Information Retrieval & Text Mining

Probabilistic Retrieval Model:
Query Likelihood

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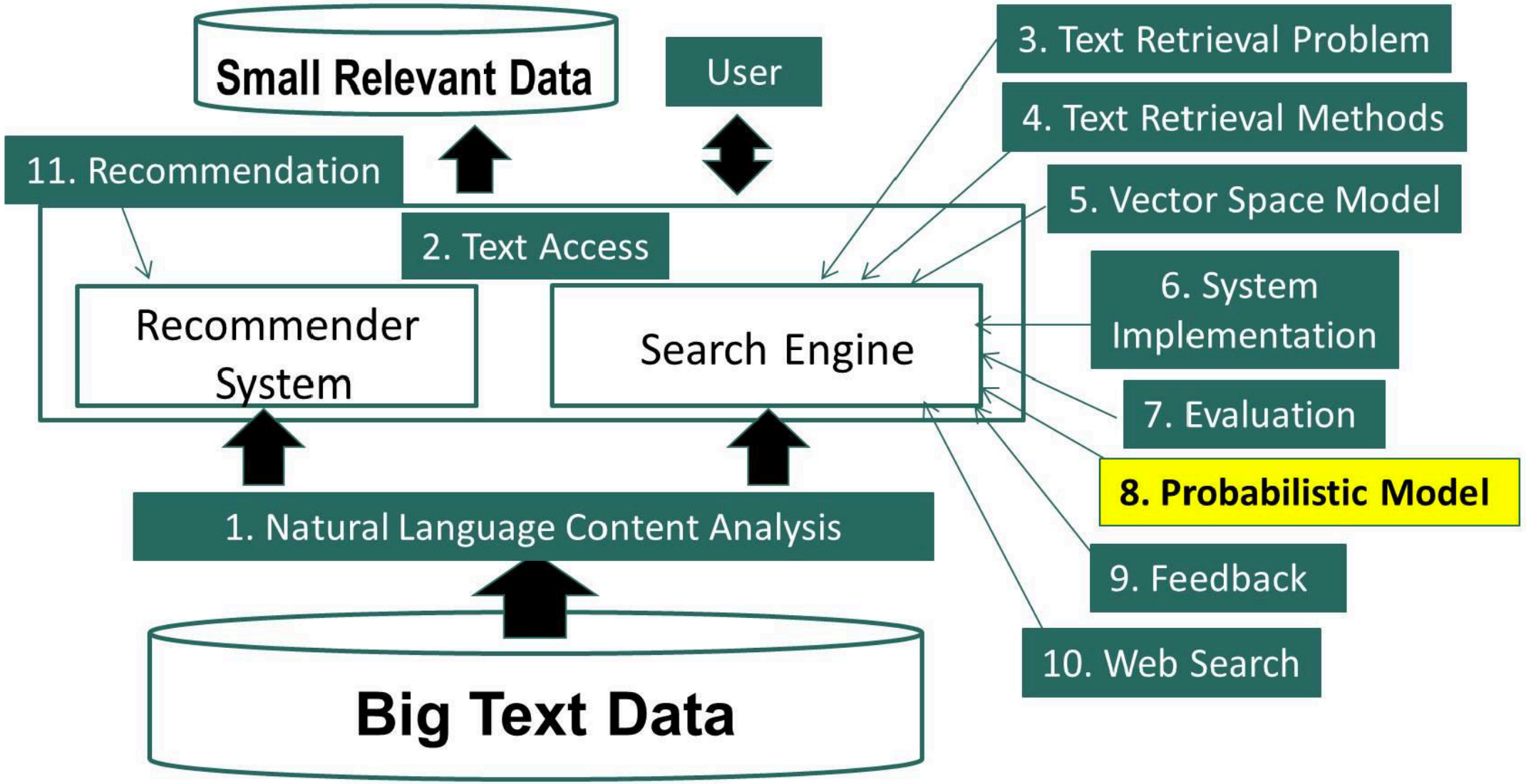
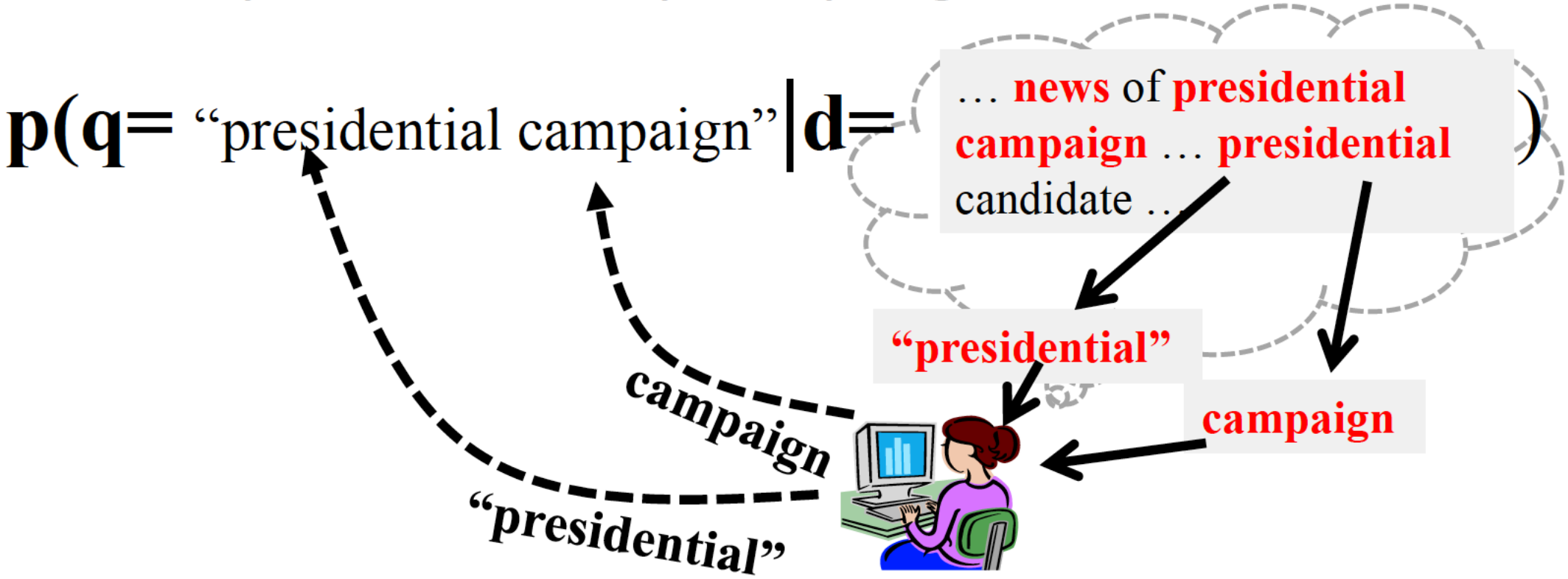
Probabilistic Retrieval Model: Query Likelihood



Query Generation by Sampling Words from Doc



If the user is **thinking of this doc** ,
how likely would she **pose this query**?

Unigram Query Likelihood

$$p(q=\text{“presidential campaign”}|d=\quad)$$

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

$$= p(\text{“presidential ”}|d) * p(\text{“campaign ”}|d)$$

$$= \frac{c(\text{" presidential"},d)}{|d|} * \frac{c(\text{"campaign"},d)}{|d|}$$

Assumption:

Each query word is generated independently

Does Query Likelihood Make Sense?

$$p(q = \text{"presidential campaign"} \mid d) = \frac{c(\text{"presidential"}, d)}{|d|} * \frac{c(\text{"campaign"}, d)}{|d|}$$

p(q|d4= … news of **presidential campaign** … **presidential** candidate … **)** $= \frac{2}{|d4|} * \frac{1}{|d4|}$

p(q|d3= … news of **presidential campaign** … **)** $= \frac{1}{|d3|} * \frac{1}{|d3|}$

p(q|d2= … news about organic food **campaign**… **)** $= \frac{0}{|d2|} * \frac{1}{|d2|} = 0$

d4> d3 > d2 as we expected

Try a Different Query?

q = "**presidential campaign update**"

p(q|d4= … news of **presidential campaign** … **presidential** candidate … **)** $= \frac{2}{|d4|} * \frac{1}{|d4|} * \frac{0}{|d4|} = 0!$

p(q|d3= … news of **presidential campaign** … **)** $= \frac{1}{|d3|} * \frac{1}{|d3|} * \frac{0}{|d3|} = 0!$

p(q|d2= … news about organic food **campaign**… **)** $= \frac{0}{|d2|} * \frac{1}{|d2|} * \frac{0}{|d2|} = 0$

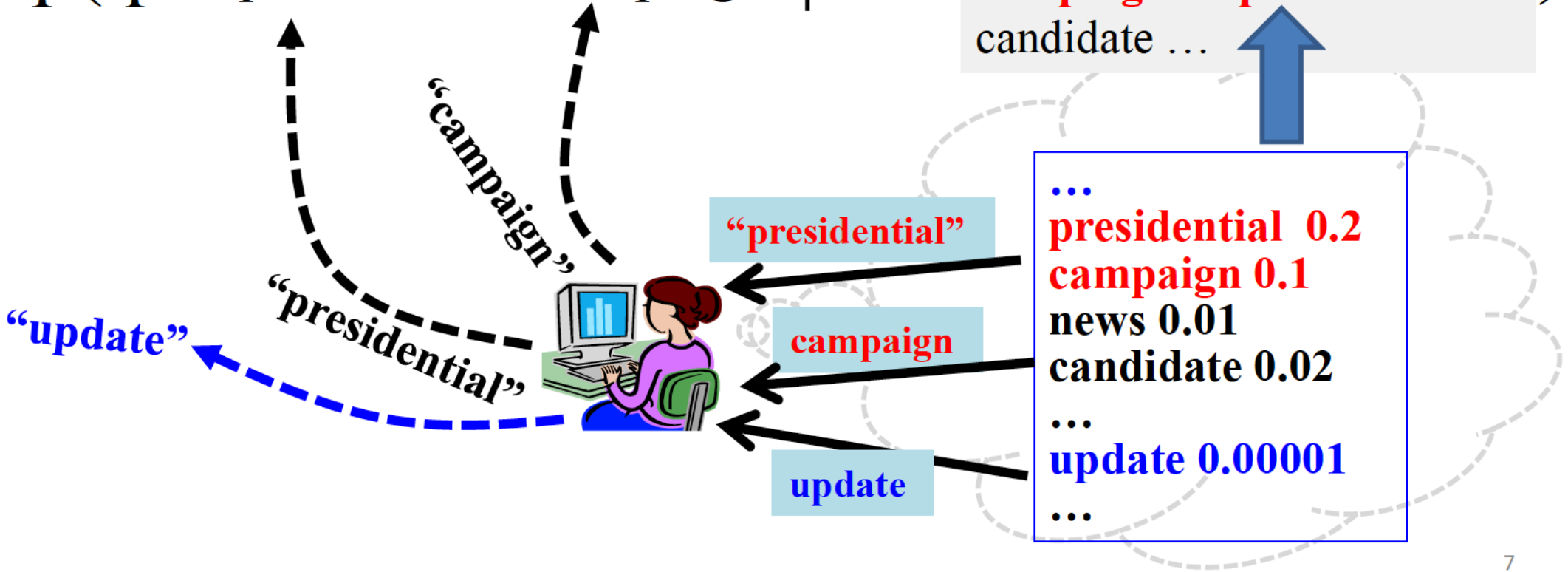
What assumption has caused this problem? How do we fix it?

Improved Model: Sampling Words from a **Doc Model**

How likely would we observe **this query** from **this doc model**?

$p(q=$ "presidential campaign" $|d=$ $)$

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



Computation of Query Likelihood

Document d1

Text mining paper

Document LM p(w|d1)

…
text 0.2
mining 0.1
association 0.01
clustering 0.02
…
food 0.00001
…

Document d2

Food nutrition paper

p(w|d2)

…
food 0.25
nutrition 0.1
healthy 0.05
diet 0.02
…

Query q =

"data mining algorithms"

$$p(\text{"data mining alg"}|d1) = p(\text{"data"}|d1) \times p(\text{"mining"}|d1) \times p(\text{"alg"}|d1)$$

$$p(\text{"data mining alg"}|d2) = p(\text{"data"}|d2) \times p(\text{"mining"}|d2) \times p(\text{"alg"}|d2)$$

Summary: Ranking based on Query Likelihood

$$q = w_1 w_2 \ldots w_n \qquad p(q \mid d) = p(w_1 \mid d) \times \ldots \times p(w_n \mid d)$$

$$f(q,d) = \log p(q \mid d) = \sum_{i=1}^{n} \log p(w_i \mid d) = \sum_{w \in V} c(w,q) \log p(w \mid d)$$

Document language model

Retrieval problem → Estimation of $p(w_i|d)$

Different estimation methods → different ranking functions