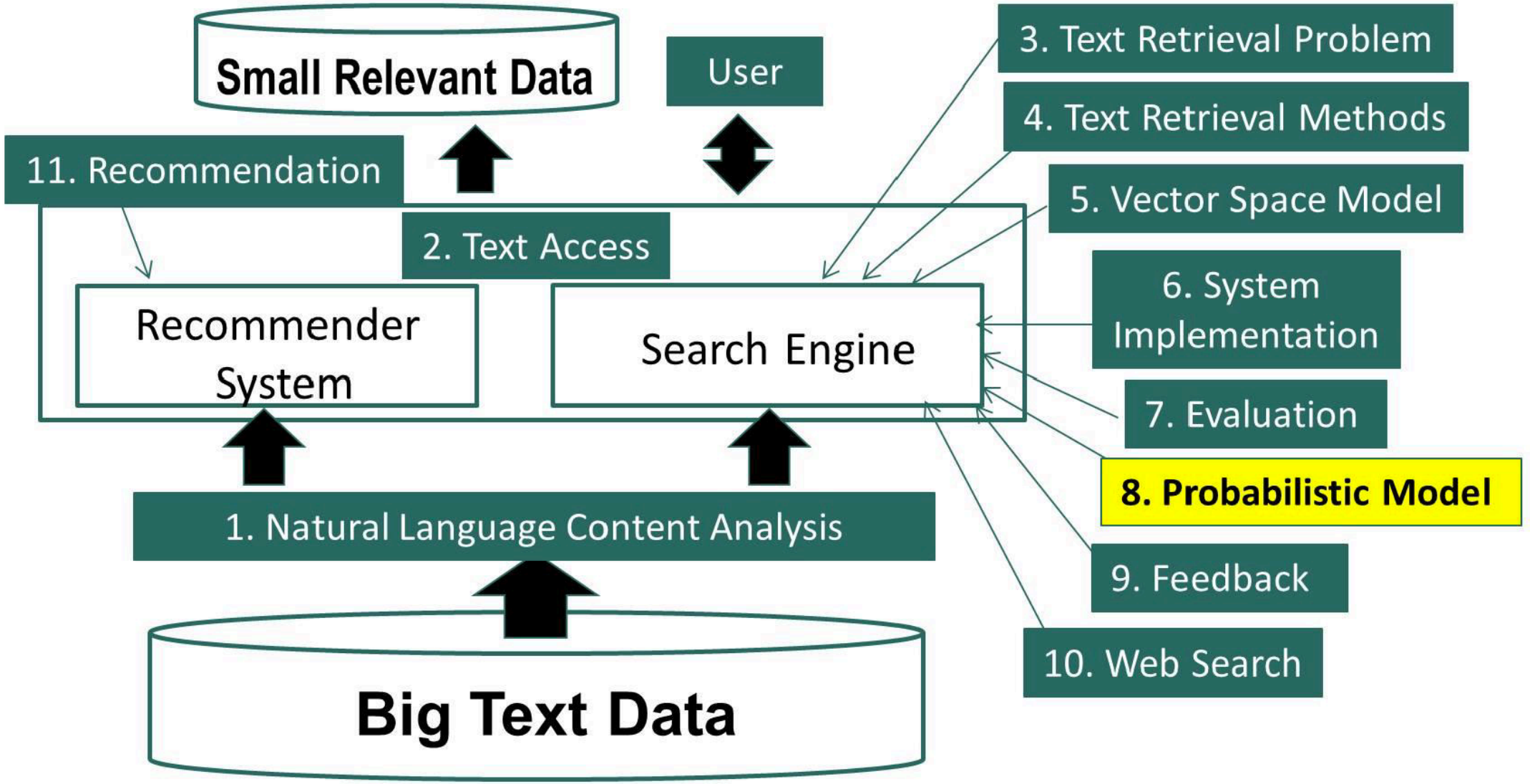
Information Retrieval & Text Mining

Probabilistic Retrieval Model:
Basic Idea

Dr. Saeed Ul Hassan
Information Technology University

Probabilistic Retrieval Model: Basic Idea



Probabilistic Model

- We define ranking function that a given document **D** is relevant to a given query **Q**.
- We introduce binary random variable $R \in \{0, 1\}$
- We assume that **Q** and **D** are observations from random variable, in vector space model we assume they are vectors
- Problem of retrieval now becomes the problem to estimate the probability of relevance.

$$f(d,q) = p(R=1 \mid d,q), \quad R \in \{0,1\}$$

Many Different Retrieval Models

- **Probabilistic models**: $f(d,q) = p(R=1|d,q), \quad R \in \{0,1\}$
  - Classic probabilistic model ➔ BM25
  - **Language model ➔Query Likelihood**

$$p(R=1|d,q) \approx p(q|d,R=1)$$

If a user likes document d, how likely would the user enter query q (in order to retrieve d)?

Probabilistic Retrieval Models: Basic Idea

Query	Doc	Rel
q	**d**	**R**
q1	d1	1
q1	d2	1
q1	d3	0
q1	d4	0
q1	d5	1
…		
q1	d1	0
q1	d2	1
q1	d3	0
q2	d3	1
q3	d1	1
q4	d2	1

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$$f(q,d)=p(R=1|d,q)=?$$

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q4	d2	1

$f(q,d)=p(R=1|d,q)=?$ $\frac{count(q,d,R=1)}{count(q,d)}$

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f(q,d)=p(R=1|d,q)=? $\frac{count(q,d,R=1)}{count(q,d)}$

P(R=1|q1,d1) = ?

P(R=1|q1,d2) = ?

P(R=1|q1,d3) = ?

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Query	Doc	Rel
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$f(q,d)=p(R=1|d,q)=?$ $\frac{count(q,d,R=1)}{count(q,d)}$

$P(R=1|q1,d1) = ?$ 1/2

$P(R=1|q1,d2) = ?$ 2/2

$P(R=1|q1,d3) = ?$ 0/2

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f(q,d)=p(R=1|d,q)=? $\frac{count(q,d,R=1)}{count(q,d)}$

P(R=1|q1,d1) = ? 1/2

P(R=1|q1,d2) = ? 2/2

P(R=1|q1,d3) = ? 0/2

What about unseen documents?

Unseen queries?

Query Likelihood Retrieval Model

Query	Doc	Rel
q	**d**	**R**
q1	d1	1
q1	d2	1
q1	d3	0
q1	d4	0
q1	d5	1
…		
q1	d1	0
q1	d2	1
q1	d3	0
q2	d3	1
q3	d1	1
q4	d2	1

$$f(q,d)=p(R=1|d,q)\approx \quad \mathbf{p(q|d,R=1)}$$

Approximations

Query Likelihood Retrieval Model

Query	Doc	Rel
q	**d**	**R**
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User likes d

$$f(q,d)=p(R=1|d,q)\approx \mathbf{p(q|d,R=1)}$$

Query Likelihood Retrieval Model

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User likes d

$$f(q,d)=p(R=1|d,q)\approx \mathbf{p(q|d,R=1)}$$

How likely the user enters q

Query Likelihood Retrieval Model

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q1	d2	1
q1	d3	0
q2	d3	1
q3	d1	1
q4	d2	1

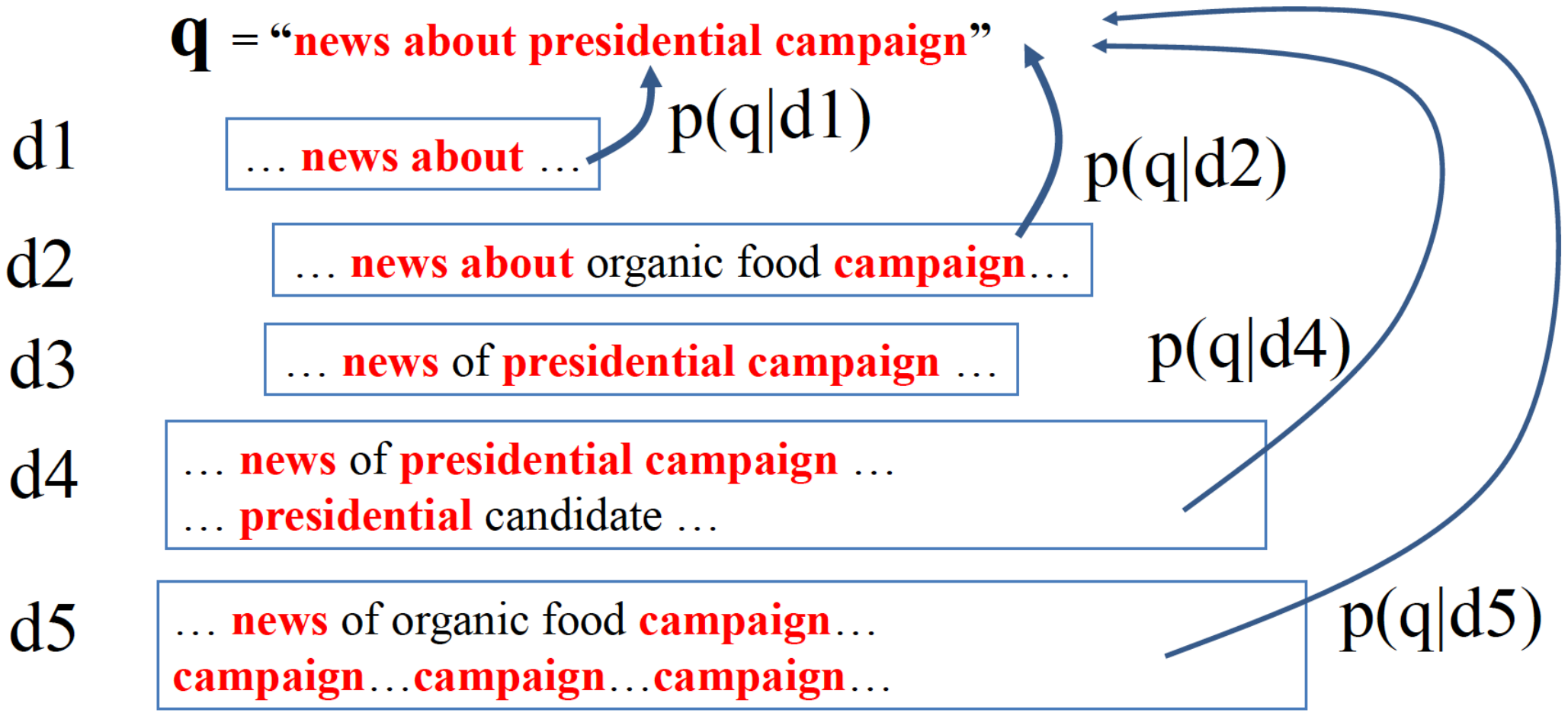
User likes d

$$f(q,d)=p(R=1|d,q)\approx \mathbf{p(q|d,R=1)}$$

How likely the user enters q

Assumption:
A user formulates a query based on an "**imaginary relevant document**"

Which doc is Most Likely the "Imaginary Relevant Doc"?



Summary

- Relevance(q,d) = p(R=1|q,d) ➔p(q|d,R=1)
- **Query likelihood** ranking function: f(q,d)=p(q|d)
  - Probability that a user who likes d would pose query q
- How to compute p(q|d)? How to compute probability of text in general? ➔ Language Model

p(q= "presidential campaign"**|d=** … **news** of **presidential** **campaign** … **presidential** candidate … **)**