# Models for Retrieval and Browsing

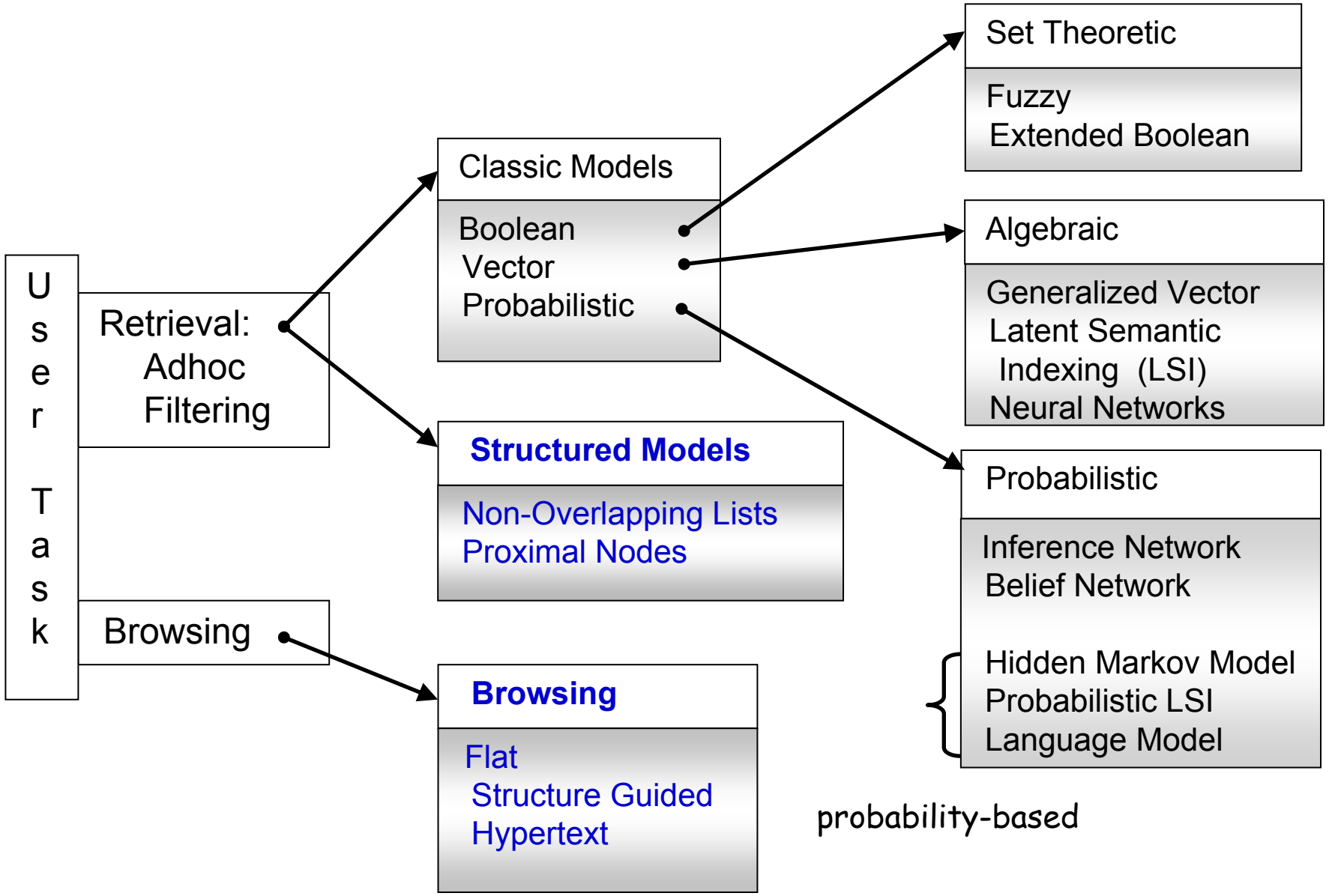
## - Structural Models and Browsing

Berlin Chen 2005

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 the 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*'

Too many doc retrieved !

- ['atomic holocaust'' and 'earth'] classical IR model
- Or a structural (more complex) query inestead

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

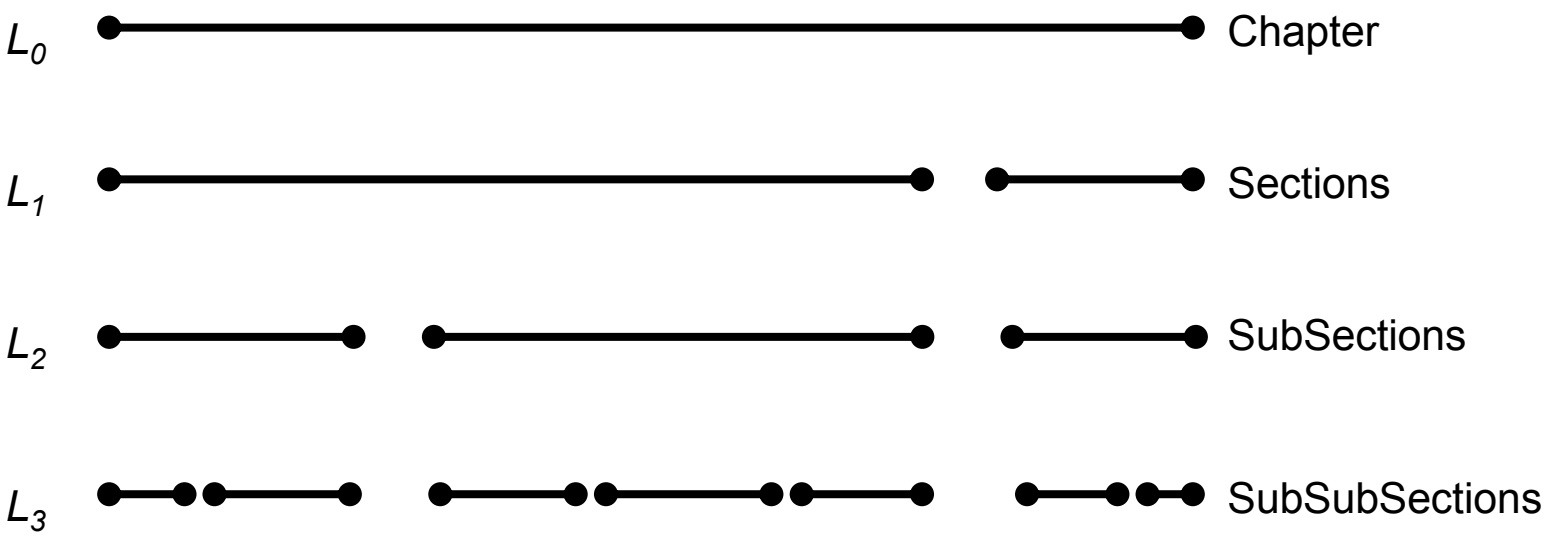
# Non-Overlapping Lists

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 lists might overlop!

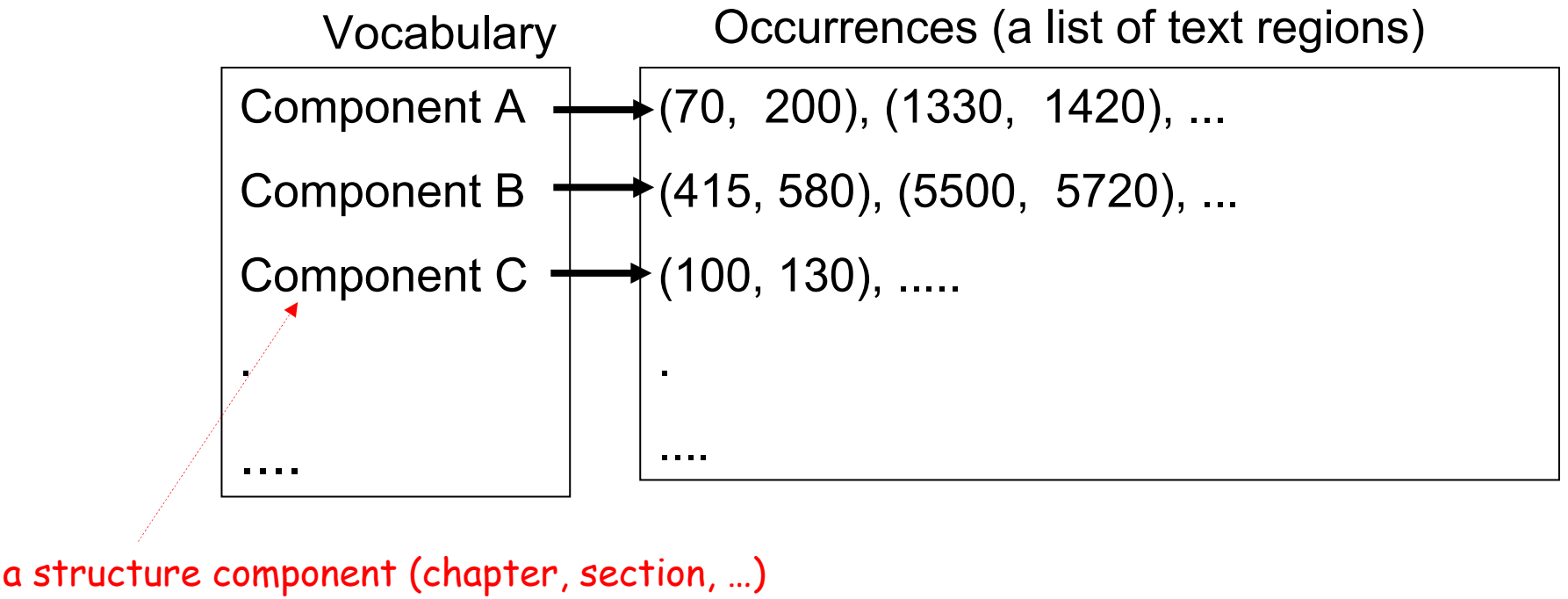


# Non-Overlapping Lists (cont.)

- 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

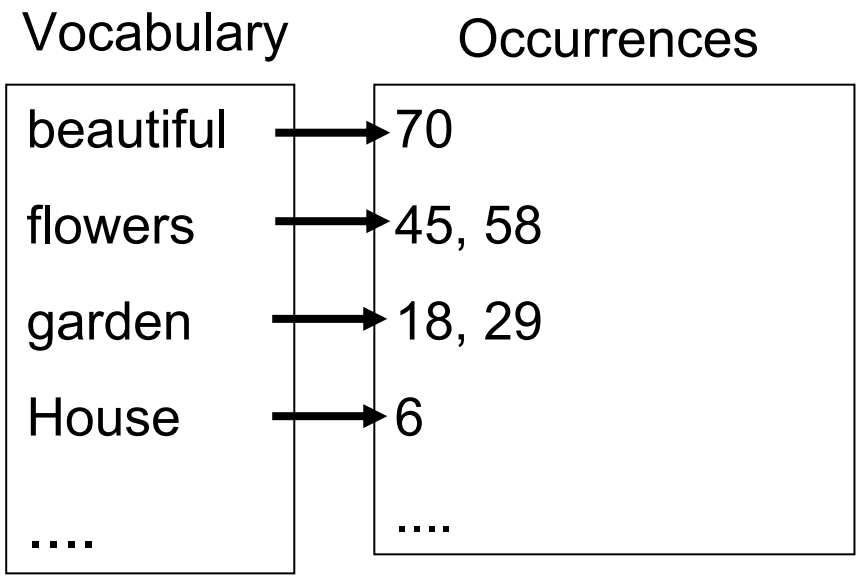
- Structure of inverted file
  - *Vocabulary*: is the set of all distinct words in the text
  - *Occurrences*: lists containing all information necessary for each word of the vocabulary (text position, frequency, documents where the word appears, etc.)

# 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



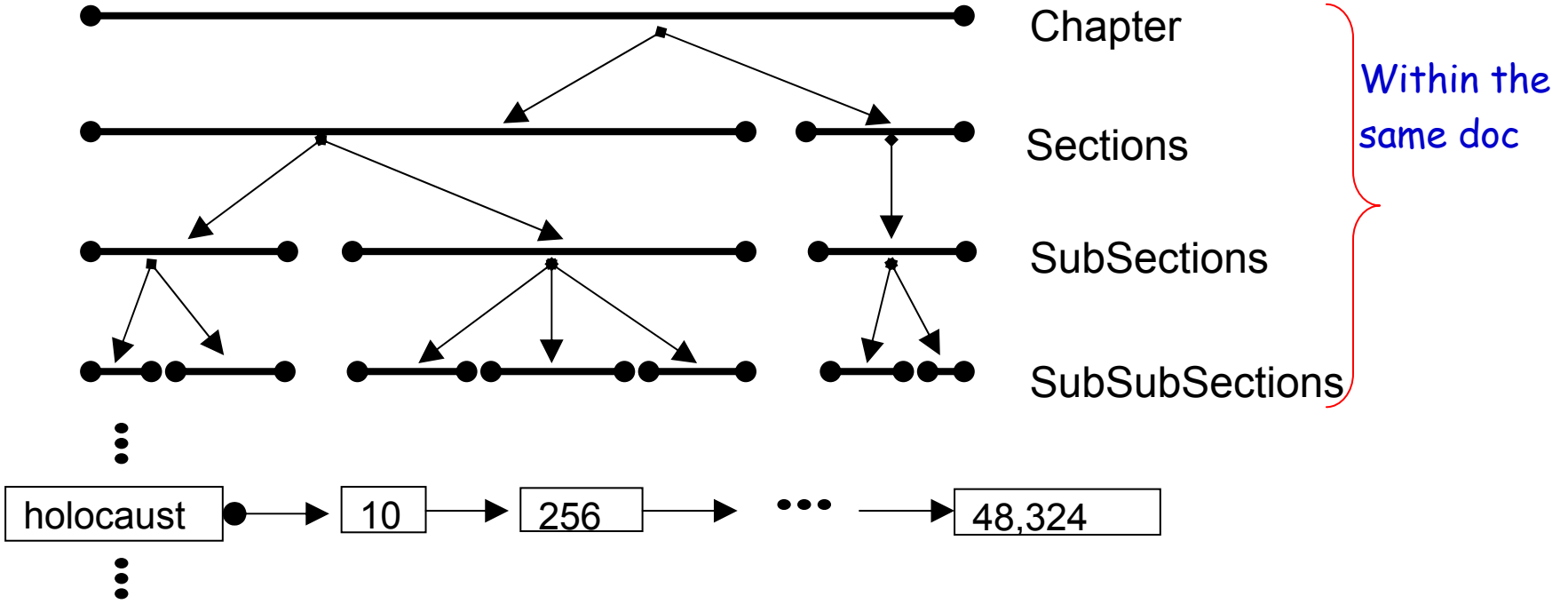

Different granularities for Occurrences
- Text position
- Doc position

# Proximal Nodes

Navarro and Baeza-Yates, 1997

- **Idea**
  - Define a strict hierarchical index over the text. This enrichs 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

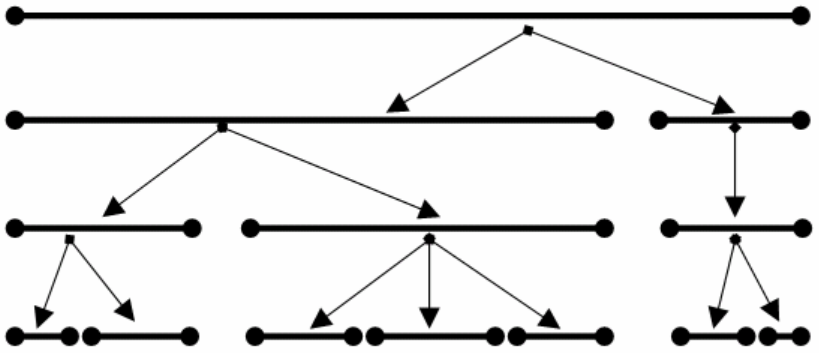
# Proximal Nodes (cont.)

- 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

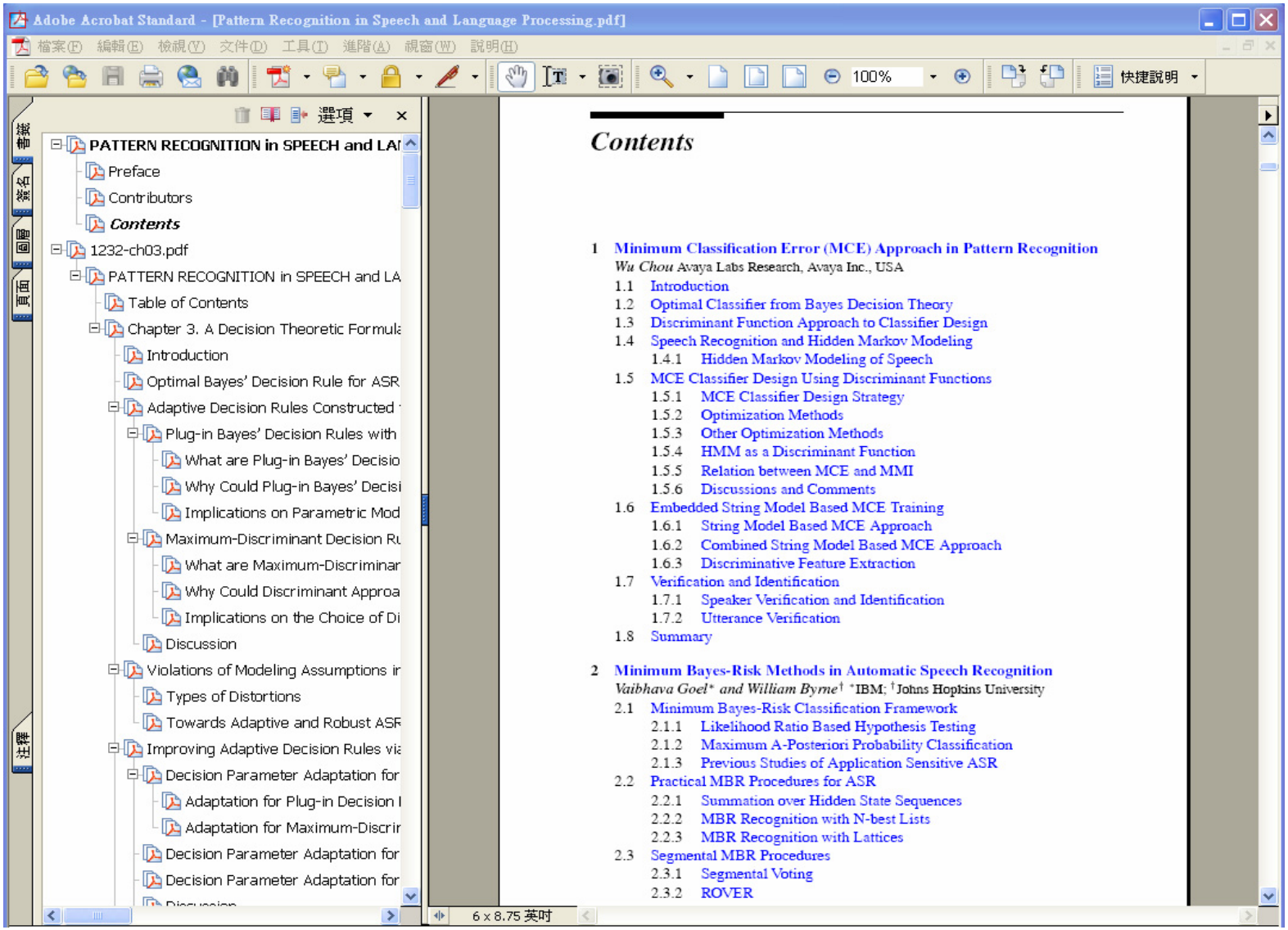
- Documents represented as dots in
  - A two-dimensional plane
  - A one-dimensional plane (list)
- **Features**
  - Glance here and there looking for information within documents visited
    - Correlations among neighbor documents not taken into consideration
  - Add keywords of interest into original 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

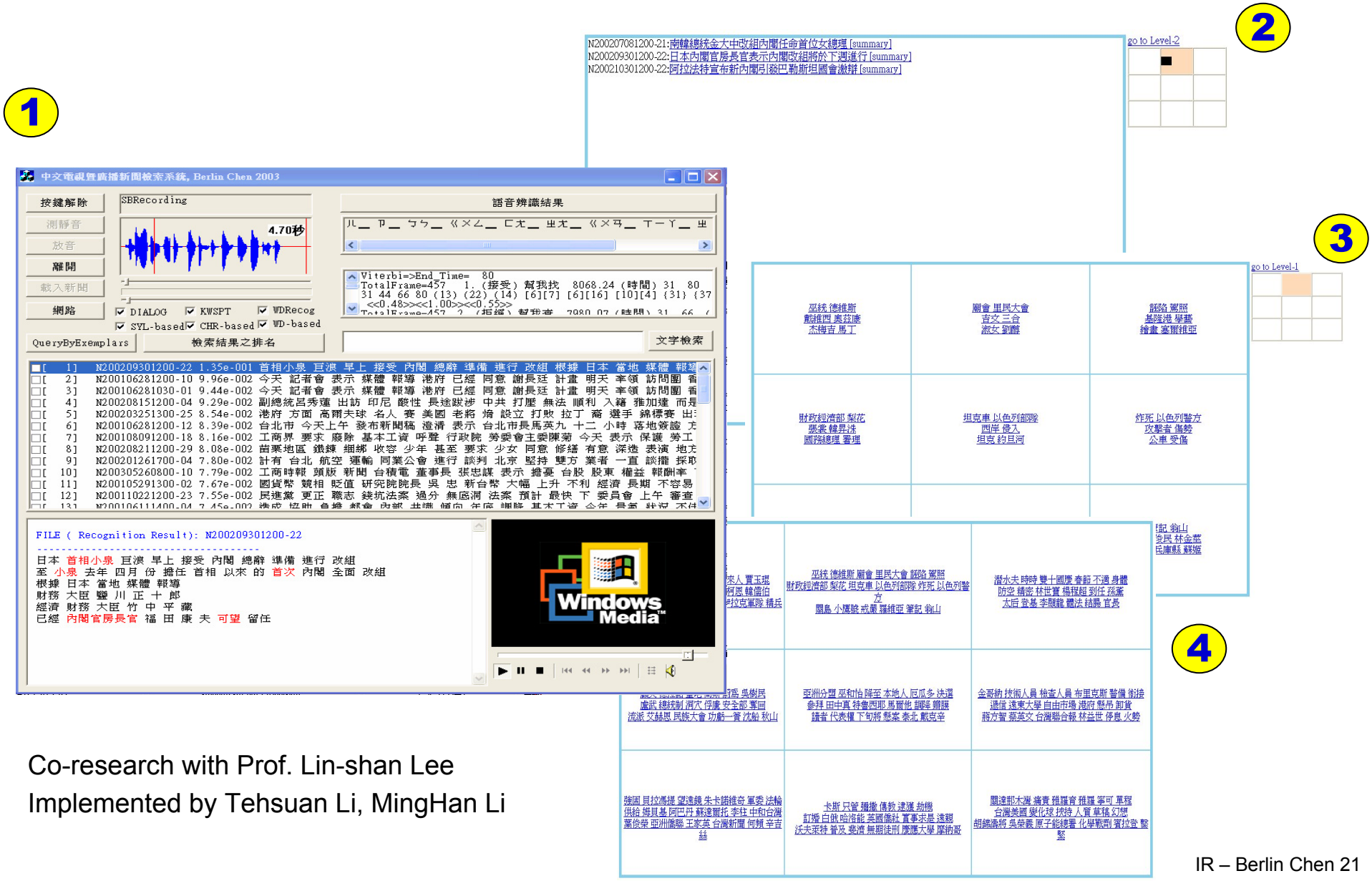
- Documents organized in a structure as a directory
  - Directories are hierarchies of classes which group documents covering related topics
  - E.g.: "Yahoo!" provides hierarchical directory

- 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.)

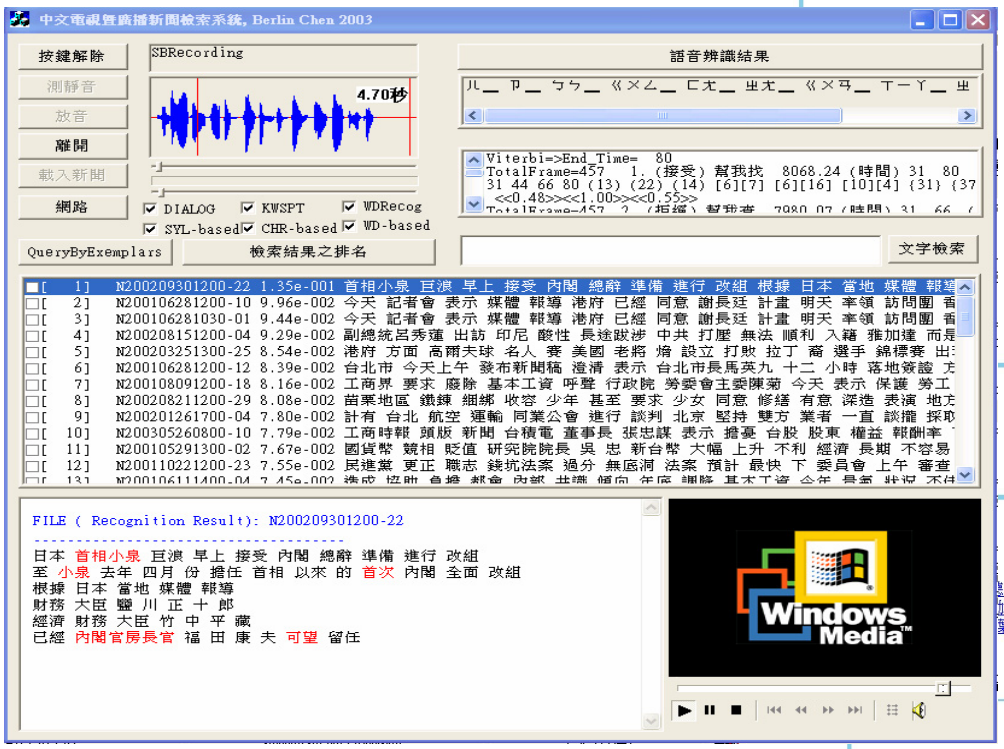



Co-research with Prof. Lin-shan Lee

Implemented by Tehsuan Li, MingHan Li

1

## Broadcast news indexing & Retrieval




N200207081200-21:南韓總統金大中改組內閣任命首位女總理 [summary]
N200209301200-22:日本內閣官房長官表示內閣改組將於下週進行 [summary]
N200210301200-22:阿拉法特宣布新內閣引發巴勒斯坦國會激辯 [summary]

go to Level-2

2

## Hierarchical Organization/Visualization of Broadcast News Collection

3

go to Level-1

| | | |
|---|---|---|
| 巫統 德維斯 戴維西 奧茲康 杰梅吉 馬丁 | 廟會 里民大會 吉交 三合 淑女 劉醫 | 部陷 駕照 基隆港 學費 繪畫 塞爾維亞 |
| 財政經濟部 梨花 張裘 韓昇洙 國務總理 署理 | 坦克車 以色列部隊 西岸 侵入 坦克 約旦河 | 炸死 以色列警方 攻擊者 傷勢 公車 受傷 |

| | | |
|---|---|---|
| 臭馬來人 賈玉琨 加拿 柯恩 韓儒伯 葉 伊拉克軍隊 精兵 | 巫統 德維斯 廟會 里民大會 部陷 駕照 財政經濟部 梨花 坦克車 以色列部隊 炸死 以色列警方 關島 小鷹號 戒嚴 羅維亞 筆記 翁山 | 潛水夫 時時 雙十國慶 春節 不適 身體 防空 精密 林世寶 楊程超 到任 孫蒼 太后 登基 李顯龍 體法 結腸 官員 |
| 顧夫 德拉諾 重地 高斯 爵爲 吳樹民 盧武 總統制 洞穴 俘虜 安全部 奪回 流派 艾赫恩 民族大會 功虧一簣 沈船 秋山 | 亞洲分盟 巫和怡 降至 本地人 厄瓜多 決選 參拜 田中真 特會西那 馬賽他 調降 攤牌 讀者 代表權 下旬將 懸案 泰北 戴克辛 | 金哥納 技術人員 檢查人員 布里克斯 警備 銜接 遞信 遠東大學 自由市場 港府 懸吊 卸貨 蔣方智 蔡英文 台灣聯合報 林益世 停息 火勢 |
| 強固 貝拉馬提 望遠鏡 朱卡錯維奇 軍委 法輪 供給 姆貝基 阿巴丹 蘇達爾托 李柱 中和台灣 葉俊榮 亞洲儒聯 王家英 台灣新聞 何賴 辛吉 茲 | 卡斯 只管 彌撒 傳教 逮獲 劫機 訂婚 白俄 哈洛能 英國僑社 置事求是 遠親 沃夫萊特 普及 斐濟 無期徒刑 慶應大學 摩納哥 | 關違那木灣 痛實 雅羅育 雅羅 寧可 單程 台灣美國 變化球 挾持 人質 草稿 幻想 胡錦濤將 吳榮義 原子能總署 化學戰劑 實拉登 繫 緊 |

4

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

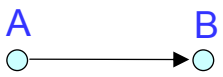
Rewrite the book?

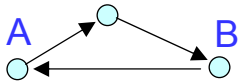
Or defining a new structure?

# 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
  - 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

Data model
Navigational plan
UI
Rules

# Example System: Live Query Term Translation

- A Query Term Translation System developed at Academia Sinica (Prof. Lee-feng Chien )
  - http://wkd.iis.sinica.edu.tw/LiveTrans/lt.html
  - Also use the meta-search strategy