Functional Dependency

Formal Definition: Attribute B is functionally dependant upon attribute A *(or a collection of attributes)* if a value of A determines a single value of attribute B at any one time.

Formal Notation: A → B This should be read as 'A determines B' or 'B is functionally dependant on A'. A is called the *determinant* and B is called the *object of the determinant*.

Example:

staffNo	job	dept	dname
SL10	Salesman	10	Sales
SA51	Manager	20	Accounts
DS40	Clerk	20	Accounts
OS45	Clerk	30	Operations

Functional Dependencies

staffNo → job
staffNo → dept
staffNo → dname

dept → dname

Partial Functional Dependency

Partial Functional Dependency: This is the situation that exists if it is necessary to only use a subset of the attributes of the composite determinant to identify its object uniquely.

Example:

Student#   Crs#   CrsName   grade

Full Functional Dependencies
(Student#, Crs#) $\rightarrow$ grade

Partial Functional Dependencies
Crs# $\rightarrow$ CrsName

Full Functional Dependency

Full Functional Dependency: Only of relevance with composite determinants. This is the situation when it is necessary to use all the attributes of the composite determinant to identify its object uniquely.

Example:

order#	Pd#	qty	price
A001	001	10	200
A002	001	20	400
A002	002	20	800
A004	001	15	300

Full Functional Dependencies
(Order#, Pd#) → qty
(Order#, Pd#) → price

Unnormalised Normal Form (UNF)

ORDER

Customer No:	001964	Order Number:	00012345
Name:	Mark Campbell	Order Date:	14-Feb-2002
Address:	1 The House		
	Leytonstone		
	E11 9ZZ		

Product Number	Product Description	Unit Price	Order Quantity	Line Total
T5060	Hook	5.00	5	25.00
PT42	Bolt	2.50	10	20.50
QZE48	Spanner	20.00	1	20.00

Order Total: 65.50

ORDER (order-no, order-date, cust-no, cust-name, cust-add,
(prod-no, prod-desc, unit-price, ord-qty, line-total), order-total

First Normal Form (1NF)

Definition: A relation is in 1NF if, and only if, all its underlying attributes contain atomic values only.

Remove repeating groups into a new relation

A repeating group is shown by a pair of brackets within the relational schema.

ORDER (order-no, order-date, cust-no, cust-name, cust-add,
(prod-no, prod-desc, unit-price, ord-qty, line-total)*, order-total

Steps from UNF to 1NF:

- Remove the outermost repeating group (and any nested repeated groups it may contain) and create a new relation to contain it.

- Add to this relation a copy of the PK of the relation immediately enclosing it.

- Name the new entity *(appending the number 1 to indicate 1NF)*

- Determine the PK of the new entity

- Repeat steps until no more repeating groups.

Example - UNF to 1NF

ORDER (<u>order-no</u>, order-date, cust-no, cust-name, cust-add,
     (prod-no, prod-desc, unit-price, ord-qty, line-total)*, order-total

1. Remove the outermost repeating group (and any nested repeated groups it may contain) and create a new relation to contain it. *(rename original to indicate 1NF)*

ORDER-1 (<u>order-no</u>, order-date, cust-no, cust-name, cust-add, order-total

(prod-no, prod-desc, unit-price, ord-qty, line-total)

2. Add to this relation a copy of the PK of the relation immediately enclosing it.

ORDER-1 (<u>order-no</u>, order-date, cust-no, cust-name, cust-add, order-total

(order-no, prod-no, prod-desc, unit-price, ord-qty, line-total)

3. Name the new entity *(appending the number 1 to indicate 1NF)*

ORDER-LINE-1 (order-no, prod-no, prod-desc, unit-price, ord-qty, line-total)

4. Determine the PK of the new entity

ORDER-LINE-1 (<u>order-no, prod-no</u>, prod-desc, unit-price, ord-qty, line-total)

Second Normal Form (2NF)

Definition: A relation is in 2NF if, and only if, it is in 1NF and every non-key attribute is fully dependent on the primary key.

Remove partial functional dependencies into a new relation

Steps from 1NF to 2NF:

- Remove the offending attributes that are only partially functionally dependent on the composite key, and place them in a new relation.

- Add to this relation a copy of the attribute(s) which are the determinants of these offending attributes. These will automatically become the primary key of this new relation.

- Name the new entity *(appending the number 2 to indicate 2NF)*

- Rename the original entity *(ending with a 2 to indicate 2NF)*

Example - 1NF to 2NF

ORDER-LINE-1 (<u>order-no, prod-no</u>, prod-desc, unit-price, ord-qty, line-total)

1. Remove the offending attributes that are only partially functionally dependent on the composite key, and place them in a new relation.

ORDER-LINE-1 (<u>order-no, prod-no</u>, ord-qty, line-total)

(prod-desc, unit-price)

2. Add to this relation a copy of the attribute(s) which determines these offending attributes. These will automatically become the primary key of this new relation..

ORDER-LINE-1 (<u>order-no, prod-no</u>, ord-qty, line-total)

(<u>prod-no</u>, prod-desc, unit-price)

3. Name the new entity *(appending the number 2 to indicate 2NF)*

PRODUCT-2 (<u>prod-no</u>, prod-desc, unit-price)

4. Rename the original entity *(ending with a 2 to indicate 2NF)*

ORDER-LINE-2 (<u>order-no, prod-no</u>, ord-qty, line-total)

Third Normal Form (3NF)

Definition: A relation is in 3NF if, and only if, it is in 2NF and every non-key attribute is non-transitively dependent on the primary key.

Remove transitive dependencies into a new relation

Steps from 2NF to 3NF:

- Remove the offending attributes that are transitively dependent on non-key attribute(s), and place them in a new relation.

- Add to this relation a copy of the attribute(s) which are the determinants of these offending attributes. These will automatically become the primary key of this new relation.

- Name the new entity *(appending the number 3 to indicate 3NF)*

- Rename the original entity *(ending with a 3 to indicate 3NF)*

Example - 2NF to 3NF

ORDER-2 (order-no, order-date, cust-no, cust-name, cust-add, order-total

1. Remove the offending attributes that are transitively dependent on non-key attributes, and place them in a new relation.

ORDER-2 (order-no, order-date, cust-no, order-total

(cust-name, cust-add)

2. Add to this relation a copy of the attribute(s) which determines these offending attributes. These will automatically become the primary key of this new relation..

ORDER-2 (order-no, order-date, cust-no, order-total

(cust-no, cust-name, cust-add)

3. Name the new entity *(appending the number 3 to indicate 3NF)*

CUSTOMER-3 (cust-no, cust-name, cust-add)

4. Rename the original entity *(ending with a 3 to indicate 3NF)*

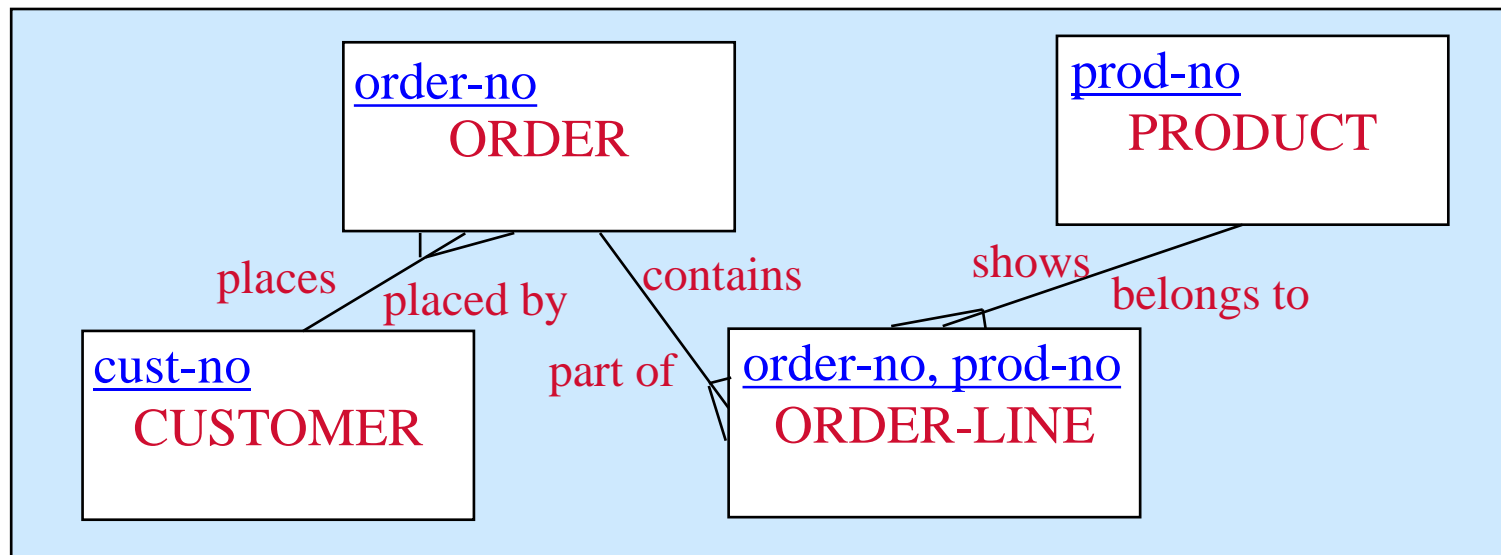ORDER-3 (order-no, order-date, cust-no, order-total

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Example - Relations in 3NF

ORDER-3 (order-no, order-date, cust-no, order-total

CUSTOMER-3 (cust-no, cust-name, cust-add)

PRODUCT-2 (prod-no, prod-desc, unit-price)

ORDER-LINE-2 (order-no, prod-no, ord-qty, line-total)

Stages of Normalisation

Unnormalised (UDF) → Remove repeating groups → First normal form (1NF) → Remove partial dependencies → Second normal form (2NF) → Remove transitive dependencies → Third normal form (3NF)