Foundations of XML Data Manipulation

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Course structure

- Data Model
- Query languages
- XPath
- Type systems, logics, tree automata
- Storing and querying

Structured data

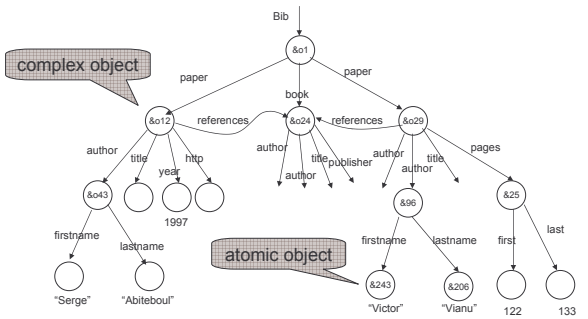
ID	Last Name	First Name	Title	Birth Date	Hire Date	City	Region

Order ID	Customer	Emp ID	Order Date	Required Date	Shipped Date

Unstructured data

- ***Sample databases included with Access***
  - Microsoft Access provides sample databases that you can use while you're learning Access.
  - **Northwind Traders sample database**
  - The Northwind database and Access project (available from the **Sample Databases** command on the **Help** menu) contains the sales data for a fictitious company called Northwind Traders, which imports and exports specialty foods from around the world. By viewing the **database objects** included in the Northwind database. …

Semistructured data



A syntax for SSD

expr ::= *value* | oid *value* | oid
value ::= *atomic* | { label : *expr* , … , label : *expr* }

```
{ Bib: &o1 { paper: &o12 {…},
             book: &o24 {…},
             paper:  &029
                    { author: &o52 "Abiteboul",
                      author: &o96 { firstname: &o243 "Victor",
                                     lastname: &o206 "Vianu"},
                      title: &o93 "Regular path queries" ,
                      references: &o24,
                      page: &o25 { first: &o64 122, last: ... }
                    }
             }
}
```

Why SSD

- The origin:
  - Data integration
  - Documents
  - Scientific databases
- The interest:
  - Cannot be ignored
  - WWW and bioinformatics

The Data Model

- The information behind the syntax, i.e.: when two pieces of data really differ
- Some alternatives:
  - OEM: SSD as graphs modulo bisimulation
  - XML: ordered trees with node identity (and with pointers)
  - TQL: unordered trees

OEM with bisimulation

- Edge-labelled version
- Bisimulation: generalizes the notion of set equality to labelled graphs:
  - {a: v, b: w} = {b: w, a: v}
  - {a: v, a: v, b: w} = {a: v, b: w, b: w}
- Exists $R \subseteq G \times G'$ such that:
  - n R m and n,l,n' in G $\Rightarrow$ exists m,l,m' in G' with n' R m' and conversely
  - n R m and n leaf in G $\Leftrightarrow$ m leaf in G'

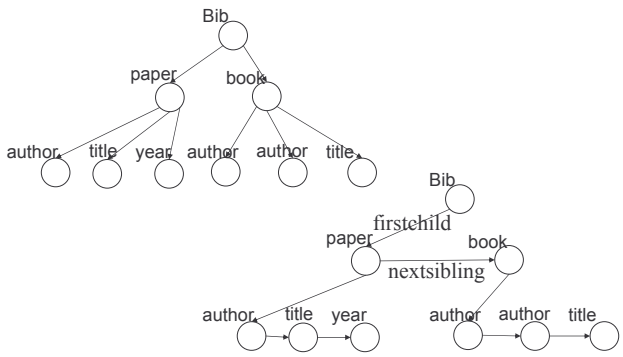
TQL data model

- Edge-labeled trees defined as multisets of label-tree pairs:
  - f ::= ø | a[f] | f | f
  - *f* ::= *{}* | *{a: f}* | $f \cup f$
- Hence:
  - {a: v, b: w} = {b: w, a: v}
  - {a: v, a: v, b: w} $\neq$ {a: v, b: w, b: w}
- The same syntax can be interpreted as node-labeled forests

Ordered children (as in XDM)

- Node-labeled ordered trees of elements
  - *item* ::= <label> *value* </label> | *leaf*
  - *value* ::= *item **
- Hence:
  - {a: v, b: w} $\neq$ {b: w, a: v}
  - {a: v, a: v, b: w} $\neq$ {a: v, b: w, b: w}

Binary representation



XML

XML

- Simplification of SGML
- Designed to substitute HTML
- The standard for data exchange and web-services invocation
- Some W3C related standards:
  - XPath/XQuery
  - XML Infoset and XDM
  - XSLT
  - DTD, XSD
  - Many other things

XML for data exchange

```
<trader ID="T12">
        <name>Wilman Kala</name>
        <address><country>….</ country>...</ address>
        <orders>
                <order OID="O121">
                        <date>1/3/2005</date>
                        <item>…</item> <item>…</item>
                </order>
                <order OID="O122">…</order>
        </orders>
</trader>
<trader ID="T13">
        <name>Hanari Cames</name>
        <address><city>…</city>...</address>
        <orders>
                <order OID="T131">
                        <date>3/3/2005</date>
                        <item>…</item>
                </order>
        </orders>
</trader>
```

XML as it was designed

<doc><title>Sample databases included with Access<title>
<subtitle>Microsoft Access provides sample databases.</subtitle>
<subtitle> <link ref= "./NT.mdb">Northwind Traders database </link> </subtitle>
<body>
<para author= "JDM" font="times">The Northwind database contains the sales data for a company called <emph>Northwind Traders</emph>, which imports and exports specialty foods from around the world. By viewing the <link ref= "./NT.mdb">database objects<link>included in the Northwind database.</para>
…</body></doc>

XDM

- A value is a sequence of nodes
- Parent axis: a node is a pair <tree, path in the tree>
  - {a:{b: w}}/b ≠ {b: w}
- Node identity: a store is a forest-structured graph <N,E>, and a node is an element of N
  - {a: v} ≠ {a: v}

Moreover

- Six other types of nodes
- Unordered attributes
- ID – IDREFs to encode pointers
- Namespaces
- Type annotations

Conclusions

- We now know what SSD is
- Questions:
  - How do we describe its structure?
  - How do we manipulate it?
  - How do we store it?

Suggested readings

- Some papers are in the “query folder”
- klarlundSchweintick: general introduction to XML, DTD, XSD, XPath, XQuery, XSLT.
- AbiQuaMcH97: OEM and Lorel
- BunDavHil96: UnQL data model
- ColGheAl06: MicroXQuery data model
- Hidders: XML data model
- CarGhe03: TQL data model
- www.w3.org/TR/xpath-datamodel: XQuery/XPath data model (XDM)