



AGH UNIVERSITY OF SCIENCE
AND TECHNOLOGY

Seminar in *Artificial Intelligence*

Word embedding

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Agenda

- 1 Introduction**
 - Why do we need word embedding
 - Types of encoding
 - General concept
- 2 Word embedding models**
 - GloVe
 - Word2Vec
 - fasttext
- 3 Applications**
 - Natural Language Processing
 - Other domains
- 4 Problems and limitations**

What is word embedding?

Introduction

Word embeddings are one of the few currently successful applications of unsupervised learning. Their main benefit arguably is that they don't require expensive annotation, but can be derived from large unannotated corpora that are readily available. Pre-trained embeddings can then be used in downstream tasks that use small amounts of labeled data.

NLP Research Scientist, Sebastian Ruder

What a **lovely** day.

What a **nice** day.

Encoding text

- Machine learning models take vectors (arrays of numbers) as input.
-

One hot encoding

What = $[1 \ 0 \ 0 \ 0 \ 0]$

a = $[0 \ 1 \ 0 \ 0 \ 0]$

lovely = $[0 \ 0 \ 1 \ 0 \ 0]$

nice = $[0 \ 0 \ 0 \ 1 \ 0]$

day = $[0 \ 0 \ 0 \ 0 \ 1]$

One hot encoding (cont.)

- Words completely independent of each other
- Inefficient approach: vector is sparse

One hot encoding (cont.)

Example:

- Dictionary of 10,000 words
- One hot encode each word
- Each vector's elements are 99.99% zeros!

Unique number encoding

What = [1]

a = [2]

lovely = [3]

nice = [4]

day = [5]

Unique number encoding (cont.)

- + Efficient - dense vector
- Encoding arbitrary - does not catch relationships between words
- Can be challenging for a model to interpret

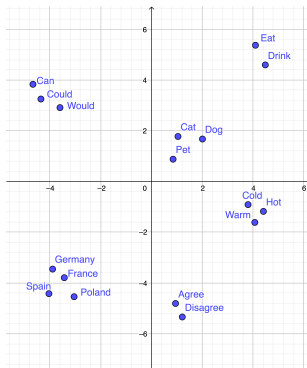
Word embedding

What = [1.2 -0.1 4.3 3.2]
a = [0.4 2.5 -0.9 0.5]
lovely = [2.1 0.3 0.1 0.4]
nice = [2.0 0.4 0.3 0.5]
day = [3.0 -0.6 3.5 -0.8]

Word embedding

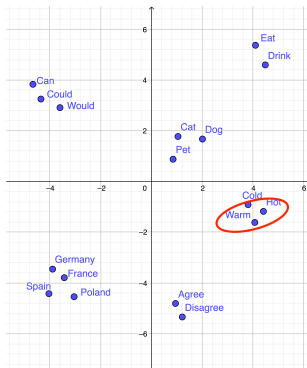
- Words with similar context occupy close spatial positions
- The cosine of the angle between words' vectors should be close to 1 (angle close to 0)

Word Embedding



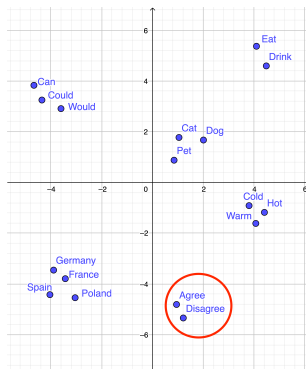
Caption of the figure

Word Embedding



Words are synonyms

Word Embedding



Words are antonyms

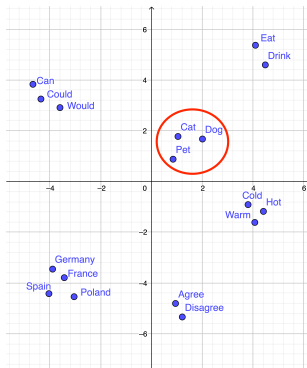
Word Embedding

Slide with a Figure from a File



Words are value on a scale

Word Embedding



Words are hyponym - hypernym

Word Embedding



Words appear in similar context

Word embedding models



GloVe



Word2Vec



fastext

How can we use it?

Natural Language Processing

- If user search for "Dell notebook battery size" we would like to match it also with "Dell laptop battery capacity"
- If user search for "Cracow Motel" we would like to match it also with "Krakow Hotel"

Natural Language Processing

- Analyzing survey responses
- Analyzing comments

Other domains

- Word2vec can catch relationships and contexts in songs the user listens to
- Data can be used for real-time music recommendation

Problems and limitations

- Multiple meanings of a word: solution - *Sense* embeddings
- Inability to handle unknown or out-of-vocabulary (OOV) words
- Scaling to new languages
- No shared representations at sub-word levels

**Thank you for your
attention!**

Q & A

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