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Student Mental Health Detection using Machine Learning

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Abstract: *Mental health has become a critical concern globally, especially among students, who face various pressures such as academic performance, peer relationships, and future career prospects. The increasing prevalence of mental health challenges among this demographic underscores the urgent need for proactive detection and intervention methods. Conventional approaches to identifying mental health issues are often limited by delayed reporting, stigma, and lack of awareness, leading to insufficient or late interventions. This project explores the application of machine learning to address these challenges by developing a system for early detection of mental health conditions among students. The proposed approach utilizes a datasets comprising behavioral, academic, and demographic features. After preprocessing and feature engineering, machine learning algorithms such as Logistic Regression, Support Vector Machines (SVM), and Random Forest are applied to classify students based on their mental health risk levels. The models are evaluated using performance metrics, including accuracy, precision, recall, and F1-score, to determine their reliability and effectiveness. Cross-validation techniques ensure the robustness of the developed system, while hyperparameter tuning optimizes model performance. This project contributes to the broader field of mental health technology by showcasing the intersection of data science and psychology. By leveraging predictive analytic , it provides a scalable, data-driven solution to a pressing issue, paving the way for smarter and more efficient mental health management strategies in educational institutions.*

Keywords: Sports Management, Face Recognition, Event Automation, Internet of Things (IoT), Data Analytics

I. INTRODUCTION

Mental health challenges among students are growing concerns globally, necessitating innovative solutions. Traditional detection methods often lack comprehensive data integration, leading to undetected or late interventions. Our system aims to address these gaps by leveraging multimodal data sources and machine learning algorithms to provide timely and actionable insights.

Key motivations include:
1. Addressing increasing mental health challenges among students.
2. Enhancing detection accuracy through advanced machine learning techniques.
3. Delivering personalized interventions and recommendations.

II. LITERATURE SURVEY

Sr	Title	Author Name	Algorithm Used
1	Stress Detection in IT Prof essionals by Image Proces sing and Artificial Intelligence	Thejaswini M, Harsha Vardhan K M, E Vigneshwar, Harsha B, Darshan S	Convolutional Neural Networks (CNN)
2	Mental Health Prediction Using Machine Learning	Satvik Gurjar, Chetna Patil, Rite sh Suryawanshi, Madhura Adadande,	Machine Learning

		Ashwin Khore, Noshir Tara pore	
3	Mental Health Prediction Using Machine Learning: Taxonomy, Applications, and Challenges	Jetli Chung, Jason Teo	Various Machine Learning Approaches
4	Heart Diseases Detection Using Naive Bayes Algorit hm	K. Vembandasamy, R. Sasipriya , E. Deepa	Naive Bayes
5	Prediction of Mental Healt h Problem Using Annual S tudent Health Survey: Mac hine Learning Approach	Ayako Baba, Kyosuke Bunji	LightGBM
6	Multi- Layered Deep Learning Pe rceptron Approach for Hea lth Risk Prediction	Thulasi Bikku	Multi-Layer Perceptron (MLP)
7	Multimodal Educational Data Fusion for Students' Mental Health Detection	Teng Guo, Wenhong Zhao, Mubarak Alrashoud, Amr Tolba, Selena Firmin, Feng Xia	Deep Neural Network (DNN), MOON, SMOTE
8	Early Detection of Disease Using Electronic Health Records and Fisher's Wishart Discriminant Analysis	Sijia Yang, Jian Bian, Zeyi Sun, Licheng Wang, Haojin Zhu, Haoyi Xiong, Yu Li	Fisher's Wishart Discriminant Analysis (FWDA)

Gap Analysis

Feature	Existing Systems	Proposed "Student Mental Health Detection" System	Gap Highlighted
Technology Stack	Use traditional backend and frontend technologies.	MERN stack for frontend, Python for backend model design.	Modern and efficient tech stack (MERN).
Data Processing	Basic data processing with predefined fields.	Advanced word processing and tokenization techniques.	Enhanced accuracy through tokenization.
Dataset Source	Limited to static datasets from specific institutions or surveys.	Combination of Kaggle and real-time data collection.	Real-time data collection for better insights.
Model Accuracy	Varies but generally ranges from 70% to 85%.	Targeting more than 90% accuracy.	Significant improvement in prediction accuracy.
Notification System	Limited or no integration of notification systems.	Email API integration for real-time notifications.	Real-time alerts for timely interventions.
Input Method	Structured forms or predefined survey responses.	Free-text input for more flexible data collection.	Increased flexibility in data input.
Personalization	Generalized models with little personalization.	Potential for personalized detection based on individual inputs.	Tailored mental health detection.
User Interface (UI)	Often less interactive or outdated.	Modern, responsive UI built with MERN stack.	Enhanced user experience with modern UI.
Scalability	Limited scalability due to older tech and static datasets.	Scalable to accommodate real-time data and cloud-based architecture.	Scalability for broader adoption.

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Objectives

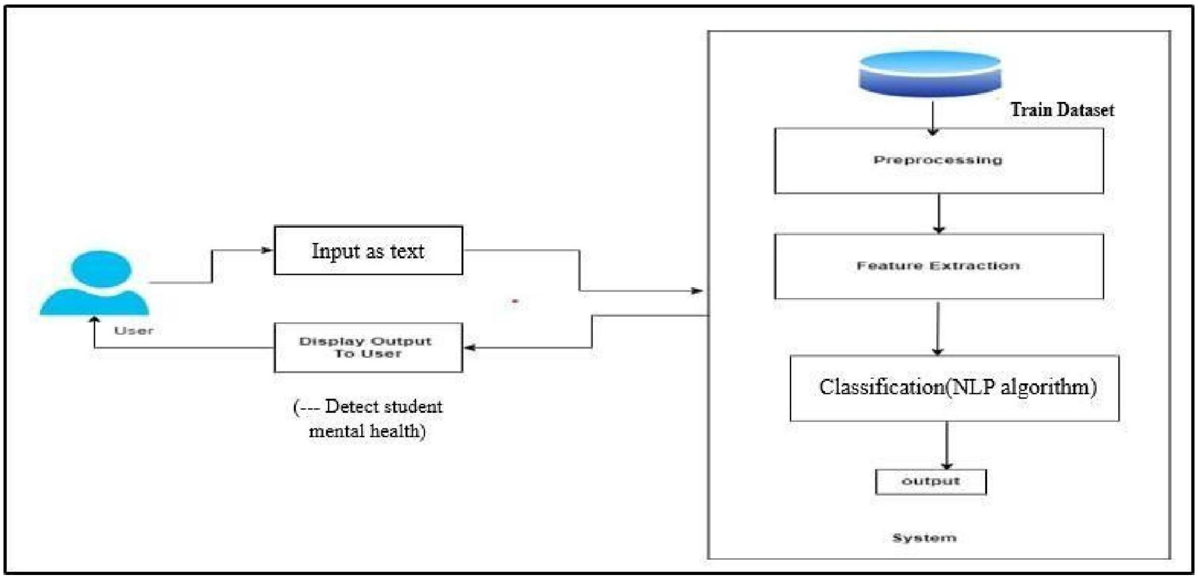
- Collect and analyze multimodal data such as academic, behavioral, physiological, and social media metrics.
- Utilize machine learning algorithms, primarily logistic regression, to classify mental health conditions.
- Generate insights, alerts, and recommendations.
- Ensure privacy and scalability for integration into educational institutions.

III. SYSTEM ARCHITECTURE

The system follows a client-server architecture using the MERN stack (MongoDB, Express.js, React, Node.js) for real-time data processing. Python modules handle data preprocessing and feature extraction. REST APIs facilitate communication between modules.

System Architecture Diagram

The diagram below illustrates the system architecture, showcasing the flow of data from collection to actionable insights.



- **Data Sources:** Academic records, behavioral metrics, social media activity.
- **Data Preprocessing:** Handled by Python modules (e.g., Scikit-learn, Pandas).
- **Machine Learning Model:** Logistic regression for classification and risk assessment.
- **User Interaction:** Web interface using MERN stack for real-time visualization and alerts

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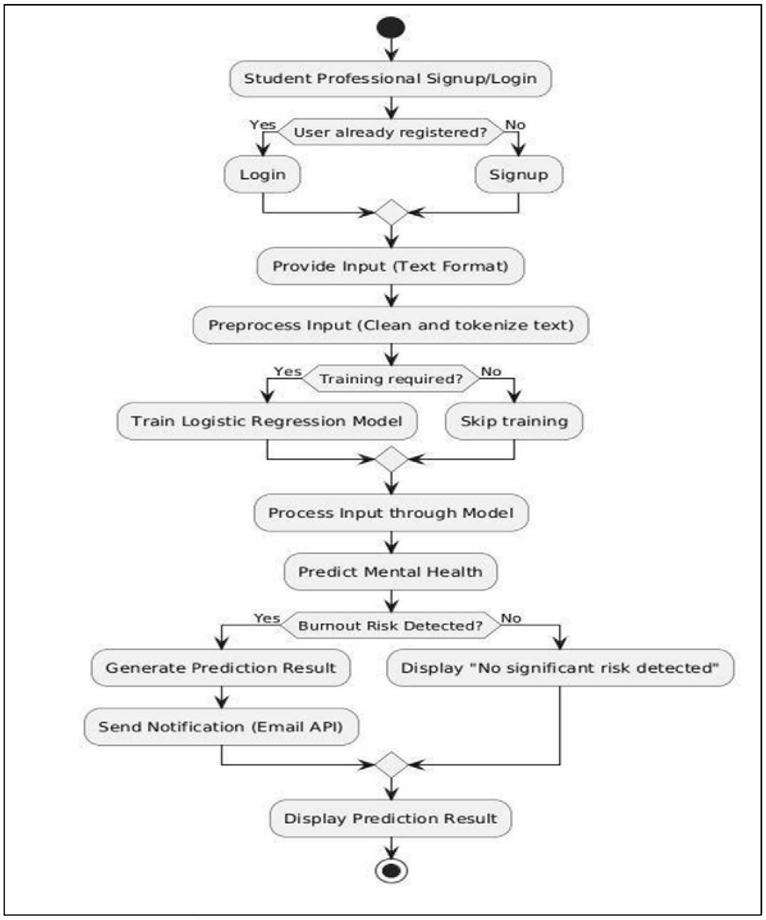
Activity Diagram



The activity diagram represents the workflow of mental health detection:

Start: The student or educator logs into the system.

Submit Input: The student provides input data (text, behavioral metrics).

Preprocessing: The system cleans and tokenizes the data.

Model Training (if required): The machine learning model is trained on the dataset.

Prediction: The system processes the data through the model to predict mental health risks.

Decision Point: If a mental health risk is detected, the system generates are commendation and triggers an Alert

End: The results are displayed, and notifications are sent if necessary

Proposed Algorithms

Logistic Regression:

Used for binary classification to assess the likelihood of mental health issues based on input features.

MERN Stack Integration:

Combines MongoDB, Express.js, React, and Node.js for a seamless, full-stack application experience, enabling real-time data processing and user interaction.

Python Module Design:
Implements data preprocessing, feature extraction, and model training for accurate predictions, leveraging libraries such as Pandas and Scikit-learn.

Data Visualization Tools:
Utilizes libraries like Matplotlib and Seaborn in Python for visualizing data trends and model outputs, aiding in interpretability.

RESTful API Development:
Facilitates communication between the front end and back end, allowing for efficient data retrieval and submission.

IV. LIMITATIONS AND FUTURE WORK

Limitations

- Dependence on data quality for accuracy.
- Challenges in scaling to larger populations beyond students.
- Privacy concerns require robust encryption methods.

Future Work

- Real-time Data Integration: Expand data sources to include biometric data and advanced sentiment analysis.
- Personalization: Tailor recommendations based on individual profiles.
- Global Adaptation: Incorporate multilingual and region-specific features for broader applicability.
- Enhanced Privacy Measures: Implement advanced encryption techniques to address ethical concerns.

V. CONCLUSION

This paper presents a novel approach to detecting student mental health issues using machine learning. By integrating diverse data sources and employing scalable technologies, the system addresses significant gaps in current frameworks. Future enhancements aim to further improve the system's accuracy, scalability, and privacy.

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