

A Review of Machine & Deep Learning Techniques in Detecting Suicidal Tendency

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Abstract: In recent years, the number of deaths due to suicide has increased. Suicide is becoming one of the major causes of death across the whole world. Early detection and prevention of suicide attempts should be addressed to save people's life. Thus, several studies found that people who are contemplating suicide can be identified by analyzing social media posts. However, finding and comprehending patterns of suicidal ideation represent a challenging task. The literature has suggested that the detection of suicide thoughts at an early stage can help to rescue the life of people. The idea of early detection has led various researchers to carry out research in this direction. Many such studies have used machine learning and deep learning models to predict the idea of suicide. So, this paper reviews the methods that have been performed towards detection of suicidal thoughts using machine learning and deep learning techniques.

Index Terms: Suicides, Suicide Ideation Detection, Machine Learning, Deep Learning

I. INTRODUCTION

One of the major social health issues that face modern society is suicide. A suicide attempt is a self-destructive attitude that is planned to result in death but has a nonfatal effect instead. Suicide prevention starts with recognizing the warning signs and taking them seriously. A powerful and essential strategy for preventing suicide is the early diagnosis of suicidal ideation. We can define suicide ideation detection as a special case of emotion detection from a text that helps to detect the affected writer or reader. Moreover, suicide ideation detection is the task of automatically extracting and analyzing user suicide ideas from suicide notes. These messages left by persons before committing suicide. Usually, they are expressed in letters or online blogs. In recent years, many people have used social networking as a platform to communicate with each other and post messages, information, images, stories, and struggles; and express their opinions, feelings, emotions, sentiments, and suffering. As a result, these posts in social networks can be a material for research and a tool for identifying suicide ideation to predict and prevent suicide.

Social networks are a popular way for people to communicate with one another; as a result, social networking platforms are a suitable option for recognizing a person's behavior based on the content of their posts. The effect of analysis on the user's posts can be detected whether or not the people have an idea of suicide. Numerous researches has been done to improve the use of social networking and analyzing online suicide notes can help to spot suicidal thinking and offer the right sort of reaction, which will eventually try to stop others from self-harming and suicide and halt the spread of suicidal thoughts. The use of social networks affects emotions and behaviors and offers useful ways to detect and prevent suicide ideation. This study reviews about projects that will use social media analysis to prevent suicidal behavior between thoughts and behavior. There is a big correlation between social networking and suicidal prediction. Adolescents are heavy users of technology such as Facebook, WhatsApp, Instagram, etc. They use it to communicate, make social connections, and share ideas, thoughts, and emotions. Therefore, this technology can be an important source of data for suicide prevention in adolescents.

II. REVIEW OF METHODS FOR SUICIDE IDEATION DETECTION

Suicidal ideation detection from social media is a challenging research area. Many of the people who have the tendency to suicide share their thoughts and opinions through social media platforms. According to various studies, it is observed that the publicly available posts from social media contain valuable criteria to effectively detect individuals with suicidal thoughts. The major objective of suicide ideation detection is to categorize the online suicide notes and recognize those who have a plan to commit suicide, which means differentiating all the terms related to suicide such as "die", "depressed", "feel alone", "suicide", "kill" and so on. We can resolve the problem of suicide ideation detection from online suicide notes using the existing approaches for textual emotion detection. The major techniques used for identifying and analyzing suicide ideation from the textual data, are machine learning and deep learning.

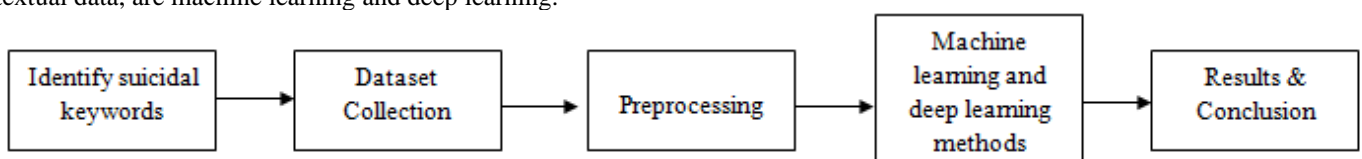


Fig. 1. Detecting suicide ideation from social media posts

Machine Learning methods are applied to resolve the suicide ideation detection problem by using machine learning algorithms to distinguish online suicide notes into different categories. A supervised or unsupervised ML approach is frequently used for this problem. Algorithms for suicidal ideation detection with feature engineering include Support Vector Machine algorithm, Naive Bayes Algorithm and Decision Tree Algorithm. Support Vector Machine can be used for both classification

and regression. The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future. Naive Bayes classifiers are a collection of classification algorithms based on Bayes' theorem. Bayes' theorem finds the probability of an event occurring given the probability of another event that has already occurred. It takes into account the frequencies of terms and uses conditional probability to classify the text data into different classes. Decision tree is the most powerful and popular tool for classification and prediction. A decision tree is a flowchart like tree structure, where each internal node denotes a test on an attribute, each branch represents an outcome of the test, and each leaf node (terminal node) holds a class label. The method first identifies the suicidal keywords, and then uses these keywords to extract texts from social media platforms using various extraction techniques. After that it pre-processes the data or extract features from the text document. Then SVM and Decision Tree algorithms are imposed on the dataset and at last determine the model efficiency on the basis of accuracy score, precision, recall and F1 scores. Texts are retrieved from social media platforms and intensity of suicidal tendency is calculated based on the weightage given to the word. Supervised machine learning approach is followed for this method. This model can reduce the rate of suicide in the society by detecting suicidal intentions from social media interactions of individuals.

Deep learning has been a great success in many applications, including computer vision, NLP, and medical diagnosis. In recent years, more studies have chosen to apply deep learning techniques and investigate the feasibility of using them to predict users who have suicidal thoughts. Social media post data can be analysed using deep learning techniques and then compare the proposed deep learning architecture with the machine learning model to automatically identify people who may attempt suicide within 30 days and six months.

Convolutional Neural Network (CNN) is a type of deep feed forward artificial neural network that uses a multilayer perceptron variation that requires little preprocessing. When we utilise CNN on text data, each convolution's result will fire a trigger when a specific pattern is found. Convolution is the result of applying a filter to an input and getting activation. When the same filter is applied to an input several times, a feature map is created, displaying the positions and strength of a recognised feature in the input. For textual data, one-dimensional convolutions are utilised. Rectified linear unit (ReLU) activation function is used with the convolution. A pooling layer is another building block of a CNN. Its function is to gradually reduce the spatial size of the representation in order to reduce the number of parameters and computations in the network. Pooling layers work independently on each feature map. As a convolutional network is trained, kernel weights are learned. Each kernel looks at a word and surrounding words in a sequential window and outputs a value. In convolution operation features are recognized as patterns in sequential word groupings and can indicate the sentiment of a text. In one dimensional convolution kernels will slide down a list of word-embeddings in sequence to process an entire sequence of words.

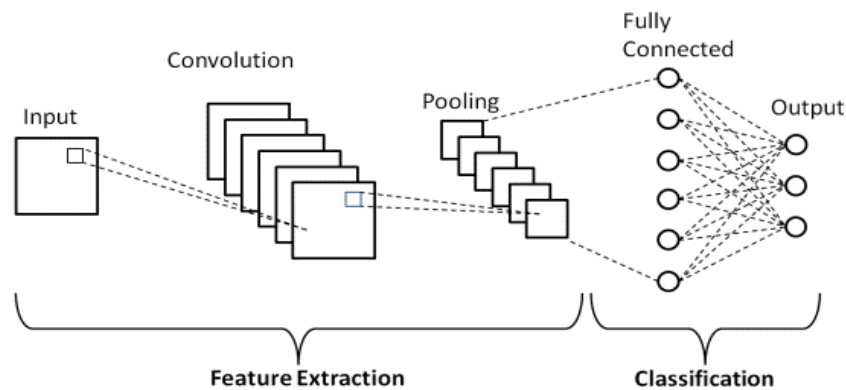


Fig. 2. Convolutional Neural Network Architecture

LSTM is a type of recurrent neural network which maintains the relevant data and discards irrelevant data. LSTM has many hidden layers. While passing through these layers the relevant data is kept and the irrelevant data is forgotten through every single cell. Information gets added and removed through the gates namely input gate, forget gate and output gate. Information from the earlier time steps can be carried to the later time steps thus it remembers patterns and reduces the effect of short memory. In the proposed system LSTM is implemented using the Sequential model. First layer is embedding layer and specification of input shape. Dropout is added to prevent overfitting. Next layer is LSTM layer containing neurons which act as memory unit for the model. Dense layer or fully connected layer is the output layer.

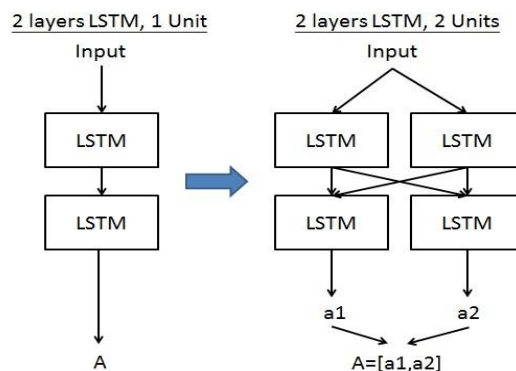


Fig. 3. LSTM Neural Network Architecture

Combined LSTM-CNN architecture consists of the LSTM layer to predict a category for the long term context dependencies and the convolutional layer for extracting important features through pooling which help to identify patterns in the textual data. The first layer includes word embedding and specifies the input shape followed by dropout layer, LSTM layer, one dimensional convolutional layer for performing, pooling layer, fully connected layer with an activation function and compilation layer.

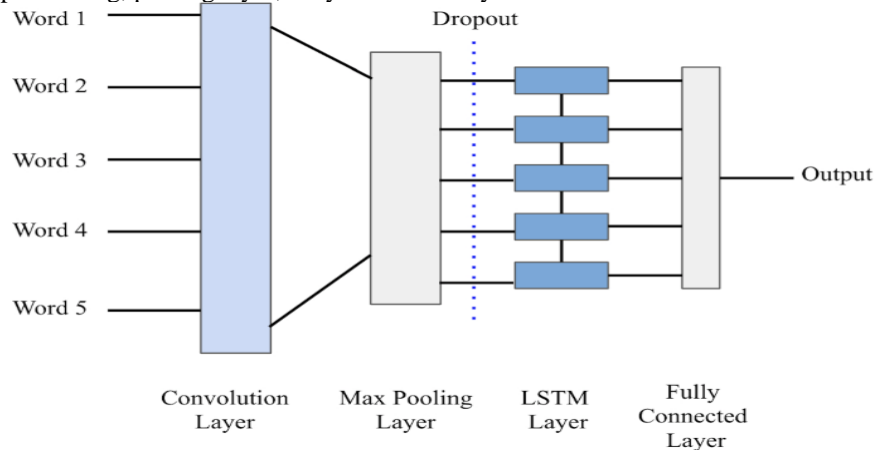


Fig. 4. LSTM-CNN Architecture

Bi-LSTM neural networks consist of LSTM blocks operating in both directions to combine past and future contextual information. The bi-LSTM network learns long-term dependencies without storing redundant contextual data. Bi-LSTM consists of two parallel layers propagating in both the forward and reverse passes to capture the dependencies in the two contexts.

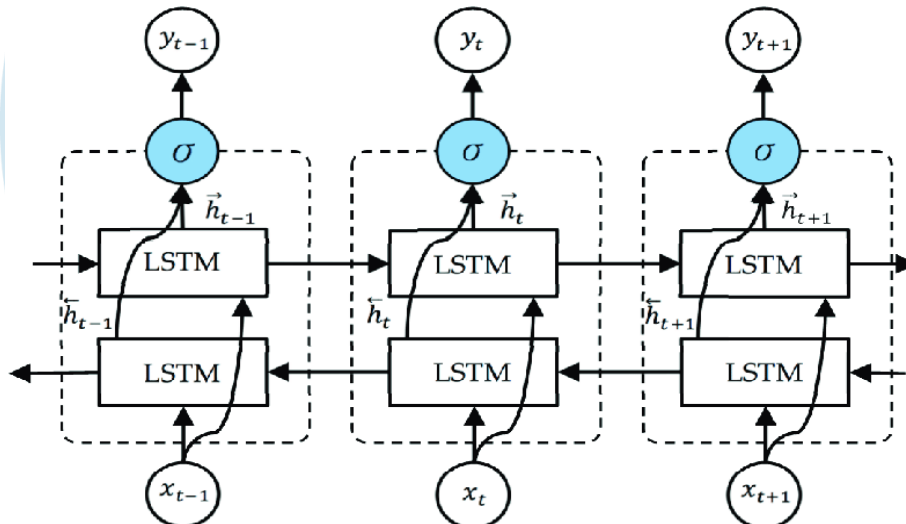


Fig. 5. Bi-LSTM Architecture

Machine learning and Deep learning classifiers are trained over Twitter dataset and used for the text classification task to categorise social media posts into suicidal or neutral category. According to the studies, Bi-LSTM exhibits highest predictive accuracy 91.75 %, hence it is the most suitable deep learning neural network architecture for prediction.

III. CONCLUSION

Suicide prevention remains an important mission in our present day society. Early detection of suicidal ideation is an essential and powerful way to prevent suicide. Lowering the suicide rate is related to how we can prevent people from committing suicide and predict their ideation and plans. There are several methods adopted to resolve this problem, such as machine learning, and deep learning. This study presents the review of each method for suicide ideation detection.

Machine Learning applied to detect suicide intention and depression amongst individual is effective as traditional approaches are hindered by factors like face-to-face conversation and shyness to express themselves. In the future, I would like to delve more into context analysis via the links to external sites. Even though ML seems to be a better method, yet it entails some shortcomings, like eventually having to use human intervention to approve the predictions by the ML model, it's limited to detecting suicidal tendencies and depression and contextual analysis as the data collected doesn't come with prior background explanation. The amount of text keeps increasing with the popularization of social networking services. So suicide detection and prevention remain a crucial task in our modern society. It is therefore essential to develop new methods to detect online texts containing suicidal ideation in the hope that suicide can be prevented.

Psychological experts have conducted maximum work in this field with statistical analysis, and computer scientists with feature engineering based machine learning and deep learning-based representation learning. This research reviewed existing tasks and further proposed new possible tasks.

Online social content is very likely to be the primary channel for suicidal ideation detection in the future. Therefore, it is essential to develop new methods, which can heal the schism between clinical mental health detection and automatic machine detection, to detect online texts containing suicidal ideation in the hope that suicide can be prevented.

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