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Guidelines Guidelines

Functional Dependencies

CSIT882: Data Management Systems

UNIVERSITY
OF WOLLONGONG
AUSTRALIA

Outline

- Functional dependency ? What is it ?
- Functional dependencies versus conceptual schemas
- Examples

How good is your DB design?

Information Preservation

- Does your design correctly capture all attributes, entities and relations?

Minimum Redundancy

- Does your design minimize redundant storage of the same information and reduce the need for multiple updates?

Example of Redundancy

Suppose we have a table *inst_dept which contain information for both instructor* and *department*.

issue: possible repetition of information, which leads to **update anomalies**.

ID	*name*	*salary*	*dept_name*	*building*	*budget*
22222	Einstein	95000	Physics	Watson	70000
12121	Wu	90000	Finance	Painter	120000
32343	El Said	60000	History	Painter	50000
45565	Katz	75000	Comp. Sci.	Taylor	100000
98345	Kim	80000	Elec. Eng.	Taylor	85000
76766	Crick	72000	Biology	Watson	90000
10101	Srinivasan	65000	Comp. Sci.	Taylor	100000
58583	Califieri	62000	History	Painter	50000
83821	Brandt	92000	Comp. Sci.	Taylor	100000
15151	Mozart	40000	Music	Packard	80000
33456	Gold	87000	Physics	Watson	70000
76543	Singh	80000	Finance	Painter	120000

Example of Redundancy

Insertion Anomalies

- To insert a new employee, we must include the correct values for his/her department or NULLs.
- How to insert department with no employees?

Deletion Anomalies

- What if we delete the last employee in a department?

Update Anomalies

- What if we change the budget of a department?

ID	*name*	*salary*	*dept_name*	*building*	*budget*
22222	Einstein	95000	Physics	Watson	70000
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Devise a Theory for what is Good

We want to do two things:

- Decide whether a particular relation R is in "good" form.
- If a relation R is not in "good" form, decompose it into a set of relations {R1, R2, ..., Rn} such that
- each relation is in good form
- the decomposition is a lossless

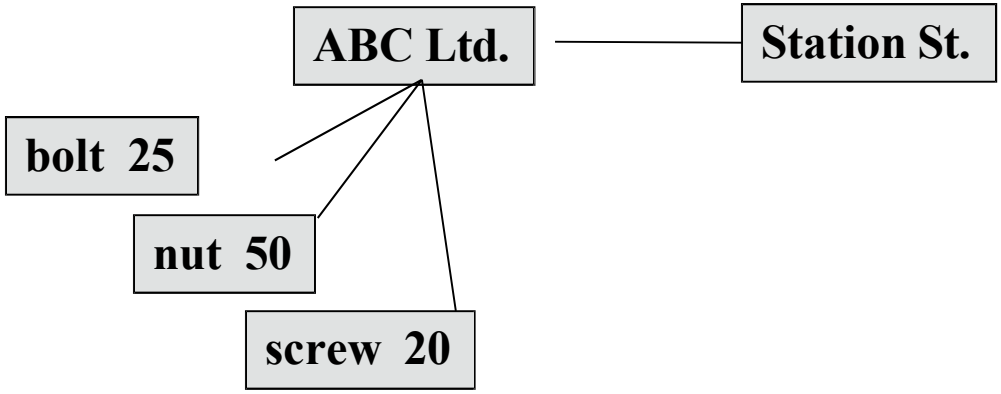
Our theory/properties are defined based on **functional dependencies**.

Functional dependency ? What is it ?

- Functional dependency describes the relationship between attributes.
  - It shows how attributes relate to other attributes.

- Consider a relation schema R=(A, B). If we know the value of A, we can only find at most one value of B in all the tuples of a relational table R. Then we have B functionally depends on A (or A functionally determines B)…
  …We write **A → B**

Functional dependency ? What is it ?



Each warehouse is located at exactly one address

warehouse → warehouse-address

At each address there is only one warehouse

warehouse-address → warehouse

At each warehouse parts of the same kind have only one total quantity

warehouse, part → quantity

Functional dependency ? What is it ?

Each car has one owner

car → person

Each child has one female parent

child → female-parent

Each child has one male parent

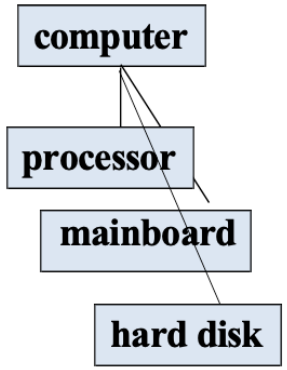
child → male-parent

Each physical part belongs to one physical product

physical-part → product

Each physical product is sold by one retailer

physical-product → retailer



Outline

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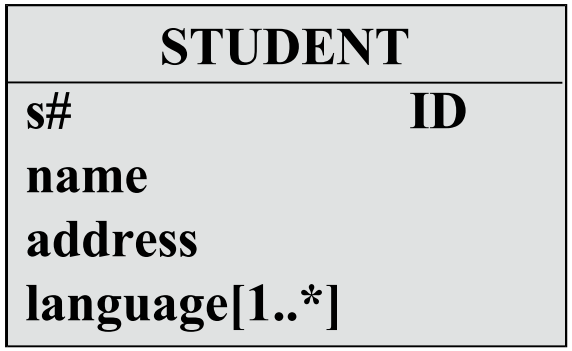
How to identify functional dependencies

- Understand the meaning of each attribute.
- Find relationships between the attributes.

- Information may be found in the user's requirement specifications.
- Database designers use common sense to provide missing information.
- Use sample data – represent all possible data values that the database may hold.

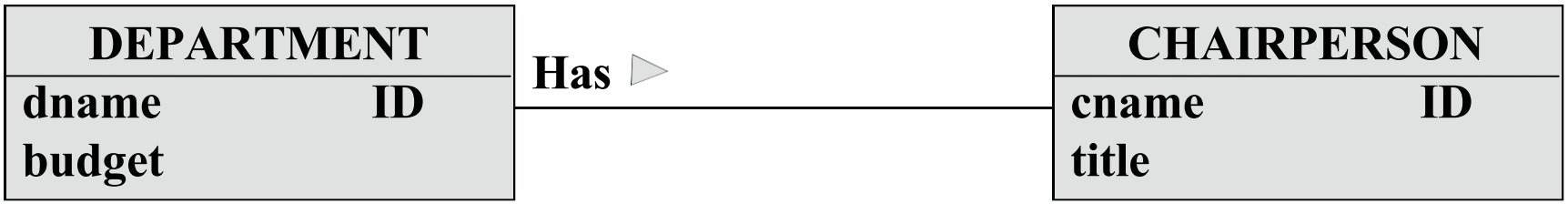
Functional dependencies versus classes



s# → name

s# → address

Functional dependencies versus associations



dname → budget

cname → title

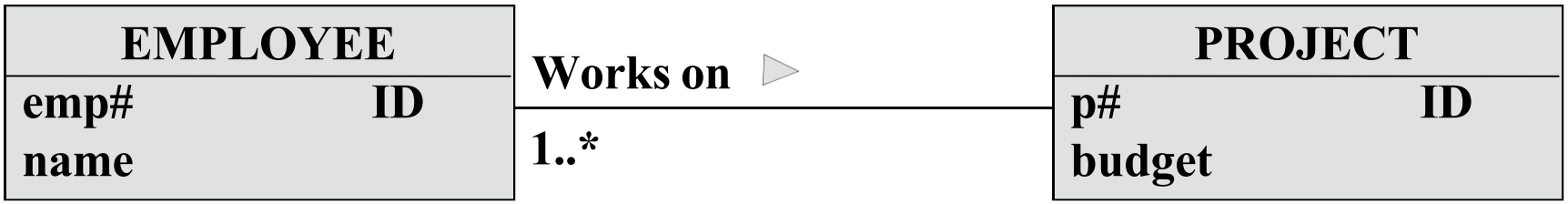
dname → title

cname → budget

cname → dname

dname → cname

Functional dependencies versus associations



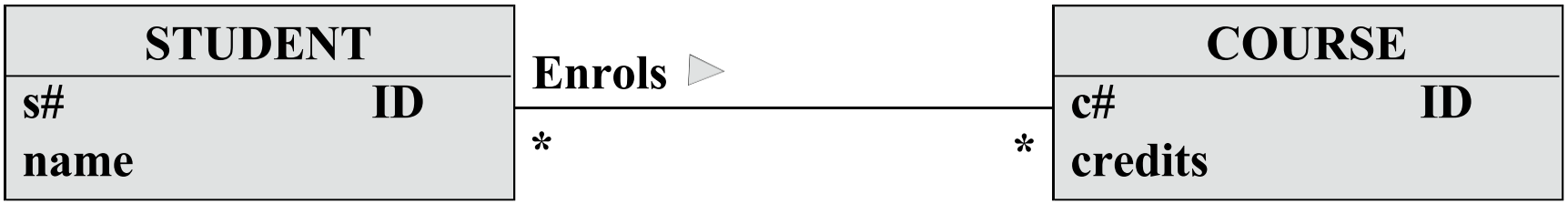
emp# → name

p# → budget

emp# → p#

emp# → budget

Functional dependencies versus associations



s# → name

c# → credits

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Functional Dependencies

Consider a relation schema R=(A, B). If we know the value of A, we can only find at most one value of B in all the tuples of a relational table R. …
…the functional dependency

A → B is true (holds)

ID	Name	Code	Grade
100	J	3550	A
200	X	3550	B
100	J	4540	B
100	J	4550	A

- Example: R = {ID, Name, Code, Grade}
  - ID → Name
  - ID → Grade,
  - ID → Code
  - ID, Name → Grade,
  - ID, Code → Grade
  - ID, Name → Name

Are they OK or not?

Functional Dependencies

Consider a relation schema R=(A, B). If we know the value of A, we can only find at most one value of B in all the tuples of a relational table R…
…the functional dependency

A → B is true (holds)

ID	Name	Code	Grade
100	J	3550	A
200	X	3550	B
100	J	4540	B
100	J	4550	A

- Example: R = {ID, Name, Code, Grade}
  - ID → Name (OK)
  - ID → Grade (not OK), ID → Code (not OK)
  - ID, Name → Grade (not OK), ID, Code → Grade (OK)
  - ID, Name → Name (trivial)

Functional Dependencies: Test

Let's see if you understand (Test 1)

F: X → Y (Assume FD X → Y)

X	Y
a	b
a	?

Functional Dependencies: Test

Let's see if you understand (Test 2)

F: X → Y

X	Y
a	b
?	b

c okay?

Functional Dependencies: Test

Let's see if you understand (Test 3 & 4)

$X, Y \rightarrow X$

$X \rightarrow X$

Note: Functional dependencies like these are trivial

Functional Dependencies: Test

Let's see if you understand (Test 5)

Consider R (A , B) with the following instances

1	4
1	5
3	7

A → B does NOT hold, but B → A does hold.

FD: relation between two sets

A functional dependency is a relation between two **sets** of attributes.

i.e., the value for a set of attributes determines the value for another set of attributes.

Examples:

$XY \rightarrow WZ$

$XW \rightarrow Z$

$Z \rightarrow XQ$

Functional Dependencies

A WORKS_ON relation

Ssn = social security number

Pnumber = project number

Question:

What might be the FDs of

WORKS_ON?

WORKS_ON

Ssn	Pnumber	Hours
123456789	1	32.5
123456789	2	7.5
666884444	3	40.0
453453453	1	20.0
453453453	2	20.0
333445555	2	10.0
333445555	3	10.0
333445555	10	10.0
333445555	20	10.0
999887777	30	30.0
999887777	10	10.0
987987987	10	35.0
987987987	30	5.0
987654321	30	20.0
987654321	20	15.0

References

- **Elmasri R., Navathe S. B., *Fundamentals of Database Systems*, chapter 10.2**
- **R. Ramakrishnan, J. Gehrke *Database Management Systems*, chapters 19.2, 19.3**