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Sentiment Analysis

Message Polarity Classification

Task 4A from SemEval-2017: Sentiment Analysis in Twitter

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HOST INSTITUTION

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CRT·AI SFI Centre for Research Training in Artificial Intelligence

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Overview

1. Task description
2. Related work
3. Data description and EDA
4. Challenges
5. Pre-processing
6. Implementation
7. Results

Task Description

Given a tweet, decide whether it expresses a POSITIVE, NEGATIVE or NEUTRAL sentiment

Sentiment Analysis

Sentiment

- Expression of emotions
- Mental attitudes or thoughts
- Social dimension
- Highly organized

Emotion

- Complex psychological states
- Psychological dimension
- Raw and natural

Levels

- Document
- Sentence (more fine-grained)
- Phrase/Word

Related Work

Pioneers

- **1999**: Subjective/objective sentences [Wiebe, Bruce, & O'Hara]
- **2002**: Classification of reviews using SVM and Naive Bayes [Pang, Turney]

Modern solutions

- **2017:** SVM [Liu], Naive Bayes, decision trees(ID3) [Phu]
- **2017**: CNN/RNN/LSTM with Attention [Baziotis, Pelekis & Doulkeridis]
- **2020**: Pre-trained models such as BERT [Devlin]

Other approaches

- **2013:** Association rule mining (lexicon of relationships between words) [Yuan]
- **2017:** Genetic algorithms (Lexicon optimisation) [Keshavarz]

Dataset Description

Twitter Dataset

Tweets are annotated for sentiment on a 3-point scale:

`POSITIVE`, `NEGATIVE` and `NEUTRAL`

637342059519680513	negative	Still bitter that they didn't tweet about MetL...
637691185100947456	positive	I remember buying my tickets to rowyso last ye...
637874723288936448	positive	@zourrysscheese hershey for tmh, on americas g...
638382158420307968	neutral	@uglyuni my mom already bought tickets and the...
6385339933448642 56	positive	Schreier Financial Services in Orange City wil...

Dataset containing tweet id, sentiment and text.

Twitter Dataset

- Collection and Preparation:
  - Tweets from 2013-2017 [Nakov et al., 2013; Rosenthal et al., 2015; Nakov et al., 2016; Rosenthal et al., 2017]
  - Express sentiment about popular topics of the time
  - Techniques used:
    - Twitter-tuned NER system
    - Bag-of words
    - Manually filtering
    - SentiWordNet

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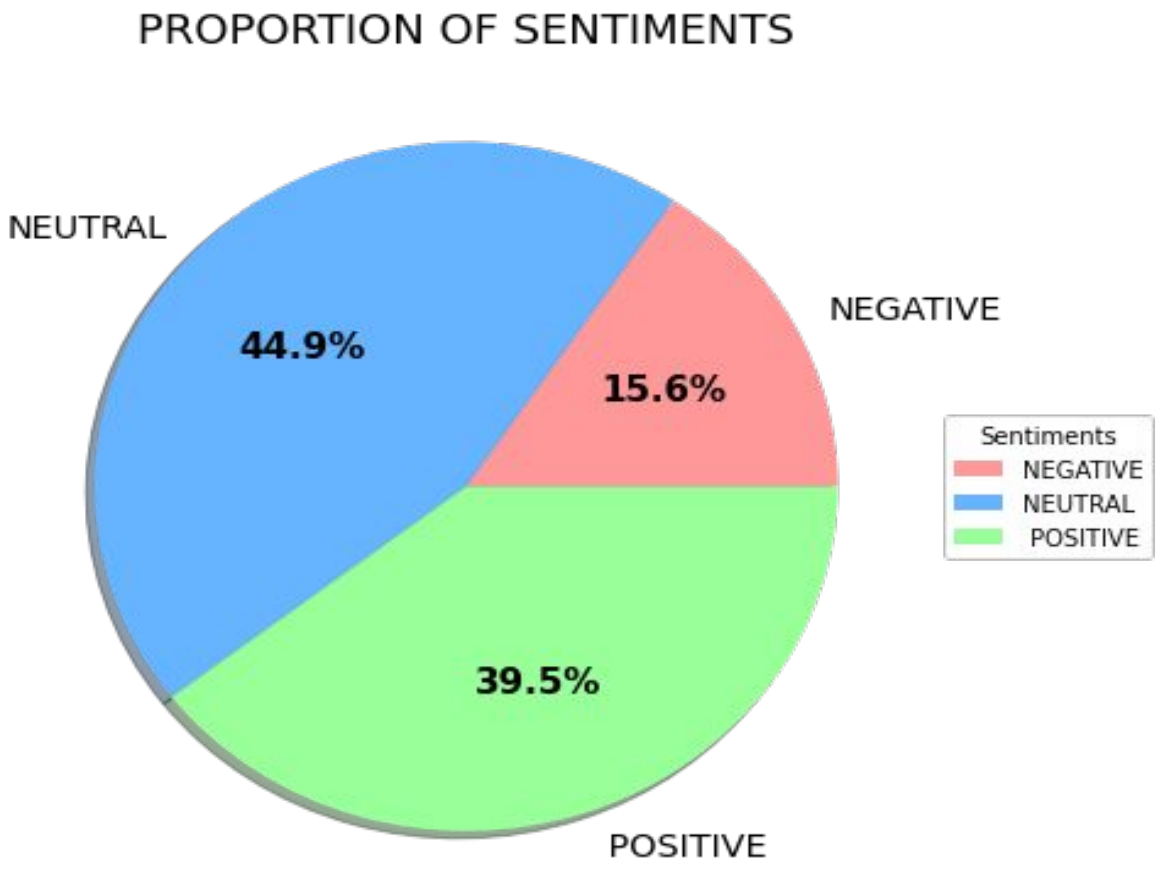
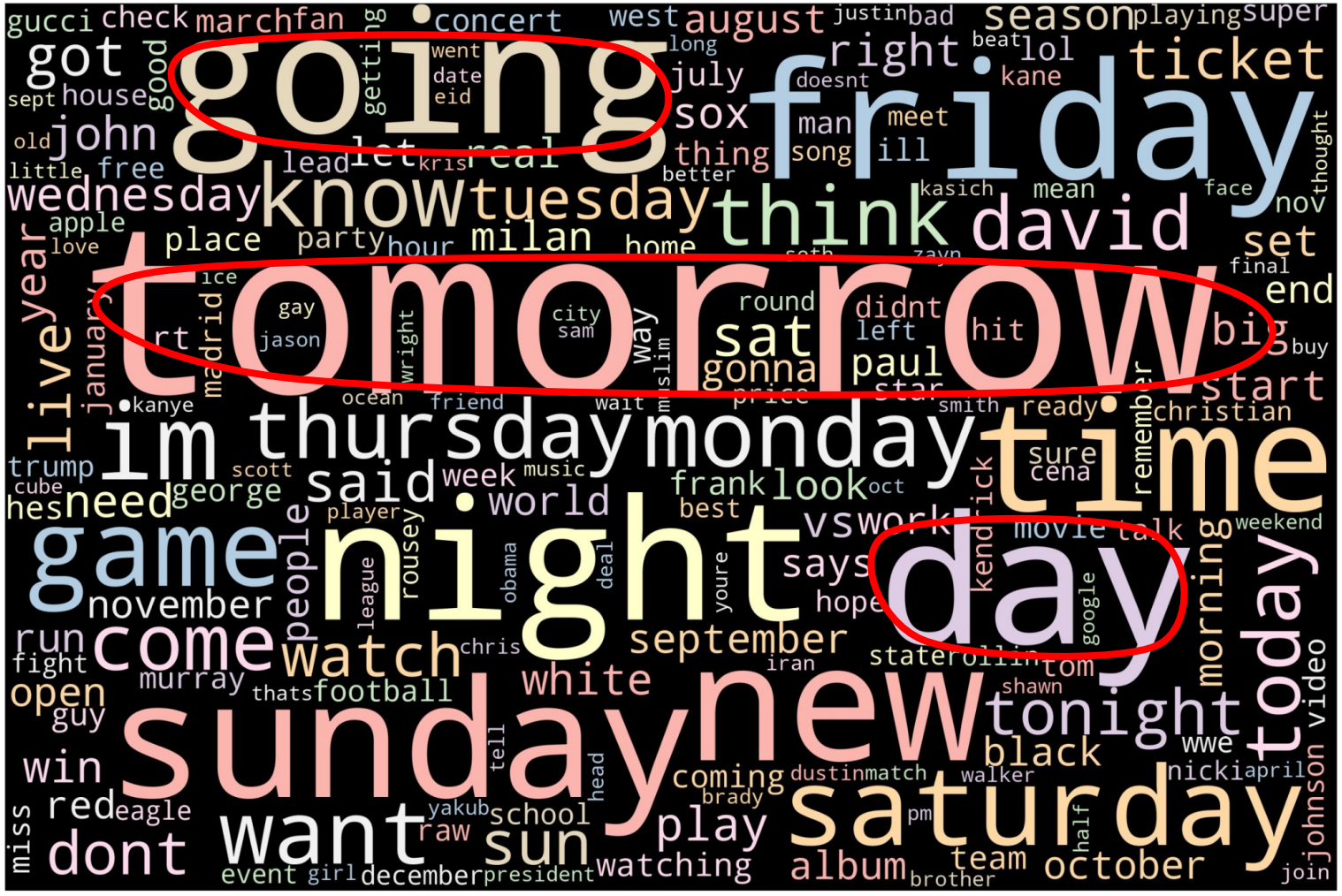
Exploratory Data Analysis

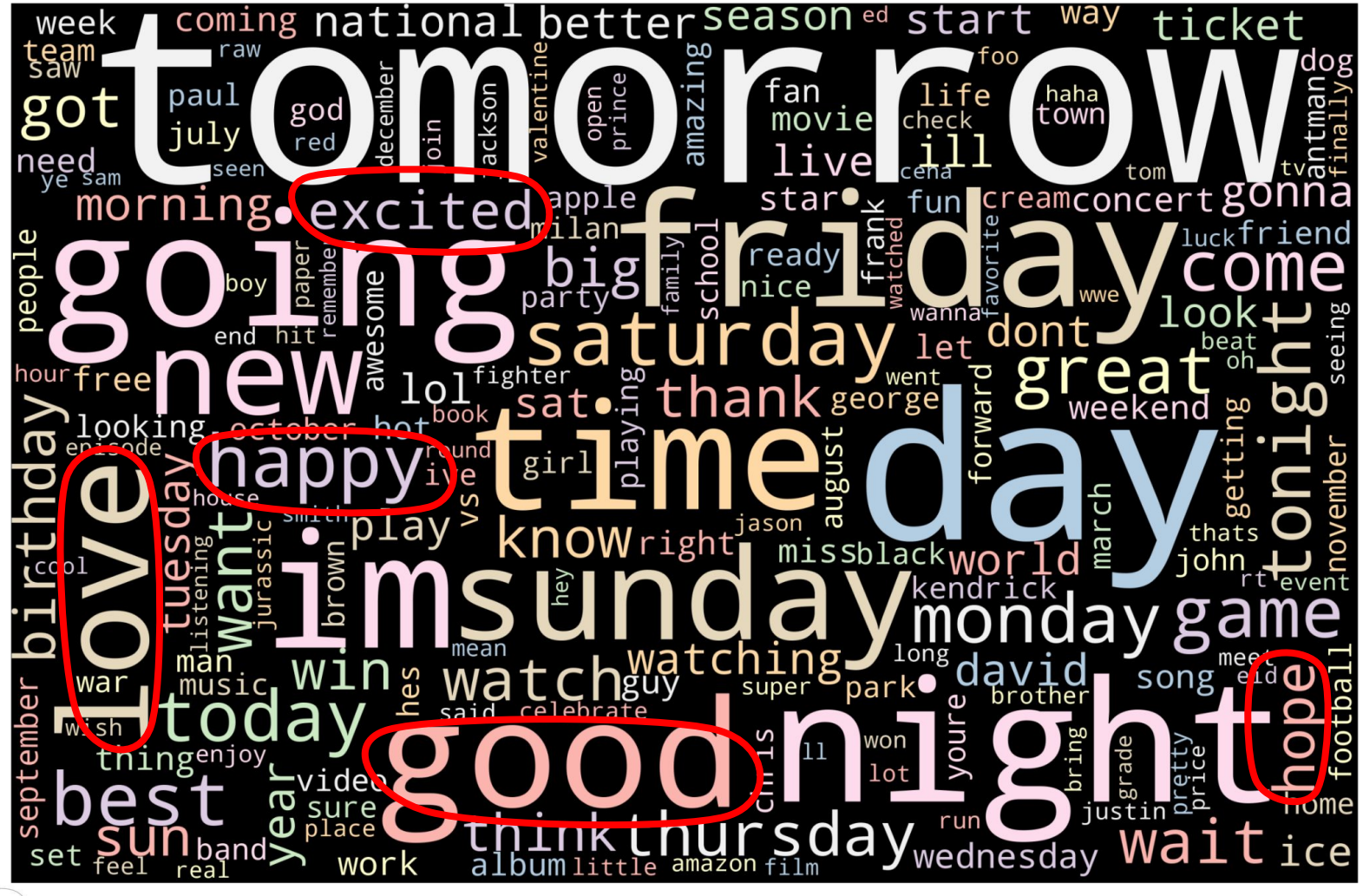
Sentiment Classes



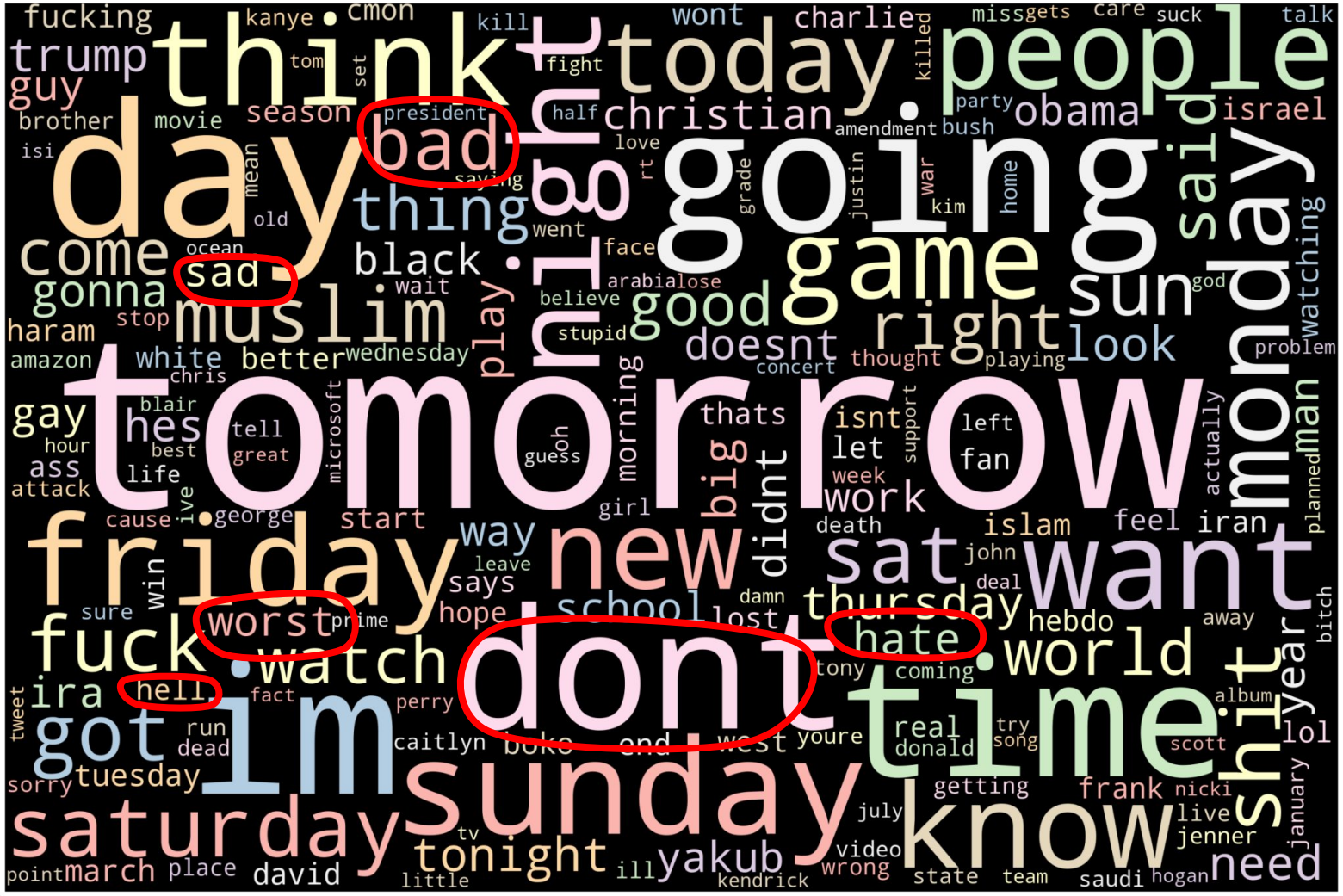
Neutral Tweets



Positive Tweets



Negative Tweets



Challenges in Tweet Classification

Misspelling

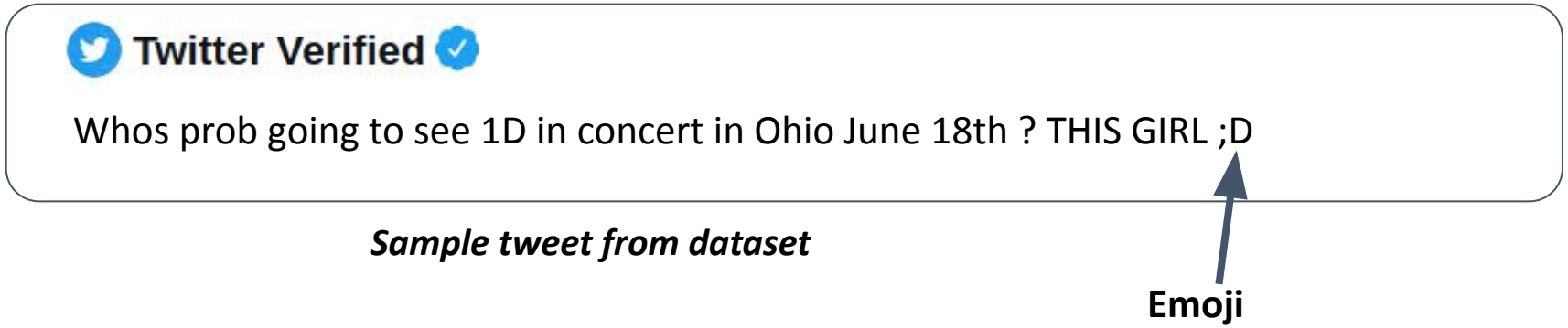
- Words found within tweets may not be in a lexicon

Sample tweet from dataset

Misspelled word

Emoji

- Emoji can provide further information about the tweet



Sample tweet from dataset

Slang

- Words and phrases that are regarded informal

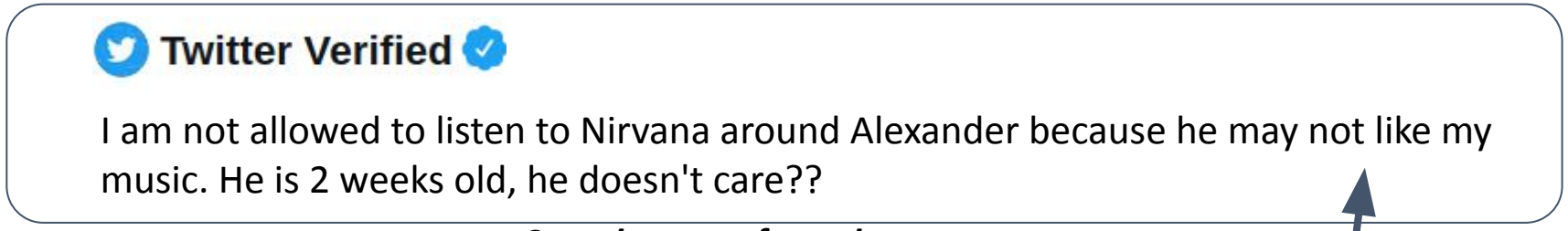
Sample tweet from dataset

Context

- Hashtags, replies and images often give more context about the tweet

Negation

- Positive words but negative sentence

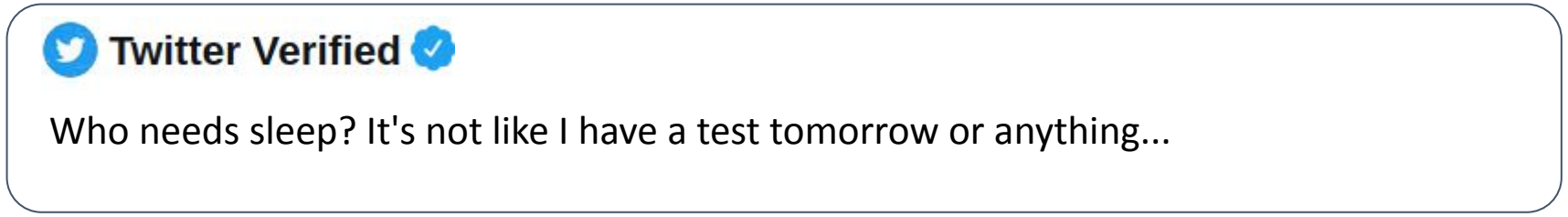


Sample tweet from dataset

Negation

Sarcasm

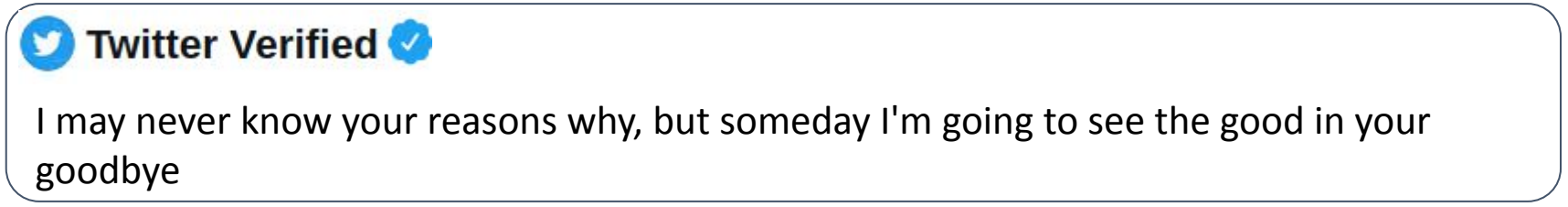
- Problem of determining if the actual meaning of a word is intended in a given tweet



Sample tweet from dataset

Implicit statement

- Neutral words used but implied statement



Sample tweet from dataset

Ambiguity

- Same words used with different sentiment

Sample tweets from dataset

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Implementation

Pre-processing Steps

- Misspelling:
  - Removing character repetition of length > *n* (`nltk.TweetTokenizer`)
- Emoji:

```
>>> emoji.demojize('Python is 👍')
'Python is :thumbs_up:'
```

- Slang:
  - Treat as it is!
- Hashtags:
  - Make sure to keep them

Techniques for Sentiment Analysis

- Rule-based Methods
  - Textblob - `PatternAnalyzer`
  - VADER: **V**alence **A**ware **D**ictionary for s**E**ntiment **R**easoning
- Probabilistic Methods
  - Naive Bayes Classifier using n-gram Features
- Deep Learning
  - BERT/BERTweet

Rule-based Methods

- Textblob - `PatternAnalyzer`
  - Uses a Subjectivity Lexicon for Adjectives

```
<word
    form="happy"
    cornetto_synset_id="d_a-9297"
    wordnet_id="a-01148283"
    pos="JJ"
    sense="enjoying or showing or marked by joy or pleasure"
    polarity="0.8"
    subjectivity="1.0"
    intensity="1.0"
    confidence="0.8"
/>
```

```
<word
    form="unhappy"
    cornetto_synset_id="n_a-521094"
    wordnet_id="a-01149494"
    pos="JJ"
    sense="experiencing or marked by or causing sadness or sorrow or discontent"
    polarity="-0.6"
    subjectivity="0.9"
    intensity="1.0"
    confidence="0.8"
/>
```

[https://github.com/clips/pattern/blob/master/pattern/text/en/en-sentiment.xml]

Rule-based Methods

- Textblob - `PatternAnalyzer`
  - Polarity (negative/positive, `-1.0` to `+1.0`)
  - Subjectivity (objective/subjective, `+0.0` to `+1.0`)
  - Words are tagged per sense:

```
<word
    form="ridiculous"
    wordnet_id="a-00752847"
    pos="JJ"
    sense="inspiring scornful pity"
    polarity="-1.0"
    subjectivity="1.0"
    intensity="1.0"
    confidence="0.9"
/>
```

```
<word
    form="ridiculous"
    wordnet_id="a-01266397"
    pos="JJ"
    sense="broadly or extravagantly humorous"
    polarity="1.0"
    subjectivity="1.0"
    intensity="1.0"
    confidence="0.9"
/>
```

Rule-based Methods

- VADER: **V**alence **A**ware **D**ictionary for s**E**ntiment **R**easoning [Hutton and Gilbert, 2014]
  - A Parsimonious Rule-based Model for Sentiment Analysis
  - Handle contractions and negations (e.g., “wasn’t very good”)
  - Punctuation to signal increased intensity (e.g., “Good!!!”)
  - Use of word-shape to signal emphasis (e.g., ALL CAPS)
  - Degree modifiers (e.g., “very”, “kind of”)
  - Slang words (e.g., “kinda”, “uber”)
  - Emoticons and UTF-8 emoji (e.g., 💘 and 😁)
  - Acronyms (e.g., “lol”)

Probabilistic Methods

- Naive Bayes Classifier
- Bayes Rule to estimate the probability of a label

$$P(\text{label}|\text{features}) = \frac{P(\text{label}) * P(\text{features}|\text{label})}{P(\text{features})}$$

- n-grams as features
- Assumption: Features are independent

[https://www.nltk.org/_modules/nltk/classify/naivebayes.html]

Most Important n-gram Features

Deep Learning

- BERT: **B**idirectional **E**ncoder **R**epresentations from **T**ransformers [Devlin et al., 2019]
- BERTweet [Nguyen et al., 2020]
  - Contextualised embeddings for tweets
  - Trained using RoBERTa procedure [Liu et al., 2019]
  - 845M Tweets; 80GB of uncompressed texts
  - 5M tweets related to COVID19 (January to March 2020)
- Tokenization
  - https://crt-ai.ie → `<HTTPURL>`
  - @somebody → `@USER`
  - 😡 → “angry”

Evaluation

- 3 Official Metrics
  - Average Recall
  - Macro-average F1
  - Accuracy

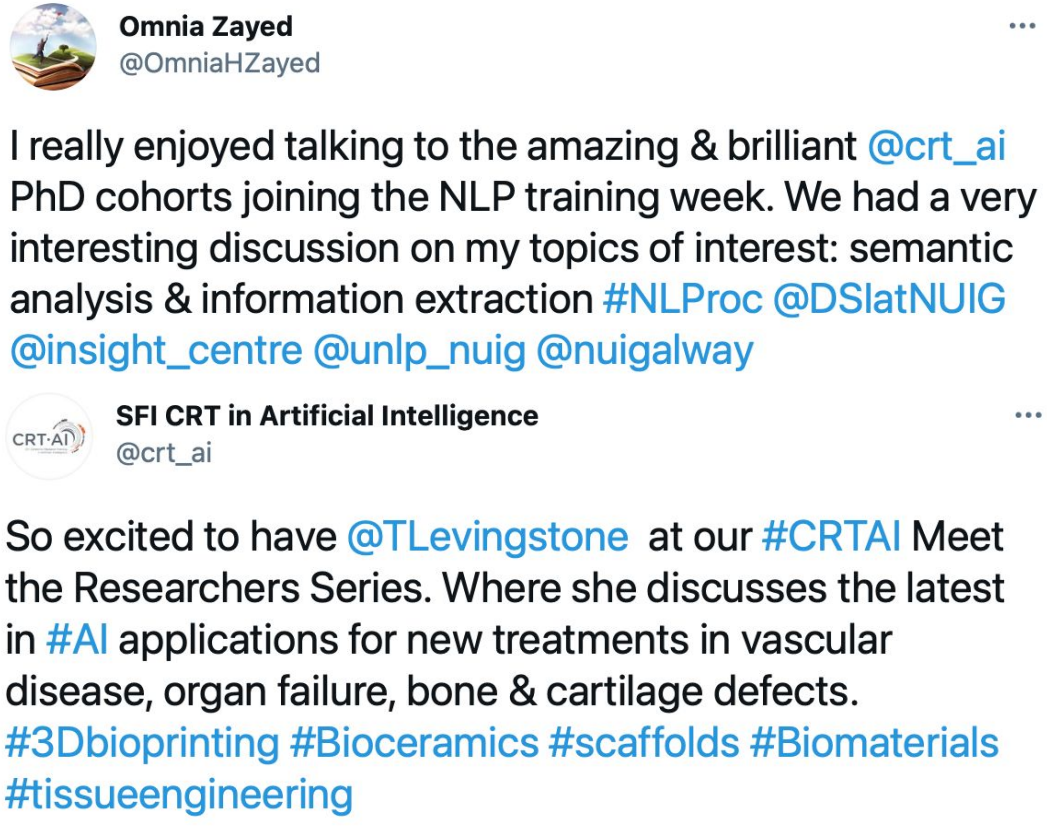
$$AvgRec = \frac{1}{3}(R^P + R^N + R^U) \qquad F_1^{PN} = \frac{1}{2}(F_1^P + F_1^N)$$

Results

System	Average Recall	Macro-average F1	Accuracy
LSTM+CNN ensemble†	0.681	0.677	0.651
Textblob	0.490	0.414	0.487
VADER	0.570	0.528	0.530
Naive Bayes	0.562	0.554	0.537
BERTweet	0.724	0.720	0.708

† Best performing system at SemEval 2017

Examples



	VADER	Textblob	Naive Bayes	BERT
I really enjoyed talking to the amazing & brilliant @crt_ai PhD cohorts joining the NLP training week. We had a very interesting discussion on my topics of interest: semantic analysis & information extraction #NLProc @DSIatNUIG @insight_centre @unlp_nuig @nuigalway	✅	✅	✅	✅
So excited to have @TLevingstone at our #CRTAI Meet the Researchers Series. Where she discusses the latest in #AI applications for new treatments in vascular disease, organ failure, bone & cartilage defects. #3Dbioprinting #Bioceramics #scaffolds #Biomaterials #tissueengineering	❌	✅	✅	✅

✅ Correct classification
❌ Incorrect classification

Examples

	VADER	Textblob	Naive Bayes	BERT
 **Omnia Zayed** @OmniaHZayed ··· I really enjoyed talking to the amazing & brilliant @crt_ai PhD cohorts joining the NLP training week. We had a very interesting discussion on my topics of interest: semantic analysis & information extraction #NLProc @DSIatNUIG @insight_centre @unlp_nuig @nuigalway	✅	✅	✅	✅
SFI CRT in Artificial Intelligence @crt_ai ··· So excited to have @TLevingstone at our #CRTAI Meet the Researchers Series. Where she discusses the latest in #AI applications for new treatments in vascular disease, organ failure, bone & cartilage defects. #3Dbioprinting #Bioceramics #scaffolds #Biomaterials #tissueengineering	❌	✅	✅	✅

✅ Correct classification
❌ Incorrect classification

Examples

	VADER	Textblob	Naive Bayes	BERT
Sarcasm	❌	❌	✅	❌
Negation	✅	✅	❌	✅

✅ Correct classification
❌ Incorrect classification

Conclusion

- Approaches for Sentiment Analysis
  - Rule-based and Lexicon-based Methods
  - Probabilistic Methods
  - Deep Learning
- More sophisticated models proved to be more accurate
- Always check your domain

Thank you for your attention

Code : https://github.com/pasricha/crt-nlp-week

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