Defining Patients with Depressive Disorder by Using Textual Information

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Abstract

Depression has been one of the serious social problems of the modern society, due to the prolonged economic stagnation, the increasing number of unemployment rate, and so on. Diseases that require long-term treatments, such as cancer and chronic diseases, are also the major cause of depression, and, eventually, that often leads the patients to committing suicide. Such circumstance requires some urgent means to prevent depression, especially of those who are suffering diseases. In this study, to propose one of the tools for preventing depression or to detect depression at its early stage of suffering, we analyze 200 blog articles to set-up an "evaluation index" that is capable of measuring the tendency of depression from written texts of the long-term patients. Firstly, we collect and analyze blog articles written by the patients who are suffering depression, as well as the articles written by those who are not suffering depression as a comparison. From the analysis, we propose an index for depression measurement. With this index, secondly, we make an analysis on the articles that are posted on a special SNS, which is particularly available for long-term patients. It comes out that posting articles on SNS for more than 12 months may mitigate depression (or depressive symptoms). This outcome suggests the possibility of SNS posting against depression for the long-term patients.

Introduction

Depression has been one of the serious social problems of the modern society, due to the prolonged economic stagnation, the increasing number of unemployment rate, and so on.

Diseases that require long-term treatments, such as cancer and chronic diseases, are also the major cause of depression, and, eventually, that often leads the patients to committing suicide. According to the Ministry of Health, Labour and Welfare of Japan, more than one million patients are suffering from depression in 2008 [1], and approximately 30,000 reported for committing suicide every year since 1998 in Japan according to the Cabinet Office of Japan and the National Police Agency of Japan [2] [3]. They state, in the same report, the emotional disturbance, especially depression, is one of the main causes of suicide. WHO (World Health Organization) report claims almost one million people die from suicide; this roughly corresponds to one death every 40 seconds, and this report also remarks depression as one of the major causes of suicide [4]. Such circumstance requires some urgent means to prevent depression, especially of those who are suffering diseases.

In this study, to propose one of the tools for preventing depression or to detect depression at its early stage of suffering,

- we analyze blog articles to set-up an evaluation index that is capable of measuring the tendency of depression from written texts of the long-term patients. Firstly, we collect and analyze blog articles written by the patients who

[1] http://www.mhlw.go.jp/seisaku/2010/07/03.html

[2] http://www8.cao.go.jp/jisatsutaisaku/whitepaper/w-2012/html/honpen/part1/s1_1_1.html

[3] http://www8.cao.go.jp/jisatsutaisaku/toukei/

[4] http://www.who.int/mental_health/prevention/suicide/suicideprevent/en/

are suffering depression, as well as the articles written by those who are not suffering depression as a comparison. From this analysis, we propose an index for depression measurement. Calculation for this task is based on a text classification by using machine learning.

- With this index, we make an analysis on the articles that are posted on a special SNS, which is particularly available for long-term patients. It comes out that posting articles on SNS for more than 12 months may mitigate depression (or depressive symptoms). This outcome suggests the possibility of SNS posting against depression for the long-term patients.

In this report, we propose an index, "D^3", to measure tendencies of depression from blog articles and also discuss the choices of features to be used for D^3 as well. Then, D^3 is actually used to analyze massive text submitted as the SNS blog articles. D^3 investigates tendencies of depression from the articles.

Related Works

Depression and/or the depressive symptoms have been drawing researchers attention for a long time. In America, information about mental disorder was officially collected as early as in 1840. By 1880, seven categories were established to describe mental disorder: "mania", "melancholy", "megalomania", "paralysis", "dementia", "alcoholism", and "epilepsia" (Takahashi, Ono, and Someya 2004). In 1965, Self-Rating Depression Scale (SDS) was designed to assess the level of depression for patients diagnosed as depressive disorder (Zung 1965). This scale has been the leading guide for diagnosing depression, and has been used all over the world.

On the other hand, some people are afraid of having face to face conversation with others, including doctors, on their private experience. Such patients, therefore, refuse to get psychological consultants (Li and Ren 2008). When researchers discovered such condition of their patients, they started to pay attention to analyzing blog articles to estimate the emotions of the writers, since such patients may feel more comfortable with expressing their emotions when having no audiences at the submission of their articles. Li and Ren (2008) listed keywords associated with particular mental states to estimate the authors' mental states by using frequencies and weights of the words extracted from the articles. Newman et al. (2012) collected the sentences that contained the figurative phrase, "depression is like X", and composed new sentences that described the original phrase. The vocabularies and phrases that were used for the newly composed sentences were extracted to examine whether such words and expressions were to show the sign of depression. Since SNS has been one of the most popular medias all over the world today, analysis of blog articles may well be an effective method to estimate the tendency of depression.

In order to follow and to bring a new aspect to above, we use modalities (Masuoka 1991; 2000) in addition to some keywords. "Modality" is a linguistic term that is mainly considered as the expression of the writer's feelings, and, thus, is an effective means to measure depressive tendencies of texts, such as blog articles.

The Index to Measure Tendencies of Depression for Articles: D^3 (Degree of Depressive Description)

In this study, we first set-up the word list and the index to measure depressive tendencies of the blog articles. To set-up this index, we use blog articles written by patients suffering from depression (hereafter, "depressive articles") and those by patients suffering from other diseases but not depression (hereafter, "non-depressive articles"). The classifier with machine learning is used for this calculation.

Since we use SVM as the classifier this time, we regard the distance from the maximum-margin hyperplane as the value of D^3. Also, in this report, we regard depressive articles as the positive examples, and non-depressive articles as negative. Thus, the depressive articles should have positive D^3 values, whereas non-depressive articles show negative D^3 values.

Features for D^3

Features used in this study are the two of the following:

1. Keywords:
   We made the list of keywords (Table 1), based on the Self-Rating Depression Scale (SDS) which was designed to assess the level of depression for patients diagnosed as depressive disorder (Zung 1965). We observe each keyword to see whether it appears in the articles or not. We do not refer to the frequency of the appearance of each keyword in articles.
2. Modalities:
   We use two levels of modalities ("the First Level Calssification" and "the Second Level Classification"). The modality list is displayed in Table 2. We observe each modality word to see whether it appears in the articles or not. We do not refer to the frequency of the appearance of each modality word in articles. We choose these modalities based on the traditional classification used in Japan (Masuoka 1991; 2000).

Materials for Machine Learning

We select 200 blogs for the training of machine learning. These blogs are from one of the most popular Japanese portal web sites for disease survivors, "TOBYO Toshoshitsu [5]". The blogs are classified according to the authors' symptoms (e.g. "depression", "breast cancer", "infertility", etc.). In this research, we randomly select 100 authors classified as "depression" (authors for depressive articles), and in the same manner, we randomly select 100 authors who are NOT classified as "depression" (authors for non-depressive articles).

To create the training data, we combine five newest articles per author and treat this combined article as one blog's document.

[5] http://www.tobyo.jp/library/

Table 1: Keywords based on SDS. Words with numbers mean the words with several different styles of Japanese characters.

depression (1)	depression (2)	blue
depressed	sluggish	boring/bored
appetite	life	sad
sadness	painful	unhappy
suicide	dissatisfaction/dissatisfied	
hard	vain	confused
not fun	unsatisfactory/unsatisfied	
about to cry	unable to cry	future
lust	spirit	worry
want to die	better die (1)	better die (2)
irritating/irritated (1)	irritating/irritated (2)	
hopeless	indecisive	impatience
reluctant (1)	reluctant (2)	vitality
fatigue (1)	fatigue (2)	constipation
palpitation (1)	palpitation (2)	sleepless
useless	losing weight	(body) weight
underestimated/underestimating		
disappointed/disappointing		

We use 200 documents for the training. Note that we eliminate articles which contain only citations or/and advertisements. The statistics (the average characters per document, the average sentences per document, and the average characters per sentence) of this 200 documents are shown in Table 3.

Results of Learning

In order to examine the weights of the features (keywords, the First Level Calssification, and the Second Level Classification) to decide which features should be used for SVM classification, we build decision trees for each feature by using C4.5 (Quinlan 1993; 1996) [6].

The accuracies of these trees are shown in Table 4. As shown in the table, the performance in the case of "ALL" shows remarkably higher accuracy level than other features. Considering the above result, we decide to use "ALL (keywords, the First Level Calssification, and the Second Level Classification)" as our feature for SVM classification.

The result of SVM classification is also shown in Table 4. We are using TinySVM (two-degree polynomial kernel) [7] as our examination application. The result of the opened environment examination shows remarkably lower accuracy rate compared to the rates of the closed environment as shown on the table (decision trees).

SNS, for Fighting against Diseases

We have already shown the possibility of measuring the depressive tendency of blog articles by using D^3. This indicates that we can see changes for the authors' depressive level along the time axis.

[6] http://www.rulequest.com/Personal/

[7] http://chasen.org/~taku/software/TinySVM/

Table 2: Modalities used in this study. "the 1st Lv C" indicates the First Level Classification. "the 2nd Lv C" indicates the Second Level Classification. "–" indicates the same modality in the First Level Classification. The scope of Japanese modalities is different from that of English. For more information of Japanese modalities, see (Masuoka 1991; 2000).

the 1st Lv C	the 2nd Lv C
topicalization	–
aspects	perfect, durative
grammatical polarity	positive, negative(negation)
tense	present, past
deontic modality	–
evidentialities of truth	truth, suspicion
politeness	–
moods	–
other functions	intentional, purpose,...

Table 3: The statistics of training data. These values denotes the average value among 200 documents.

	depressive articles	non-depressive articles
characters per document	2730.45	3229.50
sentences per document	109.45	136.61
characters per sentence	25.26	24.83

By using this method, we investigate how the SNS affects the authors by actively submitting articles on a long-term basis. We use three Research Questions (RQ) shown below:

- RQ1: Does posting articles on SNS reduce D^3?
- RQ2: Does the function of SNS reduce D^3?
- RQ3: Does the function of SNS help disease patients to continue writing blog articles?

Hereafter, we refer texts written by disease patients as "FAD (fighting against disease) texts". Also, we refer blog articles written by disease patients as "FAD blog articles".

Materials for Analysis

In this report, we use 22,720 FAD blog articles and comments posted on the Japanese largest SNS for diseases survivors, "Life Palette [8]". This is the different SNS we used to examine features for D^3. 195 registered patients involves in this SNS. We use 5,292 articles written by 21 authors (patients) for the analysis. The selection criteria: The blog authers do NOT have the characteristics listed below.

Characteristics of the Authers
to be Excluded from the Analysis:

[8] https://lifepalette.jp/

Table 4: Features and their accuracy rates. "the 1st Lv C" indicates the First Level Classification. "the 2nd Lv C" indicates the Second Level Classification. "ALL" indicates containing all features (keywords, the First Level Calssification, and the Second Level Classification).

	Features	Accuracy (correct / total)
Decision Tree (closed)	Keywords	$80.5\%(161/200)$
	the 1st Lv C	$78.0\%(156/200)$
	the 2nd Lv C	$63.0\%(126/200)$
	ALL	$91.5\%(183/200)$
SVM (opened)	ALL	$60.0\%(24.0/40)$

- the authors who write no articles but only comments on other people's articles.
- the authors whose total posted articles are less than 5 months worth.
- the authors who have one or more years of blank period.

RQ1: Does Continuous Long-Term Writing of FAD Articles Reduce the Depressive Tendency?: Probably YES

We examine the change of D^3 on the continuous posts of FAD articles according to the time axis. The results are shown below:

- Group A:
  The authors who continue posting articles more than 12 months.
- Group B:
  The authors who do NOT continue posting articles more than 12 months.
- Method for Evaluation 1:
  t-test on the average D^3 in Group A and in Group B. [9]
- Method for Evaluation 2:
  We caluculate Pearson's correlation coefficient between n and y, where y is the authors' average D^3 at n-th (n = 1,2, ... , 36) month(s) since their postings start. n is 1, when this is the very first month of posting articles. [10]

The average of D^3 for both groups (the Evaluation 1) are shown in Figure 1. The change of the D^3 average (the Evaluation 2) is shown in Figure 2. The statistical test of the Evaluation 1 does not show significant difference between both groups (A and B) ($t = -1.65, df = 17.64, p = 0.12$). There was a significant correlation between the valuables (n and y) in Evaluation 2 ($r = -0.67, df = 34, p = 7.84 \times 10^{-6}$).

[9] When he/she has a (several) blank month(s), we regard D^3 of the corresponding month(s) as the same as the closest previous month to the blank month(s).

[10] When he/she has a (several) blank month(s), we regard D^3 of the corresponding month(s) as the same as the closest previous month to the blank month(s). Just as treated at the previous method section.

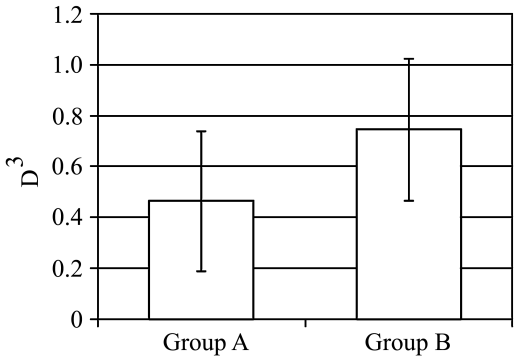

Figure 1: The average D^3 of the authors who continues writing articles for more than 12 months (Group A) and that of authors who do NOT continue writing articles more than 12 months (Group B). In this figure, error bars denote 95 percent confidential intervals.

However, it does not necessarily mean that D^3 depends on the authors' period of writing according to the result of this statistical testing. Thus, in order to examine the dependency we test the initial D^3 and its relationship with the period of writing. As a result ($r = -0.01, df = 19, p = 0.95$), it becomes clear that D^3 is likely depends on the period of writing.

The total average value of the inclination of regression line is -0.0033. This suggests it may require long-term continuous posting of articles for reducing D^3.

From such results shown above, long-term writing experience at SNS may possibly attain to improve the authors' mental condition. However, it is still uncertain whether this effects is caused by the communications through SNS, or by the process of settling their minds by expressing their feelings.

RQ2: Does Posting SNS Articles Decrease Depressive Tendency?: NO

The result of RQ1 indicates that depressive tendencies of FAD blog articles may be reduced by being an active author of the SNS on a long-term basis (at least 13 months, according to this research). However, posting articles, itself, does not particularly require functions of SNS. There are other options. For example, writing diaries, publishing books, and so on.

We, then, assume that the major function of SNS, which helps the blog authors, is that SNS gives easy access to communications among the participants. Thus, we make the hypothesis that the function of comment posting on articles is the main characteristic and the function of SNS (hereafter, we refer SNS commenting function as "SNS function"). In order to examine this hypothesis, we test the relationship between SNS function and the tendencies of depression for articles in the following manner:

- Target Group:
  The 21 authors of the Section of "Materials for Analysis".

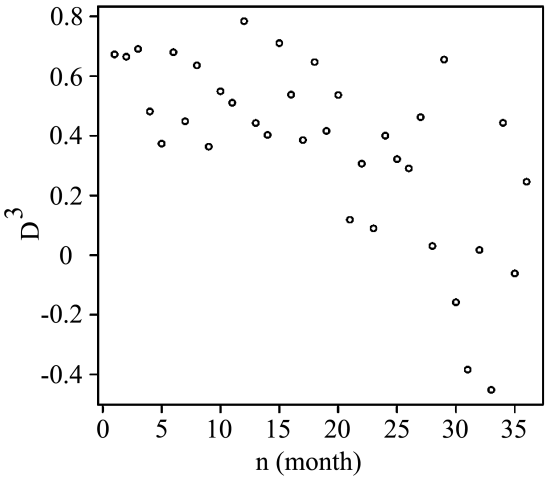

Figure 2: The average D^3 at the n-th (n = 1,2, ... , 36) months of posting. n is 1, when posting starts (means the very first month of posting).

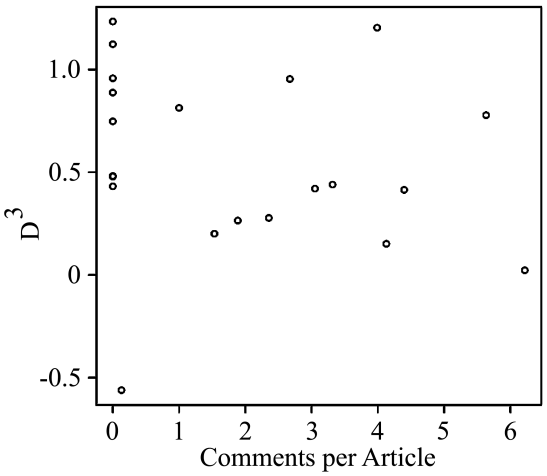

Figure 3: The number of comments per article and the average of D^3.

- Method of Investigation:
  We caluculate Pearson's correlation coefficient between x and y, where x represents the number of total comments given to an author devided by the number of total articles of the same author, and y represents the average D^3 per an author.

As a result of this evaluation, there is not a significant correlation between both variables ($r = -0.18, df = 19, p = 0.44$)(Figure 3). This result shows little relationship between SNS function and the reduction of D^3. Thus, it is hard to consider that receiving comments reduces depressive tendencies.

RQ3: Does the SNS Function Help the Motivation to Continue Posting Articles?: Probably YES

The result of RQ2 shows receiving comments does not directly reduce depressive tendencies, however, it is possibile to assume that the SNS function, which helps the communication of the participants, becomes one of the motivations to continue posting articles. In order to examine such hypothesis, we investigate whether the number of comments given (the SNS function) affects the duration of article posting. The procedures are described below:

- Target Group:
  The 21 authors of the Section of "Materials for Analysis".
- Method of Investigation:
  We caluculate Pearson's correlation coefficient between x and y, where x represents the number of total comments given to an author devided by the number of total articles of the same author, and y represents the duration of article posting per an author.

This result shows a significant correlation between both variables ($r = 0.65, df = 19, p = 0.0013$)(Figure 4). It suggests that SNS function enhances authors' motivations of posting articles. Of course, it is also assumable that continuous posting stimulates readers to send comments. Although this is a chicken-and-egg problem, it is clear that there are some relative relationships between SNS function and the duration of article posting.

Does SNS Posting Soothe the Authors?: Probably YES

From this analysis of FAD blog articles indicates the following 3 points:

- RQ1: Posting FAD articles on a long-term basis may reduce depressive tendencies within the articles.
- RQ2: Getting comments on articles does not directly relate to reducing the depressive tendencies of the articles.
- RQ3: Getting comments on the posted articles may become the motivation to continue posting on a long-term basis.

Our study has proved that with or without getting comments, posting articles may gradually decrease the depressive tendencies. However, the posting should be on a long-term basis to get effectively decreased depressvive tendency level. In short, being an active posting member of SNS on a long-term basis may help soothing the patient.

Conclusion

In this report, we have analyzed blog articles written by patients: written by those who are suffering depression, as well as by those who are not suffering depression. In order to examine such texts, we have proposed D^3, which is an index to measure tendencies of depression of blog articles. To calculate this index, we have proposed a new method: using both keywords and modalities.

With this index, we have analyzed 5,292 articles posted on one of the largest SNS for disease survivors in Japan.

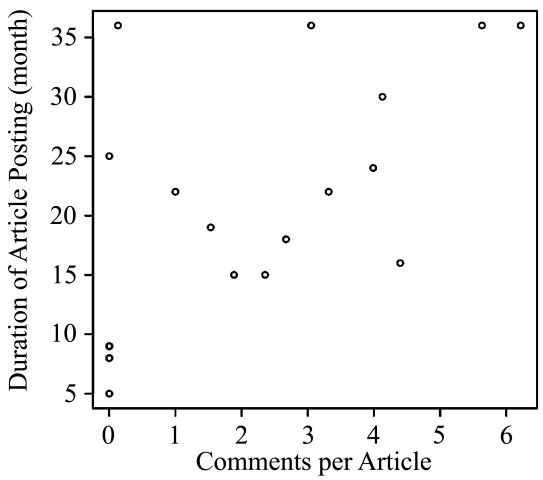

Figure 4: The number of comments per an article and the duration of article posting.

The analysis has displayed that with or without getting comments, posting articles may show the gradual decrease of the depressive tendency within articles, and that suggests the necessity of further research to examine whether the continuous posting of SNS articles on a long-term basis may gently reduce depressive tendencies. At the same time, this research has also shown that getting comments may help the article posting to be continued on a long-term basis. From such observation, it can be concluded that posting articles on SNS on a long-time basis may help patients to soothe their mental hardships.

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