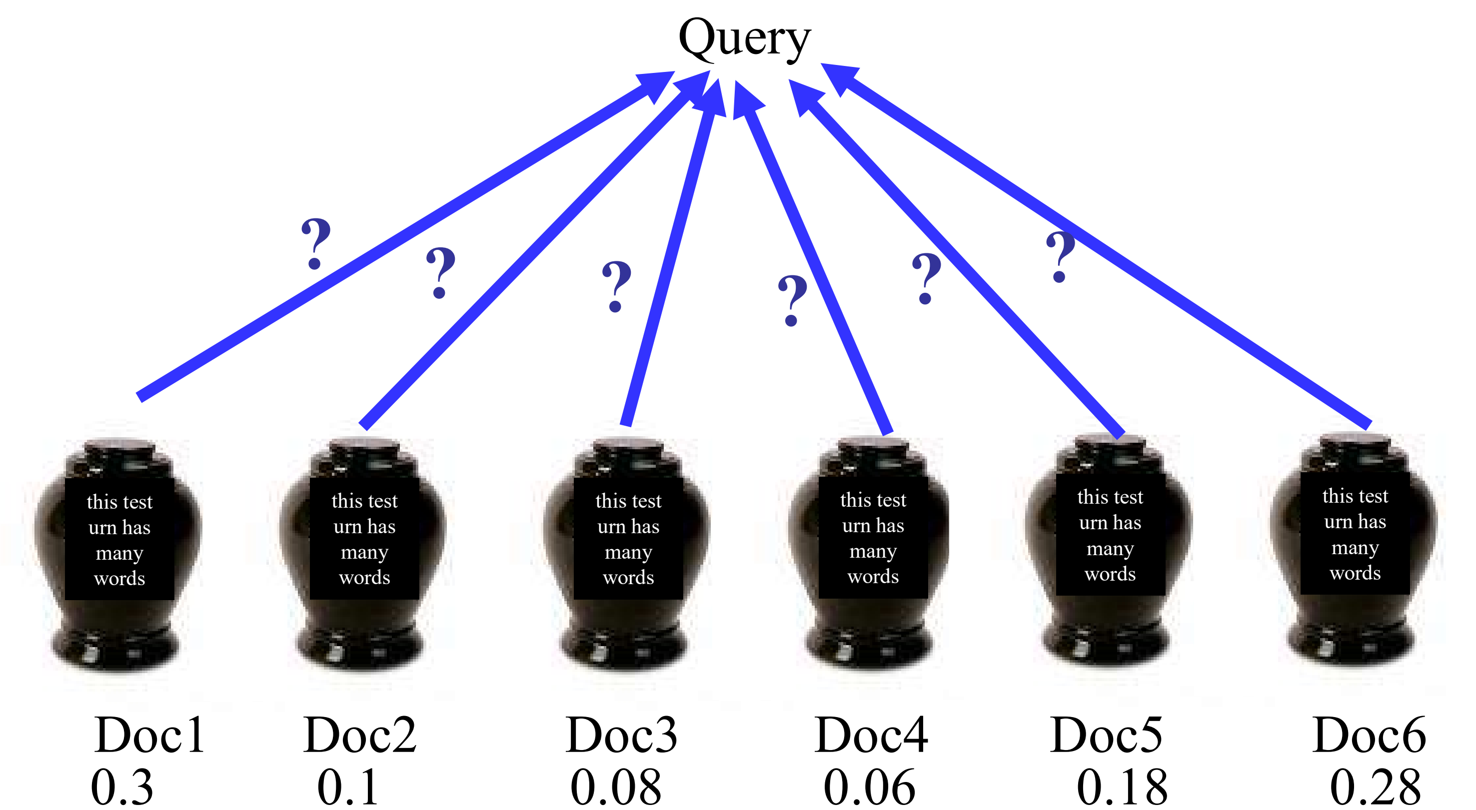
Probabilistic Language-Model Based Document Retrieval

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.
- For historical reasons, this is called the "language model" (LM) approach.

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

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.

Linear Interpolation Smoothing

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

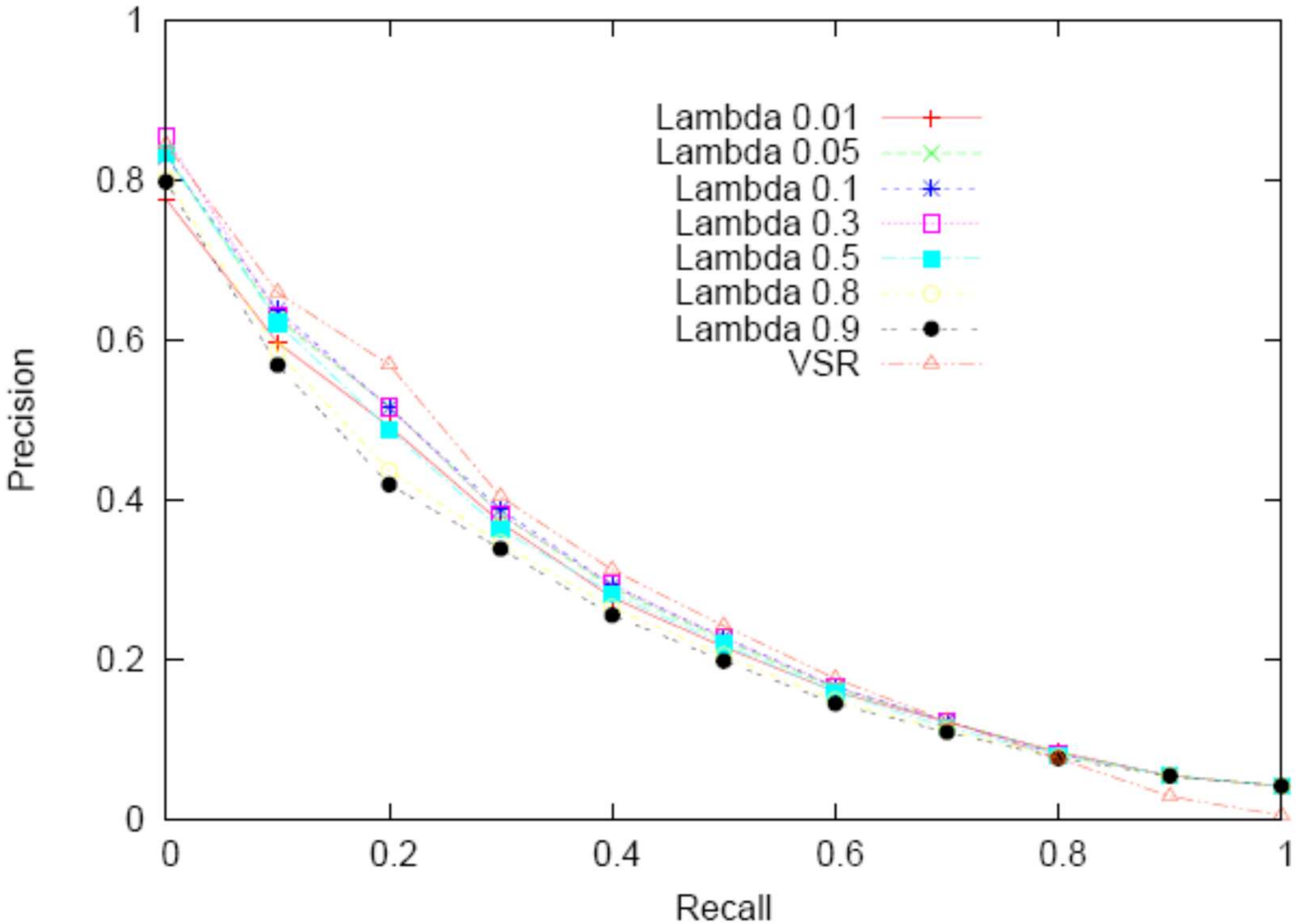
$$P(X_i \mid Y) = \lambda \hat{P}(X_i \mid Y) + (1-\lambda)\hat{P}(X_i)$$

- $\hat{\mathrm{P}}(X_i \mid Y)$ is the probability of drawing word X_i from the urn of words in category (i.e. document) Y.
- $\hat{\mathrm{P}}(X_i)$ 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).

Amount of Smoothing

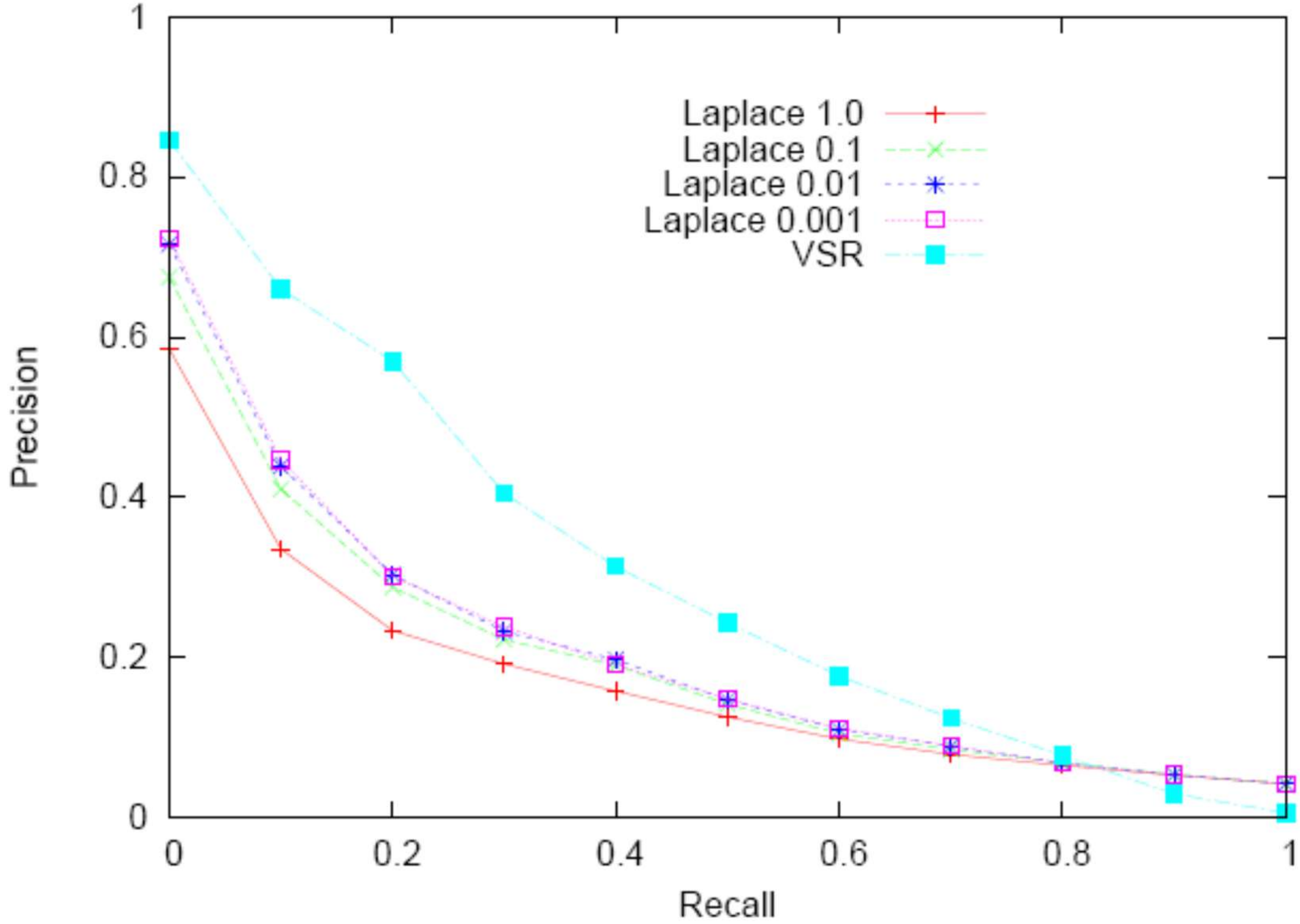
- Value of λ controls the amount of smoothing.
- The lower λ is, the more smoothing there is since the unconditioned term is weighted higher (1 − λ).
- Setting λ properly is important for good performance.
- Set λ manually or automatically based on maximizing performance on a development set of queries.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

Experimental Results on CF Corpus
Effect of λ Parameter

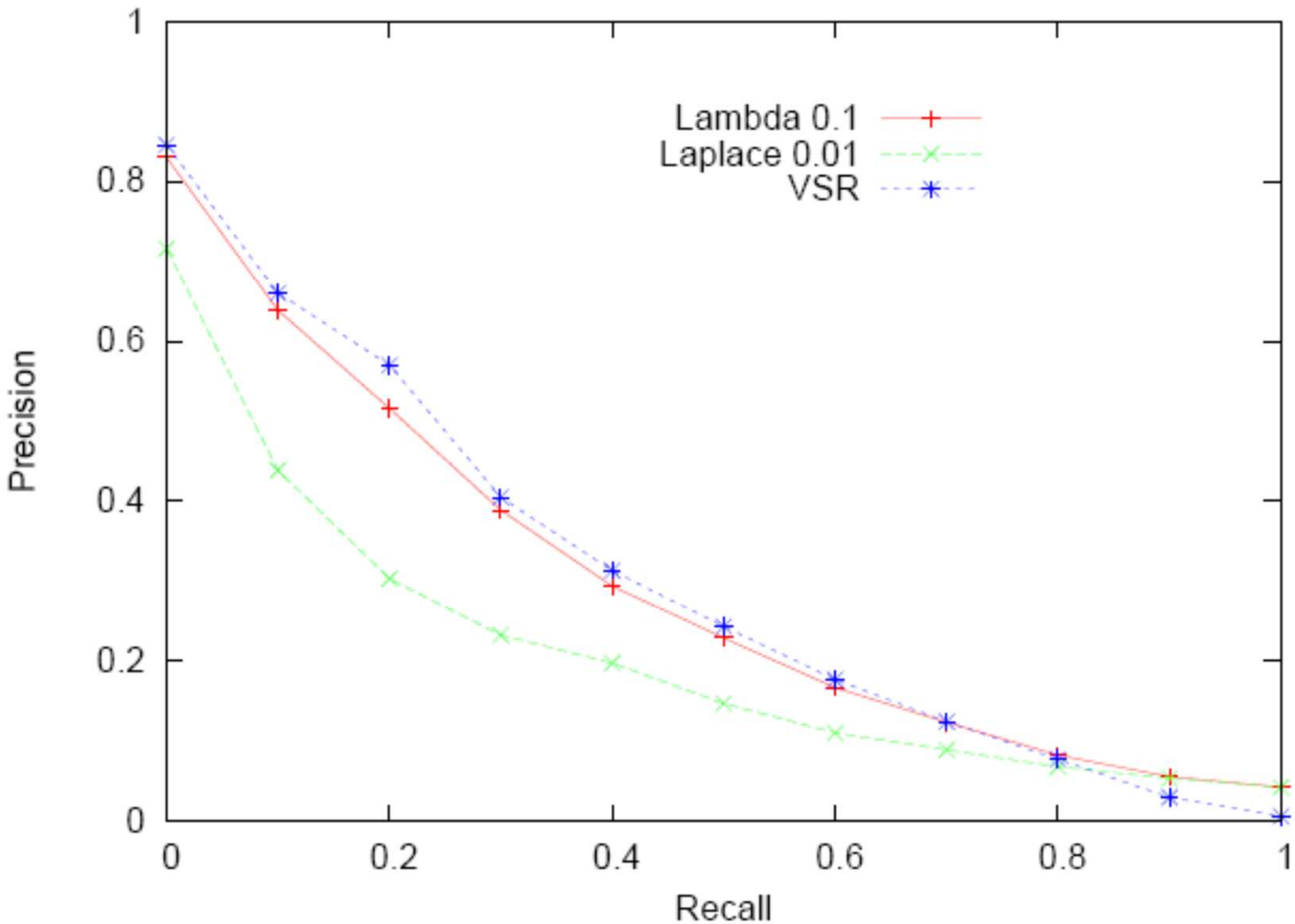


Given long queries, large amount of smoothing (λ=0.1) seems to work best

Experimental Results on CF Corpus
Effect of Laplace Smoothing Parameter



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

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.