PIMPRI CHINCHWAD EDUCATION TRUST's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, NIGDI PRADHIKARN, PUNE – 411044.

ML Mini Project Report

Anxiety Assessment Tool : Enhancing Anxiety Assessment, Machine Learning-Based Anxiety Detection.

Academic Year: 2024 – 25

Date : -

Student Name and PRN

Sr no.	Name	PRN
1	Arpit Gaikwad	122B1B081
2	Badal Gaurkhede	122B1B085

Under Guidance of : Dr. Mubin Tamboli, Professor Computer Department.

1.1 Introduction / Background

Anxiety is a prevalent mental disorder that is normally assessed through standardized questionnaires, e.g., the Beck Anxiety Inventory (BAI). Although the BAI is utilized worldwide for the diagnosis of anxiety, the questions presented by the BAI are not equally contributory in predicting the severity of anxiety in a patient. The aim of the present study is to assess the relative contribution of every question present in the BAI towards the measurement of overall anxiety level, thus identifying the most important questions that enhance diagnostic accuracy. We apply machine learning models, e.g., Logistic Regression, Support Vector Machine (SVM), Random Forest, and Gradient Boosting, along with feature importance techniques to determine the contribution of every BAI question. The results inform the best symptoms, hence the development of more sensitive diagnostic tools and better mental health measurements

1.2 Problem Statement :

Enhancing Anxiety Assessment : Leveraging Machine Learning Techniques To Identify Anxiety.

1.3 Objectives :

The main goal of this research is to improve the diagnostic validity of the Beck Anxiety Inventory (BAI) through the application of the machine learning models. In particular, this research has the following objectives:

- Determine the most important questions in the BAI that help predict overall severity of anxiety.

- Create improved models that predict anxiety severity levels from questionnaire answers.

- Enhance efficiency of mental health testing by emphasizing the most predictive characteristics while achieving high diagnostic reliability

1.4 Scope of the project:

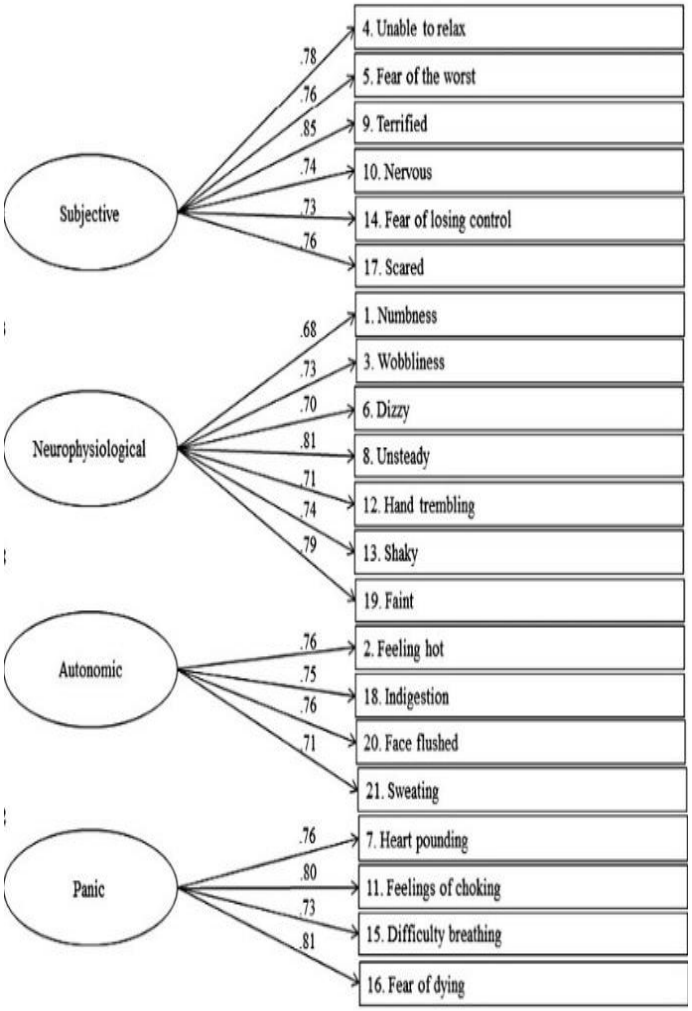
- This project enhances the accuracy and clinical utility of BDI Anxiety disorders are among the most frequent mental disorders, impacting millions globally.

- Improve diagnostic precision by asking questions with the greatest predictive value first.

2. Existing System

Anxiety disorders afflict millions globally and are defined by excessive worry, fear, and bodily symptoms including accelerated heart rate, dizziness, and shortness of breath. Aaron T. Beck's Beck Anxiety Inventory (BAI) is a 21-question self-report measure to quantify the severity of anxiety. There are different anxiety-related symptoms asked in each question, rated on a scale from 0 to 3, with higher values reflecting greater severity of anxiety.

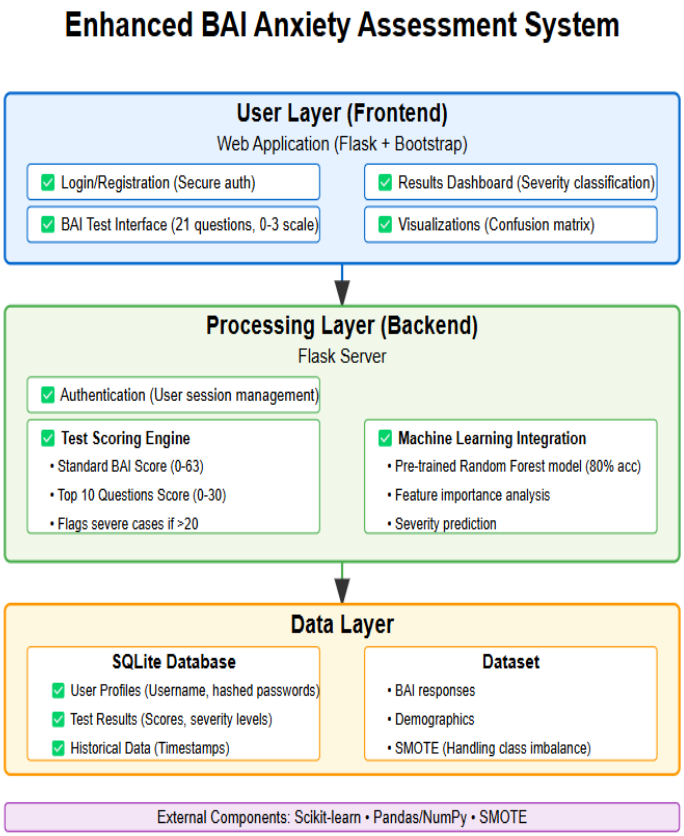
Although the BAI is universally applied, it has equal weighting of all 21 items as its assumption, which could confine its diagnostic accuracy. Different questions can predict different levels of anxiety severity to varying extents. Here, we explore the relative importance of each item of the BAI through machine learning methods and try to improve the BAI for more accurate and efficient mental health screening



By integrating the ML-based feature selection, the current research advises the improvement of the BAI to enhance the mental health diagnosis, enhances efficiency, and provides the clinicians with better decision-making tools.

3. Proposed System

The proposed system enhances the Beck Anxiety Inventory (BAI) by integrating machine learning (ML) to improve diagnostic accuracy and efficiency. The study analyzes responses from 100 participants who completed the 21-question BAI survey, which assesses anxiety symptoms on a 0-3 scale. Using Random Forest, SVM, Logistic Regression, and Gradient Boosting, the system identifies the most predictive questions (e.g., *"Fear of worst happening," "Heart pounding," "Nervous"*) while filtering out less impactful ones. The dataset is preprocessed by encoding demographic variables and balancing class distribution using SMOTE. The ML models are trained on an 80-20 split, optimized via GridSearchCV, and evaluated using accuracy (80%), precision, recall, and F1-score. A hybrid scoring system is introduced, combining the traditional BAI score (0-63) with a weighted score from the top 10 questions (0-30). If the latter exceeds 20, the system flags Severe Anxiety, even if the total score is lower, ensuring high-risk cases are not overlooked.



To make this accessible, a Flask-based web application was developed, featuring user authentication (registration/login), a dynamic BAI test interface, and personalized results. The app calculates scores in real-time, provides severity classification (Minimal, Mild, Moderate, Severe), and stores historical data for tracking. The interface is designed for ease of use, with clear visualizations (e.g., confusion matrices, feature importance charts) to help

users and clinicians interpret results. The backend uses SQLite for data storage, while the frontend employs Bootstrap for responsive design. Key innovations include streamlined questioning (prioritizing high-impact items) and explainable AI insights, bridging ML with clinical utility.

Future directions include adaptive questionnaires that adjust questions based on initial responses, deep learning integration for improved predictions, and wearable device compatibility (e.g., heart rate data) to enhance anxiety detection. This system not only refines the BAI's diagnostic precision but also offers a user-friendly, scalable platform for mental health screening. By combining ML optimization with a practical web app, it aims to reduce assessment time, improve early intervention, and support clinicians with data-driven decision-making tools. The project underscores the potential of AI-powered mental health tools to make diagnostics faster, more accurate, and widely accessible.

This integration of ML research and web development delivers a cohesive solution for modern anxiety assessment.

4. Implementation & Result

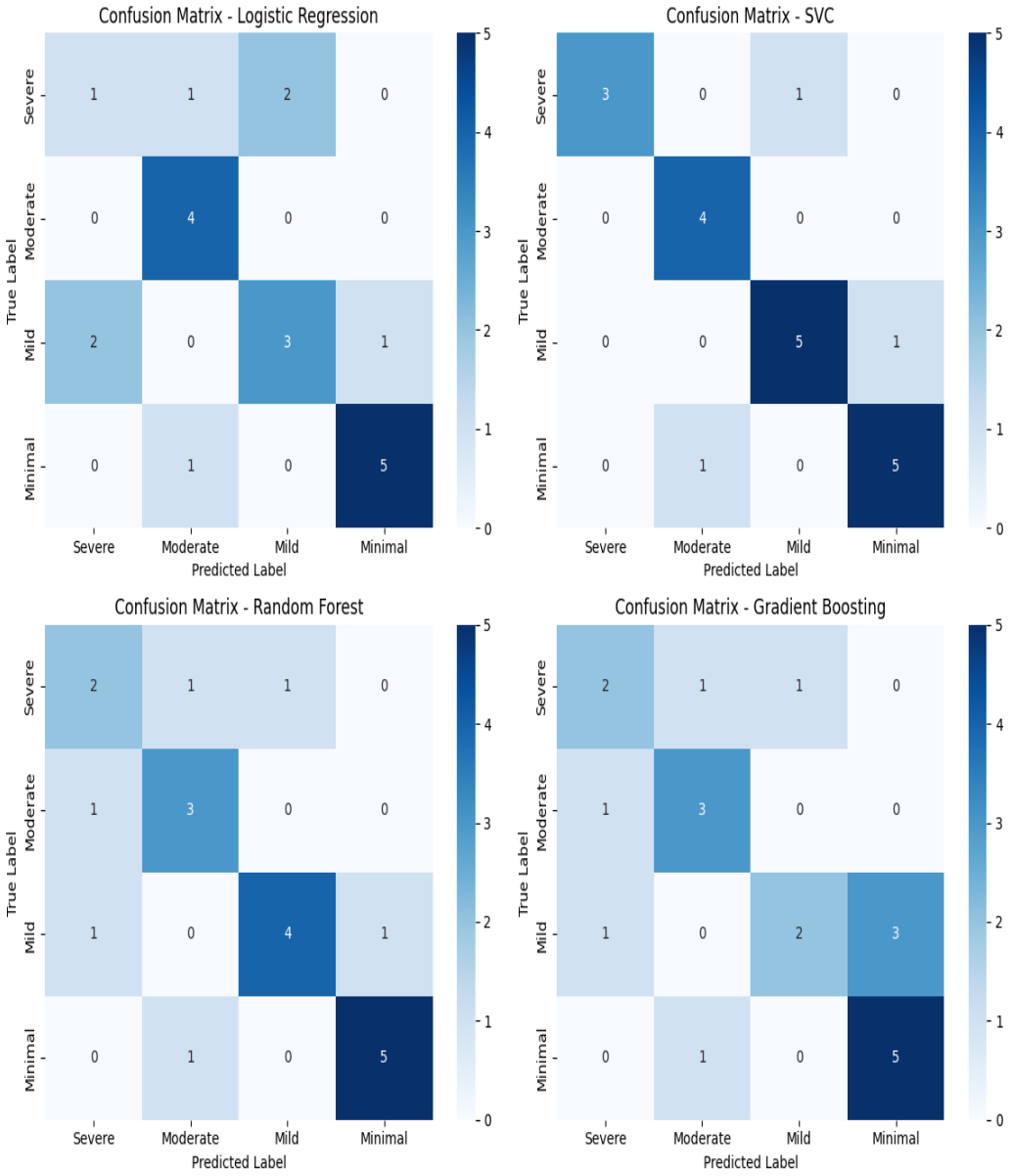
The Enhanced BAI Anxiety Assessment System leverages a modern technology stack to deliver an efficient mental health screening platform. The application is built using Flask for the web framework, complemented by HTML/CSS/Bootstrap for responsive frontend design and JavaScript for interactive elements. Python serves as the core programming language, with Flask-SQLAlchemy handling database operations and Werkzeug securing user authentication through password hashing. For the machine learning components, we utilize Scikit-learn's Random Forest, SVM, and Logistic Regression algorithms, supported by Pandas and NumPy for data preprocessing and Matplotlib/Seaborn for visualization. The system employs SQLite for lightweight data storage of user profiles and test results, with potential deployment options including Gunicorn for production and cloud platforms like Heroku.

The dataset consists of 100+ responses to the standard 21-question Beck Anxiety Inventory (BAI) questionnaire, where each symptom is scored on a 0-3 severity scale. Demographic information including gender and age groups are incorporated after label encoding. The target variable classifies anxiety levels into four categories based on total scores: Minimal (0-9), Mild (10-16), Moderate (17-29), and Severe (30-63). Comprehensive preprocessing was applied to handle missing values, encode categorical data, and address class imbalance using SMOTE to ensure robust model training.

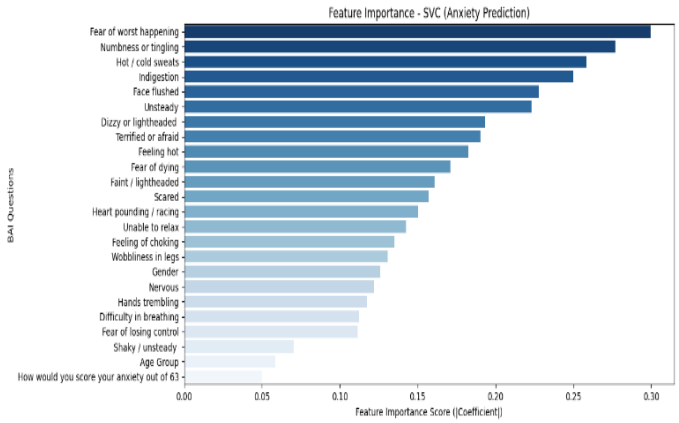
System performance was rigorously evaluated, with the Random Forest model achieving 80% accuracy in classifying anxiety severity levels. Additional metrics including precision, recall, and F1-scores were calculated for each severity class, with particular attention to correctly identifying high-risk cases. The hybrid scoring system combines traditional BAI scoring with focused evaluation of the top 10 most predictive questions identified through feature importance analysis, where scores above 20 on these key questions automatically trigger a severe anxiety classification regardless of the total score.

The system architecture comprises several major modules working in concert. The user interface module handles registration, login, and test administration through an intuitive web form. The scoring engine module processes responses using both conventional BAI algorithms and our enhanced machine learning model. A dedicated analytics module generates visualizations of test results and historical trends, while the database module securely stores all user information and test records. Together, these components form a cohesive platform that improves upon traditional anxiety assessment methods through data-driven optimization while maintaining clinical relevance and user accessibility.

ML – Result



The confusion matrix evaluates our model's classification performance across four anxiety severity levels (Minimal, Mild, Moderate, Severe). It shows correct predictions on the diagonal and misclassifications in off-diagonal cells. Our Random Forest model achieved strong diagonal dominance, indicating accurate predictions. Some confusion occurred between adjacent categories (e.g., Mild vs Moderate), reflecting natural symptom overlaps. The matrix guided improvements to our hybrid scoring system for better severity differentiation.

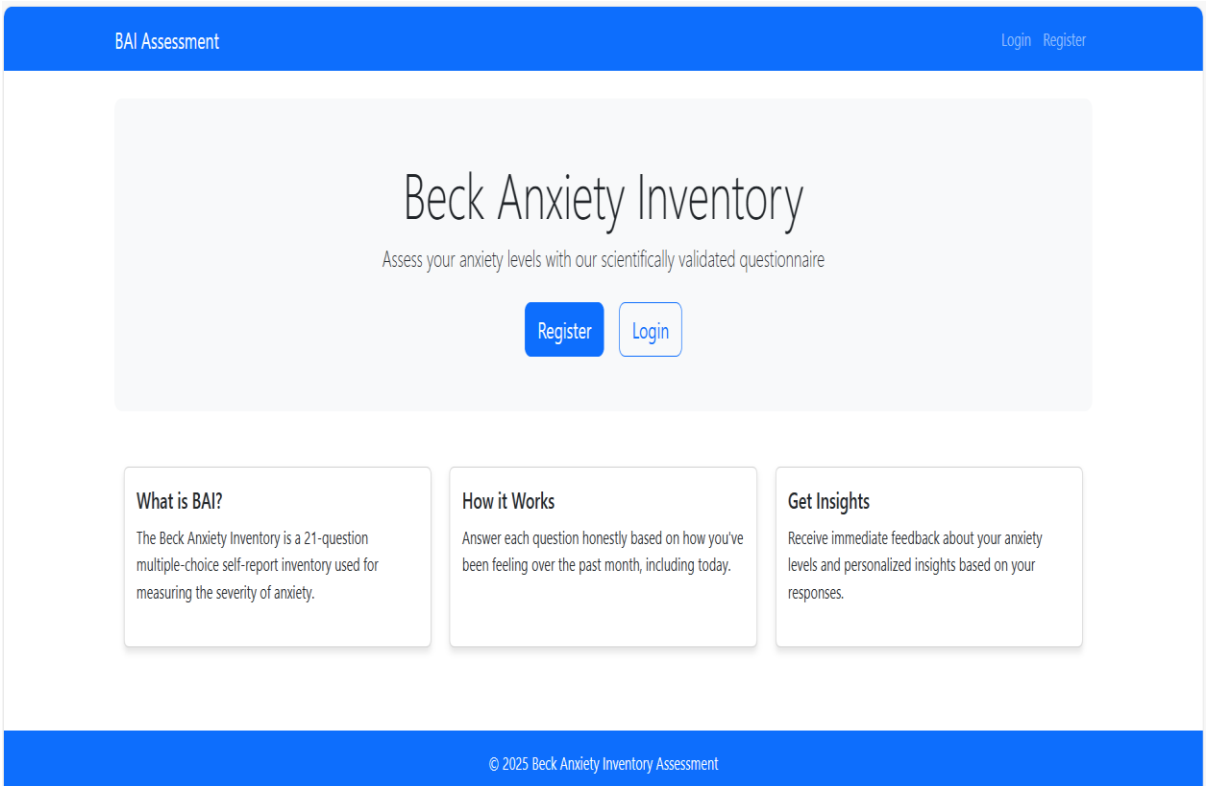


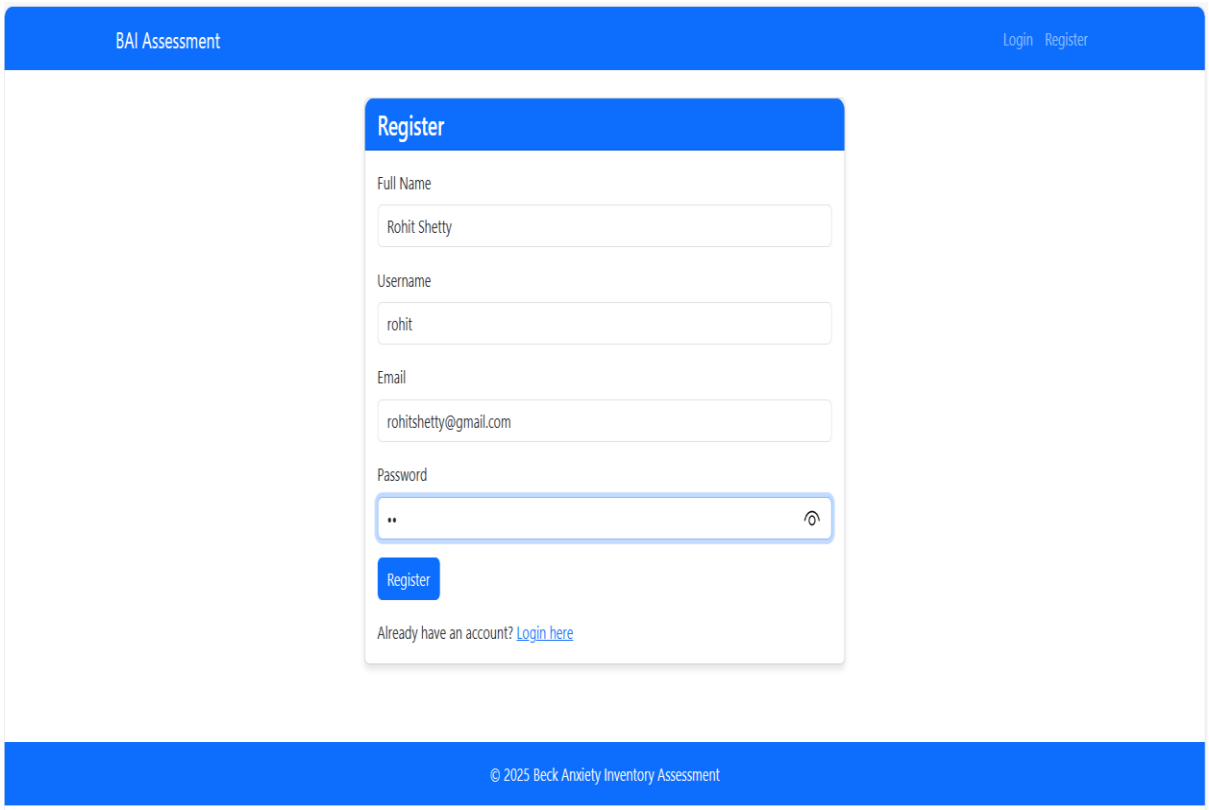
From the results:

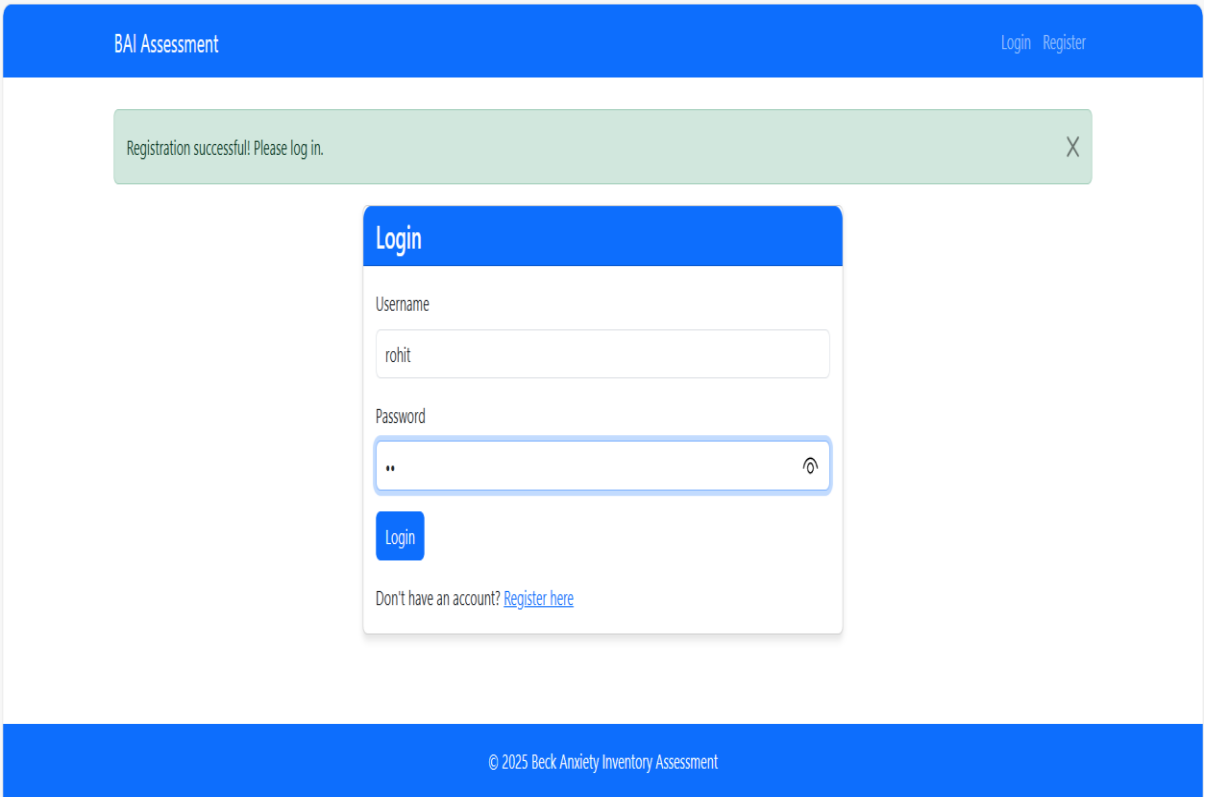
- "Fear of worst happening" was the best predictor of high anxiety.

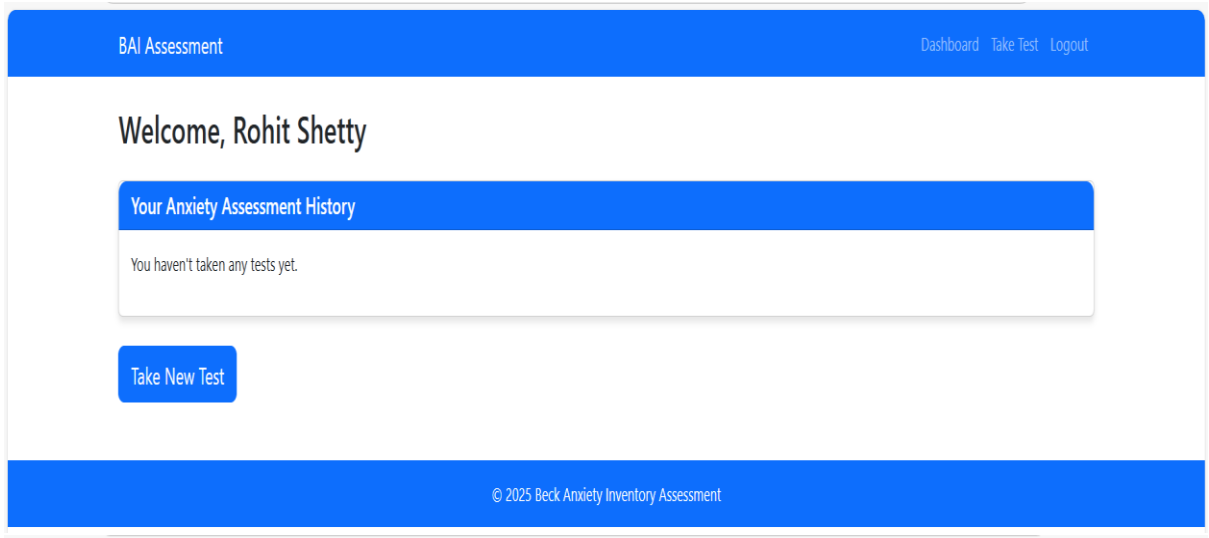
- "Heart pounding/racing" and "Fear of dying" were also critical predictors of anxiety severity.

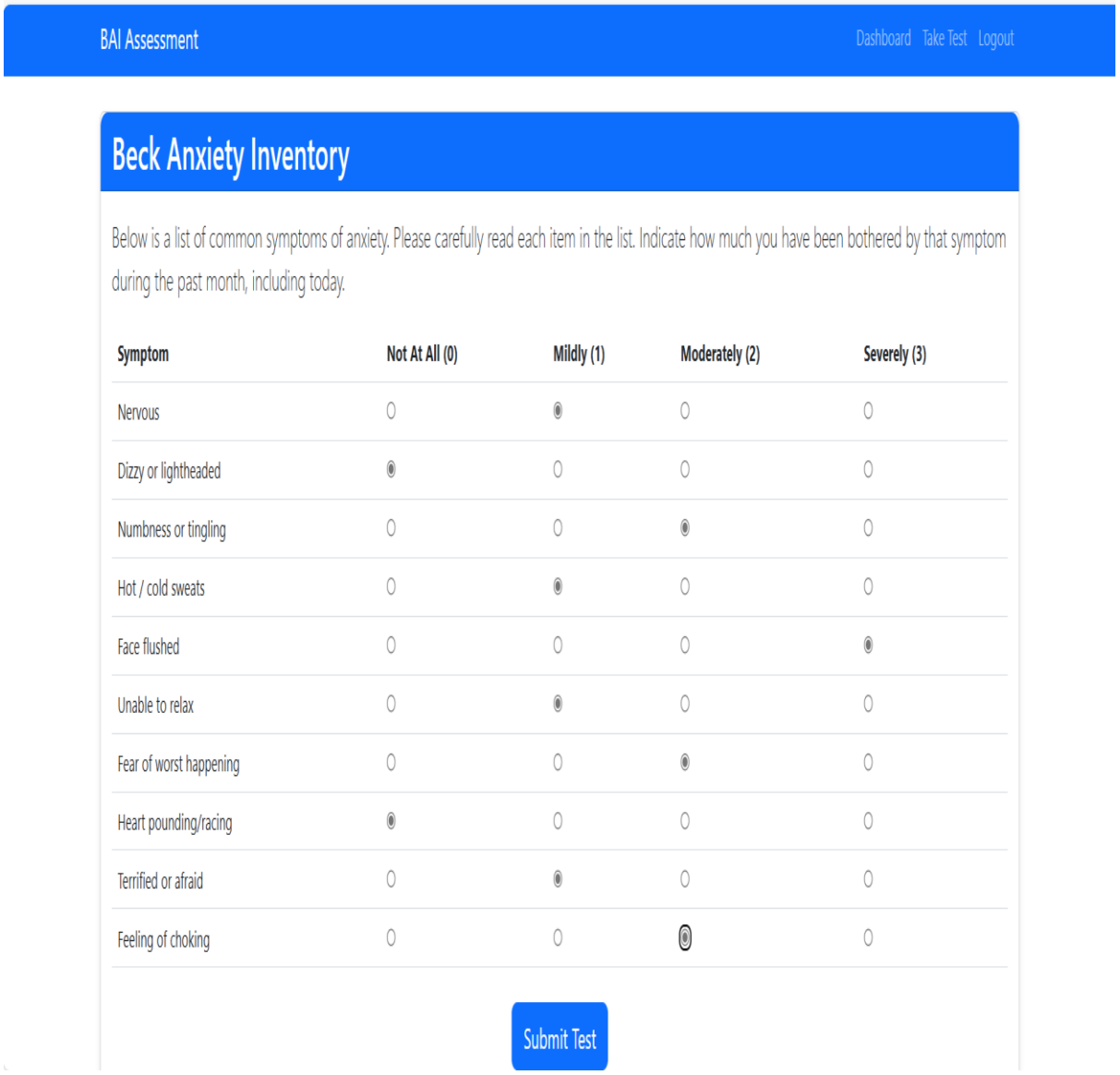
- Less intense characteristics were "Indigestion" and "Face flushing", which suggested that such symptoms may be less relevant in the prediction of the severe anxiety.

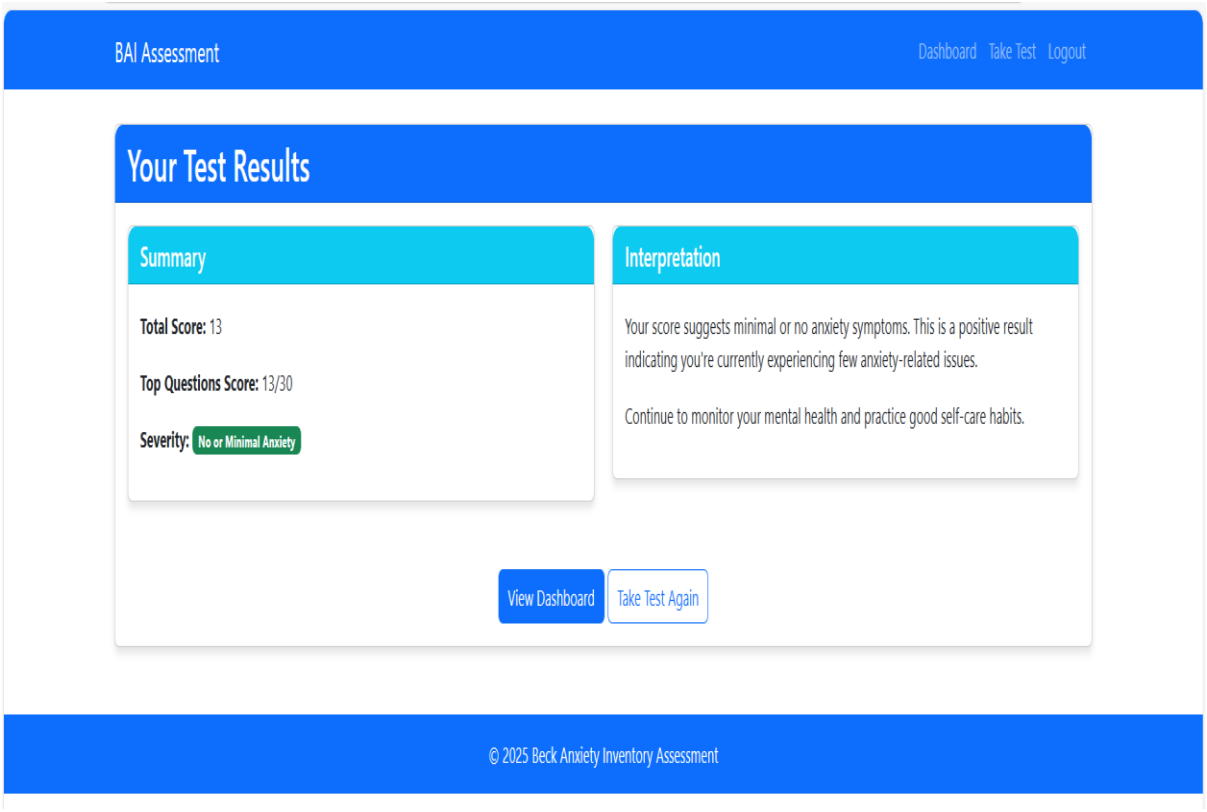


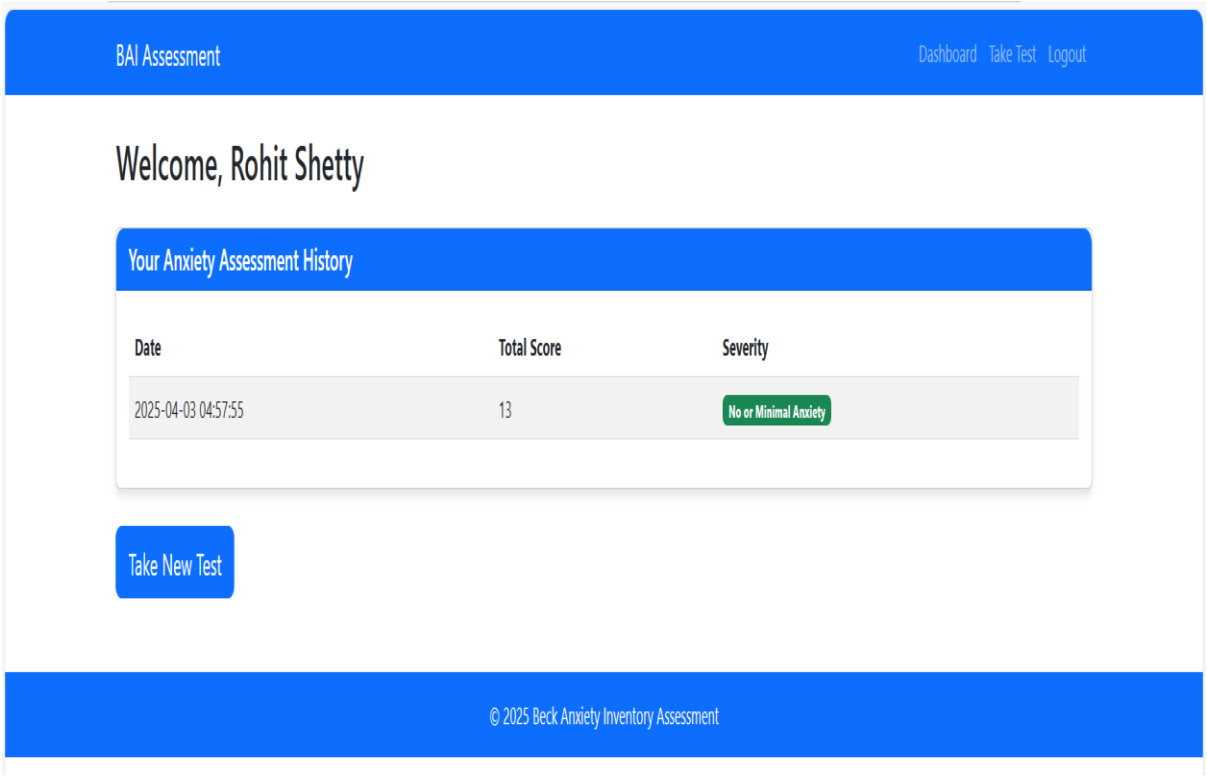

BAI Assessment
Login Register
Register
Full Name
Rohit Shetty
Username
rohit
Email
rohitshetty@gmail.com
Password
Register
Already have an account? Login here
© 2025 Beck Anxiety Inventory Assessment


BAI Assessment
Login Register
Registration successful! Please log in.
X
Login
Username
rohit
Password
Login
Don't have an account? Register here
© 2025 Beck Anxiety Inventory Assessment


BAI Assessment
Dashboard Take Test Logout
Welcome, Rohit Shetty
Your Anxiety Assessment History
You haven't taken any tests yet.
Take New Test
© 2025 Beck Anxiety Inventory Assessment


BAI Assessment
Dashboard Take Test Logout
Beck Anxiety Inventory
Below is a list of common symptoms of anxiety. Please carefully read each item in the list. Indicate how much you have been bothered by that symptom during the past month, including today.
Symptom
Not At All (0)
Mildly (1)
Moderately (2)
Severely (3)
Nervous
Dizzy or lightheaded
Numbness or tingling
Hot / cold sweats
Face flushed
Unable to relax
Fear of worst happening
Heart pounding/racing
Terrified or afraid
Feeling of choking
Submit Test


BAI Assessment
Dashboard Take Test Logout
Your Test Results
Summary
Total Score: 13
Top Questions Score: 13/30
Severity: No or Minimal Anxiety
Interpretation
Your score suggests minimal or no anxiety symptoms. This is a positive result indicating you're currently experiencing few anxiety-related issues.
Continue to monitor your mental health and practice good self-care habits.
View Dashboard
Take Test Again
© 2025 Beck Anxiety Inventory Assessment


BAI Assessment
Dashboard Take Test Logout
Welcome, Rohit Shetty
Your Anxiety Assessment History
Date
Total Score
Severity
2025-04-03 04:57:55
13
No or Minimal Anxiety
Take New Test
© 2025 Beck Anxiety Inventory Assessment

The Beck Anxiety Inventory (BAI) Assessment System is a user-friendly web application built with Flask that provides an efficient and accurate way to evaluate anxiety severity. The application begins with a homepage introducing the BAI test and offering options to register or log in, ensuring secure access through password-protected accounts. Once logged in, users can take the interactive BAI test, which presents the standard 21 anxiety-related questions with responses rated on a 0-3 scale. The system employs a hybrid scoring approach, combining the traditional BAI score (0-63) with a focused evaluation of the top 10 most predictive questions (0-30). If the critical questions score exceeds 20, the system flags potential severe anxiety—even if the total score is lower—enhancing early detection. After submission, users are directed to a personalized results dashboard, which displays their anxiety severity level (Minimal, Mild, Moderate, or Severe), a breakdown of their scores, and actionable insights. Additionally, the application maintains a test history log, allowing users to track their progress over time. The integration of machine learning (Random Forest) ensures high accuracy in classification, while the clean, responsive design (powered by Bootstrap) makes the platform accessible across devices. By combining clinical validity with modern technology, this web app delivers a fast, reliable, and user-centric tool for mental health assessment.

5. Conclusion & Future Scope

Conclusion:

The Beck Anxiety Inventory (BAI) Assessment System successfully bridges machine learning and mental health diagnostics to deliver a faster, more accurate, and user-friendly anxiety screening tool. By leveraging Random Forest and a hybrid scoring system, the application identifies high-severity cases more effectively than traditional methods while maintaining clinical validity. The Flask-based web interface ensures accessibility, allowing users to complete the test, receive instant results, and track their progress seamlessly. This project demonstrates how data-driven optimization can enhance psychological assessments without compromising reliability, offering a scalable solution for both individuals and clinicians.

Future Scope:

Future enhancements could expand the system’s capabilities through adaptive testing, where questions dynamically adjust based on user responses to reduce test length. Integrating deep learning models could improve prediction accuracy, while wearable device compatibility (e.g., heart rate or sleep data) might provide richer, real-time insights. Adding multilingual support and regional symptom weightings could make the tool globally applicable. Finally, clinician portals with advanced analytics could facilitate remote monitoring and personalized treatment plans, transforming the platform into a comprehensive mental health management ecosystem. These advancements would further solidify its role in modern, preventive healthcare.

6. References

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