# Word Mover’s Distance

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# Same content. Different words.

***“The Sicilian gelato was extremely rich”***
***“The Italian ice-cream was very velvety”***

Credit: Sudeep Das @datamusing applied WMD to restaurant reviews.
http://tech.opentable.com/2015/08/11/navigating-themes-in-restaurant-reviews-with-word-movers-distance/

# Ways to find similar documents

- Count common words ( bag of words, TF-IDF)
  - #Dimensions = #Vocabulary (thousands)

*Stuck if no words in common.*
*“Gelato” != “Ice-cream”*

Credits : Lev Konstantinovskiy
https://speakerdeck.com/tmylk/same-content-different-words

# Ways to find similar documents

- Low-dimensional latent features
  - Eigen-values (LSI)
  - Probability (LDA)

*Good representation But …*
*There is something better now… WMD!*

Credits : Lev Konstantinovskiy
https://speakerdeck.com/tmylk/same-content-different-words

# **New way** to find similar documents

- Word Mover's Distance
  - Built on top of Google's word2vec
  - Well-used concept in other fields known as Earth Mover's Distance

*Beats BOW, TF-IDF, LDA, LSI in Nearest Neigbours document classification tasks.*

Credits : Lev Konstantinovskiy
https://speakerdeck.com/tmylk/same-content-different-words

# Word Mover's distance

**From Word Embeddings To Document Distances**

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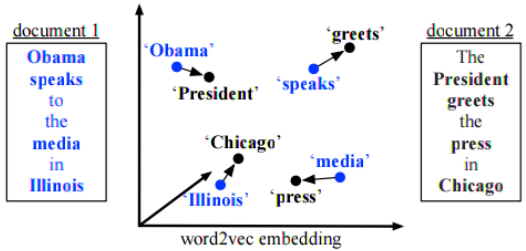
**Abstract**

We present the Word Mover's Distance (WMD), a novel distance function between text documents. Our work is based on recent results in word embeddings that learn semantically meaningful representations for words from local co-occurrences in sentences. The WMD distance measures the dissimilarity between two text doc-




http://jmlr.org/proceedings/papers/v37/kusnerb15.pdf
https://github.com/mkusner/wmd

# Word Mover's distance

$$\min_{\mathbf{T} \geq 0} \sum_{i,j=1}^{n} \mathbf{T}_{ij} c(i,j)$$

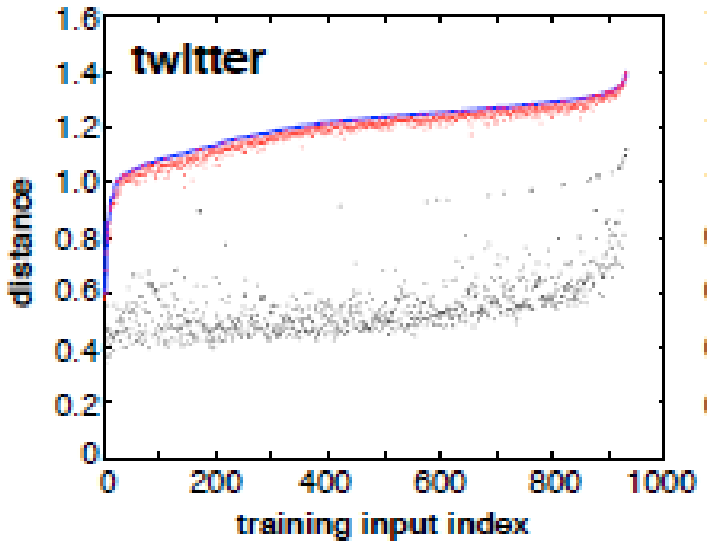
$$\text{subject to: } \sum_{j=1}^{n} \mathbf{T}_{ij} = d_i \quad \forall i \in \{1, \ldots, n\}$$

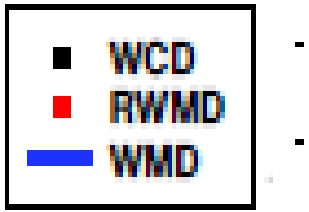
$$\sum_{i=1}^{n} \mathbf{T}_{ij} = d'_j \quad \forall j \in \{1, \ldots, n\}.$$

Optimization Expression


http://tech.opentable.com/2015/08/11/navigating-themes-in-restaurant-reviews-with-word-movers-distance/

Word Centroid Distance is a lower bound
Relaxed Word Mover's Distance is a tighter bound




http://jmlr.org/proceedings/papers/v37/kusnerb15.pdf

# Finding similar reviews

```
from gensim.similarities import WmdSimilarity

similiar_reviews = WmdSimilarity(reviews, model, num_best=10)
query = 'Very good, you should seat outdoor.'
similar_reviews[query]
```

```
0.5761 It's a great place if you can sit outside in good weather.

0.5711 It was good I like the outside

0.5362 nice view, good service

0.5359 Best seat in the house with view of water fountain, good wine,
```

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# Thanks!

Link to the Slides

https://github.com/RishabGoel/pycon_india_slides

# Extra slides

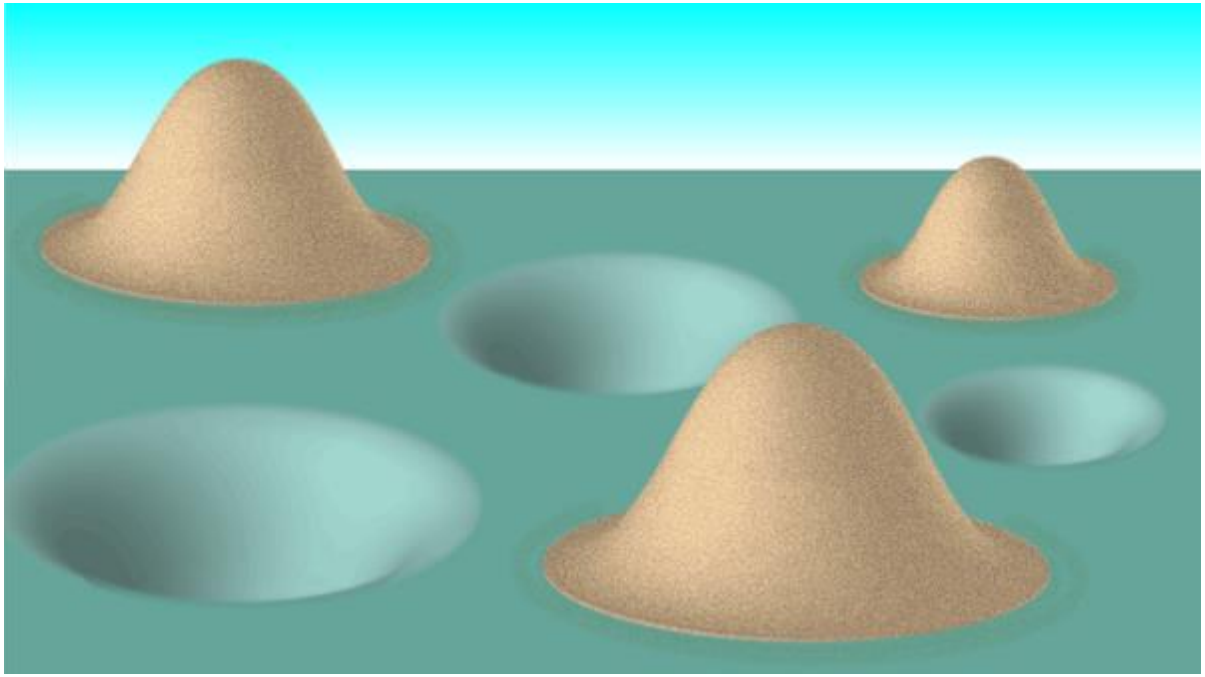
# Ways to find similar documents

- Google’s Doc2vec
  - Built on top of word2vec
  - Document tags are just extra words in the document

*Hard to tune. Slow inference.*

# Earth Mover's Distance

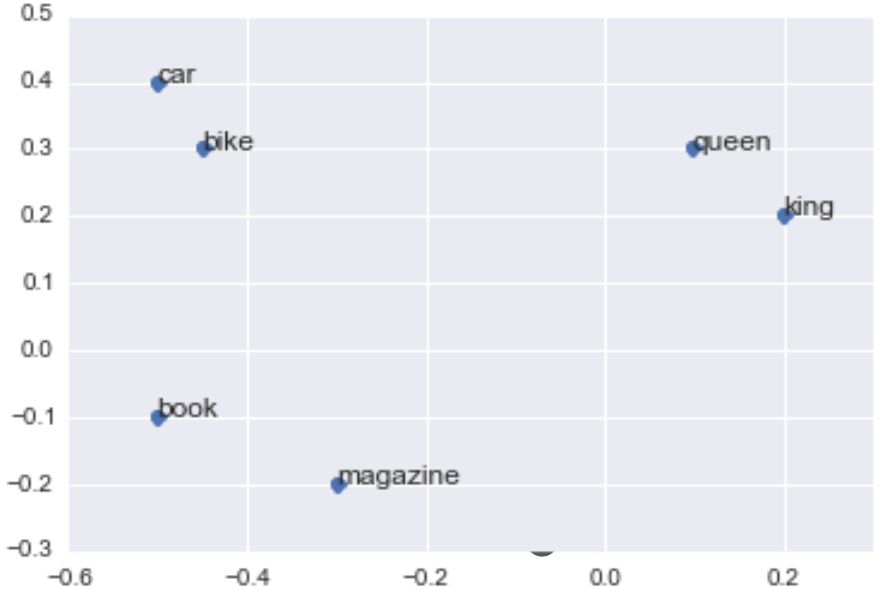
How do you best move piles of sand to fill up holes of the same total volume?



Stated by Monge in 1781. Solved by Kantorovich in

[Image: APS/Alan Stonebraker]

# Google’s Word2vec algorithm



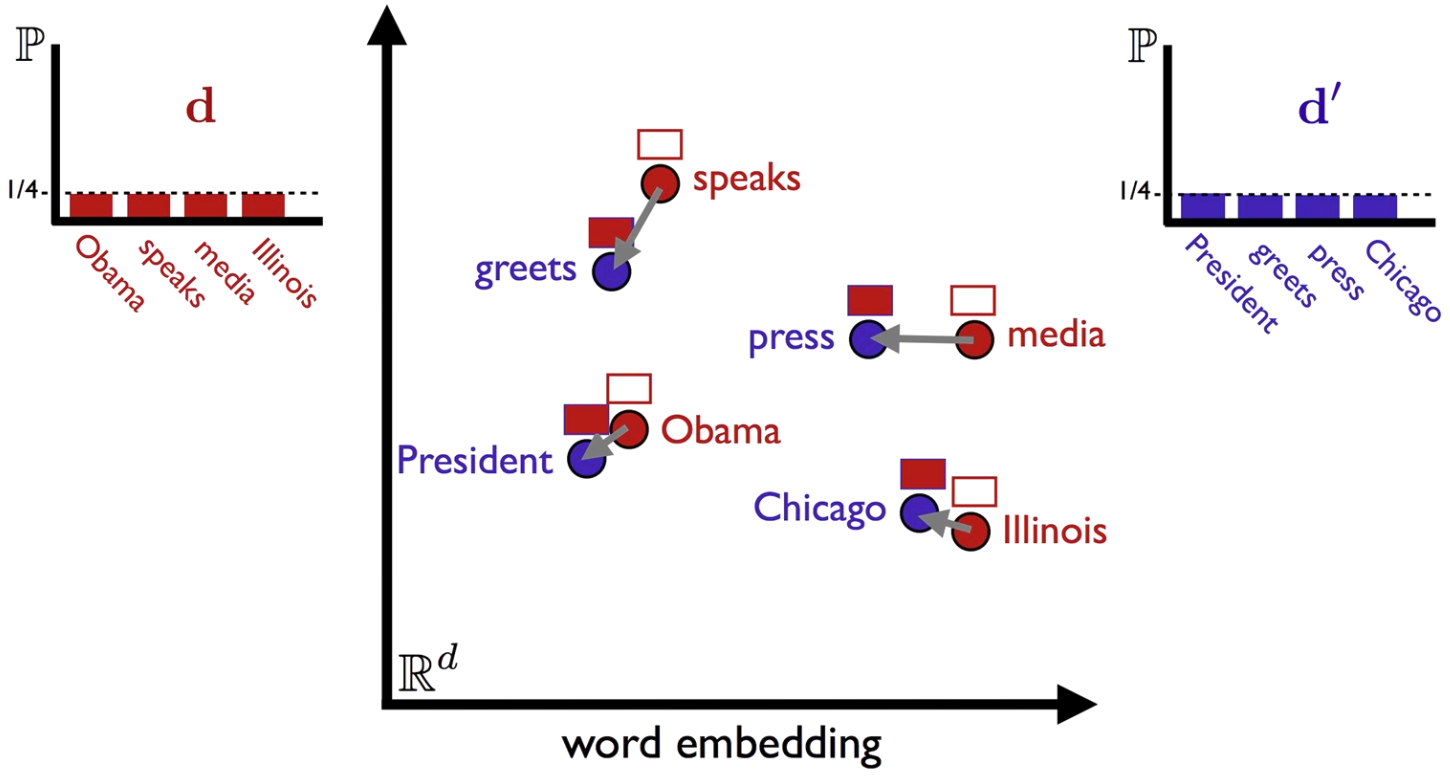

Word becomes a vector in 100-dimensional space.

- king - man + woman = queen

http://nbviewer.jupyter.org/github/fbkarsdorp/doc2vec/blob/master/doc2vec.ipynb

http://radimrehurek.com/2014/02/word2vec-tutorial

# Word Mover's distance




http://vene.ro/blog/word-movers-distance-in-python.html