Distributed representations

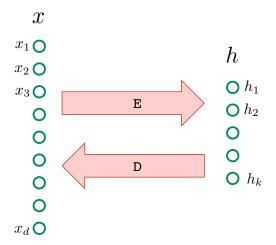
Sanjoy Dasgupta

University of California, San Diego

Topics we'll cover

- 1 One-hot versus distributed encodings
- Word embeddings

One-hot versus distributed representations



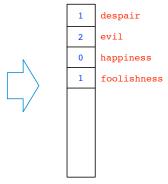
• k-means: one-hot encoding

• PCA: distributed encoding

The bag-of-words representation

One-hot encoding of words:

It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us, we were all going direct to Heaven, we were all going direct the other way — in short, the period was so far like the present period, that some of its noisiest authorities insisted on its being received, for good or for evil, in the superlative degree of comparison only.



- Fix V = some vocabulary.
- Treat each sentence (or document) as a vector of length |V|:

$$x = (x_1, x_2, \dots, x_{|V|}),$$

where $x_i = \#$ of times the *i*th word appears in the sentence.

Word co-occurrences

You shall know a word by the company it keeps. (J.R. Firth, 1957)

• Much of the meaning of a word w is captured by the words it co-occurs with:

• Find an embedding of words based on these co-occurrences.

A simple approach to word embedding

Fix a vocabulary V. Then, using a corpus of text:

- 1 Look at each word w and its surrounding context: w_1 w_2 w_3 w w_4 w_5 w_6
 - n(w, c) = # times word c occurs in the context of word w
 - Yields a probability distribution Pr(c|w).
- **2** Positive pointwise mutual information:

$$\Phi_c(w) = \max\left(0, \log \frac{\Pr(c|w)}{\Pr(c)}\right)$$

This is a |V|-dimensional representation of word w.

3 Reduce dimension using PCA.

The embedding

- Which word's vector is closest to that of Africa?
 Asia
- Solving analogy problems: king is to queen as man is to?
 - vec(king) vec(queen) = vec(man) vec(?)
 - vec(?) = vec(man) vec(king) + vec(queen)
 - Nearest neighbor of this vector is vec(woman).