

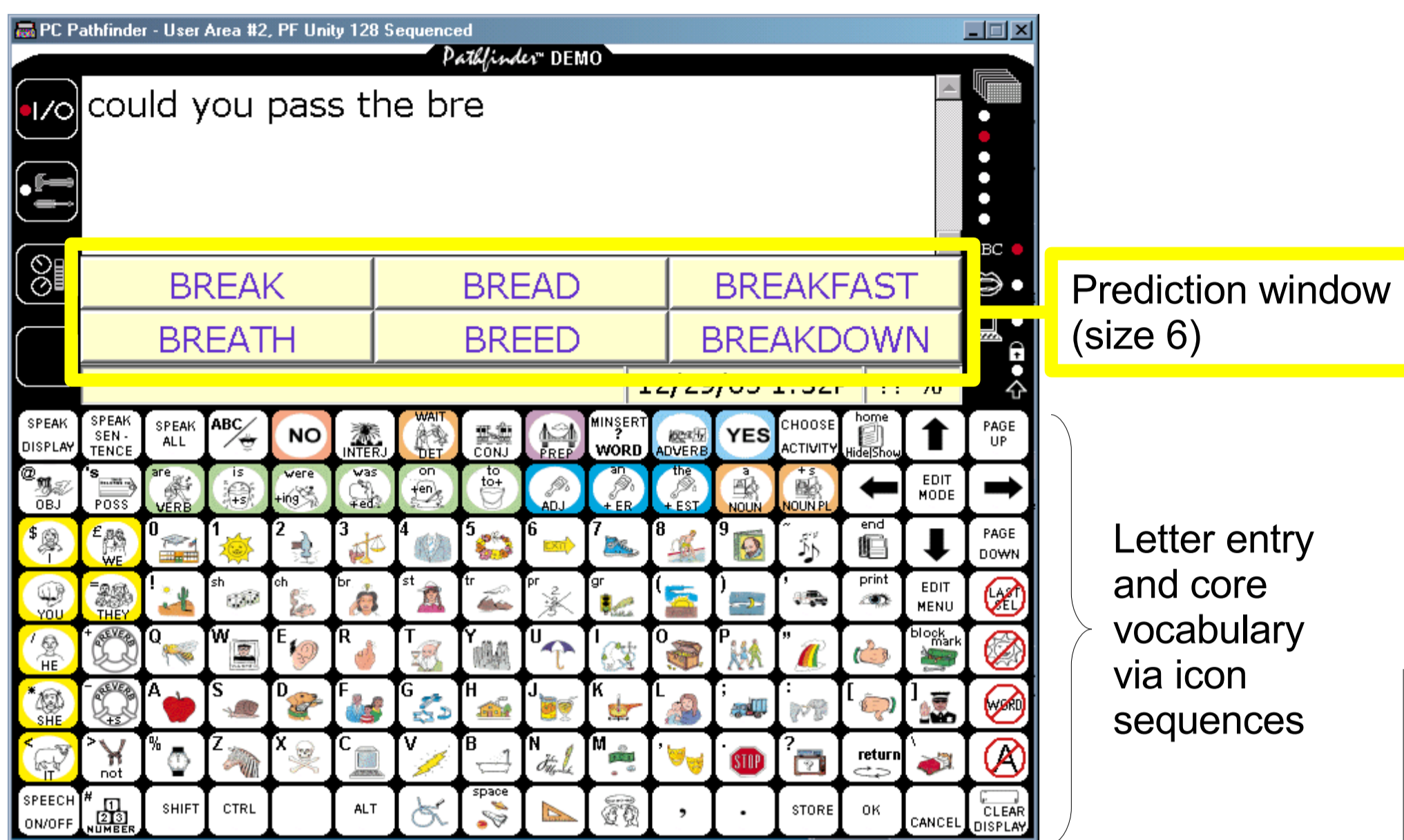
Topic Modeling in Fringe Word Prediction for AAC

Keith Trnka, Debra Yarrington, Kathleen McCoy
University of Delaware

Christopher Pennington
AgoraNet, Inc.

Motivation

Augmentative and Alternative Communication (AAC) is the field of research concerned with finding ways to help those with speech difficulties communicate more easily and completely. AAC devices such as PRC's Pathfinder (below) attempt to mitigate the lowered communication rate with unique user interfaces.

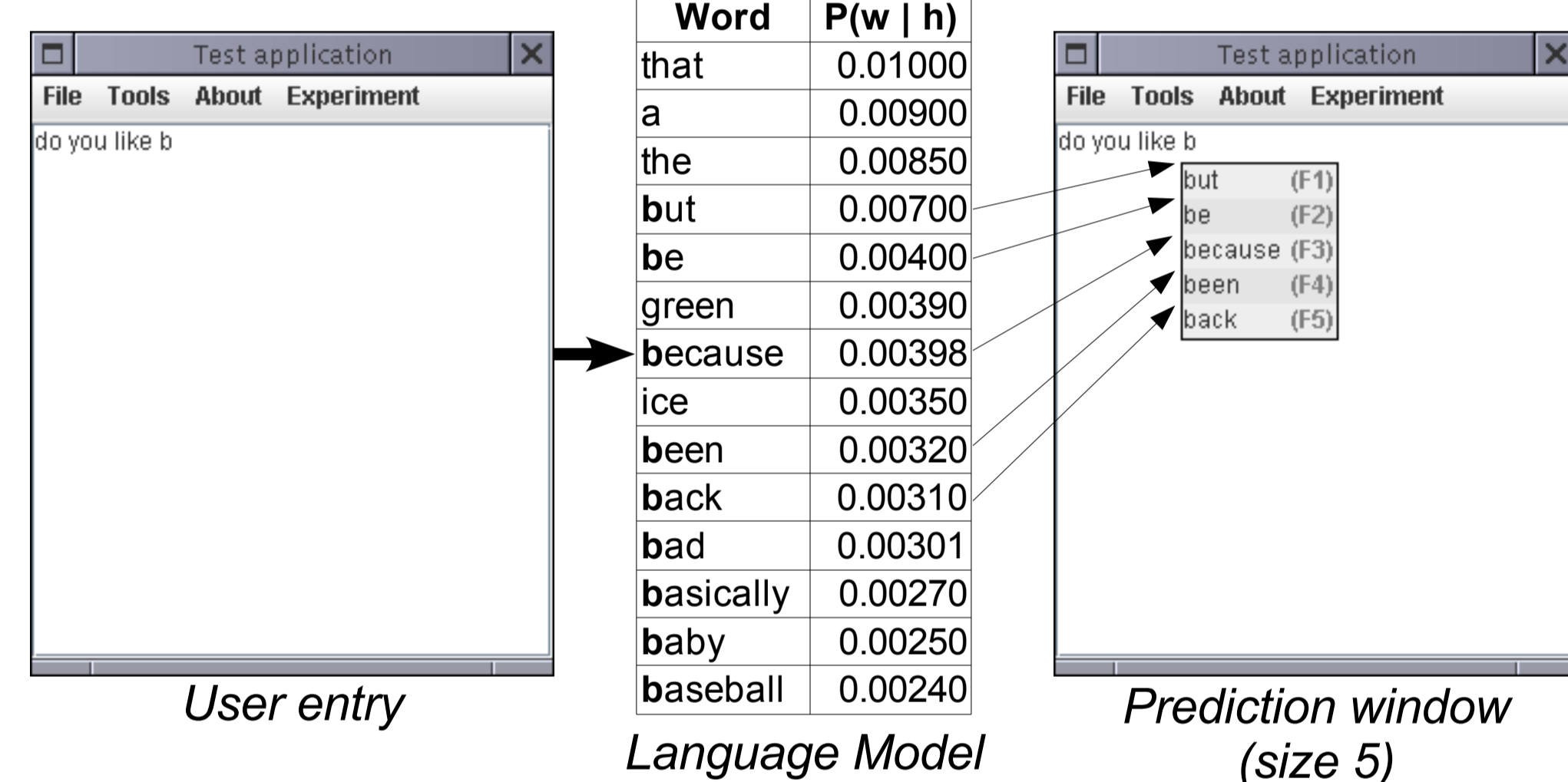


Prediction window (size 6)

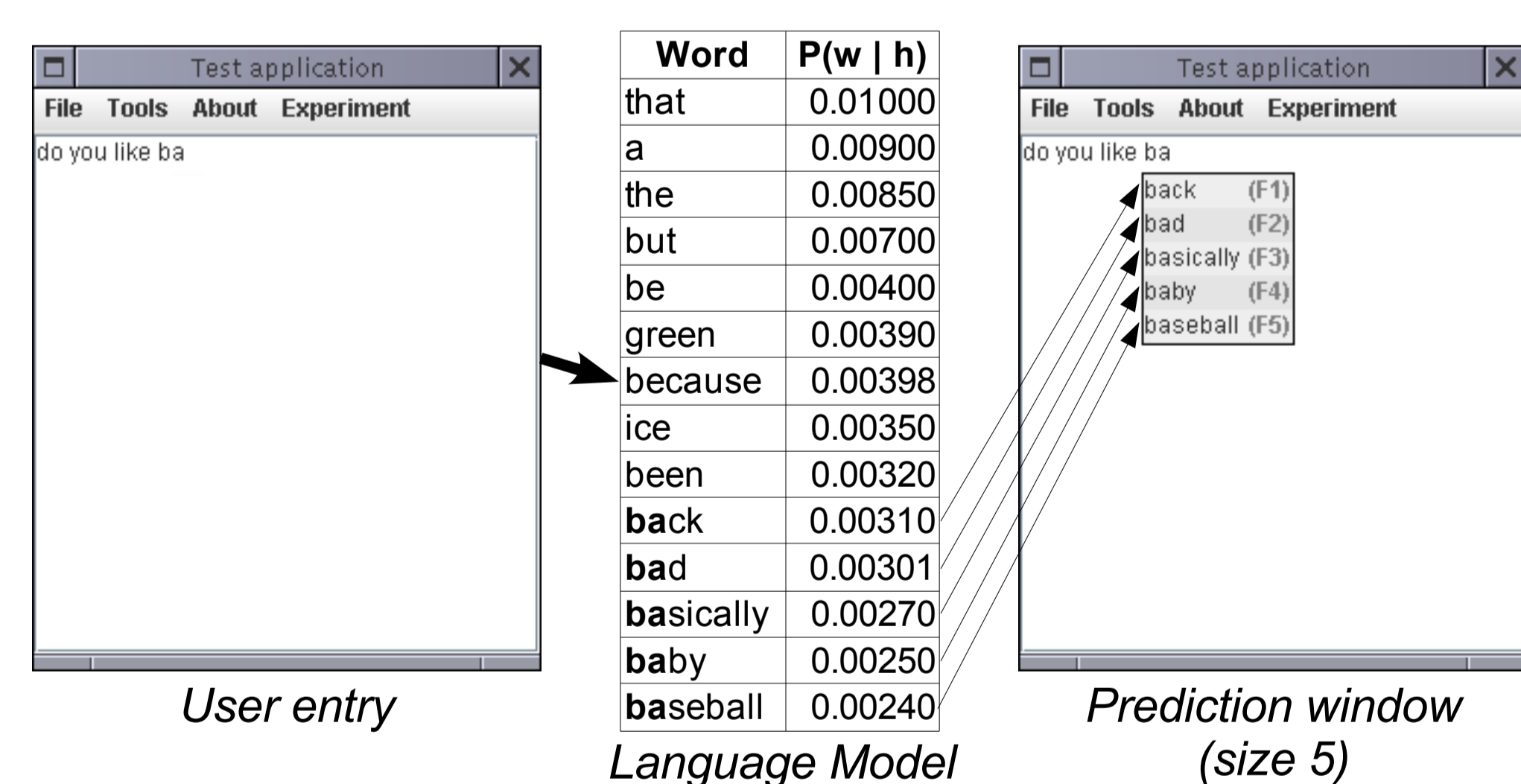
Letter entry and core vocabulary via icon sequences

Word Prediction for AAC

Suppose a user is asking a friend "do you like baseball games?"



User presses 'a'



User presses F5

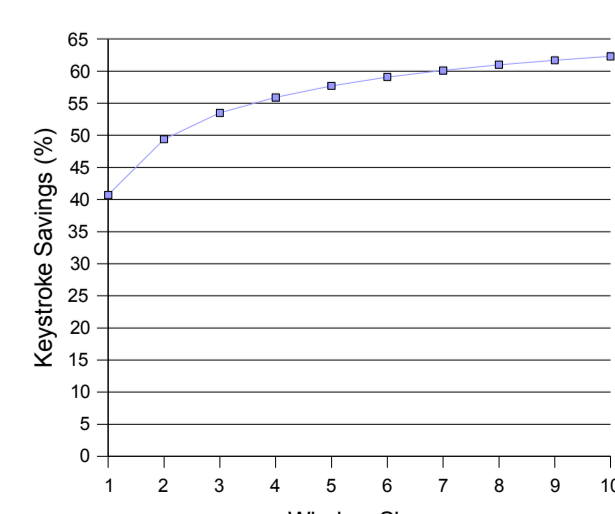
of characters: 8 + 1 (space incl.)
of keys pressed: 2 + 1
keystroke savings for "baseball" (window size 5):
 $\frac{9-3}{9} \times 100\% = 66.7\%$ savings
In general, the number of characters entered and keys pressed are accumulated over larger pieces of text:

$$KS = \frac{keys_{orig} - keys_{with prediction}}{keys_{orig}} \times 100\%$$

The user has finished typing "baseball"

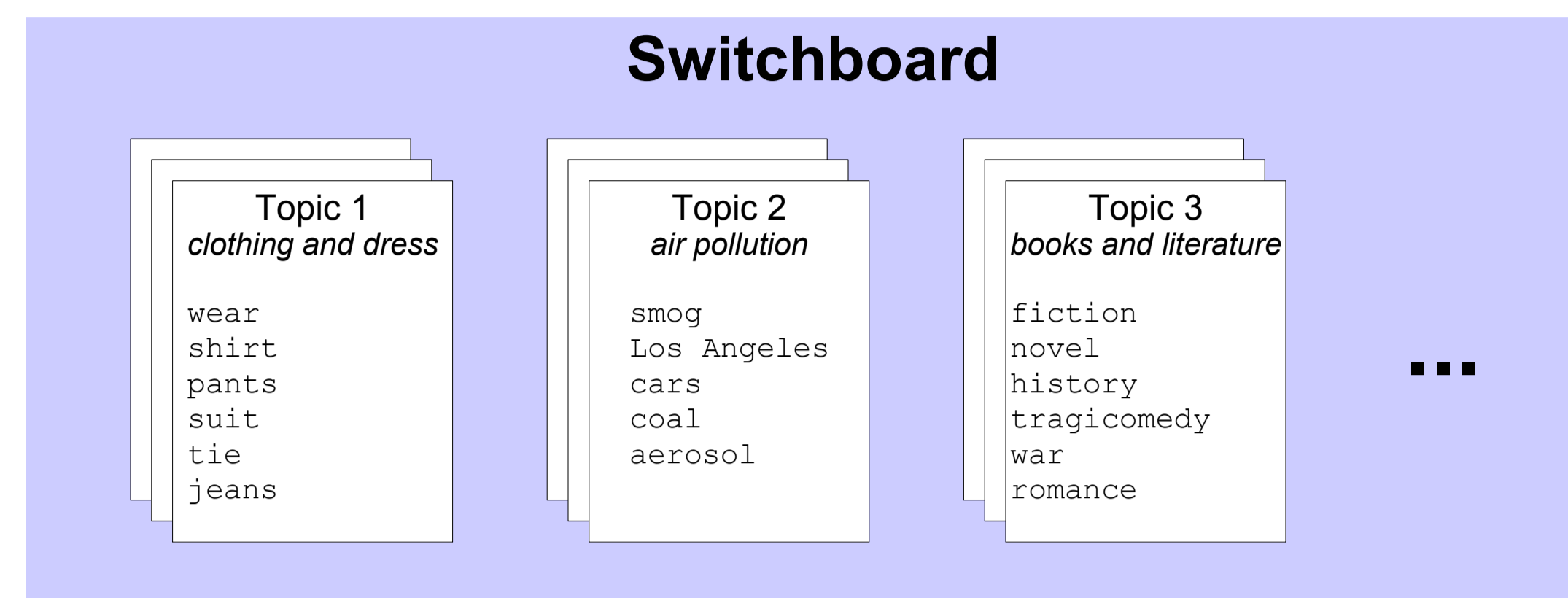
Trigram model: $P(w|h) = P(w|w_{-2} w_{-1})$

The keystroke savings of the trigram baseline is shown at several window sizes. Larger windows require fewer keystrokes.



Topic Modeling Approach

Topic Representation

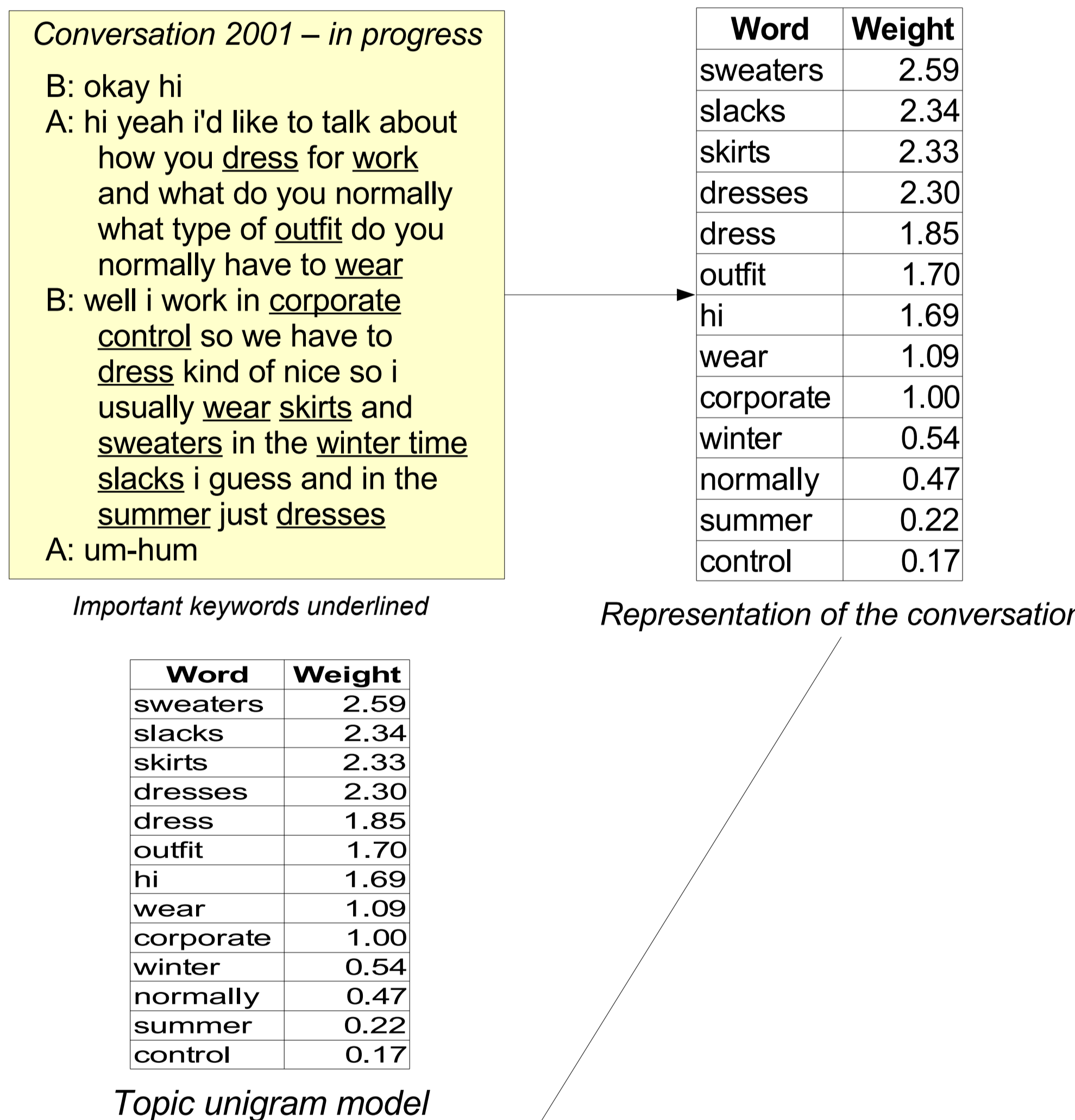


Language models are constructed from conversations in each topic. Some example high-probability keywords are shown.

Topic Identification

Questions to consider for each word

- How often is it used?
- How recently was it used?
- How good is it for topic identification?

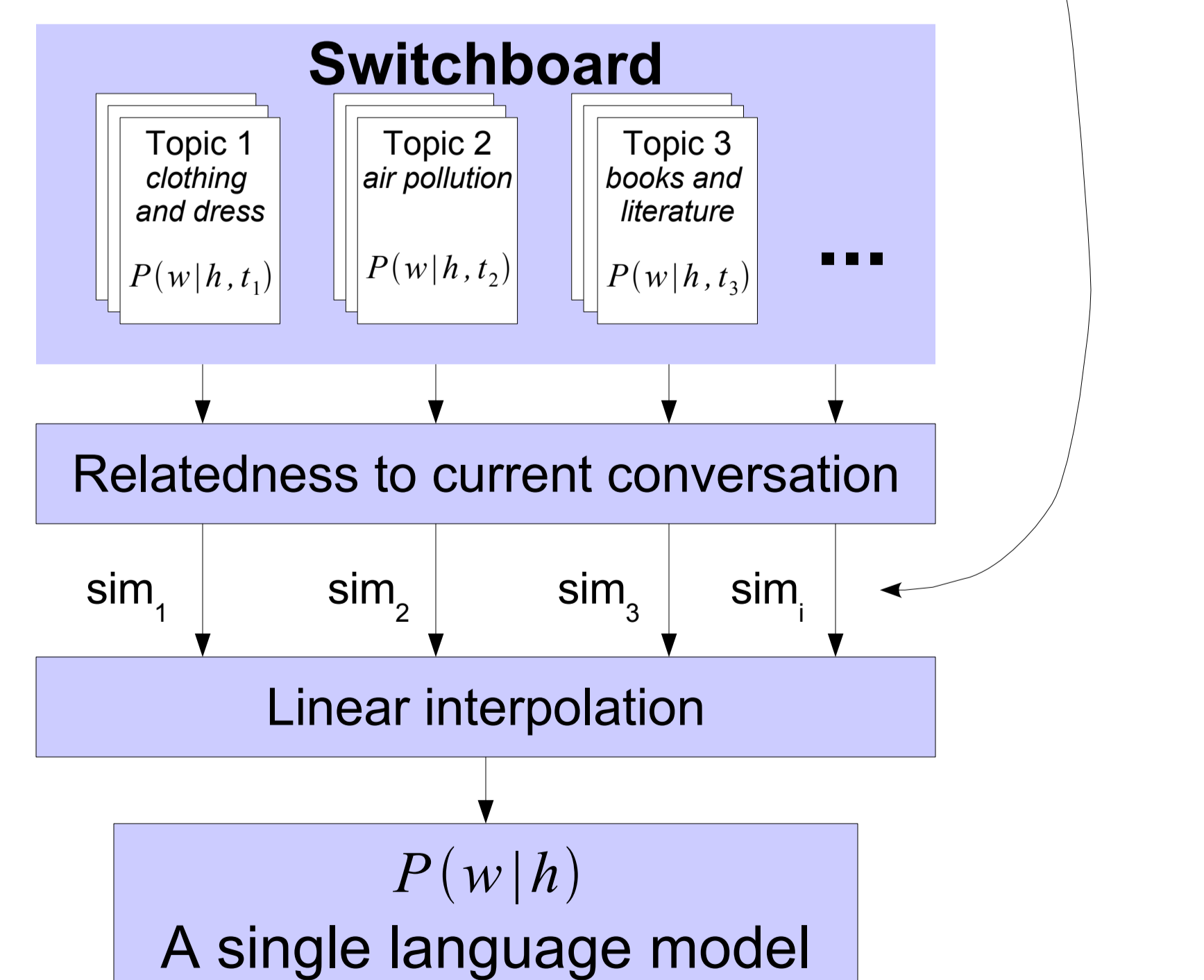


Topic unigram model

Cosine metric

Similarity score

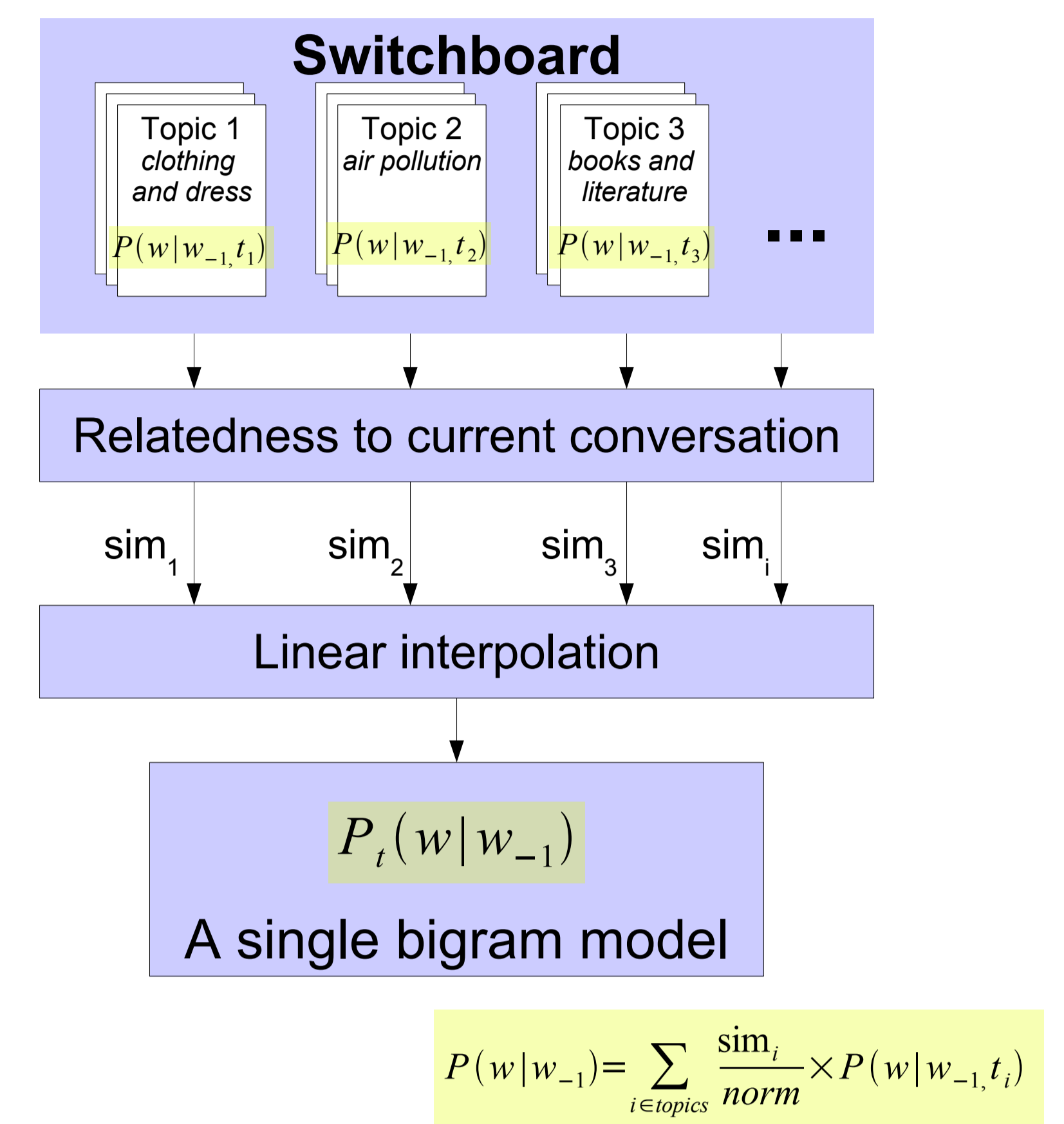
Topic Application



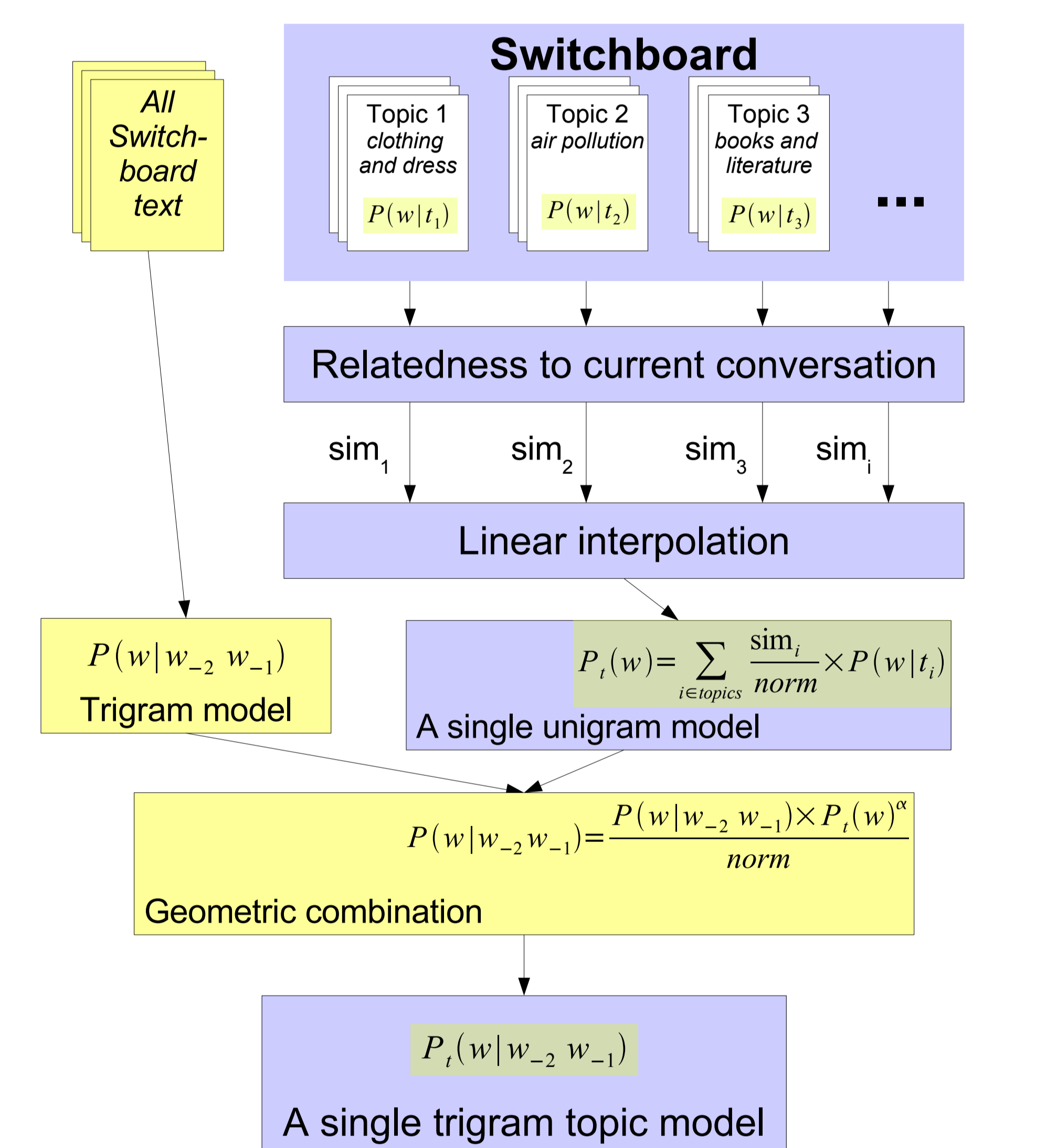
$$P(w|h) = \sum_{i \in topics} \frac{sim_i}{norm} \times P(w|h, t_i)$$

Topic Modeling in Detail

Method A



Method B



Results

Method A offers a **substantial improvement** over the baseline.

Window size	Trigrams	Method A	Δ
1	42.3	43.1	0.8
2	51.1	52.3	1.2
3	55.1	56.4	1.3
4	57.3	58.7	1.4
5	58.8	60.2	1.4
6	60.0	61.4	1.4
7	60.8	62.2	1.4
8	61.5	62.9	1.4
9	62.0	63.5	1.5
10	62.5	64.0	1.5

Window size	Trigrams	Method B	Δ
1	42.3	42.5	0.2
2	51.1	51.4	0.3
3	55.1	55.4	0.3
4	57.3	57.7	0.4
5	58.8	59.1	0.3
6	60.0	60.3	0.3
7	60.8	61.1	0.3
8	61.5	61.8	0.3
9	62.0	62.3	0.3
10	62.5	62.8	0.3

Method B improves over the baseline by a smaller amount, but is **computationally inexpensive**.

Window size	Method A	Method B	Δ
1	43.1	42.5	0.6
2	52.3	51.4	0.9
3	56.4	55.4	1.0
4	58.7	57.7	1.0
5	60.2	59.1	1.1
6	61.4	60.3	1.1
7	62.2	61.1	1.1
8	62.9	61.8	1.1
9	63.5	62.3	1.2
10	64.0	62.8	1.2

Method A clearly outperforms Method B, however, Method A is slower due to the cost of dynamically updating a bigram model as opposed to a unigram model.