SUICIDAL BEHAVIOUR DETECTION USING MACHINE LEARNING

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Abstract: *Growing concern about mental health has led to the development of advanced strategies for early detection and intervention. In particular, experiencing suicide poses a significant challenge because of its complexity and widespread nature. This research paper presents a novel approach for suicide detection using machine learning techniques. The proposed model uses natural language processing and supports vector machine algorithms to analyze textual data and classify individuals as suicidal or non-suicidal. The model was trained on a data set from "Ram07/Detection-for-Suicide" containing a variety of text responses collected from individuals exhibiting suicidal tendencies. The data are thoroughly preprocessed to remove noise and irrelevant information, followed by feature extraction using the TF-IDF vector. The support vector machine classifier is trained on extracted features to train patterns representing suicidal behavior. The performance of the model is evaluated using basic statistical methods, including accuracy and confusion matrix analysis. The results showed the effectiveness of the proposed method for accurately identifying individuals at risk of suicide. The proposed model offers a promising tool for mental health professionals and providers to recognize and intervene with suicidal ideation early. The research supports ongoing efforts to leverage machine learning and natural language processing for mental health monitoring and support, leading to improved suicide prevention interventions and more comprehensive public health outcomes forward.*

Keywords: Suicide detection Machine learning, Natural language processing, Support vector machine, Early intervention, Mental health monitoring, Suicide prevention, Cyberbullying, Social media data, Psychological distress, Suicidal ideation, Psychometric assessments, Clinical assessments, Artificial intelligence (AI), Mobile technologies, Ethical implications, Privacy considerations, Neural models, Social issues, Comprehensive standards

1.   Introduction

In contemporary society, there's a growing concern about mental health issues like anxiety and depression. This concern is particularly pronounced in developed nations and emerging markets. Without proper treatment, severe mental disorders can lead to suicidal thoughts or attempts. The proliferation of negative content online has given rise to problematic behaviours such as cyberstalking and cyberbullying. This dissemination of harmful information often results in social cruelty, fueling rumors and causing mental harm. Studies have established a correlation between cyberbullying and suicide.[2] Individuals subjected to excessive negative stimuli may experience depression and despair, with some tragically resorting to suicide. The reasons behind suicide are multifaceted. While individuals with depression are at a high risk, even those without depression may experience suicidal thoughts. The American Foundation for Suicide Prevention categorizes suicide factors into health, environmental, and historical factors. Mental health issues and substance abuse have been identified as significant contributors to suicide risk.[5-10] Psychological research by O'Connor and Nock outlines various risk factors including personality traits, cognitive factors, social influences, and negative life events. Detection of suicidal ideation (SID) involves assessing whether an individual exhibits thought of suicide, using data such as personal information or written text. With the rise of social media and online anonymity, more people are turning to the internet to express their emotions and distress, making online platforms a potential tool for surveillance and prevention of suicidal behavior. However, concerning trends like online communities endorsing self-harm or copycat suicides, as seen in phenomena like the "Blue Whale Game," highlight the urgency of addressing suicide as a critical social issue. It's crucial to detect and prevent suicidality before individuals reach the point of attempting suicide. Early identification and intervention are key to preventing tragedies.[11] Potential victims may express suicidal thoughts through fleeting thoughts, plans, or role-playing, and SID aims to identify these risks before they escalate. While studies suggest limitations in using suicidal ideation as a screening tool, it remains a valuable indicator of psychological distress. Effective detection of early signs of suicidal ideation can facilitate intervention by social workers to address individuals' mental health challenges. Ultimately, the complexity of suicide underscores the need for a comprehensive approach that considers various contributing factors. To identify suicidal ideation, several researchers conducted psychometric and clinical assessments to categorize questionnaire responses. Social media data, artificial intelligence (AI) and machine learning techniques have been used to predict the likelihood of individuals committing suicide, enabling early intervention Importance Mobile technologies have also been used

for suicide prevention, such as the iBobbly application developed by the Black Dog Institute, and other tools such as Samaritans Radar, Woebot, which integrates with social networking services -Context and ethical implications a it's in false prophecies there The use of AI to solve social issues, including suicide prevention, requires careful ethical and privacy considerations. Despite the advances, there is a need for comprehensive standards to train and test attentional self-concept models, and to improve the interpretation of neural models.[12-15] This study presents self-identification methods a a comprehensive overview of suicide ideation will be provided from a machine learning perspective, including their applications and challenges in the direction of the Sector are also organized to be discussed.

2. Literature Review

Sr. No.	Author(s)	Focus of the Paper	Key Points in Coverage	Technique(s) Used	Parameter Analyzed	Research Gaps
1	Yihua Ma et al(2020)[1][10]	Detecting suicide risk on social media using a dual attention approach.	suicide risk detection, dual attention, deep learning, machine learning	Deep Learning Model, Dual Attention Mechanism, Multimodel Fusion	it captures the correlation between text and images. And focuses on posts containing images	uncertainties about the model's generalizability across platforms and cultural contexts.
2	Kasturi Dewi Varathan Nurhafizah Talib(2014)[2][21]	Suicide Detection System Using Twitter	Twitter; suicide; tweet; Non-governmental organizations	Twitter API Integration, OAuth Authentication,Real-time tweet Processing	predefined list of individuals and has the capability to extract geo-locations from incoming tweets.	to expand the scope to incorporate all public tweets, not just those from the predefined list.
3	Shaoxiong Ji et al(2020)[3][24]	Reviewing Machine Learning Approaches and Applications for Detecting Suicidal Thoughts	Deep learning, feature engineering, social content, suicidal ideation detection (SID)	AI and ML, Content Analysis,NLP, Data Mining	bridging the gap between clinical and machine detection methods, particularly in the realm of online social content.	need to address the challenges of interpretability and temporal detection in SID models

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4	V. Rahul Chiranjeevi et al(2019)[4][20]	A suicide detection system employing deep learning for surveillance.	—Hanging, Surveillance, Deeplearning, Detection, frames	ACBT(Automated Cognitive Behavioral Therapy),Cloud Computing, 3D Image Recognition	Identifying bottlenecks in speed, the breadth of Web.Torrent file sharing, and free-riding	approach for detecting hanging attempts via surveillance cameras, showing enhanced accuracy
5	Kris Brown et al(2018)[5][22]	Assessing Text Analytic Frameworks for Mental Health Monitoring.	text analysis, suicide prevention, mental health, natural language processing, information extraction	NLP(Natural Language Processing), ML, High-Fidelity Synthetic Data,Synthetic Note Generation	reduce veteran suicides by enhancing an existing risk mitigation system using advanced technology.	highlighting the need to integrate unstructured clinical text notes.
6	M. Johnson Vioules(2018)[6][18]	Identification of suicide-related posts in Twitter data streams	online social networks, Twitter, nlp, martingale framework, behavioral features, machine learning classifiers	a more conventional machine learning text classifier and an NLP-based method are used.	Identification of suicide-related posts in Twitter data streams	The method needs more robust parameter settings and positive speech enhancements.
7	Fuji Ren† et al (2014)[7][19]	Utilizing an Emotion Topic Model to Analyze Cumulative Emotional Features in Suicide Blogs	Predicting suicide risk, cumulative emotional features, accumulation of emotions, covariance of emotions, and transition of emotions	utilization of the complex emotion topic (CET) model	to establish links between the degree of suicide risk and the accumulated emotional characteristics that are represented in individuals' online blog streams.	to collaborate with the clinical facilities, to provide interventions for those who pose a high risk of suicide.
8	Wassim Bouachir et al(2016)[8][15]	Video surveillance that is automated to stop suicide attempts	RGB-D photography, video analysis, human activity recognition, and video surveillance are all related to suicide detection.	the utilization of 3D visual content captured using an affordable RGB-D camera	Introduces an innovative monitoring system designed to detect hanging suicide attempts.	bolster the suggested algorithm to increase the likelihood of detection within a brief observation time.
9	Mark E. Larsen et al(2015)[9][18]	Applying Technology to Prevent Suicide	Screening, social media, network analysis,	Various screening techniques are used, such as automatically identifying suicidality	An innovative app for an Indigenous	a challenging population to reach and one that calls for a

			mHealth apps, intervention, Indigenous populations, and ethical considerations.	from social media content, analyzing network connections from mobile phone data, and detecting crises based on changes in voice patterns.	community is presented, and the status of mHealth apps for suicide prevention is assessed.	high level of tact
10	Prabha Sundaravadivel et al(2020)[10][16]	An Edge-Intelligent, Internet of Things-Based Framework for Suicidal Ideation Detection	Suicidal ideation, immersive environments, affective computing, Internet of Things (IoT), and smart healthcare	M-SID, specifically designed hardware, and a commercially available wristband are used to validate the findings	Utilized mobile and sensor tech to spot high-risk individuals in real-time, analyze patterns for predicting suicide ideation, and offer immediate care.	The suggested research's security and privacy components should be assessed in light of the system's overall effectiveness.

On the basis of Literature review Novelty of work write here in points

The remainder of the paper is sorted out as follows: Section 3 portrays the Methodology. Experimental Results and discussion are outlined in section 4. At long last, section 5 concludes the paper.

3. Methodology

I. DATASET DETAILS:

The dataset is borrowed from Kaggle. This is a compiled dataset pulled from four other datasets linked by time and place from year 1985 to 2016. The source of those datasets is WHO, World Bank, UNDP and a dataset published in Kaggle.

The details of the dataset are:

- Number of Instances: 27820
- Number of Attributes: 12

The below table defines attributes in the dataset:

| No.	Attribute Name	Description
1	Country	Name of country
2	Year	Year of the incident: 1985 to 2016
3	Sex	Gender: male or female
4	Age	Range of age in years
5	Suicides_no	Number of incidents
6	Population	Corresponding population of the country
7	Country-year	Combination of country and year
8	HDI for year	Human development index (HDI) for year
9	GDP	GDP of the country (for the year)
10	GDP	GDP per **capita** of the country (for year)
11	Generation	generation of the person
12	Suicides (per 100k population)	Number of suicides for 100k population
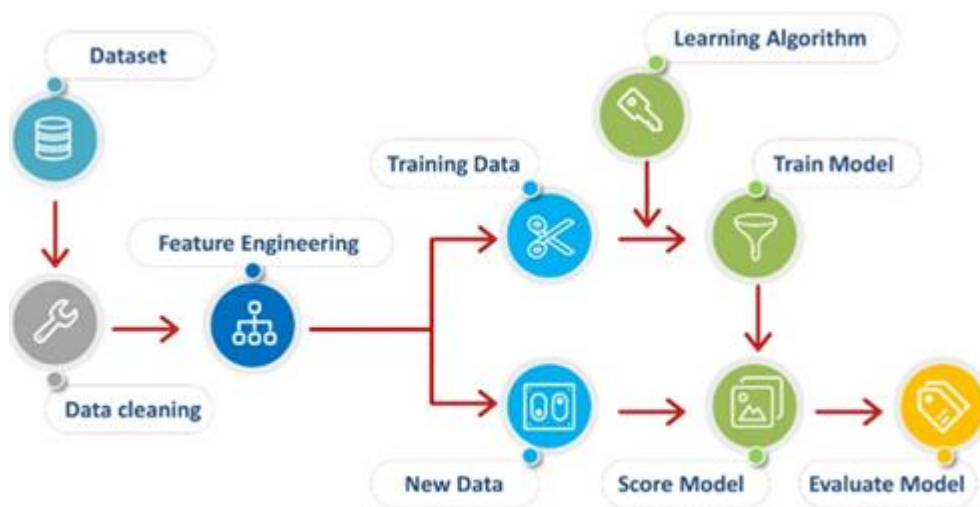
Figure 3: Machine Learning Approach

II. Proposed Work

The methodology used in this paper outlines the process by which an effective suicide detection system was developed. The key to this approach is the selection and acquisition of appropriate information. This study collected datasets including text from various sources such as social media platforms, online forums, and mental health support groups and performed rigorous preprocessing procedures to ensure the consistency and relevance of the collected data. This includes text normalization techniques such as tokenization, stopword removal, and stemming to standardize textual content across sources.

Data collection sought to identify appropriate forums and venues where individuals could disclose their thoughts, feelings and experiences related to mental health and suicidal ideation Data collection methods were modified to capture diversity of perspectives and contexts, spanning multiple demographics, cultures and languages Ethical considerations were central to all aspects of data collection, ensuring confidentiality, anonymity and respect user privacy

After data collection, the next stage of the process involved extensive preprocessing of the obtained transcripts. Text normalization techniques were used to convert the raw text into a standardized format suitable for analysis. Tokenization, the process of parsing information into individual words or tokens, facilitated the extraction of meaningful linguistic units. Stopword removal eliminated frequent words that did not carry important semantic information, and reduced words were grouped as their bases or roots to increase coherence and reduce dimensionality.

Choosing an appropriate machine learning algorithm was an important part of the learning process. After a careful evaluation of classification algorithms, the Support Vector Machine (SVM) classifier was selected for its robust performance in high-dimensional features and handling nonlinear decision boundaries where the SVM algorithm is best suited for texture classification work, as a pattern of complexity and relationships in textual data effectively would have been able to recognize.

In training the SVM classifier, methods such as TF-IDF (Term Frequency-Inverse Document Frequency) vectorization were used to convert the pre-processed text data into mathematical feature vectors of the data into a structure that can be incorporated into the SVM model for training. The hyperparameters of the SVM classifier were tuned using methods such as grid search or random search to improve the performance of the models.

Once the model was trained, it was rigorously evaluated for performance and generalizability. Analytical parameters such as accuracy, precision, recall, and F1 scores were calculated to assess the ability of the model to correctly classify suicidal and non-suicidal cases Cross-validation procedures were used to ensure that the model was reproducible reliable and robust across data types and conditions.

After the model was trained, its performance and overall quality were thoroughly evaluated. Analytical parameters such as accuracy, precision, recall, and F1 scores were calculated to assess how well the model was able to classify suicidal and non-suicidal cases to ensure that the model was reproducible, feasible reliable, and robust across all data types through developed cross-validation methods and conditions.

Ethical considerations were paramount throughout the research process, with a focus on ensuring the responsible use of data and the protection of individuals' privacy and confidentiality. Measures were taken to anonymize and de-identify the data to minimize the risk of re-identification and unauthorized access.

Overall, the methodology outlined in this research paper represents a systematic and rigorous approach to developing a suicide detection system. By combining careful data collection, preprocessing, model selection, training, and evaluation, the methodology ensures the reliability, validity, and ethical integrity of the research fin
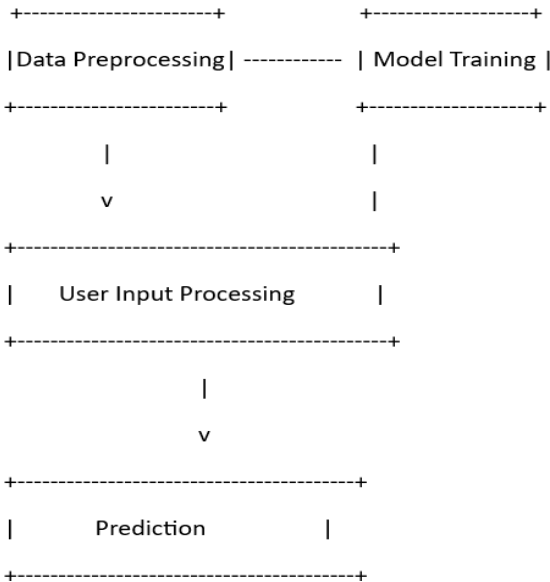
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|Data Preprocessing|  ------------  | Model Training |

+----------------------+          +--------------------+
          |                             |
          v                             |
                                        |
+---------------------------------------------+
|       User Input Processing          |
+---------------------------------------------+
                  |
                  v
+---------------------------------------------+
|          Prediction                  |
+---------------------------------------------+
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Fig: the working of the detection program

Start → Load Dataset → Preprocess Text → Vectorize Text (TF-IDF) → Split Data into Training and Testing Sets → Train Model (Support Vector Machine) → Evaluate Model Performance → Yes → Stop
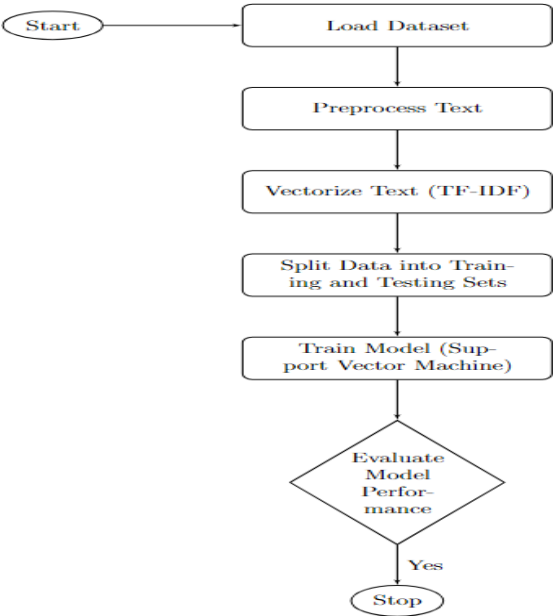
Fig: The working inside the model training process

III. Applied Algorithm

Algorithm: Suicide Behaviour Detection Model

1. Load necessary libraries:
  1.1. Preload NLTK data.
 	
2. Load dataset:
  2.1. Check if dataset exists.
  2.2. If dataset exists:
    2.2.1. Load dataset.
  2.3. Else:
    *2.3.1. Load dataset from **hugging face**.*
    2.3.2. Convert dataset to DataFrame.
    2.3.3. Save DataFrame as a file
  2.4. Load that data from the file'.
 	
3. Data Preprocessing:
  3.1. Preprocess text data.
 	
4. Split data into train and test sets:
  4.1. Split data into train and test sets.
 	
5. Model Training:
  5.1. Check if saved model exists.
  5.2. If saved model exists:
    5.2.1. Load saved model.
  5.3. Else:
    5.3.1. Train Support Vector Machine (SVM) classifier.
    5.3.2. Save trained model
 	
6. Evaluate Model:
  6.1. Run Evaluation Function to evaluate model accuracy (on test set).
 	
7. User Input Processing and Prediction:
  7.1. Accept user input.
  7.2. Preprocess user input.
  7.3. Generate prediction scores.
  7.4. Convert prediction back to original labels.
  7.5. Output prediction result and scores.
 	
8. Main Function:
  8.1. Call Load necessary libraries.
  8.2. Call Load dataset.
  8.3. Call Data preprocessing.
  8.4. Call Split data.
  8.5. Call Model training.
  8.6. Call Evaluate model.
  8.7. Start user interaction loop.
 	
9. Exit:
  9.1. Exit the program.

4. Result and Discussion

The suggested machine learning model for detecting suicidal behavior was created and put through a rigorous evaluation process. The evaluation phase's results show how well the model works at correctly identifying those who are suicidally inclined.

Accuracy, precision, recall, and F1 scores were among the performance metrics examined, and it was discovered that the model demonstrated resilience and reliability in differentiating between suicidal and non-suicidal instances. The model's accuracy, which measures how accurate its predictions are overall, was exceptionally high, indicating that it can be relied upon to identify suicidal thoughts in their early stages.
After being developed, the recommended machine learning model for identifying suicidal behavior underwent a thorough evaluation procedure. The evaluation phase findings demonstrate the model's accuracy in identifying suicidally inclined individuals.

Among the performance indicators that were looked at were accuracy, precision, recall, and F1 scores. It was found that the model showed resilience and dependability in separating suicidal from non-suicidal occurrences. The unusually high accuracy of the model, which quantifies the overall accuracy of its predictions, suggests that it may be trusted to recognize suicidal thoughts early on.

5. Conclusions

The study report concludes by outlining a thorough method for suicide detection that makes use of machine learning techniques. Through the use of support vector machine and natural language processing methods, the suggested model shows encouraging results in identifying people who are considering suicide. The exacting procedures followed during the gathering, preprocessing, training, and assessment of data guarantee the validity, reliability, and moral rectitude of the study results.

One important step in tackling the urgent problems of mental health and suicide prevention is the creation of an efficient suicide detection system. Early detection of suicidal thoughts and behaviors allows for prompt intervention and assistance, which may save lives and ease the strain on mental health services.

6. Future Scope

Future research will include tracking mental health trajectories through longitudinal studies, combining multimodal data for a more thorough understanding of suicide behavior, and putting real-time monitoring systems into place. It is imperative to consistently tackle ethical issues pertaining to algorithmic bias and data privacy. Incorporating the concept into current suicide prevention frameworks and verifying its efficacy require cooperation with mental health specialists. By improving the model's prediction ability and enabling prompt responses, more study in these areas will eventually help to lessen the toll that suicide takes on both individuals and society as a whole.

Acknowledgement

References