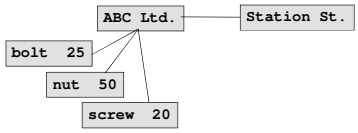
Functional dependencies

Functional dependency ? What is it ?



Each warehouse is located at exactly one address

`warehouse → warehouse-address`

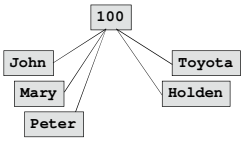
At each address there is only one warehouse

`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`

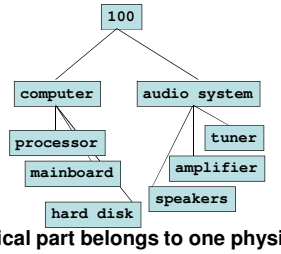
Each child has one female parent

`child → female-parent`

Each child has one male parent

`child → male-parent`

Functional dependency ? What is it ?



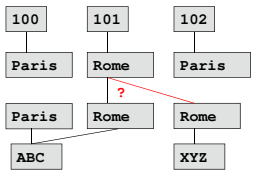
Each physical part belongs to one physical product

`physical-part → product`

Each physical product is sold by one retailer

`physical-product → retailer`

Functional dependency ? What is it ?



Each supplier lives in one city

`supplier → city`

It is not true that each company is located in one city

`company ↛ city`

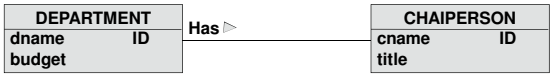
Functional dependencies versus classes

STUDENT
s# ID
name
address
language[1..*]

`s# → name`

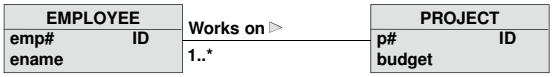
`s# → address`

Functional dependencies versus associations



dname → budget
cname → title
dname → title
cname → budget
cname → dname
dname → cname

Functional dependencies versus associations



emp# → ename
p# → budget
emp# → p#
emp# → budget

Functional dependencies versus associations

s# → sname
c# → credits

Derivations of functional dependencies

Employee

e# ename department department-address chairperson

e# → ename
e# → department
department → department-address
department → chairperson
chairperson → department
e# → department-address
e# → chairperson
chairperson → department-address
e# → ename, department

Derivations of functional dependencies

Employee

e# ename department department-address chairperson

e# → e#
e# → e#, ename
e#, ename → e#, ename
e#, ename → e#
e#, department → ename

Derivations of functional dependencies

It is always true that $a \rightarrow a$ (no matter what a means)

It is always true that $a,b \rightarrow a$
(no matter what a,b mean)

If it is true that $a \rightarrow b$ then it is true that $a,c \rightarrow b$

If it is true that $a \rightarrow b,c$ then
it is true that $a \rightarrow b$ and $a \rightarrow c$

If it is true that $a \rightarrow b$ and $b \rightarrow c$ then
it is true that $a \rightarrow c$

Functional dependency

Let $R = (A_1, \ldots, A_n)$ be a relational schema (a header of relational table) and let X, Y be nonempty subsets of R

We say that functional dependency $X \rightarrow Y$ is valid in relational schema R if ...

... for any relational table r with relational schema R, it is not possible that r has two rows that agree in the components for all attributes in set X yet ...

... disagree in one or more component for attributes in set Y

Armstrong axioms

Let $R = (A_1, \ldots, A_n)$ be a relational schema (a header of relational table) and let X, Y be nonempty subsets of R

(i) If $Y \subseteq X$ then $X \rightarrow Y$ (reflexivity)

(ii) If $X \rightarrow Y$ then $XZ \rightarrow YZ$ (augmentation)

(iii) If $X \rightarrow Y$ and $Y \rightarrow Z$ then $X \rightarrow Z$ (transitivity)

(i), (ii), (iii) form a minimal and complete set of axioms

A -> B (THE -> MEANS “DERIVES”) and from a u can get b

Additional inference rules

Let $R = (A_1, \ldots, A_n)$ be a relational schema (a header of relational table) and let X, Y be nonempty subsets of R

If $X \rightarrow Y$ and $X \rightarrow Z$ then $X \rightarrow YZ$ (union)

If $X \rightarrow Y$ and $WY \rightarrow Z$ then $WX \rightarrow Z$ (pseudotransitivity)

If $X \rightarrow Y$ and $Z \subseteq Y$ then $X \rightarrow Z$ (decomposition)

Derivations of functional dependencies

Given $F = \{A \rightarrow B, B \rightarrow C\}$
Is it true that $A \rightarrow C$?

$A \rightarrow B \ \& \ B \rightarrow C$

transitivity axiom

$A \rightarrow C$

Derivations of functional dependencies

Given $F = \{A \rightarrow BC\}$
Is it true that $A \rightarrow B$ and $A \rightarrow C$?

$BC \rightarrow C$ reflexivity axiom

$A \rightarrow BC \ \& \ BC \rightarrow C$

transitivity axiom

$A \rightarrow C$

Derivations of functional dependencies

Given $F = \{A \rightarrow B, A \rightarrow C\}$
Is it true that $A \rightarrow BC$?

$A \rightarrow B$ augmentation axiom $A \rightarrow AB$

$A \rightarrow C$ augmentation axiom $AB \rightarrow BC$

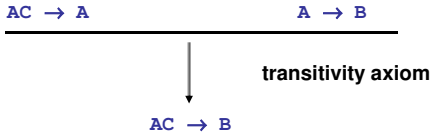
transitivity axiom

$A \rightarrow BC$

Derivations of functional dependencies

Given $F = \{A \rightarrow B\}$
Is it true that $AC \rightarrow B$?

$AC \rightarrow A$ reflexivity axiom



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