Conceptual Modeling for XML Data

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DASFAA'2003 Panel Discussion

Outlines

- Why do we need conceptual modeling?
- What are the important semantic information to be captured?
- Uses of conceptual model for some XML research topics

Motivation: Why do we need to have a conceptual model to represent XML Data?

```
<department number ="cs">
 <name> computer science</name>
 <course number = "cs4221">
  <name> Database </name>
  <student number = "1234" >
   <name> B.Y.Smith</name>
   <grade> 70</grade>
  </student>
  <student number="1235">
   <name> C.U.Brown </name>
   <grade> 60</grade>
  </student>
 </course>
</department>
```

(a) XML document

```
<! ELEMENT department
          (name,course+)>
  <! ATTLIST department
          number ID #REQUIRED>
<! ELEMENT course (name, student*)>
  <! ATTLIST course
          number ID #REQUIRED>
<! ELEMENT student (name, grade?)>
  <! ATTLIST student
          number CDATA #REQUIRED>
<! ELEMENT name (#PCDATA)>
<! ELEMENT grade (#PCDATA)>
```

(b) An XML DTD for (a)

Motivation (cont.)

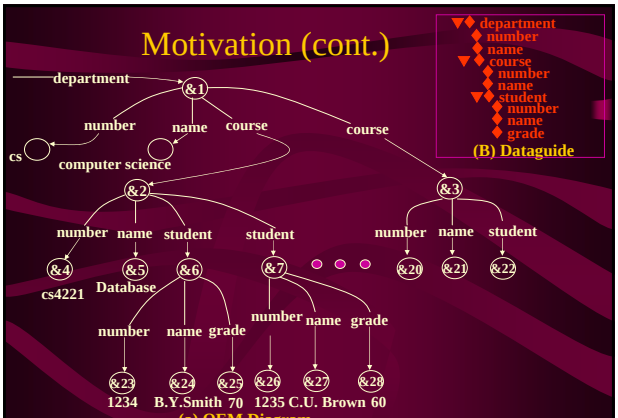


Figure 1: Sample instance demonstrating OEM and dataguide

Motivation (continue)

Q: What are the important semantic information and constraints cannot be captured by the DTD and Dataguide?

- What are the object classes? department, course, student?
- Attributes of object classes?
- Identifiers of object classes?
- What are the relationship types defined among object classes? e.g. Relationship types among department, course, student?
- What is "grade"? Object class? Attribute of student?
- Are there redundancies?

Semantic Information to be captured by an XML conceptual model

- Object class
  - attributes of object class
  - ordering on object class
- Relationship Type
  - Represent hierarchical structure
  - degree of n-ary relationship type
  - participation constraints of object classes in relationship type
  - attributes of relationship type
  - disjunctive relationship type
  - recursive relationship type
- Reference

Semantic Information to be captured by an XML conceptual model (cont.)

- Attribute
  - key attribute / identifier
  - composite attribute
  - disjunctive attribute
  - attributes with unknown structure
  - fixed and default values of attribute
  - derived attribute
- Functional dependencies and other constraints
- Inheritance hierarchy (class hierarchy)
- Semi-structured data instance representation

Q: What are the semantic information cannot be represented by Dataguide, DTD, XML Schema?

- Attribute or object class
- Degree of relationship type
- Attibute of object class or relationship type
- Class hierarchy
- Functional dependency
- …

A solution: ORA-SS, an object-relationship attribute model for semi-structured data.

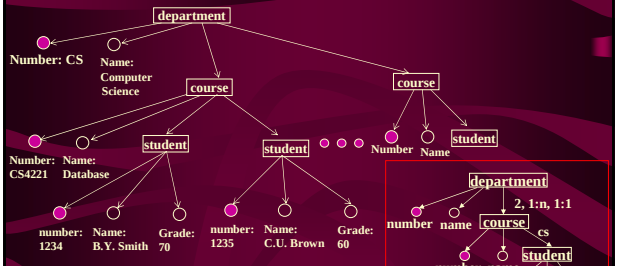
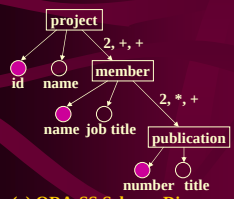


Figure 2: ORA-SS instance diagram

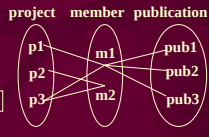
Figure 3: ORA-SS schema diagram

The data model of ORA-SS – Relationship Type

- attributes of relationship type
- degree of n-ary relationship type
- participation constraints of objects in relationship type
- disjunctive relationship type
- recursive relationship type



(a) ORA-SS Schema Diagram

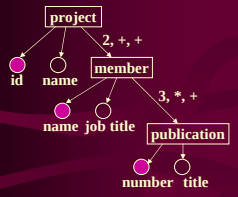


(b) Instance Relationship

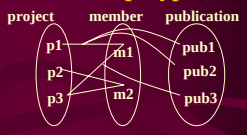
(c) Dataguide

Figure 5: Representing binary relationship type

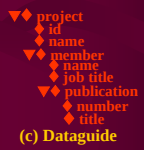
The data model of ORA-SS – Relationship Type (cont.)



(a) ORA-SS Schema Diagram



(b) Instance Relationship



(c) Dataguide

Figure 6: Representing ternary relationship type

The data model of ORA-SS – Attribute

- key attribute
- composite attribute
- disjunctive attribute
- attribute with unknown structure
- fixed and default values of attribute
- derived attribute

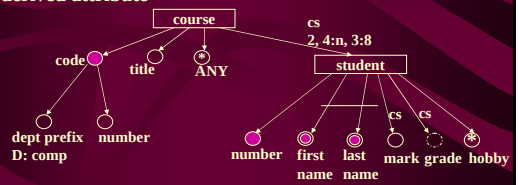


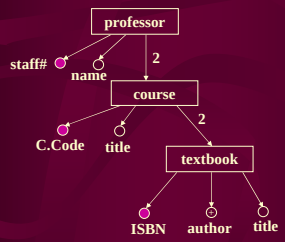
Figure 7: Object classes with relationship type and attributes in an ORA-SS schema diagram

Uses of the Conceptual model for XML research

- Normal form XML schema
  - remove redundant data
  - resolve multiple inheritance conflicts
- Storage structure for XML databases
  - use Object Relational Model
- XML Views
  - derived information from references and class hierarchy
  - defining views
  - materialized view maintenance
  - view updates
- Integration of XML documents
- Evaluating XML queries on XML databases

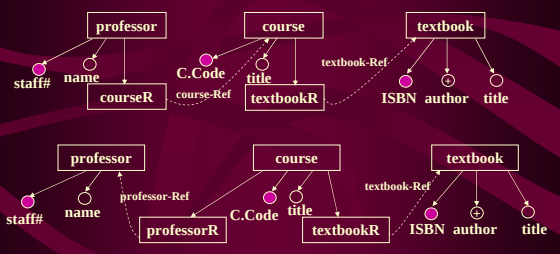
Normal Form XML Schema

- Schema may have a lot of redundant data
- Update anomalies
- Normal Form schema is needed



NF XML Schema (cont.)

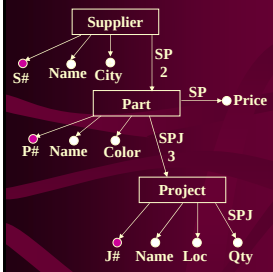
- Some better solutions:
- Redundancies are removed, in normal form



Storage Structure for XML Databases

- Main Rules
  - Each object class together with its attributes form a nested relation (object relation)
  - Each relationship type together with its attributes form a nested relation (relationship relation)
- Nested relations can be handled by Object Relational model, e.g. ORACLE 8*i*.

Storage Structure for XML Databases



Object Relations

Supplier (S#, Name, (City))

Part (P#, Name, color)

Project(J#, Name, Loc)

Relationship relations

SP (S#, P#, price)

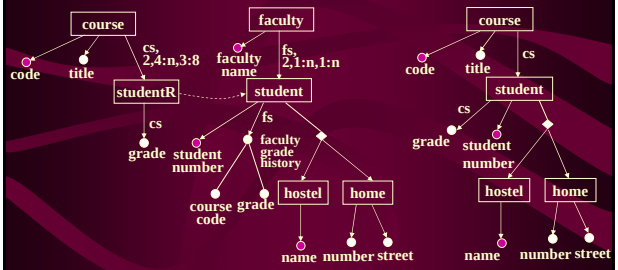
SPJ (S#, P#, J#, Qty)

Constraint:

SPJ[S#, P#] ⊆ SP[S#, P#]

XML Views

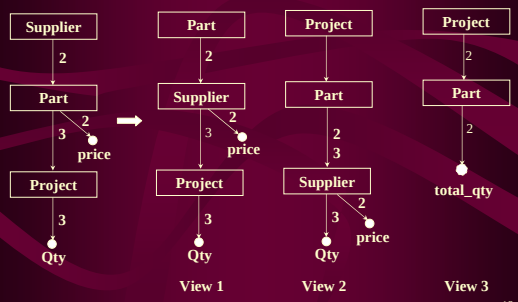
- What information can be directly derived from references and class hierarchy



Referencing an object class in an ORA-SS schema diagram

XML Views (cont.)

- Valid views of an ORA-SS schema
- Operations: selection, projection, join, up/down



Conclusion

- A good conceptual model is needed for XML database applications:
  - * normal form schema
  - * storage structure
  - * view design and view updates
  - * ….