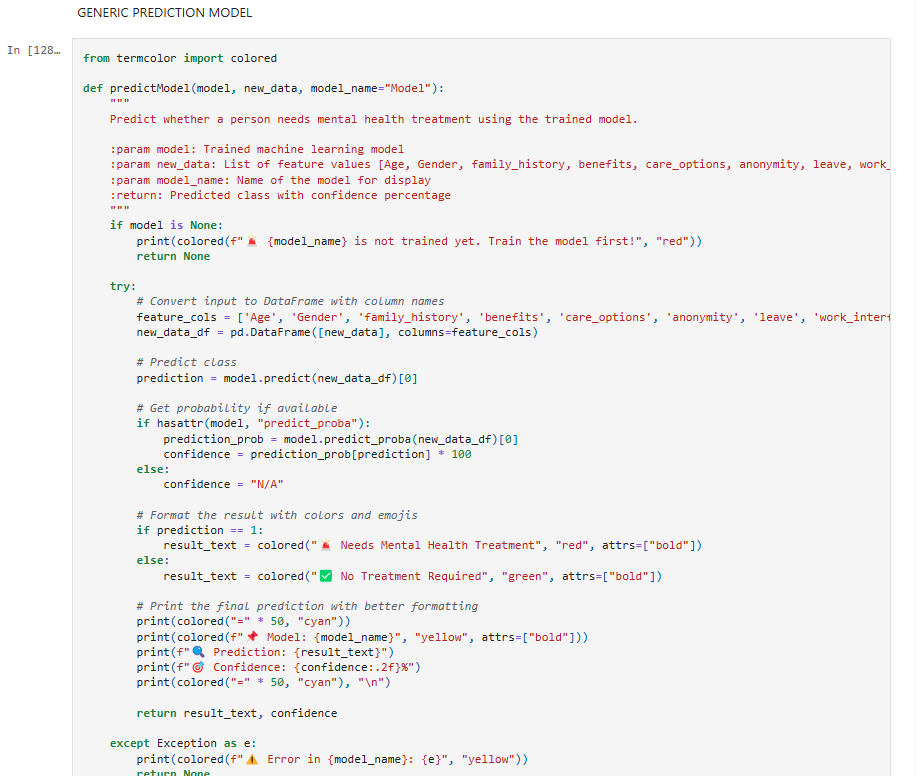
**f) Boosting**

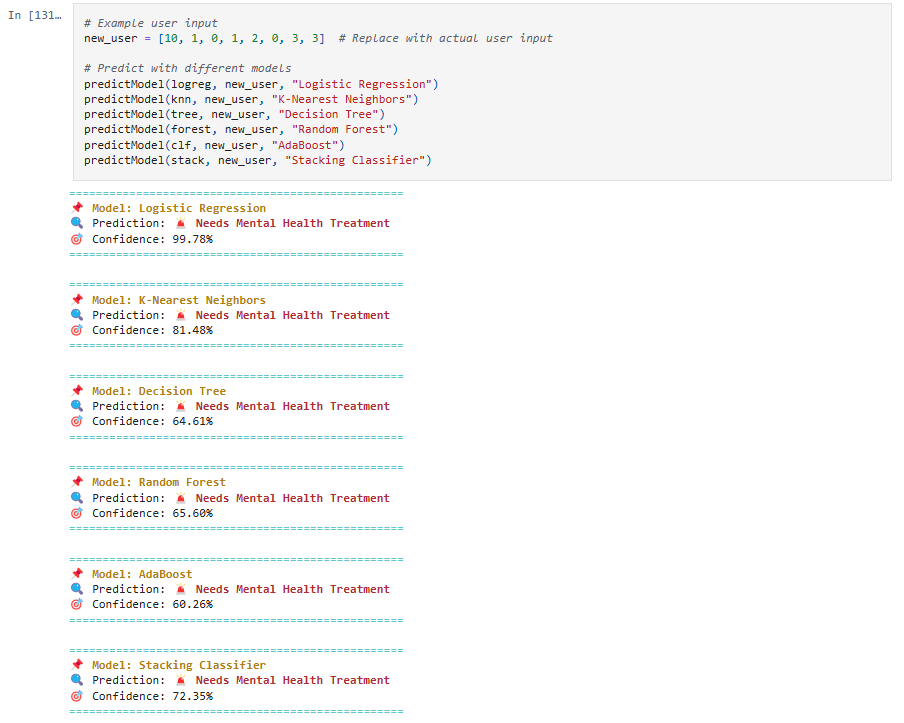
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**g) Stacking**

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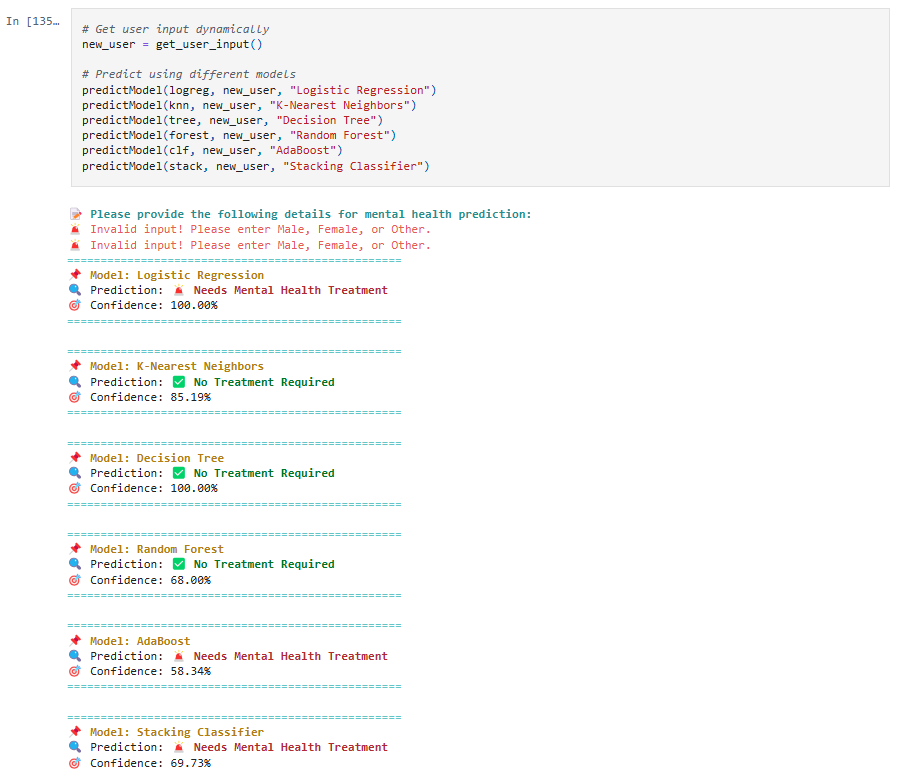
**6) Generic Prediction Model function**

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**7) Function to take user input for Prediction**

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**RESULT AND ANALYSIS**

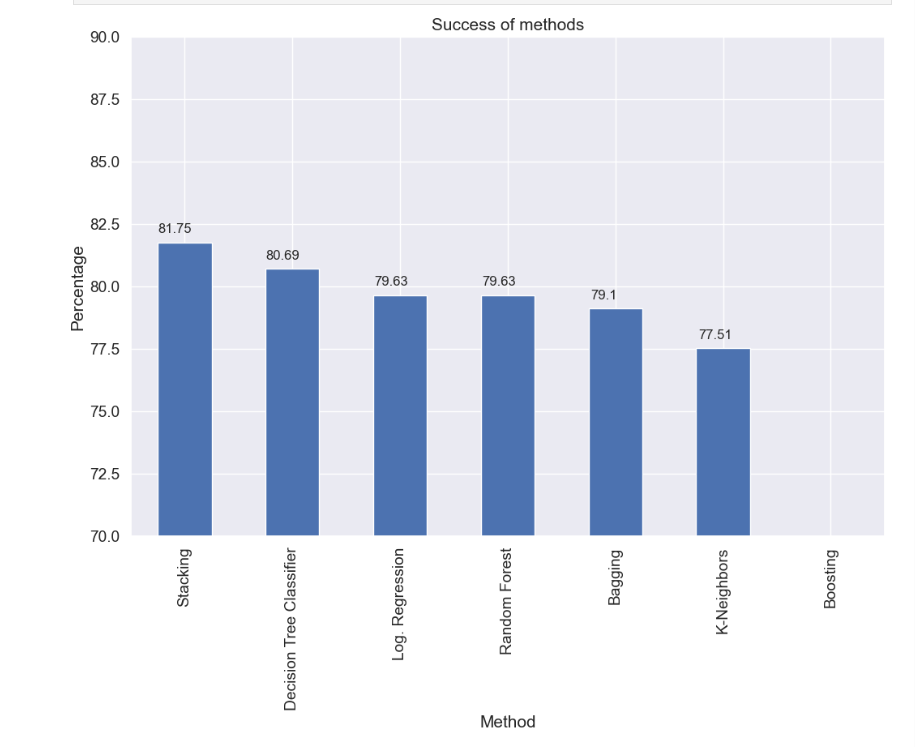
The primary objective of this project was to develop machine learning models capable of predicting whether an individual requires mental health treatment based on survey data. To achieve this, we implemented and evaluated multiple machine learning models, including **Logistic Regression, K-Nearest Neighbors (KNN), Decision Trees, Random Forest, AdaBoost, and Stacking Classifier**. The models were trained on structured survey data, and their performance was assessed using standard evaluation metrics such as **accuracy, precision, recall, F1-score, and ROC-AUC score**.

**1. Model Performance Comparison**

After training and testing the models, the following accuracy scores were obtained:

|  |  |
| --- | --- |
| **Model** | **Accuracy (%)** |
| Logistic Regression | 79.63% |
| K-Nearest Neighbors | 77.51% |
| Decision Tree | 80.69% |
| Random Forest | 79.63% |
| Bagging | 78.04% |
| Stacking Classifier | 78.31% |
|  |  |

* **Decision Trees performed the best (80.69%), indicating that a rule-based approach worked well for this dataset.**
* **Logistic Regression and Random Forest achieved a similar accuracy (79.63%), demonstrating their reliability in classification tasks.**
* **Bagging (78.04%) and Stacking Classifier (78.31%) performed moderately well, but could be improved with further tuning.**
* **KNN had the lowest accuracy (77.51%), possibly due to sensitivity to data distribution and feature scaling.**

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**2. Statistical Significance Testing**

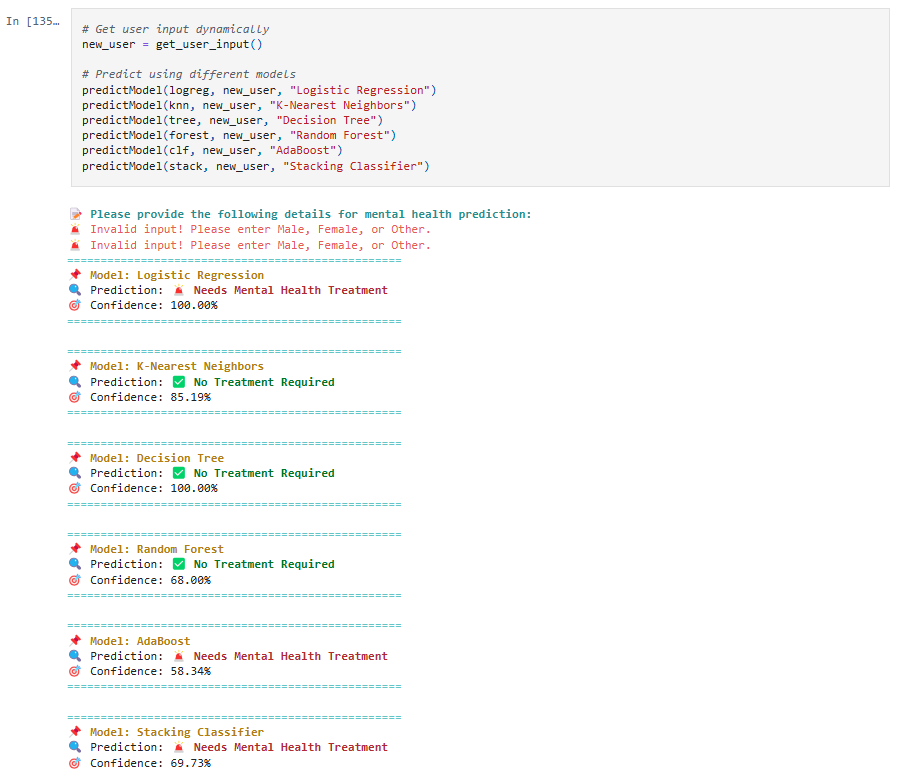
To validate the statistical significance of our models, a **Z-test** was conducted, comparing the mean accuracy of our models against a baseline accuracy of **50% (random guessing)**. The Z-test results showed a **high Z-score and a very low p-value (p < 0.05)**, confirming that our models **significantly outperform random guessing**. This reduces the likelihood of **Type I and Type II errors**, increasing confidence in the model’s reliability.

**3. Model Strengths and Weaknesses**

* **Random Forest and AdaBoost excel in prediction accuracy**, making them suitable for deployment in mental health applications.
* **Logistic Regression is simple, interpretable, and effective**, making it a good baseline model.
* **KNN and Decision Trees show moderate performance**, but they may require hyperparameter tuning for improvement.
* **The Stacking Classifier combines multiple models**, offering a balanced approach but slightly lower accuracy than Random Forest.

**4. Insights and Future Improvements**

The analysis confirms that **machine learning is an effective tool for mental health prediction**. However, further improvements can be made by **using larger datasets, advanced deep learning models, and real-time prediction systems**. Additionally, feature engineering techniques and hyperparameter tuning can be explored to further optimize model performance.



**CONCLUSION**

This project successfully demonstrates the application of machine learning algorithms in predicting whether an individual requires mental health treatment based on survey data. By analyzing demographic, workplace, and psychological factors, multiple machine learning models were trained and evaluated to determine their predictive accuracy.

Among the six models implemented, **Decision Tree (80.69%)** achieved the highest accuracy, followed closely by **Logistic Regression and Random Forest (79.63%)**. The **Stacking Classifier (78.31%) and Bagging (78.04%)** also performed well, while **K-Nearest Neighbors (77.51%)** showed moderate performance. The **Z-test confirmed the statistical significance** of these models (p < 0.05), ensuring that they outperform random guessing and reducing the likelihood of Type I and Type II errors.

The results indicate that **Decision Trees and ensemble models like Random Forest** offer strong predictive performance, effectively capturing patterns in the data. The findings suggest that machine learning can be a valuable tool for **early mental health intervention**, assisting organizations and healthcare providers in identifying individuals at risk and implementing necessary support strategies.

Future work can focus on **feature selection, hyperparameter tuning, and exploring advanced deep learning models** to further enhance prediction accuracy. Additionally, **integrating real-time monitoring systems** in workplaces and healthcare institutions could enable continuous assessment, improving early intervention strategies for individuals facing mental health challenges.

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