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Suicidal Ideation Detection System using Hybrid Machine Learning and NLP Techniques

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ABSTRACT: Every year, approximately 800,000 people lose their lives to suicide, underscoring the urgent need to identify individuals at risk. With the widespread use of social media, many individuals openly share their thoughts, including expressions of suicidal ideation, providing an opportunity for timely intervention. This study introduces an advanced system for detecting suicidal content on social media platforms using a combination of Natural Language Processing (NLP), Deep Learning, and Machine Learning techniques. The system leverages keyword-based detection, sentiment analysis, and contextual NLP methods to identify posts indicative of suicidal ideation. A hybrid approach is adopted, integrating Logistic regression, Random Forest, Support Vector Machine, Naive Bayes and Artificial Neural Networks (ANNs) to enhance text classification performance and improve detection accuracy. The model is trained on a carefully curated dataset of labeled posts and evaluated using metrics such as precision, recall, and F1-score, demonstrating significant improvements in the accurate detection of concerning content. This automated system is designed for deployment by social media platforms to flag potentially harmful posts, allowing mental health professionals to review and provide timely support. By enhancing early identification and intervention efforts, this system offers a valuable tool for reducing suicide risks and potentially saving lives. In cases where suicidal content is identified, the system prompts the user with a supportive questionnaire, text box, or chatbot interface to offer immediate assistance or guidance. This project contributes to mental health awareness by providing an automated, accurate, and accessible tool for early detection of suicidal ideation, facilitating timely intervention and support.

KEYWORDS: Deep Learning, Machine Learning, NLP, ANN.

I. INTRODUCTION

The work of preventing suicide is important right now since, according to World Health Organisation statistics, more than 800 000 individuals commit themselves annually. The Russian Federation is one of the five nations with the highest rate of suicides per 100,000 people, according to the same data. Numerous organisations are working to find solutions to this issue because the Internet is the most convenient platform for disseminating suicidal content in the form of various web pages dedicated to suicide. Take, for instance, the well-known social network Facebook, which can identify suspicious profiles of users who are at risk of suicide and posts with suicidal content. Federal agencies are working to find a solution. For instance, in Russia, Roskomnadzor developed guidelines in 2016 for media dissemination of information on suicide cases, which is likely affecting search engine rankings on this subject. Additionally, a single register that lists websites restricted in the Russian Federation has existed since 2006 is available. Blocking does not occur instantly, though. Some people are able to access risky websites. Manually censoring suicide websites is scarcely a successful countermeasure to the propagation of suicidal content. After several years of these obstructions, there has been a substantial increase in juvenile suicides in Russia. One of the reasons might be that websites containing suicidal content can make their own copies (mirrors), in addition to the "death groups" in social networks that platform developers are already actively combating. This article addresses the potential for identifying such web pages by utilising machine learning algorithms to analyse their content in real-time. On the

client's end, detection takes place. It is feasible to recognise a person who is suicidal at an early stage in this way, with sufficient precision to detect risky websites frequented by the user.

II. SYSTEM MODEL

Here, we suggest a technique for identifying suicidal profiles. First, we use as much of the data as is feasible to assess a number of profiles from the social network. Then, in order to differentiate between profiles that are and are not suicidal, we adopt a number of criteria. Using various data mining methods and methodologies, these features can be either explicitly extracted from the user profile or implicitly inferred. Here, we concentrate on emotional characteristics and sentiment analysis, which provide clues regarding the mental health of suicidal profiles. Additionally, we employ account features to recognise people based on the shared data on their profiles. Finally, each user is shown as an integrated vector of all the features they have used.

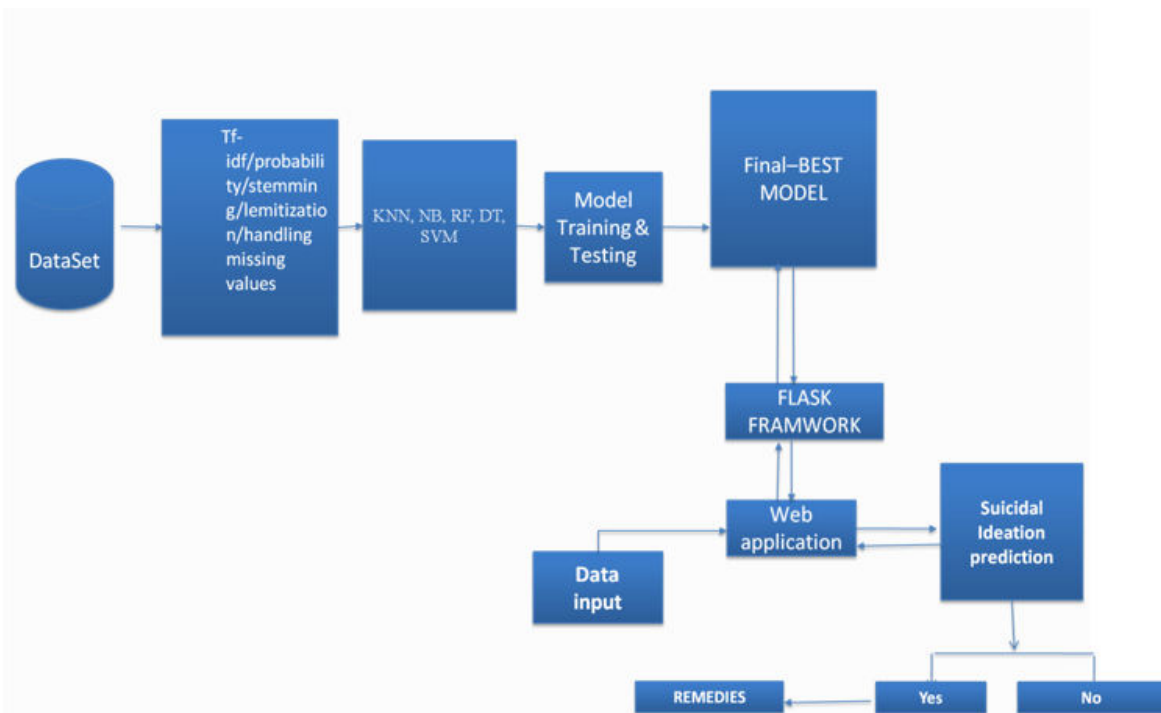


Fig 1: Design Architecture

When combined with machine learning techniques, NLP approaches can be used to classify different types of depression and their severity. NLP approaches concentrate on the analysis of acoustic and linguistic elements of human language acquired from speech and text. High ecological validity, low subjectivity, low cost of frequent assessments, and shorter task administration compared to routine assessments are all benefits of employing these methods to comprehend depression symptoms through speech. The ability to collect speech data remotely is a further advantage of speech analysis using NLP, which fills a critical demand for remote cognitive and behavioural examinations in the era of the coronavirus disease (COVID-19) pandemic. Identification and treatment of depression in older persons are crucial given the world's ageing population. The use of NLP techniques is demonstrating promise in the assessment, monitoring, and detection of depression and other comorbidities in both younger and older people.

The hardware requirements may form the basis of the contract to implement the system and should therefore be a complete and consistent specification of the entire system. Which are used by software engineers for initial system design purposes. It shows what the system does and how it should be implemented.

A software requirements document is a specification of a system. It should include both an implementation and a specification & configuration of requirements. The organization is a set of what to do rather than how to do it. Software requirements provide the basis for developing software requirements specifications. It is useful in calculating costs, planning team activities, executing tasks and monitoring the team, and monitoring the progress of the team throughout the development activity.

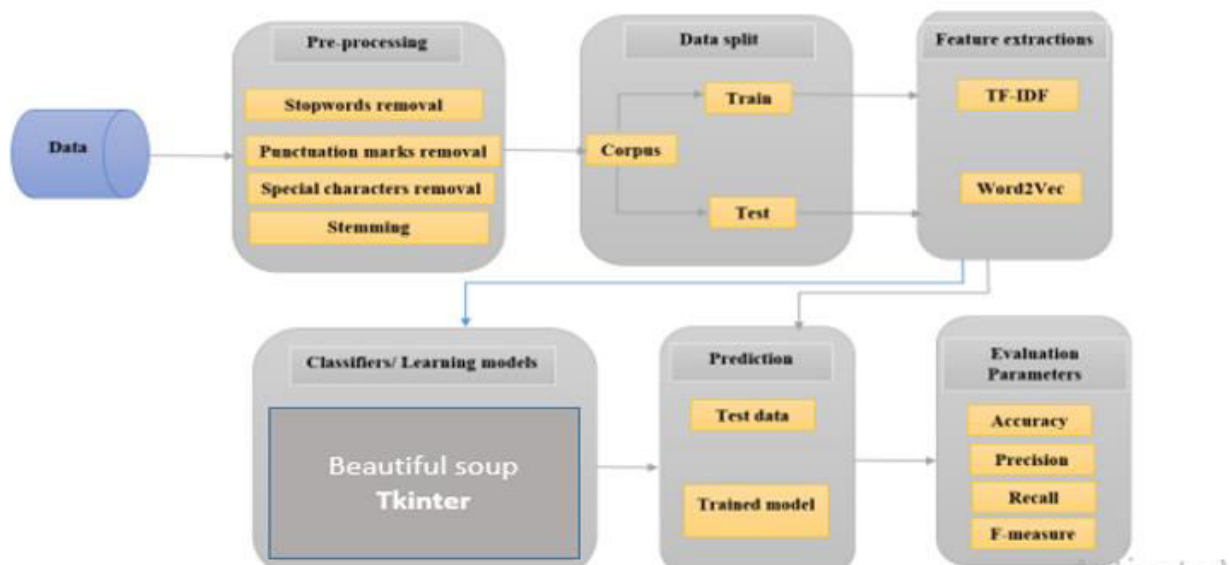


Fig:2 Flow Diagram

This block diagram represents a text classification process using machine learning. First, raw text data is collected and passed through a pre-processing stage where stopwords, punctuation, and special characters are removed, and stemming is applied to reduce words to their root forms. Next, the cleaned data is split into training and testing sets. Feature extraction techniques like TF-IDF and Word2Vec are then used to convert the text into numerical form that can be understood by machine learning models. The training data is used to build classifiers or learning models, possibly with the help of tools like BeautifulSoup for data scraping and Tkinter for creating a user interface. The trained model is then used to make predictions on the test data. Finally, the model's performance is evaluated using metrics such as accuracy, precision, recall, and F-measure.

The process begins with data collection, where raw text data is gathered from various sources such as websites, documents, or user inputs. This data then undergoes a pre-processing stage which is crucial for cleaning and preparing the text. Common steps include removing stopwords (common words like “is”, “the”), punctuation marks, and special characters, followed by stemming, which reduces words to their root form (e.g., “running” becomes “run”) to standardize the text. Once pre-processed, the data is split into training and testing sets to develop and evaluate the model. Feature extraction methods like TF-IDF (Term Frequency-Inverse Document Frequency) and Word2Vec are applied to convert textual information into numerical vectors that machine learning algorithms can process. These features are fed into classifiers or learning models, which are trained to recognize patterns in the data. Tools like BeautifulSoup may be used to extract data from websites, and Tkinter might be used to build a simple user interface for the application. After training, the model is tested on the test data to make predictions. Finally, the model's performance is assessed using evaluation parameters such as accuracy, precision, recall, and F-measure, which help determine how well the model performs in classifying or analyzing the text data. This entire process is vital in applications like sentiment analysis, spam detection, topic classification, and more.

III. LITERATURE REVIEW

The work of preventing suicide is important right now since, according to World Health Organisation statistics, more than 800 000 individuals commit themselves annually. The Russian Federation is one of the five nations with the highest rate of suicides per 100,000 people, according to the same data. Numerous organisations are working to find solutions to this issue because the Internet is the most convenient platform for disseminating suicidal content in the form of various web pages dedicated to suicide. This literature survey reviewed recent research related to the use of Natural Language Processing (NLP) and Machine Learning (ML) techniques for detecting suicidal content on social media platforms. One of the studies reviewed was "Automatic Detection of Suicidal Ideation in Social Media Posts" by Karami et al. (2021). In this study, the authors proposed a deep learning model to detect suicidal ideation in social media posts, using a dataset of 5,000 tweets labeled as suicidal or non-suicidal. The model achieved an F1-score of 0.78, indicating promising results in detecting suicidal content on social media. The literature survey also highlighted other studies that have used NLP and ML techniques to detect suicidal ideation in social media posts and online user content. While these techniques have shown promising results, further research is needed to develop more accurate and robust models for detecting and preventing suicidal content on social media platforms.

In the study titled Detecting Suicidal Ideation on Social Media Using Neural Language Models by Zhang et al. (2020), the authors address the growing concern of suicidal ideation expressed on social media platforms, particularly Twitter. They propose the use of a neural language model to effectively detect suicidal content. Utilizing a dataset of 7,000 tweets labeled as either suicidal or non-suicidal, their model achieved a notable F1-score of 0.82, highlighting its effectiveness in identifying such sensitive content. The findings by Zhang et al. demonstrate the significant potential of neural language models in monitoring and mitigating suicidal ideation online, while also emphasizing the need for further research to develop even more accurate and robust detection systems for use on social media platforms.

Assessing suicide risk in online forums has become an important issue in mental health research. Nguyen et al. (2019) proposed a text classification model to assess suicide risk in forum posts, incorporating both textual features and user engagement metrics such as the number of comments and upvotes. Using a dataset of 2,500 posts labeled as high or low suicide risk, their model achieved an F1-score of 0.81. The study demonstrates the potential of combining content and engagement signals for identifying posts with a higher risk of suicide. While the results are promising, further research is needed to develop more accurate and effective methods for detecting and preventing suicidal content on social media platforms.

Suicide prevention has become increasingly important, with over 800,000 lives lost annually, according to the World Health Organization. The Russian Federation is among the countries with the highest suicide rates, and the internet has become a common medium for the spread of suicidal content. Recent research has focused on using Natural Language Processing (NLP) and Machine Learning (ML) to detect suicidal ideation on social media. Karami et al. (2021) proposed a deep learning model that achieved an F1-score of 0.78 using 5,000 labeled tweets, while Zhang et al. (2020) utilized a neural language model on 7,000 tweets, achieving a higher F1-score of 0.82. Nguyen et al. (2019) explored suicide risk assessment in online forums by combining textual and user engagement features, reaching an F1-score of 0.81 on a dataset of 2,500 posts. These studies highlight the promising potential of NLP and ML in identifying suicidal content online, though further research is needed to improve the accuracy and robustness of these detection systems.

IV. RESULT AND DISCUSSION

the development of a Suicidal Ideation detection model using machine learning techniques, integrating both structured questionnaire responses and unstructured Twitter data, presents a promising approach to automating the critical task of Suicidal Ideation monitoring. By leveraging the power of advanced technologies, this project strives to contribute to the field of mental health by offering a comprehensive and proactive solution.

The structured questionnaire responses, encompassing a broad spectrum of Suicidal Ideation-related indicators, serve as a foundation for training the machine learning model. These responses provide a labeled dataset, enabling the model to learn and recognize patterns associated with Suicidal Ideation across various emotional and behavioral dimensions.

The incorporation of unstructured Twitter data introduces a dynamic and real-world element to the model. By treating tweets as potential indicators of Suicidal Ideation, the project broadens its scope to capture the nuances of Suicidal Ideation expression in diverse online contexts. This integration aims to enhance the model's adaptability and sensitivity to the evolving nature of Suicidal Ideation-related communication.

As we progress towards a more data-driven and technologically advanced era, the implications of this Suicidal Ideation detection model extend beyond mere identification. The proactive nature of the model, coupled with its ability to process real-time social media data, opens avenues for timely intervention and mental health support. By combining structured and unstructured data sources, the model achieves a holistic understanding of Suicidal Ideation, encompassing both individual responses and broader social expressions.

V CONCLUSION

As part of this work, a method for detecting dangerous web pages containing suicidal content, based on machine learning algorithms, was presented. Based on the experimental results obtained, we can conclude that the method described in this article is able to detect dangerous web pages. The obtained results of detecting the control group can be considered satisfactory, which indicates the possibilities of applying the method in real life. In the future, we schedule to improve the system for checking web pages for suicidal content, namely:

1. Add images verification as these images may be suicidal or contain symbols of death groups. The last one may be an indication that the website containing it belongs to this group.
2. Add links verification on the page as they may be related to relevant websites.
3. Add checking for suicidal instructions. We also going to improve this method in the future by analyzing more machine learning algorithms and text processing libraries. Research in this area is worth continuing to improve the accuracy of the detection of dangerous web pages.

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