

Designing Semistructured Databases Using **ORA-SS** Data Model

ORA-SS:

An **O**bject-**R**elationship-**A**tttribute Model for
Semistructured **D**ata

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 - Storage schema for ORA-SS/XML databases
 - ORA-SS/XML views
 - Evaluating XML queries on ORA-SS databases
 - Translating relational schema into ORA-SS schema
 - Integration of XML documents

Motivation – An XML Document

```
<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)

Notes:



- (1) Student's **number** cannot be declared as ID.
- (2) The subelements **name** and **grade** are defined in the same way. However, name is a property of student but grade is a relationship attribute.

Motivation (cont.)

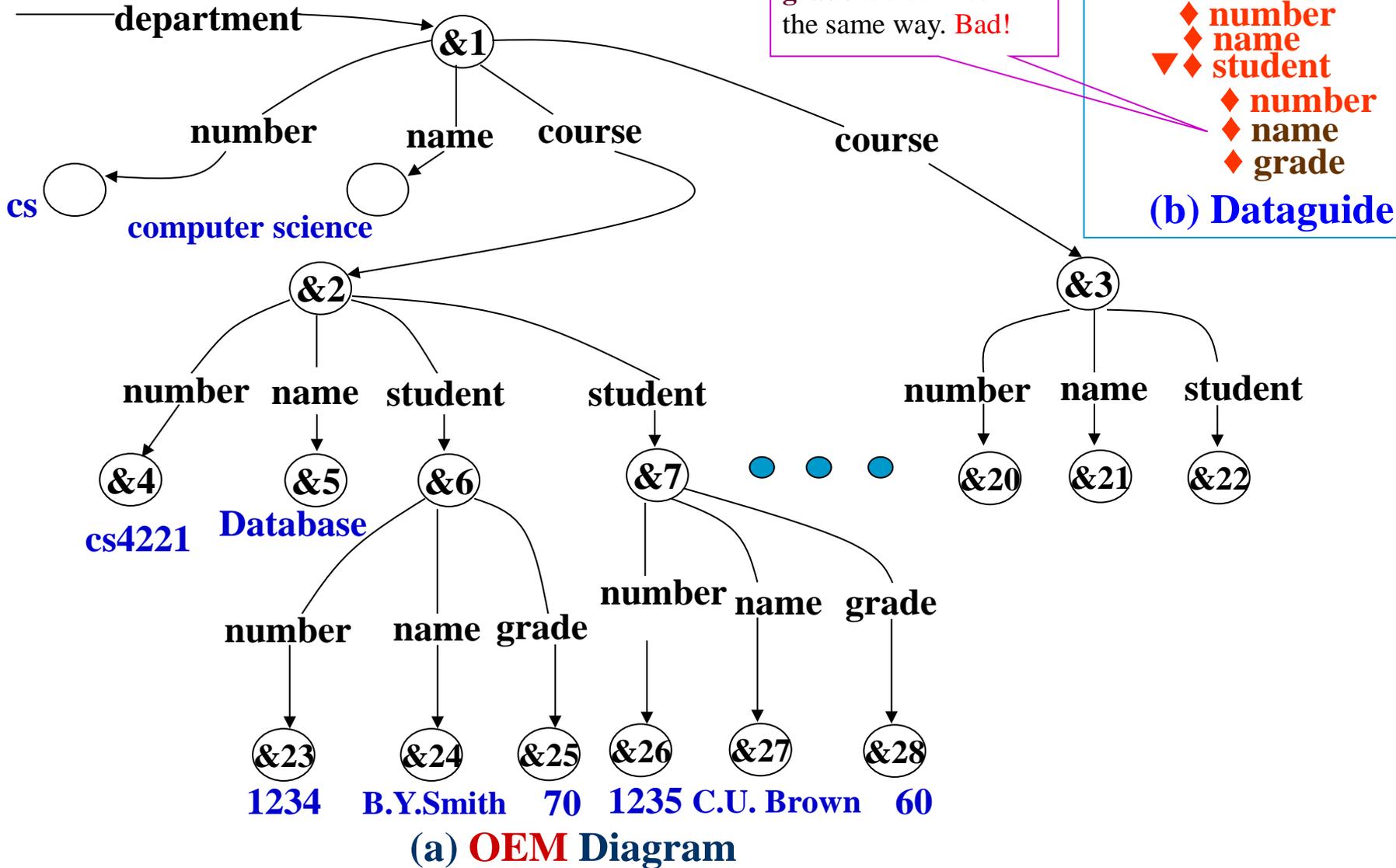


Figure 1: Sample instance demonstrating OEM and Dataguide

Motivation (cont.)

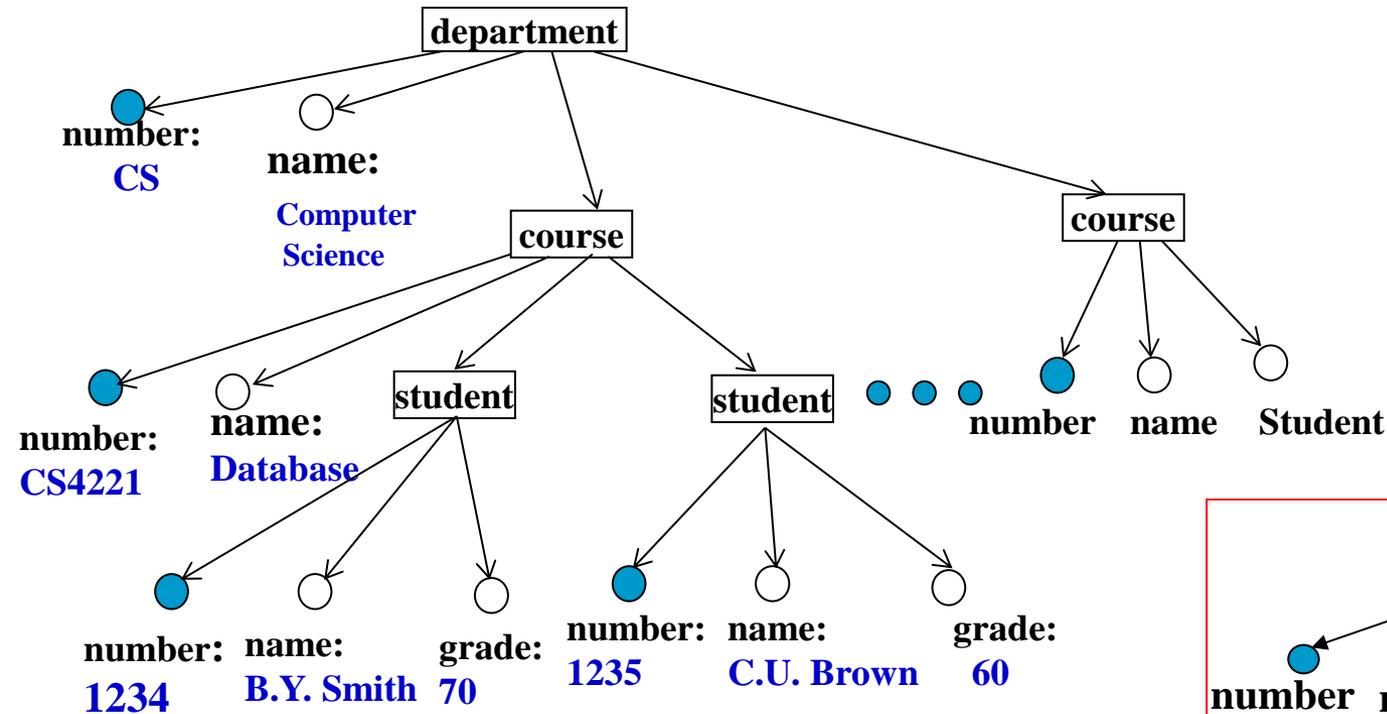


Figure 2: ORA-SS instance diagram

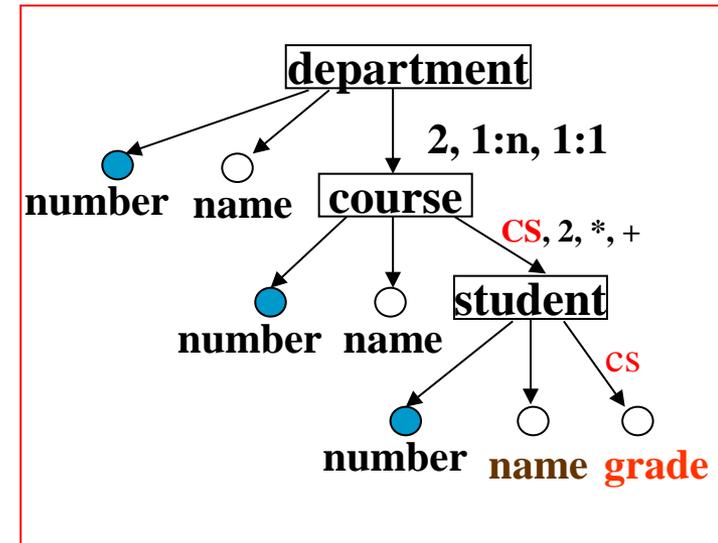


Figure 3: ORA-SS schema diagram



Note: **grade** is declared as an attribute of the binary relationship type **cs**.

ORA-SS - The Data Model

- Object class
 - attributes of object class
 - ordering on object class
 - weak object class

- Relationship Type
 - attributes of relationship type
 - degree of n-ary relationship type
 - participation of objects in relationship type
 - disjunctive relationship type
 - recursive relationship type
 - IDD (identifier dependency) relationship type

- ❖ **Note** that DTD and XML Schema have no concept of relationship type, they only describe the hierarchical structure of the xml documents.

- Reference

The Data Model (cont.)

■ Attribute

- Attribute of **object class** or **relationship type**
- **key** attribute (identifier)
- composite attribute
- disjunctive attribute
- attributes with unknown structure
- ordering on attribute
- fixed and default values of attribute
- derived attribute

■ Semistructured data instance

■ Functional dependencies and other constraints

■ Inheritance hierarchy

Object Class

- represented by a rectangle
- attributes of object class by a circle
- identifier of object class by a filled circle
- ordering on object class by a symbol <

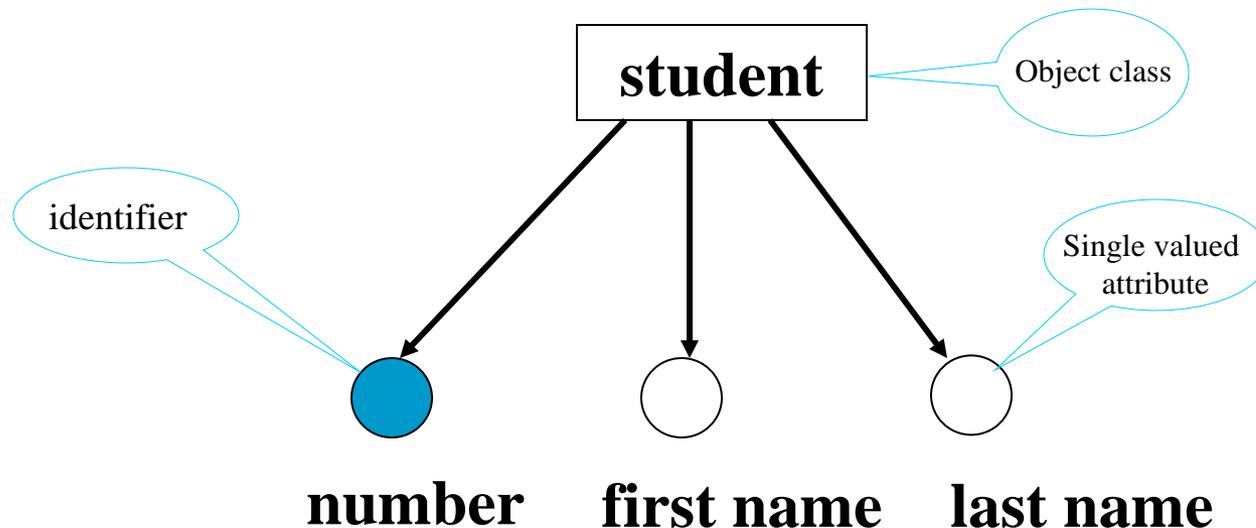
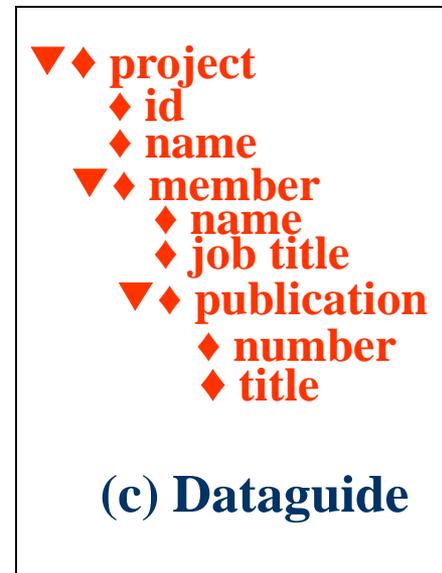
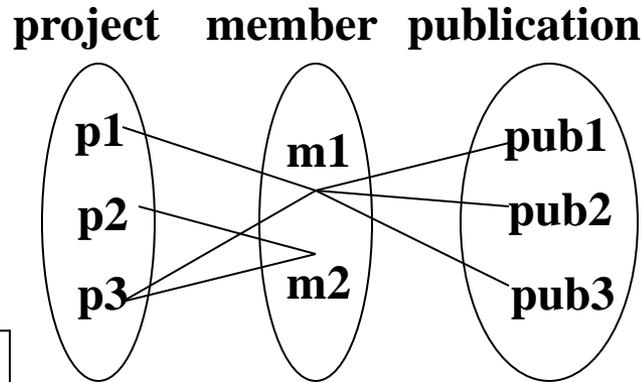
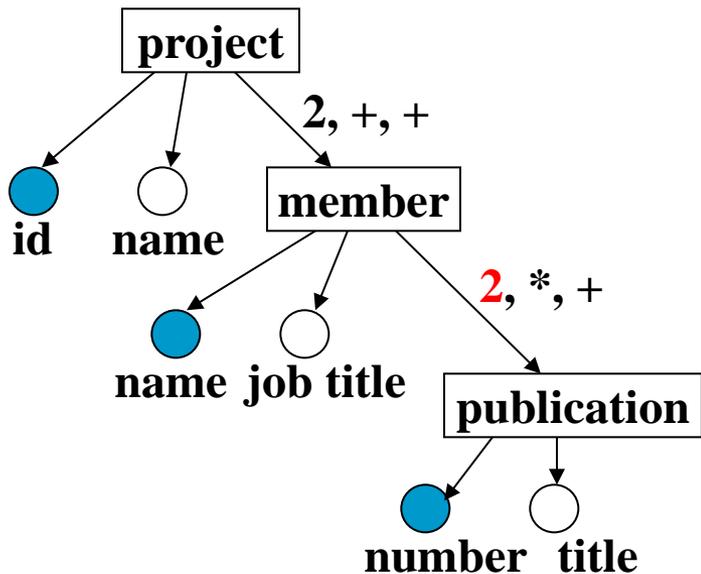


Figure 4: Object class *student* with attributes in an ORA-SS schema diagram

Relationship Type

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



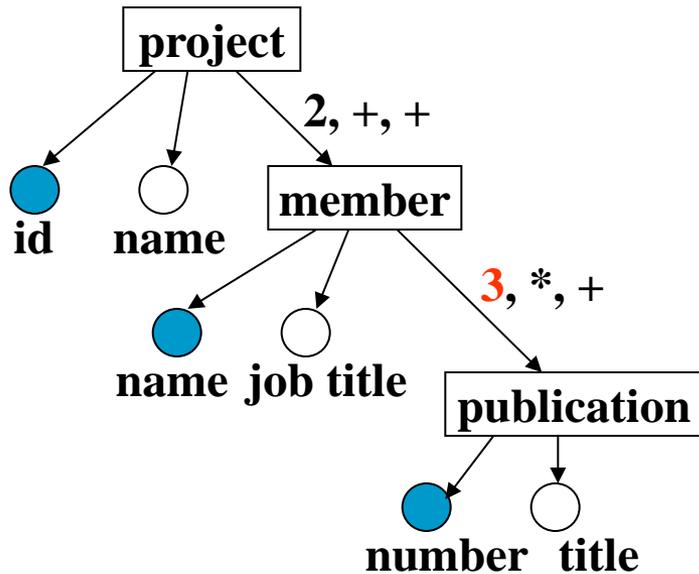
(a) ORA-SS Schema Diagram

(b) Relationship instance

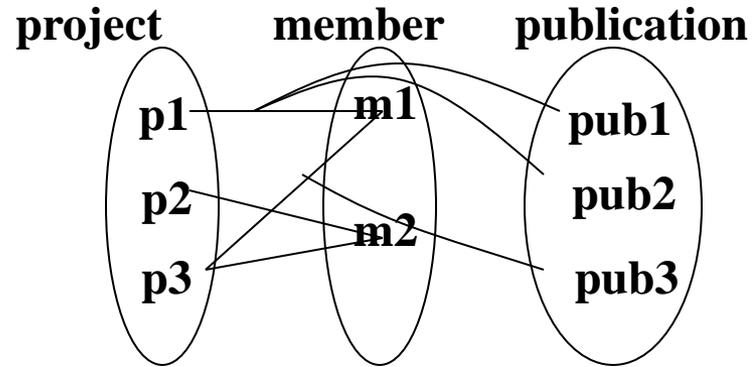
(c) Dataguide

Figure 5: Representing **binary** relationship type

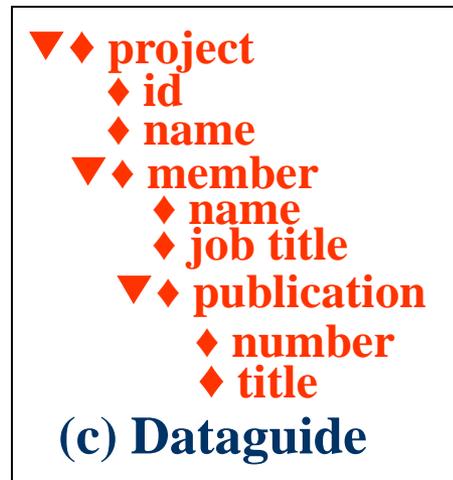
Relationship Type (cont.)



(a) ORA-SS Schema Diagram



(b) Relationship instance



❖ Note: This Dataguide diagram is identical to the previous one. Dataguide cannot differentiate the two different XML schemas.

Figure 6: Representing **ternary** relationship type

IDD Relationship Type

- Some object classes may not have identifier.
E.g. chapters of a book do not have a unique identifier.
- However, a chapter of a book can be identify by the identifier of the book (i.e. ISBN) and the chapter number of the chapter.
- We call the object class chapter a **weak object class** with a **weak identifier** chapter_no.
- The relationship type between book and chapter is called an **identifier dependency (IDD)** relationship type. Chapter is a **dependent object class** of the book object class.
- It is similar to weak entity type and **ID relationship type** in ER approach.

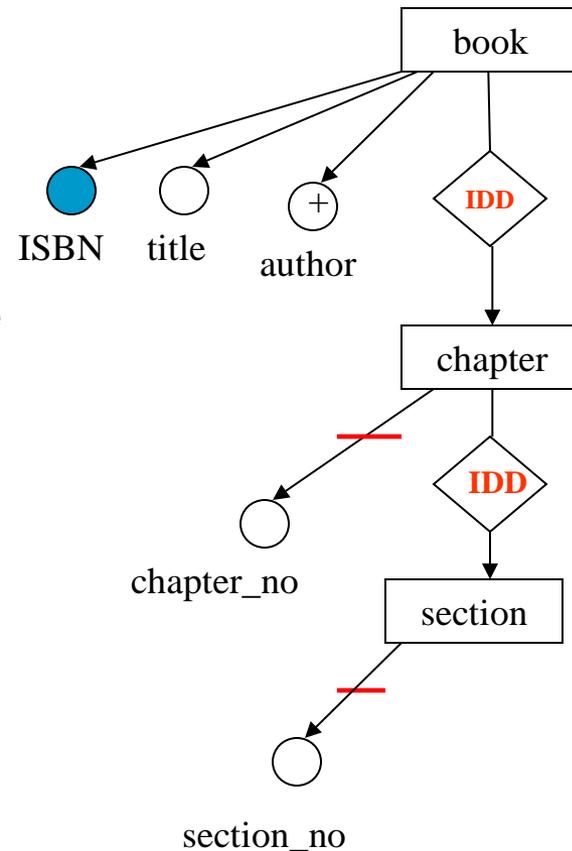


Figure: **IDD** relationship types

Attribute

- **key attribute** or **Object Identifier (OID)**
- ❖ – **Attribute of object class and relationship type**
- **composite attribute**
- **disjunctive attribute** (denoted by |)
- **attribute with unknown structure** (denoted by **ANY**)
- **ordering on attribute** (denoted by <)
- **fixed and default values of attribute** (denoted by **F** and **D**)
- **derived attribute** (denoted by **dotted circle**)

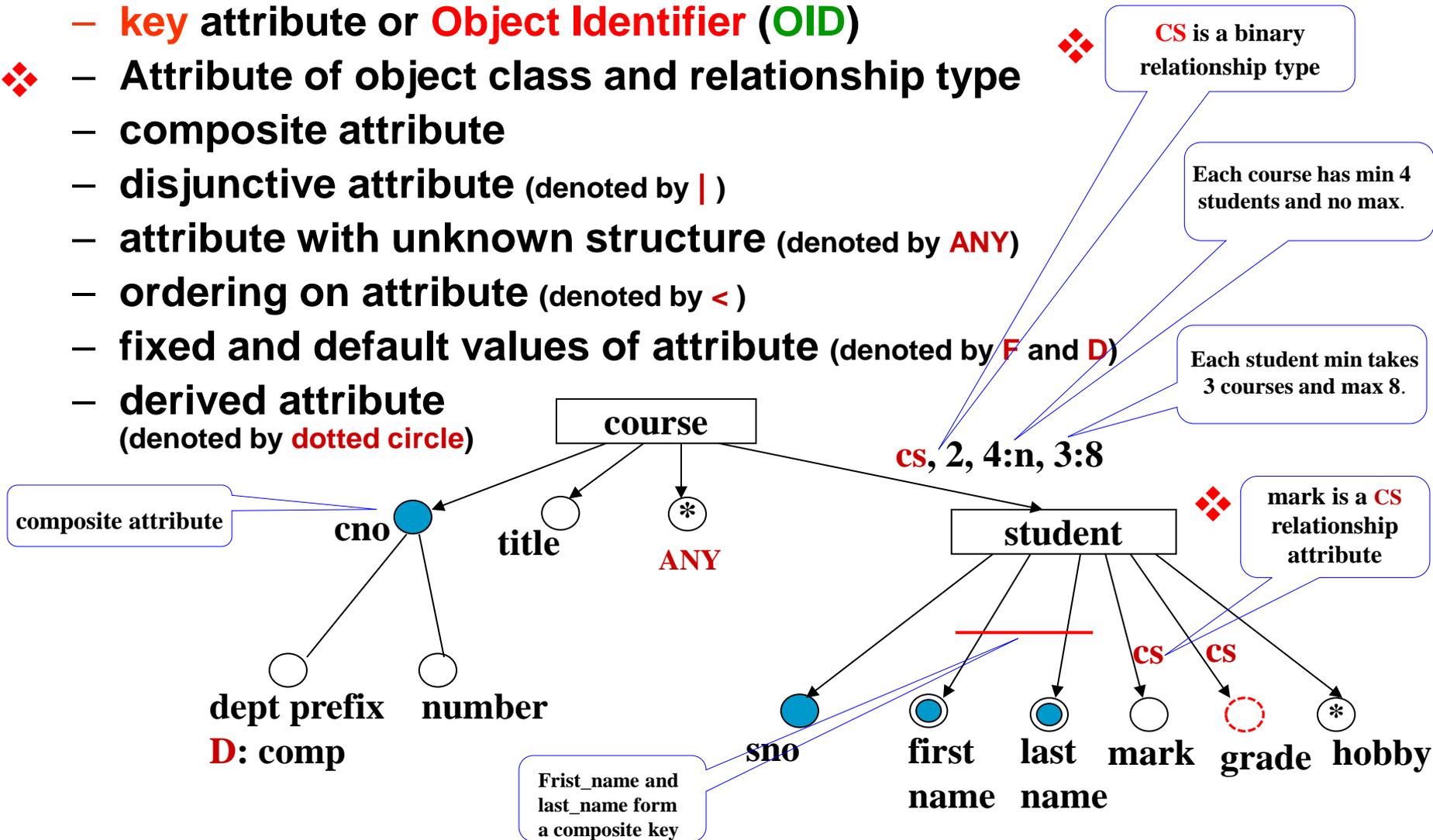
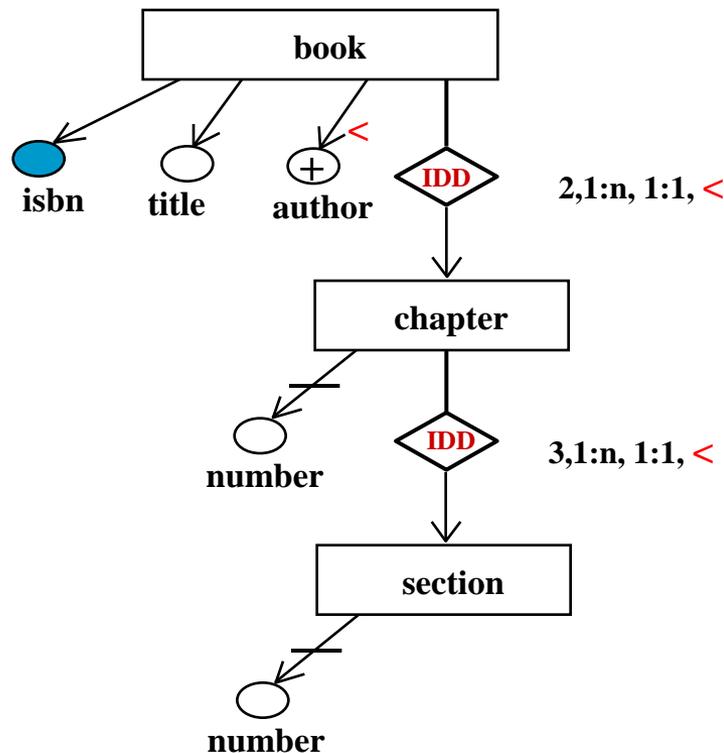


Figure 7: Object classes with relationship type and attributes in an ORA-SS schema diagram

Ordering

- the instances of an object class can be ordered,
- the values of an attribute can be ordered, and
- the set of attributes of an object class can be ordered



Note: IDD means identifier dependency relationship, similar to ID in ER diagram.

Note: The authors of a book are ordered. The chapters of a book are ordered. The sections of a chapter of a book are ordered.

Figure 8: Ordered object classes and attributes in an ORA-SS schema diagram

Disjunction

- disjunctive object class, and
- disjunctive attribute.

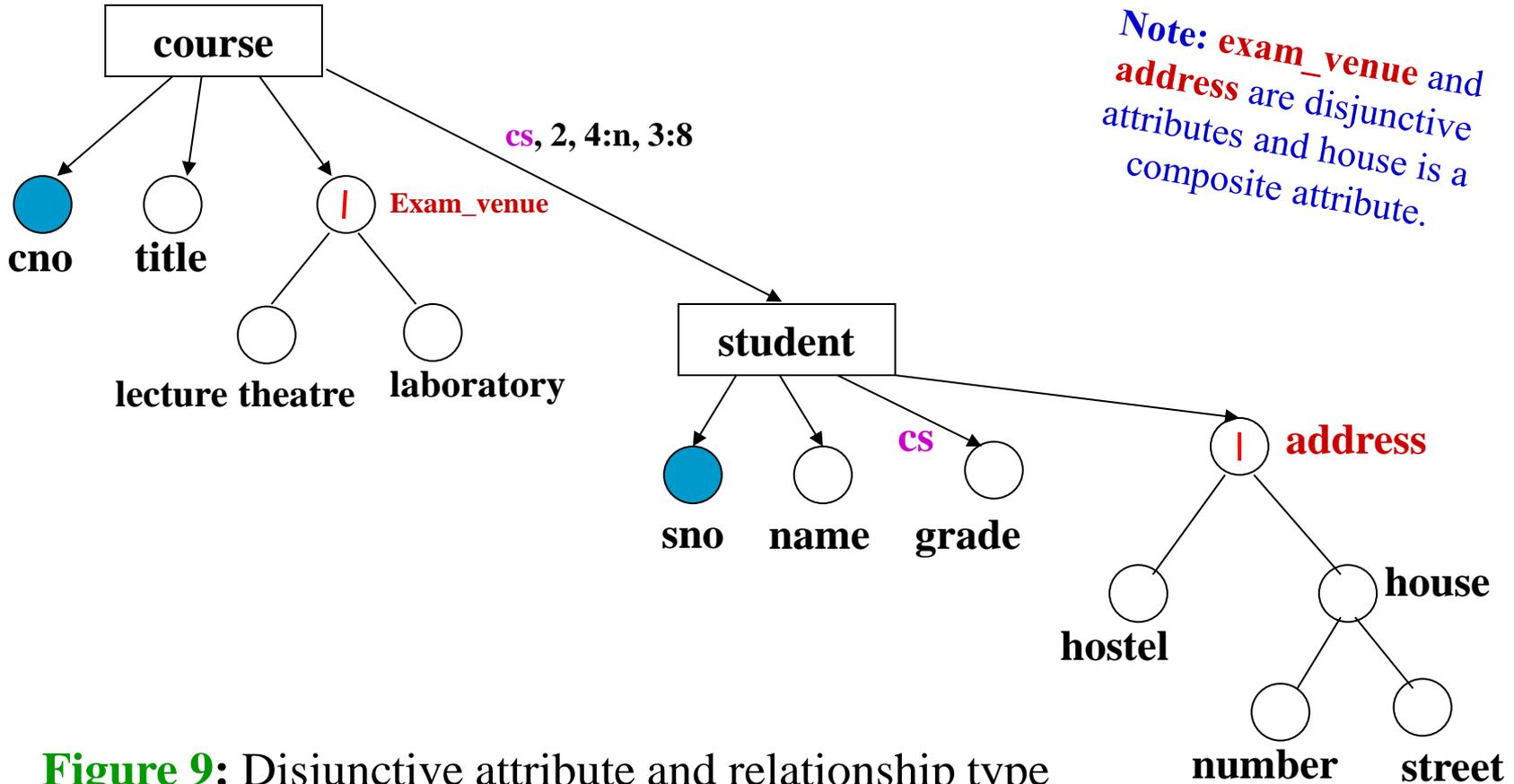


Figure 9: Disjunctive attribute and relationship type in an ORA-SS schema diagram

References

- Similar to IDREF in DTD

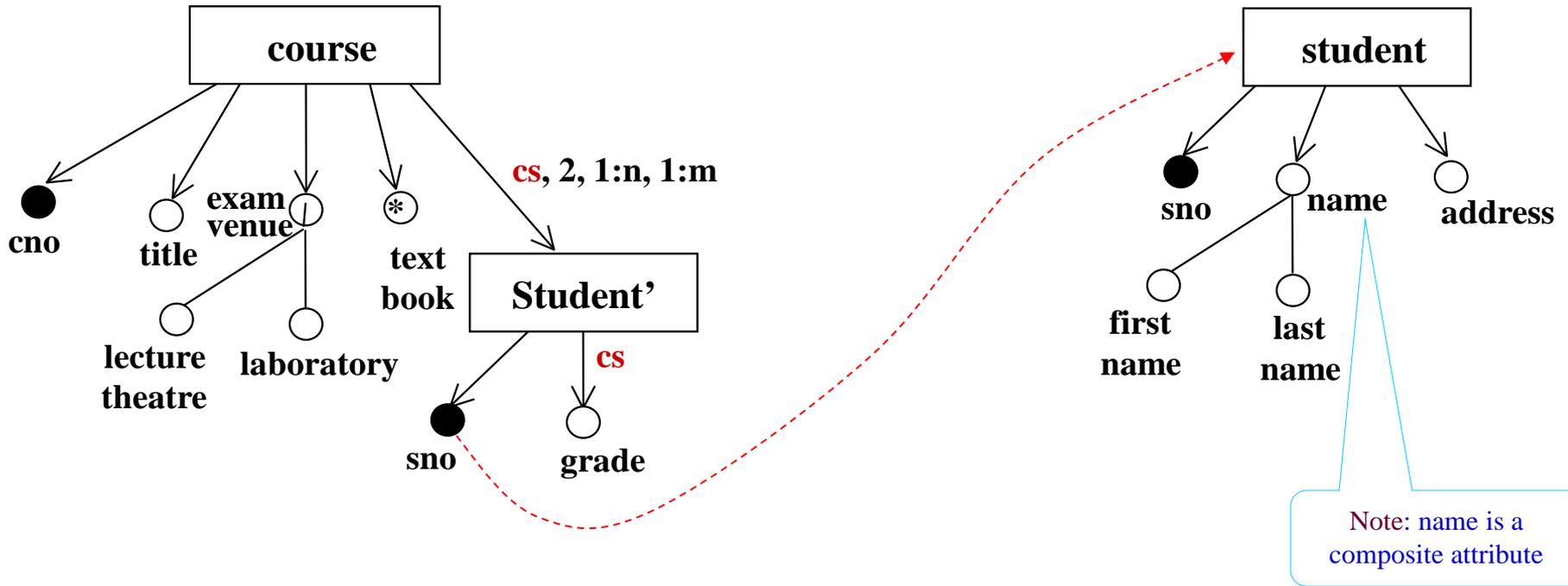


Figure 10: Referencing an object class in an ORA-SS Schema Diagram

References (cont.)

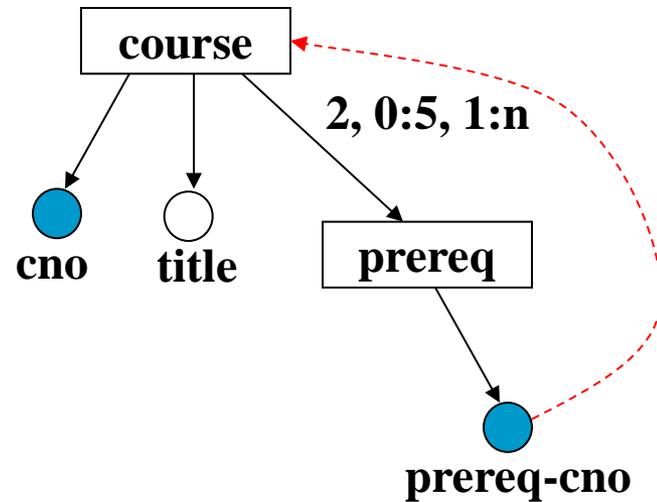


Figure 11: Example of a **recursive relationship type** in an ORA-SS Schema Diagram

References (cont.)

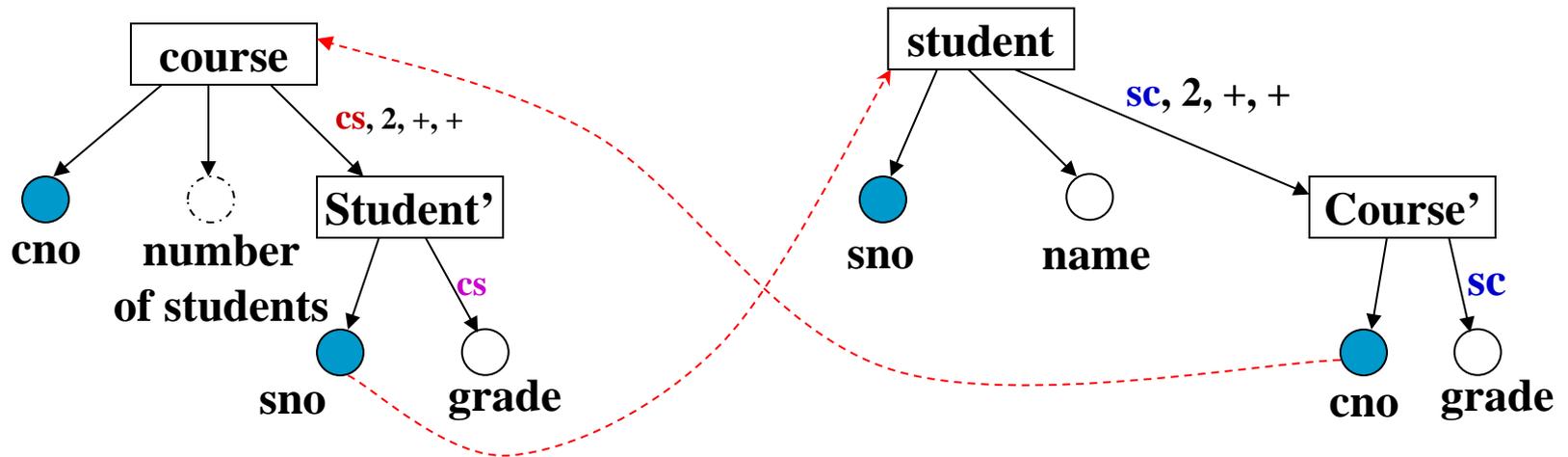


Figure 12: Representing a binary relationship type as 2 **symmetric** relationship types to facilitate symmetric queries. Redundancy occurs.

Functional Dependencies

student, course \rightarrow tutor

tutor \rightarrow course

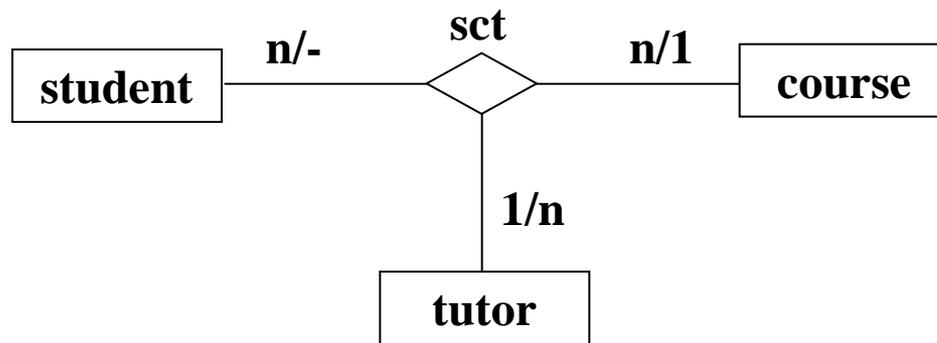
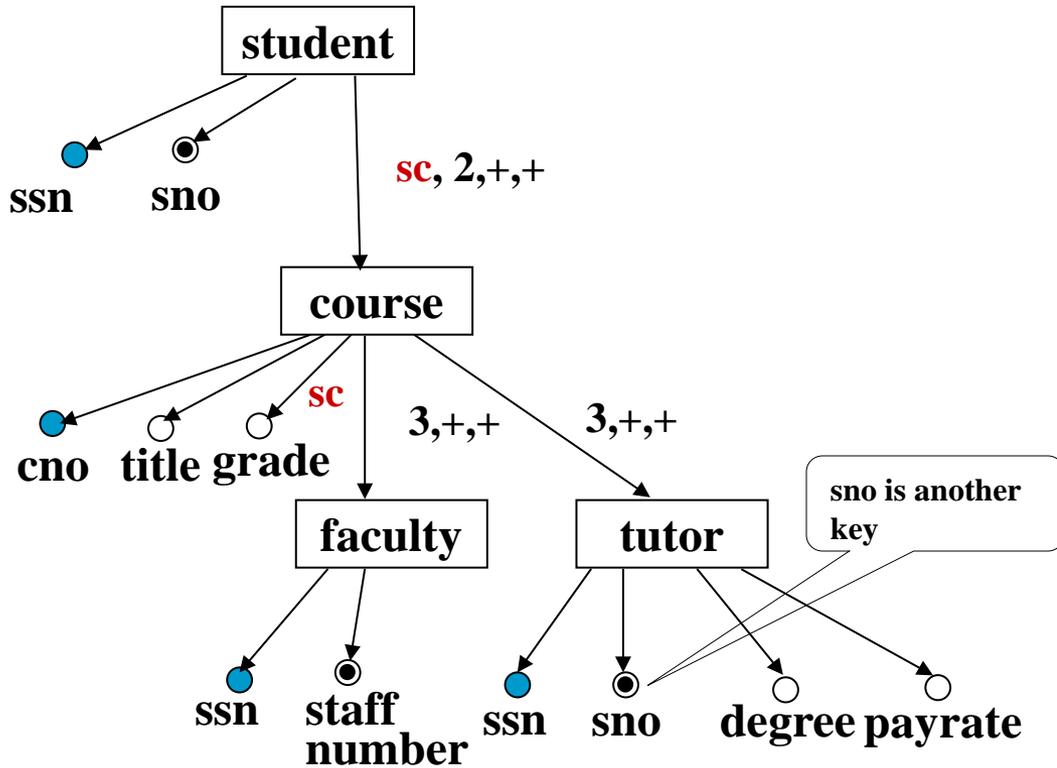
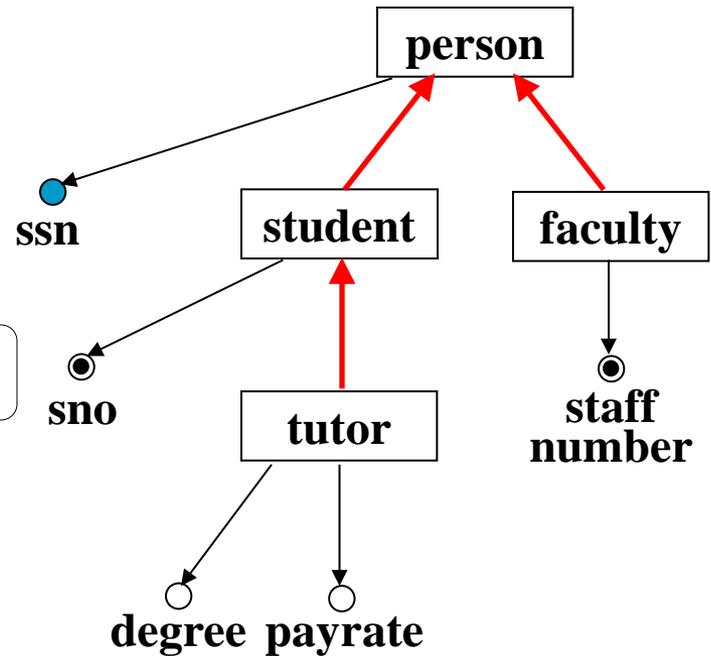


Figure 15: Functional dependencies diagram

Inheritance Hierarchy



(a) ORA-SS Schema Diagram

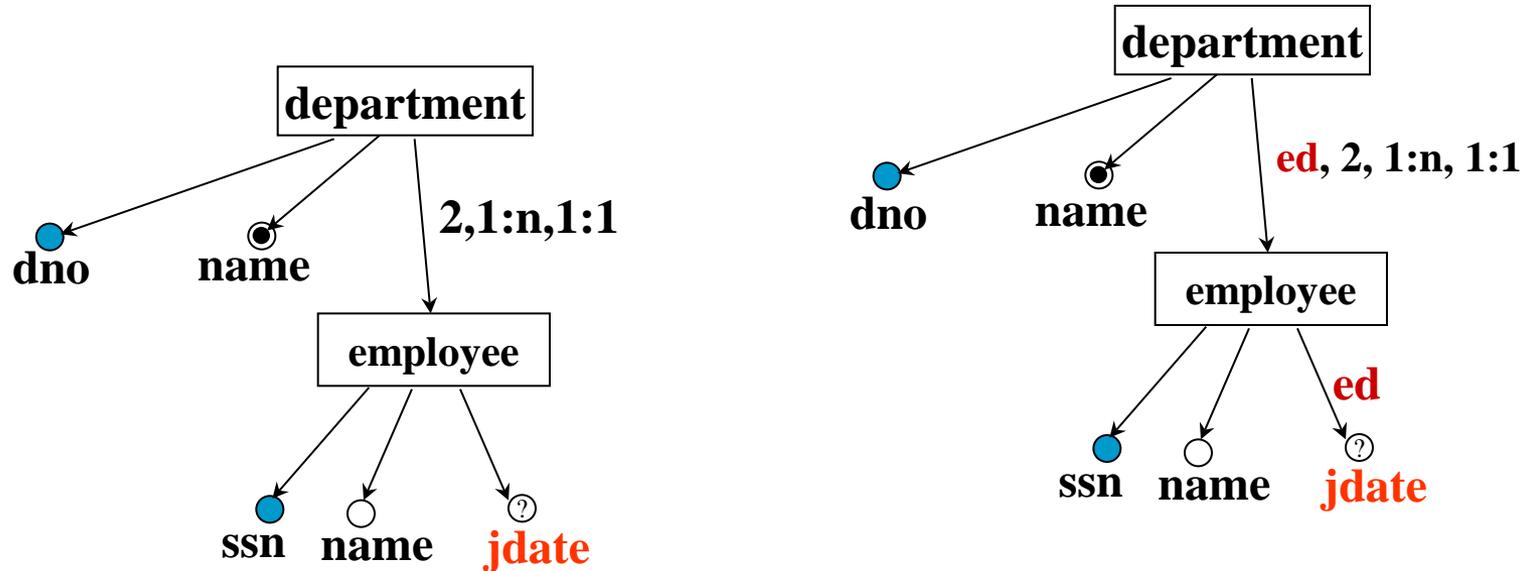


(b) Inheritance Diagram

Figure 16: ORA-SS schema diagram and inheritance diagram

Constraints

- Inclusion dependency
- ❖ ■ Semantic dependencies



(a) **jdate** of employee joined company, i.e. jdate is **semantically determined** by employee only.

(b) **jdate** of employee joined department, i.e. jdate is **semantically determined** by employee and department.

Figure 17: Modeling join date (jdate) ORA-SS schema diagram