

Implementation of a Model of Depressive Emotions in Suicidal Messages

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Abstract. In this investigation, we will be presenting the creation of a dictionary labeled with a value that will represent the depressive content of messages where the word has been used. This value can be used in computational linguistic areas. First of all, the messages were extracted from chats rooms from the social network called *Tumblr* which were labeled with topics such as suicide, pain, depression, sadness, loneliness, etc., Each message was evaluated by multiples evaluators. The evaluation focuses on assessing the messages according to the cognitive triad of depression proposed by Aaron Beck. In addition to Becks Triad, the evaluator proposes the depressive grade of the message and indicates if exist possible threat of suicide conduct. Based in this, a concordance analysis was made using the Kappa Method, considering multiples evaluators. With these results a measure is proposed that estimates how often a word is used in messages that denote a depressive degree. This indicate as a factor of depressive probability (FDP). This factor will be used to calculate a value of written expressions and use them in informatics systems of sentiments analysis in texts. This factor FPD expresses a tendency of the use of each word and should not be taken as a categorical, but it will be very helpful on the automatic sentiments analysis in texts for the computational linguistics [1]. This research will be try to reduce deaths by suicide which is first place in Mexico among all 32 states, with the final numbers of 2018 to Chihuahua State.

Keywords. Dictionary, Probability Factor of Depressive use, Sentiments Analysis, Kappa Method, Aaron Beck Cognitive Triad.

1 Introduction

The creation of tools to detect in an automatic way sentiments inside of text is more demanded day by day because of the constant and accelerated internet use. In recent investigations of the CONAPO (Consejo Nacional de Población) and INEGI (Instituto Nacional de Estadística y Geografía) shows, that in 2015 exits more than 65 million of internet users. Approximately 65% of this user are under the age of 30 years. The average time that this individual spend is 7 hours and 14 minutes. Where in which the 79% the principal activity is to access to the social media networking. Three of each 4 internet users had declared that the internet has changed the way they make the things. The social media had changed the way in which we communicate, and if the tendencias continue in the same way, this can be a common communication tool for the individuals. Aunque no hay detalles en los estudios sobre el uso de las redes sociales se observa que ya es una de las principales maneras de mantener la comunicación entre los individuos.

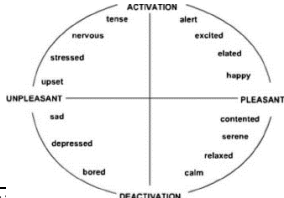
Even though there are no details in the studies about the use is social media, we can observe that is one of the most important way to maintain the communication among the individuals All of this dynamic make more attractive the exploitation of the huge quantities of information that are generated. If this is treated in the correct way, it will be converted in an important source of data for their analysis and the Knowledge acquisition for multiple application. For example, marketing, politics, government, and any other discipline that need to extract knowledge of opinions, emotions, products observation or evaluation of any kind. In order to obtain this knowledge some disciplines where the classification of the word, texts or documents according to the sentiment, emotion or opinion's that are being expressed. These techniques are known by the Sentiment Analysis or Opinion Mining [1].

The sentiments analysis can be used as an auxiliary tool in the detection of text with depressive or suicide content. Nowadays, around the topics of depression and suicide exists alarming numbers where the last one has been passed to the second death cause among the persons between 15 to 29 years of age. In general terms, more than 800'000 persons commit suicide each year, resulting in a death every forty seconds around the world [2]. It exists a wide list of the causes and risks factors that are detonating of a suicide conduct; First, the ideas of the death and their will of dying come in constant thoughts and desire to die that are constantly manifesting and reinforces the desire, next symptom is the threats against themselves expressed verbal or in writing, then the materialization of those threats trying to end their own life and finishing with killing himself. [3] [4] [2].

In the present research, we were committed to elaborate a dictionary of words with depressive content that helps us as a tool in the sentiment analysis in the detection of suicide conduct in the threat stage, principally in the written expression analysis. At the moment of the detection of sentiments in words or

texts, there are some challenges to face, for example most words can potentially have affective content, although some seem to denote neutrality. Another case may occur with the word "cry" whose emotional meaning will depend in some cases on the context in which it is expressed, for example "I want to cry of happiness" would imply a different emotion to the phrase "I want to cry of courage" where the first would denote Joy and the second anger when generally crying is because of a sadness [5]. For the identification of emotions in texts there are several techniques that can be implemented; in the following table, we show the ones that are proposed as the most important after a study by [6]:

Table 1 Approaches to the detection of emotions, constructed from [1] [6]

Circumplex Model Rusell, 1980	
Descriptions based on evaluations Scherer y Ekman, 1984	Positive or Negative Result or event evaluation processes based on a set of evaluation criteria
Emotional Dimentionions Wundt, 1896	Valence (Polarity) → Positive / Negative Activation → Active /Pasive Control → Dominación / Sumisión
Emotional categories Smith, 1989	Anger, Repulsion, fear, joy, sadness, surprise, anger. Proposal by Ekman, Friese y Ellsworth.

2 Triad Cognitive Proposed

One of the fundamental and critical stages in the area of medicine is at the time of diagnosis, which is also the basis for an effective treatment; this is based on symptoms (medically relevant indications provided by the patient), signs (revealed in physical examinations made by medical personnel) in addition to findings of complementary explorations. In our case, which is to identify texts specifically with depressive content, we propose to focus beyond the emotional level; the proposal is to directly assign a depressive degree to the sentence without first identifying the basic emotional category it denotes.

Considering the above the Beck's cognitive model of depression is one that best can adapt to our objective since to diagnose the depression in based on three aspects that are fundamental in the way that an individual perceives life:

1. Negative perception of itself
2. Negative perception of environment.
3. Negative perception of the future

In the cognitive triad, the person has a negative vision of the future, itself and tend to interpret the experience of the day in negative way.

In the cognitive triad, the person has a negative view of his future, of himself and tends to interpret everyday experiences in a negative way.

The person looks miserable, clumsy, with little worth. Tend to underrate itself, to criticize itself on the basis of those defects has. Believes that the world interposes his insuperable obstacles, the environment frustrated continuously. From the future, they only expect sorrow, frustration and deprivation endless. When a person faces a circumstance, the scheme (stable cognitive patterns) is the basis to transforming the data into cognitions. Schemes activated in a specific situation determinate how a person responds. In

the depression, these schemes are inadequate. The subject loses big part of the voluntary control over their thought processes and is unable to attend to other more appropriate schemes. In the cognitive triad, the person has a negative vision of the future, itself and tend to interpret the experience of the day in negative way.

As depression worsens, thinking is increasingly dominated by negative ideas. In the most serious depressive states, the subject's thinking can become totally absorbed in negative, repetitive, persevering thoughts, finding it extremely difficult to concentrate on external stimuli (eg reading) or undertaking voluntary mental activities (problem solving, memories)

The systematic errors that occur in the thinking of the depressive maintain the subject's belief in the validity of his negative concepts, even in spite of the existence of contrary evidence. [7].

Mensaje	Parametro
!Déjenme tranquila; Dejen que este sufrimiento acabe conmigo... De cualquier manera, ya no hay nada que puedan hacer por mí.	
"Hay cortadas que son hermosas."	suicidio
- ¿Cometerias el mismo error? - ¿Que sienta? - Ya sabes, al querer amar. Dios - Sufriendote, ¿lo harías? - Lo haria mejor.	frases,citas,textos,depression,vida,suicidio
Maí mai pregato Dio per fatti morire? - No, è stupido richiedere delle cose così assurde ai nostri tempi. - O, figlia. Mamãe, porque a conhora me deixou ? - Eu só estava tentando ser forte filha, mas a mamãe não conseguiu. - Tudo bem mamãe, agora a senhora está em casa. Eu sempre soube que a senhora era um anjo.	muerte,dios,suicidio,dolor

Figure 1 Crawler of messages from the chat rooms of the social networking *Tumblr*.

3 Construction of the dictionary

The main objective is to construct a dictionary that contains a label (weighting) with a depressive degree in each word that conforms it. To carry it out they took 3000 messages from the social network *Tumblr*, first the messages were extracted from chats rooms tagged with the subjects of suicide, suicide, sadness, pain, depression in the social networking *Tumblr*. For the extraction of these messages we used the API offered by the social network in the section for developers, this was implemented in a script in the PHP programming language. The following image shows the interface that was developed to extract messages from the social network. This screen shows the messages extracted from the chat rooms with the tags of our interest:

Once the messages were crawled then the evaluators made each message the assessment that corresponds to them:

To each message several evaluators assigned a value based on their experience about the depressive content that observed within the message and based on this we performed a concordance analysis with the weighted kappa method.

Mensaje	Visión		
	Negativa De-Sí-Mismo	Consideración Negativa De-Su-Entorno	Consideración Negativa Del-Futuro
!Déjenme tranquila; Dejen que este sufrimiento acabe conmigo... De cualquier manera, ya no hay nada que puedan hacer por mí.	Alta	Alta	Alta
"Hay cortadas que son hermosas."	Baja	Media	Alta

Showing 1 to 2 of 2 entries

Previous 1 Next

Figure 2 Interface for evaluators.

3.1 Evaluation of the experts.

The objective of the evaluators was to assign each message the depressive content through 5 characteristics of which 3 were taken from Beck's cognitive triad. The fourth characteristic is the depressive content and the fifth is to determine if the message has suicidal content. We will calculate the depressive grade from the values assigned in the Likert scale used (null, low, medium, high). It is decided by this scale for its popularity, simplicity and its frequent use in the application of surveys. Unlike the dichotomous questions with yes / no answer, the Likert scale allows us to measure attitudes and know the degree of conformity of the respondent with any affirmation we propose.

It is especially useful to use it in situations where we want the person to clarify their opinion. In this sense, the categories of response will serve to capture the intensity of the feelings that the evaluator perceives were captured by the author of the message. The criteria for each scale value for our evaluators are described below. The variable "Depressive Degree" was used as an example to exemplify the characteristics to be evaluated.

Scale Values

- "Null": 0%
Depressive Degree: The message shows zero indications that the author tries to express depressive feelings or behaviors.
Beck's Triad (Negative Considerations): The message shows zero indications that the author has negative considerations (of himself, of his environment, and his future).
- "Low": 33.33%
Depressive Degree: The message shows slight indications that the author tries to express depressive feelings or behaviors.
Beck's Triad (Negative Considerations): The message shows slight indications that the author has negative considerations (of himself, of his environment, and his future)
- "Medium": 66.66%
Depressive Degree: The message shows moderately indications that the author tries to express depressive feelings or behaviors.
Beck's Triad (Negative Considerations): The message shows moderately indications that the author has negative considerations (of himself, of his environment, and his future).
- "High": 99.99%
Depressive Degree: The message shows clear indications that its author tries to express depressive feelings or behaviors.
Beck's Triad (Negative Considerations): The message shows clear indications that the author has negative considerations (of himself, his environment, and his future).

Table 2 Assignment of values by area experts (psychiatrists and psychologists).

	Characteristics of depressive content according to Beck cognitive triad.		
	Negative perception of self	Negative perception of environment.	Negative perception of the future
"Él no sabía amar, yo quizás... demasiado."	Null Low Medium High	Null Low Medium High	Null Low Medium High

As a result, we will have a message evaluated by several evaluators, then to assign them the unique value we used the technique of analysis of concordance with the Kappa index. The introduction of this kappa coefficient was proposed in a publication in the journal Educational and Psychological Measurement in the 1960s (Cohen, 1960). A similar measure called Scott's pi is also known, the difference being in the way they calculate $Pr(e)$ (Hypothetical probability of agreement by Randomness).

We must be clear that Cohen's kappa is only a measure for 2 observers. This Cohen kappa coefficient is a value used as a measure that adjusts the effect of randomness proportionally with the observed agreement applied to qualitative values (categorical variables). This index can substitute for the calculation of the percentage of concordance since in most cases this measure gives a better representation of the values obtained from the observation than when calculating the percentage. In [9] there is a concern about the tendency to assure the frequencies of the observed categories, which could cause the agreement to be underestimated in a category of habitual use and is by That k is considered an excessively conservative measure. Also in [10] make the observation and take the issue that kappa "considers" the fact that it is possible to reach agreement. To deal with this possibility the model must capture the effect of chance when the observer makes the decision. Therefore, if there is not full security, the evaluators give an answer that does not coincide with reality.

The agreement of two observers is what the Cohen kappa index or coefficient delivers as a result or measurement at the time of classifying N elements into C mutually exclusive categories expressed in equation

$$k = \frac{[\text{Pr}(a) - \text{Pr}(e)]}{[1 - \text{Pr}(e)]} \quad (1)$$

Where $\text{Pr}(a)$ is the calculated relative agreement between observers, and $\text{Pr}(e)$ is the hypothetical probability of agreement by randomize, using the observed data to calculate the probabilities that each observer will randomly rank each category. If the observers are completely in agreement k will take the value of 1, otherwise, since there is no agreement between the two evaluators that differs from that expected according to chance, this is $\text{Pr}(e)$, then k take the value of zero.

Table 3 Format of the data of a concordance study

	Observer 2				
Observer 1	1	2	...	C	Total
1	X_{11}	X_{12}	...	X_{1c}	X_1
2	X_{21}	X_{22}	...	X_{2c}	X_2
.					.
C					X_c
Total	X_{c1}	X_{c2}	...	X_{cc}	n

In our case we have more than 2 evaluators so we will use a proposed adaptation in [1]. Where it is proposed to work in pairs of evaluators so that the latter is calculated the total average with all values obtained.

Once the agreement of the evaluators for each message is calculated, a single value will be obtained for each of the characteristics c_1 to c_5 evaluated, leaving as a vector of depressive characteristics of the message as shown below:

$$fm_n = \{c_{1n} \dots c_{5n}\} \quad (2)$$

Where each characteristics represents:

C_1	C_2	C_3	C_4	C_5
General Depressive Degree	Suicidal tendency shows?	Negative Vision of Self	Negative Consideration of Your Environment	Negative Consideration of the Future

Then we will have a corpus of n messages m_n of w_{kn} words where k is the number of words w of message n . Each message will be its characteristic vector fm_n . These characteristics will be assigned to each of the words w_{kn} of the message m_n . We know that words are repeated within the corpus of

messages then the characteristic vector of each word f_{w_i} was obtained by calculating the average as follows:

$$f_{w_i} = \sum_{i=0}^n \frac{\{c_1, \dots, c_5\}}{n} \quad (3).$$

The following messages shown in the following table obtained a high depressive load score:

Table 4 Some messages in the corpus of messages with high depressive load.

Characteristics =>	C3	C4	C5	FPDm
<i>Cada pensamiento es una batalla. Cada inspiración es una guerra y no creo que gane más.</i>	1	1	1	1
<i>Es triste como un día parezco tenerlo todo y al día siguiente lo pierdo todo tan rápido.</i>	1	0.75	0.75	0.83
<i>La depresión es como ahogarse, excepto que nadie te puede ver.</i>	0.75	1	1	0.91
<i>A veces me siento triste, cansado y desgraciado sin ninguna razón.</i>	1	0.75	0.75	0.83
<i>Cada pensamiento es una batalla. Cada inspiración es una guerra y no creo que gane más.</i>	1	0.75	1	0.91
<i>Necesito dormir unos meses, por favor.</i>	0	0	0.75	0.25
<i>Mamá tu hija ahora mismo está llorando en su habitación porque tiene unas ganas inmensas de morir.</i>	0.75	0.33	1	0.69
<i>¿Qué tiene de malo la muerte? Ella me promete esa felicidad que no logro conseguir en vida</i>	0.33	1	1	0.77
<i>Solo quiero dormir y nunca más despertar</i>	0.33	0.33	1	0.55
<i>Mi madre me dice que necesito descansar ya. Quizá me está concediendo el permiso de suicidarme y descansar de este mundo enfermo.</i>	0.75	1	1	0.91
<i>Algunos duermen con el deseo de no despertar y dejar de pensar.</i>	0.75	0.3	1	0.69

As we can see already each message has a depressive value perceived by the evaluator. The proposed value $FPDm$ for the message results from computing the average of the value assigned by the evaluators in each of the characteristics $c_1 \dots c_5$ of f_{m_n} . Then we have that the Depressive Use Probability Factor of each word is:

$$FPDm = \sum_{x=1}^5 \frac{c_x}{5} \quad (4).$$

Some of the messages that were rated with a high depressive content are shown in the table above. Already with that value each word will have its weighting that will be calculated from the average values that each word corresponds to each message that appears. Then we have that the Depressive Use Probability Factor of each word is given by the average of each of the characteristics in f_{w_i} .

$$FPDw = \sum_{x=1}^5 \frac{c_x}{5} \quad (5).$$

4 Resulting Dictionary and Conclusions.

Table 5. Dictionary of weighted words with their depressive use factor $FPDw$ their relative frequency fr .

	Palabra w	FPDw	fr_i
1	profundas	0.99851	0.10%
2	cuerpo	0.99851	0.10%
3	dolorosas	0.99851	0.10%
4	cualquiera	0.99851	0.10%
5	rompemos	0.859911	0.05%
6	valioso	0.859911	0.05%
7	haber	0.859911	0.05%
8	perdido	0.859911	0.05%
9	duro	0.839046	0.05%
10	mente	0.827124	0.20%
11	paciente	0.827124	0.10%
12	brillante	0.827124	0.10%
13	ningún	0.769001	0.10%

14	corte	0.769001	0.05%
15	comenzó	0.754098	0.05%
16	empezó	0.754098	0.05%
17	entonces	0.754098	0.05%
18	intentas	0.754098	0.05%
19	recordar	0.754098	0.05%
20	hablar	0.721311	0.15%
21	rodeado	0.721311	0.10%
22	mucha	0.721311	0.05%
23	confiar	0.721311	0.05%
24	solitario	0.721311	0.05%
25	sentirte	0.721311	0.05%
26	hace	0.716344	0.15%
27	muy	0.713115	0.10%
28	heridas	0.712866	0.15%
29	era	0.69225	0.10%
30	romper	0.684054	0.05%

In the previous table, we show the dictionary that resulted from processing messages, assigning finally depressive use Factor FPD_w of each word and its frequency relative f_{r_i} . This factor denotes the calculated depressive degree from messages in depressive contexts where the word was used.

Is interesting to see as shows an important difference the FPD_w compared with f_{r_i} ; This can be an important factor in the calculation of depressive content in messages since we will not only rely on the frequency of words as calculation element but also the FPD_w to use it separately, in conjunction and / or compare results in the resulting depressive content. This factor can be used in automatic classification systems (neural networks, super vector machine, associative memories, etc.) As a value of depressive content and thus improve the classifiers that are developed. The concordance calculation method was used to improve the quality of the data obtained from the expert evaluations of the messages. Although we use the kappa method with adaptation to multiple evaluators, other techniques that serve the same purpose can be tried. The words that make up the dictionary are the result of the first 3000 messages valued. The number of words and the factor should improve as more text messages are evaluated. Although we do not know an optimum number of messages to obtain good classifiers, we intend to reach the necessary number of messages for optimum results. We must keep in mind that each Hispanic speaking region has different words to denote depression although there will be coincidences it is recommended to add the region to the dictionary for better performance.

Future Research

Is recommended for the application in a mobile device with current photographs and the main recommendations in the time available for the trip. The Intelligent Tool will be used by different types of people who need to travel together with different situations related with displacement. In addition, this application will be used as a recommendation system when traveling to other cities or places in different societies and will explain different scenarios based on time, limited resources and location. Another field topic that will benefit from a more appropriate organization is Logistics of the product or service as it describes the use of Cultural Algorithms to improve a Logistics network. We propose the use of a mobile computing device that can indicate during the tour fun options based on our own tastes and priorities, according to the type of activity you want to perform.

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