Models for Retrieval and Browsing

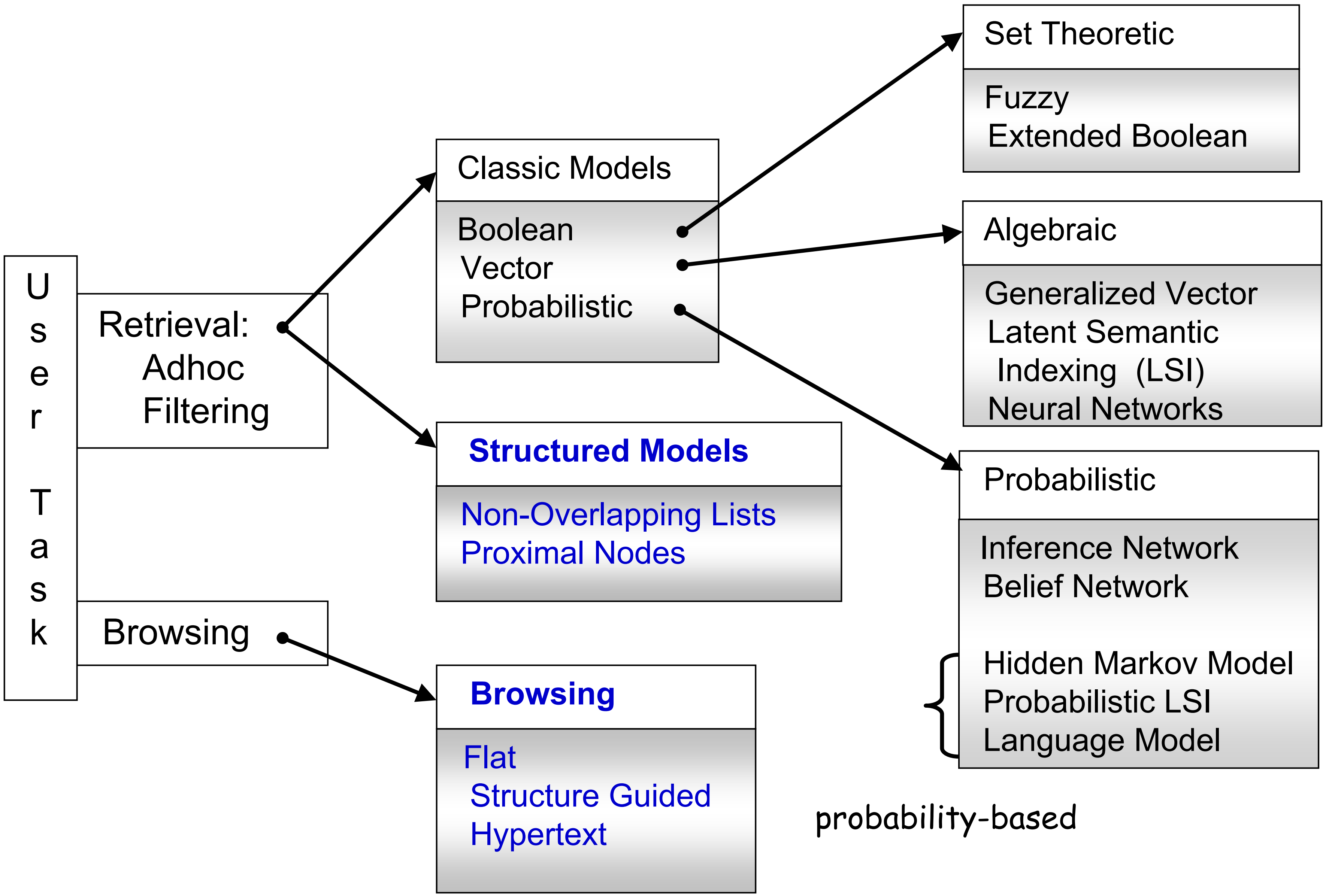
- Structural Models and Browsing

Berlin Chen 2004

Reference:

1. *Modern Information Retrieval*, chapter 2

Taxonomy of Classic IR Models



Structured Text Retrieval Models

- Structured Text Retrieval Models
  - Retrieval models which combine information on text content with information on the document structure
  - That is, the document structure is one additional piece of information which can be taken advantage
- E.g.: Consider the following information need
  - Retrieve all docs which contain a page in which the string '*atomic holocaust*' appears in italic in the text surrounding a Figure whose label contains the word '*earth*'
    - ['atomic holocaust'' and 'earth'] classical IR model
    - Or a structural (more complex) query inestead

Too many doc retrieved !

data retrieval?

same-page(near('*atomic holocaust*', Figure(label('earth'))))

Structured Text Retrieval Models (cont.)

- Drawbacks
  - Difficult to specify the structural query
    - An advanced user interface is needed
  - Structured text retrieval models include no ranking (open research problem!)

- Tradeoffs
  - The more expressive the model, the less efficient is its query evaluation strategy

- Two structured text retrieval models are introduced here
  - Non-Overlapping Lists
  - Proximal Nodes

Basic Definitions

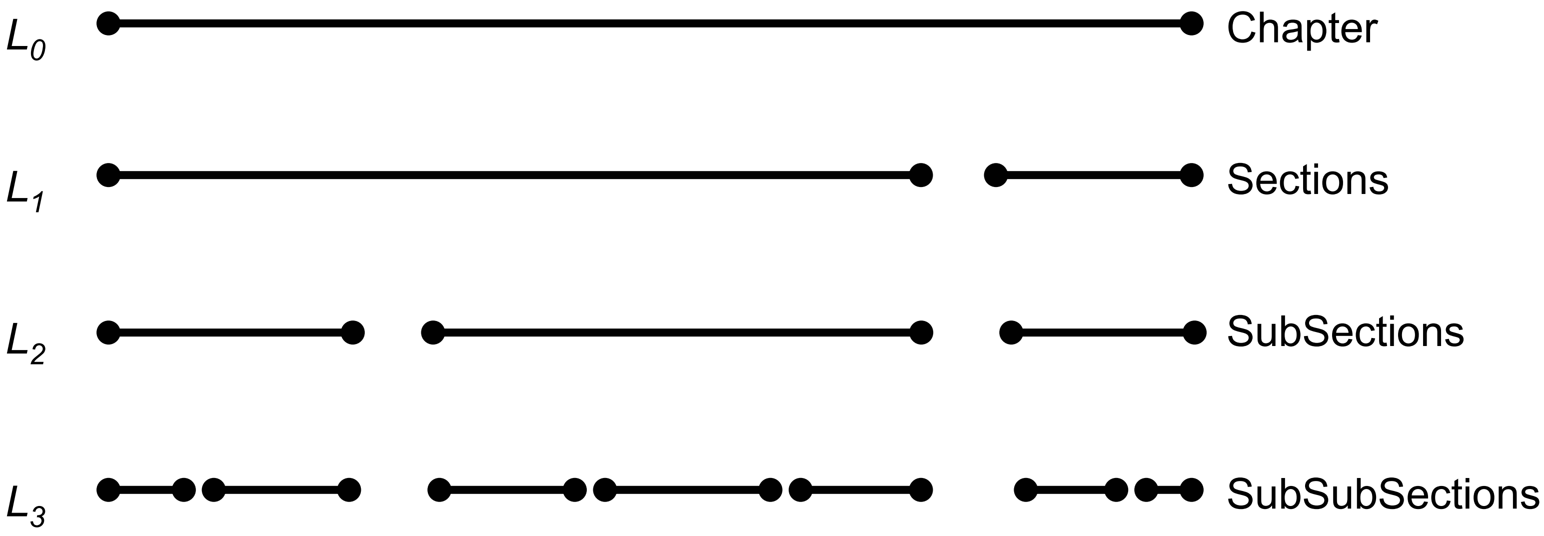
- **Match point**: the position in the text of a sequence of words that match the query
  - Query: "atomic holocaust in Hiroshima"
  - Doc d_j: contains 3 lines with this string
  - Then, doc d_j contains 3 match points
- **Region**: a contiguous portion of the text
- **Node**: a structural component of the text such as a chapter, a section, a subsection, etc.
  - That is, a region with predefined topological properties

Non-Overlapping Lists

Burkowski, 1992

- **Idea**: divide the whole text of a document in *non-overlapping* text regions which are collected in a *list*
  - Multiple list generated
    - A list for chapters
    - A list for sections
    - A list for subsections

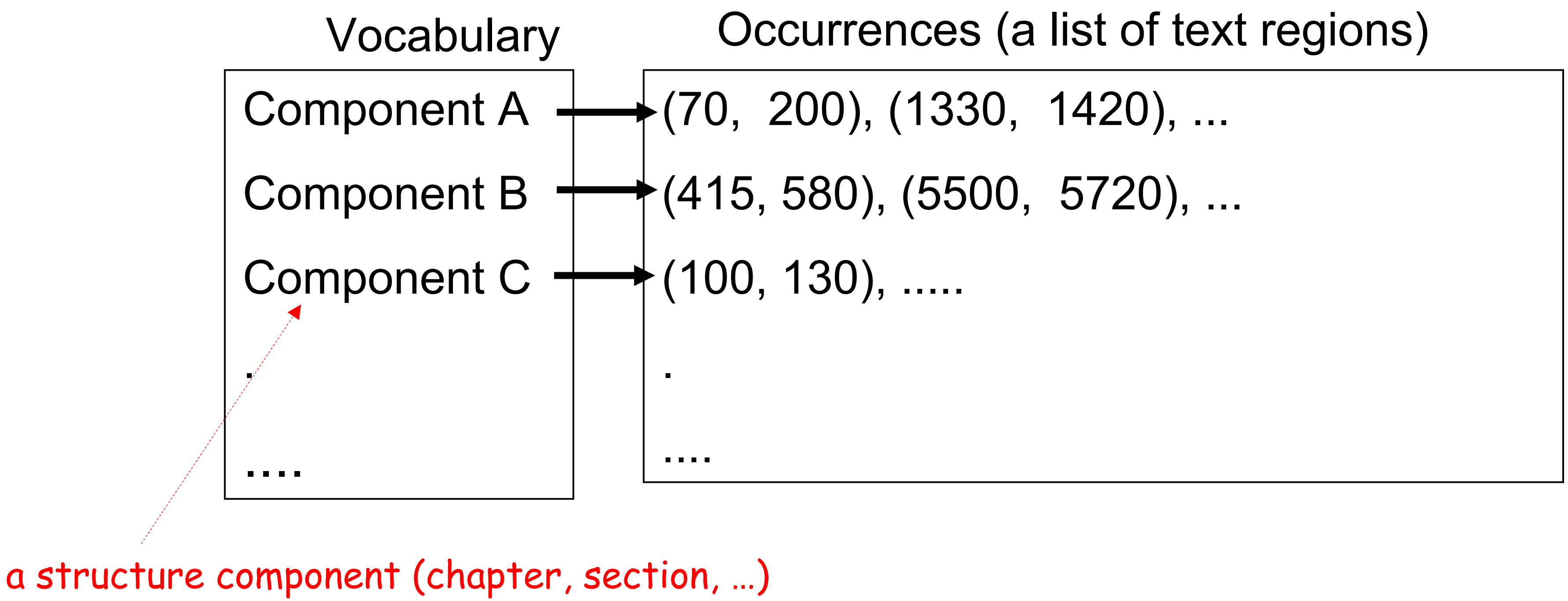
1. Kept as separate and distinct data structures
2. Text regions from distinct list might overlop!



Non-Overlapping Lists (cont.)

- Implementation:
  - A single inverted file build, in which each structural component stands as an entry in the index (see next slide)
  - Each entry has a list of text regions as a list occurrences
  - Such a list could be easily merged with the tranditional inverted file
- Example types of queries
  - Select a region which contains a given word (and doesn't contain any regions) innermost structural component
  - Select a region A which does not contain any other region B of distinct lists
  - Select a region not contained within any other region
    outermost structural component

Non-Overlapping Lists (cont.)



A inverted-file structure for non-overlapping lists

Inverted Files

- **Definition**
  - An inverted file is a word-oriented mechanism for indexing a text collection in order to speed up the searching task

- Structure of inverted file
  - *Vocabulary*: is the set of all distinct words in the text
  - *Occurrences*: lists containing all information necessary for each word of the vocabulary (text position, frequency, documents where the word appears, etc.)

Inverted Files (cont.)

- Text:

1 6 12 16 18 25 29 36 40 45 54 58 66 70

That house has a garden. The garden has many flowers. The flowers are beautiful

- Inverted file

Vocabulary	Occurrences
beautiful	70
flowers	45, 58
garden	18, 29
House	6
….	….

Different granularities for Occurrences
- Text position
- Doc position

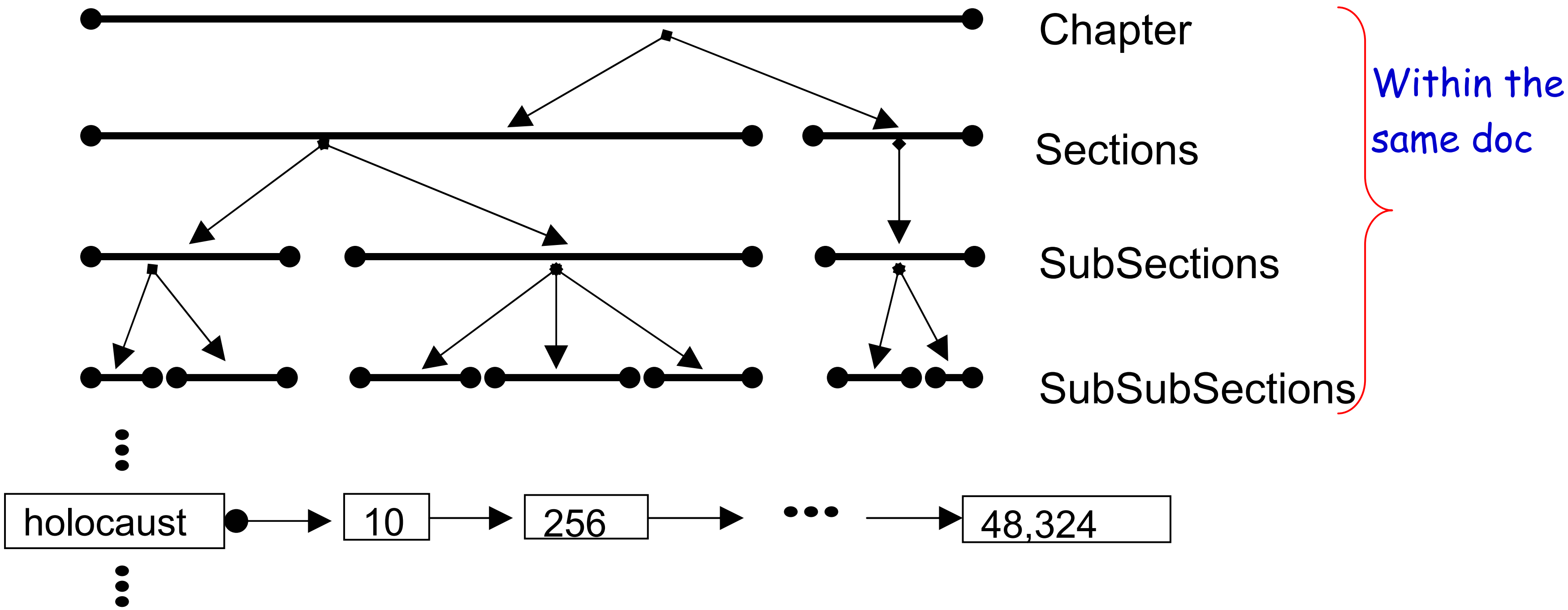
Proximal Nodes

Navarro and Baeza-Yates, 1997

- **Idea**
  - Define a strict hierarchical index over the text. This enriches the previous model that used flat lists (*see next slide*)
  - Multiple index hierarchies might be defined
  - Two distinct index hierarchies might refer to text regions that overlap

- Each indexing structure is a strict hierarchy composed of
  - *Chapters*, *sections*, *subsections*, *paragraphs* or *lines*
  - Each of these components is called a *node*
    - Each node is associated with a text region

Proximal Nodes (cont.)



- **Features**
  - One node might be contained within another node
  - But, two nodes of a same hierarchy cannot overlap
  - The inverted list for words complements the hierarchical index

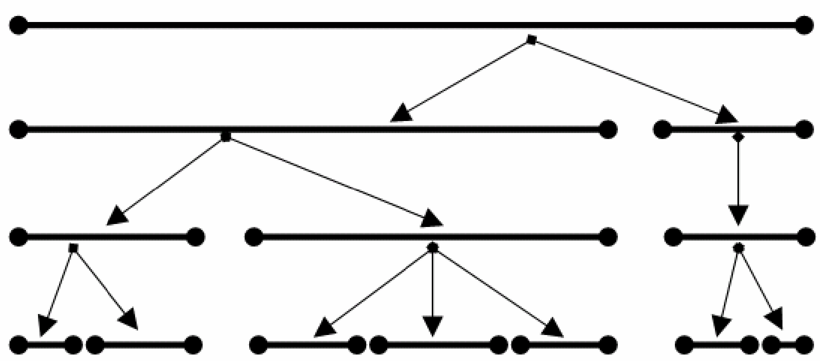
Proximal Nodes (cont.)

- Query Language in regular expressions
  - Search for strings
  - References to structural components by name
  - Combination of these

- An example query: [(*section) with ("holocaust")]
  - Search for the sections, the subsections, and the subsubsections that contain the word "holocaust"

Proximal Nodes (cont.)

- Simple query processing for previous example
  - Traverse the inverted list for “holocaust” and **determine all match points** (all occurrance entries)
  - Use the match points to search in the hierarchical index for the structural components
    - Look for sections, subsections, and subsections containing that occurrence of the term



Proximal Nodes (cont.)

- Sophisticated query processing
  - Get the **first entry in the inverted list** for "holocaust"
  - Use this match point to search in the hierarchical index for the structural components unitil innermost matching structural component (the last and smallest one) found
    - At the bottom of the hierarchy
  - Check if innermost matching component includes the second entry in the inverted list for "holocaust"
  - If it does, check the two, the third entries,and so on. If not, travse up to higher nodes then travse down ....
  - This allows matching efficiently the nearby (or proximal) nodes

Proximal Nodes (cont.)

- **Conclusions**
  - The model allows formulating queries that are more sophisticated than those allowed by non-overlapping lists
  - To speed up query processing, nearby nodes are inspected
  - Types of queries that can be asked are somewhat limited (all nodes in the answer must come from a same index hierarchy!)
  - The model is a compromise between efficiency and expressiveness

[(*section) with ("holocaust")]

Models for Browsing

- **Premise**: the user is usually interested in browsing the documents instead of searching (specifying the queries)
  - User have goals to purse in both cases
  - However, the goal of a searching task is clearer in the mind of the user than the goal of a browsing task

- Three types of browsing discussed here
  - Flat Browsing
  - Structure Guided Browsing
  - The Hypertext Model

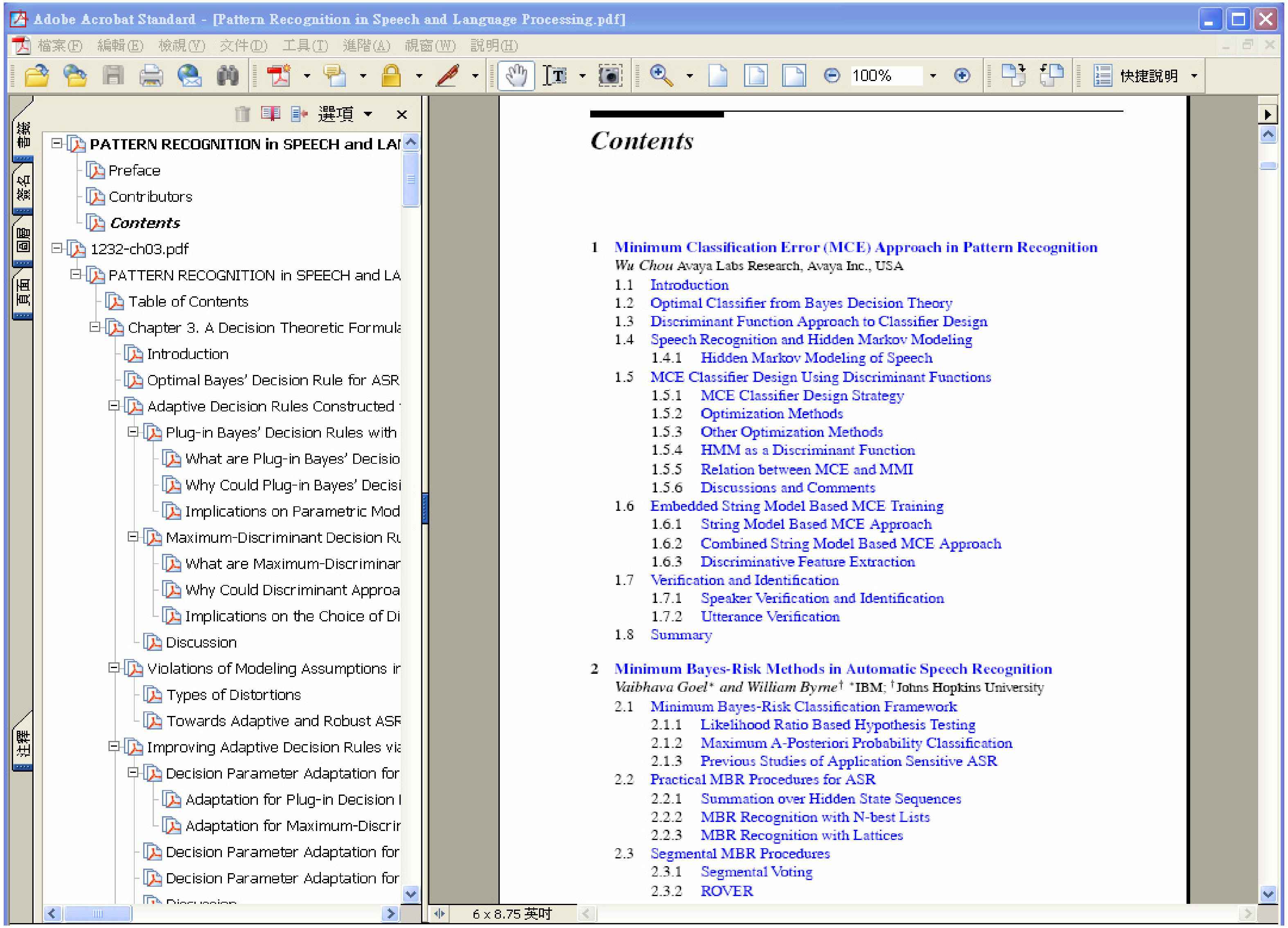
Flat Browsing

- Documents represented as dots in
  - A two-dimensional plane
  - A one-dimensional plane (list)
- **Features**
  - Glance here and there looking for information within documents visited
    - Correlations among neighbor documents
  - Add keywords of interest into original query
    - Relevance feedback or query expansion
  - Also, explore a single document in a flat manner (like a web page)
- **Drawbacks**
  - No indication about the context where the user is

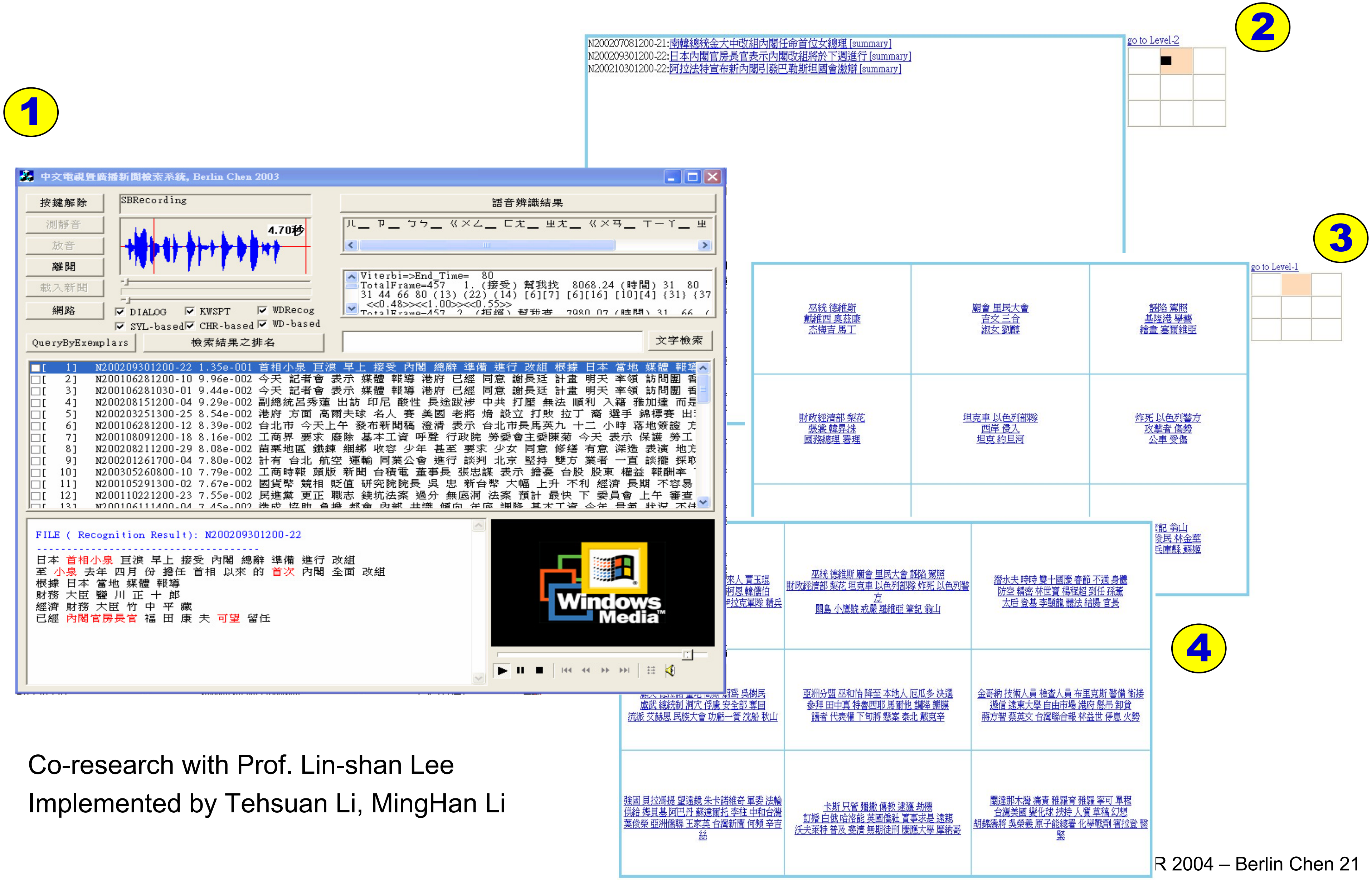
Structure Guided Browsing

- Documents organized in a structure as a directory
  - Directories are hierarchies of classes which group documents covering related topics
  - E.g.: "Yahoo!" provides hierarchical directory
- Same idea applied to a single document
  - Chapter level, section level, etc.
  - The last level is the text itself (flat!)
  - ***A good UI needed*** for keeping track of the context
  - E.g.: the adobe acrobat *pdf* files

Structure Guided Browsing (cont.)



Structure Guided Browsing (cont.)



Co-research with Prof. Lin-shan Lee

Implemented by Tehsuan Li, MingHan Li

Structure Guided Browsing (cont.)

- Additional facilities provided when searching
  - *A history map* identifies classes recently visited
  - *Display occurrences* (of terms) by showing the structures in a global context, in addition to the text positions

The Hypertext Model

- **Premise**: communication between writer and user
  - A sequenced organizational structure lies underneath most written text
  - The reader should not expect to fully understand the message conveyed by the writer by randomly reading pieces of text here and there

The Hypertext Model (cont.)

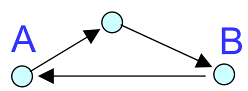
- Sometimes, we even can't capture the information through sequential reading of the whole text
  - E.g.: a book about "the history of the wars" is organized chronologically, but we only interested in "the regional wars in Europe"
    - Wars fought by each European country
    - War fought in Europe in chronological order

Rewrite the book?
Or defining a new structure?

The Hypertext Model (cont.)

- **Hypertext**
  - A high level interactive navigational structure allowing users to browse text non-sequentially
  - Consist of **nodes** (text regions) correlated by directed links in a graph structure
    - A **node** could be a chapter in a book, a section in an article, or a web page
    - Links are attached to specific strings inside the nodes

- Hypertexts provide the basis for HTML and HTTP
  - HTML: hypertext markup language
  - HTTP: hypertext transfer protocol



The Hypertext Model (cont.)

- **Features**
  - The process of navigating the hypertext is like a traversal of a directed graph

- **Drawbacks**
  - **Lost in hyperspace**: the user will lose track of the organizational structure of the hypertext when it is large
    - A hypertext map shows where the user is at all times (graphical user interface design)

  - But, the user is restricted to the intended flow of information previously convinced by the hypertext designer
    - Should take into account the needs of potential users

Analyzing before implementation

Guiding tools needed (hypertext map)

Trends and Research Issues

- Three main types of IR related products and systems
  - Library systems
  - Specialized retrieval systems
  - The Web

- **Library systems**
  - Much interest in cognitive and behavioral issues
    - Oriented particularly at a better understanding of which criteria the users adopt to judge relevance (most systems here adopt Boolean model)
      - Ranking strategies
      - User interface design
  - How to implement

Trends and Research Issues (cont.)

- **Specialized retrieval systems**
  - E.g. LEXIS-NEXIS: a system to access a very large collection of legal and business documents
  - How to retrieve almost all relevant documents without retrieving a large number of unrelated documents
    - Sophisticated ranking algorithms are desirable

Trends and Research Issues (cont.)

- **The Web** A pool of partially interconnected webs
  - User does not know what he wants or has great difficulty in properly formulating his request
  - Study how the paradigm adopted for the user interface affects the ranking

    Data model
    Navigational plan
    UI
    Rules
  - The indexes maintained by various Web search engine are almost disjoint
    - The intersection corresponds to less than 2% of the total number of page indexed
  - **Meta-search**
    - Search engines which work by fusing the ranking generated by other search engines