

Lesson: 1st Normal Form (1NF), 2nd Normal Form (2NF) & 3rd Normal Form (3NF)

Learning Outcomes

- **Affirm your understanding of 1NF**
- **Rules associated with second (2NF)**
- **Rules associated with third (3NF).**

Normalization: 1st Normal Form (1NF)



A table is in first normal form (1NF):

- 1. There are no repeating attributes – every attribute is single valued – each cell in the table contains one value.**
- 2. Each attribute has a unique name – the column names are unique**
- 3. Each Table/Relation has a primary key (PK) which uniquely identifies each row/tuple in the relation.**

Reminder 1st Normal Form - 1NF



2) Every attribute is uniquely named



3) Assign a PK



CustID	CustName	SalesPerson	Region
8023	J Anderson	Smith	South
9167	A Bancroft	Hicks	West
7924	D Hobbs	Smith	South
6837	G Tucker		
		ndez	
8596	W Eckersley	Hicks	West
7018	C Arnold	Faulb	North

1) Every attribute is single valued



CustID (PK)	CustInitial	CustName	SalesPerson	Region
8023	J	Anderson	Smith	South
9167	A	Bancroft	Hicks	West
7924	D	Hobbs	Smith	South
6837	G	Tucker	Hernandez	East
8596	W	Eckersley	Hicks	West
7018	C	Arnold	Faulb	North

Note: If you can not assign a PK, then split the table using functional dependency. Also when splitting the table ensure you understand the attribute groupings & purpose of the table.

Is everyone now super duper
confident with 1NF and knows
exactly what they are doing?

Normalization: 1st Normal Form (1NF)

Watch the following video:

<https://www.youtube.com/watch?v=v3N5PIbUHTs>

- **Can you spot the mistakes in the video?**

Convert this table to 1NF

Student Number	StudentName	Address	Module Details
210458897	Bob Jones	31 New Street High Wycombe Buckinghamshire HP12 7CV	CO560 Database Design CO550 Web Development CO555 Research Methods CO565 Mobile Technology

Every attribute is single valued

StudentNumber	StudentF Name	Student SName	AddressLine1	Town	County	Postcode	ModuleCode	ModuleTitle
210458897	Bob	Jones	31 New Street	High Wycombe	Buckinghamshire	HP12 7CV	CO560	Database Design
210458897	Bob	Jones	31 New Street	High Wycombe	Buckinghamshire	HP12 7CV	CO550	Web Development
210458897	Bob	Jones	31 New Street	High Wycombe	Buckinghamshire	HP12 7CV	CO555	Research Methods
210458897	Bob	Jones	31 New Street	High Wycombe	Buckinghamshire	HP12 7CV	CO565	Mobile Technology

Assigning PK

StudentNumber	StudentF Name	Student SName	AddressLine1	Town	County	Postcode	ModuleCode	ModuleTitle
210458897	Bob	Jones	31 New Street	High Wycombe	Buckinghamshire	HP12 7CV	CO560	Database Design
210458897	Bob	Jones	31 New Street	High Wycombe	Buckinghamshire	HP12 7CV	CO550	Web Development
210458897	Bob	Jones	31 New Street	High Wycombe	Buckinghamshire	HP12 7CV	CO555	Research Methods
210458897	Bob	Jones	31 New Street	High Wycombe	Buckinghamshire	HP12 7CV	CO565	Mobile Technology

Everything about where the student lives

Everything about taught modules

StudentNumber	StudentFName	StudentSName	AddressLine1	Town	County	Postcode	ModuleCode (FK)
210458897	Bob	Jones	31 New Street	High Wycombe	Buckinghamshire	HP12 7CV	CO560
210458897	Bob	Jones	31 New Street	High Wycombe	Buckinghamshire	HP12 7CV	CO550
210458897	Bob	Jones	31 New Street	High Wycombe	Buckinghamshire	HP12 7CV	CO555
210458897	Bob	Jones	31 New Street	High Wycombe	Buckinghamshire	HP12 7CV	CO565



Assigning PK

ModuleCode (PK)	ModuleTitle
CO560	Database Design
CO550	Web Development
CO555	Research Methods
CO565	Mobile Technology

Tables in 1NF

StudentNumber (PK)	StudentFName	StudentSName	AddressLine1	Town	County	Postcode
210458897	Bob	Jones	31 New Street	High Wycombe	Buckinghamshire	HP12 7CV

Everything about where the student lives

StudentNumber (FK)	ModuleCode (FK)
210458897	CO560
210458897	CO550
210458897	CO555
210458897	CO565

Which students studies which modules

ModuleCode (PK)	ModuleTitle
CO560	Database Design
CO550	Web Development
CO555	Research Methods
CO565	Mobile Technology

Everything about taught modules

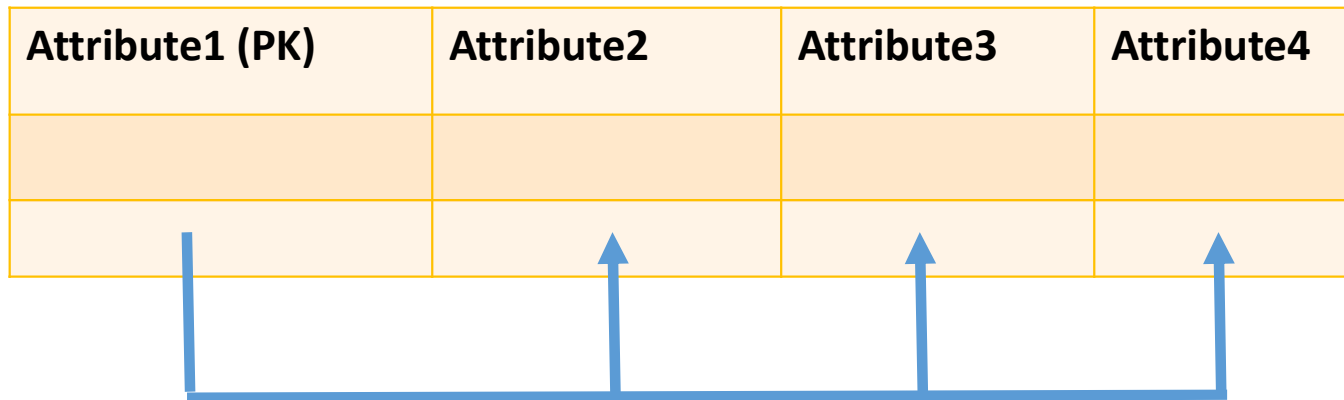
2NF – Normalization Steps

A table is in second normal form (2NF):

- 1. All tables are in first normal form (1NF)**
- 2. All non-key attributes are fully dependent on the primary key - attributes that are not PK's are fully dependant on the assigned primary key**
- 3. Each Table/Relation has a primary key (PK) which uniquely identifies each row/tuple in the relation.**

All non-key attributes are fully dependent on the primary key

1:m relationship – integrity constraint



Attribute1 ---> Attribute2, Attribute3, Attribute4

If we know the value of Attribute1, then when we examine the table we will know the value of Attribute2, Attribute3 and Attribute4.


Convert this relation to 2NF

CustID (PK)	CustName	SalesID	SalesName	Region
8023	Anderson	SM003	Smith	South
9167	Bancroft	HK001	Hicks	West
7924	Hobbs	SM003	Smith	South
6837	Tucker	HD005	Hernandez	East
8596	Eckersley	HK001	Hicks	West
7018	Arnold	FB009	Faulb	North

What is the first step?

Determining if relation is in 1NF


3) Assign a PK



CustID (PK)	CustName	SalesID	SalesName	Region
8023	Anderson	SM003	Smith	South
9167	Bancroft	HK001	Hicks	West
7924	Hobbs	SM003	Smith	South
6837	Tucker	HD005	Hernandez	East
8596	Eckersley	HK001	Hicks	West
7018	Arnold	FB009	Faulb	North



2) Every attribute is uniquely named







1) Every attribute is single valued

What is the next step?

All non-key attributes are fully dependent on the primary key

CustID (PK)	CustName	SalesID	SalesName	Region
8023	Anderson	SM003	Smith	South
9167	Bancroft	HK001	Hicks	West
7924	Hobbs	SM003	Smith	South
6837	Tucker	HD005	Hernandez	East
8596	Eckersley	HK001	Hicks	West
7018	Arnold	FB009	Faulb	North

TRUE or FALSE?

Determinant	Dependant	True or False
CustID	CustName	
CustID	SalesID	
CustID	SalesName	
CustID	Region	

All non-key attributes are fully dependent on the primary key

The relationship/
constraint between
attributes

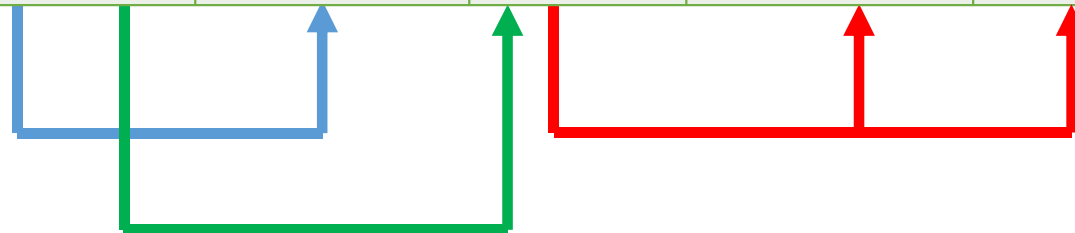
CustID (PK)	CustName	SalesID	SalesName	Region
8023	Anderson	SM003	Smith	South
9167	Bancroft	HK001	Hicks	West
7924	Hobbs	SM003	Smith	South
6837	Tucker	HD005	Hernandez	East
8596	Eckersley	HK001	Hicks	West
7018	Arnold	FB009	Faulb	North

Determinant **Dependants**

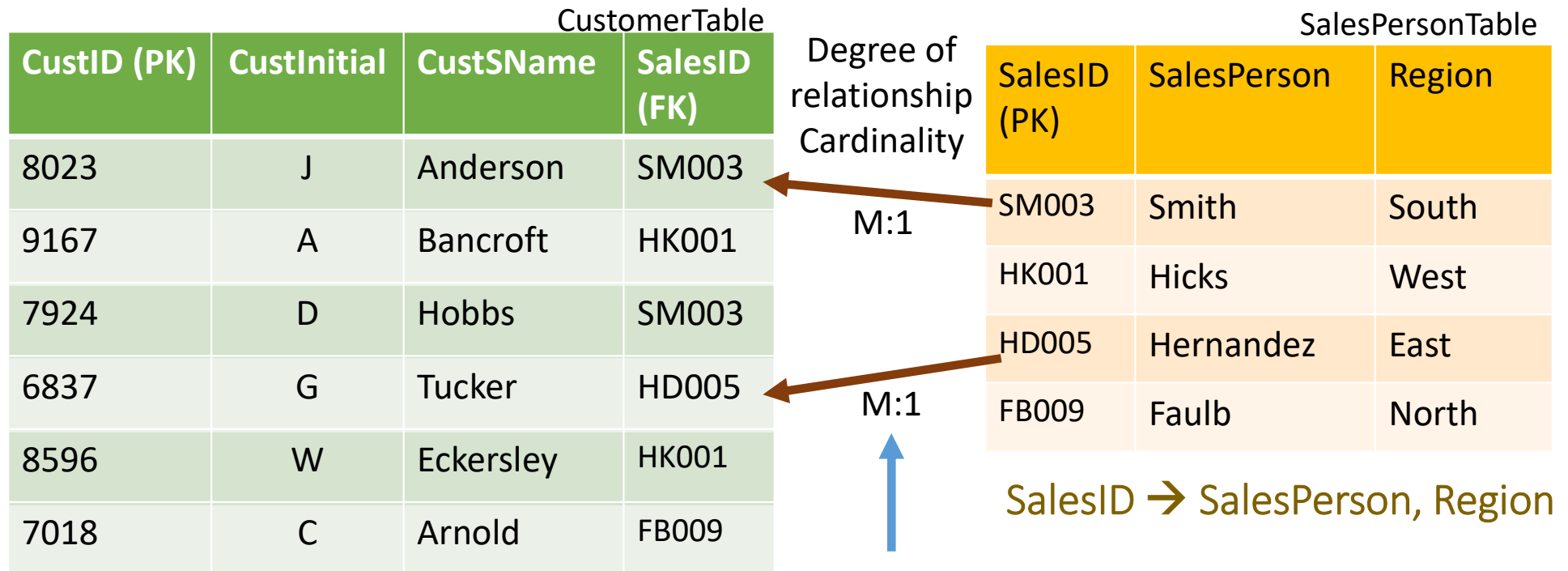
CustID → CustName

SalesID → SalesName, Region

CustID → SalesID



All non-key attributes are fully dependent on the primary key



CustID → CustInitial, CustSName

For every one instance of a sales person in the relation SalesPerson, we can have a number of instances in CustomerTable. This tells us which SalesPerson manages which Customers.

These tables are in 2NF

2NF – Normalization Steps

A table is in second normal form (2NF):

1.The relation is in first normal form (1NF)

2.All non key attributes are fully dependent on the primary key

3.Each relation has a primary key

dCenterNo (PK)	dAddress1	dAddress2	dPostcode
D001	8 Jefferson Way	High Wycombe	HP11 8TY
D002	City Centre	Manchester	MD1 1JU
D003	14 Avenue	Slough	SL6 782
D004	West Gate	Oxford	OX7 2QA

Is this table in 1NF and 2NF?

1NF and 2NF

3) Assign a PK (1NF)



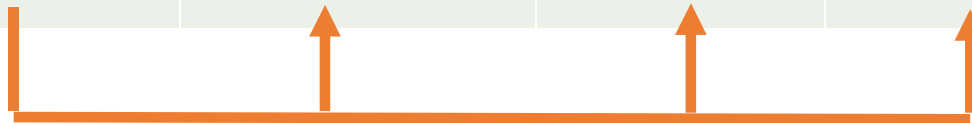
dCenterNo (PK)	dAddress1	dAddress2	dPostcode
D001	8 Jefferson Way	High Wycombe	HP11 8TY
D002	City Centre	Manchester	MD1 1JU
D003	14 Avenue	Slough	SL6 782
D004	West Gate	Oxford	OX7 2QA



2) Every attribute is uniquely named (1NF)

2) All non key attributes are fully dependent on the primary key (2NF)

dCenerNo → dAdres1, dAddress2, dPostcode



1) Every attribute is single valued (1NF)

dTelNo (PK)	dCenterNo (FK)
503 555 3618	D001
503 666 2598	D001
061 852 147	D002
0161 236 111	D002
015 025 951	D003
015 782 456	D003
023 357 753	D004

**Is this table in 1NF
and 2NF?**

There are no non-key attributes so this table is in 1NF

dTelNo (PK)	dCenterNo (FK)
503 555 3618	D001
503 666 2598	D001
061 852 147	D002
0161 236 111	D002
015 025 951	D003
015 782 456	D003
023 357 753	D004

Is this table in 1NF and 2NF?



dTelNo → dCenterNo
dCenterNo → dTelNo

Can you convert this tables to 1NF & 2NF?



StaffNo	FirstName	Surname	Position	Salary	dCenterNo	dAddress	dTelNo
S1500	Tom	Daniels	Manager	48000	D001	8 Jefferson Way, High Wycombe, HP11 8TY	503 555 3618
S0003	Sally	Adams	Assistant	30000	D001	8 Jefferson Way, High Wycombe, HP11 8TY	503 666 2598
S0010	Mary	Martinez	Manager	51000	D002	City Centre, Manchester, MD1 1JU	061 852 147
S3250	Robert	Chin	Assistant	33000	D002	City Centre, Manchester, MD1 1JU	0161 236 111
S0415	Art	Peters	Manager	42000	D003	14 Avenue, Slough, SL6 782	015 025 951
S2250	Sally	Stern	Manager	48000	D004	West Gate, Oxford, OX7 2QA	023 357 753

1NF



StaffNo (PK)	FirstName	Surname	Position	Salary	dCenterNo	dAddressLine1	dTown	dPostcode	dTelNo
S1500	Tom	Daniels	Manager	48000	D001	8 Jefferson Way	High Wycombe	HP11 8TY	503 555 3618
S0003	Sally	Adams	Assistant	30000	D001	8 Jefferson Way	High Wycombe	HP11 8TY	503 666 2598
S0010	Mary	Martinez	Manager	51000	D002	City Centre	Manchester	MD1 1JU	061 852 147
S3250	Robert	Chin	Assistant	33000	D002	City Centre	Manchester	MD1 1JU	0161 236 111
S0415	Art	Peters	Manager	42000	D003	14 Avenue	Slough	SL6 782	015 025 951
S2250	Sally	Stern	Manager	48000	D004	West Gate	Oxford	OX7 2QA	023 357 753

2NF – Normalization Steps

A table is in second normal form (2NF):

1.The relation is in first normal form (1NF)

2.All non key attributes are fully dependent on the primary key

3.Each relation has a primary key

StaffNo (PK)	FirstName	Surname	Position	Salary	dCentreNo	dAddressLine1	dTown	dPostcode	dTelNo
S1500	Tom	Daniels	Manager	48000	D001	8 Jefferson Way	High Wycombe	HP11 8TY	503 555 3618

Determinant	Dependant	True or False
StaffNo	FirstName	<input checked="" type="checkbox"/>
StaffNo	Surname	<input checked="" type="checkbox"/>
StaffNo	Position	<input checked="" type="checkbox"/>
StaffNo	Salary	<input checked="" type="checkbox"/>
StaffNo	dCentreNo	<input type="checkbox"/>
StaffNo	dAddressLine1	<input type="checkbox"/>
StaffNo	dTown	<input type="checkbox"/>
StaffNo	dPostcode	<input type="checkbox"/>
StaffNo	dTelNo	<input type="checkbox"/>

TRUE or **FALSE?**

Everything about manager

StaffNo (PK)	FirstName	Surname	Position	Salary	dCentreNo	dAddressLine1	Town	Postcode	dTelNo
S1500	Tom	Daniels	Manager	48000	D001	8 Jefferson Way	High Wycombe	HP11 8TY	503 555 3618
S0003	Sally	Adams	Assistant	30000	D001	8 Jefferson Way	High Wycombe	HP11 8TY	503 666 2598
S0010	Mary	Martinez	Manager	51000	D002	City Centre	Manchester	MD1 1JU	061 852 147
S3250	Robert	Chin	Assistant	33000	D002	City Centre	Manchester	MD1 1JU	0161 236 111
S0415	Art	Peters	Manager	42000	D003	14 Avenue	Slough	SL6 782	015 025 951
S2250	Sally	Stern	Manager	48000	D004	West Gate	Oxford	OX7 2QA	023 357 753

Everything about the data centres

StaffNo (PK)	FirstName	Surname	Position	Salary	dCentreNo (FK)
S1500	Tom	Daniels	Manager	48000	D001
S0003	Sally	Adams	Assistant	30000	D001
S0010	Mary	Martinez	Manager	51000	D002
S3250	Robert	Chin	Assistant	33000	D002
S0415	Art	Peters	Manager	42000	D003
S2250	Sally	Stern	Manager	48000	D004

Degree of relationship
Cardinality M:1

For every one instance of a dCentre in the relation, we can have a number of instances in Staff relation. This tells us which staff member works in which dCentre.

Everything about manager with a link to the data centre they work in

Everything about the data centres

dCentreNo (PK)	dAddressLine1	Town	Postcode	dTelNo
D001	8 Jefferson Way	High Wycombe	HP11 8TY	503 555 3618
D002	City Centre	Manchester	MD1 1JU	061 852 147
D003	14 Avenue	Slough	SL6 782	015 025 951
D004	West Gate	Oxford	OX7 2QA	023 357 753

Tables in UNF, 1NF & 2NF

UNF	1NF	2NF
StaffNo FirstName Surname Postion dCentreNo dAddressLine dTennNo	StaffNo (PK) FirstName Surname Postion dCentreNo dAddressLine1 Town Postcode dTennNo	StaffNo (PK) FirstName Surname Postion dCentreNo (FK) dCentreNo (PK) dAddressLine1 Town Postcode dTennNo

Convert this table into 1NF & 2NF?



Project Code	ProjectTitle	Project Manager	Project Budget	EmployeeNo.	EmployeeName	DepartmentNo.	Department Name	HourlyRate
PC010	Pensions System	M Phillips	24500	S10001	A Smith	L004	IT	£22.00
PC010	Pensions System	M Phillips	24500	S10030	L Jones	L023	Pensions	£18.50
PC010	Pensions System	M Phillips	24500	S21010	P Lewis	L004	IT	£21.00
PC045	Salaries System	H Martin	17400	S10010	B Jones	L004	IT	£21.75
PC045	Salaries System	H Martin	17400	S10001	A Smith	L004	IT	£18.00
PC045	Salaries System	H Martin	17400	S31002	T Gilbert	L028	Database	£25.50
PC045	Salaries System	H Martin	17400	S13210	W Richards	L008	Salary	£17.00
PC064	HR System	K Lewis	12250	S31002	T Gilbert	L028	Database	£23.25
PC064	HR System	K Lewis	12250	S21010	P Lewis	L004	IT	£17.50
PC064	HR System	K Lewis	12250	S10034	B James	L009	HR	£16.50
PC010	Pensions System	M Phillips	24500	S10001	A Smith	L004	IT	£22.00
PC010	Pensions System	M Phillips	24500	S10030	L Jones	L023	Pensions	£18.50
PC010	Pensions System	M Phillips	24500	S21010	P Lewis	L004	IT	£21.00
PC045	Salaries System	H Martin	17400	S10010	B Jones	L004	IT	£21.75
PC045	Salaries System	H Martin	17400	S10001	A Smith	L004	IT	£18.00
PC045	Salaries System	H Martin	17400	S31002	T Gilbert	L028	Database	£25.50
PC045	Salaries System	H Martin	17400	S13210	W Richards	L008	Salary	£17.00
PC064	HR System	K Lewis	12250	S31002	T Gilbert	L028	Database	£23.25
PC064	HR System	K Lewis	12250	S21010	P Lewis	L004	IT	£17.50
PC064	HR System	K Lewis	12250	S10034	B James	L009	HR	£16.50

Everything about the project

1NF: Functional dependency

Project Code	ProjectTitle	Project Manager	Project Budget	EmployeeNo	EmployeeName	DepartmentNo	Department Name	HourlyRate
PC010	Pensions System	M Phillips	24500	S10001	A Smith	L004	IT	£22.00
PC010	Pensions System	M Phillips	24500	S10030	L Jones	L023	Pensions	£18.50
PC010	Pensions System	M Phillips	24500	S21010	P Lewis	L004	IT	£21.00
PC045	Salaries System	H Martin	17400	S10010	B Jones	L004	IT	£21.75
PC045	Salaries System	H Martin	17400	S10001	A Smith	L004	IT	£18.00
PC045	Salaries System	H Martin	17400	S31002	T Gilbert	L028	Database	£25.50
PC045	Salaries System	H Martin	17400	S13210	W Richards	L008	Salary	£17.00
PC064	HR System	K Lewis	12250	S31002	T Gilbert	L028	Database	£23.25
PC064	HR System	K Lewis	12250	S21010	P Lewis	L004	IT	£17.50
PC064	HR System	K Lewis	12250	S10034	B James	L009	HR	£16.50
PC010	Pensions System	M Phillips	24500	S10001	A Smith	L004	IT	£22.00
PC010	Pensions System	M Phillips	24500	S10030	L Jones	L023	Pensions	£18.50
PC010	Pensions System	M Phillips	24500	S21010	P Lewis	L004	IT	£21.00
PC045	Salaries System	H Martin	17400	S10010	B Jones	L004	IT	£21.75
PC045	Salaries System	H Martin	17400	S10001	A Smith	L004	IT	£18.00
PC045	Salaries System	H Martin	17400	S31002	T Gilbert	L028	Database	£25.50
PC045	Salaries System	H Martin	17400	S13210	W Richards	L008	Salary	£17.00
PC064	HR System	K Lewis	12250	S31002	T Gilbert	L028	Database	£23.25
PC064	HR System	K Lewis	12250	S21010	P Lewis	L004	IT	£17.50
PC064	HR System	K Lewis	12250	S10034	B James	L009	HR	£16.50

Everything about the employee working on the project


Tables in 1NF

UNF	1NF
ProjectCode	ProjectCode (PK)
ProjectTitle	ProjectTitle
ProjectManager	ProjectManagerInitial
ProjectBudget	ProjectManagerSName
EmployeeNo	ProjectBudget
EmployeeName	EmployeeNo (PK)
DepartmentNo	ProjectCode (FK)
DepartmentName	EmployeeInitial
HourlyRate	EmployeeSName
	DepartmentNo
	DepartmentName
	HourlyRate

Project Code (PK)	ProjectTitle	Project Manager Initial	Project Manager SName	Project Budget
PC010	Pensions System	M	Phillips	24500
PC045	Salaries System	H	Martin	17400
PC064	HR System	K	Lewis	12250

EmployeeNo (PK)	ProjectCode (FK)	EmployeeInitial	EmployeeSName	DepartmentNo.	DepartmentName	HourlyRate
S10001	PC010	A	Smith	L004	IT	£22.00
S10001	PC045	A	Smith	L004	IT	£18.00
S10034	PC064	B	James	L009	HR	£16.50
S10010	PC045	B	Jones	L004	IT	£21.75
S10030	PC010	L	Jones	L023	Pensions	£18.50
S21010	PC010	P	Lewis	L004	IT	£21.00
S21010	PC064	P	Lewis	L004	IT	£17.50
S31002	PC045	T	Gilbert	L028	Database	£25.50
S31002	PC064	T	Gilbert	L028	Database	£23.25
S13210	PC045	W	Richards	L008	Salary	£17.00

2NF: Functional dependency between primary key and non-key attributes



Project Code (PK)	ProjectTitle	Project Manager	Project Budget
PC010	Pensions System	M Phillips	24500
PC045	Salaries System	H Martin	17400
PC064	HR System	K Lewis	12250

2NF

ProjectTable

ProjectCodeNo (PK)

ProjectTitle

ProjectManager


ProjectBudget

This table is already in 2NF


2NF: Functional dependency between primary key and non-key attributes

Everything about the rate of pay for an employee and the respective project

Remember you are comparing all non key attributes are fully dependent on the primary key



EmployeeNo (PK)	ProjectCode (FK)	EmployeeInitial	EmployeeSName	DepartmentNo.	DepartmentName	HourlyRate
S10001	PC010	A	Smith	L004	IT	£22.00
S10001	PC045	A	Smith	L004	IT	£18.00
S10034	PC064	B	James	L009	HR	£16.50
S10010	PC045	B	Jones	L004	IT	£21.75
S10030	PC010	L	Jones	L023	Pensions	£18.50
S21010	PC010	P	Lewis	L004	IT	£21.00
S21010	PC064	P	Lewis	L004	IT	£17.50
S31002	PC045	T	Gilbert	L028	Database	£25.50
S31002	PC064	T	Gilbert	L028	Database	£23.25
S13210	PC045	W	Richards	L008	Salary	£17.00



Everything about the employee and the department they work for

EmployeeNo (PK)	EmployeeInitial	EmployeeSName	DepartmentNo	DepartmentName
S10001	A	Smith	L004	IT
S10034	B	James	L009	HR
S10010	B	Jones	L004	IT
S10030	L	Jones	L023	Pensions
S21010	P	Lewis	L004	IT
S31002	T	Gilbert	L028	Database
S13210	W	Richards	L008	Salary

Relations are in 2NF

2NF

StaffTable

EmployeeNo (PK)
 EmployeeInitial
 EmployeeSName
 DepartmentNo
 DepartmentName

ProjectTable

ProjectCode (FK)
 EmployeeNo (FK)
 HourlyRate

EmployeeNo (FK)	ProjectCode (FK)	HourlyRate
S10001	PC010	£22.00
S10030	PC010	£18.50
S21010	PC010	£21.00
S10001	PC045	£18.00
S10010	PC045	£21.75
S31002	PC045	£25.50
S13210	PC045	£17.00
S10034	PC064	£16.50
S21010	PC064	£17.50
S31002	PC064	£23.25

Relations are in 2NF

Project Code (PK)	ProjectTitle	Project Manager Initial	Project Manager Name	Project Budget
PC010	Pensions System	M	Phillips	24500
PC045	Salaries System	H	Martin	17400
PC064	HR System	K	Lewis	12250

EmployeeNo (PK)	Employee Initial	Employee SName	DepartmentNo	DepartmentName
S10001	A	Smith	L004	IT
S10034	B	James	L009	HR
S10010	B	Jones	L004	IT
S10030	L	Jones	L023	Pensions
S21010	P	Lewis	L004	IT
S31002	T	Gilbert	L028	Database
S13210	W	Richards	L008	Salary

EmployeeNo (FK)	ProjectCode (FK)	HourlyRate
S10001	PC010	£22.00
S10030	PC010	£18.50
S21010	PC010	£21.00
S10001	PC045	£18.00
S10010	PC045	£21.75
S31002	PC045	£25.50
S13210	PC045	£17.00
S10034	PC064	£16.50
S21010	PC064	£17.50
S31002	PC064	£23.25

UNF	1NF	2NF
ProjectCode ProjectTitle ProjectManager ProjectBudget EmployeeNo EmployeeName DepartmentNo DepartmentName HourlyRate	ProjectCode (PK) ProjectTitle ProjectManagerInitial ProjectManagerSName ProjectBudget EmployeeNo (PK) ProjectCode (FK) EmployeeInitial EmployeeSName DepartmentNo DepartmentName HourlyRate	ProjectCode (PK) ProjectTitle ProjectManagerInitial ProjectManagerSName ProjectBudget EmployeeNo (PK) EmployeeInitial EmployeeSName DepartmentNo DepartmentName EmployeeNo (FK) ProjectCode (FK) HourlyRate

Relations in UNF, 1NF, & 2NF

Can you convert this table into 1NF & 2NF?



Order No	Order Date	CustomerID	CustomerName	CustomerAddress	Postcode	Pizza Code	PizzaName	Quantity	Price	TotalPrice
1250	123456	AA48	Tom Smith	45 New Street High Wycombe	HP12 3UY	P	Pepperoni	1	£5.55	£29.10
						MF	Meat Feast	1	£8.55	
						V	Vegetarian	3	£5.00	
1251	789101	AA49	Aysha Ali	88 High Street High Wycombe	HP11 4OP	CM	ChickMush	2	£5.55	£33.10
						V	Vegetarian	4	£5.00	
						M	Margarita	1	£2.00	

1NF : There are no repeating attributes – every attribute is single valued

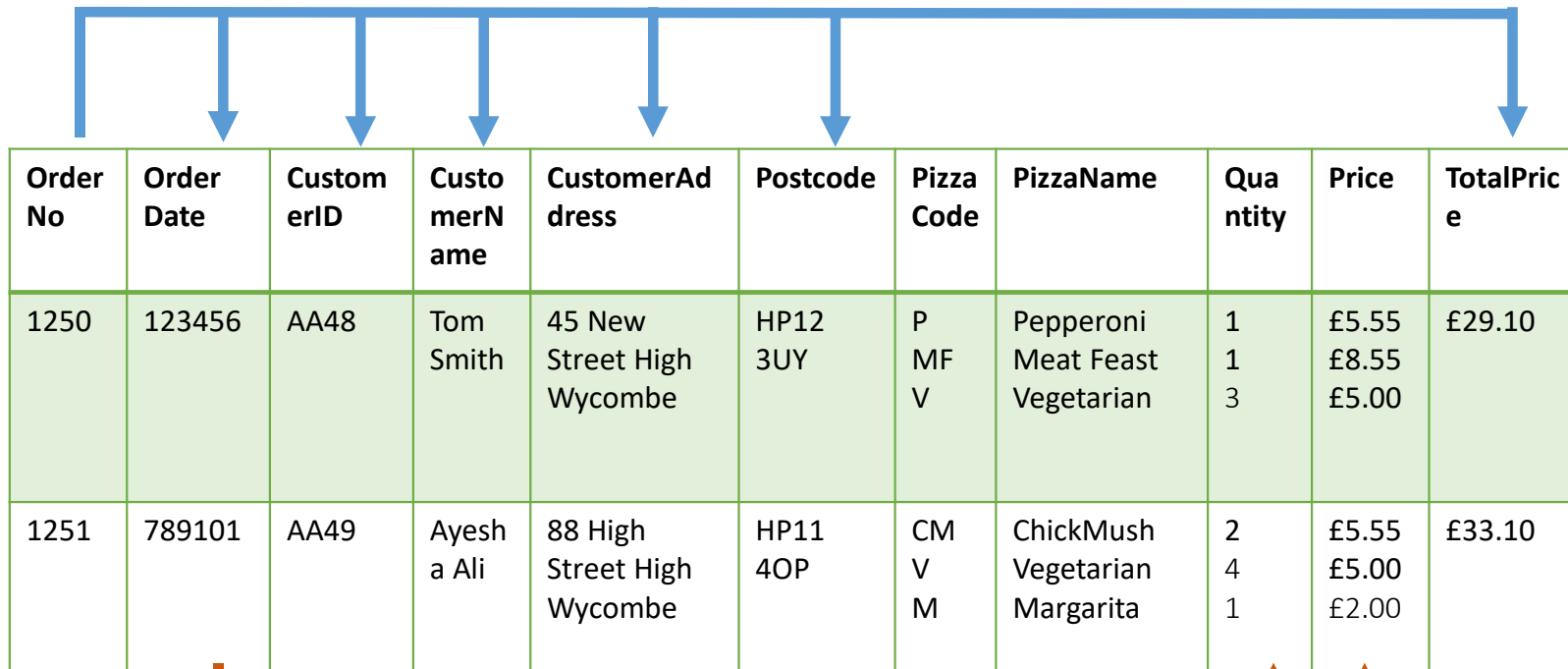
Order No	Order Date	CustomerID	CustomerName	CustomerAddress	Postcode	Pizza Code	PizzaName	Quantity	Price	TotalPrice
1250	123456	AA48	Tom Smith	45 New Street High Wycombe	HP12 3UY	P	Pepperoni	1	£5.55	£29.10
						MF	Meat Feast	1	£8.55	
						V	Vegetarian	3	£5.00	
1251	789101	AA49	Ayesh a Ali	88 High Street High Wycombe	HP11 4OP	CM	ChickMush	2	£5.55	£33.10
						V	Vegetarian	4	£5.00	
						M	Margarita	1	£2.00	

Order No	Order Date	CustomerID	CustomerF Name	CustomerS Name	CustomerAddressLine 1	CustomerTown	Postcode	Pizza Code	PizzaName	Quantity	Price	TotalPrice
1250	123456	AA48	Tom	Smith	45 New Street	High Wycombe	HP12 3UY	P	Pepperoni	1	£5.55	£29.10
1250	123456	AA48	Tom	Smith	45 New Street	High Wycombe	HP12 3UY	MF	Meat Feast	1	£8.55	£29.10
1250	123456	AA48	Tom	Smith	45 New Street	High Wycombe	HP12 3UY	V	Vegetarian	3	£5.00	£29.10
1251	789101	AA49	Ayesh a	Ali	88 High Street	High Wycombe	HP11 4OP	CM	ChickMush	2	£5.55	£33.10
1251	789101	AA49	Ayesh a	Ali	88 High Street	High Wycombe	HP11 4OP	V	Vegetarian	4	£5.00	£33.10
1251	789101	AA49	Ayesh a	Ali	88 High Street	High Wycombe	HP11 4OP	M	Margarita	1	£2.00	£33.10

Attributes is single valued

1NF: Assigning PK

Everything to do with the customer order – to deliver the pizza



Order No	Order Date	CustomerID	CustomerName	CustomerAddress	Postcode	Pizza Code	PizzaName	Quantity	Price	TotalPrice
1250	123456	AA48	Tom Smith	45 New Street High Wycombe	HP12 3UY	P	Pepperoni	1	£5.55	£29.10
						MF	Meat Feast	1	£8.55	
						V	Vegetarian	3	£5.00	
1251	789101	AA49	Aysha Ali	88 High Street High Wycombe	HP11 4OP	CM	ChickMush	2	£5.55	£33.10
						V	Vegetarian	4	£5.00	
						M	Margarita	1	£2.00	

Everything to do with pizza menu – to make the pizza

Relations in 1NF

Order No (PK)	Order Date	CustomerID	CustomerFName	CustomerS FName	CustomerAddress1	Town	Postcode	TotalPrice
1250	123456	AA48	Tom	Smith	45 New Street	High Wycombe	HP12 3UY	£29.10
1251	789101	AA49	Ayesha	Ali	88 High Street	High Wycombe	HP11 4OP	£33.10


Order No (FK)	Pizza Code (PK)	PizzaName	Quantity	Price
1250	P	Pepperoni	1	£5.55
1250	MF	Meat Feast	1	£8.55
1250	V	Vegetarian	3	£5.00
1251	CM	ChickenMushroom	2	£5.55
1251	V	Vegetarian	4	£5.00
1251	M	Margarita	1	£2.00

1NF

UNF	1NF
OrderNo	OrderNo (PK)
OrderDate	OrderDate
CustomerID	CustomerID
CustomerName	CustomerFName
CustomerAddress	CustomerSName
Postcode	CustomerAddressLine1
TotalPrice	CustomerTown
PizzaCode	Postcode
PizzaName	TotalPrice
Quantity	
Price	OrderNo (FK)
	PizzaCode (PK)
	PizzaType
	Quantity
	Price

2NF: All non key attributes are fully dependent on the primary key

Order No (PK)	Order Date	CustomerID	CustomerFName	CustomerS FName	CustomerAddress1	Town	Postcode	TotalPrice
1250	123456	AA48	Tom	Smith	45 New Street	High Wycombe	HP12 3UY	£29.10
1251	789101	AA49	Ayesha	Ali	88 High Street	High Wycombe	HP11 4OP	£33.10



This relation is in 2NF

We need the CustomerNo to know where to deliver the pizza and the total amount of the order

2NF: All non key attributes are fully dependent on the primary key

For the PizzaCode we can identify the PizzaName and the price – the stock levels of pizza

Order No (FK)	Pizza Code (PK)	PizzaType	Quantity	Price
1250	P	Pepperoni	1	£5.55
1250	MF	Meat Feast	1	£8.55
1250	V	Vegetarian	3	£5.00
1251	CM	ChickenMushroom	2	£5.55
1251	V	Vegetarian	4	£5.00
1251	M	Margarita	1	£2.00

For the OrderNo you identify the Pizza name, quantity of the order – how many of each type of pizza to make for the respective order

Relations in 2NF

Order No (FK)	Pizza Code (FK)	Quantity
1250	P	1
1250	MF	1
1250	V	3
1251	CM	2
1251	V	4
1251	M	1

Pizza Code (PK)	Pizza Name	Price
P	Pepperoni	£5.55
MF	Meat Feast	£8.55
V	Vegetarian	£5.00
CM	ChickenMushroom	£5.55
M	Margarita	£2.00

1NF	2NF
OrderNo (FK) PizzaCode (PK) PizzaName Quantity Price	OrderNo (FK) PizzaCode (FK) Quantity PizzaCode (PK) PizzaName Price

Relations in 2NF

Order No (PK)	Order Date	CustomerID	CustomerFName	CustomerSName	CustomerAddress1	Town	Postcode	TotalPrice
1250	123456	AA48	Tom	Smith	45 New Street	High Wycombe	HP12 3UY	£29.10
1251	789101	AA49	Ayesha	Ali	88 High Street	High Wycombe	HP11 4OP	£33.10

Order No (FK)	Pizza Code (FK)	Quantity
1250	P	1
1250	MF	1
1250	V	3
1251	CM	2
1251	V	4
1251	M	1

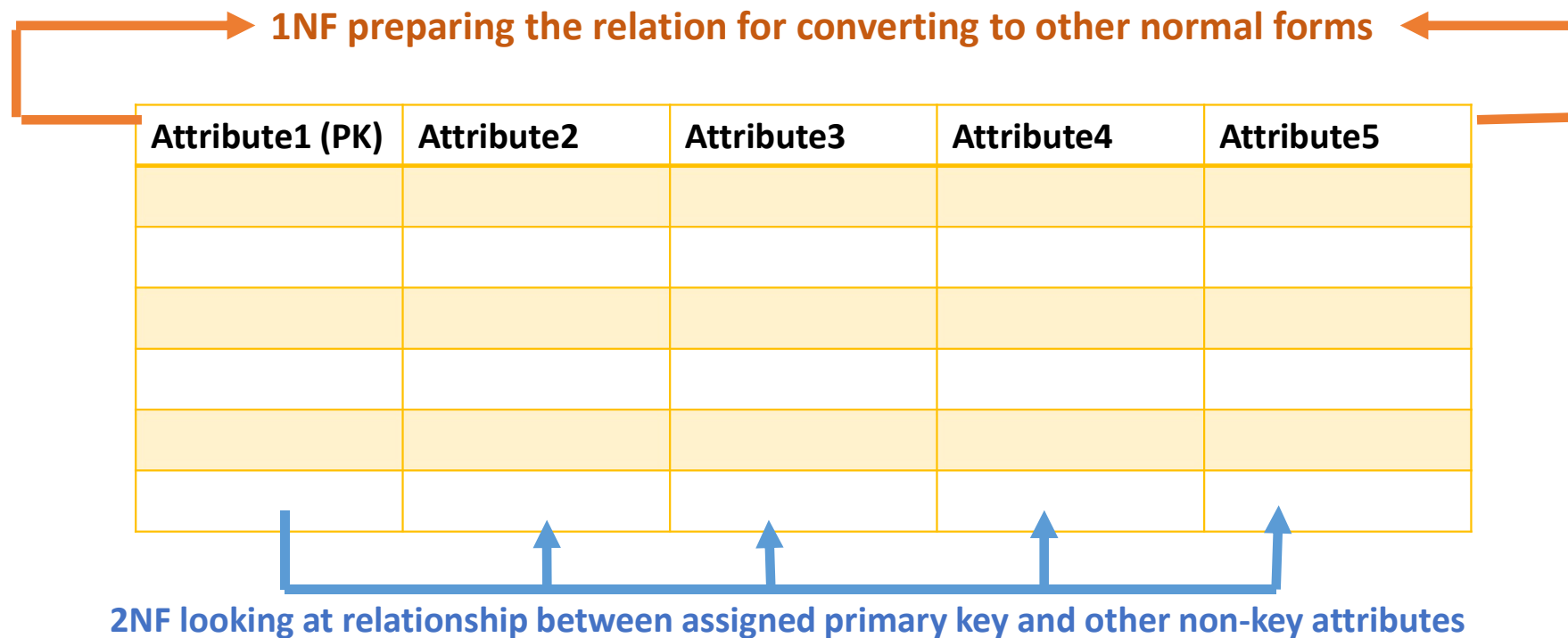
Pizza Code (PK)	Pizza Name	Price
P	Pepperoni	£5.55
MF	Meat Feast	£8.55
V	Vegetarian	£5.00
CM	ChickenMushroom	£5.55
M	Margarita	£2.00

Relations in UNF, 1NF & 2NF

UNF	1NF	2NF
OrderNo	OrderNo (PK)	OrderNo (PK)
OrderDate	OrderDate	OrderDate
CustomerID	CustomerID	CustomerID
CustomerName	CustomerName	CustomerName
CustomerAddress	CustomerAddress1	CustomerAddress1
Postcode	Town	Town
TotalPrice	Postcode	Postcode
PizzaCode	TotalPrice	TotalPrice
PizzaName		OrderNo (FK)
Quantity	OrderNo (FK)	PizzaCode (FK)
Price	PizzaCode (PK)	Quantity
	PizzaName	
	Quantity	PizzaCode (PK)
	Price	PizzaName
		Price

**Are you confident converting a table to
UNF, 1NF & 2NF?**

Summary of 1NF & 2NF



Which attribute relationships are we comparing for 3NF?

3NF – Normalization Steps

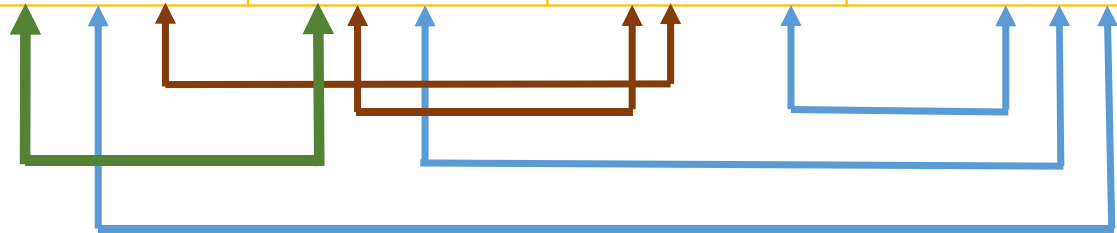
A table is in third normal form (3NF):

1. The relation is in second normal form (2NF)
2. If all associations where All non-key attributes are not dependent on any other non-key attributes are resolved
3. Each relation has a primary key
4. All relations are uniquely named

1. Resolving all associations where All non-key attributes are not dependent on any other non-key attributes

Attribute1 (PK)	Attribute2	Attribute3	Attribute4	Attribute5

There should be no dependency between the non-key attributes



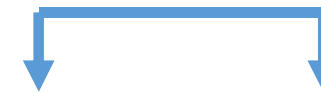
Are there any associations where All non key attributes are not dependent on any other non-key attributes are resolved?



Looking at non-key attributes and determining if any dependency exists

CustID (PK)	CustInitial	CustSName	SalesID (FK)
8023	J	Anderson	SM003
9167	A	Bancroft	HK001
7924	D	Hobbs	SM003
6837	G	Tucker	HD005
8596	W	Eckersley	HK001
7018	C	Arnold	FB009

Does a dependency exist between Custinitial and CustName?



SalesID (PK)	SalesPerson	Region
SM003	Smith	South
HK001	Hicks	West
HD005	Hernandez	East
FB009	Faulb	North

Does a dependency exist between SalesPerson and Region?

These relations are in 3NF

There is no dependency between the non-key attributes

CustID (PK)	CustInitial	CustSName	SalesID (FK)
8023	J	Anderson	SM003
9167	A	Bancroft	HK001
7924	D	Hobbs	SM003
6837	G	Tucker	HD005
8596	W	Eckersley	HK001
7018	C	Arnold	FB009

SalesID (PK)	SalesPerson	Region
SM003	Smith	South
HK001	Hicks	West
HD005	Hernandez	East
FB009	Faulb	North

EmployeeNo (PK)	EmployeeInitial	EmployeeSName	DepartmentNo	DepartmentName
S10001	A	Smith	L004	IT
S10034	B	James	L009	HR
S10010	B	Jones	L004	IT
S10030	L	Jones	L023	Pensions
S21010	P	Lewis	L004	IT
S31002	T	Gilbert	L028	Database
S13210	W	Richards	L008	Salary

Convert these relations in to 3NF

EmployeeNo (FK)	ProjectCode (FK)	HourlyRate
S10001	PC010	£22.00
S10030	PC010	£18.50
S21010	PC010	£21.00
S10001	PC045	£18.00
S10010	PC045	£21.75
S31002	PC045	£25.50
S13210	PC045	£17.00
S10034	PC064	£16.50
S21010	PC064	£17.50
S31002	PC064	£23.25

Project Code (PK)	ProjectTitle	Project Manager Initial	Project ManagerSName	Project Budget
PC010	Pensions System	M	Phillips	24500
PC045	Salaries System	H	Martin	17400
PC064	HR System	K	Lewis	12250

TRUE or FALSE?

Determinant	Dependant	True or False
ProjectTitle	ProjectManagerInitial	✗
ProjectTitle	ProjectManagerSName	✗
ProjectTitle	ProjectBudget	✗
ProjectManagerInitial	ProjectManagerSName	✗
ProjectManagerInitial	ProjectBudget	✗
ProjectManagerSName	ProjectBudget	✗

Project Code (PK)	ProjectTitle	Project Manager Initial	Project ManagerSName	Project Budget
PC010	Pensions System	M	Phillips	24500
PC045	Salaries System	H	Martin	17400
PC064	HR System	K	Lewis	12250

This relation is in 3NF

Project Code (PK)	ProjectTitle	PMInitials	PMSName	Project Budget
PC010	Pensions System	M	Phillips	24500
PC045	Salaries System	H	Martin	17400
PC064	HR System	K	Lewis	12250

Convert these relations in to 3NF

EmployeeNo (PK)	EmployeeName	DepartmentNo	DepartmentName
S10001	A Smith	L004	IT
S10034	B James	L009	HR
S10010	B Jones	L004	IT
S10030	L Jones	L023	Pensions
S21010	P Lewis	L004	IT
S31002	T Gilbert	L028	Database
S13210	W Richards	L008	Salary

This relation is already in 3NF

Projects

Project Code (PK)	ProjectTitle	PMInitials	PMSName	Project Budget
PC010	Pensions System	M	Phillips	24500
PC045	Salaries System	H	Martin	17400
PC064	HR System	K	Lewis	12250

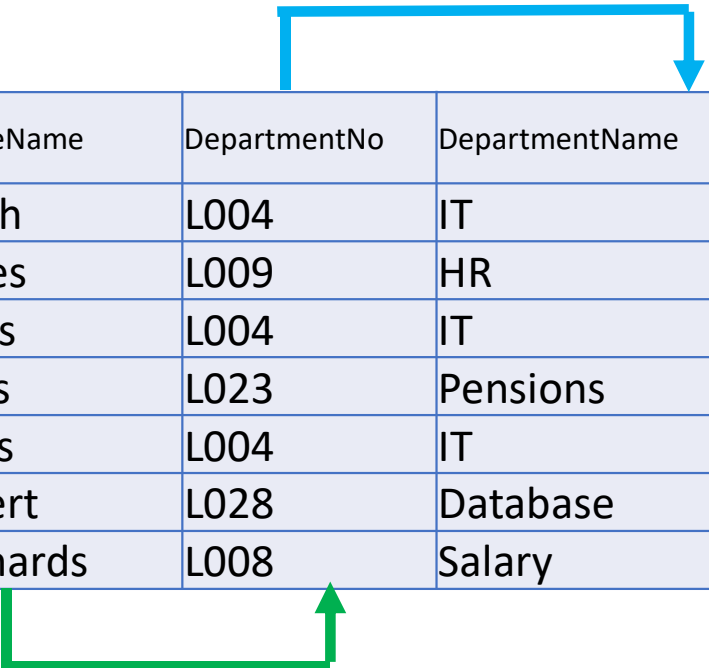
Last step name the table

Determining any functional dependency between non-PK attributes?

EmployeeNo (PK)	EmployeeName	DepartmentNo	DepartmentName
S10001	A Smith	L004	IT
S10034	B James	L009	HR
S10010	B Jones	L004	IT
S10030	L Jones	L023	Pensions
S21010	P Lewis	L004	IT
S31002	T Gilbert	L028	Database
S13210	W Richards	L008	Salary

Functional dependency between non-key attributes

EmployeeNo (PK)	EmployeeName	DepartmentNo	DepartmentName
S10001	A Smith	L004	IT
S10034	B James	L009	HR
S10010	B Jones	L004	IT
S10030	L Jones	L023	Pensions
S21010	P Lewis	L004	IT
S31002	T Gilbert	L028	Database
S13210	W Richards	L008	Salary



Relation is in 3NF

EmployeeNo (PK)	EmployeeName	DepartmentNo	DepartmentName
S10001	A Smith	L004	IT
S10034	B James	L009	HR
S10010	B Jones	L004	IT
S10030	L Jones	L023	Pensions
S21010	P Lewis	L004	IT
S31002	T Gilbert	L028	Database
S13210	W Richards	L008	Salary

EmployeeNo (PK)	EmployeeName	DepartmentNo (FK)
S10001	A Smith	L004
S10034	B James	L009
S10010	B Jones	L004
S10030	L Jones	L023
S21010	P Lewis	L004
S31002	T Gilbert	L028
S13210	W Richards	L008

DepartmentNo (PK)	DepartmentName
L004	IT
L009	HR
L023	Pensions
L028	Database
L008	Salary

3NF

StaffTable

EmployeeNo (PK)

EmployeeName

DepartmentNo (FK)

DepartmentTable

DepartmentNo (PK)

DepartmentName

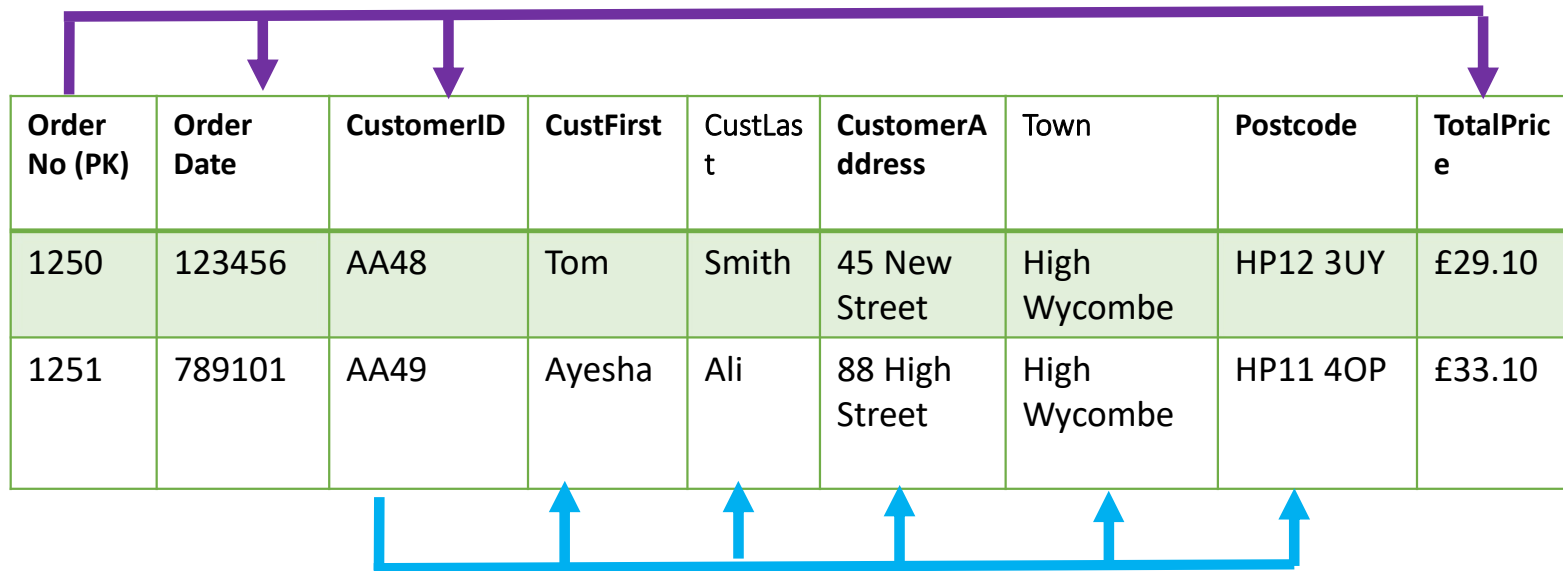
Convert to 3NF

Order No (PK)	Order Date	CustomerID	CustomerFName	CustomerSName	CustomerAddress1	Town	Postcode	TotalPrice
1250	123456	AA48	Tom	Smith	45 New Street	High Wycombe	HP12 3UY	£29.10
1251	789101	AA49	Ayesha	Ali	88 High Street	High Wycombe	HP11 4OP	£33.10

Order No (FK)	Pizza Code (FK)	Quantity
1250	P	1
1250	MF	1
1250	V	3
1251	CM	2
1251	V	4
1251	M	1

Pizza Code (PK)	Pizza Name	Price
P	Pepperoni	£5.55
MF	Meat Feast	£8.55
V	Vegetarian	£5.00
CM	ChickenMushroom	£5.55
M	Margarita	£2.00

Determining Functional dependency between non-PK attributes



Order No (PK)	Order Date	CustomerID	CustFirst	CustLast	CustomerAddress	Town	Postcode	TotalPrice
1250	123456	AA48	Tom	Smith	45 New Street	High Wycombe	HP12 3UY	£29.10
1251	789101	AA49	Ayesha	Ali	88 High Street	High Wycombe	HP11 4OP	£33.10

Relations are now in 3NF

Order No (PK)	Order Date	CustomerID (FK)	TotalPrice
1250	123456	AA48	£29.10
1251	789101	AA49	£33.10

CustomerID (PK)	CustFirst	CustLast	CustomerAddress	Town	Postcode
AA48	Tom	Smith	45 New Street	High Wycombe	HP12 3UY
AA49	Ayesha	Ali	88 High Street	High Wycombe	HP11 4OP

2NF	3NF
OrderNo (PK) OrderDate CustomerID CustomerName CustAddress1 Town Postcode TotalPrice	OrderTable OrderNo (PK) OrderDate CustomerID (FK) TotalPrice CustomerTable CustomerID (PK) CustomerName CustAddress1 Town Postcode

Orders

Order No (PK)	Order Date	CustomerID (FK)	TotalPrice
1250	123456	AA48	£29.10
1251	789101	AA49	£33.10

Pizzas

Pizza Code (PK)	Pizza Name	Price
P	Pepperoni	£5.55
MF	Meat Feast	£8.55
V	Vegetarian	£5.00
CM	ChickenMushroom	£5.55
M	Margarita	£2.00

OrderQty

Order No (FK)	Pizza Code (FK)	Quantity
1250	P	1
1250	MF	1
1250	V	3
1251	CM	2
1251	V	4
1251	M	1

3NF

Customers

CustomerID (PK)	CustFirst	CustLast	CustomerAddress	Town	Postcode
AA48	Tom	Smith	45 New Street	High Wycombe	HP12 3UY
AA49	Ayesha	Ali	88 High Street	High Wycombe	HP11 4OP

UNF, 1NF, 2NF & 3NF

UNF	1NF	2NF	3NF
OrderNo OrderDate CustomerID CustomerName CustomerAddress Postcode TotalPrice PizzaCode PizzaName Quantity Price	OrderNo (PK) OrderDate CustomerID CustomerName CustomerAddress1 Town Postcode TotalPrice OrderNo (FK) PizzaCode (PK) PizzaName Quantity Price	OrderNo (PK) OrderDate CustomerID CustomerName CustAddress1 Town Postcode TotalPrice OrderNo (FK) PizzaCode (PK) Quantity PizzaCode (PK) PizzaName Price	Orders OrderNo (PK) OrderDate CustomerID (FK) TotalPrice Customers CustomerID (PK) CustomerName CustAddress1 Town Postcode OrderQty OrderNo (FK) PizzaCode (PK) Quantity Pizzas PizzaCode (PK) PizzaName Price

Convert this data to 3NF



CustomerName	CustID	Address	SubType	SubAmount	MovieDownloads	DownloadDate
Tom Smith	WS951	5 High Street Aylesbury HP20 4YB	1 Month	£5.00	AV – Avengers Age of Ultron (Sci-Fi)	12/12/2014
Tom Smith	WS951	5 High Street Aylesbury HP20 4YB	1 Month	£5.00	JW – Jurassic World (Sci-Fi)	14/12/2014
Tom Smith	WS951	5 High Street Aylesbury HP20 4YB	1 Month	£5.00	TR – Train (Comedy)	16/12/2014
Tom Smith	WS951	5 High Street Aylesbury HP20 4YB	1 Month	£5.00	IO – Inside Out (Animated)	20/12/2014
Rebecca Zane	AK123	77 Green Street High Wycombe HP14JQ	12 months	£50.00	TG – Terminator Genisys (Sci-Fi)	23/05/2012
Rebecca Zane	AK123	77 Green Street High Wycombe HP14JQ	12 months	£50.00	IO – Inside Out (Animated)	05/11/2013
Rebecca Zane	AK123	77 Green Street High Wycombe HP14JQ	12 months	£50.00	MN – Minions (Animated)	08/01/2015
Rebecca Zane	AK123	77 Green Street High Wycombe HP14JQ	12 months	£50.00	IO – Inside Out (Animated)	08/01/2015

HILLTOP ANIMAL HOSPITAL
 INVOICE # 987
 MR. RICHARD COOK
 123 THIS STREET
 MY CITY, ONTARIO
 Z5Z 6G6

DATE: JAN 13/2002



<u>PET</u>	<u>PROCEDURE</u>	<u>AMOUNT</u>
ROVER	RABIES VACCINATION	30.00
MORRIS	RABIES VACCINATION	24.00
TOTAL		54.00
TAX (8%)		<u>4.32</u>
AMOUNT OWING		<u>58.32</u>

Convert this
data to 3NF

INVOICE

INVOICENO	DATE	Name	Address	Pet	PROCEDURE	AMOUNT	TOTAL	TAX (8%)	AMOUNT OWING
987	JAN 13/2002	Mr Richard Cook	123 THIS STREET MY CITY, ONTARIO Z5Z 6G6	ROVER	RABIES VACCINATION	30.00	54.00	4.32	<u>58.32</u>
987	JAN 13/2002	Mr Richard Cook	123 THIS STREET MY CITY, ONTARIO Z5Z 6G6	MORRIS	RABIES VACCINATION	24.00			