Text Retrieval & Search Engines

Vector Space Model: Doc Length Normalization

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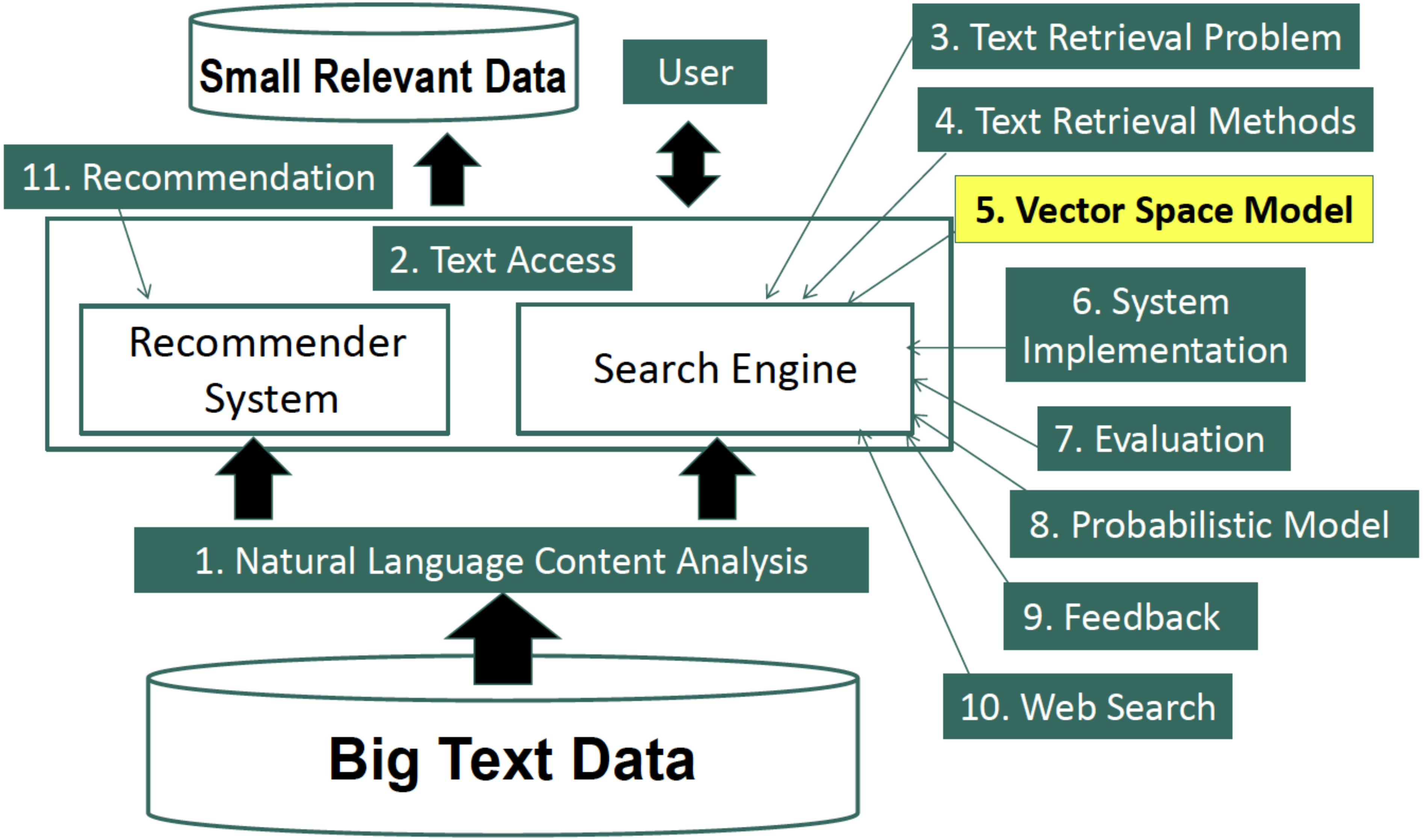
Course Schedule



What about Document Length?

Query = “news about presidential campaign”

d4

… **news** of **presidential campaign** …

… **presidential** candidate …

100 words

d6 > d4?

d6

… **campaign**……… **campaign**………………… **5000 words** …..

…………………………………………………………………..

……….**news**……………………………………………………

…………………………………………………………………..

…………………………………………………… **news**…..

…………………………………………………………………..

……………………………………… ………………………….

……………………… **presidential** ……. **presidential**……

Document Length Normalization

- Penalize a long doc with a doc length normalizer
  - Long doc has a better chance to match any query
  - Need to avoid over-penalization
- A document is long because
  - it uses more words ➔ more penalization Abstract and full paper
  - it has more contents ➔ less penalization Abstracts concatenated from multiple papers
- Pivoted length normalizer: average doc length as "pivot"
  - Normalizer = 1 if |d| =average doc length (avdl)

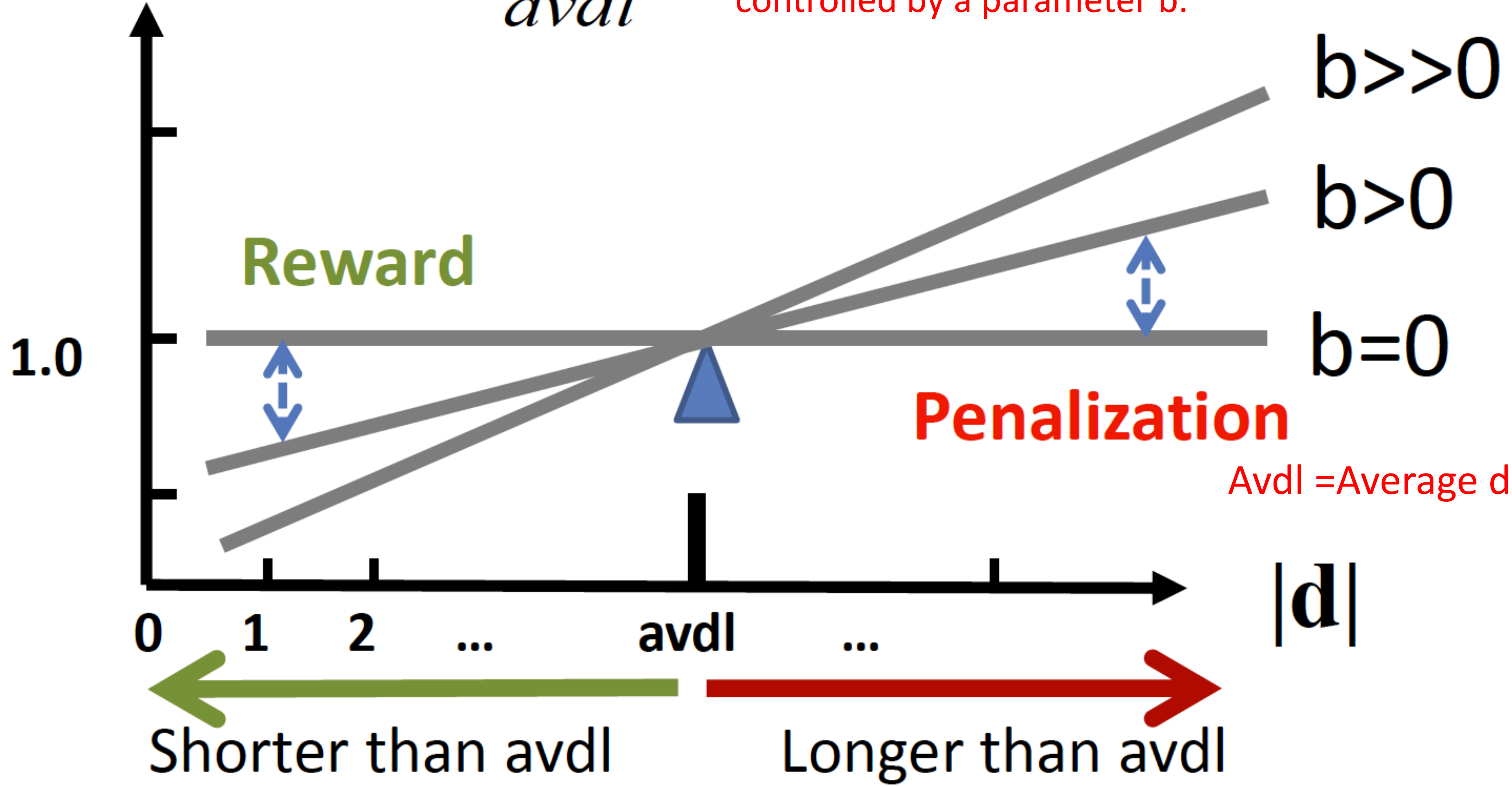
We need to be careful using right degree of length penalization.

Pivoted Length Normalization

$$normalizer = 1 - b + b\frac{|d|}{avdl}$$

Interpolation of one and the normalized document lengths, controlled by a parameter b.

$$b \in [0,1]$$



Avdl =Average document length

State of the Art VSM Ranking Functions

We put the document length normalizer in the denominator of the TF formula, which causes a penalty to the long documents, since larger the denominator is smaller the TF weight is.

- Pivoted Length Normalization VSM [Singhal et al 96]

$$f(q,d)=\sum_{w\in q\cap d} c(w,q)\frac{\ln[1+\ln[1+c(w,d)]]}{1-b+b\frac{|d|}{avdl}}\log\frac{M+1}{df(w)}$$

- BM25/Okapi [Robertson & Walker 94]

$$b\in[0,1]$$
$$k_1,k_3\in[0,+\infty)$$

$$f(q,d)=\sum_{w\in q\cap d} c(w,q)\frac{(k+1)c(w,d)}{c(w,d)+k(1-b+b\frac{|d|}{avdl})}\log\frac{M+1}{df(w)}$$

Further Improvement of VSM?

- Improved instantiation of **dimension?**
  - stemmed words, stop word removal, phrases, latent semantic indexing (word clusters), character n-grams, ...
  - bag-of-words with phrases is often sufficient in practice
  - Language-specific and domain-specific tokenization is important to ensure "normalization of terms"
- Improved instantiation of **similarity function?**
  - cosine of angle between two vectors?
  - Euclidean?
  - dot product seems still the best (sufficiently general especially with appropriate term weighting)

Further Improvement of BM25

Title field, abstract field and the body of the research article, anchar text (on web pages).

- BM25F [Robertson & Zaragoza 09]
  - Use BM25 for documents with structures (“F”=fields)
  - Key idea: combine the frequency counts of terms in all fields and then apply BM25 (instead of the other way)
- BM25+ [Lv & Zhai 11]
  - Address the problem of over penalization of long documents by BM25 by adding a small constant to TF
  - Empirically and **analytically** shown to be better than BM25

Further Improvement of BM25

$$\boxed{BM25(Q,L) = \sum_{t\in q}\left\{\log\frac{N}{Lf_t} \times \frac{(k_1+1)tf_{tl}}{k_1\left((1-b)+b\times\left(\frac{l_L}{l_{av}}\right)\right)+tf_{tl}} \times \frac{(k_3+1)\,tf_{tq}}{k_3+tf_{tq}}\right\}}$$

Summary of Vector Space Model

- Relevance(q,d) = similarity(q,d)
- Query and documents are represented as vectors
- Heuristic design of ranking function
- Major term weighting heuristics
  - TF weighting and transformation
  - IDF weighting
  - Document length normalization
- BM25 and Pivoted normalization seem to be most effective

Additional Readings

- A. Singhal, C. Buckley, and M. Mitra. Pivoted document length normalization. In *Proceedings of ACM SIGIR 1996.*
- S. E. Robertson and S. Walker. Some simple effective approximations to the 2-Poisson model for probabilistic weighted retrieval, *Proceedings of ACM SIGIR 1994*.
- S. Robertson and H. Zaragoza. The Probabilistic Relevance Framework: BM25 and Beyond, *Found. Trends Inf. Retr.* 3, 4 (April 2009).
- Y. Lv, C. Zhai, Lower-bounding term frequency normalization. In *Proceedings of ACM CIKM 2011.*

Quiz #1

Friday, 11 March 2022

Content: Lecture 1- Lecture 6

(NLCA to VSM)