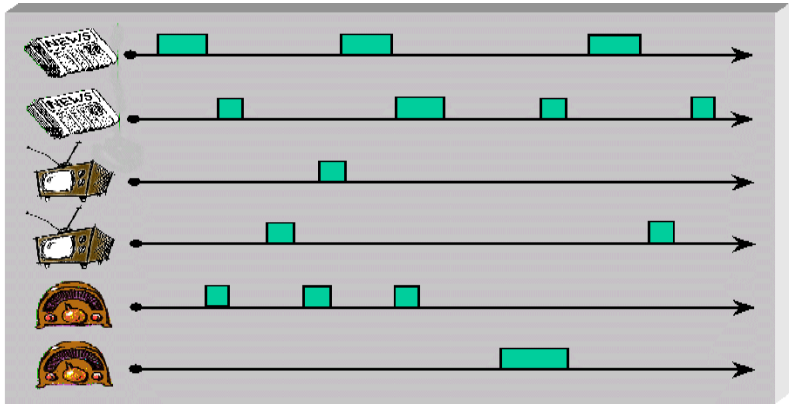
Information Retrieval and Extraction

Berlin Chen 2008



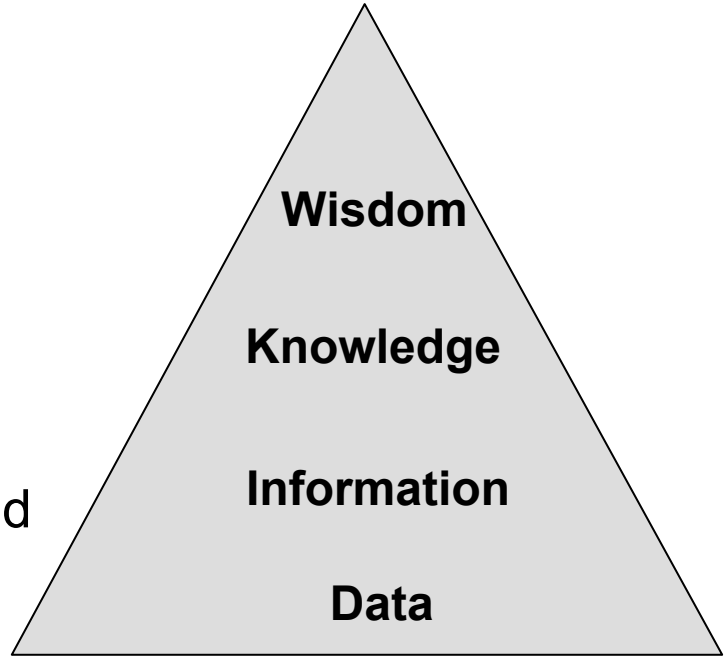
(Picture from the TREC web site)

Textbook and References

- Textbook
  - Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, ***Introduction to Information Retrieval***, Cambridge University Press. 2008
  - R. Baeza-Yates and B. Ribeiro-Neto. ***Modern Information Retrieval.*** Addison Wesley Longman, 1999
- References
  - D. A. Grossman, O. Frieder, ***Information Retrieval: Algorithms and Heuristics***, Springer. 2004
  - W. B. Croft and J. Lafferty (Editors). ***Language Modeling for Information Retrieval***. Kluwer-Academic Publishers, July 2003
  - I. H. Witten, A. Moffat, and T. C. Bell. ***Managing Gigabytes: Compressing and Indexing Documents and Images***. Morgan Kaufmann Publishing, 1999
  - C. Manning and H. Schutze. ***Foundations of Statistical Natural Language Processing***. MIT Press, 1999

Motivation (1/2)

- Information Hierarchy
  - Data
    - The raw material of information
  - Information
    - Data organized and presented by someone
  - Knowledge
    - Information read, heard or seen and understood
  - Wisdom
    - Distilled and integrated knowledge and understanding



Motivation (2/2)

- User information need
  - Find all docs containing information on college tennis teams which:
    (1) are maintained by a USA university and
    (2) participate in the NCAA tournament
    (3) National ranking in last three years and contact information

Query

Search engine/IR system

Emphasis is on the retrieval of information (not data)

Information Retrieval

- Deal with the representation, storage, organization of, and access to information items (such as documents)

- Focus is on the user information need
  - Information about a subject or topic
  - Semantics is frequently loose
  - Small errors are tolerated

- Handle natural language text (or free text) which is not always well structured and could be semantically ambiguous

Data Retrieval

- Determine which document of a collection contain the *keywords* in the user query
- Retrieve all objects (attributes) which satisfy clearly defined conditions in a regular expression or a relational algebra expression
  - Which documents contain a set of keywords (attributes) in some specific fields?
  - Well defined semantics & structures
  - A single erroneous object implies failure!

IR system

- Interpret contents of information items (documents)
- Generate a ranking (i.e., a ranked list of documents) which reflects relevance
- Notion of *relevance* is most important

IR at the Center of the Stage

- IR in the last 20 years:
  - Modelng, classification, clustering, filtering
  - User interfaces and visualization
  - Systems and languages

- WWW environment (90~)
  - Universal repository of knowledge and culture
  - Without frontiers: free universal access
  - Lack of well-defined data model

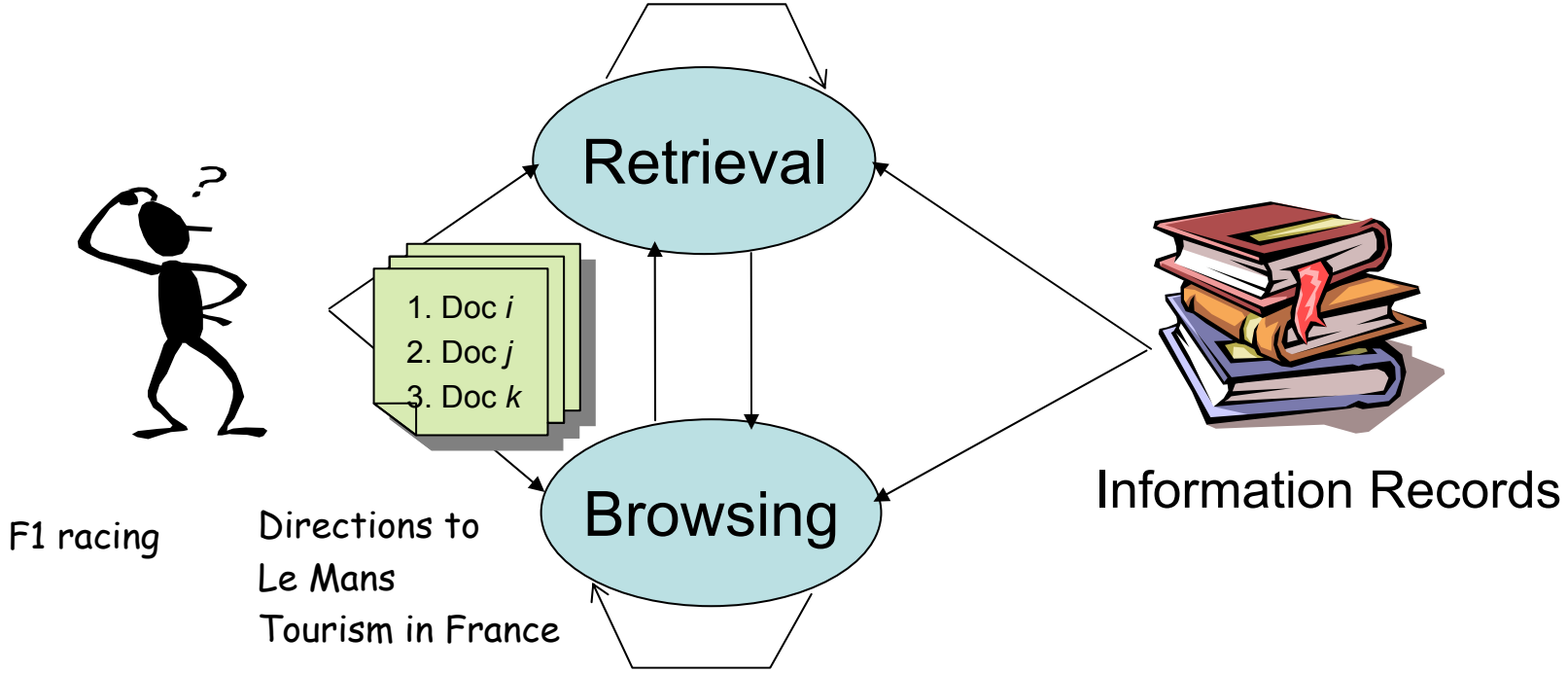
IR Main Issues

- The effective retrieval of relevant information affected by
  - The user task
  - Logical view of the documents

The User Task

- Translate the information need into a query in the language provided by the system
  - A set of words conveying the semantics of the information need

- Browse the retrieved documents

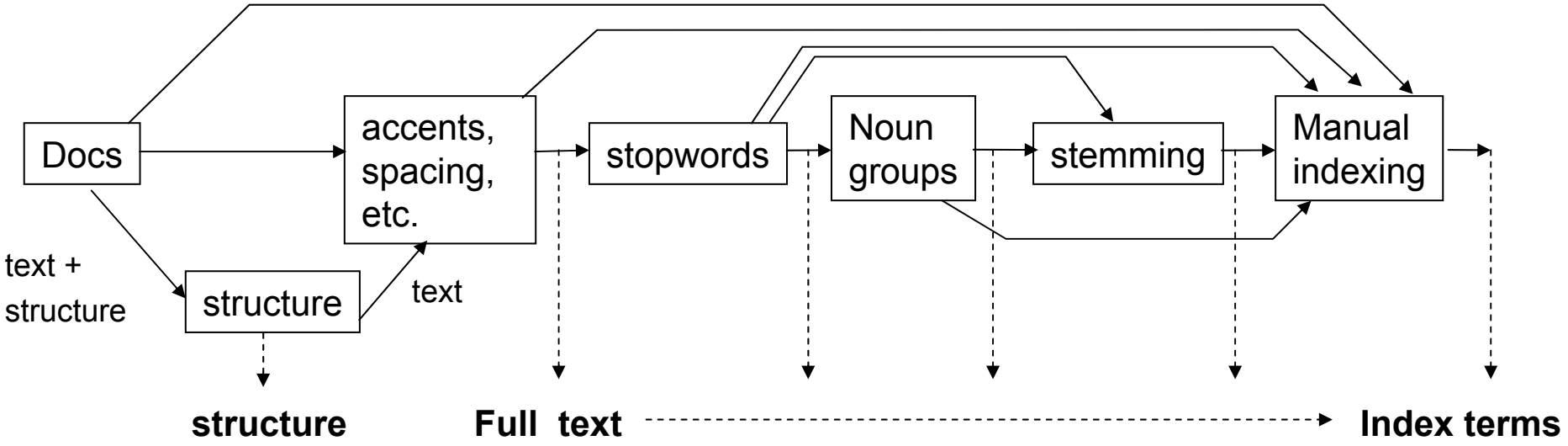


Logical View of the Documents (1/2)

- A full text view (representation)
  - Represent document by its whole set of words
    - Complete but higher computational cost
- A set of index terms by a human subject
  - Derived automatically or generated by a specialist
    - Concise but may poor
- An intermediate representation with feasible *text operations*

Logical View of the Documents (2/2)

- Text operations
  - Elimination of stop-words (e.g. articles, connectives, …)
  - The use of stemming (e.g. tense, …)
  - The identification of noun groups
  - Compression ….
- Text structure (chapters, sections, …)



Different Views of the IR Problem

- Computer-centered (commercial perspective)
  - Efficient indexing approaches
  - High-performance matching ranking algorithms

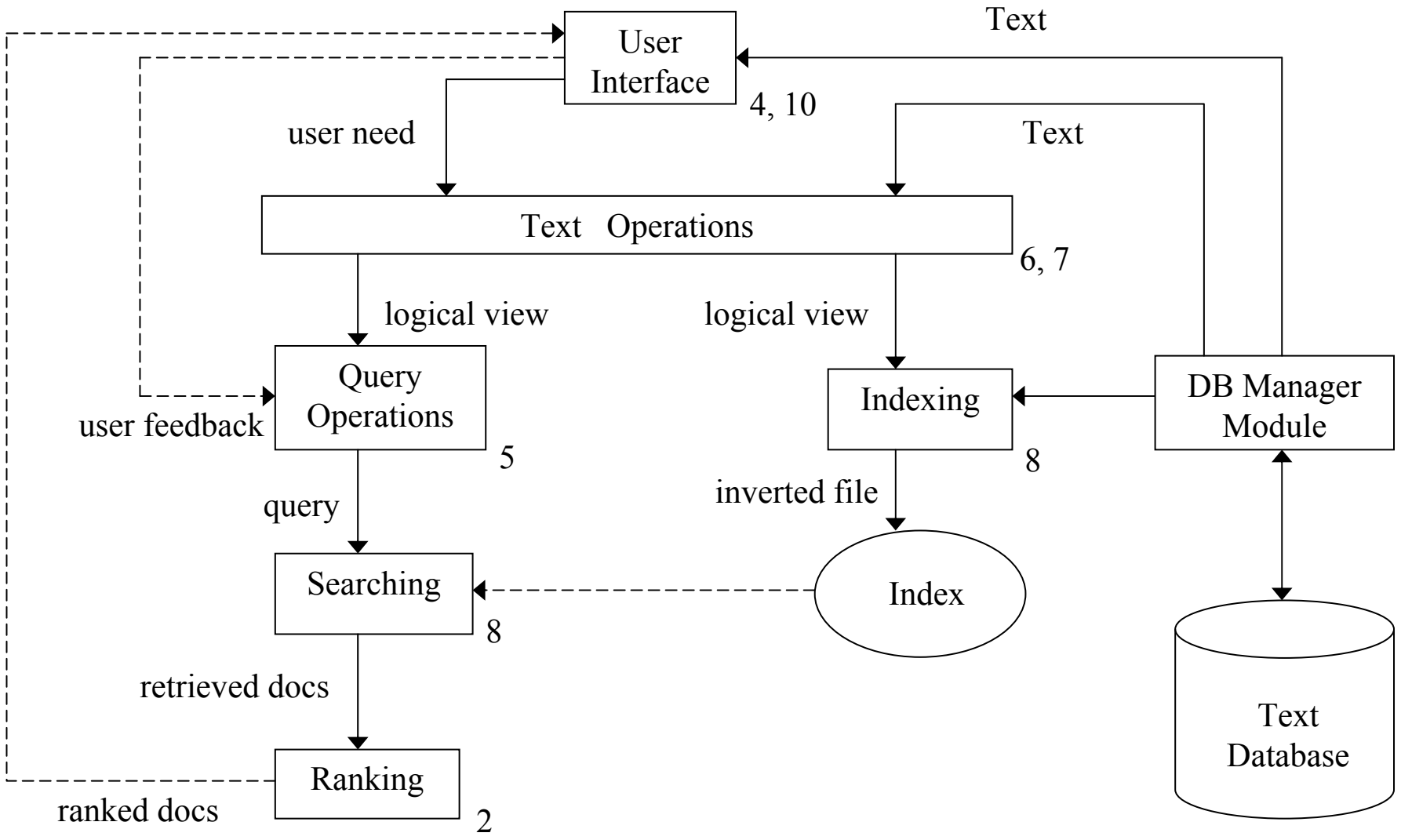
- Human-centered (academic perceptive)
  - Studies of user behaviors
  - Understanding of user needs

Library science
psychology
....

IR for Web and Digital Libraries

- Questions should be addressed
  - Still difficult to retrieve information relevant to user needs
  - Quick response is becoming more and more a pressing factor (Precision vs. Recall)
  - The user interaction with the system (HCI, Human Computer Interaction)
- Other concerns
  - Security and privacy
  - Copyright and patent

The Retrieval Process (1/2)



The Retrieval Process (2/2)

- In current retrieval systems
  - Users almost never declare his information need
    - Only a short queries composed few words (typically fewer than 4 words)
  - Users have no knowledge of the text or query operations

Poor formulated queries lead to poor retrieval !

Major Topics (1/2)

- Four Main Topics

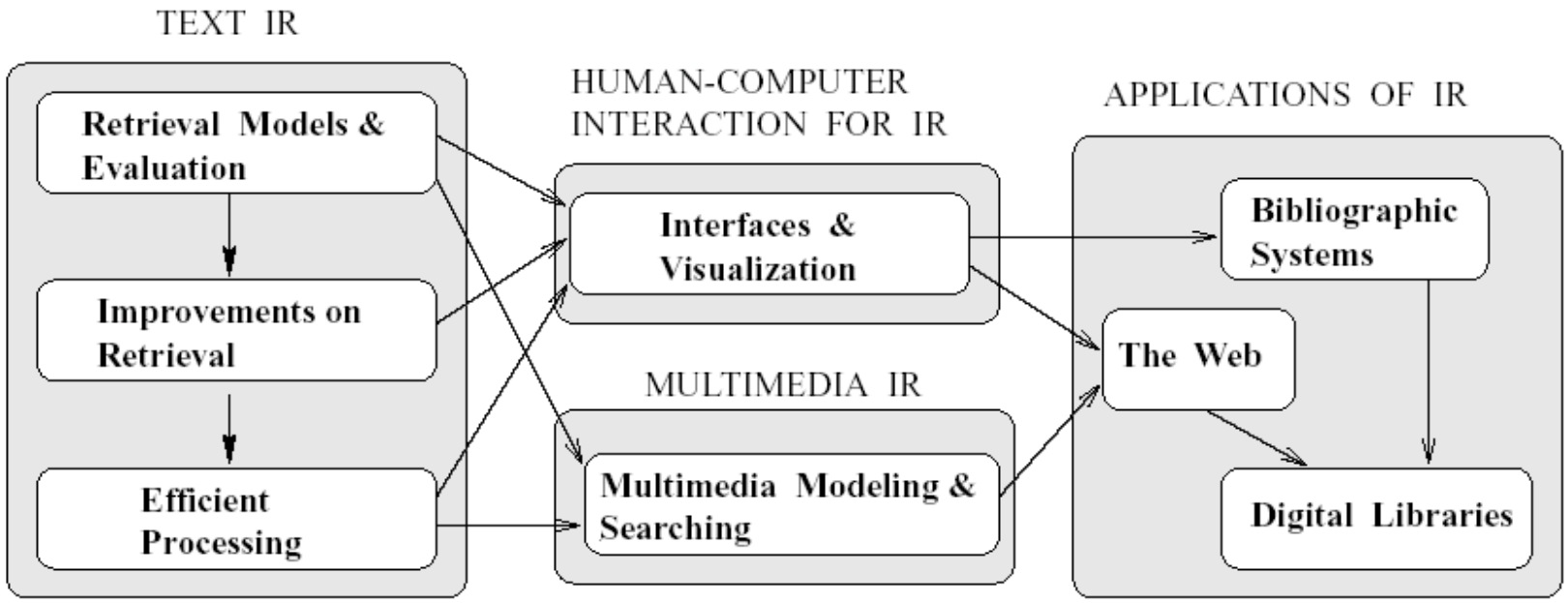
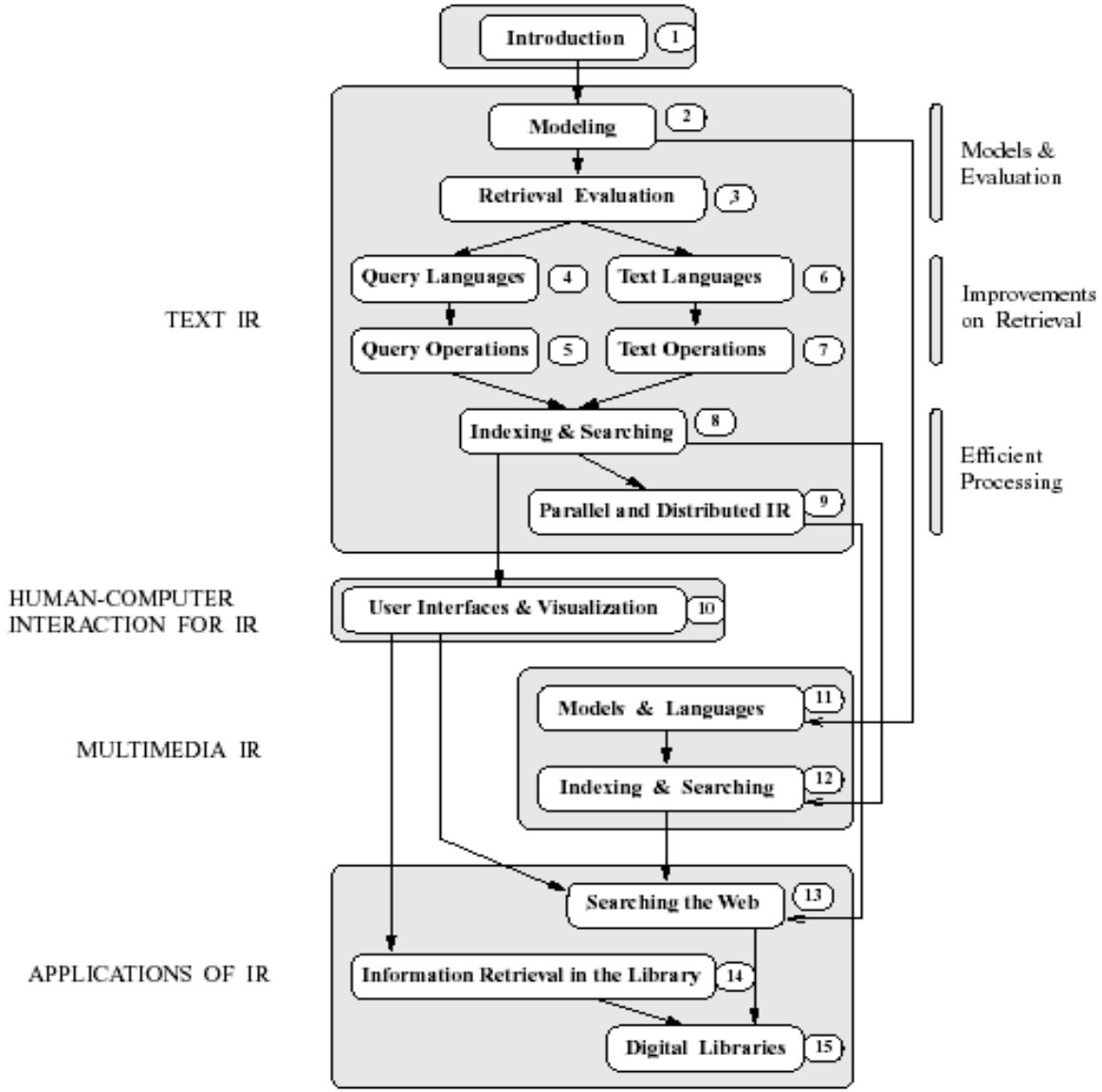


Figure 1.4 Topics which compose the book and their relationships.

Major Topics (2/2)

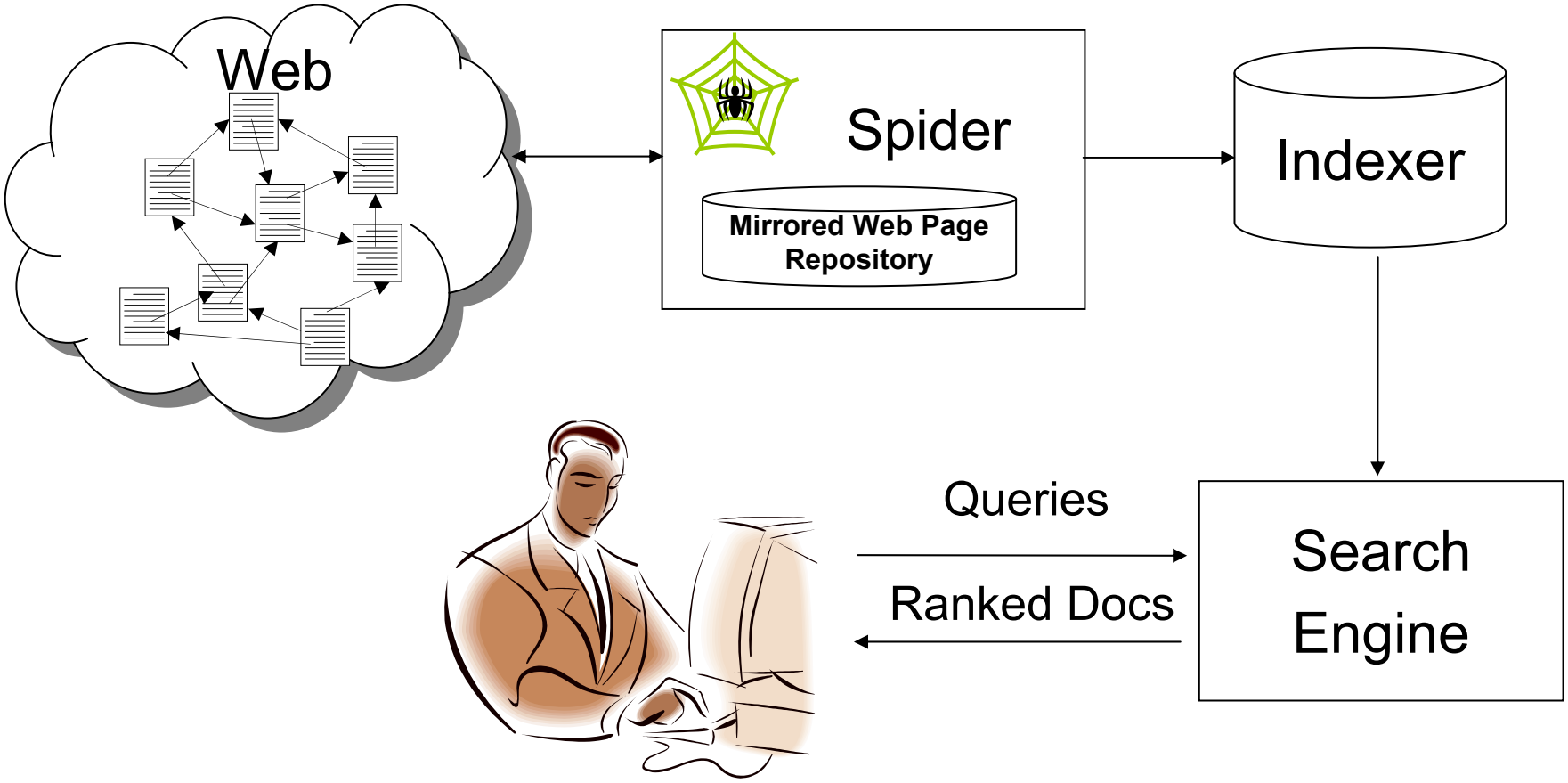
- Text IR
  - Retrieval models, evaluation methods, indexing
- Human-Computer Interaction (HCI)
  - Improved user interfaces and better data visualization tools
- Multimedia IR
  - Text, speech, audio and video contents
  - Multidisciplinary approaches
  - Can multimedia be treated in a unified manner?
- Applications
  - Web, bibliographic systems, digital libraries

Textbook Topics



Text Information Retrieval (1/4)

- Internet searching engine



Text Information Retrieval (2/4)

- http://www.google.com

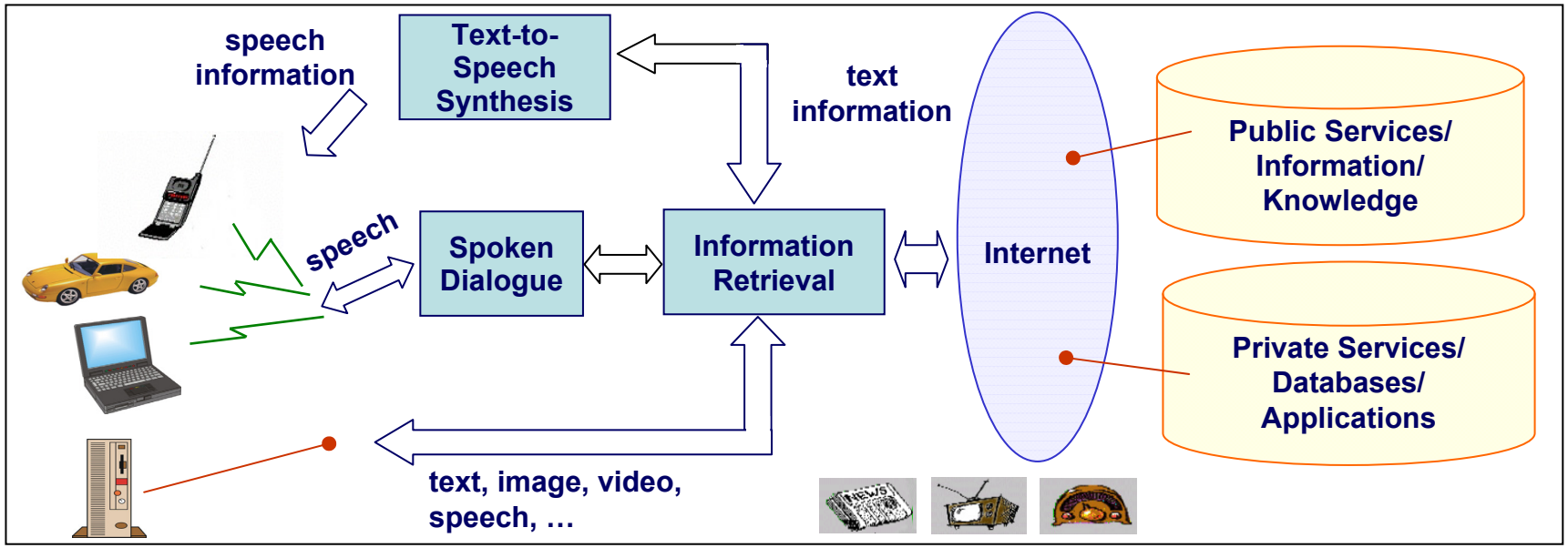
Text Information Retrieval (3/4)

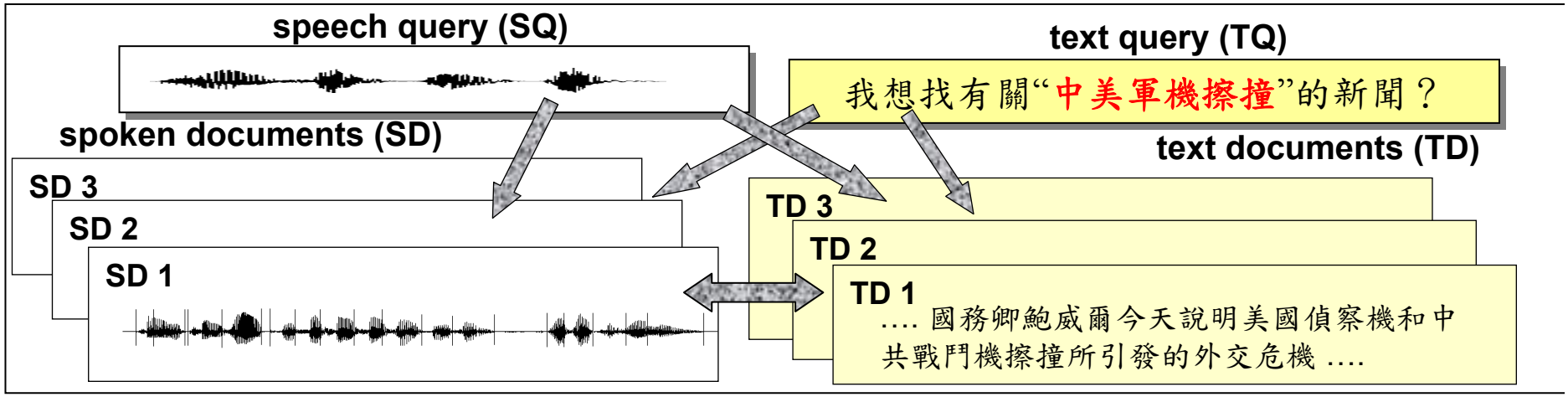
- http://www.openfind.com.tw (Service is No Longer Available)

Text Information Retrieval (4/4)

- http://www.baidu.com

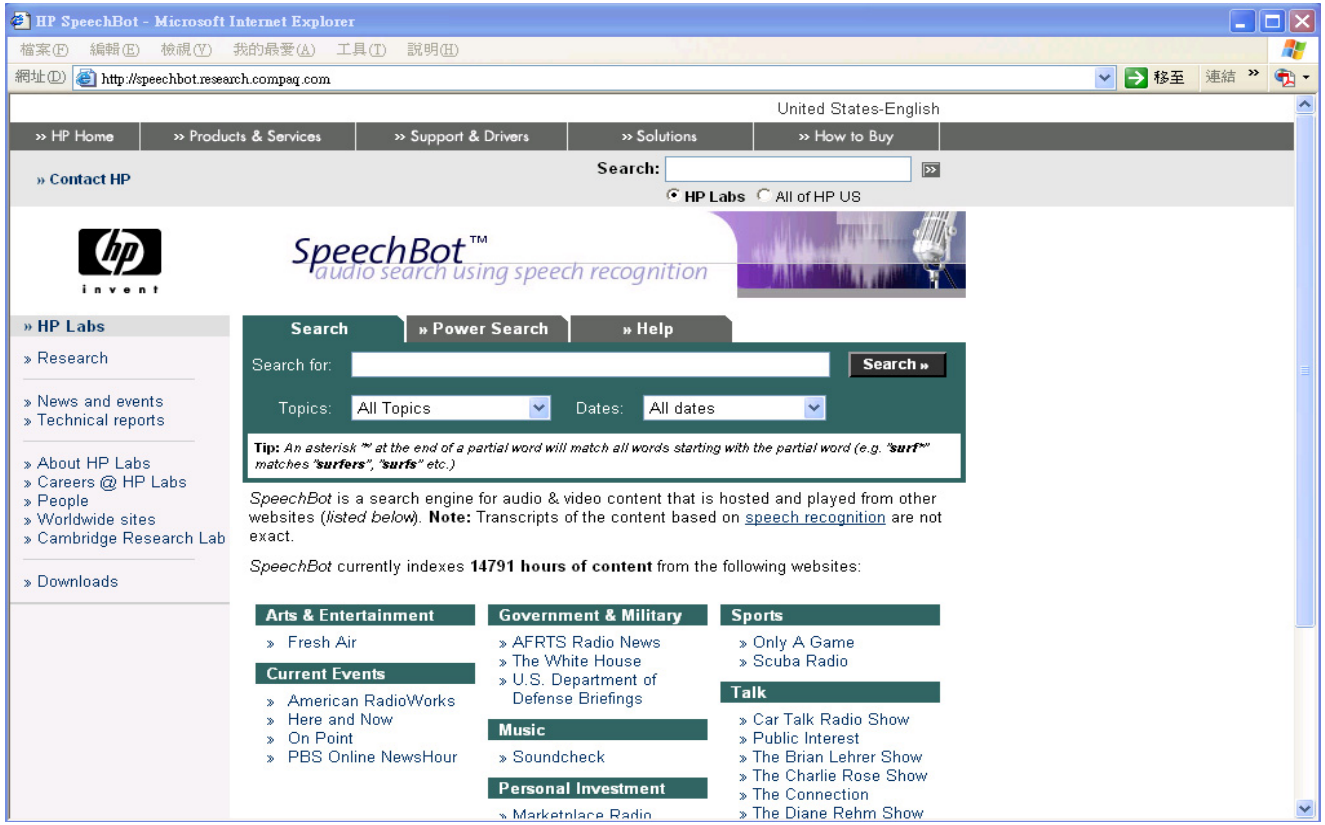
Speech Information Retrieval (1/4)





Speech Information Retrieval (2/4)

- HP Research Group – Speechbot System
  (Service is No Longer Available)
  - Broadcast news speech recognition, Information retrieval, and topic segmentation (SIGIR2001)
  - Currently indexes **14,791 hours of content** (2004/09/22, http://speechbot.research.compaq.com/)

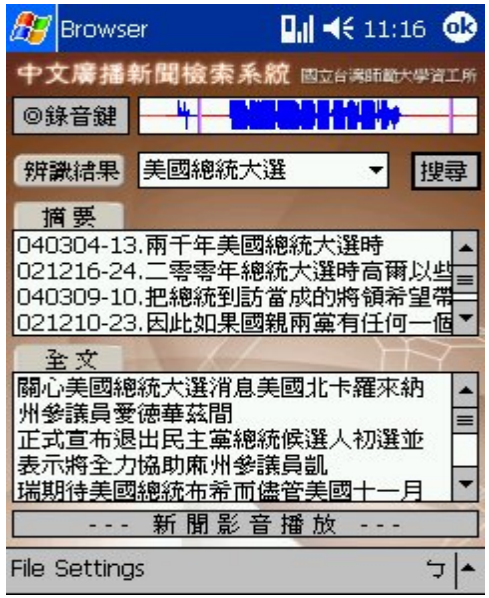


Speech Information Retrieval (3/4)

- Speech Summarization and Retrieval

輸入聲音問句：“請幫我查總統府升旗典禮”

中文影音多媒體資訊檢索雛形展示系統。



Speech Information Retrieval (4/4)

- Speech Organization

- L.-S. Lee and B. Chen, "Spoken Document Understanding and Organization," *IEEE Signal Processing Magazine* 22(5), pp. 42-60, Sept. 2005

Visual Information Retrieval (1/4)

- Content-based approach

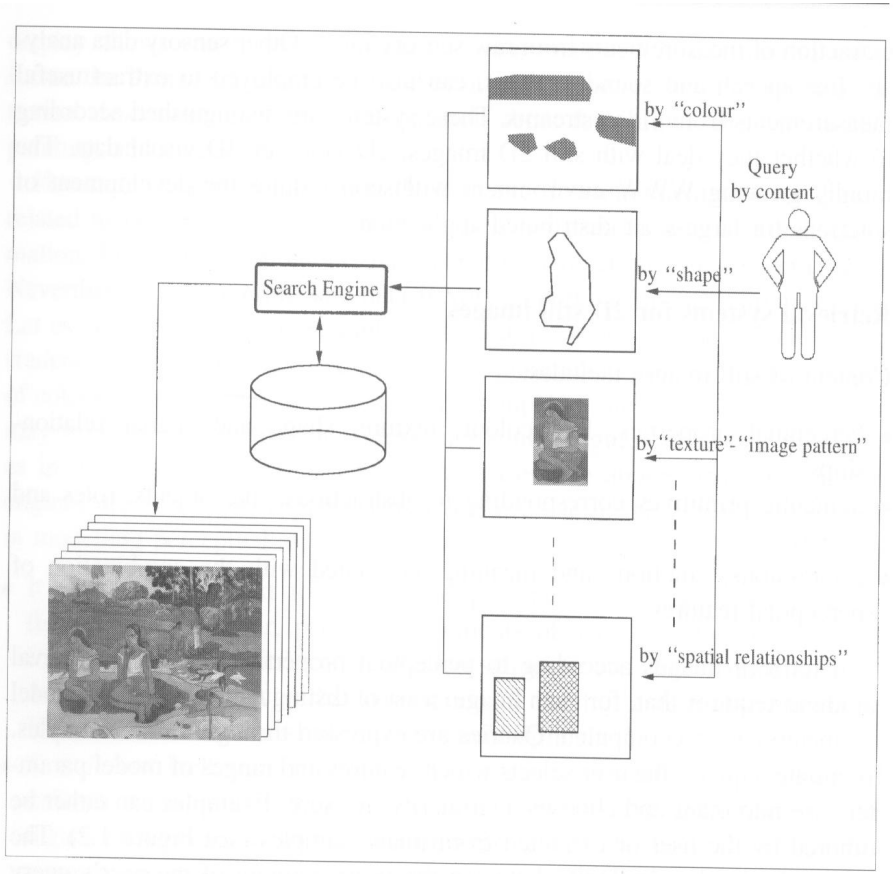


Figure 1.2 Different types of query by example.

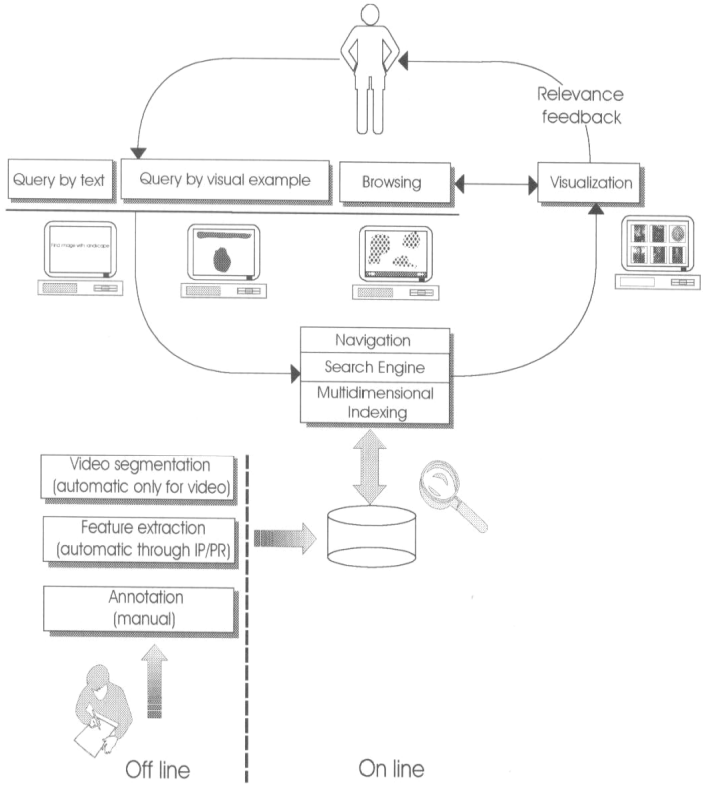


Figure 1.5 Sketch of a new-generation visual information retrieval system for video.

Visual Information Retrieval (2/4)

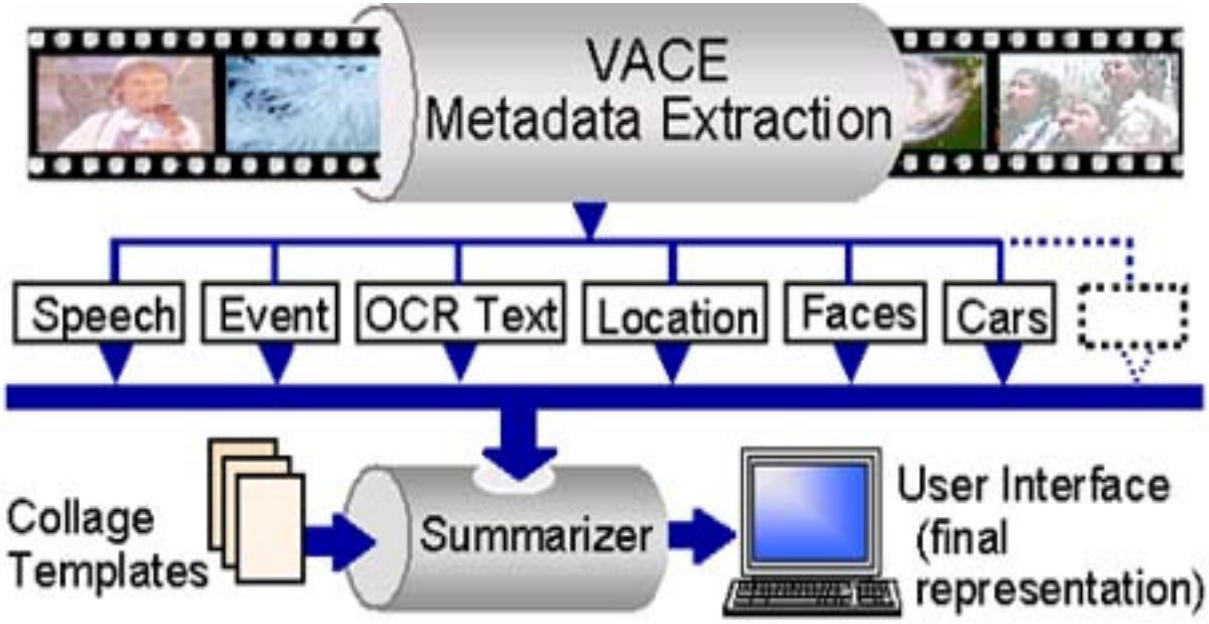
- Images with Texts (Metadata)

Visual Information Retrieval (3/4)

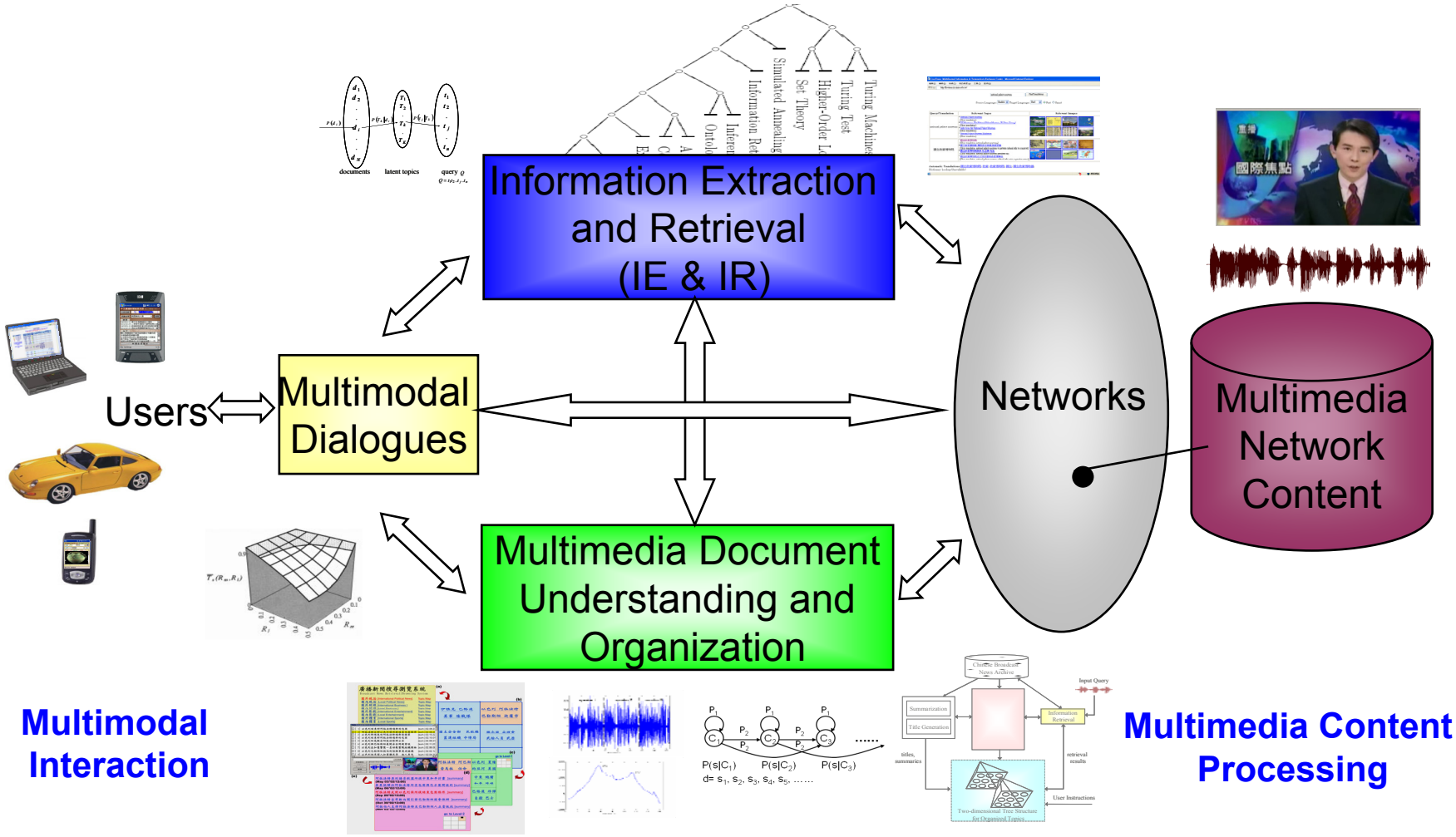
- Content-based Image Retrieval

Visual Information Retrieval (4/4)

Video Analysis and Content Extraction



Scenario for Multimedia information access



Other IR-Related Tasks

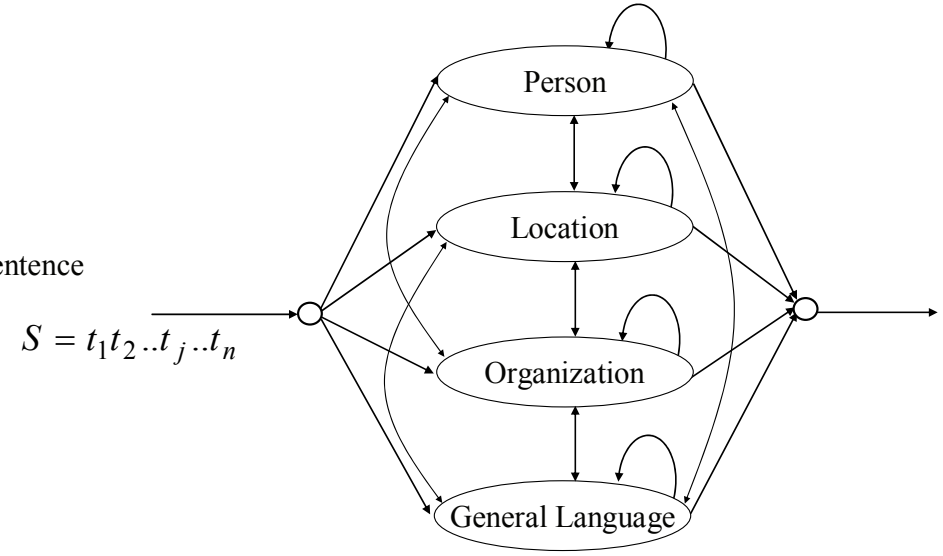
- Information filtering and routing
- **Term/Document categorization**
- **Term/Document clustering**
- **Document summarization**
- **Information extraction**
- Question answering
- Crosslingual information retrieval
- …..

Document Summarization

- Audience
  - Generic summarization
  - User-focused summarization
    - Query-focused summarization
    - Topic-focused summarization
- Function
  - Indicative summarization
  - Informative summarization
- Extracts vs. abstracts
  - Extract: consists wholly of portions from the source
  - Abstract: contains material which is not present in the source
- Output modality
  - Speech-to-text summarization
  - Speech-to-speech summarization
- Single vs. multiple documents

Information Extraction

- E.g., Named-Entity Extraction
  - NE has it origin from the Message Understanding Conferences (MUC) sponsored by U.S. DARPA program
    - Began in the 1990's
    - Aimed at extraction of information from text documents
    - Extended to many other languages and spoken documents (mainly broadcast news)
  - Common approaches to NE
    - Rule-based approach
    - Model-based approach
    - Combined approach

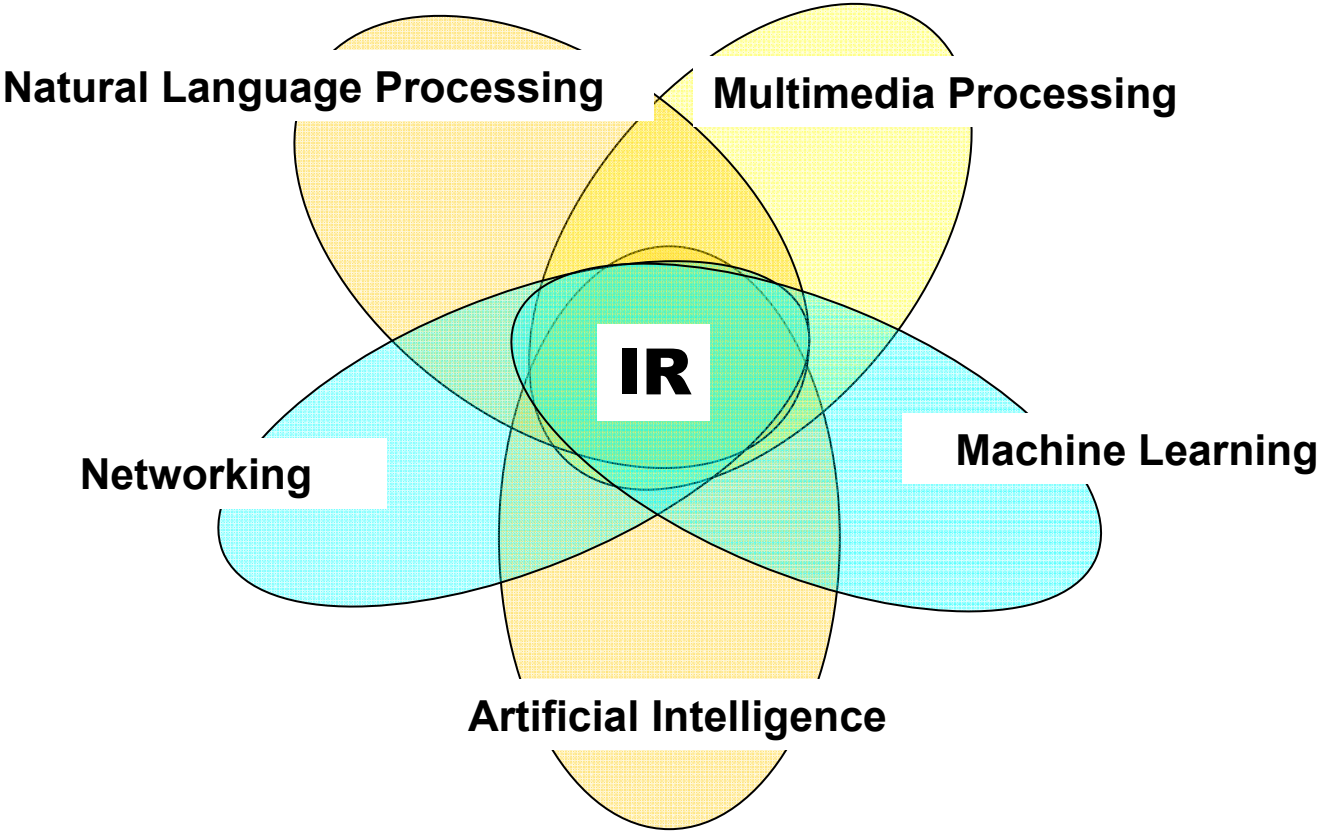


Cross-lingual Information Retrieval

- E.g., Automatic Term Translation
  - Discovering translations of unknown query terms in different languages
  - E.g., The Live Query Term Translation System (LiveTrans) developed at Academia Sinica/by Dr. Chien Lee-Feng

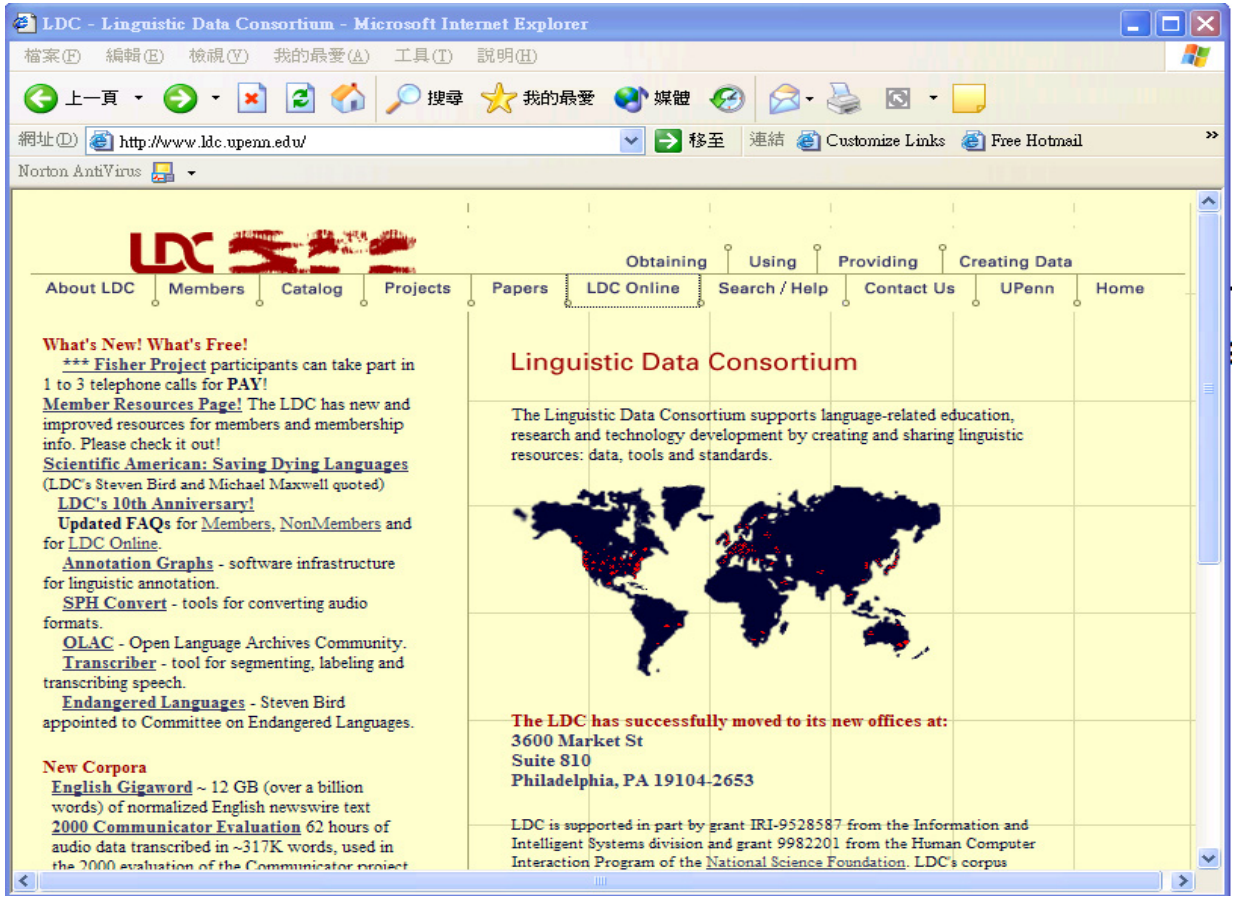
Machine-Extracted Translation

Multidisciplinary Approaches



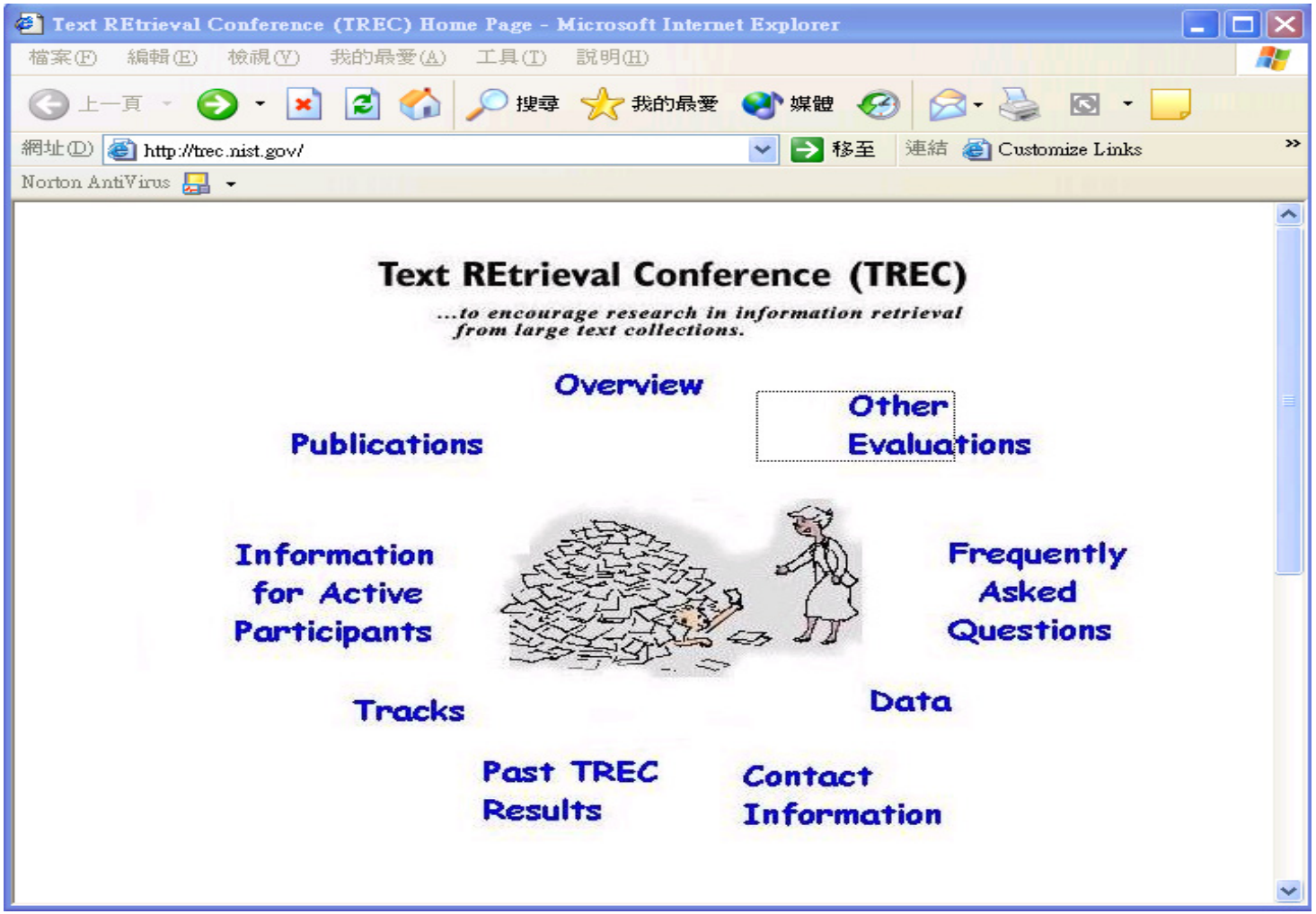
Resources

- Corpora (Speech/Language resources)
  - Refer speech waveforms, machine-readable text, dictionaries, thesauri as well as tools for processing them
    - LDC - Linguistic Data Consortium



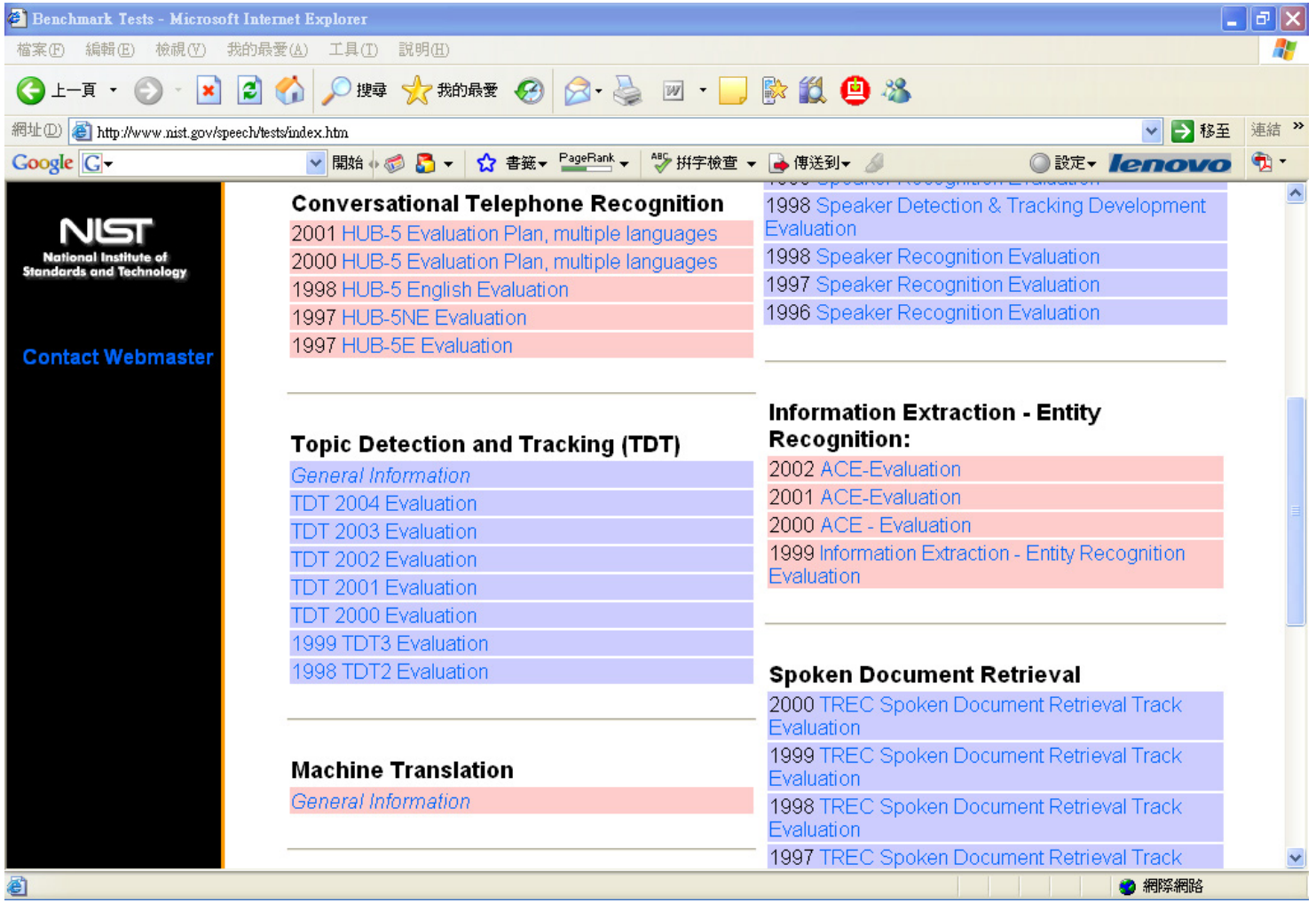
Contests (1/2)

- Text REtrieval Conference (TREC)



Contests (2/2)

- US National Institute of Standards and Technology



Conferences/Journals

- Conferences
  - ACM Annual International Conference on Research and Development in Information Retrieval (SIGIR)
  - ACM Conference on Information Knowledge Management (CIKM)
  - …
- Journals
  - ACM Transactions on Information Systems (TOIS)
  - ACM Transactions on Asian Language Information Processing (TALIP)
  - Information Processing and Management (IP&M)
  - Journal of the American Society for Information Science (JASIS)
  - …

Tentative Topic List

Course Overview & Introduction
Retrieval Models (I) - Classic Retrieval Models (Boolean, Vector Space and Probabilistic Models)
Retrieval Performance Evaluation - Measures
Retrieval Performance Evaluation - Collections
Retrieval Models (II) - Improved Approaches (Fuzzy Set, Extended Boolean, Generalized Vector Space Models)
Query Operations (Query Expansion and Term Re-weighting)
Retrieval Models (III) - Latent Semantic Analysis (LSA)
Retrieval Models (IV) - Language Models
Retrieval Models (V) - Learning to Rank
Clustering for Information Retrieval
Classification for Information Retrieval
Efficient Indexing and Searching
Web Search Basics
Cross-lingual Information Retrieval
Spoken Document Recognition, Retrieval and Summarization

Grading (Tentative)

- Midterm (or Final): 20%
- Homework/Projects: 50%
- Presentation: 20%
- Attendance/Other: 10%

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