



### Learning Outcomes

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

## Lesson: 1<sup>st</sup> Normal Form (1NF), 2<sup>nd</sup> Normal Form (2NF) & 3<sup>rd</sup> Normal Form (3NF)

### Normalization: 1<sup>st</sup> 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 1<sup>st</sup> Normal Form - 1NF



2) Every attribute is uniquely named

3) Assign a PK

1) Every attribute is single valued

CustID	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.



### Normalization: 1<sup>st</sup> Normal Form (1NF)



Watch the following video:

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

- Can you spot the mistakes in the video?

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

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	StudentFName	StudentSName	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	StudentFName	StudentSName	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

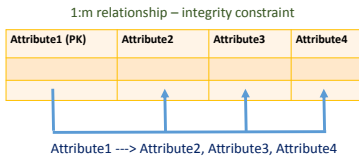
2NF – Normalization Steps



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



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



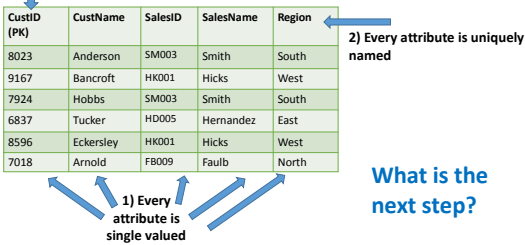
CustID (PK)	CustName	SalesID	SalesName	Region
8023	Anderson	SM003	Smith	South
9167	Bancroft	HK001	Hicks	West
7924	Hobbs	SM003	Smith	South
6837	Tucker	HD005	Hernandez	East
8596	Eckersley	HK001	Hicks	West
7018	Arnold	FB009	Faulb	North

What is the first step?

Determining is relation is in 1NF



3) Assign a PK



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

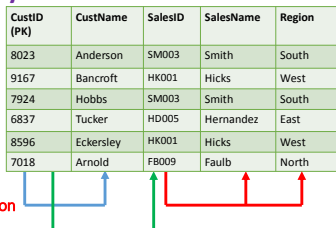
TRUE or FALSE?

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

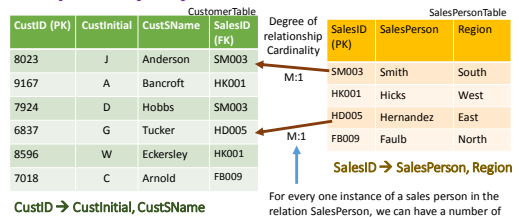
All non-key attributes are fully dependent on the primary key



The relationship/constraint between attributes



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



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 → dAddress1, 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	First Name	Surname	Position	Salary	dCenterNo	dAddress	dTelNo
S1500	Tom	Daniel s	Manager	48000	D001	8 Jefferson Way, High Wycombe, HP11 8TY	503 555 3618
S0003	Sally	Adam s	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)	First Name	Surname	Position	Salary	dCentreNo	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)	First Name	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	✓
StaffNo	Surname	✓
StaffNo	Position	✓
StaffNo	Salary	✓
StaffNo	dCentreNo	✗
StaffNo	dAddressLine1	✗
StaffNo	dTown	✗
StaffNo	dPostcode	✗
StaffNo	dTelNo	✗

TRUE or FALSE?

Everything about manager

StaffNo (PK)	First Name	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)	First Name	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 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

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

Tables in UNF, 1NF & 2NF

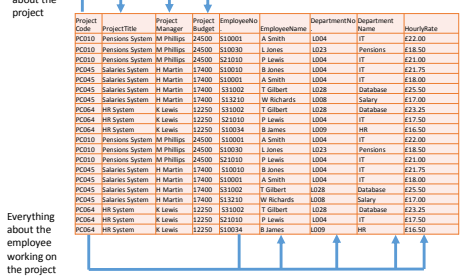
UNF	1NF	2NF
StaffNo FirstName Surname Position dCentreNo dAddressLine1 dTenNo	StaffNo (PK) FirstName Surname Position dCentreNo dAddressLine1 Town Postcode dTenNo	StaffNo (PK) FirstName Surname Position dCentreNo (FK) dCentreNo (PK) dAddressLine1 Town Postcode dTenNo

### Convert this table into 1NF & 2NF?



Project Code	Project Title	Project Manager	Project Budget	EmployeeNo.	EmployeeName	DepartmentNo.	Department Name	HourlyRate
PC010	Pensions System	M Phillips	24500	S10001	A Smith	L004	IT	E22.00
PC010	Pensions System	M Phillips	24500	S10030	L Jones	L023	Pensions	E18.50
PC010	Pensions System	M Phillips	24500	S21010	P Lewis	L004	IT	E21.00
PC045	Salaries System	H Martin	17400	S10010	B Jones	L004	IT	E21.75
PC045	Salaries System	H Martin	17400	S10001	A Smith	L004	IT	E18.00
PC045	Salaries System	H Martin	17400	S31002	T Gilbert	L028	Database	E25.50
PC064	HR System	K Lewis	12250	S31002	T Gilbert	L028	Database	E23.25
PC064	HR System	K Lewis	12250	S21010	P Lewis	L004	IT	E17.50
PC064	HR System	K Lewis	12250	S10034	B James	L009	HR	E16.50
PC010	Pensions System	M Phillips	24500	S10001	A Smith	L004	IT	E22.00
PC010	Pensions System	M Phillips	24500	S10030	L Jones	L023	Pensions	E18.50
PC010	Pensions System	M Phillips	24500	S21010	P Lewis	L004	IT	E21.00
PC045	Salaries System	H Martin	17400	S10010	B Jones	L004	IT	E21.75
PC045	Salaries System	H Martin	17400	S10001	A Smith	L004	IT	E18.00
PC045	Salaries System	H Martin	17400	S31002	T Gilbert	L028	Database	E25.50
PC064	HR System	K Lewis	12250	S31002	T Gilbert	L028	Database	E23.25
PC064	HR System	K Lewis	12250	S21010	P Lewis	L004	IT	E17.50
PC064	HR System	K Lewis	12250	S10034	B James	L009	HR	E16.50

### 1NF: Functional dependency



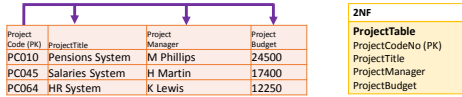
### Tables in 1NF



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

Project Code (PK)	Project Title	Project Manager Initial	Project Budget	EmployeeNo	EmployeeName	DepartmentNo.	DepartmentName	HourlyRate
PC010	Pensions System	M	24500					
PC045	Salaries System	H	17400					
PC064	HR System	K	12250					
S10001	PC010	A	Smith	L004	IT	E22.00		
S10001	PC045	A	Smith	L004	IT	E18.00		
S10034	PC064	B	James	L009	HR	E16.50		
S10010	PC045	B	Jones	L004	IT	E21.75		
S10030	PC010	L	Jones	L023	Pensions	E18.50		
S21010	PC010	P	Lewis	L004	IT	E21.00		
S21010	PC064	P	Lewis	L004	IT	E17.50		
S31002	PC045	T	Gilbert	L028	Database	E25.50		
S31002	PC064	T	Gilbert	L028	Database	E23.25		
S13210	PC045	W	Richards	L008	Salary	E17.00		

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



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 (FK)	ProjectCode (FK)	EmployeeInitial	EmployeeName	DepartmentNo.	DepartmentName	HourlyRate
S10001	PC010	A	Smith	L004	IT	E22.00
S10034	PC064	B	James	L009	HR	E16.50
S10010	PC045	B	Jones	L004	IT	E21.75
S10030	PC010	L	Jones	L023	Pensions	E18.50
S21010	PC010	P	Lewis	L004	IT	E21.00
S21010	PC064	P	Lewis	L004	IT	E17.50
S31002	PC045	T	Gilbert	L028	Database	E25.50
S31002	PC064	T	Gilbert	L028	Database	E23.25
S13210	PC045	W	Richards	L008	Salary	E17.00

Everything about the employee and the department they work for

EmployeeNo (PK)	EmployeeInitial	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

### Relations are in 2NF

EmployeeNo (FK)	ProjectCode (FK)	HourlyRate
S10001	PC010	E22.00
S10030	PC010	E18.50
S21010	PC010	E21.00
S10001	PC045	E18.00
S10010	PC045	E21.75
S31002	PC045	E25.50
S13210	PC045	E17.00
S10034	PC064	E16.50
S21010	PC064	E17.50
S31002	PC064	E23.25

StaffTable	ProjectTable
EmployeeNo (PK)	ProjectCode (FK)
EmployeeInitial	EmployeeName
DepartmentNo	DepartmentName
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

Relations are in 2NF

EmployeeNo (PK)	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

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



UNF	1NF	2NF
ProjectCode	ProjectCode (PK)	ProjectCode (PK)
ProjectTitle	ProjectTitle	ProjectTitle
ProjectManager	ProjectManagerInitial	ProjectManagerInitial
ProjectBudget	ProjectManagerSName	ProjectManagerSName
EmployeeNo	ProjectBudget	ProjectBudget
EmployeeName		
DepartmentNo	EmployeeNo (FK)	EmployeeNo (FK)
DepartmentName	ProjectCode (FK)	ProjectCode (FK)
HourlyRate	EmployeeInitial	EmployeeInitial
	EmployeeSName	EmployeeSName
	DepartmentNo	DepartmentNo
	DepartmentName	DepartmentName
	HourlyRate	HourlyRate
		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 Meat Feast	1	£5.55	£29.10
						MF	Vegetarian	1	£8.55	
						V		3	£5.00	
1251	789101	AA49	Ayesha Ali	88 High Street High Wycombe	HP11 4OP	CM	ChickMush Vegetarian	2	£5.55	£33.10
						V	Margarita	4	£5.00	
						M		1	£2.00	

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

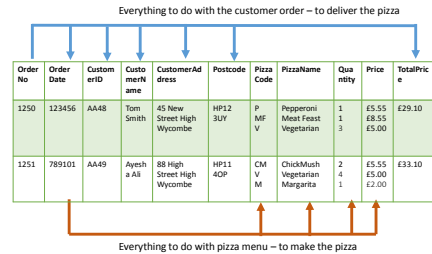


Order No	Order Date	CustomerID	CustomerName	CustomerAddress	Postcode	Pizza Code	PizzaName	Quantity	Price	TotalPrice
1250	123456	AA48	Tom Smith	45 New Street High Wycombe	HP12 3UY	P	Pepperoni Meat Feast	1	£5.55	£29.10
						MF	Vegetarian	1	£8.55	
						V		3	£5.00	
1251	789101	AA49	Ayesha Ali	88 High Street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

Order No	Order Date	CustomerID	CustomerName	CustomerSName	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	Ayesha	Ali	88 High Street	High Wycombe	HP11 4OP	CM	ChickMush	2	£5.55	£33.10
1251	789101	AA49	Ayesha	Ali	88 High Street	High Wycombe	HP11 4OP	V	Vegetarian	4	£5.00	£33.10
1251	789101	AA49	Ayesha	Ali	88 High Street	High Wycombe	HP11 4OP	M	Margarita	1	£2.00	£33.10

Attributes is single valued

1NF: Assigning PK



Relations in 1NF



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

Order No (PK)	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	CustomerName
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	CustomerName	CustomerSName	CustomerAddress1	Town	Postcode	TotalPrice
1250	123456	AA48	Tom	Smith	45 New Street	High Wycombe	HP12 3UY	£29.10
1251	789101	AA49	Aysha	Ali	88 High Street	High Wycombe	HP11 4DP	£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



Order No (PK)	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 PizzaCode we can identify the PizzaName and the price – the stock levels of pizza

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 (PK)	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)	OrderNo (FK)
PizzaCode (PK)	PizzaCode (FK)
PizzaName	Quantity
Quantity	PizzaCode (PK)
Price	PizzaName
	Price

Relations in 2NF



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

Order No (PK)	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



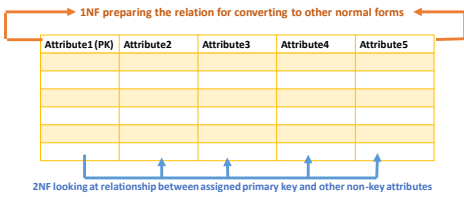
### Relations in UNF, 1NF & 2NF



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 (FK)	Quantity
	PizzaName	PizzaCode (FK)
	Quantity	PizzaName
	Price	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):

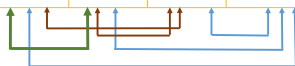
1. The relation is in second normal form (2NF)
2. If all associations where All non-key attributes are not dependent on any other non-key attributes are resolved
3. Each relation has a primary key
4. All relations are uniquely named

### 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



Convert these relations in to 3NF

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

EmployeeNo (FK)	ProjectCode (FK)	HourRate
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



Determining any functional dependency between non-PK attributes?



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

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 (FK)	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 (FK)  
 EmployeeName  
 DepartmentNo (FK)

**DepartmentTable**  
 DepartmentNo (PK)  
 DepartmentName

UNF	1NF	2NF	3NF
ProjectCode	ProjectCode	ProjectCode	ProjectTable
ProjectTitle	ProjectTitle	ProjectTitle	ProjectCode
ProjectManager	PMInitials	PMInitials	ProjectTitle
ProjectBudget	PMSName	PMSName	PMInitials
EmployeeName	ProjectBudget	ProjectBudget	PMSName
DepartmentNo	EmployeeNo	EmployeeNo	ProjectBudget
DepartmentName	ProjectCode	ProjectCode	ProjectRatesTable
HourlyRate	EMPInitials	EMPInitials	EmployeeNo
	EMPSName	EMPSName	ProjectCode
	DepartmentNo	DepartmentName	HourlyRate
	DepartmentNo	DepartmentName	EmployeeTable
	HourlyRate	HourlyRate	PK EmployeeNo
			EMPInitials
			EMPSName
			FK DepartmentNo
			DepartmentTable
			FK DepartmentNo
			DepartmentName

**Normalization 1NF, 2NF, & 3NF**

### Convert to 3NF



Order No (PK)	Order Date	CustomerID	CustomerName	CustomerF Name	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 (FK)	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 (FK)	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**  
 OrderNo (PK)  
 OrderDate  
 CustomerID  
 CustomerName  
 CustAddress1  
 Town  
 Postcode  
 TotalPrice

**3NF**  
**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	Alli	88 High Street	High Wycombe	HP11 4DP

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 (FK) PizzaName Quantity Price	OrderNo (PK) OrderDate CustomerID CustomerName CustAddress1 Town Postcode TotalPrice  OrderNo (FK) PizzaCode (FK) Quantity PizzaName Price	Orders OrderNo (FK) OrderDate CustomerID (FK) CustomerName CustAddress1 Town Postcode  Customers CustomerID (FK) CustomerName CustAddress1 Town Postcode  OrderQty OrderNo (FK) PizzaCode (FK) Quantity  Pizzas PizzaCode (FK) PizzaName Price



**UNF, 1NF, 2NF & 3NF**

**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

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



**Convert this data to 3NF**

INVOICE

INVOICE NO	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	58.32
987	JAN 13/2002	Mr Richard Cook	123 THIS STREET MY CITY, ONTARIO Z5Z 6G6	MORRIS	RABIES VACCINATION	24.00			