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AGH University of Science and Technology

Seminar in *Artificial Intelligence*
Word embedding

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Agenda

1. **Introduction**
   - Necessity for encoding text
   - Simpler types of encoding
2. **Word embedding details**
   - Detail1
   - Detail2
   - Detail3
   - Detail4
3. **Applications**
4. **Problems and limitations**

Introduction

What is word embedding?

Introduction

What a **lovely** day.
What a **nice** day.

Encoding text

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

One hot encoding

$$\begin{aligned}
\text{What} &= [1 \;\; 0 \;\; 0 \;\; 0 \;\; 0] \\
\text{a} &= [0 \;\; 1 \;\; 0 \;\; 0 \;\; 0] \\
\text{lovely} &= [0 \;\; 0 \;\; 1 \;\; 0 \;\; 0] \\
\text{nice} &= [0 \;\; 0 \;\; 0 \;\; 1 \;\; 0] \\
\text{day} &= [0 \;\; 0 \;\; 0 \;\; 0 \;\; 1]
\end{aligned}$$

One hot encoding ctd.

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

One hot encoding ctd.

Example:

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

Unique number encoding

$$\begin{aligned}\text{What} &= [1]\\ \text{a} &= [2]\\ \text{lovely} &= [3]\\ \text{nice} &= [4]\\ \text{day} &= [5]\end{aligned}$$

Unique number encoding ctd.

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

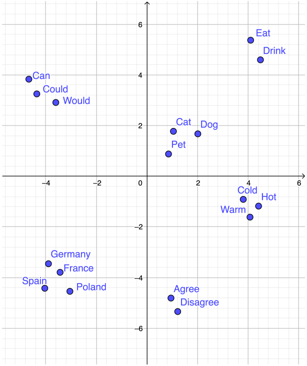
Word embedding

$$\begin{array}{rcl} \text{What} & = & [1.2 \quad -0.1 \quad 4.3 \quad 3.2] \\ \text{a} & = & [0.4 \quad 2.5 \quad -0.9 \quad 0.5] \\ \text{lovely} & = & [2.1 \quad 0.3 \quad 0.1 \quad 0.4] \\ \text{nice} & = & [2.0 \quad 0.4 \quad 0.3 \quad 0.5] \\ \text{day} & = & [3.0 \quad -0.6 \quad 3.5 \quad -0.8] \end{array}$$

Word embedding

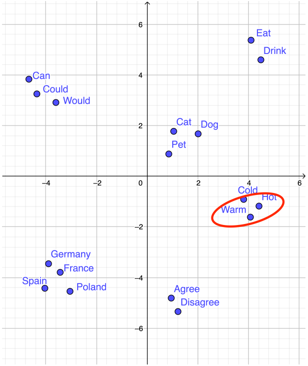
- Words with similar context occupy close spatial positions
- The cosine of the angle between words' vectors should be close to 1 (angle close to 0)

Word Embedding



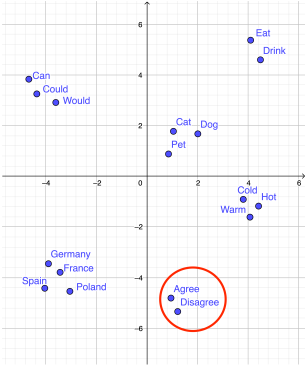
Caption of the figure

Word Embedding



Words are synonyms

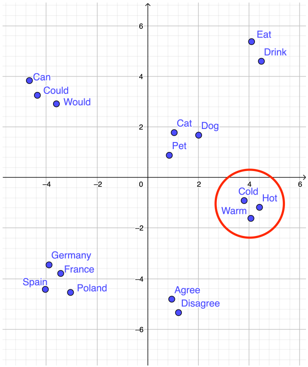
Word Embedding



Words are antonyms

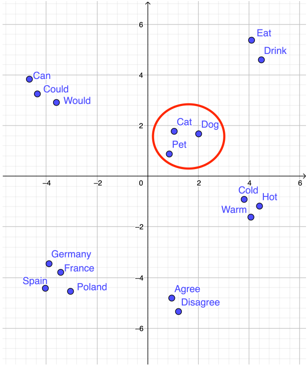
Word Embedding

Slide with a Figure from a File



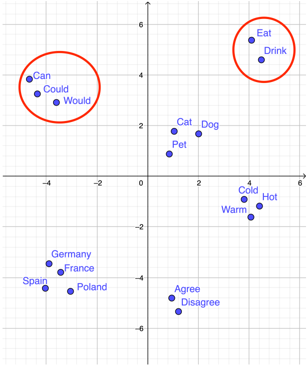
Words are value on a scale

Word Embedding



Words are hyponym - hypernym

Word Embedding



Words appear in similar context

How can we use it?

- 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”

ALalalal

.....One of the main limitations of word embeddings (word vector space models in general) is that possible meanings of a word are conflated into a single representation (a single vector in the semantic space). Sense embeddings[17] are proposed as a solution to this problem: individual meanings of words are represented as distinct vectors in the space.....

Thank you for your attention!

Q & A

- Intro to word embeddings.
  https://www.tensorflow.org/alpha/tutorials/text/word_embeddings.
  Accessed: 2019-05-11.

- Intro to word embeddings.
  https://towardsdatascience.com/introduction-to-word-embedding-and-word2vec-652d0c2060f
  fbclid=IwAR3c2RpZOmbWC84_mKFtRI6PwTD7vJRxiquKPp2Y3en3_OfDpBsWjjSinv8.
  Accessed: 2019-05-11.