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Web Information Retrieval

HCI

SOSE2023

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Credit for these slides

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These slides have been adapted from

- Web IR (Zeyd Boukhers-WeST, SOSE 2020)

Recapitulation

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- PageRank
  - Web graph
  - Origins
  - Motivation
  - Idea of PageRank
  - Recursive formalization
  - Random surfer
  - Formal Model

Objectives of this Lecture

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- Query Specification
- Query Reformulation
- Retrieval Results Display
- Visualizing Research Results
- Design & Evaluation

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1. Query Specification

User Interfaces for Search

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- Query specification
- Retrieval result display
- Organizing search results
- Visualization in search interfaces
- Design and evaluation

Query Specification

- The primary methods for users to express their information need(s) are either
  - entering words into a **search entry** form
  - selecting links from a **directory** or other information organization display
- For Web search engines, the query is specified in textual form
- Typically, Web queries today are very short consisting of one to three words

Query Specification

- Short queries reflect the standard usage scenario
  - If the results do not look relevant, then the user reformulates their query
  - If the results are promising, then the user navigates to the most relevant-looking Web site
- This search behavior is a demonstration of the **orienteering strategy** of Web search

Query Specification

- Before the Web, search systems regularly supported **Boolean operators** and **command-based syntax**
  - However, these are often difficult for most users to understand
- Jansen *et al* conducted a study over a Web log with 1.5M queries, and found that
  - 2.1% of the queries contained Boolean operators
  - 7.6% contained other query syntax, primarily double-quotation marks for phrases
- White *et al* examined interaction logs of nearly 600,000 users, and found that
  - 1.1% of the queries contained one or more operators
  - 8.7% of the users used an operator at any time

Query Specification Interfaces

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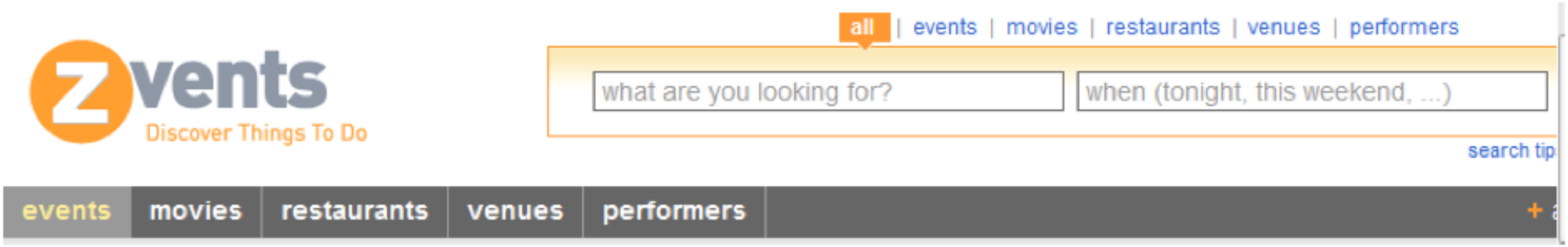
- The standard interface for a textual query is a **search box entry form**
- Studies suggest a relationship between query length and the width of the entry form
  - Results found that either small forms discourage long queries or wide forms encourage longer queries

Query Specification Interfaces

- Some entry forms are followed by a form that filters the query in some way
- For instance, at yelp.com, the user can refine the search by location using a second form
- Notice that the yelp.com form also shows the user's home location, if it has been specified previously

Query Specification Interfaces

- Some search forms show hints on what kind of information should be entered into each form
- For instance, in zvents.com search, the first box is labeled “what are you looking for”?



Query Specification Interfaces

- The previous example also illustrates specialized input types that some search engines are supporting today
  - The zvents.com site recognizes that words like “tomorrow” are time-sensitive
  - It also allows flexibility in the syntax of dates
- To illustrate, searching for “*comedy on wed*”, *it* automatically computes the date for the nearest future Wednesday
  - This is an example of how the interface can be designed to reflect how people think

Query Specification Interfaces

- Some interfaces show a list of query suggestions as the user types the query
  - This is referred to as **auto-complete, auto-suggest**, or **dynamic query suggestions**
  - Anick *et al* found that users clicked on dynamic Yahoo suggestions one third of the time
- Often the suggestions shown are those whose prefix matches the characters typed so far
  - However, in some cases, suggestions are shown when only interior letters match
- Further, suggestions may be shown that are synonyms of the words typed so far

Query Specification Interfaces

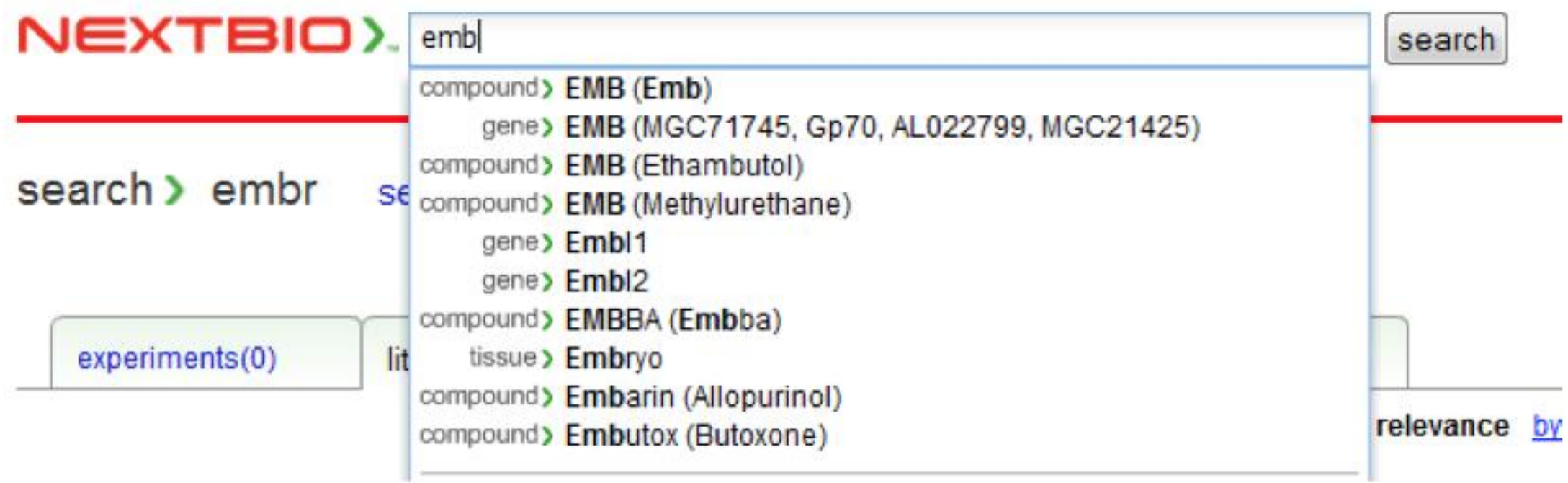
- Dynamic query suggestions, from Netflix.com

Query Specification Interfaces

- The dynamic query suggestions can be derived from several sources, including
  - The user's own query history
  - A set of metadata that a Web site's designer considers important
  - All of the text contained within a Web site

Query Specification Interfaces

- Dynamic query suggestions, grouped by type, from NextBio.com



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2. Query Reformulation

Query Reformulation

- There are tools to help users **reformulate** their query
  - One technique consists of showing terms related to the query or to the documents retrieved in response to the query
- A special case of this is **spelling corrections** or **suggestions**
  - Usually only one suggested alternative is shown: clicking on that alternative re-executes the query
  - In years back, the search results were shown using the purportedly incorrect spelling

Query Reformulation

- **Term expansion**: search interfaces are increasingly employing related term suggestions
- Log studies suggest that term suggestions are a somewhat heavily-used feature in Web search
- Jansen *et al* made a log study and found that 8% of queries were generated from term suggestions
- Anick *et al* found that 6% of users who were exposed to term suggestions chose to click on them

Query Reformulation

- Some query term suggestions are based on the entire search session of the particular user
- Others are based on behavior of other users who have issued the same or similar queries in the past
  - One strategy is to show similar queries by other users
  - Another is to extract terms from documents that have been clicked on in the past by searchers who issued the same query

Query Reformulation

- **Relevance feedback** is another method whose goal is to aid in query reformulation
- The main idea is to have the user indicate which documents are relevant to their query
  - In some variations, users also indicate which terms extracted from those documents are relevant
- The system then computes a new query from this information and shows a new retrieval set

Query Reformulation

- Nonetheless, this method has not been found to be successful from a usability perspective
  - Because of that, it does not appear in standard interfaces today
- This stems from several factors
  - People are not particularly good at judging document relevance, especially for topics with which they are unfamiliar
  - The beneficial behavior of relevance feedback is inconsistent

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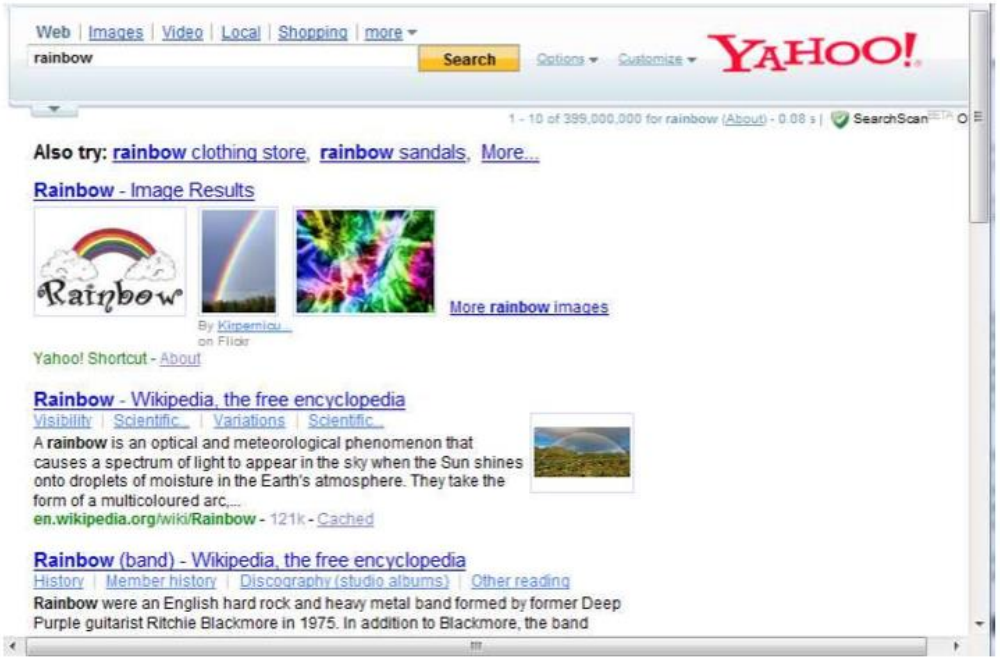
3. Retrieval Results Display

Retrieval Results Display

- In Web search, the **page title** is usually shown prominently, along with the URL and other metadata
- In search over information collections, metadata such as **date published** and **author** are often displayed
- Text **summary** (or **snippet**) containing text extracted from the document is also critical
- Currently, the standard results display is a vertical list of textual summaries
- This list is sometimes referred to as the *SERP* (Search Engine Results Page)

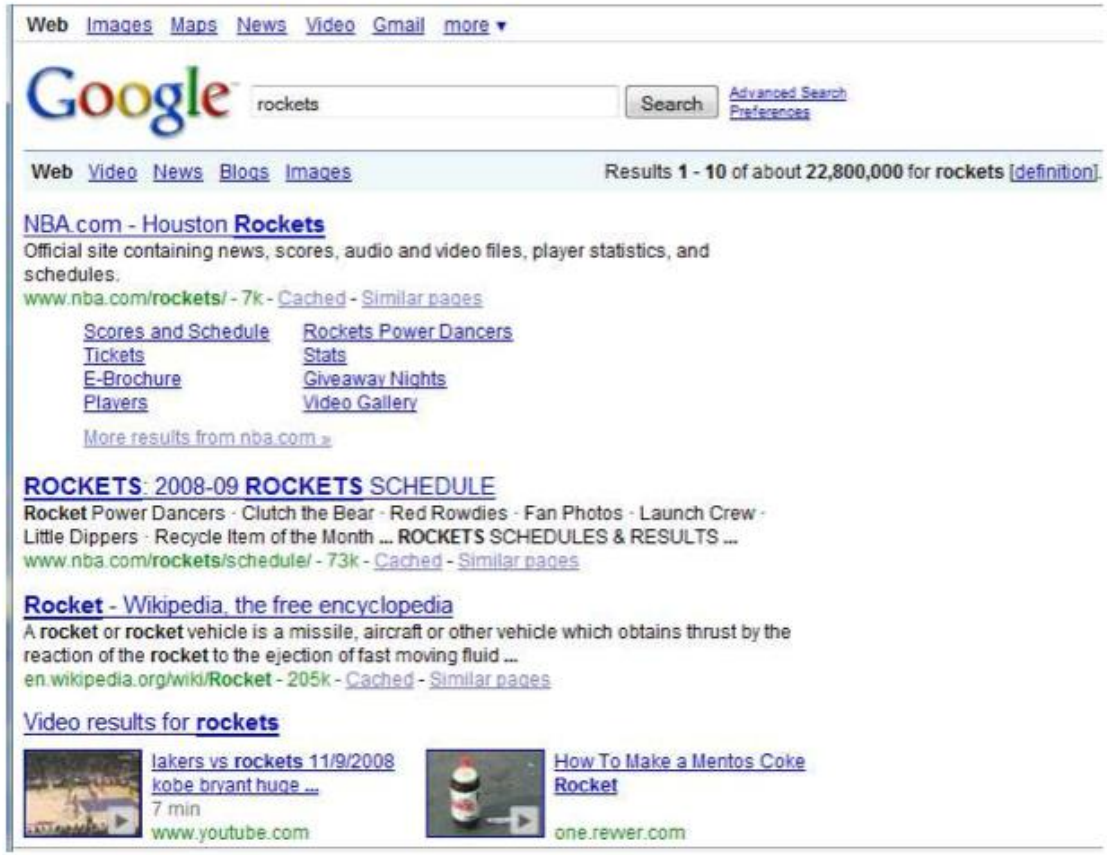
Retrieval Results Display

- In some cases the summaries are excerpts drawn from the full text that contain the query terms
- In other cases, specialized kinds of metadata are shown in addition to standard textual results
  - This technique is known as **blended results** or **universal search**



Retrieval Results Display

- A query on the name of a sports team might retrieve the latest game scores and a link to buy tickets



Retrieval Results Display

- Nielsen notes that in some cases the information need is satisfied directly in the search results listing
  - This makes the search engine an “answer engine”
- Displaying the query terms in the context in which they appear in the document
  - Improves the user’s ability to gauge the relevance of the results
  - It is sometimes referred to as **KWIC** - keywords in context
  - It is also known as query-biased summaries, query-oriented summaries, or user-directed summaries

Retrieval Results Display

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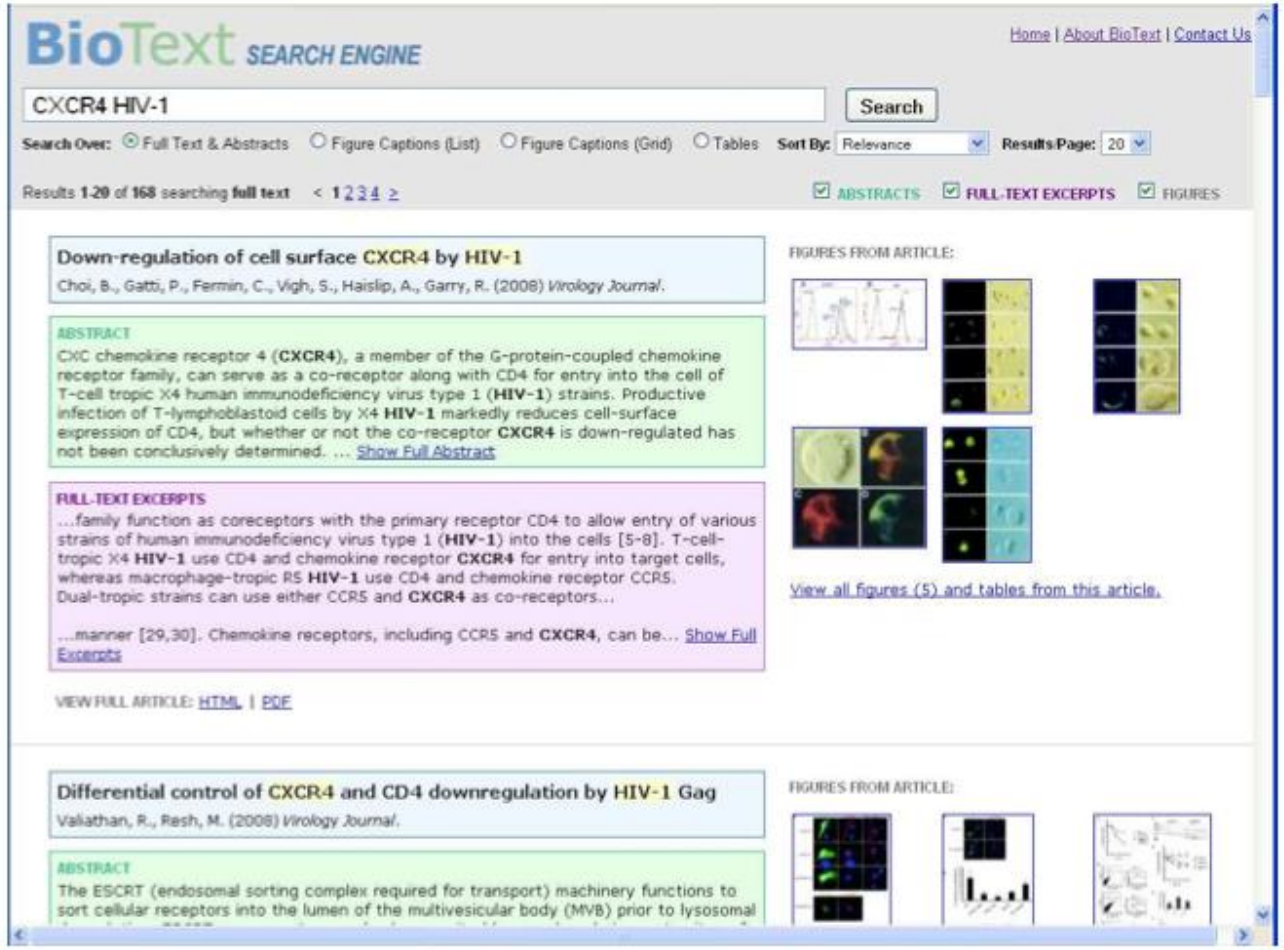
- The visual effect of query **term highlighting** can also improve usability of search results listings
  - Highlighting can be shown both in document surrogates in the retrieval results and in the retrieved documents
- Determining which text to place in the summary, and how much text to show, is a challenging problem
- Often the summaries contain all the query terms in close proximity to one another
- However, there is a trade-off between
  - Showing contiguous sentences, to aid in coherence in the result
  - Showing sentences that contain the query terms

Retrieval Results Display

- Some results suggest that it is better to show full sentences rather than cut them off
  - On the other hand, very long sentences are usually not desirable in the results listing
- Further, the kind of information to display should vary according to the intent of the query
  - Longer results are deemed better than shorter ones for certain types of information need
  - On the other hand, abbreviated listing is preferable for navigational queries
  - Similarly, requests for factual information can be satisfied with a concise results display

Retrieval Results Display

- The page results below show figures extracted from journal articles alongside the search results



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4. Organizing Search Results

Organizing Search Results

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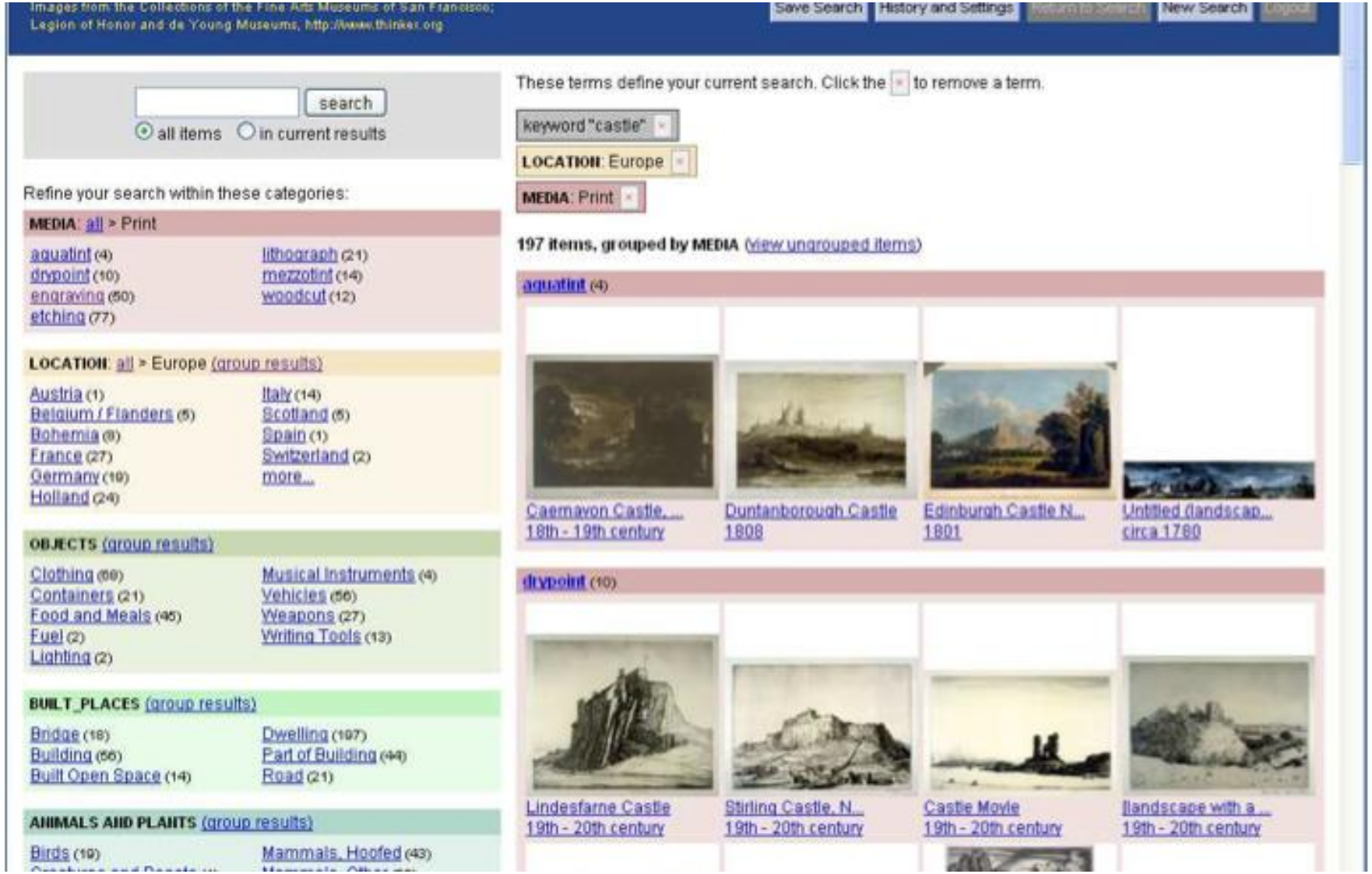
- Organizing results into meaningful groups can help users understand the results and decide what to do next
- Popular methods for grouping search results: **category systems** and **clustering**
- **Category system**: meaningful labels organized in such a way as to reflect the concepts relevant to a domain
  - Good category systems have the characteristics of being coherent and relatively complete
  - Their structure is predictable and consistent across search results for an information collection

Organizing Search Results



Organizing Search Results

- **Clustering** refers to the grouping of items according to some measure of similarity
- It groups together documents that are similar to one another but different from the rest of the collection
  - Such as all the document written in Japanese that appear in a collection of primarily English articles
- The greatest advantage of clustering is that it is fully automatable
- The disadvantages of clustering include
  - an unpredictability in the form and quality of results
  - the difficulty of labeling the groups
  - the counter-intuitiveness of cluster sub-hierarchies

Organizing Search Results

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Organizing Search Results

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Web News Images Video

senate Search

Results **1-20** of about **133,005,879** | Details

Sources Sites Time Topics

Top 879 Clusters remix

+ U.S. Senate (160)
+ State Senate (118)
+ Police, Reform (40)
+ Small Businesses (41)
+ Relief (29)
+ University, Student (35)
+ Biden (24)
+ China (22)
+ Mitch McConnell (26)
+ History (24)
+ Senate Hearing (24)
+ Photos, Biography (29)
+ Floyd (12)
+ Senate confirms (17)
+ Fauci (11)
+ Burr, Chair (11)
+ Immigration (13)
+ Ohio (15)
+ Kentucky, McGrath (12)

1. U.S. **Senate** new window preview
Date: 2020-06-24T08:27:00
Senate Stories. Presented to enlighten, amuse, and inform, our new **Senate** history blog explores the forces, events, and personalities that have shaped the modern **Senate**. The **Senate** and Women's Fight for the Vote. Learn about the **Senate**'s long road to approving the Nineteenth Amendment.
https://www.**senate**.gov - Yippy Index V

2. U.S. **Senate**: Senators new window preview
Date: 2020-06-24T08:30:00
• Senators who have Cast more than 10,000 Votes • Senators who have Delivered Washington's Farewell Address. Political Parties • Senators Representing Third or Minor Parties • Senators who Changed Parties during **Senate** Service (since 1890) Diversity in the **Senate** • Foreign-born Senators • Ethnic Diversity in the **Senate** • Women ...
https://www.**senate**.gov/senators/contact - Yippy Index V

3. United States **Senate** - Wikipedia new window preview
Date: 2020-06-24T20:44:00
The United States **Senate** is the upper chamber of the United States Congress, which, along with the United States House of Representatives—the lower chamber—constitutes the legislature of the United States.The **Senate** chamber is located in the north wing of the Capitol Building in Washington, D.C.. The composition and powers of the **Senate** are established by Article One of the United States ...
https://en.wikipedia.org/wiki/United_States_**Senate** - Yippy Index V

4. U.S. **Senate** | USAGov new window preview

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5. Visualization in Search Interfaces

Visualization in Search Interfaces

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- Experimentation with visualization for search has been primarily applied in the following ways
  - Visualizing Boolean syntax
  - Visualizing query terms within retrieval results
  - Visualizing relationships among words and documents
  - Visualization for text mining

Visualizing Boolean Syntax

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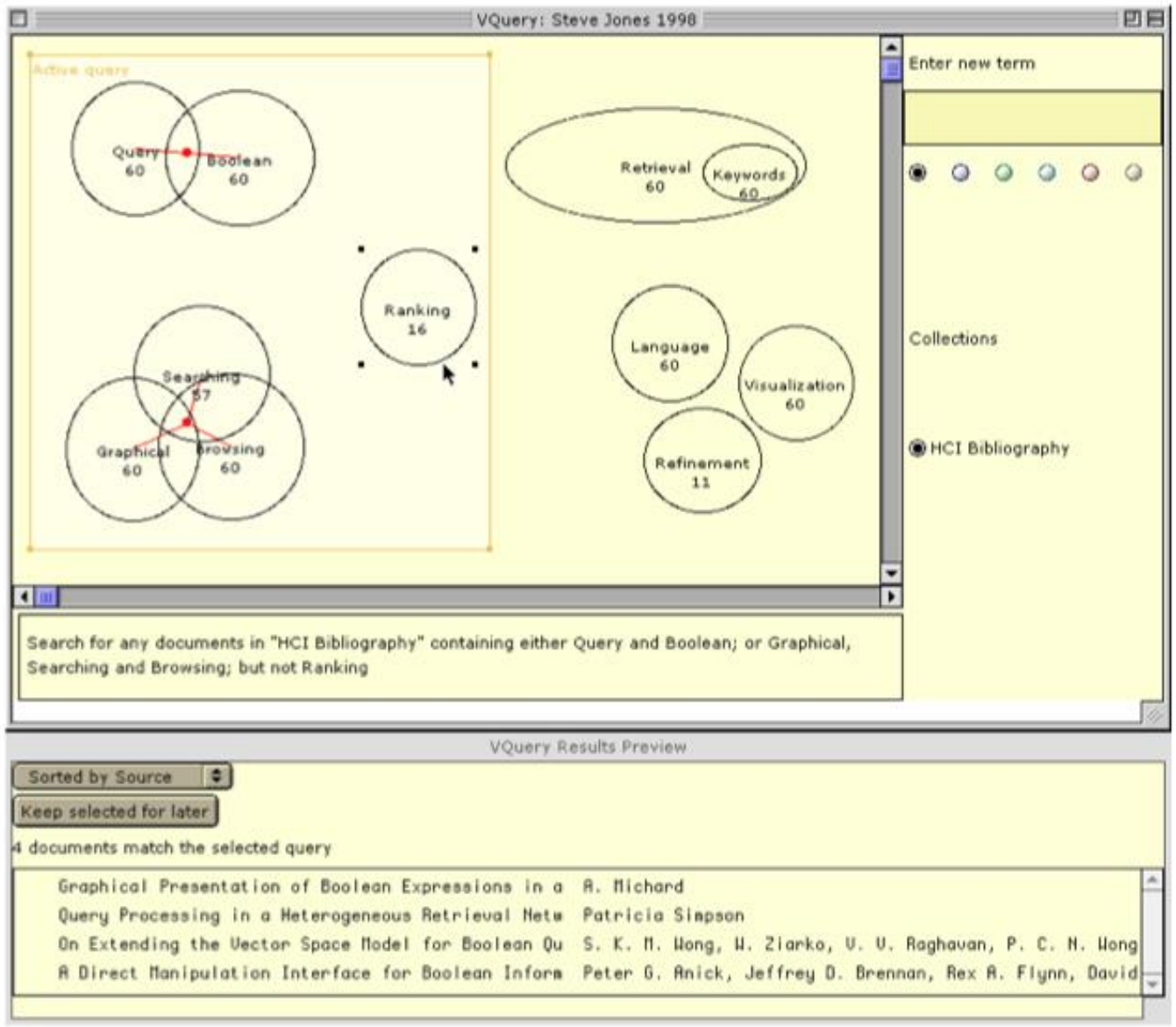
- Boolean query syntax is difficult for most users and is rarely used in Web search
- For many years, researchers have experimented with how to visualize Boolean query specification
- A common approach is to show **Venn diagrams**
- A more flexible version of this idea was seen in the **VQuery system**, proposed by Steve Jones

Visualizing Boolean Syntax



Visualizing Query Terms

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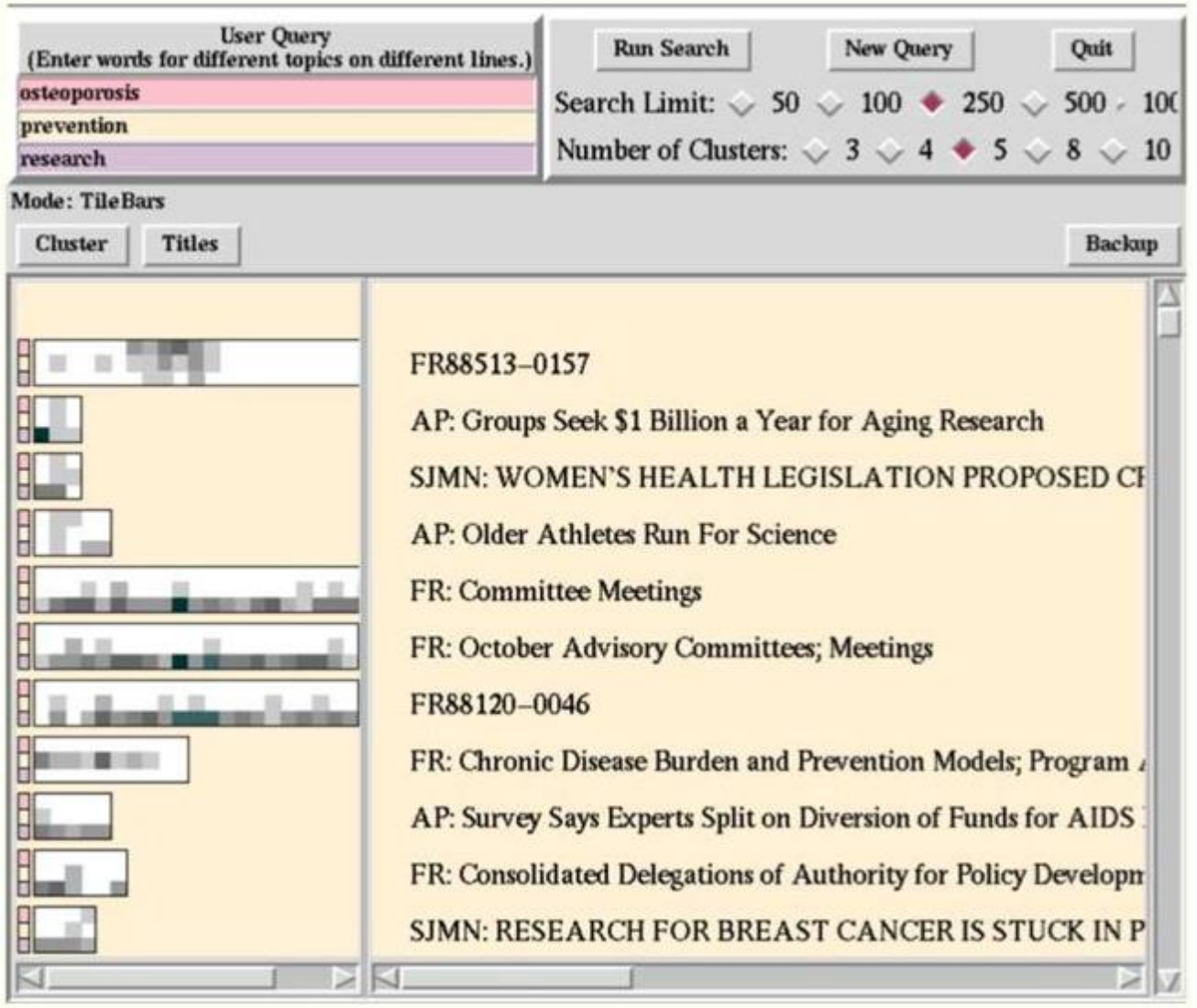
The TileBars interface

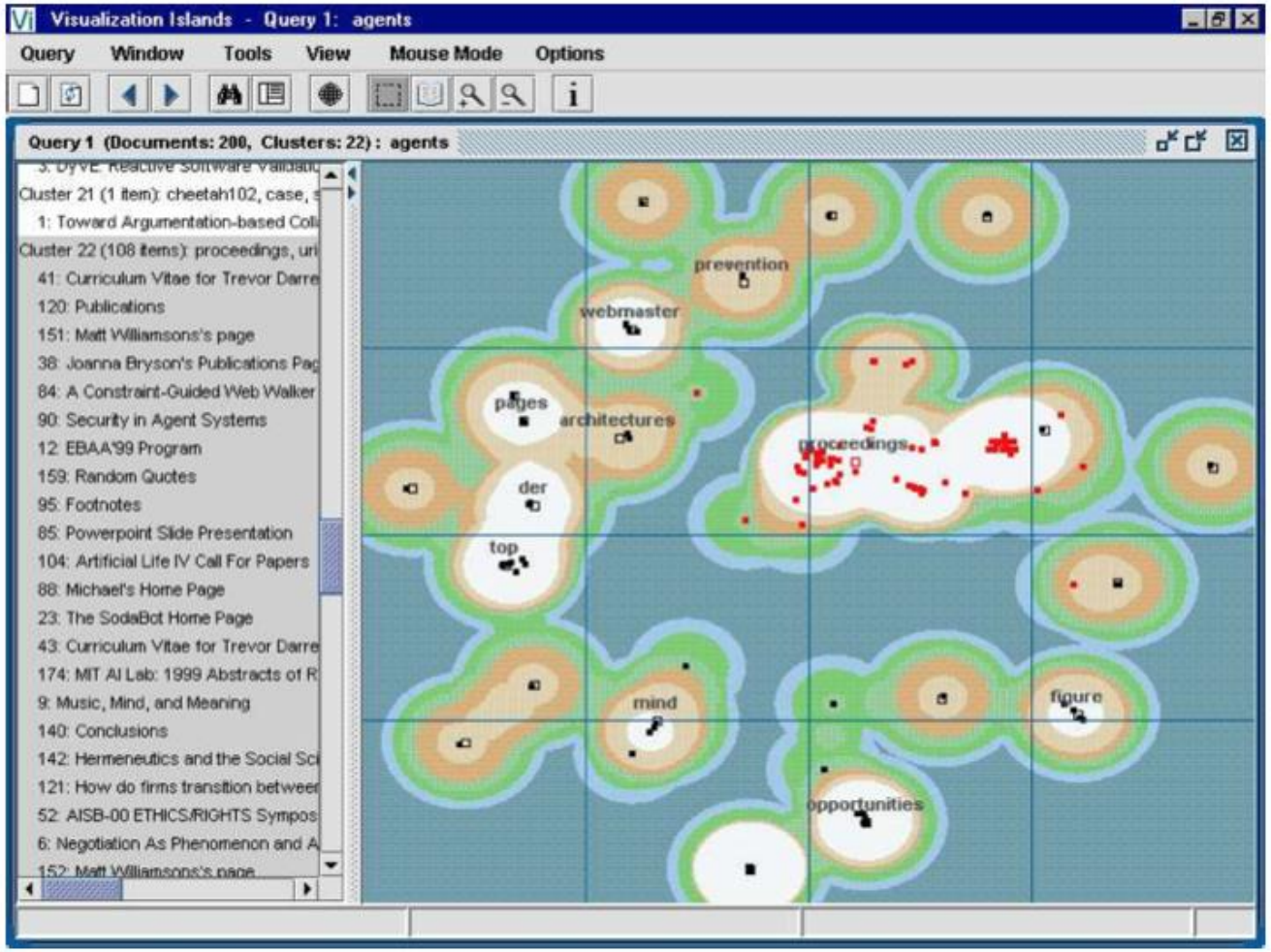


Visualizing Query Terms

Textually enhanced thumbnails

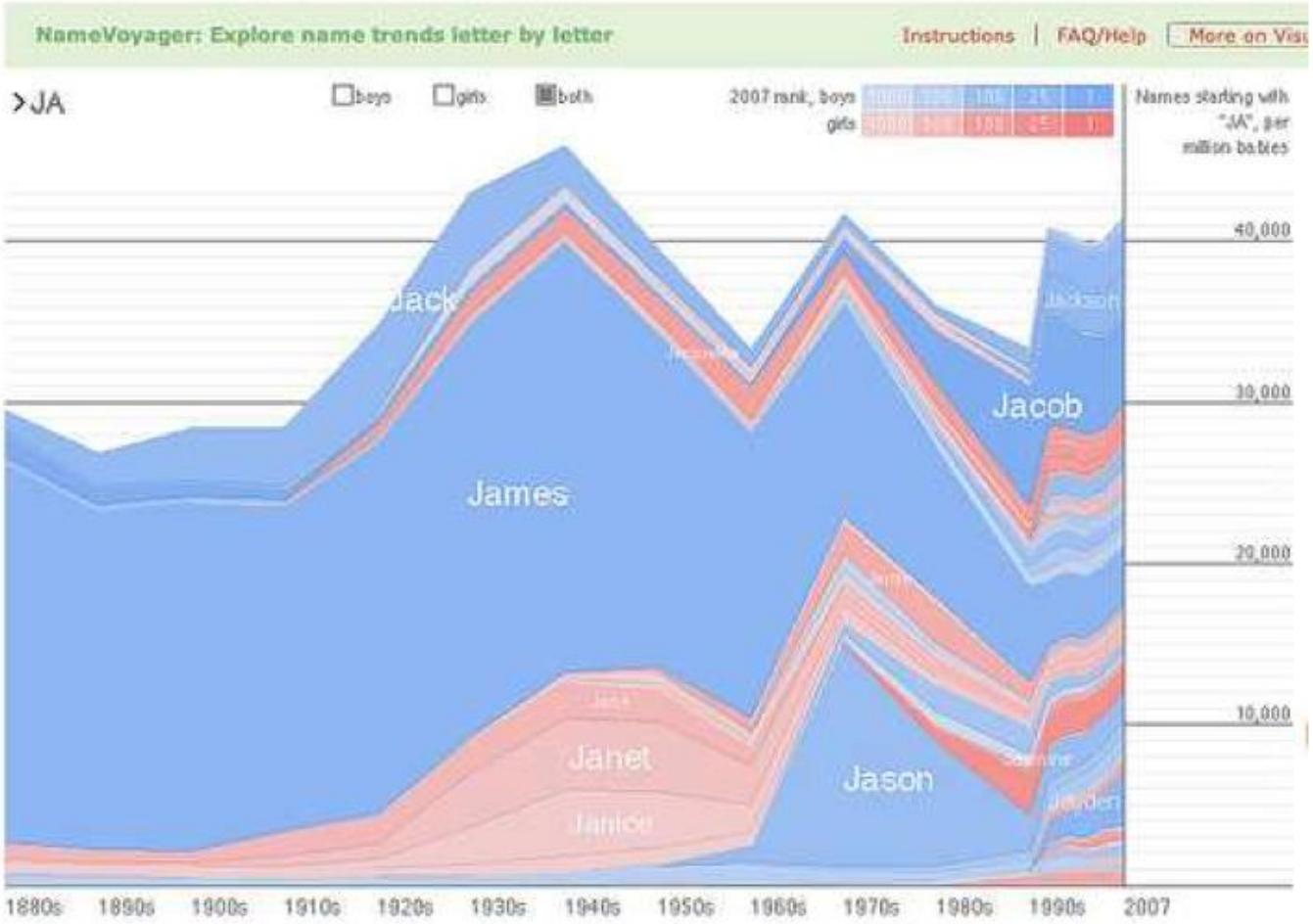
Words and Docs Relationships

xFIND's VisIslands, from Andrews *et al*



Words and Docs Relationships

- The popularity of baby names over time (names beginning with JA), from babynamewizard.com



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6. Design & Evaluation

Design and Evaluation

- User interface design: a field of Human-Computer Interaction (HCI)
- This field studies how people think about, respond to, and use technology
- User-centered design: a set of practices developed to facilitate the design of interfaces
- The design process begins by determining what the intended users' **goals** are
- Then, the interface is devised to help people achieve those goals by completing a series of **tasks**

Design and Evaluation

- Evaluating a user interface is often different from evaluating a ranking algorithm or a crawling technique
  - A crawler can be assessed by crisp quantitative metrics such as coverage and freshness
  - A ranking algorithm can be evaluated by precision, recall, and speed
- The quality of a user interface is determined by how people respond to it
- Subjective responses are as, if not more, important than quantitative measures
- If a person has a choice between two systems, they will use the one they prefer

Design and Evaluation

- How best to evaluate a user interface depends on the current stage in the development cycle
- When starting with a new design or idea, **discount** usability methods are typically used
  - Example: showing a few users different designs asking them to indicate which parts are promising and which are not
- Another commonly used discount evaluation method is **heuristic evaluation**
  - Usability experts “walk through” a design and evaluate the functionality in accordance with a set of design guidelines

Design and Evaluation

- A formal experiment must be carefully designed to take into account potentially confounding factors
  - For instance, it is important for participants to be motivated to do well on the task
- This kind of study can uncover important subjective results
  - Such as whether a new design is strongly preferred over a baseline
- However, it is difficult to find accurate quantitative differences with a small number of participants

Design and Evaluation

- Another problem: the timing variable is not the right measure for evaluating an interactive search session
  - A tool that allows the users to learn about their subject matter as they search may be more beneficial, but take more time
- Two approaches to evaluating search interfaces have gained in popularity in recent years
  - One is to conduct a **longitudinal study**
    - Participants use a new interface for an extended period of time, and their usage is monitored and logged
    - Evaluation is based both on log analysis and questionnaires and interviews with the participants

Design and Evaluation

- Another evaluation technique is to perform experiments on already heavily-used Web sites
- Consider a search engine that receives millions of queries a day
  - a randomly selected subset of the users is shown a new design
  - their actions are logged and compared to another randomly selected control group that continues to use the existing interface
  - this approach is often referred to as **bucket testing, A/B testing**

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4. Summary

Summary

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- Query Specification
- Query Reformulation
- Retrieval Results Display
- Visualizing Research Results
- Design & Evaluation

References

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[2] https://nlp.stanford.edu/IR-book/information-retrieval-book.html
Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, Introduction to Information Retrieval, Cambridge University Press. 2008

[3] Ricardo Baeza-Yates, Berthier Ribeiro-Neto, *Modern Information Retrieval*, Addison-Wesley Professional, 2011.

► Chapter 10: User Interfaces and Visualization, available here