



CSCC43: Introduction to Database Systems

Lecture 3

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Acknowledgment: these slides are partially based on Prof. Garcia-Molina & Prof. Ullman slides accompanying the course's textbook.



Normalization Example 1: patient and hospital



Example: Medical Records

- We have:
 - patients with unique NI#, each having a name and a GP;
 - each GP has an id.number, name & address;
 - a hospital appointment connects a patient, a date, a hospital and a consultant;
 - a consultant has a phone number and visits one hospital on any given day;
 - a hospital has an address.

U(NI# , Appdate, Apptime, PTname, GP# , GPaddress,
GPname, Cname, Cphone, Hosp, HospAddress)

What are the functional dependencies?



What are the Functional Dependencies?

- From a patient's number, we can determine the patient's name and GP:

$NI\# \rightarrow \{PTname, GP\# \}$

- From a GP's ID we determine the GP's name and address:

$GP\# \rightarrow \{GPname, GPaddress \}$



What are the Functional Dependencies?

- From a particular patient on a particular day we can determine the consultant information, the time of the appointment and which was the hospital:

$NI\#, AppDate \rightarrow \{Cname, AppTime, Hosp\}$

- Each consultant has one phone number:

$Cname \rightarrow Cphone$

- Each hospital has only one address:

$Hosp \rightarrow HospAddress$



Normalising the Example

- Starting with the Universal Relation we find all kinds of redundancy.
- So moving to 2NF split off those attributes only dependent on part of the primary key:

Patient (NI# , PTname, GP# , GPaddress, GPname)

Appt (NI# , AppDate, AppTime, Cname, Cphone, Hosp, HospAddress)

- Patient is 2NF but not 3NF since $NI\# \rightarrow GP\# \rightarrow \{GPaddress, GPname\}$



Normalising the Example – cont'd

- So split off the GP information

Patient2 (NI# , PTname, GP#)

GP (GP# , GPaddress, GPname)

- Similarly, Appt becomes

App (NI# , AppDate, AppTime, Cname, Hosp)

Con (Cname, Cphone)

Hospital (Hosp, HospAddress)



Normalising the Example

Final result:

Patient2 (NI# , PTname, GP#)

GP (GP# , GPaddress, GPname)

App (NI# , AppDate, AppTime, Cname, Hosp)

Con (Cname, Cphone)

Hospital (Hosp, HospAddress)



Normalization Example 2: salesperson and customer



Salesperson and Customer

■ Unnormalized Relation

Sales Report (Salesperson-No, Salesperson-Name, Sales-Area, {Customer-No, Customer-Name, Warehouse-No, Warehouse-Location, Sales-Amount})

} -- repeating group

■ 1NF -- removes repeating groups

Salesperson (Salesperson-No, Salesperson-Name, Sales-Area)

Salesperson-Customer (Salesperson-No, Customer-No, Customer-Name, Warehouse-No, Warehouse-Location, Sales-Amount)



Salesperson and Customer

■ 1NF

Salesperson (Salesperson-No, Salesperson-Name, Sales-Area)

Salesperson-Customer (Salesperson-No, Customer-No, Customer-Name,
Warehouse-No, Warehouse-Location, Sales-Amount)

■ 2NF -- removes non-full dependencies on primary key

Salesperson (Salesperson-No, Salesperson-Name, Sales-Area)

Sales (Salesperson-No, Customer-No, Sales-Amount)

Customer-Warehouse (Customer-No, Customer-Name, Warehouse-No,
Warehouse-Location)



Salesperson and Customer

■ 2NF

Salesperson (Salesperson-No, Salesperson-Name, Sales-Area)

Sales (Salesperson-No, Customer-No, Sales-Amount)

Customer-Warehouse (Customer-No, Customer-Name, Warehouse-No,
Warehouse-Location)

■ 3NF -- removes transitive dependencies

Salesperson (Salesperson-No, Salesperson-Name, Sales-Area)

Sales (Salesperson-No, Customer-No, Sales-Amount)

Customer-Warehouse (Customer-No, Customer-Name, Warehouse-No)

Warehouse (Warehouse-No, Warehouse-Location)



Normalization Example 3: salesperson and products

SALESPERSON/PRODUCT table

<u>Salesperson Number</u>	Product Number	Salesperson Name	Commission Percentage	Year of Hire	Department Number	Manager Name	Product Name	Unit Price	Quantity
137	19440	Baker	10	1995	73	Scott	Hammer	17.50	473
	24013						Saw	26.25	170
	26722						Pliers	11.50	688
186	16386	Adams	15	2001	59	Lopez	Wrench	12.95	1745
	19440						Hammer	17.50	2529
	21765						Drill	32.99	1962
	24013						Saw	26.25	3071
204	21765	Dickens	10	1998	73	Scott	Drill	32.99	809
	26722						Pliers	11.50	734
361	16386	Carlyle	20	2001	73	Scott	Wrench	12.95	3729
	21765						Drill	32.99	3110
	26722						Pliers	11.50	2738

First Normal Form

SALESPERSON/PRODUCT table

<u>Salesperson Number</u>	<u>Product Number</u>	Salesperson Name	Commission Percentage	Year of Hire	Department Number	Manager Name	Product Name	Unit Price	Quantity
137	19440	Baker	10	1995	73	Scott	Hammer	17.50	473
137	24013	Baker	10	1995	73	Scott	Saw	26.25	170
137	26722	Baker	10	1995	73	Scott	Pliers	11.50	688
186	16386	Adams	15	2001	59	Lopez	Wrench	12.95	1475
186	19440	Adams	15	2001	59	Lopez	Hammer	17.50	2529
186	21765	Adams	15	2001	59	Lopez	Drill	32.99	1962
186	24013	Adams	15	2001	59	Lopez	Saw	26.25	3071
204	21765	Dickens	10	1998	73	Scott	Drill	32.99	809
204	26722	Dickens	10	1998	73	Scott	Pliers	11.50	734
361	16386	Carlyle	20	2001	73	Scott	Wrench	12.95	3729
361	21765	Carlyle	20	2001	73	Scott	Drill	32.99	3110
361	26722	Carlyle	20	2001	73	Scott	Pliers	11.50	2738

Second Normal Form

SALESPERSON table					
<u>Salesperson Number</u>	Salesperson Name	Commission Percentage	Year of Hire	Department Number	Manager Name
PRODUCT table					
<u>Product Number</u>	Product Name			Unit Price	
QUANTITY table					
<u><u>Salesperson Number</u></u>	<u><u>Product Number</u></u>			Quantity	

Third Normal Form

SALESPERSON table				
<u>Salesperson Number</u>	Salesperson Name	Commission Percentage	Year of Hire	<u>Department Number</u>

DEPARTMENT table	
<u>Department Number</u>	Manager Name

PRODUCT table		
<u>Product Number</u>	Product Name	Unit Price

QUANTITY table		
<u>Salesperson Number</u>	<u>Product Number</u>	Quantity



Normalization Example 4: patient and subscription



Wellmeadows Hospital

Patient Medication Form

Patient Number: _____

Patient Name: _____

Ward Number: _____

Ward Name: _____

Drug Number	Name	Description	Dosage	Method of Admin	Units per Day	Start Date	Finish Date
10223	Morphine	Pain Killer	10 mg/ml	Oral	50	03/24/04	04/24/04
10334	Tetracycline	Antibiotic	0.5 mg/ml	IV	10	03/24/04	04/17/04
10223	Morphine	Pain Killer	10 mg/ml	Oral	10	04/25/04	05/24/04

Functional Dependencies:

Patient No → Full Name

Ward No → Ward Name

Drug No → Name, Description, Dosage, Method of Admin

Patient No, Drug No, Start Date → Units per Day, Finish date



■ First Normal Form

Patient No, Drug No, Start Date, Full Name, Ward No, Ward Name,
Bed No, Name, Description, Dosage, Method of Admin, Units per
Day, Finish Date

■ Second Normal Form

Patient No, Drug No, Start Date, Ward No, Ward Name, Bed No,
Units per Day, Finish Date

Drug No, Name, Description, Dosage, Method of Admin
Patient No, Full Name

■ Third Normal Form/BCNF

Patient No, Drug No, Start Date, Ward No, Bed No, Units per Day,
Finish Date

Drug No, Name, Description, Dosage, Method of Admin

Patient No, Full Name

Ward No, Ward Name



Normalization Example 5: car-owner and car



Car-owner and car

■ Unnormalized Relation

Owner-Car (Owner-ID, Owner-Name, Address, {Registration-No, Model, Manufacturer, No-Cylinders, Dealer, Dealer-Address, Sales-Amount})

{ } -- repeating group

■ 1NF -- removes repeating groups

Owner (Owner-ID, Owner-Name, Address)

Owner-Registration (Owner-ID, Registration-No, Model, Manufacturer, No-Cylinders, Dealer, Dealer-Address, Sales-Amount)



Car-owner and car

■ 1NF

Owner (Owner-ID, Owner-Name, Address)

Owner-Registration (Owner-ID, Registration-No, Model, Manufacturer, No-Cylinders, Dealer, Dealer-Address, Sales-Amount)

■ 2NF -- removes non-full dependencies on primary key

Owner (Owner-ID, Owner-Name, Address)

Owner-Registration (Owner-ID, Registration-No)

Registration (Registration-No, Model, Manufacturer, No-Cylinders, Dealer, Dealer-Address, Sales-Amount)



Car-owner and car

■ 2NF

Owner (Owner-ID, Owner-Name, Address)

Owner-Registration (Owner-ID, Registration-No)

Registration (Registration-No, Model, Manufacturer, No-Cylinders, Dealer, Dealer-Address, Sales-Amount)

■ 3NF -- removes transitive dependencies

Owner (Owner-ID, Owner-Name, Address)

Owner-Registration (Owner-ID, Registration-No)

Registration (Registration-No, Model, Manufacturer, No-Cylinders, Dealer, Sales-Amount)

Dealer (Dealer, Dealer-Address)



Intuitive Normalization

- 1NF** Tables represent entities
- 2NF** Each table represents only one entity
- 3NF** Tables do not contain attributes from embedded entities