Retrieval Interface

Introduction

- Information Retrieval interaction: "… the interactive communication processes that occur during the retrieval of information by involving all the major participants in IR, i.e. the user, the intermediary, and the IR system." (Ingwersen, 1992)

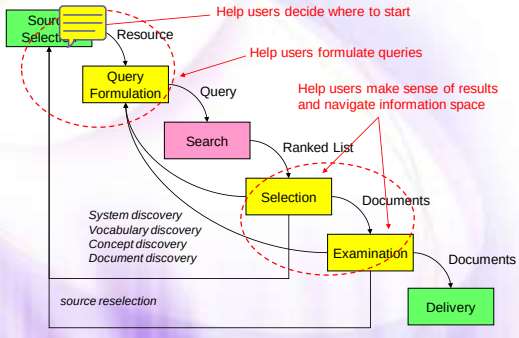
→ What variables are involved?
- models give lists

→ How do they affect the process? How to control?
- experiments, experience, observation give answers

→ Do given interventions or communications improve or degrade the process?
- e.g. searcher's (intermediaries or end-users) actions

→ Can systems be designed so that searcher's intervention improves performance?

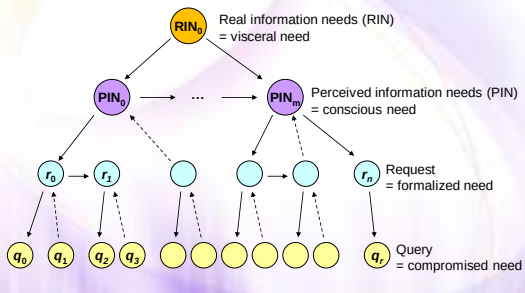
Interaction Points



Covered topics

- Information needs
- IR basic models
- Interaction points
  - Query formulation
  - Selection
  - Examination
  - Source selection
- Appliance: Retrieval System and Mobile Search

1. Information Needs



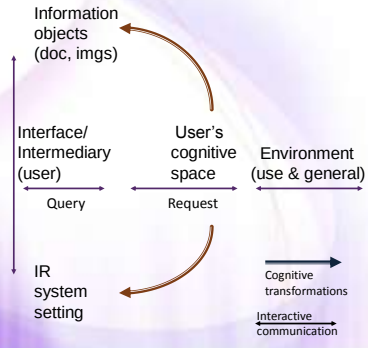
Stefano Mizzaro. (1999) How Many Relevances in Information Retrieval? *Interacting With Computers*, 10(3), 305-322.

2. Interactive IR models

- Several models proposed
  - none as widely accepted as the traditional IR model
- They all try to incorporate
  - information objects ("texts"):
  - IR system & setting
  - interface
  - intermediary, if present
  - user's characteristics
    - cognitive aspects; task; problem; interest; goal; preferences …
  - social environment
  - variety of processes between them all.

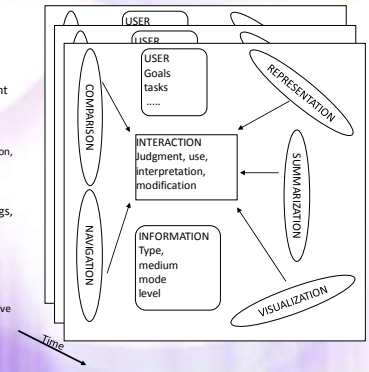
Ingwersen's cognitive model

- Among the first to view IR differently from traditional model
- Included IR as system but also things outside system that interact
  - path of request from environment (problem) to query
  - path of cognitive changes
  - path of communication
  - various other paths of interactions



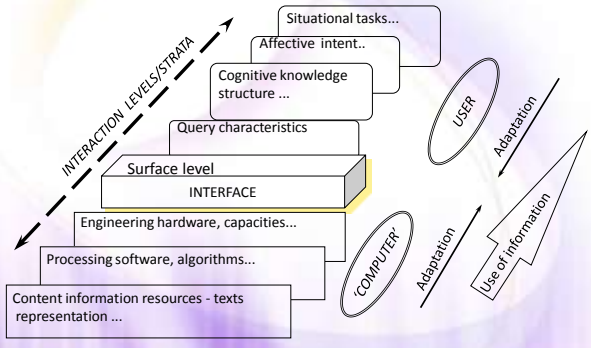
Belkin's episodes model

- Concentrates on what happen in interaction as process
- Viewed interaction as a series of episodes where a number of different things happen over time
  - depending on user's goals, tasks: judgment, use, interpretation…
  - processes of navigation, comparison, summarization …
  - involving different aspects of information & inf. objects
- While interacting we do diverse things, perform various tasks, & involve different objects
- → Belkin: Searchers do not clearly understand
  - The problem itself
  - What information is needed to solve the problem



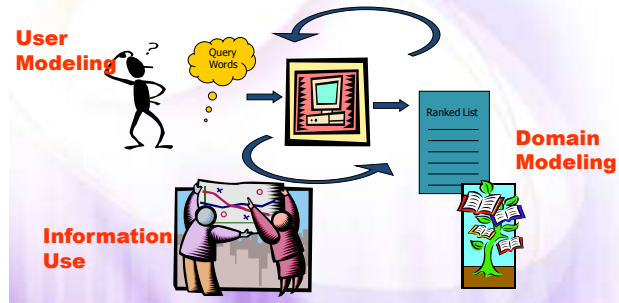
Stratified model

Users interact with IR systems to use information



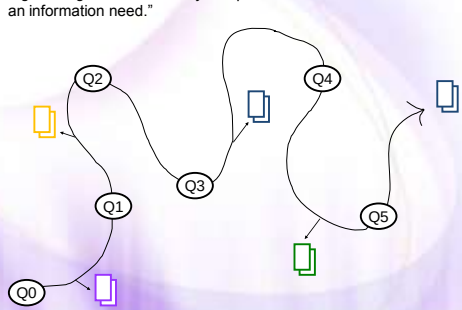
Broader View of Information Retrieval

The query results from a clarification process



Bates' "Berry Picking" Model

A sketch of a searcher… "moving through many actions towards a general goal of satisfactory completion of research related to an information need."



Broder's Web Query Taxonomy

- Navigational (~20%)
  - Reach a particular site ("known item")
- Informational (~50%)
  - Acquire static information ("topical")
- Transactional (~30%)
  - Perform a Web-mediated activity ("service")

Andrei Broder, *SIGIR Forum*, Fall 2002

Some Desirable Features

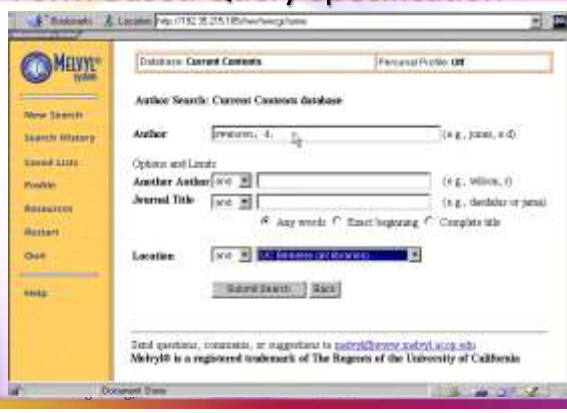
- Make exploration easy
- Relate documents with why they are retrieved
- Highlight relationships between documents

2. Query Formulation

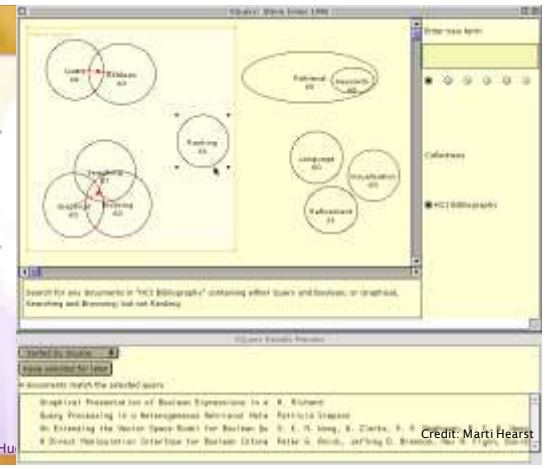
- Command Language
- Form Fill-in
- Menu Selection
- Direct Manipulation
- Natural Language

Ben Shneiderman, 1997

Form-Based Query Specification



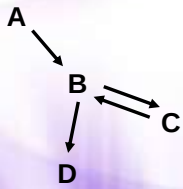
Direct Manipulation Spec. VQUERY (Jones 98)



Credit: Marti Hearst

The "Back" Button

- Behavior is counterintuitive to many users

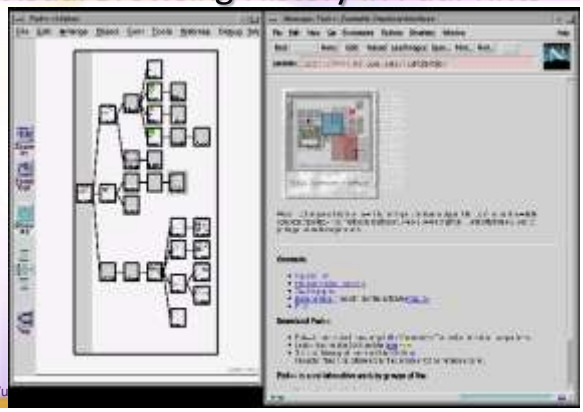


You hit "back" twice from page D. Where do you end up?

PadPrints

- Tree-based history of recently visited Web pages
  - History map placed to left of browser window
  - Node = title + thumbnail
  - Visually shows navigation history
- Zoomable: ability to grow and shrink sub-trees

Visual Browsing History in PadPrints



PadPrints Thumbnails

Alternate Query Modalities

- Spoken queries
  - Used for telephone and hands-free applications
  - Reasonable performance with limited vocabularies
    - But some error correction method must be included
- Handwritten queries
  - Palm pilot graffiti, touch-screens, …
  - Fairly effective if some form of shorthand is used
    - Ordinary handwriting often has too much ambiguity

3. Selection

- A Selection Interface Taxonomy
  - One dimensional lists
    - Content: title, source, date, summary, ratings, ...
    - Order: retrieval status value, date, alphabetic, ...
    - Size: scrolling, specified number, score threshold
  - Two dimensional displays
    - Construction: clustering, starfield, projection
    - Navigation: jump, pan, zoom
  - Three dimensional displays
    - Contour maps, fishtank VR, immersive VR

Google: KeyWord In Context (KWIC)

- Query: truong dai hoc bach khoa ha noi

Indicative vs. Informative

- Terms often applied to document abstracts
  - Indicative abstracts support selection
    - They describe the contents of a document
  - Informative abstracts support understanding
    - They summarize the contents of a document
- Applies to any information presentation
  - Presented for indicative or informative purposes

Selection/Examination Tasks

- "Indicative" tasks
  - Recognizing what you are looking for
  - Determining that no answer exists in a source
  - Probing to refine mental models of system operation
- "Informative" tasks
  - Vocabulary acquisition
  - Concept learning
  - Information use

Generated Summaries

- Fluent summaries for a specific domain
- Define a knowledge structure for the domain
  - Frames are commonly used
- Analysis: process documents to fill the structure
  - Studied separately as "information extraction"
- Compression: select which facts to retain
- Generation: create fluent summaries
  - Templates for initial candidates
  - Use language model to select an alternative

Extraction-Based Summarization

- Robust technique for making disfluent summaries
- Four broad types:
  - Query-biased vs. generic
  - Term-oriented vs. sentence-oriented
- Combine evidence for selection:
  - Salience: similarity to the query
  - Specificity: IDF or chi-squared
  - Emphasis: title, first sentence

Ask: Suggested Query Refinements

Selection principles

- Classification: Automatically assign labels to documents
  - Machine learning
  - K nearest neighbor
  - Cat-a-cone
- Clustering: Automatically group documents into clusters
  - Hierarchical Agglomerative Clustering
  - K-means clustering
  - Scatter/gather

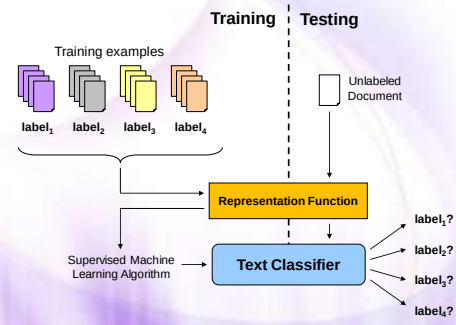
Text Classification

- Problem: automatically sort items into bins
- Machine learning approach
  - Obtain a training set with ground truth labels
  - Use a machine learning algorithm to "train" a classifier
    - kNN, Bayesian classifier, SVMs, decision trees, etc.
  - Apply classifier to new documents
    - System assigns labels according to patterns learned in the training set

Open Directory Project

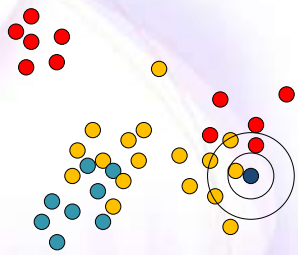
http://www.dmoz.org/; keyword: solar

Machine Learning



k Nearest Neighbor (kNN) Classifier

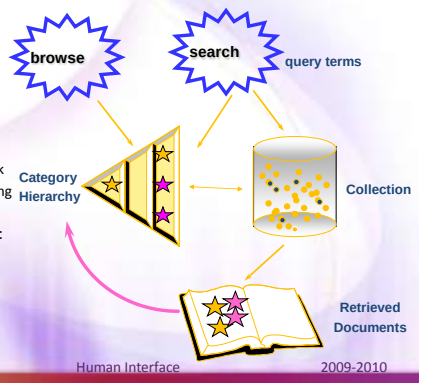
- Algorithm:
  - Select k most similar labeled documents
  - Have them "vote" on the best label:
    - Each document gets one vote, or
    - More similar documents get a larger vote
  - How can similarity be defined?



Cat-a-Cone

Cat-a-Cone

- Key Ideas:
  - Separate documents from category labels
  - Show both simultaneously
  - Link the two for iterative feedback
  - Integrate searching and browsing
- Distinguish between:
  - Searching for documents
  - Searching for categories



Clustering

- The Cluster Hypothesis: "Closely associated documents tend to be relevant to the same requests." (van Rijsbergen 1979)
- Advantages:
  - Provides an overview of main themes in search results
  - Helps overcome polysemy
- Disadvantages:
  - Documents can be clustered in many ways
  - Not always easy to understand the theme of a cluster
  - What is the correct level of granularity?
  - More information to present

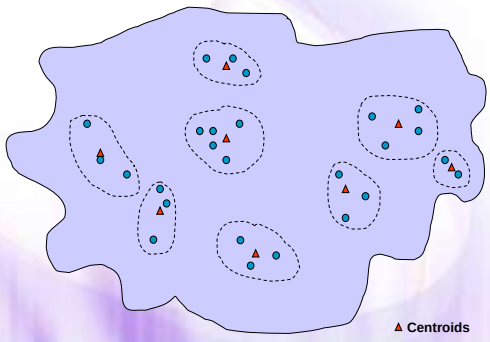
Vivisimo: Clustered Results

http://clusty.com/

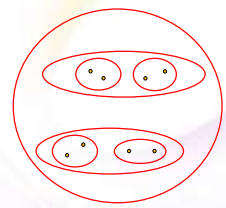
Clustering Result Sets

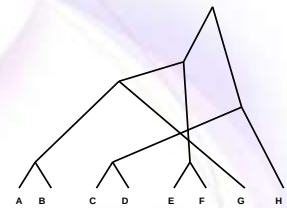
- Advantages:
  - Topically coherent document sets are presented together
  - User gets a sense for the themes in the result set
  - Supports browsing retrieved hits
- Disadvantages:
  - May be difficult to understand the theme of a cluster based on summary terms
  - Clusters themselves might not “make sense”
  - Computational cost

Visualizing Clusters



Hierarchical Agglomerative Clustering





- Algorithm:
  - Start with each document in its own cluster
  - Until there is only one cluster:
  - Determine the two most similar clusters ci and cj
  - Replace ci and cj with a single cluster ci ∪ cj
  - The history of merging forms the hierarchy

Cluster Similarity

- Assume a similarity function that determines the similarity of two instances: sim(x,y)
  - What’s appropriate for documents?
- What’s the similarity between two clusters?
  - Single Link: similarity of two most similar members
  - Complete Link: similarity of two least similar members
  - Group Average: average similarity between members

K-Means Clustering

Pick seeds

Reassign clusters

Compute centroids

Reasssign clusters

Compute centroids

Reassign clusters

Converged!

K-Means

- Each cluster is characterized by its centroid (center of gravity):

$$\vec{\mu}(c) = \frac{1}{|c|}\sum_{\vec{x}\in c}\vec{x}$$

- Reassignment of documents to clusters is based on distance to the current cluster centroids
- Let *d* be the distance measure between documents
- Select *k* random instances {s_1, s_2,... s_k} as seeds
- Until clustering converges:
  - Assign each instance x_i to the cluster c_j such that $d(x_i, s_j)$ is minimal
  - Update the seeds to the centroid of each cluster
  - For each cluster c_j, $s_j = \mu(c_j)$

How do you select *k*?
Results can vary based on random seed selection
Some seeds can result in poor convergence rate, or convergence to sub-optimal clusters

Scatter/Gather

- Clusters documents into "themes"
  - Displays clusters by showing:
    - Topical terms
    - Typical titles
- User chooses a subset of the clusters
- System re-clusters documents in selected cluster
  - New clusters have different, more refined, "themes"

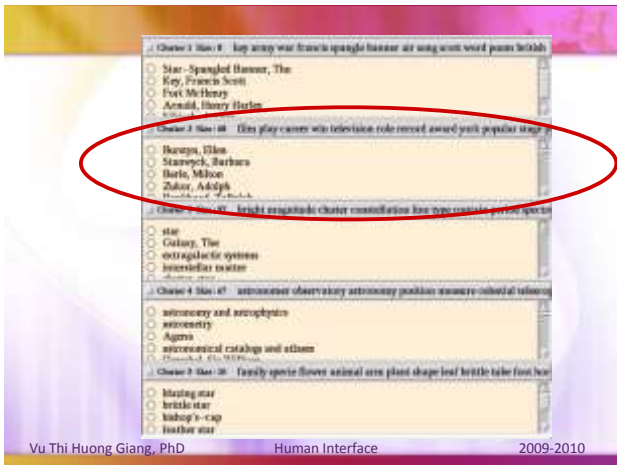
Query = "star" on encyclopedic text

symbols	8 docs
film, tv	68 docs
astrophysics	97 docs
astronomy	67 docs
flora/fauna	10 docs

sports	14 docs
film, tv	47 docs
music	7 docs

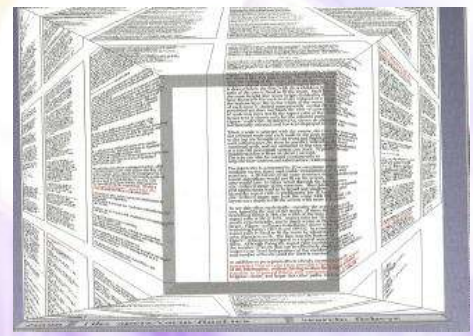
stellar phenomena	12 docs
galaxies, stars	49 docs
constellations	29 docs
miscellaneous	7 docs

Clustering and re-clustering is entirely automated



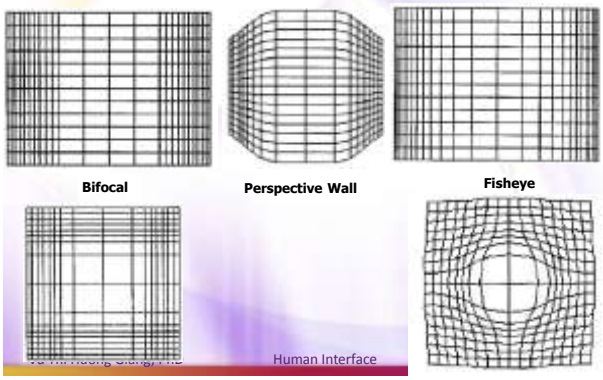
4. Examining Individual Documents

Document lens



Robertson & Mackinlay, UIST'93, Atlanta, 1993

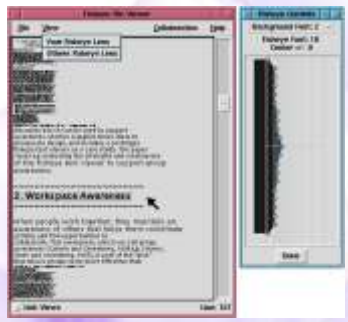
Distorting Reality



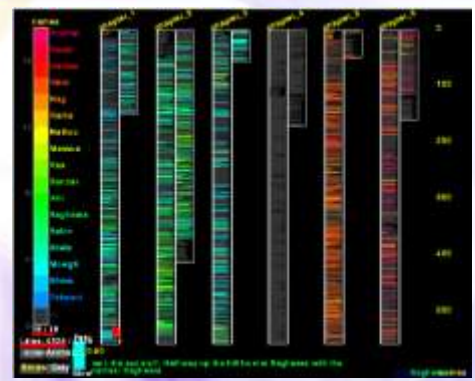
1-D Fisheye Menu

http://www.cs.umd.edu/hcil/fisheyemenu/fisheyemenu-demo.shtml

1-D Fisheye Document Viewer



SeeSoft



TileBars

Topic: reliability of DBMS (database systems)
Query terms: DBMS, reliability

Mainly about both DBMS and reliability

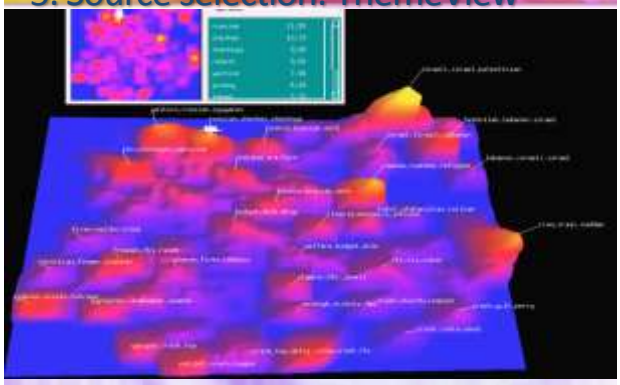
Mainly about DBMS, discusses reliability

Mainly about, say, banking, with a subtopic discussion on DBMS/Reliability

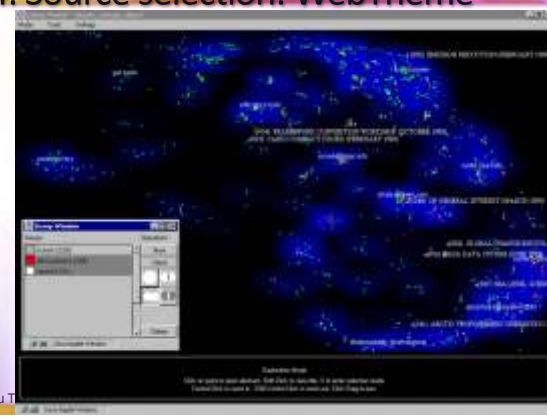
Mainly about high-tech layoffs

U Mass: Scrollbar-Tilebar

5. Source selection: ThemeView



4. Source selection: WebTheme



Ben S' 'Seamless Interface' Principles

- Informative feedback
- Easy reversal
- User in control
  - Anticipatable outcomes
  - Explainable results
  - Browsable content
- Limited working memory load
  - Query context
  - Path suspension
- Alternatives for novices and experts
  - Scaffolding

Some 'Synergistic Interaction' Principles

- Interdependence with process ("interaction models")
  - Co-design with search strategy
  - Speed
- System initiative
  - Guided process
  - Exposing the structure of knowledge
- Support for reasoning
  - Representation of uncertainty
  - Meaningful dimensions
- Synergy with features used for search
  - Weakness of similarity, Strength of language
- Easily learned
  - Familiar metaphors (timelines, ranked lists, maps)

Some Good Ideas

- Show the query in the selection interface
  - It provides context for the display
- Suggest options to the user
  - Query refinements, for example
- Explain what the system has done
  - Highlight query terms in the results, for example
- Complement what the system has done
  - Users add value by doing things the system can't
  - Expose the information users need to judge utility