A Suicidal Ideation Detection Framework on Social Media Using Machine Learning and Genetic Algorithms – Based Feature Selection

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Abstract— **Suicide is a critical issue worldwide, with early detection of suicidal ideation being essential for prevention. Social media has become a common platform for individuals, especially young people, to express their emotions, including suicidal thoughts, influenced by factors such as depression, anxiety, and social isolation. Detecting such ideation from social media data presents significant challenges in both natural language processing (NLP) and psychology. The dataset used for this analysis, "Suicide_Detection," includes text data from social media posts, with features extracted using TFIDF and NGRAM methods, applied to both original and linguistic features. This study proposes a novel approach to effectively detect suicidal ideation by utilizing a genetic algorithm for feature selection, enhancing model performance. The analysis includes various machine learning algorithms, with the Voting Classifier combining Random Forest, Decision Tree, and XGBoost achieving the highest performance. The model achieved 97.45% accuracy with original genetic features and 95.50% accuracy with linguistic genetic features, demonstrating the effectiveness of the proposed approach in detecting suicidal ideation from social media content.**

Index Terms— **Suicide Detection, Suicidal Ideation, Social Media Analysis, Natural Language Processing (NLP), TF–IDF, N-gram, Genetic Algorithm, Feature Selection, Machine Learning, Voting Classifier, Random Forest, Decision Tree, XGBoost**

I. INTRODUCTION

Mental health is a worldwide concern. According to the World Bank, at least 10% of the world's population suffers from mental health problems. Suicide attempts are significantly increased by mental health issues. Suicide has been recognized as a significant public health issue on a global scale. According to the US National Alliance on Mental Illness, 46% of suicide victims had mental health issues Suicide ranks as the fourth leading cause of death among individuals aged 15 to 29, resulting in approximately 800,000 deaths worldwide annually, a suicide occurs every 40 seconds, according to the World Health Organization (WHO) in 2019. Previous research on suicide analysis has predominantly focused on the psychological and clinical aspects of the phenomenon.

Multiple studies have recently focused on natural language processing approaches and machine learning. These studies, however, have limitations. (1) Although gathering data on patients is very expensive from a psychological standpoint, some online data may aid in understanding suicidal thoughts. (2) Simple feature sets are insufficient to detect suicidal ideation, necessitating the development of new detection methods. Language preferences could be used to predict mental health status, which can help detect suicidal ideation early.

1.1 Objective:

The objective of this work is to develop an effective framework for detecting suicidal ideation on social media platforms by leveraging machine learning techniques and genetic algorithms. The framework aims to extract meaningful features from text data using TFIDF and NGRAM methods, applied to both original and linguistic features. By utilizing genetic algorithms for feature selection, the goal is to enhance

1.2 Problem Statement:

- Suicide is often caused by underlying issues such as depression, anxiety, hopelessness, and social isolation, which can lead individuals to express suicidal thoughts, especially in vulnerable moments on online platforms like social media.

- Social media has become a major outlet for individuals to express emotions, including suicidal ideation, making it a challenging environment for detecting such sensitive content using traditional methods in natural language processing and psychological analysis.

II.LITERATURE SURVEY

1.3 SOFTWARE REQUIREMENTS

1) Software: Anaconda

2) Primary Language: Python

3) Frontend Framework: Flask

4) Back-end Framework: Jupyter Notebook

5) Database: Sqlite3

6) Front-End Technologies: HTML, CSS, JavaScript and Bootstrap4

1.4 HARDWARE REQUIREMENTS

1) Operating System: Windows Only

2) Processor: i5 and above

3) Ram: 8GB and above

4) Hard Disk: 25 GB in local drive

II. FEASIBILITY STUDY

2. FEASIBILITY STUDY

A feasibility study—sometimes called a feasibility analysis or feasibility report—is a way to evaluate whether or not a project plan could be successful. A feasibility study evaluates the practicality of your project plan in order to judge whether or not you're able to move forward with the project.

Types of feasibility studies:

There are five main types of feasibility studies: technical feasibility, financial feasibility, market feasibility (or market fit), operational feasibility, and legal feasibility. Most comprehensive feasibility studies will include an assessment of all five of these areas.

Technical feasibility: A technical feasibility study reviews the technical resources available for your project. This study determines if you have the right equipment, enough equipment, and the right technical knowledge to complete your project objectives. For example, if your project plan proposes creating 50,000 products per month, but you can only produce 30,000 products per month in your factories, this project isn't technically feasible.

III LITERATURE SURVEY

3.1 A self-attention TCN-based model for suicidal ideation detection from social media posts: https://www.sciencedirect.com/science/article/pii/S0957417424017226

ABSTRACT: Early suicidal ideation detection has long been regarded as an important task that can benefit both society and individuals. In this regard, it has been shown that, very frequently, the first symptoms of this problem can be identified by analyzing the contents shared on social media. Machine learning classification models have proven promising in capturing behavioral and textual features from posts shared on social media.

IV. SYSTEM ANALYSIS

4.1 EXISTING SYSTEM:

The existing systems for detecting suicidal ideation on social media platforms utilize a variety of features such as statistical characteristics, word embeddings, sentiment analysis, emoticons, and temporal data. Several studies have explored different machine learning and deep learning approaches, employing classifiers like Logistic Regression, Decision Trees, Naïve Bayes, and Random Forest to identify suicidal ideation from social media data. Some systems rely on feature extraction methods such as TF-IDF, vector decomposition, and topic modeling, while others integrate ensemble learning strategies for improved accuracy. Many studies focus on platforms like Twitter and Reddit, utilizing datasets to train models for early detection of suicidal thoughts. These systems aim to analyze user posts, detect warning signs of suicidal ideation, and provide insights for timely intervention.

4.1.1 DISADVANTAGES OF EXISTING SYSTEM:

1. Existing systems rely on traditional feature extraction methods, which may not capture subtle nuances or contextual clues in social media posts that could indicate suicidal ideation.
2. Feature selection methods used in current systems are often limited, reducing the accuracy and

performance in detecting early signs of suicidal ideation, especially in unstructured data.

V. SYSTEM DESIGN

5.1 SYSTEM ARCHITECTURE:

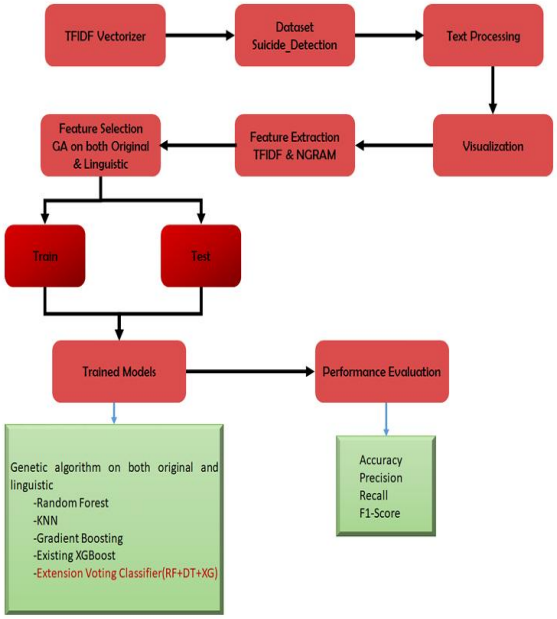


Fig.5.1.1 System architecture

DATA FLOW DIAGRAM: The data flow in the proposed system begins with the collection of social media posts containing text data. These posts are pre-processed to remove noise and irrelevant content, such as stop words, special characters, and unnecessary symbols.

Goals:

1 To develop an efficient framework that detects suicidal ideation in social media posts, enabling timely intervention for individuals at risk and contributing to suicide prevention efforts.
2 To enhance feature extraction techniques using TFIDF and NGRAM methods, ensuring meaningful and accurate representation of text data for effective suicidal ideation detection.
3 To apply genetic algorithms for feature selection, improving the performance of machine learning models by optimizing relevant features and reducing noise in the dataset.

VI. IMPLEMENTATION

6. IMPLEMENTATION MODULES:

• Tfidf Vectorizer:

The TFIDF Vectorizer is used to transform the original and linguistic features into numerical vectors, capturing the importance of words in the text data to enable machine learning model training.

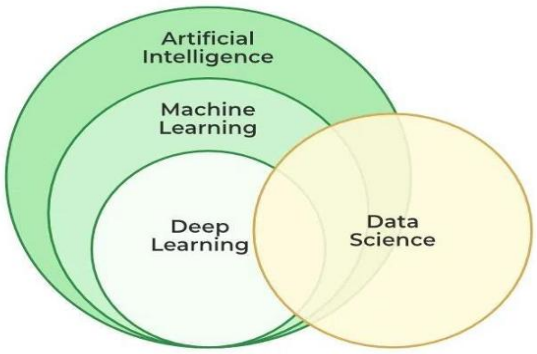
Exploring the Dataset: The dataset, titled Suicide Detection, is explored to understand its structure, including the number of social media posts and their labels. It provides insights into the features and distributions of the data.

Text Processing: Text processing involves cleaning the dataset by removing stop words, applying lemmatization and stemming, and extracting part-of-speech (POS) tags to prepare the data for further feature extraction and modeling.

VII. SOFTWARE ENVIRONMENT

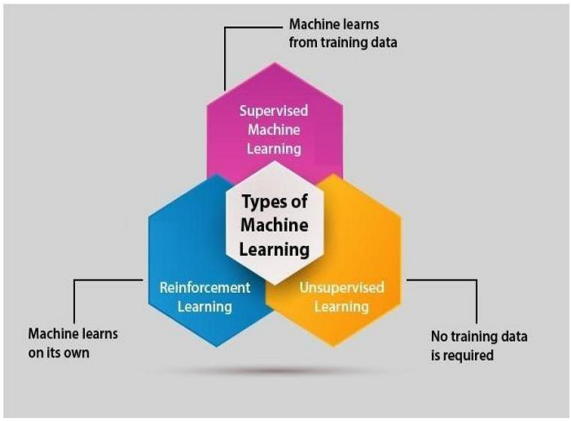
7. SOFTWARE ENVIRONMENT

Machine Learning: Machine learning is a branch of artificial intelligence that enables algorithms to uncover hidden patterns within datasets, allowing them to make predictions on new, similar data without explicit programming for each task. Traditional machine learning combines data with statistical tools to predict outputs, yielding actionable insights. This technology finds applications in diverse fields such as image and speech recognition, natural language processing, recommendation systems, fraud detection, portfolio optimization, and automating tasks.



7.1.1 Machine Learning

Types of Machine Learning:



7.1.2 Types of MachineLearning

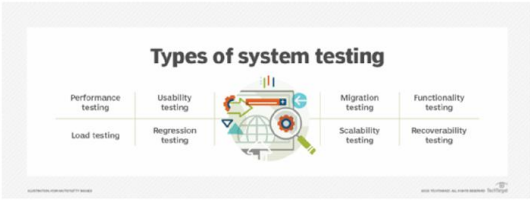
VIII SYSTEM TESTING

System testing, also referred to as system-level testing or system integration testing, is the process in which a quality assurance (QA) team evaluates how the various components of an application interact together in the full, integrated system or application. System testing verifies that an application performs tasks as designed. It's a type of black box testing that focuses on the functionality of an application rather than the inner workings of a system, which white box testing is concerned with.

8.1 Types of system testing

With system testing, a QA team gauges if an application meets all of its technical, business and functional requirements. To accomplish this, the QA team might utilize various types of software testing techniques that determine the overall test coverage for an application and help catch critical defects that hamper an application's core functionalities before release. The following are the common types of system testing techniques:

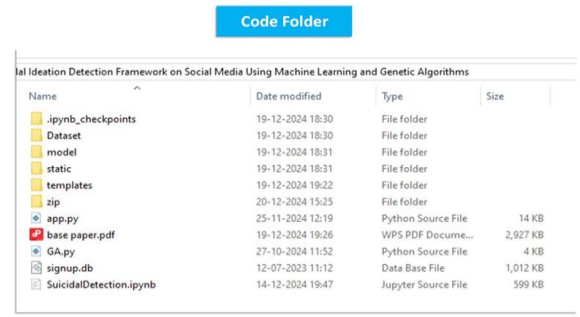
Performance testing: Performance testing measures the speed, average load time, stability, reliability and peak response times of the system under various conditions. It's typically coupled with stress testing and may include both hardware and software testing tools.

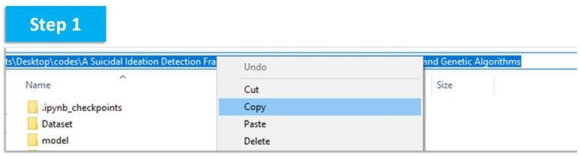


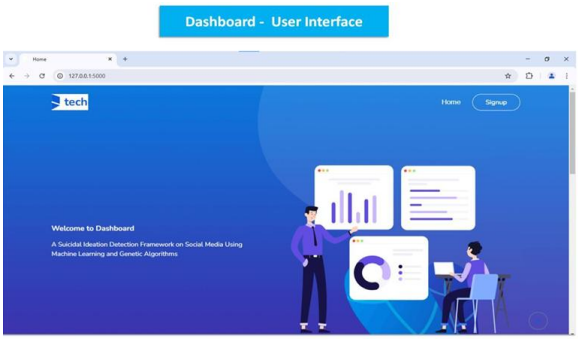
8.1.1 Types of System Testing

IX RESULT

Front-End Screens:







X.CONCLUSION

Mental health concerns, such as depression, anxiety, and ideations of suicide, are becoming increasingly worrisome in modern society. Social media platforms have emerged as a primary outlet for individuals, particularly young people, to express their emotions, including suicidal ideation. Early detection of these thoughts is crucial for timely intervention and

prevention. This study presents a framework that leverages machine learning techniques combined with genetic algorithms to detect suicidal ideation from social media posts. By extracting meaningful features from text data using TFIDF and NGRAM methods, and optimizing feature selection through a genetic algorithm, the system aims to enhance detection accuracy. Among the various machine learning models tested, the Voting Classifier, which combines Random Forest, Decision Tree, and XGBoost, demonstrated the highest performance. With original genetic features, the model achieved an impressive accuracy of 97.45%, while using linguistic genetic features, it reached 95.50%. These results highlight the effectiveness of the proposed framework in identifying suicidal ideation, offering a potential solution for early intervention in mental health crises.

FUTURE SCOPE Future work should explore incorporating additional factors such as historical data, user posts, temporal, and spatial information to enhance the detection of suicidal ideation. Alternative feature selection methods could further improve accuracy. Furthermore, the development of a hybrid model that combines features from both social media and conventional data sources holds promise for capturing a broader spectrum of indicators, potentially leading to more comprehensive and accurate suicide ideation detection. These advancements could significantly improve early intervention efforts.

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