

INF5820

Distributional Semantics: Extracting Meaning from Data

Lecture 4

Beyond words: distributional representations of texts

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- 1 Brief recap
- 2 Problem description
- 3 Can we do without semantics?
- 4 Distributed models: composing from word vectors
- 5 Distributed models: training document vectors
- 6 In the next week

What we are going to cover today

- ▶ Problem of document classification;
- ▶ Traditional bag-of-words approach;
- ▶ Compositional distributed approaches;
- ▶ 'Proper' distributional approaches (document vectors).

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Problem description

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- ▶ But we also need to represent **variable-length documents!**
 - ▶ for **classification**,
 - ▶ for **clustering**,
 - ▶ for **information retrieval** (including web search).



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Note: this lecture does not cover **sequence-to-sequence** sentence modeling approaches based on RNNs (LSTM, GRU, etc). A good example of those is the **Skip-Thought** algorithm [Kiros et al., 2015].

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Can we do without semantics?

Bag-of-words with TF-IDF

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Can we do without semantics?

Bag-of-words with TF-IDF

A very strong baseline approach for document representation, hard to beat by modern methods:

1. Extract **vocabulary** V of all words (terms) in the training collection consisting of N documents;
2. For each term, calculate its **document frequency**: in how many documents it occurs (df);
3. Represent each document as a **sparse vector of frequencies for all terms** from V contained in it (tf);
4. For each value, calculate the weighted frequency wf using **term frequency / inverted document frequency** (TF-IDF):
5. $wf = 1 + \log_{10}(tf) \times \log_{10}\left(\frac{N}{df}\right)$
6. Use these **weighted document vectors** in your downstream tasks.

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It means we need more sophisticated semantically-aware **distributed methods**, like neural embeddings.

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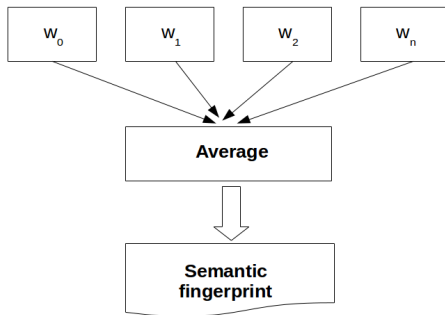
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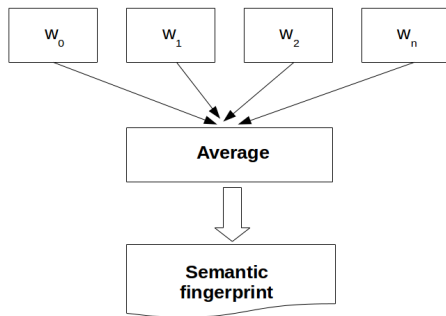
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- ▶ It is very important to remove stop words beforehand!

Distributed models: composing from word vectors

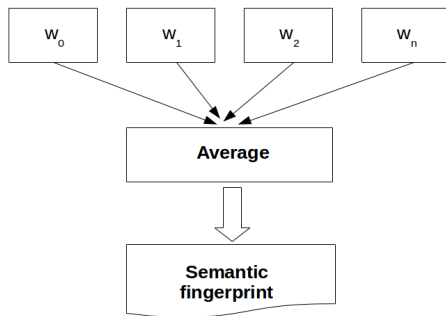


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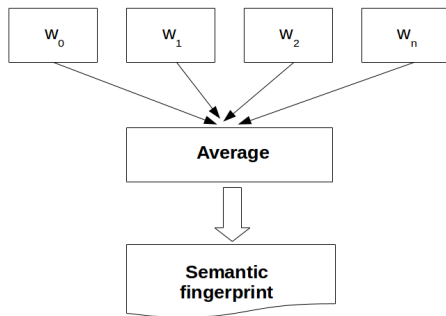
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- ▶ You even **don't have to average**. Summing vectors is enough: cosine is about **angles**, not **magnitudes**.
- ▶ However, averaging makes difference in case of other distance metrics (**Euclidean distance**, etc).
- ▶ Also helps to keep things tidy and normalized.

Distributed models: composing from word vectors

Composition functions

- ▶ One can experiment with different combinations of word vectors, not only averaging:
 - ▶ **Concatenation**

Distributed models: composing from word vectors

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- ▶ One can experiment with different combinations of word vectors, not only averaging:
 - ▶ Concatenation
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 - ▶ etc...
- ▶ Can introduce **word order** knowledge by using **n-grams** instead of **words**.
- ▶ See [Mitchell and Lapata, 2010] for extensive description and evaluation of various compositional models.

Distributed models: composing from word vectors

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See more in [Kutuzov et al., 2016].

Distributed models: composing from word vectors

Deep inverse regression

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- ▶ **Classify documents by inverting distributional models:**

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- ▶ drawback: you need **separate models for each of your classes**.

Distributed models: composing from word vectors

But...

However, for some problems such compositional approaches are not enough and we need to generate **real document embeddings**.

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Many questions

- ▶ Should we treat the document as a **single target unit** surrounded by its counterparts?

Distributed models: training document vectors

Many questions

- ▶ Should we treat the document as a **single target unit** surrounded by its counterparts?
- ▶ Or should we take into account the composing words, but go beyond simple composition functions?

Paragraph Vector

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Distributed models: training document vectors

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Not much evaluated (however, see [Hill et al., 2016] and [Lau and Baldwin, 2016])

Distributed models: training document vectors

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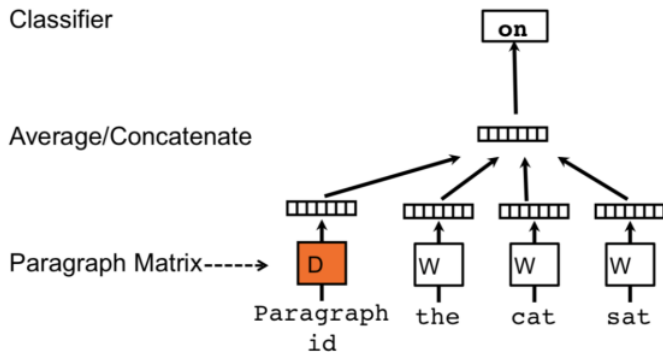
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PV-DM seems to be generally better than PV-DBOW (not clear).

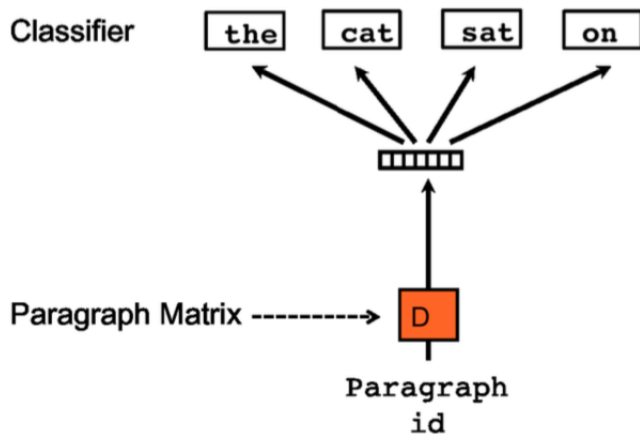
Distributed models: training document vectors

Paragraph Vector - Distributed memory (PV-DM)



Distributed models: training document vectors

Paragraph Vector - Distributed Bag-of-words (PV-DBOW)



Distributed models: training document vectors

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- ▶ The resulting embeddings are shown to perform very good on sentiment analysis and other document classification tasks, as well as in IR tasks.

Distributed models: training document vectors

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- ▶ You **train the model**, then **inference embeddings** for the documents you are interested in.
- ▶ The resulting embeddings are shown to perform very good on sentiment analysis and other document classification tasks, as well as in IR tasks.
- ▶ Very **memory-hungry**: each sentence gets its own vector (many millions of sentences in the real-life corpora).

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- ▶ Very **memory-hungry**: each sentence gets its own vector (many millions of sentences in the real-life corpora).
- ▶ It is possible to reduce the memory footprint by training a limited number of vectors: **group sentences into classes**.

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For example:

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For example:

interpret sentences or paragraphs as 'words' and train a common word embedding model.

The choice of an approach depends very much on your downstream task.

Questions?

INF5820

Distributional Semantics: Extracting Meaning from Data

Lecture 4

Beyond words: distributional representations of texts

Homework: obligatory assignment 3.

Contents



- 1 Brief recap
- 2 Problem description
- 3 Can we do without semantics?
- 4 Distributed models: composing from word vectors
- 5 Distributed models: training document vectors
- 6 In the next week**

In the next week




Kings and queens, men and women: semantic relations between word embeddings

- ▶ Distributional models contain not only words, but also relations between them;
- ▶ Why is that so?
- ▶ Mathematics behind this;
- ▶ Possible applications of semantic relations in distributional models;
- ▶ Projecting one model into another;
- ▶ etc...

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