Probabilistic Language-Model Based Document Retrieval

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Naïve Bayes for Retrieval

- Naïve Bayes can also be used for ad-hoc document retrieval.
- Treat each of the *n* documents as a category with only one training example, the document itself.
- Classify queries using this *n*-way categorization.
- Rank documents based on the posterior probability of their category.
- Effectively using Naïve Bayes as a simple1-gram language model for each document.

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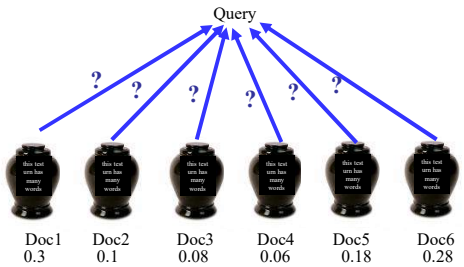
Generative Model for Retrieval



Ranked Retrievals:

Doc 1 0.3
Doc 6 0.28
Doc 5 0.18
Doc 2 0.1
Doc 3 0.08
Doc 4 0.06

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Smoothing

- Proper smoothing is important for this approach to work well.
- Laplace smoothing does not work well for this application.
- Better to use ***linear interpolation*** for smoothing.

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Linear Interpolation Smoothing

- Estimate conditional probabilities $P(X_i \mid Y)$ as a mixture of conditioned and unconditioned estimates:

$$P(X_i \mid Y) = \lambda \hat{P}(X_i \mid Y) + (1-\lambda)\hat{P}(X_i)$$

- $\hat{P}(X_i \mid Y)$ is the probability of drawing word X_i from the urn of words in category (i.e. document) Y.
- $\hat{P}(X_i)$ is the probability of drawing word X_i from the urn of words in the entire corpus (i.e. all document urns combined into one big urn).

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Amount of Smoothing

- Value of λ controls the amount of smoothing.
- The lower λ is, the more smoothing there is since the unconditioned term is weighted higher (1 − λ).
- Setting λ properly is important for good performance.
- Set λ manually or automatically based on maximizing performance on a development set of queries.
- Lower λ tends to work better for long queries, high λ for short queries.

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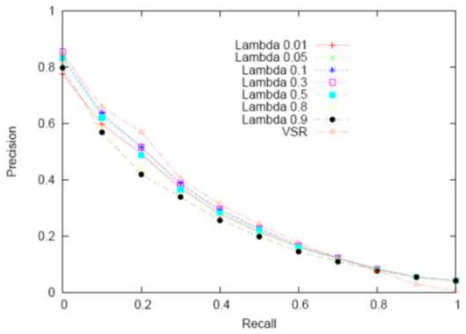
Experimental Results on CF Corpus
Effect of λ Parameter



Given long queries, large amount of smoothing (λ=0.1) seems to work best

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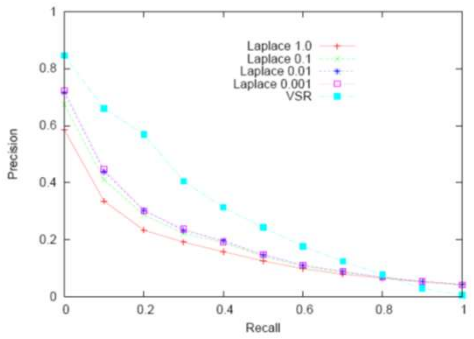
Experimental Results on CF Corpus
Effect of Laplace Smoothing Parameter



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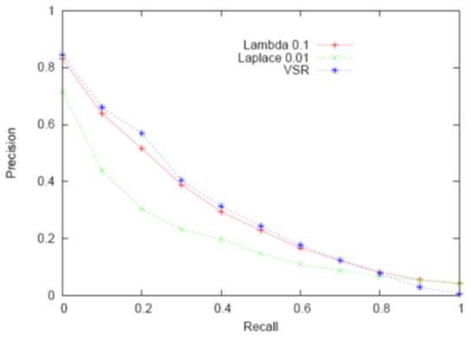
Experimental Results on CF Corpus
Comparison of Smothing Methods and VSR



Laplace smoothing does much worse.

Linear interp does about the same as vector-space

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Performance of Language Model Approach

- Larger scale TREC experiments demonstrate that the LM approach with proper smoothing works slightly better than a well-tuned vector-space approach.
- Need to make LM approach efficient by exploiting inverted index.
  - Don't bother to the compute probability of documents that do not contain *any* of the query words.

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