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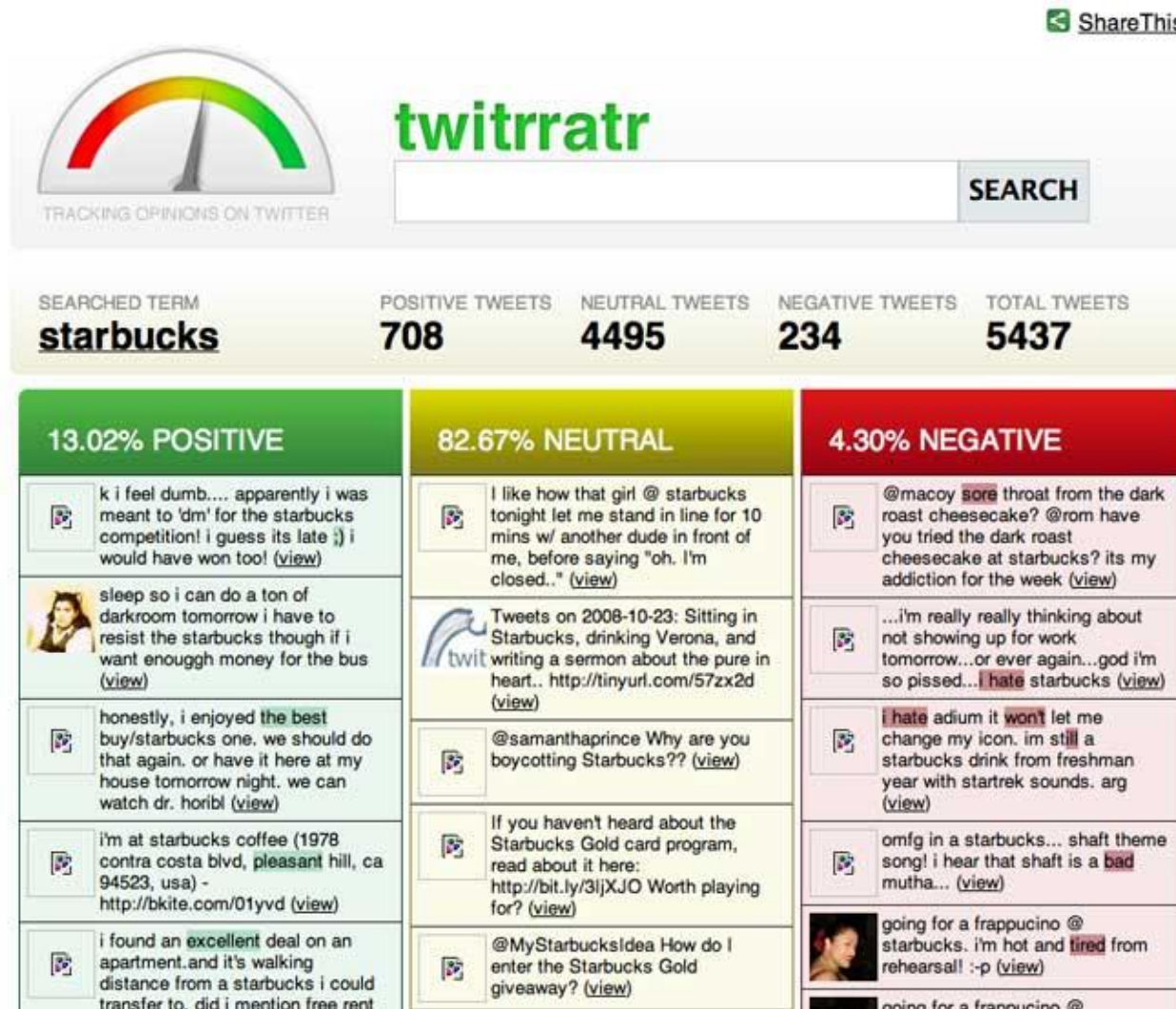
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MIE1624H – Introduction to Data Science and Analytics

Assignment 2 – Natural Language Processing of Tweets

Text analytics and sentiment analysis



Sentiment analysis of tweets

Natural Language Processing: features and target variable in sentiment analysis

examples (news articles)

All bears are lovely
Our tea was bad
That bear drinks with bear
The bear drinks tea
We love bears

features (words)

target

bear tea love bad drink

sentim

56%

-35%

-5%

4%

63%

x_1

x_2

x_3

x_4

x_5

y

Stop words that were removed:

- ☐ all
- ☐ are, was
- ☐ our
- ☐ that
- ☐ with
- ☐ the

Natural Language Processing: 'bag of words' based on Word Frequency (WF) and sentiment analysis

examples (news articles)

All bears are lovely
Our tea was bad
That bear drinks with bear
The bear drinks tea
We love bears

features (WF)					target
bear	tea	love	bad	drink	sentim
1	0	1	0	0	56%
0	1	0	1	0	-35%
2	0	0	0	1	-5%
1	1	0	0	1	4%
1	0	1	0	0	63%
bag of words					y
x_1	x_2	x_3	x_4	x_5	

Supervised machine learning algorithm:

- ☐ Linear regression
- ☐ Decision trees
- ☐ SVM regression
- ☐ k-NN regression
- ☐ Ensembles (random forests, XGBoost)
- ☐ Artificial neural nets (deep learning)

$$y = f_{\theta}(x) = f_{\theta}(x_1, \dots, x_5)$$

$$y = \theta_0 + \theta_1 \cdot x_1 + \theta_2 \cdot x_2 + \dots + \theta_5 \cdot x_5 + \epsilon$$

Natural Language Processing: Term Frequency (TF) and sentiment analysis

examples (news articles)

$$\text{TF} = \frac{\text{Word Frequency}}{\text{number of words in document}}$$

All bears are lovely
Our tea was bad
That bear drinks with bear
The bear drinks tea
We love bears

features (TF)

target

bear	tea	love	bad	drink	sentim
1/2	0	1/2	0	0	56%
0	1/2	0	1/2	0	-35%
2/3	0	0	0	1/3	-5%
1/3	1/3	0	0	1/3	4%
1/2	0	1/2	0	0	63%
x_1	x_2	x_3	x_4	x_5	y

Supervised machine learning algorithm:

- ☐ Linear regression
- ☐ Decision trees
- ☐ SVM regression
- ☐ k-NN regression
- ☐ Ensembles (random forests, XGBoost)
- ☐ Artificial neural nets (deep learning)

$$y = f_{\theta}(x) = f_{\theta}(x_1, \dots, x_5)$$

$$y = \theta_0 + \theta_1 \cdot x_1 + \theta_2 \cdot x_2 + \dots + \theta_5 \cdot x_5 + \epsilon$$

Natural Language Processing: TF-IDF and sentiment analysis

TF-IDF is short for “term frequency–inverse document frequency”

$$\text{tf-idf}(t, d, D) = \text{tf}(t, d) \cdot \text{idf}(t, D)$$

where **tf** is “term frequency” and **idf** is “inverse document frequency”.

$$\text{tf}(t) = \frac{\text{word } t \text{ frequency}}{\text{number of words in document}}$$

$$\text{idf}(t) = \log \frac{\text{total number of documents}}{\text{number of documents with term } t \text{ in it}} = \log \frac{N}{|\{d \in D : t \in d\}|}$$

with

- N : total number of documents in the corpus $N = |D|$
- $|\{d \in D : t \in d\}|$: number of documents where the term t appears (i.e., $\text{tf}(t, d) \neq 0$).

There are a number of variants for **tf** and **idf** weights.

For the example in next page, we use word frequency as term frequency and the following equation to calculate **idf**. This is also the default of **TfidfVectorizer** in Python.

$$\text{idf}(d, t) = \log \left[\frac{1 + N}{1 + \text{df}(d, t)} \right] + 1$$

Natural Language Processing: TF-IDF and sentiment analysis

examples (news articles)

All bears are lovely
Our tea was bad
That bear drinks with bear
The bear drinks tea
We love bears

features (TF-IDF)					target
bear	tea	love	bad	drink	sentim
1.2	0	1.7	0	0	56%
0	1.7	0	2.1	0	-35%
2.4	0	0	0	1.7	-5%
1.2	1.7	0	0	1.7	4%
1.2	0	1.7	0	0	63%
x_1	x_2	x_3	x_4	x_5	y

Supervised machine learning algorithm:

- ☐ Linear regression
- ☐ Decision trees
- ☐ SVM regression
- ☐ k-NN regression
- ☐ Ensembles (random forests, XGBoost)
- ☐ Artificial neural nets (deep learning)

$$y = f_{\theta}(x) = f_{\theta}(x_1, \dots, x_5)$$

$$y = \theta_0 + \theta_1 \cdot x_1 + \theta_2 \cdot x_2 + \dots + \theta_5 \cdot x_5 + \epsilon$$

Natural Language Processing: word embeddings and sentiment analysis

examples (news articles)

All bears are lovely
Our tea was bad
That bear drinks with bear
The bear drinks tea
We love bears

features vector (word embedding)

[2.31	1.09	-1.7	...	1.08]
[-3.2	1.72	1.56	...	-1.78]
[2.66	4.09	-1.04	...	2.92]
[-1.82	8.88	1.45	...	2.75]
[2.31	1.1	-1.71	...	1.08]

target

sentim

56%

-35%

-5%

4%

63%

x_1

x_2

...

x_n

y

Supervised machine learning algorithm:

- ☐ Linear regression
- ☐ Decision trees
- ☐ SVM regression
- ☐ k-NN regression
- ☐ Ensembles (random forests, XGBoost)
- ☐ Artificial neural nets (deep learning)

$$y = f_{\theta}(x) = f_{\theta}(x_1, \dots, x_n)$$

More reading material about word embedding:
<https://towardsdatascience.com/word-embeddings-exploration-explanation-and-exploitation-with-code-in-python-5dac99d5d795>

Natural Language Processing: word frequency (Word Cloud)

Word Cloud about Toyota

