Information Retrieval & Text Mining

Overview of Text Retrieval Methods

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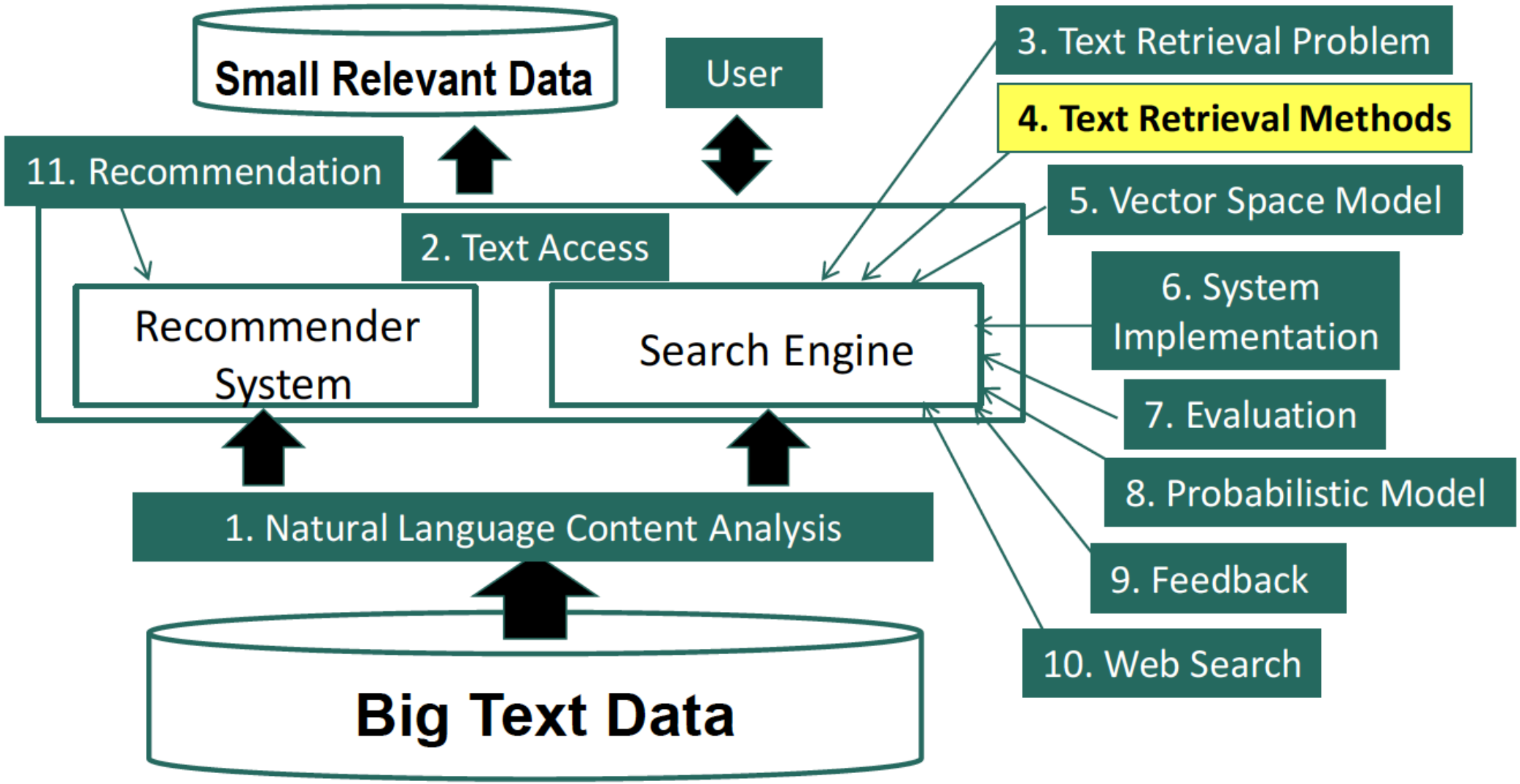
Course Schedule



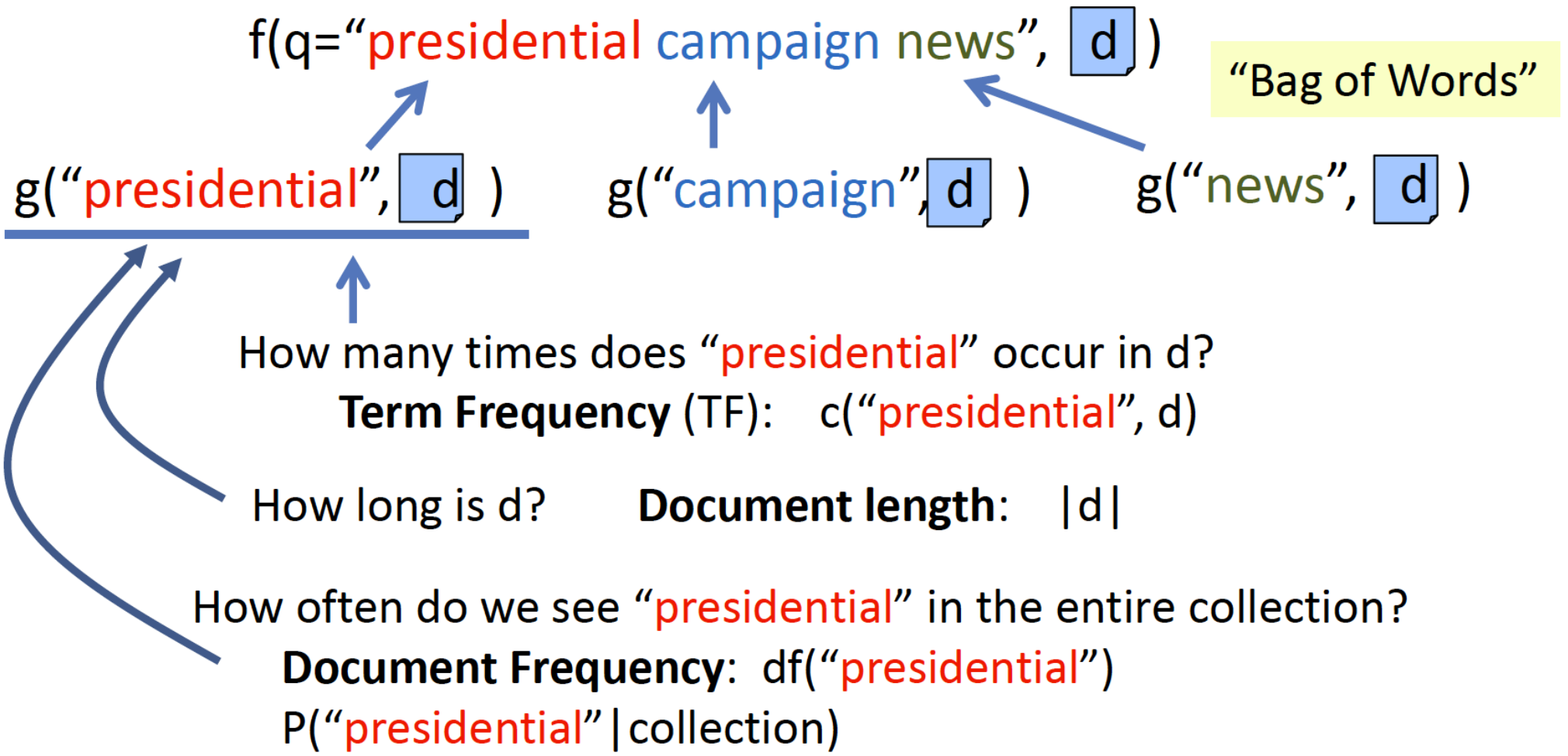
How to Design a Ranking Function

- **Query:** $q = q_1,\ldots,q_{m,}$ where $q_i \in V$
- **Document:** $d = d_1,\ldots,d_{n,}$ where $d_i \in V$
- **Ranking function:** $f(q, d) \in \Re$
- A good ranking function should rank relevant documents on top of non-relevant ones
- Key challenge: how to measure the likelihood that document d is relevant to query q
- **Retrieval model** = formalization of relevance (give a computational definition of relevance)

Many Different Retrieval Models

- **Similarity-based models**: f(q,d) = similarity(q,d)
  - Vector space model
- **Probabilistic models**: f(d,q) = p(R=1|d,q), where R $\in$ {0,1}
  - Classic probabilistic model
  - Language model
  - Divergence-from-randomness model
- **Probabilistic inference model**: f(q,d) = p(d→q)
- **Axiomatic model**: f(q,d) must satisfy a set of constraints
- These different models tend to result in similar ranking functions involving similar variables

Common Ideas in State of the Art Retrieval Models



Which Model Works the Best?

- When optimized, the following models tend to perform equally well [Fang et al. 11]:
  - **Pivoted length normalization**
  - **BM25**
  - **Query likelihood**

- BM25 is most popular

Summary

- Design of ranking function f(q,d) pre-requires a computational definition of relevance (retrieval model)
- Many models are equally effective with no single winner
- State of the art ranking functions tend to rely on
  - Bag of words representation
  - Term Frequency (TF) and Document Frequency (DF) of words
  - Document length

Additional Readings

- Detailed discussion and comparison of state of the art models
  - Hui Fang, Tao Tao, and Chengxiang Zhai. 2011. Diagnostic Evaluation of Information Retrieval Models. *ACM Trans. Inf. Syst.* 29, 2, Article 7 (April 2011)

- Broad review of different retrieval models
  - ChengXiang Zhai, *Statistical Language Models for Information Retrieval* , Morgan & Claypool Publishers, 2008. (Chapter 2)

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Vector Space Retrieval Model
Basic Idea

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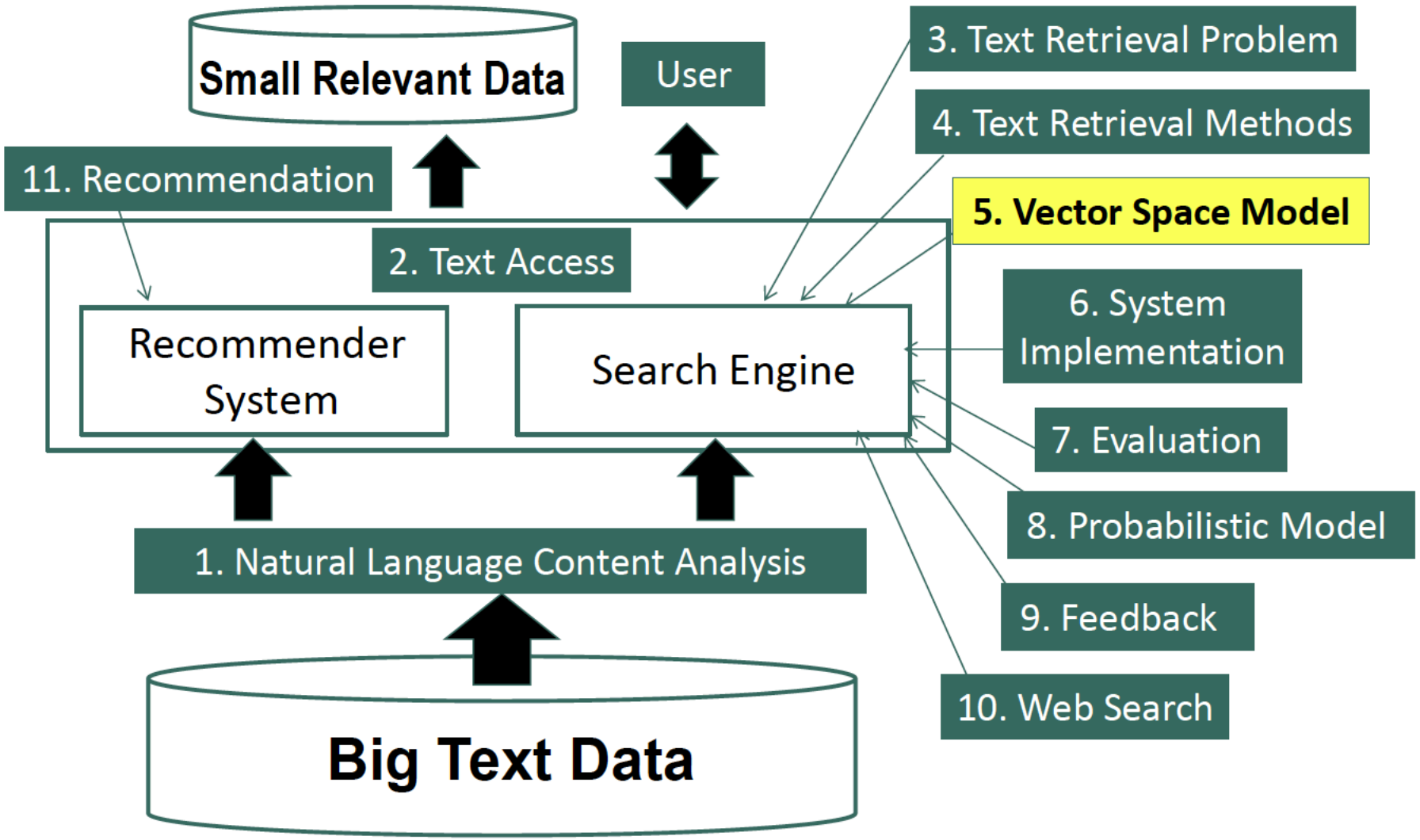
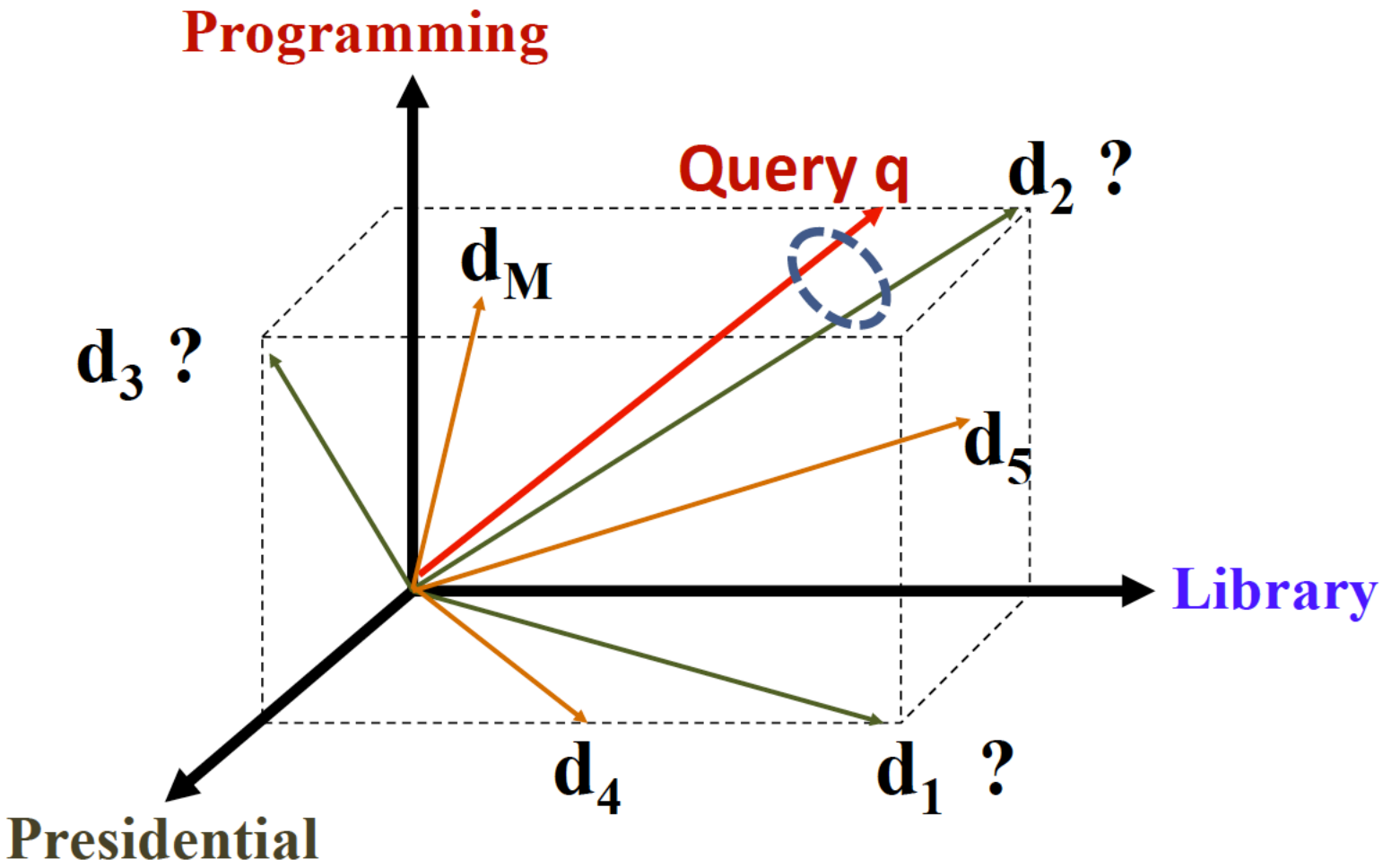


Many Different Retrieval Models

- Similarity-based models: f(q,d) = similarity(q,d)
  - Vector space model

Vector Space Model (VSM): Illustration



VSM Is a Framework

- Represent a doc/query by a term vector
  - **Term**: basic concept, e.g., word or phrase
  - Each term defines one dimension
  - N terms define an **N-dimensional space**
  - **Query** vector: **q**=(x_1, …x_N), $x_i \in \Re$ is query term weight
  - **Doc** vector: **d**=(y_1, …y_N), $y_j \in \Re$ is doc term weight

- relevance(q,d) $\propto$ similarity(**q**,**d**) =f(q,d)

What VSM Doesn't Say

- How to define/select the "basic concept"
  - Concepts are assumed to be orthogonal → Statistically Independent
- How to place docs and query in the space (= how to assign term weights)
  - Term weight in query indicates importance of term
  - Term weight in doc indicates how well the term characterizes the doc
- How to define the similarity measure