COEN 169

Relevance Feedback

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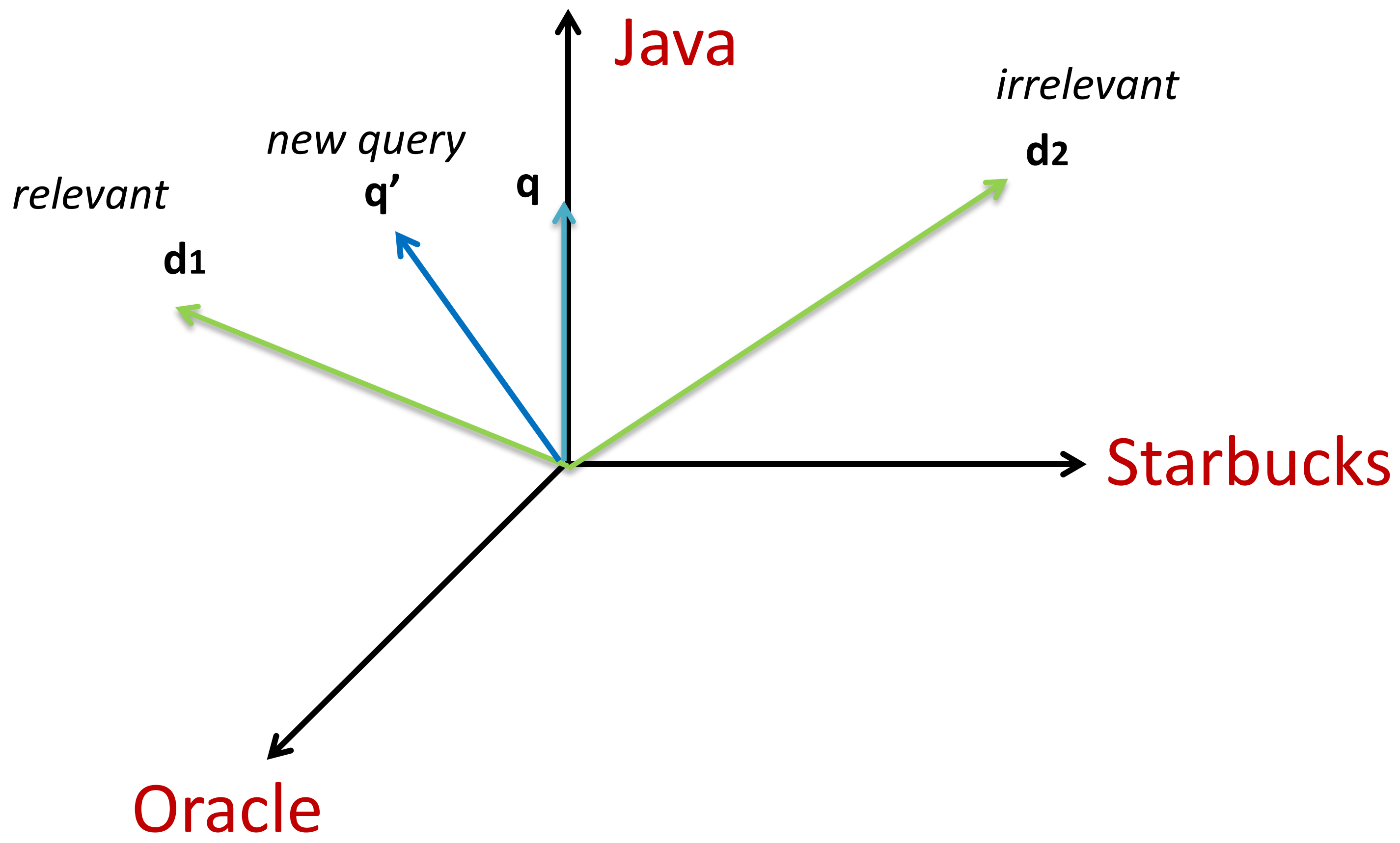
Query representation

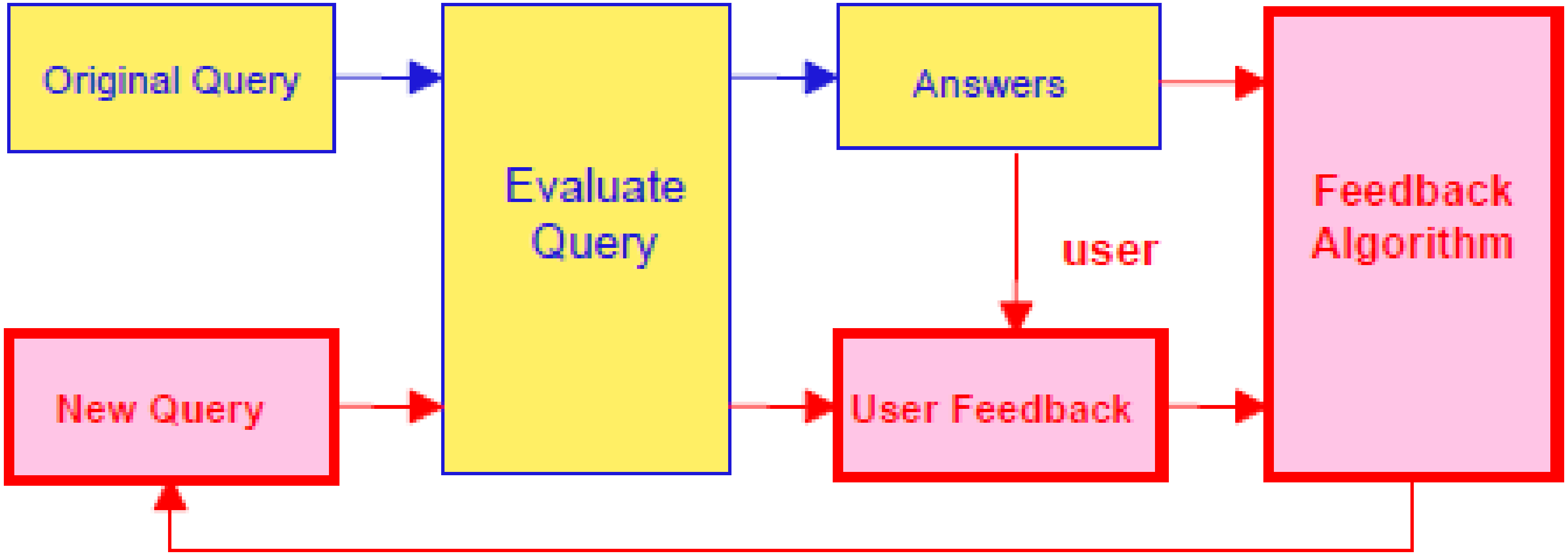
- Improving results
  - For high recall. E.g., searching for *aircraft* doesn't match with *plane;* nor *car* with *automobile*
- Options for improving results…
  - Local methods
    - Relevance feedback
    - Pseudo relevance feedback
  - Global methods
    - Query expansion
      - Thesauri
      - Automatic thesaurus generation

Query representation



Relevance feedback

- Relevance feedback: user feedback on relevance of docs in initial set of results
  - User issues a (short, simple) query
  - The user marks some results as relevant or non-relevant.
  - The system computes a better representation of the information need based on feedback.
  - Relevance feedback can go through one or more iterations.
- Idea: it may be difficult to formulate a good query when you don’t know the collection well, so iterate


Original Query
Evaluate Query
Answers
Feedback Algorithm
user
New Query
User Feedback

Example: image search

Euclidean distance

32-D HSV histograms

QueryImage

This is the initial query, for which 2 object are assessed as relevant by the user

Precision = 0.3 (including the query image)

Example: image search

- These are the results of the “refined” (new) query

  Precision = 0.8

Example: document search

- Initial query: *New space satellite applications*
  - \+ 1. 0.539, 08/13/91, NASA Hasn't Scrapped Imaging Spectrometer
  - \+ 2. 0.533, 07/09/91, NASA Scratches Environment Gear From Satellite Plan
  - 3. 0.528, 04/04/90, Science Panel Backs NASA Satellite Plan, But Urges Launches of Smaller Probes
  - 4. 0.526, 09/09/91, A NASA Satellite Project Accomplishes Incredible Feat: Staying Within Budget
  - 5. 0.525, 07/24/90, Scientist Who Exposed Global Warming Proposes Satellites for Climate Research
  - 6. 0.524, 08/22/90, Report Provides Support for the Critics Of Using Big Satellites to Study Climate
  - 7. 0.516, 04/13/87, Arianespace Receives Satellite Launch Pact From Telesat Canada
  - \+ 8. 0.509, 12/02/87, Telecommunications Tale of Two Companies
- User then marks relevant documents with "+".

Expanded query after relevance feedback

- 2.074 new
- 30.816 satellite
- 5.991 nasa
- 4.196 launch
- 3.516 instrument
- 3.004 bundespost
- 2.790 rocket
- 2.003 broadcast
- 0.836 oil

15.106 space
5.660 application
5.196 eos
3.972 aster
3.446 arianespace
2.806 ss
2.053 scientist
1.172 earth
0.646 measure

Results for expanded query

2 1. 0.513, 07/09/91, NASA Scratches Environment Gear From Satellite Plan

1 2. 0.500, 08/13/91, NASA Hasn't Scrapped Imaging Spectrometer

3. 0.493, 08/07/89, When the Pentagon Launches a Secret Satellite, Space Sleuths Do Some Spy Work of Their Own

4. 0.493, 07/31/89, NASA Uses 'Warm' Superconductors For Fast Circuit

8 5. 0.492, 12/02/87, Telecommunications Tale of Two Companies

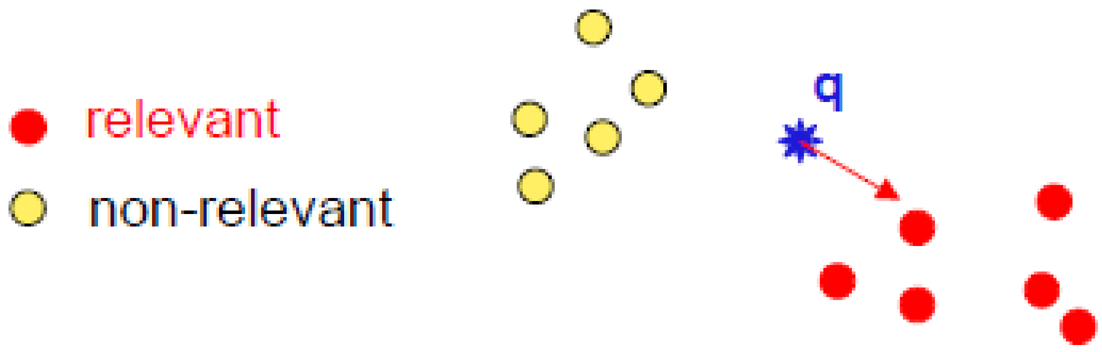
6. 0.491, 07/09/91, Soviets May Adapt Parts of SS-20 Missile For Commercial Use

7. 0.490, 07/12/88, Gaping Gap: Pentagon Lags in Race To Match the Soviets In Rocket Launchers

8. 0.490, 06/14/90, Rescue of Satellite By Space Agency To Cost $90 Million

Query point movement

The idea is simply to move the query point so as to get closer to relevant objects



Rocchio Algorithm

- The first formulation of the query point movement (QPM) strategy dates back to 70's, when it was proposed by J.J. Rocchio
- The <u>centroid</u> is the center of mass of a set of points
- Remember that we represent documents as points in a high-dimensional space
- Definition: Centroid

$$\vec{\mu}(C) = \frac{1}{|C|} \sum_{d \in C} \vec{d}$$

where C is a set of documents.

Rocchio 1971 Algorithm (SMART)

- Used in practice:

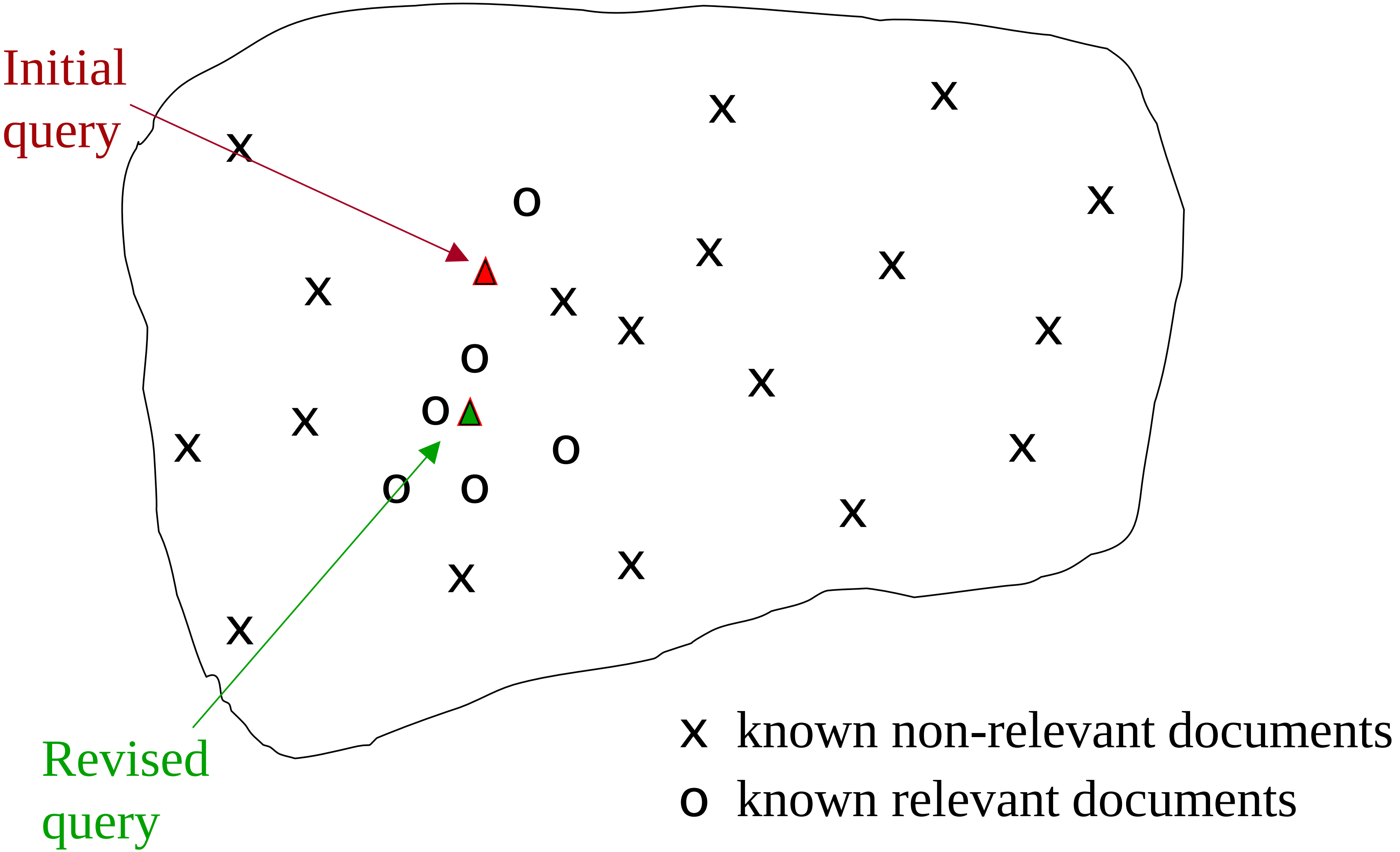
$$\vec{q}_m = \alpha \vec{q}_0 + \beta \frac{1}{|D_r|} \sum_{\vec{d}_j \in D_r} \vec{d}_j - \gamma \frac{1}{|D_{nr}|} \sum_{\vec{d}_j \in D_{nr}} \vec{d}_j$$

- D_r = set of <u>known</u> relevant doc vectors
- D_{nr} = set of <u>known</u> irrelevant doc vectors
- q_m = modified query vector; q_0 = original query vector
- α,β,γ: weights (hand-chosen or set empirically)
- New query moves toward relevant documents and away from irrelevant documents

Subtleties to note

- Tradeoff α vs. β/γ : If we have a lot of judged documents, we want a higher β/γ.
- In general, $\alpha=1$, $\beta=0.75$, $\gamma=0.25$
- Some weights in query vector can go negative
  - Negative term weights are ignored (set to 0)

Relevance feedback on initial query



Relevance Feedback in vector spaces

- We can modify the query based on relevance feedback and apply standard vector space model.
- Use only the docs that were marked.
- Relevance feedback can improve recall and precision
- Relevance feedback is most useful for increasing *recall* in situations where recall is important
  - Users can be expected to review results and to take time to iterate

Positive vs Negative Feedback

- Positive feedback is more valuable than negative feedback (so, set $\gamma < \beta$; e.g. $\gamma = 0.25$, $\beta = 0.75$).
- Many systems only allow positive feedback ($\gamma=0$).

Relevance Feedback: Assumptions

- Assumption 1: User has reasonable knowledge for initial query.
- Assumption 2: Relevance prototypes are "well-behaved".
  - Term distribution in relevant documents will be similar
  - Term distribution in non-relevant documents will be different from those in relevant documents
    - All relevant documents are tightly clustered
    - Similarities between relevant and irrelevant documents are small

Violation of Assumption 2

- Relevant (or irrelevant) documents show multimodal behaviors

Relevance Feedback: Problems

- Long queries are inefficient for typical IR engine.
  - Long response times for user.
  - High cost for retrieval system.
  - Partial solution:
    - Only reweight certain prominent terms
      - Perhaps top 20 by term frequency
- Users are often reluctant to provide explicit feedback

Rule-of-thumb

- Empirically, one round of relevance feedback is often very useful. Two rounds is sometimes marginally useful.
- Having at least 5 judged documents is recommended

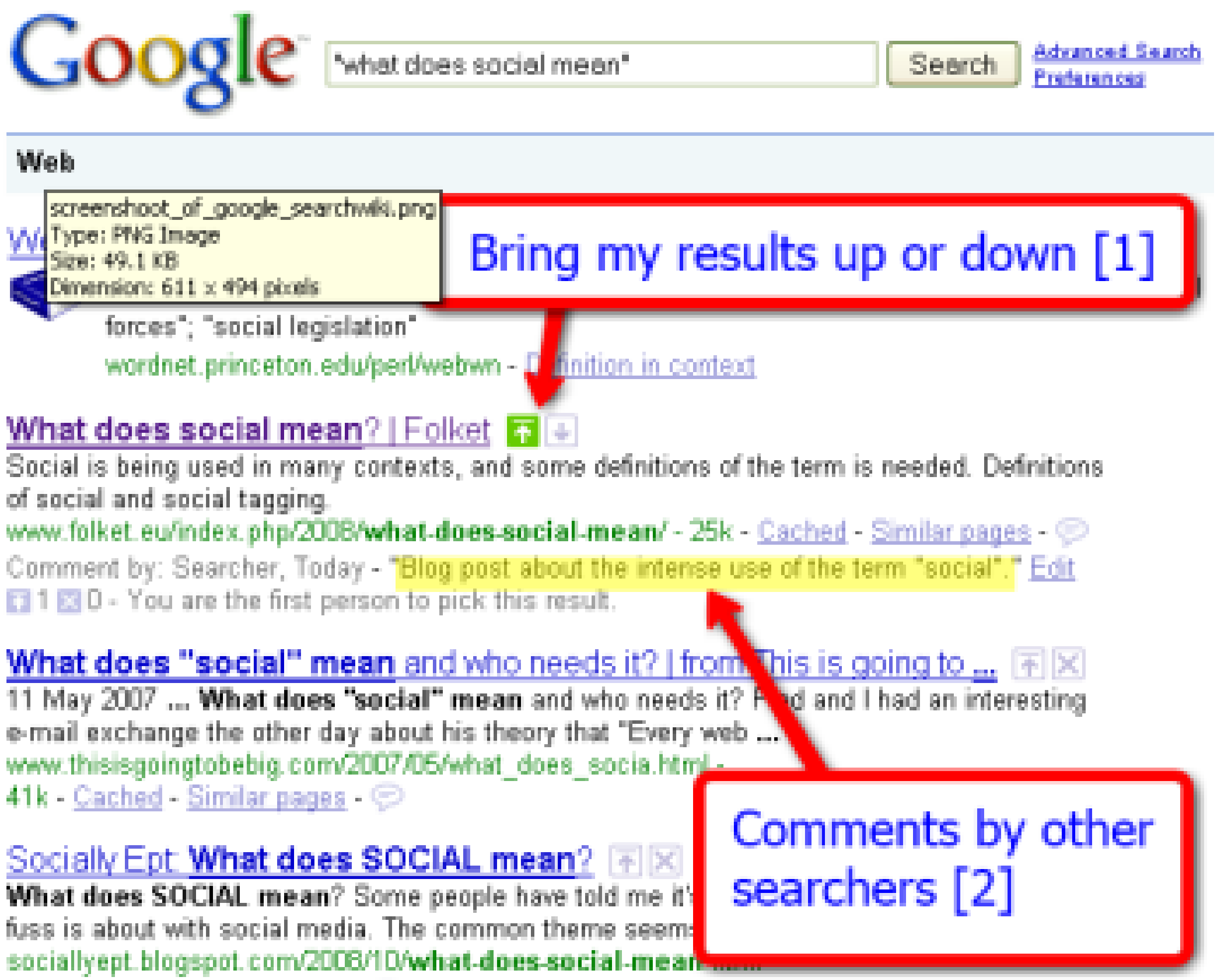
Relevance Feedback on the Web

- Most Web search engines do not provide the relevance feedback feature because it is hard to explain to average user:
  - Google
  - Bing
  - Yahoo

- Google's SearchWiki was released in 2008 and discontinued in 2010

  - allowed logged-in users to annotate and re-order search results

Google's SearchWiki



Excite Relevance Feedback

- Excite initially had true relevance feedback, but abandoned it due to lack of use

Spink et al. 2000

- Only about 4% of query sessions from a user used relevance feedback option
  - Expressed as “More like this” link next to each result
- Relevance feedback improved results about 2/3 of the time

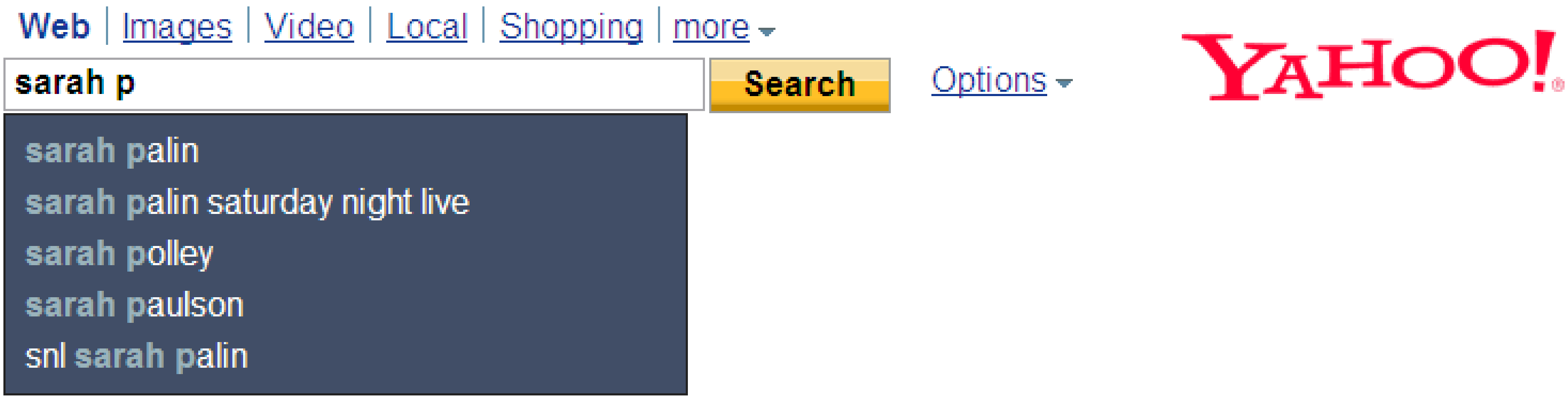
Pseudo relevance feedback

- Pseudo-relevance feedback automates the "manual" part of true relevance feedback.
- Pseudo-relevance algorithm:
  - Retrieve a ranked list of hits for the user's query
  - Assume that the top k documents are relevant.
  - Do relevance feedback (e.g., Rocchio)
- Works very well on average
- But can go horribly wrong for some queries.
- Several iterations can cause query drift.

Query Suggestion

- In relevance feedback, users give additional input (relevant/non-relevant) on documents, which is used to reweight terms in the documents
- In query suggestion, users give additional input (good/bad search term) on words or phrases

Query assist



Would you expect such a feature to increase the query volume at a search engine?

How do we augment the user query?

- Thesaurus
  - E.g. MedLine: physician, syn: doc, doctor, MD, medico
  - Can be query rather than just synonyms
- Global Analysis: (static; of all documents in collection)
  - Automatically derived thesaurus
    - (co-occurrence statistics)
  - Refinements based on query log mining
    - Common on the web
- Local Analysis: (dynamic)
  - Analysis of documents in result set

Thesaurus-based query expansion

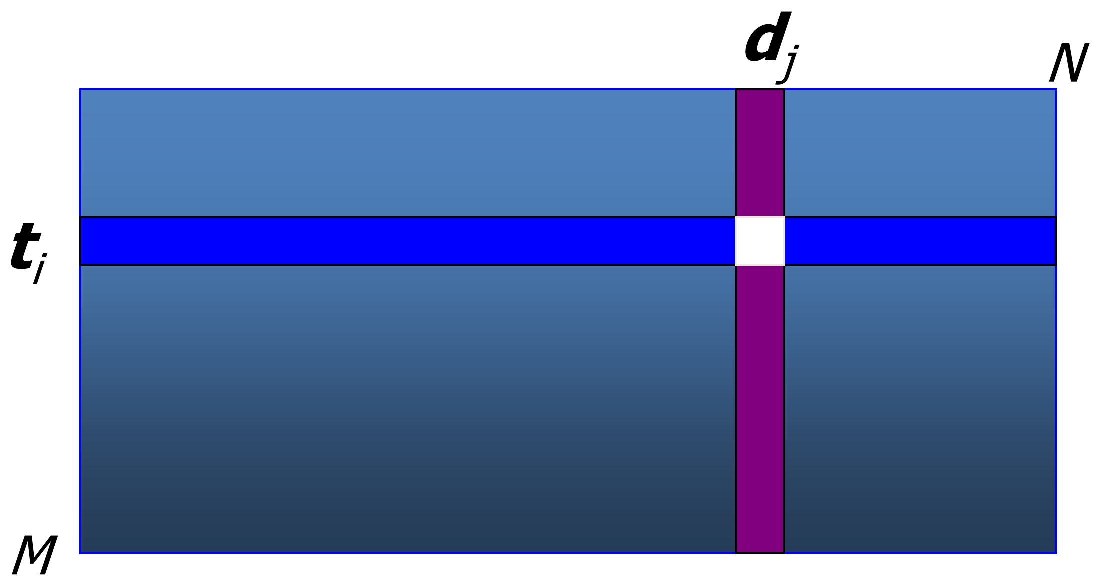
- For each term, *t*, in a query, expand the query with synonyms and related words of *t* from the thesaurus
  - feline → feline cat
- May weight added terms less than original query terms.
- Generally increases recall
- Widely used in many science/engineering fields
- May significantly decrease precision, particularly with ambiguous terms.
  - "interest rate" → "interest rate fascinate evaluate"
- There is a high cost of manually producing a thesaurus
  - And for updating it for scientific changes

Automatic Thesaurus Generation

- Attempt to generate a thesaurus automatically by analyzing the collection of documents
- Fundamental notion: similarity between two words
- Definition 1: Two words are similar if they co-occur frequently in a document or paragraph.
- Definition 2: Two words are similar if they occur in a given grammatical relation with the same words.
- You can harvest, peel, eat, or prepare apples and pears, so apples and pears must be similar.
- Co-occurrence based is more robust, grammatical relations are more accurate.

Co-occurrence Thesaurus

- Simplest way to compute one is based on term-term similarities in $C = AA^T$ where A is term-document matrix.
- $w_{i,j}$ = (normalized) weight for (t_i ,$\boldsymbol{d}_j$)



What does C contain if A is a term-doc binary (0/1) matrix?

- For each t_i, pick terms with high values in C

Automatic Thesaurus Generation Example

word	ten nearest neighbors
absolutely	absurd whatsoever totally exactly nothing
bottomed	dip copper drops topped slide trimmed slig
captivating	shimmer stunningly superbly plucky witty
doghouse	dog porch crawling beside downstairs gazec
Makeup	repellent lotion glossy sunscreen Skin gel p
mediating	reconciliation negotiate cease conciliation p
keeping	hoping bring wiping could some would othe
lithographs	drawings Picasso Dali sculptures Gauguin
pathogens	toxins bacteria organisms bacterial parasite
senses	grasp psyche truly clumsy naive innate awk

Automatic Thesaurus Generation Discussion

- Quality of associations is usually a problem.
- Term ambiguity may introduce irrelevant statistically correlated terms.
  - "Apple computer" $\rightarrow$ "Apple red fruit computer"
- Problems:
  - False positives: Words deemed similar that are not
  - False negatives: Words deemed dissimilar that are similar
- Since terms are highly correlated anyway, expansion may not retrieve many additional documents.

Indirect relevance feedback

- On the web, indirect/implicit relevance feedback is abundantly available
- implicit relevance feedback:

  - which documents they do and do not select for viewing

  - the duration of time spent viewing a document

  - page browsing or scrolling actions, etc.
- Not necessarily user or query specific
  - This is the general area of ***clickstream mining***
- Today – handled as part of machine-learned ranking