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Text Classification for Suicidal Ideation Detection on Online Social Networks

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***Abstract** - Online social networks have become a common medium of communications. Studies have shown that it is more likely for a user to share their opinions and ideation. In spite of the fact that this could be beneficial, there are some developing concerns with respect to its negative effect on the users, such as, the spread of self-destructive ideation. According to the World Health Organization (WHO), more than 800,000 people die by suicide each year, a number that translates to one death every 40 seconds. Thus, this study aims to detect suicidal ideation from tweets based from pronouns and absolutist words weights using TF-IDF (Term Frequency – Inverse Document Frequency). Furthermore it will evaluate the performance of two machine classifiers in identifying suicide-related text from Twitter (tweets) using Rapid Miner.*

***CCS Concepts** - Computing methodologies → Supervised learning by classification*

***Keywords** - Suicidal Ideation, Text Classification, data analysis, Machine Learning*

1. INTRODUCTION

Online social networks have become a common medium of communications. Studies have shown that it is more likely for a user to share their opinions and ideation. In spite of the fact that this could be beneficial, there are some developing concerns with respect to its negative effect on the users, such as, the spread of self-destructive ideation. Close to 800, 000 people take their own lives each year and there are many more people trying to commit suicide. Each suicide is a tragedy that affects the community and has long - lasting effect on the family of the person who committed suicide. Suicide occurs in all ages and in 2016 it was the world's second leading cause of death among 15-29 years old [1]. Suicide is a serious public health problem, but with timely interventions, suicides can be prevented. Specific patterns of a word's usage have been identified that are being used for monitoring. Depressed persons significantly use more first-person singular pronouns – such as "me", "myself" and "I" – and significantly fewer second and third person pronouns – such as "they", "them" or "she". This pattern of pronoun use suggests that people with depression are more focused on themselves, and less connected with others [2]. Other studies have reported that pronouns are actually more reliable in identifying depression than negative emotion words [3].AlMosaiwi and Johnstone conducted a big data text analysis of 64 different online mental health forums, examining over 6,400 members using the Linguistic Inquiry and Word Count software to examine absolutism at the linguistic level which they conclude that absolutist thinking may be a vulnerability factor for suicide. Absolutist thinking underlies many of the cognitive distortions (Beck, 1979; Burns, 1989) and irrational beliefs (A. Ellis & Harper, 1975) that are purported to mediate the core affective disorders. "Absolutist words" – which convey absolute magnitudes or probabilities, such as "always", "nothing" or "completely". Table 1 shows the 19 Independently Validated Absolutist Words.

Table 1. List of 19 Independently Validated Absolutist Words

	Absolutist Words
1	Absolutely
2	All
3	Always
4	Complete
5	Completely
6	Constant
7	Constantly
8	Definitely
9	Entire
10	Ever
11	Every
12	Everyone
13	Everything
14	Full
15	Must
16	Never
17	Nothing
18	Totally
19	Whole

In this study we aim to detect if a tweet has a suicidal ideation by calculating the weight of Absolutist Words and first-person singular pronoun on it.

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2. METHODOLOGY

2.1 Data collection

The first step is the data collection. The data is collected from Twitter using streaming API and the collected data is stored in a excel sheet. Data collected from Twitter and geographical filtered was applied to restrict the tweets analyzed to those likely to originate in the Philippines.

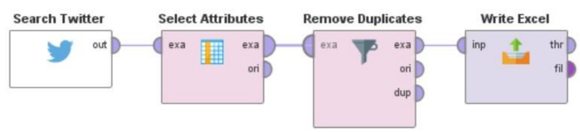

Figure 1. Fetching of data.

Figure 1 shows the fetching of data from the twitter by using search twitter operator and save the data in excel file by using write excel operator

2.2 Data Processing

The data stored in an excel file will then be loaded for processing using the Read Excel Operator of Rapid Miner

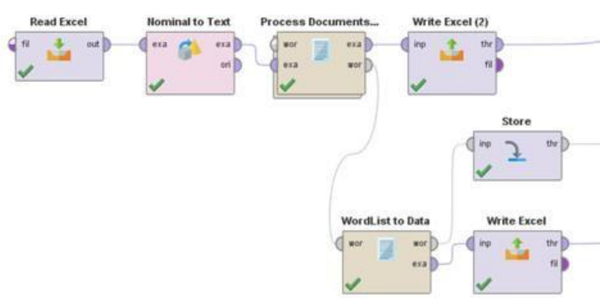

Figure 2. Generates word vectors from the excel file.

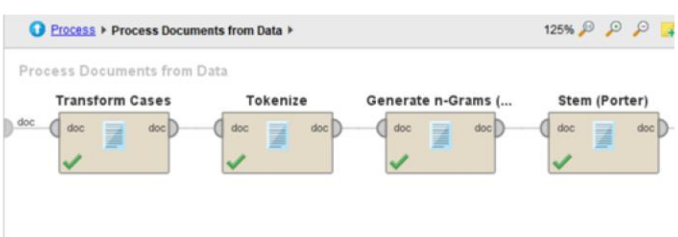

Figure 3. Process Document from Data.

2.2.1 Transform Cases

Will use transform case operator to change the word case to its lower case.

2.2.2 Tokenize

This operator splits the text of each tweets into a sequence of tokens. Tokenization is the process of breaking a stream of text up into phrases, words, symbols, or other meaningful elements.

2.2.3 Generate N-Grams

This operator creates term n-Grams of tokens in the tweet. The term n-Grams generated by this operator consist of all series of consecutive tokens of length n. In the tweets 3 n-grams are used.

2.2.4 Stemming

And lastly the tweets should be stem. Stemming reduces the words to their barest minimum. It is also known as lemmatization, it is a technique for the reduction of words into their stems, base or root. For example, words "responsibilities" and "responsible" indicate the same thing.

2.3 Annotation

The word list that has weights will now be written into an excel file. The word weights are obtained by calculating TF-IDF (Term Frequency – Inverse Document Frequency).Then will select the Absolutist word and pronouns then will compute the total of the weights as seen on Figure 4. Then, any tweet that has a weight of greater than 1 will we automatically annotated with "Suicidal' and 'Not Suicidal" if otherwise using the excel 'if' statement.

	everyting	i	i_ll	i_m	Total
725	.2	.6	.0	.4	1.2
2523	.0	.7	.0	.5	1.2
1836	.0	.8	.0	.3	1.1
2209	.0	.4	.6	.1	1.1
2231	.0	.4	.6	.1	1.1
2251	.0	.4	.6	.1	1.1
1841	.0	.8	.0	.3	1.1
2203	.0	.4	.0	.6	1.1

Figure 4. Word List with Weight.

2.4 Performance Analysis

For training purpose, we classify the tweets in two types of labels Suicidal and Not Suicidal. These labels will be then used to train the classifier and based on this learning predict the label of the testing dataset. The dataset provided for the testing and based on the learning provided to the classifier. We are using here two different classifiers Naïve Bayes and K-NN to predict the label. These classifiers were chosen due to their popularity, as well as their properties. The naive Bayes Classifier is based on Bayes' Theorem with strong independence assumptions between the features, it is also

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highly scalable and requires linear parameters in the number of variables (predictors) in a training set. While K-Nearest Neighbor (KNN) takes all the cases in the data and classifies that in new cases on the basis of similarity measures. KNearest Neighbor (KNN) works on a distance metric, hence we need to define a metric point for measuring the distance between the query point and cases from the sample. It is a conditional probability model. Figure 6 show the operators used on the prediction of these two classifiers.

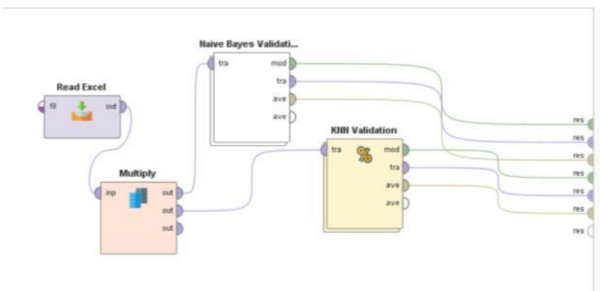

Figure 6. Performance

Figure 7 shows the operator uses in the Naïve Bayes Validation, which includes the training and testing to test its performance.

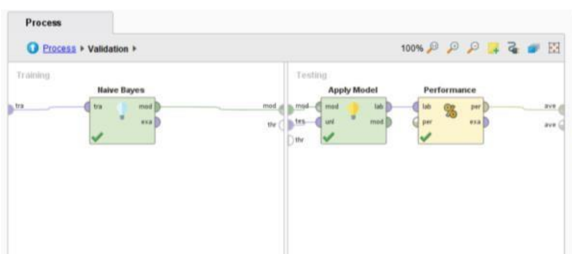

Figure 7. Naïve Bayes Validation

Then, figure 8,9 and 10 displays its output which are the accuracy, precision and recall.

accuracy: 99.98% +/- 0.06% (micro average: 99.98%)

	true Suicidal	true Not Suicidal	class precision
pred. Suicidal	35	0	100.00%
pred. Not Suicidal	2	9963	99.98%
class recall	94.59%	100.00%	

Figure 8. Naïve Bayes Accuracy Result

precision: 99.98% +/- 0.06% (micro average: 99.98%) (positive class: Not Suicidal)

	true Suicidal	true Not Suicidal	class precision
pred. Suicidal	35	0	100.00%
pred. Not Suicidal	2	9963	99.98%
class recall	94.59%	100.00%	

Figure 9. Naïve Bayes Precision Result

recall: 100.00% +/- 0.00% (micro average: 100.00%) (positive class: Not Suicidal)

	true Suicidal	true Not Suicidal	class precision
pred. Suicidal	35	0	100.00%
pred. Not Suicidal	2	9963	99.98%
class recall	94.59%	100.00%	

Figure 10. Naïve Bayes Recall Result

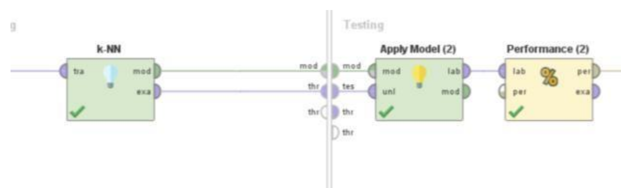

Figure 11. KNN Performance

Figure 11 shows the K-NN Performance, for K-NN we use the Split parameter and used 70 and 30 ratio for training and testing. Figure 12 below displays the accuracy result.

accuracy: 99.63%

	true Suicidal	true Not Suicidal	class precision
pred. Suicidal	0	0	0.00%
pred. Not Suicidal	11	2989	99.63%
class recall	0.00%	100.00%	

Figure 12. K-NN Accuracy Result

precision: 99.63% (positive class: Not Suicidal)

	true Suicidal	true Not Suicidal	class precision
pred. Suicidal	0	0	0.00%
pred. Not Suicidal	11	2989	99.63%
class recall	0.00%	100.00%	

Figure 13. K-NN Precision Result

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3. DISCUSSION AND FINDINGS

3.1 Suicidal Ideation Detection

Al-Mosaiwi and Johnstone discussed that people who are depressed and has suicidal ideation uses a lot of absolutist terms on their sentences, also they used first person singular pronouns. To determine if the tweets are suicidal or not, the researcher used word weights. The word weights are obtained by calculating TF-IDF (Term Frequency – Inverse Document Frequency) - numerical characteristics defined by the frequency of word occurrence in the document and the inverse document frequency. This weight is a statistical measure used to evaluate how important a word is to a tweet. The importance increases proportionally to the number of times a word appears in the tweet but is offset by the frequency of the word in the corpus. Figure 14 shows 1 absolutist word 'everything' and three first person singular pronoun.

	everyting	i	i_ll	i_m	Total
725	.2	.6	.0	.4	1.2
2523	.0	.7	.0	.5	1.2
1836	.0	.8	.0	.3	1.1
2209	.0	.4	.6	.1	1.1
2231	.0	.4	.6	.1	1.1
2251	.0	.4	.6	.1	1.1
1841	.0	.8	.0	.3	1.1
2203	.0	.4	.0	.6	1.1

Figure 14. Word Weight.

Based from the tweet as shown on Figure 15, twitter user on row 725 had the highest word weight, which means that this user has a high probability of having a suicidal ideation and need proper intervention.

	Text
725	calls hotline Hey, how can I help you? "I'm tired of everything, I just want you to know that I'm gonna suicide right now.."
1836	I'm so tired .. I want end my life ..i want to kill my self .. Always me .. Always me, i'm the stupid person always .. All the things i do is wrong even not .. I want freedom .. I want space .. ??????????

Figure 15. Tweets.

3.2 Classifiers Performance

The two classifiers, Naïve Bayes and KNN predicted the labels for a dataset. The result shows that accuracy of K-NN is 99.63 while Naïve Bayes is 99.98. The result also shows that the precision of K-NN is 99.63 while Naïve Bayes is 99.98.

4. CONCLUSION

What this study provides is an evidence that through calculating TF-IDF (Term Frequency – Inverse Document Frequency) of Absolutist words and first person pronoun word weight in a tweet, it can be detected that a tweet is with a suicidal ideation. This is a useful tool to identify individuals at risk and to provide intervention. Additionally, Naïve Bayes is better classifier to be used with social media dataset as it gives the more accurate and precise prediction.

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