Detecting Behaviour Change in Social Media: Towards Early Depression Detection

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Outline

1. Context
2. Related Work in Depression Detection
3. Our Natural Language Processing Approach
4. Extracted Features
5. Experimental Framework
6. Results
7. Error Analysis
8. Conclusion and Perspectives
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Context

➢ Mental trouble: influence a lot our private life
➢ Psychologic diagnosis of behavior change: time-consuming
➢ Social media platforms: allow people to share their personal experiences, ideas or thoughts in a much more straight way
➢ Automatic methods: develop an assistant automatic system to detect users’ behavior change through social media platforms

Objective: help people to detect their behavior change in social media in order to achieve an early depression detection.
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Related Work in Depression Detection

Supervised learning approaches based on 6 main groups of features:

- **N-grams**: unigram, bigram and trigram [Yang et al., 2015];
- **Relevant Lexicons**: depression symptoms, lexicon of drug names etc. (wikipedia);
- **Linguistic Style**: frequency of negative word, quantifiers, quantity of first personal pronoun, quantity of emoticons, numbers of exclamation and question marks etc. [Coppersmith et al., 2014];
- **Users Behaviors**: number of words/posts, proportion of reply posts from a user per day etc., user’s active period or posting time span [Choudhury, 2016];
- **Sentiment analysis**: sentence polarity, sentiment words - positive and negative sentiment [Mowery et al., 2016];
- **Emotion analysis**: categories of emotions - emotional degree [Choudhury, 2016].
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Our Natural Language Processing Approach

Users’ writing (posts and comments) → Features Extraction → Preprocess

Train → Test → Machine Learning → Model → Application

Feature Selection → Evaluation
Text Sample 1

Text examples of depressive and non-depressive users: use of first personal nouns

Depressive user comment:
“*I'm* struggling right now with all *my* relationships. *I* just broke up with *my* girl because *my* heart wasn't in it and it was the right thing to do [...]. The problem is *I* underestimated the friendship *I* had with *my* gf. It wasn't perfect but at least *I* had someone who was obligated to put *me* before everyone else. At least *I* had someone to vent to. Now that *I'm* single and depressed nobody is around. *I* have friends, but *I* always feel like *I'm* bothering them and they all have other priorities whether it's kids or a significant other. So this leaves *me* by myself. Who am *I* supposed to talk to? *I* feel like nobody understands *me*.”

Non-Depressive user comment:
"Because it was my First kitchen job and *I* didn't know any better. *I* was the KM/Cook of a Mom Pop Pizza shop. The owner was a cool guy who *I* got along with to an extent and *I* pretty much had full control over the place since he was barely around. Well he would hire in these teeny bopper girls to run the counter, and started to notice why he would hire in these girls is so he could try to get a piece of jailbait ass. In the long run the business started to take on water fast. We ended up losing our contract with pepsi because the bill wasn't getting paid on top of them being unable to deliver."
Repartition of 5 First Personal Pronouns

Blue: positive (depressive); Red: negative (non-depressive)
Yeah I completely relate with that. **I hate myself**, I think I'm horrible at everything, and the world would be a better place without me but people are constantly telling me how confident I am. Even when I tell people I'm terrified of anything and everything, they don't really seem to believe me.

I already *had* the best time of my life, and now he's gone, it's said and done. I tried to kill myself (and failed, obviously) just to escape the inevitable downward spiral. Now, I'm just a girl with “psychotic depression” and an extremely pessimistic attitude. The pills? Make me feel like a zombie. I'm empty inside and I just **want to die**.
Repartition of 25 Specific 3-Grams and 5-Grams

Blue: positive (depressive); Red: negative (non-depressive)
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5 Main Groups of Extracted Features

➢ **Bag of Words**: 18 unigrams as our baseline
➢ **Group 1**: Language Style
➢ **Group 2**: Self-Preoccupation
➢ **Group 3**: Reminiscence and Relevant Words
➢ **Group 4**: Sentiment and Emotion
**Extracted Features (Our Baseline)**

**Bag of Words:** 18 most relevant unigrams extracted from positive users’ texts that are used as our baseline.

<table>
<thead>
<tr>
<th>im</th>
<th>feel</th>
</tr>
</thead>
<tbody>
<tr>
<td>like</td>
<td>going</td>
</tr>
<tr>
<td>dont</td>
<td>something</td>
</tr>
<tr>
<td>people</td>
<td>someone</td>
</tr>
<tr>
<td>know</td>
<td>day</td>
</tr>
<tr>
<td>time</td>
<td>things</td>
</tr>
<tr>
<td>ive</td>
<td>life</td>
</tr>
<tr>
<td>even</td>
<td>though</td>
</tr>
<tr>
<td>much</td>
<td>help</td>
</tr>
</tbody>
</table>
# Extracted Features (Group 1: Language Style)

<table>
<thead>
<tr>
<th>13 Features</th>
<th>Capital Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjective Frequency [Choudhury, 2016]</td>
<td>Average Comment Number [Hall, 2012]</td>
</tr>
<tr>
<td>Verb Frequency [Choudhury, 2016]</td>
<td>Number of Words in Comment</td>
</tr>
<tr>
<td>Noun Frequency [Choudhury, 2016]</td>
<td>Average Post Number [Hall, 2012]</td>
</tr>
<tr>
<td>Negation Frequency</td>
<td>Number of Words in a Post [Hall, 2012]</td>
</tr>
<tr>
<td>Punctuation Frequency</td>
<td></td>
</tr>
<tr>
<td>Emoticon Frequency [Karoui, 2017]</td>
<td></td>
</tr>
</tbody>
</table>
Extracted Features (Group 2: Self-Preoccupation)

9 Features

- 6 features: Frequency of “my”, “I”, “Myself”, “mine”, “I’m”, “me” [Rude, 2004]
- 1 feature: Frequency of Personal Pronouns [Wang et al., 2015]
- 1 feature: “i” Frequency in Subjective Context (“i”+verb+adjective)
- 1 feature: Quantifiers('everything','everyone','anyone','nothing'...) [Danielle, 2016]

Example of « “i” frequency in subjective context »

- "I’m not fat"
- "I’m a bit stuck"
- I’m also nervous
- I’m afraid

Using a syntax grammar

- (“I”, “fat”)
- (“I”, “stuck”)
- (“I”, “nervous”)
- (“I”, “afraid”)
## Extracted Features (Group 3: Reminiscence/Relevant Words)

<table>
<thead>
<tr>
<th>Reference to Past (5 Features) [Danielle, 2016]</th>
<th>Relevant Words (5 Features)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Past Frequency</td>
<td>Drug Symptom Frequency [list from Wikipédia]</td>
</tr>
<tr>
<td>Past Tense Frequency</td>
<td>Sleepy Words Frequency (&quot;depress&quot;, &quot;sad&quot;, &quot;sleep&quot;)</td>
</tr>
<tr>
<td>Past Words Frequency</td>
<td>Frequency of “depress”</td>
</tr>
<tr>
<td>“was” “were” Frequency</td>
<td>5-grams (list of “5-grams” from [Colombo, 2015])</td>
</tr>
<tr>
<td>Ratio of Posting Time in Deep Night (00 pm-7 am)</td>
<td>3-grams (list of “3-grams” from [Colombo, 2015])</td>
</tr>
</tbody>
</table>

**Past words:** "yesterday", "ago", "past", "back", "earlier", "later", "nostalgia"...
## Extracted Features (Group 4: Sentiment / Emotion)

### 4 Features by Using Saif Mahammad’s Lexicon

<table>
<thead>
<tr>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Sentiment</td>
</tr>
<tr>
<td>Negative Sentiment</td>
</tr>
<tr>
<td>Depressive Emotion</td>
</tr>
</tbody>
</table>

### 8 emotions: anger, fear, anticipation, trust, surprise, sadness, joy, and disgust
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Experimental Framework: eRisk Data and Weka

eRisk 2017 (Early risk prediction): It is a competition for early risk prediction of depression from data extracted from Reddit, an American social news aggregation, web content rating, and discussion website.


**WEKA**: a machine learning software specializing in data preprocessing, clustering, classification, regression, visualization, and feature selection.
Experimental Framework: Data Overview

Training Data
- 403 Negative User (non-depressive)
- 83 Positive User (depressive)

Test Data
- 349 Negative User (non-depressive)
- 52 Positive User (depressive)

eRisk Data
Experimental Framework: Description of Data

- Data format: XML (one XML file refers to one user, the comments and posts of this user are contained in the same file)

Example of comment:

```
<ID>train_subject96</ID>
<WRITING>
  <TITLE> </TITLE>
  <DATE> 2015-06-13 22:35:52 </DATE>
  <INFO> reddit post </INFO>
  <TEXT> To be fair, it is pretty subjective. </TEXT>
</WRITING>
```

Example of post:

```
<WRITING>
  <TITLE> My face when I break my 2-year dry spell </TITLE>
  <DATE> 2014-10-07 04:03:51 </DATE>
  <INFO> reddit post </INFO>
  <TEXT> </TEXT>
</WRITING>
```
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Results

Model 1: Baseline + Group 1: Language Style;
Model 2: Features of Model 1 + Group 2: Self-Preoccupation;
Model 3: Features of Model 2 + Group 3: Reminiscence and Relevant Words;
Model 4: Features of Model 3 + Group 4: Sentiment and Emotion.
Results with Feature Selection

Feature Selection Evaluator: ChiSquaredAttributeEval in WEKA (45 features are selected)
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Error Analysis (Negative Wrongly Classified as Positive)

Compare the values of 6 first personal pronouns features
Error Analysis (Positive Wrongly Classified as Negative)

Compare the values of 4 features for the wrongly classified user.

- Red: positive (depressive) user wrong classified as negative user
- Green: mean value for all the positive (depressive) user
- Blue: mean value for all the negative (non-depressive) user
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Conclusion and Perspectives

➢ **Conclusion:** after feature selection (with 45 features), the best results are achieved with Random Forest. It can detect the depressive users with a precision of **80.6%**, a recall of **55.8%**, and an accuracy of **92.5%**.

➢ **Perspectives:**
  - Sentiment and emotion features to be improved (more specific lexicon);
  - Reconsider the temporal indicator (season par ex.);
  - LDA topics to be considered in the future.
Thank You