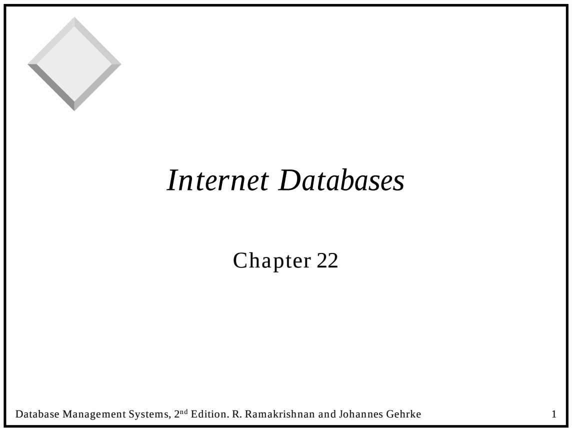
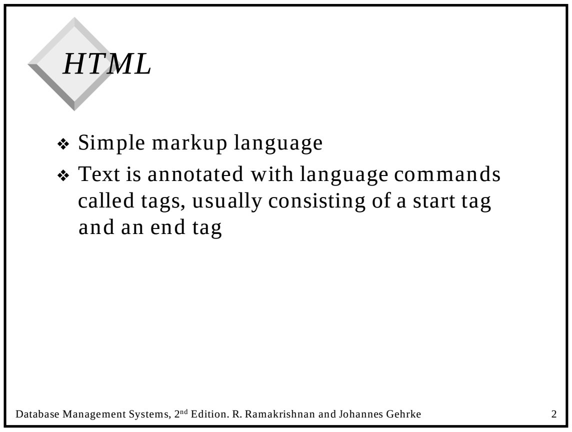


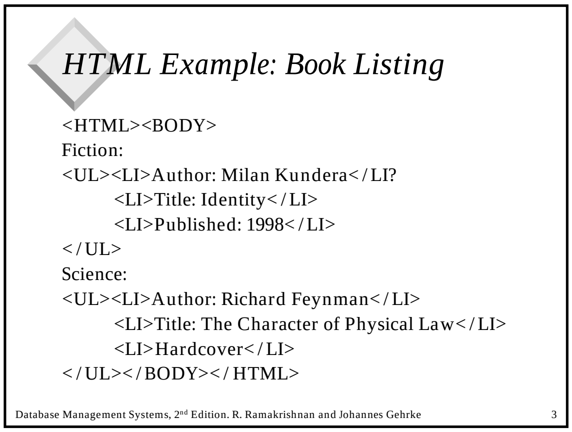
Internet Databases

Chapter 22



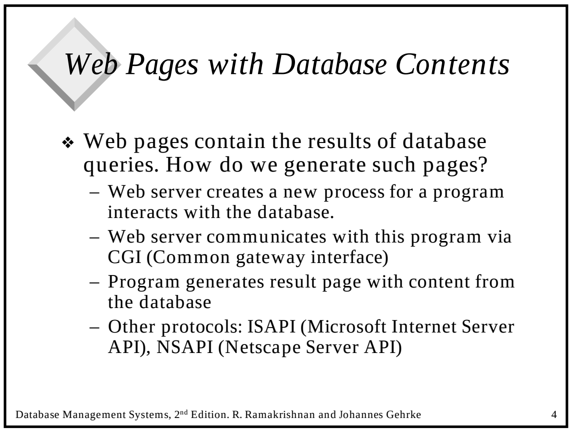
HTML

- Simple markup language
- Text is annotated with language commands called tags, usually consisting of a start tag and an end tag



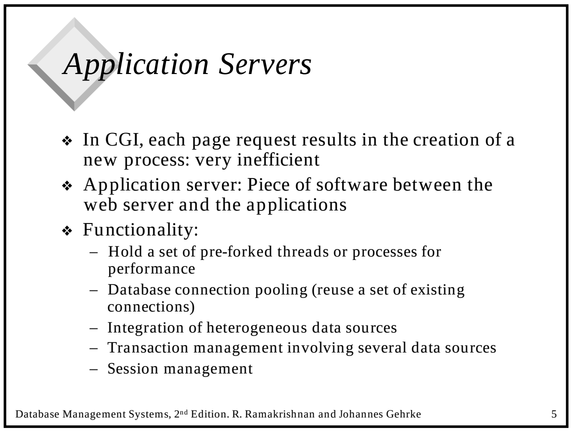
HTML Example: Book Listing

```
<HTML><BODY>
Fiction:
<UL><LI>Author: Milan Kundera</LI?
        <LI>Title: Identity</LI>
        <LI>Published: 1998</LI>
</UL>
Science:
<UL><LI>Author: Richard Feynman</LI>
        <LI>Title: The Character of Physical Law</LI>
        <LI>Hardcover</LI>
</UL></BODY></HTML>
```



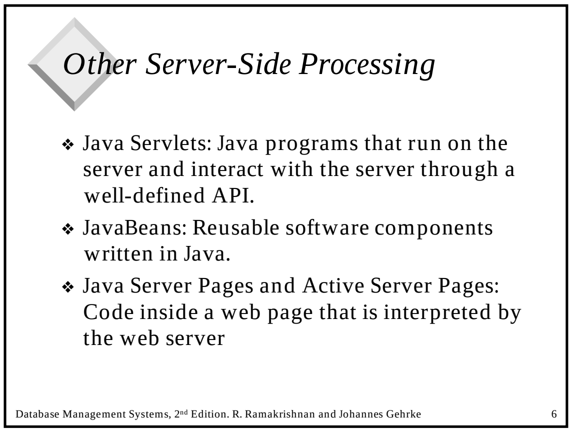
Web Pages with Database Contents

- Web pages contain the results of database queries. How do we generate such pages?
  - Web server creates a new process for a program interacts with the database.
  - Web server communicates with this program via CGI (Common gateway interface)
  - Program generates result page with content from the database
  - Other protocols: ISAPI (Microsoft Internet Server API), NSAPI (Netscape Server API)



Application Servers

- In CGI, each page request results in the creation of a new process: very inefficient
- Application server: Piece of software between the web server and the applications
- Functionality:
  - Hold a set of pre-forked threads or processes for performance
  - Database connection pooling (reuse a set of existing connections)
  - Integration of heterogeneous data sources
  - Transaction management involving several data sources
  - Session management



Other Server-Side Processing

- Java Servlets: Java programs that run on the server and interact with the server through a well-defined API.
- JavaBeans: Reusable software components written in Java.
- Java Server Pages and Active Server Pages: Code inside a web page that is interpreted by the web server

Beyond HTML: XML

- Extensible Markup Language (XML): "Extensible HTML"
- Confluence of SGML and HTML: The power of SGML with the simplicity of HTML
- Allows definition of new markup languages, called document type declarations (DTDs)

XML: Language Constructs

- Elements
  - Main structural building blocks of XML
  - Start and end tag
  - Must be properly nested
- Element can have attributes that provide additional information about the element
- Entities: like macros, represent common text.
- Comments
- Document type declarations (DTDs)

Booklist Example in XML

```
<?XML version="1.0" standalone="yes"?>
<!DOCTYPE BOOKLIST SYSTEM "booklist.dtd">
<BOOKLIST>
<BOOK genre="Fiction">
  <AUTHOR>
    <FIRST>Milan</FIRST><LAST>Kundera</LAST>
  </AUTHOR>
  <TITLE>Identity</TITLE>
  <PUBLISHED>1998</PUBLISHED>
<BOOK genre="Science" format="Hardcover">
  <AUTHOR>
    <FIRST>Richard</FIRST><LAST>Feynman</LAST>
  </AUTHOR>
  <TITLE>The Character of Physical Law</TITLE>
</BOOK></BOOKLIST>
```

XML: DTDs

- A DTD is a set of rules that defines the elements, attributes, and entities that are allowed in the document.
- An XML document is well-formed if it does not have an associated DTD but it is properly nested.
- An XML document is valid if it has a DTD and the document follows the rules in the DTD.

An Example DTD

```
<!DOCTYPE BOOKLIST [
  <!ELEMENT BOOKLIST (BOOK)*>
  <!ELEMENT BOOK (AUTHOR, TITLE, PUBLISHED?)>
  <!ELEMENT AUTHOR (FIRST, LAST)>
    <!ELEMENT FIRST (#PCDATA)>
    <!ELEMENT LAST (#PCDATA)>
  <!ELEMENT TITLE (#PCDATA)>
  <!ELEMENT PUBLISHED (#PCDATA)>
  <!ATTLIST BOOK genre (Science|Fiction) #REQUIRED>
  <!ATTLIST BOOK format (Paperback|Hardcover) "Paperback">
]>
```

Domain-Specific DTDs

- Development of standardized DTDs for specialized domains enables data exchange between heterogeneous sources
- Example: Mathematical Markup Language (MathML)
  - Encodes mathematical material on the web
  - In HTML: <IMG SRC="xysq.gif" ALT="(x+y)^2">
  - In MathML:

```
<apply> <power/>
  <apply> <plus/> <ci>x</ci> <ci>y</ci> </apply>
  <cn>2</cn>
</apply>
```

XML-QL: Querying XML Data

- ❖ Goal: High-level, declarative language that allows manipulation of XML documents
- ❖ No standard yet
- ❖ Example query in XML-QL:

```
WHERE
  <BOOK>
    <NAME><LAST>$1</LAST></NAME>
  </BOOK> in “www.booklist.com/books.xml
CONSTRUCT <RESULT> $1 </RESULT>
```

XML-QL (Contd.)

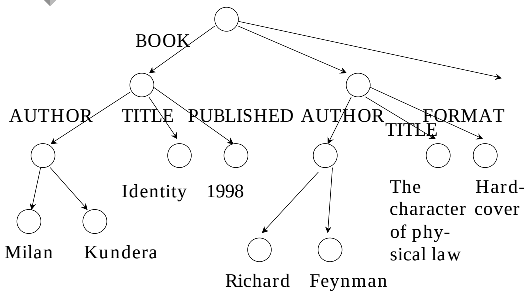
A more complicated example:

```
WHERE <BOOK>  $b  <BOOK> IN
    “www.booklist.com/books.xml”,
  <AUTHOR> $n </AUTHOR>
  <PUBLISHED> $p </PUBLISHED> in $e
CONSTRUCT
  <RESULT>
    <PUBLISHED> $p </PUBLISHED>
      WHERE <LAST> $l </LAST> IN $n
      CONSTRUCT <LAST> $l </LAST>
  </RESULT>
```

Semi-structured Data

- ❖ Data with partial structure
- ❖ All data models for semi-structured data use some type of labeled graph
- ❖ We introduce the object exchange model (OEM):
  - – Object is triple (label, type, value)
  - – Complex objects are decomposed hierarchically into smaller objects

Example: Booklist Data in OEM



Indexing for Text Search

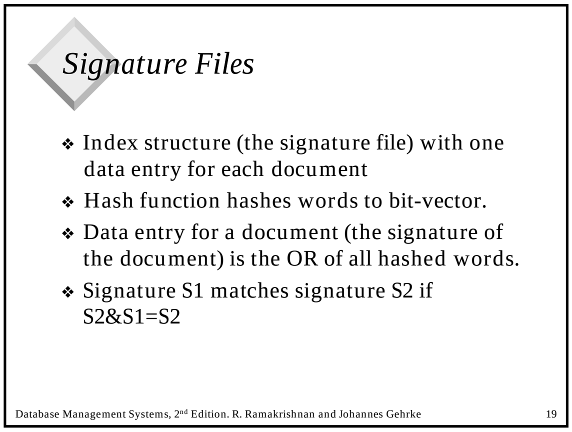
- ❖ Text database: Collection of text documents
- ❖ Important class of queries: Keyword searches
  - – Boolean queries: Query terms connected with AND, OR and NOT. Result is list of documents that satisfy the boolean expression.
  - – Ranked queries: Result is list of documents ranked by their “relevance”.
  - – IR: Precision (percentage of retrieved documents that are relevant) and recall (percentage of relevant objects that are retrieved)

Inverted Files

- ❖ For each possible query term, store an ordered list (the inverted list) of document identifiers that contain the term.
- ❖ Query evaluation: Intersection or Union of inverted lists.
- ❖ Example: Agent AND James

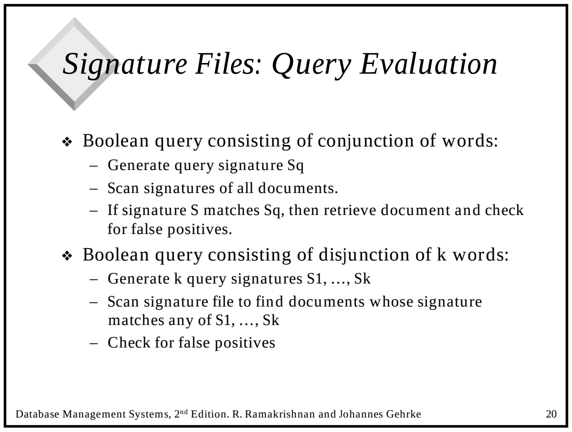
RID	Document
1	Agent James
2	Mobile agent

Word	Inverted List
Agent	<1,2>
James	<1>
Mobile	<2>



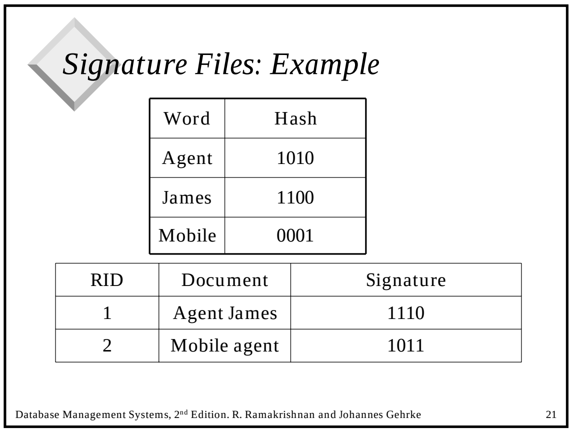
Signature Files

- Index structure (the signature file) with one data entry for each document
- Hash function hashes words to bit-vector.
- Data entry for a document (the signature of the document) is the OR of all hashed words.
- Signature S1 matches signature S2 if S2&S1=S2



Signature Files: Query Evaluation

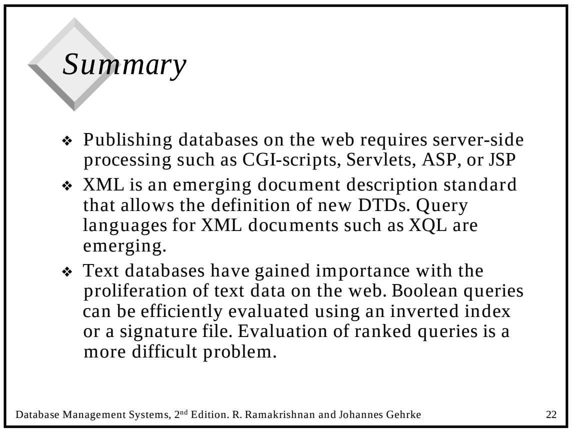
- Boolean query consisting of conjunction of words:
  - Generate query signature Sq
  - Scan signatures of all documents.
  - If signature S matches Sq, then retrieve document and check for false positives.
- Boolean query consisting of disjunction of k words:
  - Generate k query signatures S1, …, Sk
  - Scan signature file to find documents whose signature matches any of S1, …, Sk
  - Check for false positives



Signature Files: Example

Word	Hash
Agent	1010
James	1100
Mobile	0001

RID	Document	Signature
1	Agent James	1110
2	Mobile agent	1011



Summary

- Publishing databases on the web requires server-side processing such as CGI-scripts, Servlets, ASP, or JSP
- XML is an emerging document description standard that allows the definition of new DTDs. Query languages for XML documents such as XQL are emerging.
- Text databases have gained importance with the proliferation of text data on the web. Boolean queries can be efficiently evaluated using an inverted index or a signature file. Evaluation of ranked queries is a more difficult problem.