Tackling fairness, change and polysemy in word embeddings

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RELELA
Representations for
Learning and Language

Word Vectors

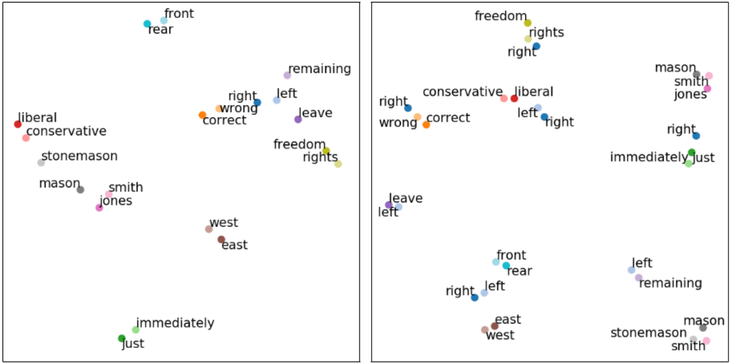
- A major component in neural networks for language is the use of an embedding layer.
- A mapping of discrete symbols to continuous vectors.
- When embedding words, they transform from being isolated distinct symbols into mathematical objects that can be operated on.
- Distance between vectors can be equated to distance between words.
- This makes easier to generalize the behavior from one word to another.

Distributional Vectors

- **Distributional Hypothesis**: words occurring in the same **contexts** tend to have similar meanings.
- Or equivalently: “a word is characterized by the **company** it keeps”.
- In this talk we summarize our research addressing three limitations of static word embeddings: 1) fairness, 2) semantic change, and 3) polysemy.

PolyLM: a polysemous language model

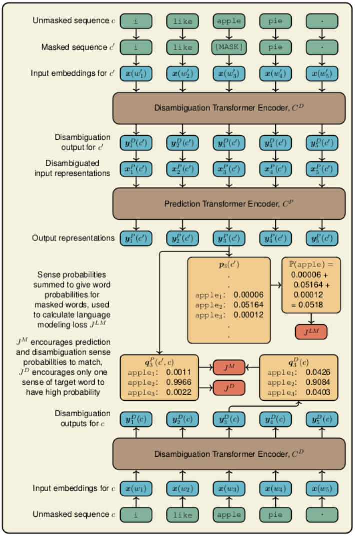
- A language model capable of automatically learning multiple meanings of a word (e.g. apple:apple, apple:company) [Ansell et al., 2021].



(a) Word embeddings

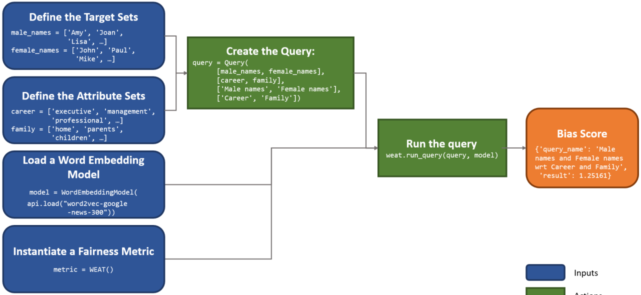
(b) Sense embeddings

PolyLM: a polysemous language model



WEFE: The Word Embeddings Fairness Evaluation Framework

- The Word Embeddings Fairness Evaluation (WEFE) is a framework for measuring and mitigating bias in word embeddings (e.g. man is to programmer as woman is to housewife). [Badilla et al., 2020].



Define the Target Sets

```
male_names = ['Amy', 'Joan',
              'Lisa', …]
female_names = ['John', 'Paul',
                'Mike', …]
```

Define the Attribute Sets

```
career = ['executive', 'management',
          'professional', …]
family = ['home', 'parents',
          'children', …]
```

Load a Word Embedding Model

```
model = WordEmbeddingModel(
api.load("word2vec-google
          -news-300"))
```

Instantiate a Fairness Metric

```
metric = WEAT()
```

Create the Query:

```
query = Query(
      [male_names, female_names],
      [career, family],
      ['Male names', 'Female names'],
      ['Career', 'Family'])
```

Run the query

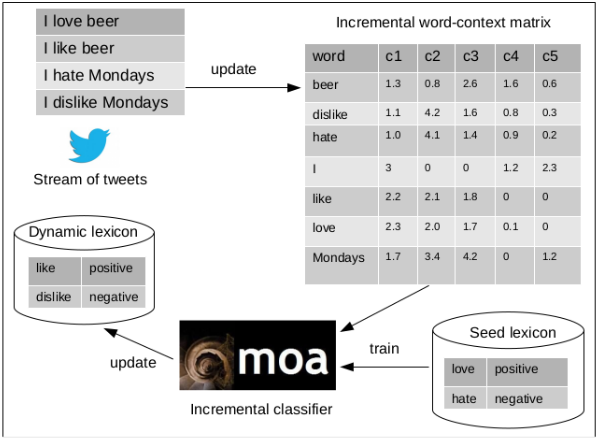
```
weat.run_query(query, model)
```

Bias Score

```
{'query_name': 'Male
names and Female names
wrt Career and Family',
 'result': 1.25161}
```

Incremental Word Vectors

- An algorithm capable of continuously learning word vectors and thus understanding how the meaning evolves over time (e.g., monitoring the word “estallido” in social networks during the Chilean social unrest). [Bravo-Marquez et al., 2021].



I love beer
I like beer
I hate Mondays
I dislike Mondays

Stream of tweets

update

Incremental word-context matrix

word	c1	c2	c3	c4	c5
beer	1.3	0.8	2.6	1.6	0.6
dislike	1.1	4.2	1.6	0.8	0.3
hate	1.0	4.1	1.4	0.9	0.2
I	3	0	0	1.2	2.3
like	2.2	2.1	1.8	0	0
love	2.3	2.0	1.7	0.1	0
Mondays	1.7	3.4	4.2	0	1.2

Dynamic lexicon

like	positive
dislike	negative

update

Incremental classifier

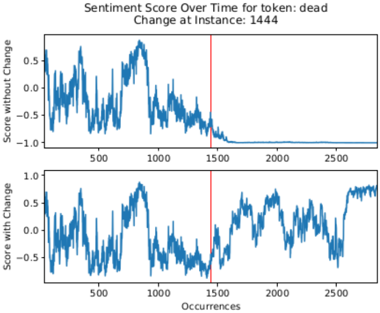
train

Seed lexicon

love	positive
hate	negative

Incremental Word Vectors

- We simulate sentiment change by randomly picking some words and swapping their context with the context of words exhibiting the opposite sentiment.



1. (a) dead

- Our approach allows for successfully tracking of the sentiment of words over time even when drastic change is induced.

Questions?

Thanks for your Attention!

References I

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Wefe: The word embeddings fairness evaluation framework.
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Cognitive Computation, pages 1–17.