CS630 Representing and Accessing Digital Information

Using Hypertext Structure

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What Information can Hyperlinks Convey?

Isolated documents:

- Retrieval methods have focused on the content of the document
- Information is provided by the author itself

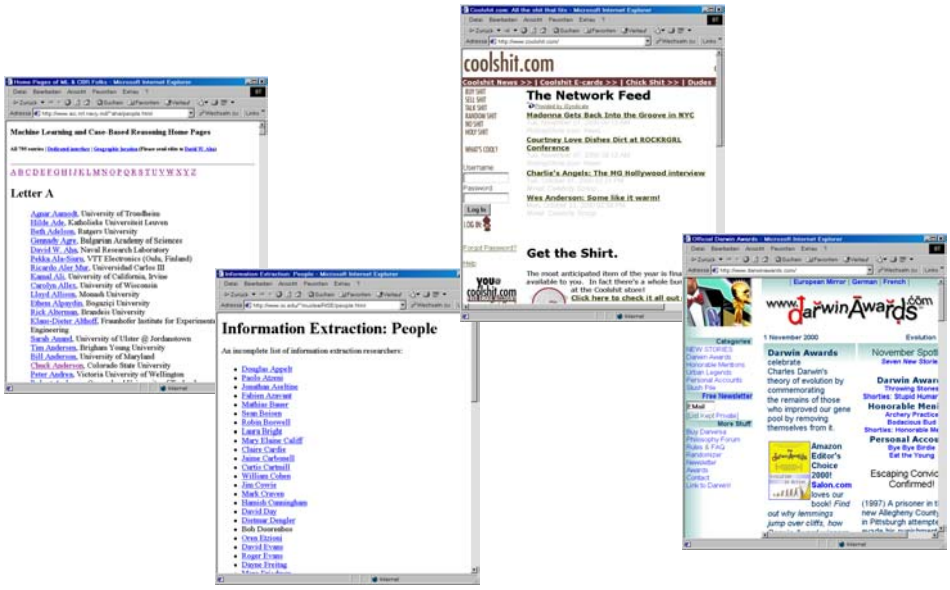
Hypertext and citations:

- Other documents make statement about document
- Structural organization of collection shared among community

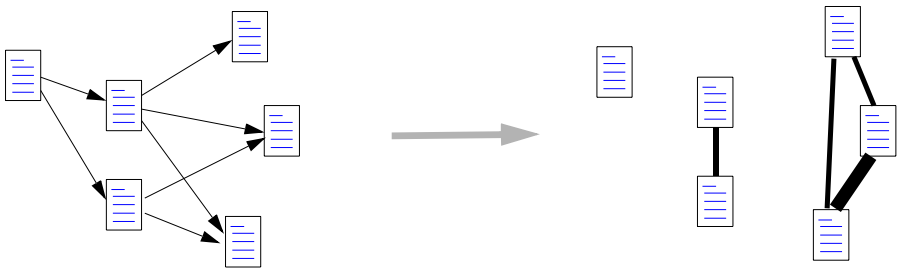
Possible uses:

- Relatedness of documents
- Centrality of documents
- Authority / prestige of documents
- Social network behind information network
- ...

WWW Pages Classify Other WWW Pages



Hypertext Structure Gives Info about Relatedness!



Idea:

- two pages are similar (with respect to some aspect), if they are frequently co-cited
- the more frequently two pages are co-cited, the more similar they are

Algorithm for finding similar pages:

- use Google to find all pages that link to a given set of pages
- download those pages and count the frequency of their links

Experiment: Human vs. WebLearn

Fill in the missing page:

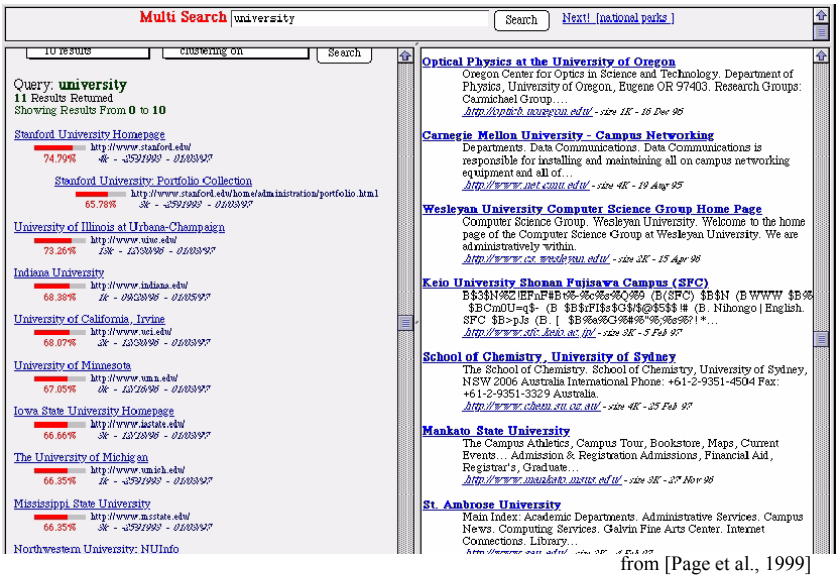
?

Hypertext Structure as a Measure of Similarity

- co-citation groups pages by some aspect of similarity
  - aspect not necessarily easy to identify automatically
  - noise: " best viewed with internet explorer"
  - not all aspects of similarity on the WWW
- Bibliometrics [Small, 1973]
- Use for finding related WWW pages [Joachims et al. 1995/1997] [Larson, 1996], [Dean & Henzinger, 1999], Commercial: Netscape, Google, etc.
- Use in text classification [Chakrabarti et al., 1998], [Joachims et al. 2001]

Matching User Expectations in Text Retrieval

Problem: Many pages match the word " university" , but what are the most important (most popular) pages on this topic?

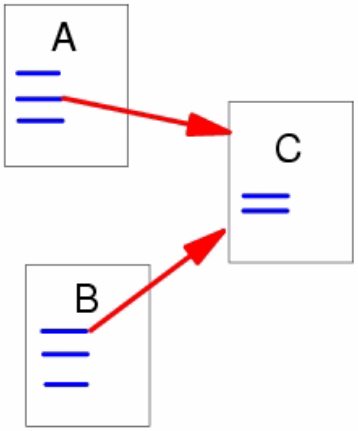


from [Page et al., 1999]

In-Links as an Endorsement

Approach 1:

- A document is more important / popular, the more in-links (back-links) it has.



Simplified PageRank

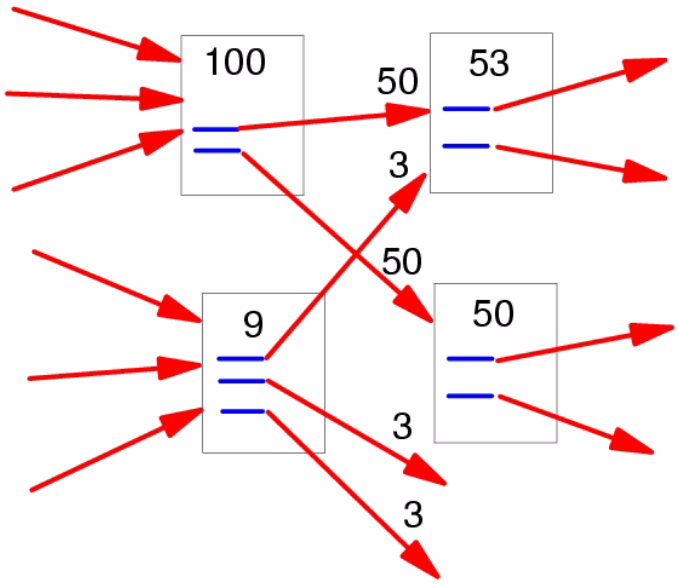
Approach 2:

A document is more important, if it is linked to from many important documents.

- u, v: documents
- F(u): outlinks out of u
- B(u): inlinks pointing to u
- r(u): importance of u

$$r_{i+1}(u) = \sum_{v \in B(u)} \frac{r_i(v)}{|F(v)|}$$

Iteration of Simplified Page Rank



What is the problem with this simplified algorithm?

PageRank

A document is more important, if it is linked to from many important documents + some smoothing.

- u, v: documents
- F(u): outlinks out of u
- B(u): inlinks pointing to u
- e(u): inherent importance of u (sum to 1)
- d: trade-off parameter
- r(u): importance of u

$$r_{i+1}(u) = (1 - d) \sum_{v \in B(u)} \frac{r_i(v)}{|F(v)|} + de(u)$$

Normalize r so that $||r||_1 = 1$.

Random Surfer

Model:

- Forever:
  - with high probability, follow a random link on the page.
  - or with low probability (e.g. 15%), jump to a random page.

What is the probability, that the surfer is currently at page u?

=> Probability distribution over pages for Markov Random Walk

Good approximation for " probability that user wants to see this page" !?

Searching with PageRank

Retrieval function combines:

- vector space similarity
- weighting of html tags
- proximity of matches
- anchor text
- PageRank

=> trade-off with different weights

Hubs and Authorities

Idea [Kleinberg, 1998]: A good hub points to many authorities, and an authority is pointed to by many good hubs.

$$hub(u) = \sum_{v \in outlinks(u)} authority(v)$$

$$authority(v) = \sum_{u \in outlinks(u)} hub(u)$$

=> Eigenvectors of A' A (authority) and AA' (hub)

Literature

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