Welcome to the class of Advanced Topics in Information Retrieval !

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Tea Time

IBM Watson DeepQA

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Jeopardy: An American TV show

Requires the players to suss out the subtleties of language from jokes and puns to irony and anagrams

IBM Watson @ Jeopardy

- February 14, 15, and 16, 2011
  - *Jeopardy's* two biggest champions
  - Brad Rutter (right):
    - Won a whopping $3.25 million playing *Jeopardy*, the most cash ever awarded on the show.
    - He is a Johns Hopkins University dropout
  - Ken Jennings (left):
    - Holds the title for longest *Jeopardy* winning streak, with 74 consecutive wins in 2004.
    - He holds degrees in computer science and English, from Brigham Young University, and an international BA diploma from Seoul Foreign School.

IBM Watson won the Jeopardy

- Towards the Open Advancement of Question Answering Systems

Final:

$77,147

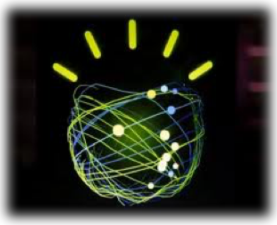
(5,000+35,734+41,413)

vs.

$21,600 &

$24,000.

IBM Watson



- In development for 4 years
- Runs on 90 Power 7 servers
  - Each: 4*8 power 7
- Does not connect to the Internet
- Search on a large scale knowledge base, not Internet
  - Search on billion pages within 3s
- Trained with previous questions and games
  - With Jeopardy players: 77 (2009) + 55 (2010, winners)
  - Lack of real-time learning ability
  - E.g. Category: US Cities
    - *Q: "Its largest airport was named for a World War II hero; its second largest, for a World War II battle."*
    - *A: "What is Chicago / Toronto?"*

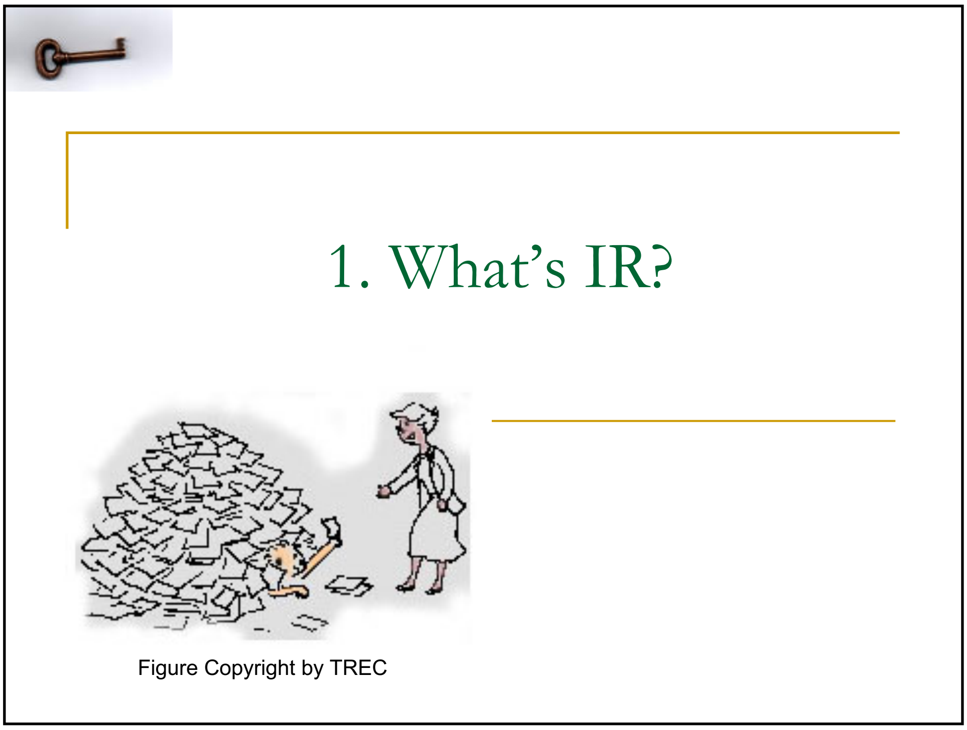
Technical requirements

- Answers to questions on any topic
  - Science, geography, popular culture …
- Accuracy: not only an answer, but a confident right answer
- Speed: within 3 second or less

- Advanced linguistic understanding
  - Parser complex sentences, recognize and understand jokes, metaphors, puns and riddles
- Real time analysis of questions
- Learn from mistakes
- Be prepared to handle the unexpected …

Techniques involved -- DeepQA

- A massively parallel probabilistic evidence-based architecture for answer questions
  - Non-database approach
  - Deep text analytics
    - NLP and statistical NLP
  - Formulating parallel hypotheses with confidence score
    - Voting, Question interpretation…
  - Search
  - Risk assessment
  - Hadoop and UIMA
- Difficulties/Problems in real application scenarios



1. What’s IR?

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Review: What is Information Retrieval (IR)?

- Narrow-sense:
  - IR = Search Engine Technologies (i.e. IR =
    - Google, Yahoo, Bing, Ask, Baidu, Sogou, …
    - Library info search, enterprise search, in-site search, destop search…
    - PicSearch, Greplin, Blekko, SkyScanner, KooXoo, Qunar, …

Review: What's IR? (cont.)

- Broad-sense: IR ~ **Information Management**
  - General problem: how to manage information?
  - How to **find** useful information? (retrieval & recommendation)
    - Beyond search engine:
    - e.g. in news feed, movie, travel, e-commerce, financial… scenarios
    - e.g. in social media platform, e.g. Twitter, Facebook, YouTube, WeChat, Weibo, Zhihu, ……
  - How to **organize** information? (classification & filtering)
    - e.g., automatically assign email to different folders
  - How to **discover** information (or even knowledge) from the data? (mining)
    - e.g., discover correlation of events

Review: What's IR? (cont.)

- Goal:
  - Find documents *relevant* to an information need from a large document set
- And now:
  - Beyond relevance
  - Multi-modal documents
  - Users' (implicit) information need
  - Heterogeneous environment

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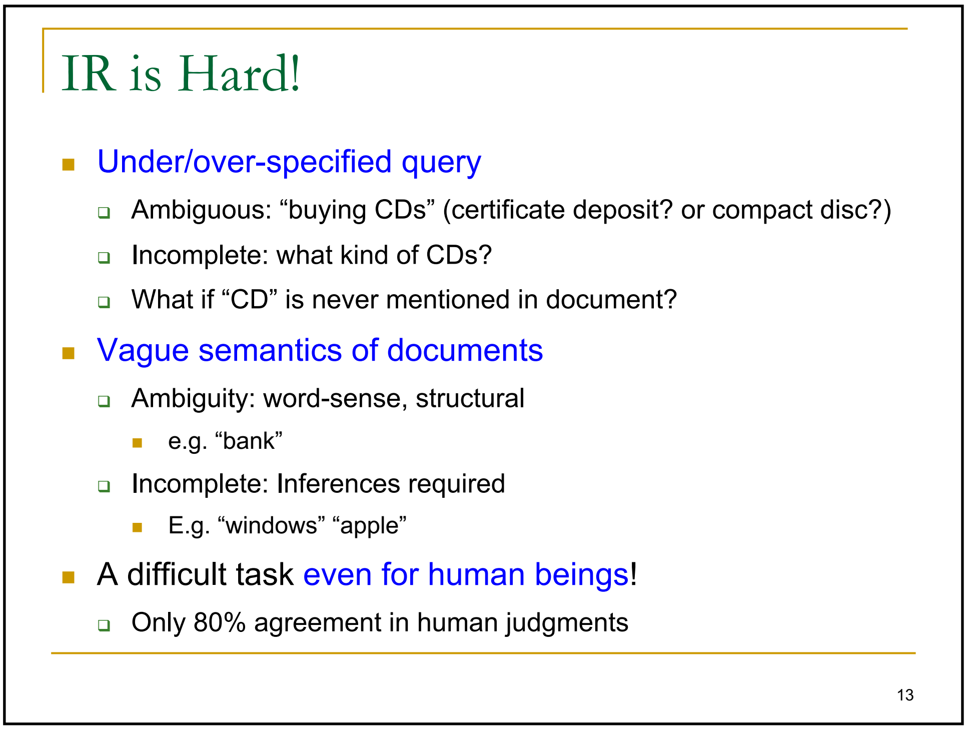
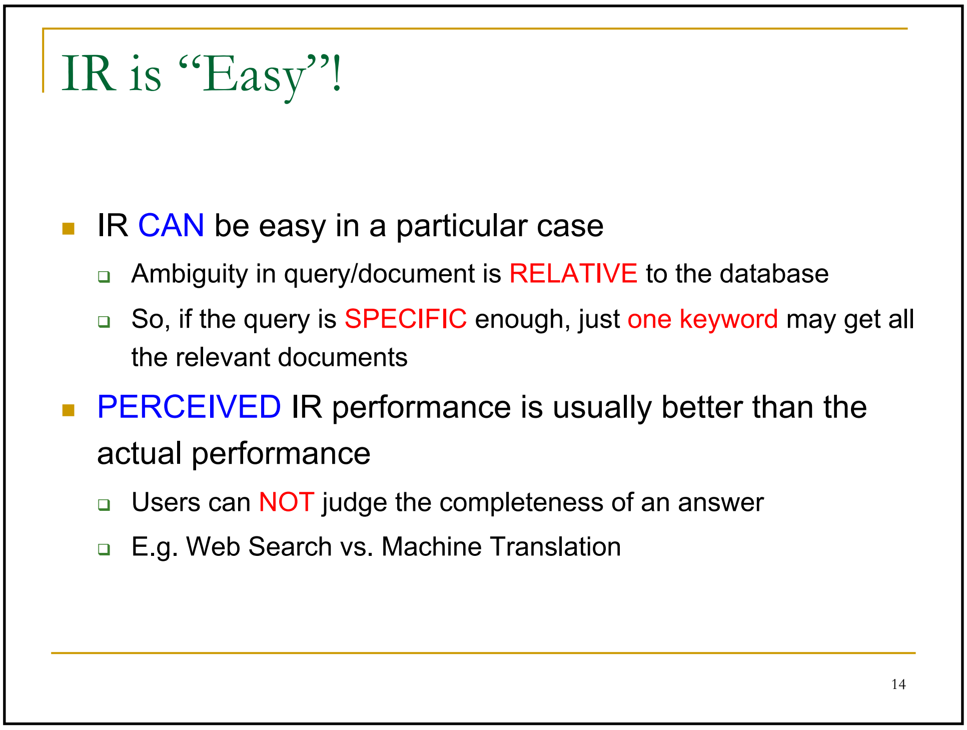


IR is Hard!

- Under/over-specified query
  - Ambiguous: “buying CDs” (certificate deposit? or compact disc?)
  - Incomplete: what kind of CDs?
  - What if “CD” is never mentioned in document?
- Vague semantics of documents
  - Ambiguity: word-sense, structural
    - e.g. “bank”
  - Incomplete: Inferences required
    - E.g. “windows” “apple”
- A difficult task even for human beings!
  - Only 80% agreement in human judgments



IR is “Easy”!

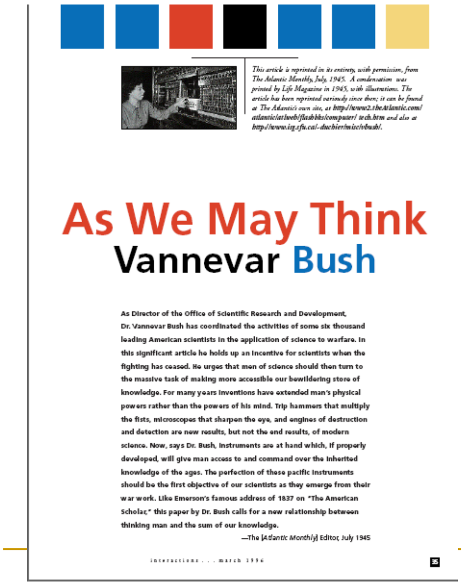
- IR CAN be easy in a particular case
  - Ambiguity in query/document is RELATIVE to the database
  - So, if the query is SPECIFIC enough, just one keyword may get all the relevant documents
- PERCEIVED IR performance is usually better than the actual performance
  - Users can NOT judge the completeness of an answer
  - E.g. Web Search vs. Machine Translation

History of IR* on One Slide

**(The history of Web Search will be discussed in later lectures)*

- Birth of IR
  - 1945: Vannevar Bush's article "As we may think"
  - 1957: H. P. Luhn's idea of word counting and matching
- Indexing & Evaluation Methodology (1960's)
  - Smart system (G. Salton's group)
  - Cranfield test collection (C. Cleverdon's group)
  - Indexing: automatic can be as good as manual (controlled vocabulary)
- IR Models (1970's & 1980's, late 1990's & early 2000's, 2009~2015) …
- Large-scale Evaluation & Applications (1990's~present)
  - TREC (D. Harman & E. Voorhees, NIST)， CLEF, NTCIR, …
- Web search (2000's ~ present)
  - Search engine companies, Boundary with related areas are disappearing
- Vertical Search, Knowledge, Social, User (2010's ~ present)

As we may think



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As We May Think
Vannevar Bush

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—The [*Atlantic Monthly*] Editor, July 1945

interactions . . . march 1996

Set a goal of fast access to the contents of the world's libraries:

- A 1M book library

LUHN H.P.

- LUHN, H.P., 'A statistical approach to mechanised encoding and searching of library information', *IBM Journal of Research and Development,* 1, 309-317 (1957).

- 'It is here proposed that the frequency of word occurrence in an article furnishes a useful measurement of word significance. It is further proposed that the relative position within a sentence of words having given values of significance furnish a useful measurement for determining the significance of sentences. The significance factor of a sentence will therefore be based on a combination of these two measurements.‘

---- LUHN, H.P., 'The automatic creation of literature abstracts', *IBM Journal of Research and Development*, 2, 159-165 (1958).

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2. A general (Basic) IR procedure

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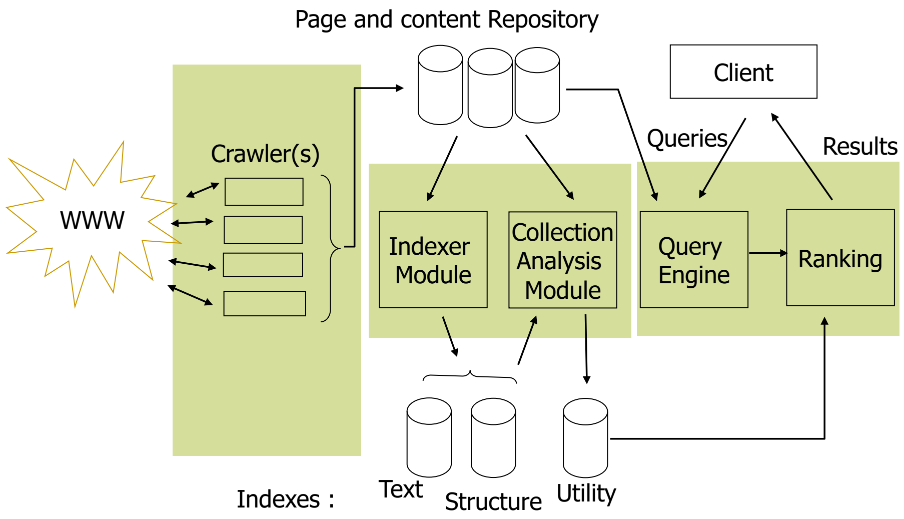
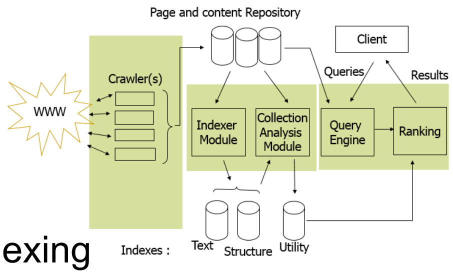
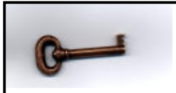
Example: search engine architecture



Basic IR procedure



- Data acquisition
  - How to collect fulfill resources?
- Document and query indexing
  - How to represent their contents?
- Ranking
  - How to measure the (ordered) relevance between a document and the query?
- System evaluation
  - How good is a system? Are the retrieved documents relevant and useful?



3. Brief introduction to IR fundamentals – I

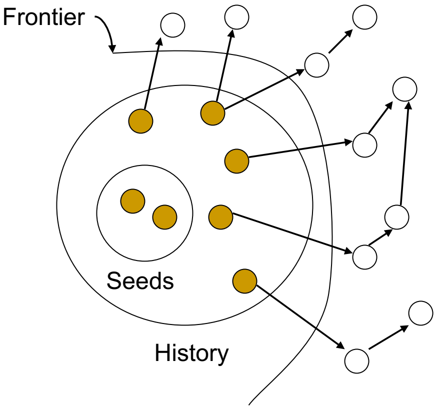
(Mainly Text IR;
Visual IR will be discussed by a specific lecture later)

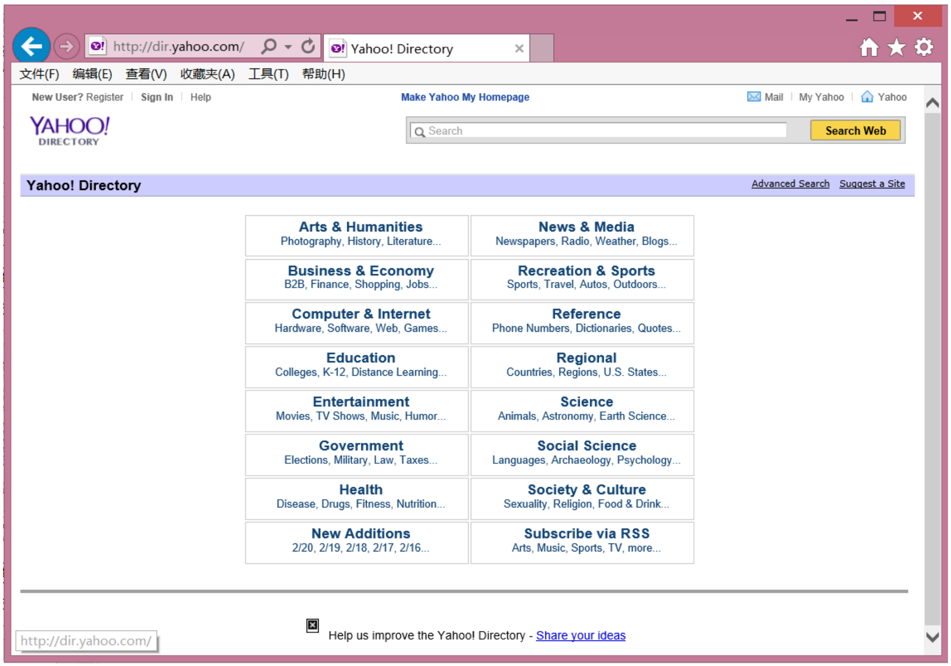
Outline

- Basic IR procedure
  - Data acquisition – on the Web: Crawler
  - Indexing
  - Ranking
  - System evaluation

Crawler – Crawl "all" Web pages?

- Problem: No catalog of all accessible URLs on the Web.
- Solution (basic crawler operation)
  - 1. Given: Initial set of URLs U (in some order) -- "seed" pages





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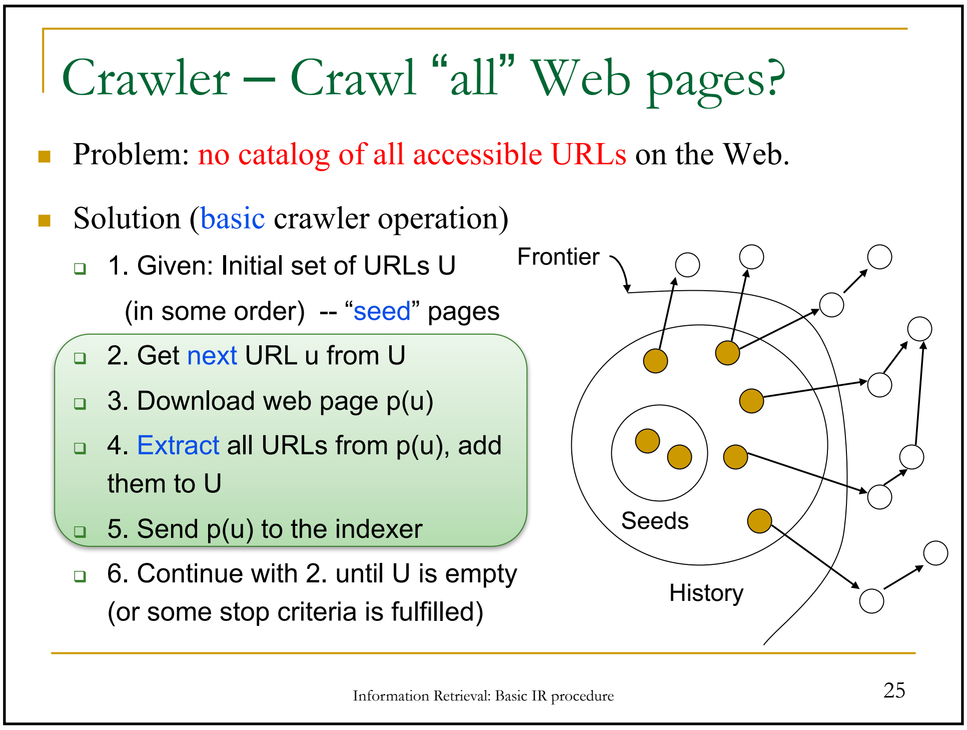
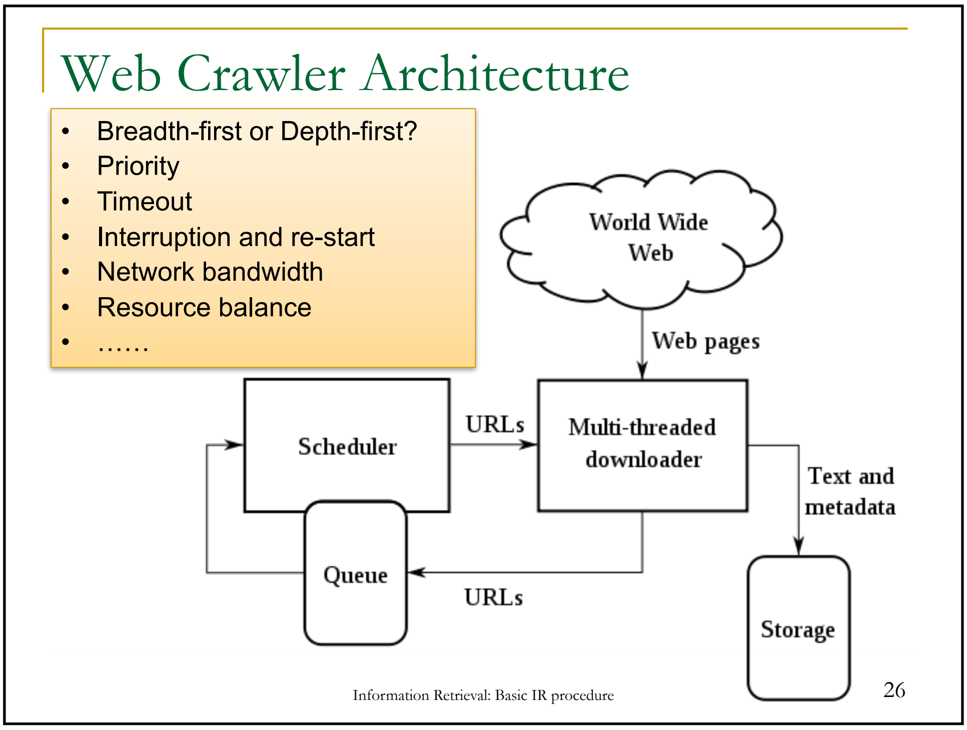


Crawler – Crawl "all" Web pages?

- Problem: no catalog of all accessible URLs on the Web.
- Solution (basic crawler operation)
  - 1. Given: Initial set of URLs U
    (in some order) -- "seed" pages
  - 2. Get next URL u from U
  - 3. Download web page p(u)
  - 4. Extract all URLs from p(u), add them to U
  - 5. Send p(u) to the indexer
  - 6. Continue with 2. until U is empty (or some stop criteria is fulfilled)



Web Crawler Architecture

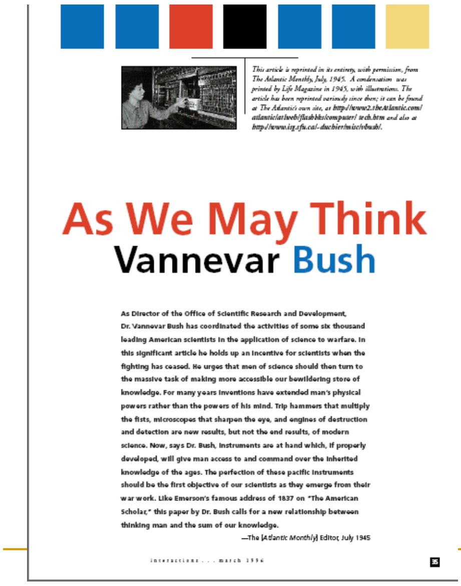
- Breadth-first or Depth-first?
- Priority
- Timeout
- Interruption and re-start
- Network bandwidth
- Resource balance
- ……

"It is fairly easy to build a slow crawler that downloads a few pages per second for a short period of time, building a high-performance system that can download hundreds of millions of pages over several weeks presents a number of challenges in system design, I/O and network efficiency, and robustness and manageability."

Eichmann, D. (1994). The RBSE spider: balancing effective search against Web load. In Proceedings of the First World Wide Web Conference, Geneva, Switzerland.

APPENDIX

As we may think



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