

# Normalization

## The Database Environment

### Data Modelling

# Learning Outcomes



- **Affirm your understanding of Normalization to 3<sup>rd</sup> Normal Form (3NF)**
- **Understand the components of an integrated database environment**
- **Concisely define key terms regarding a relational databases.**
- **Begin to develop ideas of modelling data for the database environment.**
- **Understand how Normalization and data modelling are related**

## Normalization: Short knowledge quiz

1. Which of the following is not a goal of Normalization?

- A) Minimize data redundancy.
- B) Make it easier to keep records of primary keys.
- C) Utilise storage more efficiently.
- D) Make it easier to maintain data.

# Normalization: Short knowledge quiz



2. When all multivalued attributes have been removed from a relation, it is said to be in:

- A) 1st Normal Form (1NF).
- B) 2nd Normal Form (2NF).
- C) Boyce-Codd Normal Form.
- D) 3rd Normal Form (3NF).

# Normalization: short knowledge quiz



3. A relation that contains no multivalued attributes and has non-key attributes that are solely dependent on the primary key is in which normal form?

- A) First (1NF)
- B) Second (2NF)
- C) Third (3NF)
- D) Fourth (4NF)

# Normalization: short knowledge quiz



4. A constraint between two attributes is called  $a \rightarrow b$ :

- A) Functional relation.
- B) Attribute dependency.
- C) Functional dependency.
- D) Functional relation constraint.

# Normalization: short knowledge quiz



5. Which of the following conditions is **not true** when assigning a primary key:

- A) The key must uniquely identify the row.
- B) The key must indicate the row's position in the relation.
- C) The key must be non-redundant (one entry in the relation).
- D) Each non-key attribute is functionally dependent upon it.

# 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.**



# 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

**1NF : There are no repeating attributes – every attribute is single valued – each cell in the table contains one value**

CustomerFirst Name	CustomerLastName	CustID	AddressLine1	Town	Postcode	SubType	SubAmount	MovieDownloadsID	MovieDownloadsName	MovieDownloadsType	DownloadDate
Tom	Smith	WS951	5 High Street	Aylesbury	HP204YB	1 Month	£5.00	AV	Avengers Age of Ultron	Sci-Fi	12/12/2014
Tom	Smith	WS951	5 High Street	Aylesbury	HP204YB	1 Month	£5.00	JW	Jurassic World	Sci-Fi	14/12/2014
Tom	Smith	WS951	5 High Street	Aylesbury	HP204YB	1 Month	£5.00	TR	Train	Comedy	16/12/2014
Tom	Smith	WS951	5 High Street	Aylesbury	HP204YB	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

## 1NF: Each attribute has a unique name – the column names are unique

Customer FirstName	Customer LastName	CustID	AddressL ine1	Town	Postc ode	SubTyp e	SubAmoun t	MovieDo wnloadsI D	MovieD ownload sName	MovieD ownloa dsType	Downloa dDate
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

# 1NF: Identifying Primary Key (PK)

Everything about the customer & subscription

Everything about the movies & downloads

About the download Determinant

Determinant

Determinant

Customer FirstName	Customer LastName	CustID	AddressL ine1	Town	Postc ode	SubTyp e	SubAmoun t	MovieDo wnloadsI D (PK)	MovieD ownload sName	MovieD ownloa dsType	Downloa dDate (PK)
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

Note: you will need to decide on how you are going to maintain a relationship between the two tables

UNF	1NF
CustomerName CustID Address SubType SubAmount MovieDownloads DownloadDate	<b>CustID (PK)</b> CustomerFirstName CustomerLastName AddressLine1 Town Postcode SubType SubAmount  <b>CustID (FK)</b> <b>DownloadDate (PK)</b> <b>MovieDownloadsID (PK)</b> MovieDownloadsName MovieDownloadsType

# 1NF

# Normalization: 2<sup>nd</sup> Normal Form (2NF)

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

1. If the relation is in first normal form (1NF)
2. If all non key attributes are fully dependent on the primary key
3. If each relation has a primary key

## 2NF: Are all non-key attributes fully dependent on the primary key for this relation?

CustID (PK)	CustomerFirstName	CustomerLastName	AddressLine1	Town	Postcode	SubType	SubAmount
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✓ Yes they are fully dependant on the primary key, because all are related to the customer and the subscription held. If you look up a customer you can determine details about the customer and their subscription.

## Are all non-key attributes fully dependent on the primary key for this relation?

CustID (FK)	MovieDownloadsID (PK)	MovieDownloadsName	MovieDownloadsType	DownloadDate (PK)
-------------	-----------------------	--------------------	--------------------	-------------------

✗ No there are non-key attributes that are not fully dependant on the two primary keys

- the movie and download date are dependant on the customer and their choice of movie and viewing
- if were determining the details of a movie, you would not look up the customer, you would look up the movie

## 2NF: Determining of all non-key attributes are fully dependent on the primary key for this relation

As a customer you choose the movies you like to watch and movie night!

The date that a movie is downloaded is dependant of the customer and the movie

CustID (FK)	MovieDownloadsID (PK)	MovieDownloadsName	MovieDownloadsType	DownloadDate (PK)
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The movie name and type are dependant the MovieID

This is like your movie stock record



**2NF: All non-key attributes are fully dependent on the primary key for this relation**



CustID (PK)	CustomerFirst Name	CustomerLast Name	AddressLine1	Town	Postcode	SubType	SubAmount
WS951	Tom	Smith	5 High Street	Aylesbury	HP20 4YB	1 Month	£5.00
AK123	Rebecca	Zane	77 Green Street	High Wycombe	HP14JQ	12 months	£50.00

CustID (FK)	MovieDownloadsID (FK)	DownloadDate (PK)
WS951	AVU	12/12/2014
WS951	JW	14/12/2014
WS951	TR	16/12/2014
WS951	IO	20/12/2014
AK123	TG	23/05/2012
AK123	IO	05/11/2013
AK123	MN	08/01/2015
AK123	IO	08/01/2015

MovieDownloadsID (PK)	MovieDownloadsName	MovieDownloadsType
AV	Avengers Age of Ultron	Sci-Fi
JW	Jurassic World	Sci-Fi
TR	Train	Comedy
IO	Inside Out	Animated
TG	Terminator Genisys	Sci-Fi
MN	Minions	Animated

**You are assuming that new films added to the stock will be assigned a unique ID**

UNF	1NF	2NF
CustomerName CustID Address SubType SubAmount MovieDownloads DownloadDate	<b>CustID (PK)</b> CustomerFirstName CustomerLastName AddressLine1 Town Postcode SubType SubAmount  <b>CustID (FK)</b> <b>MovieDownloadsID (PK)</b> MovieDownloadsName MovieDownloadsType DownloadDate	<b>CustID (PK)</b> CustomerFirstName CustomerLastName AddressLine1 Town Postcode SubType SubAmount  <b>CustID (FK)</b> <b>MovieDownloadsID (FK)</b> <b>DownloadDate (PK)</b>  <b>MovieDownloadsID (PK)</b> MovieDownloadsName MovieDownloadsType

# 1NF & 2NF

# Normalization: 3NF

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

- 1. If 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. If each relation has a primary key**
- 4. If all relations are uniquely named**

**3NF: Determining if all associations where All non-key attributes are not dependent on any other non-key attributes**

**2NF: Are there any associations where non-key attributes are dependent on any other non-key attribute?**

CustID (PK)	CustomerFirst Name	CustomerLast Name	AddressLine1	Town	Postcode	SubType	SubAmount
WS951	Tom	Smith	5 High Street	Aylesbury	HP20 4YB	1 Month	£5.00
AK123	Rebecca	Zane	77 Green Street	High Wycombe	HP14JQ	12 months	£50.00



**This is all about the customer and their details**



**The subscription amount is related to the length of the subscription**

## 3NF: Resolving all associations where All non-key attributes are not dependent on any other non-key attributes

CustID (PK)	CustomerFirst Name	CustomerLast Name	AddressLine1	Town	Postcode
WS951	Tom	Smith	5 High Street	Aylesbury	HP20 4YB
AK123	Rebecca	Zane	77 Green Street	High Wycombe	HP14JQ

CustID (FK)	SubType	SubAmount
WS951	1 Month	£5.00
AK123	12 months	£50.00

## 3NF: Determining if all associations where all non-key attributes are not dependent on any other non-key attributes

CustID (FK)	MovieDownloadsID (FK)	DownloadDate (PK)
WS951	AVU	12/12/2014
WS951	JW	14/12/2014
WS951	TR	16/12/2014
WS951	IO	20/12/2014
AK123	TG	23/05/2012
AK123	IO	05/11/2013
AK123	MN	08/01/2015
AK123	IO	08/01/2015

**DownloadDate is the only non-key attribute. There are no other non-key attributes**

MovieDownloadsID (PK)	MovieDownloadsName	MovieDownloadsType
AV	Avengers Age of Ultron	Sci-Fi
JW	Jurassic World	Sci-Fi
TR	Train	Comedy
IO	Inside Out	Animated
TG	Terminator Genisys	Sci-Fi
MN	Minions	Animated

**MovieDownloadName and MovieDownloadType are strongly related but there is no dependency**

# 3NF: All relations are uniquely named

## Customer

CustID (PK)	CustomerFirst Name	CustomerLast Name	AddressLine1	Town	Postcode
WS951	Tom	Smith	5 High Street	Aylesbury	HP20 4YB
AK123	Rebecca	Zane	77 Green Street	High Wycombe	HP14JQ

## SubscriptionMembership

CustID (FK)	SubType	SubAmount
WS951	1 Month	£5.00
AK123	12 months	£50.00

## Movies

MovieDownloadsID (PK)	MovieDownloadsName	MovieDownloadsType
AV	Avengers Age of Ultron	Sci-Fi
JW	Jurassic World	Sci-Fi
TR	Train	Comedy
IO	Inside Out	Animated
TG	Terminator Genisys	Sci-Fi
MN	Minions	Animated

## MovieDownload

CustID (FK)	MovieDownloadsID (FK)	DownloadDate (PK)
WS951	AVU	12/12/2014
WS951	JW	14/12/2014
WS951	TR	16/12/2014
WS951	IO	20/12/2014
AK123	TG	23/05/2012
AK123	IO	05/11/2013
AK123	MN	08/01/2015
AK123	IO	08/01/2015

UNF	1NF	2NF	3NF
CustomerName CustID Address SubType SubAmount MovieDownloads DownloadDate	<b>CustID (PK)</b> CustomerFirstName CustomerLastName AddressLine1 Town Postcode SubType SubAmount  <b>CustID (FK)</b> <b>MovieDownloadsID (PK)</b> MovieDownloadsName MovieDownloadsType DownloadDate	<b>CustID (PK)</b> CustomerFirstName CustomerLastName AddressLine1 Town Postcode SubType SubAmount  <b>CustID (FK)</b> <b>MovieDownloadsID (FK)</b> DownloadDate (PK)  <b>MovieDownloadsID (PK)</b> MovieDownloadsName MovieDownloadsType	<b>Customer</b> <b>CustID (PK)</b> CustomerFirstName CustomerLastName AddressLine1 Town Postcode  <b>SubscriptionMembership</b> <b>CustID (FK)</b> SubType SubAmount  <b>MovieDownloads</b> <b>CustID (FK)</b> <b>MovieDownloadsID (FK)</b> <b>DownloadDate (PK)</b>  <b>Movies</b> <b>MovieDownloadsID (PK)</b> MovieDownloadsName MovieDownloadsType

1NF, 2NF & 3NF



Let's take a break from Normalization  
– but we will be coming back to it!

# Monday Class: What is a database?



Something that  
can store, sort  
and display data.

Computer system that contains  
information and permits searching

Hold peoples information

Contains data in an organised way

Contains information

Area where data is kept

Examples: university database and library

Can display  
information

# Tuesday Class: What is a database?



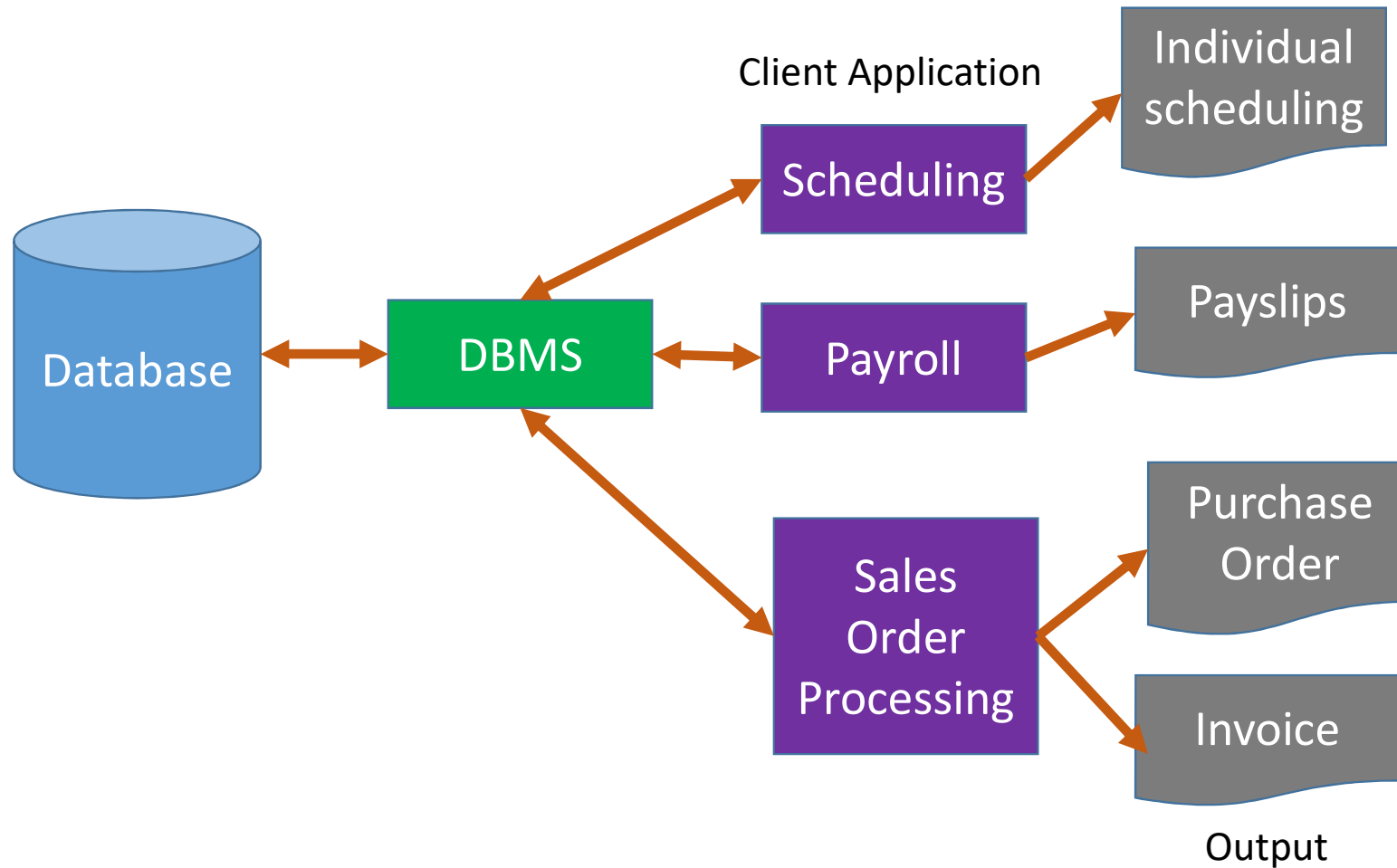
# What is a database?

- Represents some aspect of the real world
- A logically coherent collection of data
- A database is designed, built and populated with data for a specific purpose
- The purpose is aimed to meet the requirements of the user of the database

# Types of Databases

Type	Architecture	Example
Client-server database	Relational	Oracle, Microsoft SQL Server, Filemaker Pro, Amazon Aurora, PostgreSQL, MySQL, MariaDB
Hypertext database		
Distributed database		
Database-as-a-Service		
Data Warehouses		
Key-value pair database	NOSQL	DynamoDB, Raik, Redis, Aerospike, Azure Table Storage
Colum family store database		
Document database		
Graph database		

# Relational Database Environment



# NOSQL Database Environment



(Sullivan, 2015, p.49)

# Categories of databases

**We can categorize databases according to:**

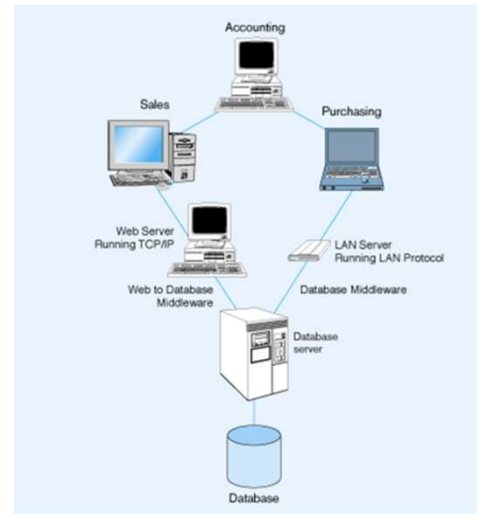
- **Scale**
- **Function**
- **Topology/Structure**
- **Type**



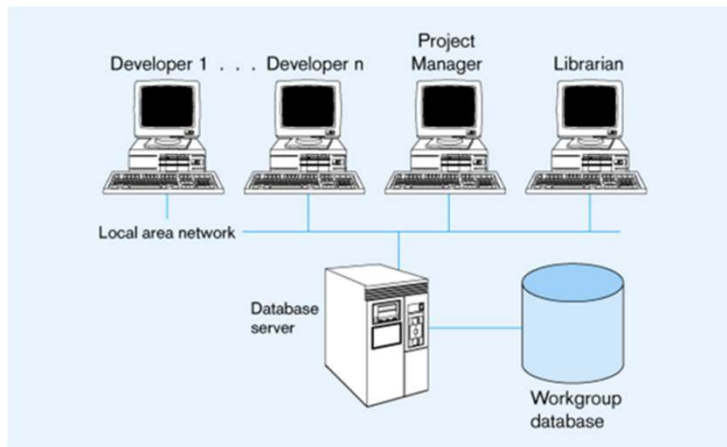
# Scale

ID	First Name	Last Name	Street Ad
1	Tracey	Beckham	7 East Walker
2	Lucinda	George	789 Brewer St.
3	Jerrold	Smith	211 St. George
4	Brett	Newkirk	47 Hillsboroug
5	Chloe	Jones	23 Solo Ln.
6	Quinton	Boyd	4 Cypress Cr.
7	Alex	Hinton	1011 Hodge Lr
8	Nisha	Hall	123 Huntingto
9	Hillary	Clayton	2516 Newman
10	Kiara	Williams	9014 Miller Ln
11	Katy	Jones	456 Denver Rd
12	Beatrix	Joslin	85 North West
13	Mariah	Allen	12 Jupe

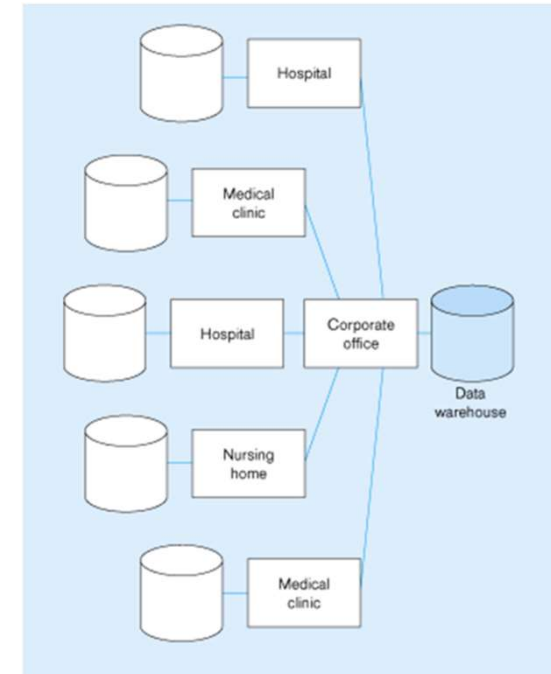
Personal Database



Department Database

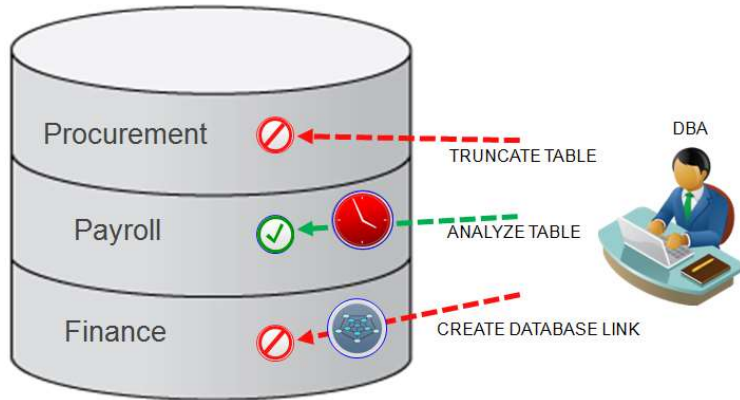


Workgroup Database



Enterprise Database

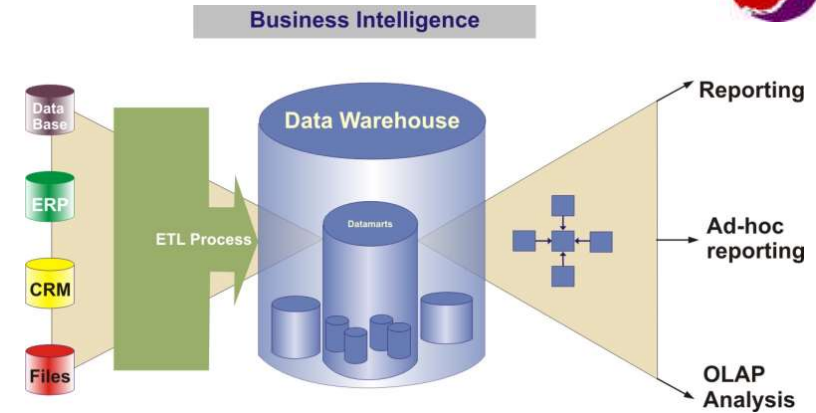
# Function



## Operational Database



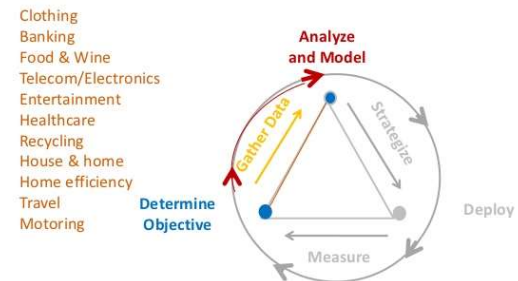
## Distributed Database



## Data Warehouse

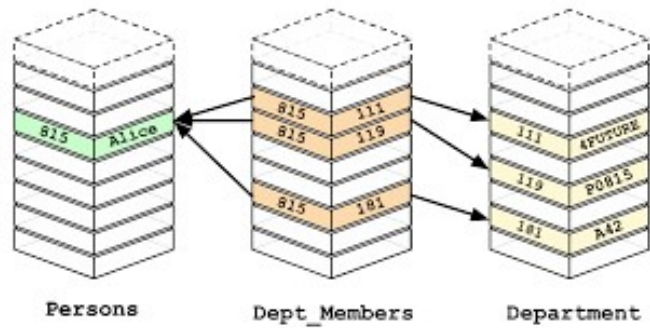
Tesco Clubcard

*Gather data: Clubcard sign up, transactional touchpoints.*

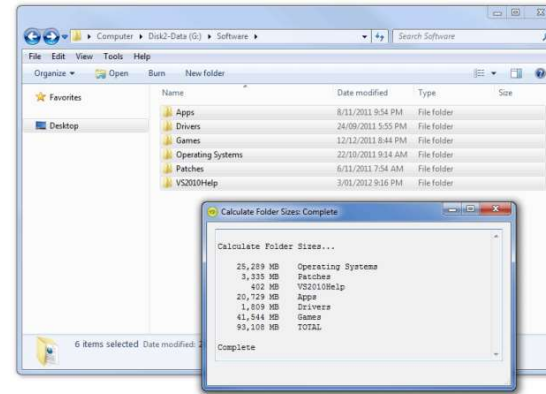


## Analytic Database

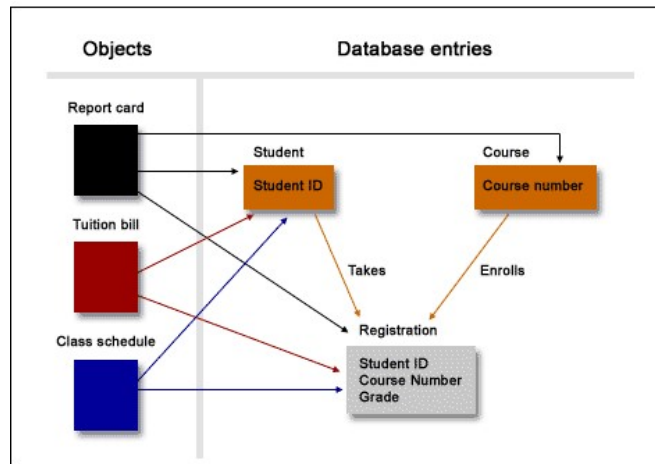
# Topology/Structure



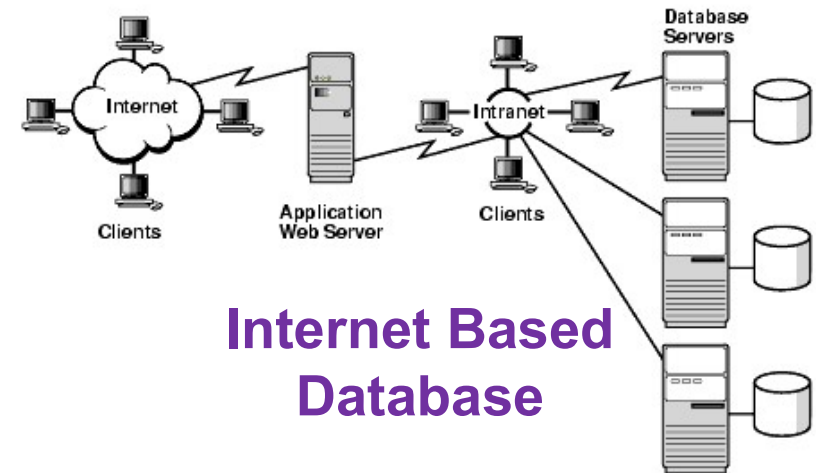
**Relational Database**



**Hierarchical Database**

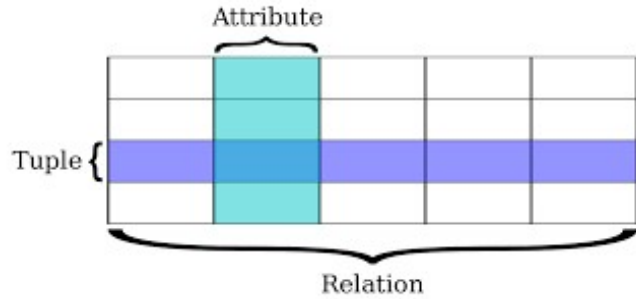


**Object Orientated Database**



**Internet Based Database**

# Type



## Relational

Table

Country	Product	Sales
US	Alpha	3,000
US	Beta	1,250
JP	Alpha	700
UK	Alpha	450

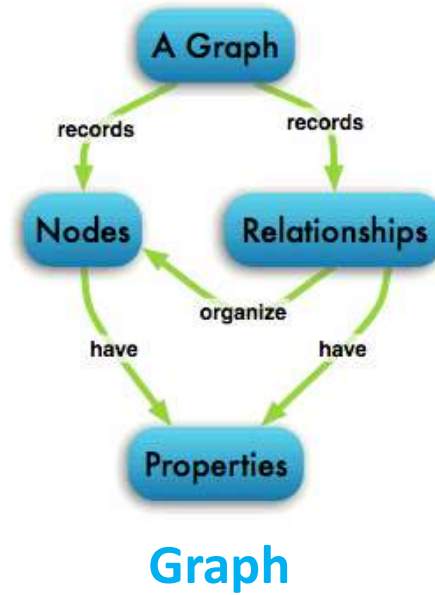
Row Store

Row	Country	Product	Sales
Row 1	US	Alpha	3,000
Row 2	US	Beta	1,250
Row 3	JP	Alpha	700
Row 4	UK	Alpha	450

Column Store

Country	Product	Sales
US	Alpha	3,000
US	Beta	1,250
JP	Alpha	700
UK	Alpha	450

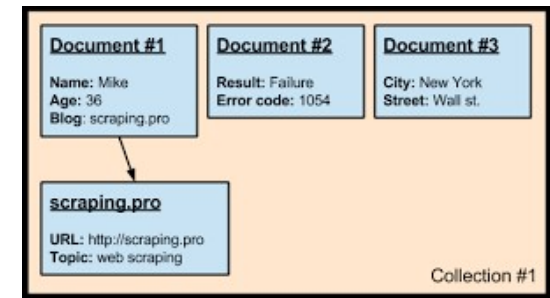
## Column-Orientated



## Graph

row key	columns ...			
jbellis	name	email	address	state
	jonathan	jb@ds.com	123 main	TX
dhutch	name	email	address	state
	daria	dh@ds.com	45 2 <sup>nd</sup> St.	CA
egilmore	name	email		
	eric	eg@ds.com		

## Key Value



## Document-orientated

# Back to Normalization and data modelling.

# Un-Normalized (UNF) Relation

ModuleCode	ModuleTitle	Student ID	Course	Tutor	AssignmentTitle	Date Due	QualityControl	Comments
CO621	Database	21012561	Computing	Wayne	CW2	15/03/13	Not Checked	Blank
CO621	Database	25062041	Computing	Wayne	CW1	15/02/13	Checked	Blank
CO623	E-Business	21012561	Computing	Wayne	CW1	12/05/13	Not Checked	Blank

Visually we can see this relation represents:

- Assessment submitted for a module
- It represents students submitting the assessment
- Tutors responsible for the module
- Assessment that has undergone quality control

What is the next step after UNF?

# 1NF: There are no repeating attributes – each cell contains one value.



Module Code	Module Title	Student ID	Tutor	Course	Assignment Title	Date Due	QualityControl	Comments
CO621	Database	21012561	Wayne	Computing	CW2	15/02/13	Not Checked	Blank
CO621	Database	25062041	Wayne	Computing	CW1	15/02/13	Checked	Blank
CO623	E-Business	21012561	Wayne	Computing	CW1	12/05/13	Not Checked	Blank

**What the next step to 1NF?**

# 1NF: Assigning a Primary Key

Module Code	Module Title	Student ID	Course	Tutor	Assignment Title	Date Due	Quality Control	Comments
CO621	Database	21012561	Computing	Wayne	CW2	15/03/13	Not Checked	Blank
CO621	Database	25062041	Computing	Wayne	CW1	15/02/13	Checked	Blank
CO623	E-Business	21012561	Computing	Hilary	CW1	12/05/13	Not Checked	Blank

**Assigning either of these attributes as a Primary Key will not ensure uniqueness we need to assign both**



# 1NF: Assigning a Primary Key

Module Code (PK)	Module Title	Student ID (PK)	Course	Tutor	Assignment Title	Date Due	QualityControl	Comments
CO621	Database	21012561	Computing	Wayne	CW2	15/03/13	Not Checked	Blank
CO621	Database	25062041	Computing	Wayne	CW1	15/02/13	Checked	Blank
CO623	E-Business	21012561	Computing	Wayne	CW1	12/05/13	Not Checked	Blank

**This relation is now in 1NF**

# Overview of data modelling (E-R Diagram)



- The data model describes the database and its structure.
- The main constructs of a data model are the entities, attributes, relationship and constraints/cardinality.
- Entities represents the data and are objects, people, events from the real world which we want to record information about.
- The relationships denote a connection via primary key/foreign key between tables/entities
- Cardinality or constraints represent set rules that need to be applied.

# First Step: Data modelling (E-R Diagram)

## Entity Type

**Entity Type** – collection of entities (often corresponds to a relation).

We refer to an Entity instance – a person, place, object, event, concept (it often corresponds to a row in a table)



## Relationship

**Relationship** - link between entities (corresponds to primary key or foreign key) and includes a descriptive sentence.

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Links attribute to entity, links entity to relationship & links attribute to relationship

# Conceptual modelling

Module Code (PK)	Module Title	Student ID (PK)	Course	Tutor	Assignment Title	Date Due	QualityControlStat	Comments
CO621	Database	21012561	Computing	Wayne	CW2	15/03/13	Not Checked	Blank
CO621	Database	25062041	Computing	Wayne	CW1	15/02/13	Checked	Blank
CO623	E-Business	21012561	Computing	Hilary	CW1	12/05/13	Not Checked	Blank

Assessment

This entity type does not inform us about all the elements in our database!

- ✘ Assessment submitted for a module
- ✘ It represents students submitting assessment
- ✘ Tutors responsible for the module
- ✘ Assessment that as undergone quality control

## 2NF: If all non key attributes are fully dependent on the primary key

Everything about the student and the assessment submission

Module Code (PK)	ModuleTitle	StudentID (PK)	Course	Tutor	Assignment Title	DateDue	QualityControl	Comments
CO621	Database	21012561	Computing	Wayne	CW2	15/03/13	Not Checked	Blank
CO621	Database	25062041	Computing	Wayne	CW1	15/02/13	Checked	Blank
CO623	E-Business	21012561	Computing	Hilary	CW1	12/05/13	Not Checked	Blank

Everything about who teaches the module

Assigning either of these attributes as a Primary Key will not ensure uniqueness we need to assign both. !For this example take the data at face value.

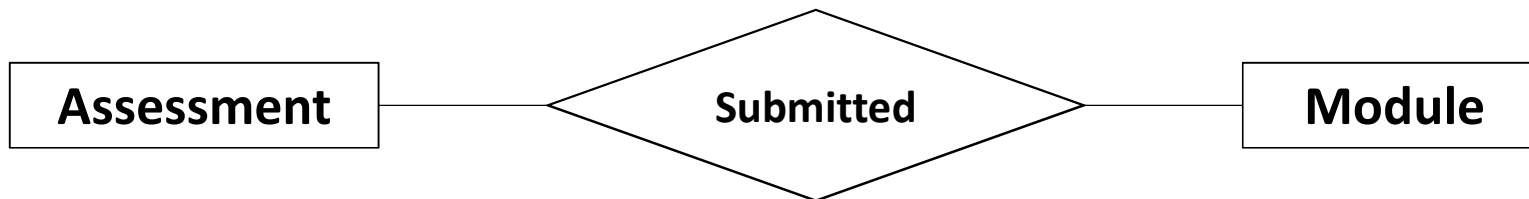
# 2NF

ModuleCode (FK)	Student ID (PK)	Course	Assignment Title	DateDue	AssignmentChecklist	Comments
CO621	21012561	Computing	CW2	15/02/13	Not Checked	Blank
CO621	25062041	Computing	CW1	15/02/13	Checked	Blank
CO623	21012561	Computing	CW1	12/05/13	Not Checked	Blank

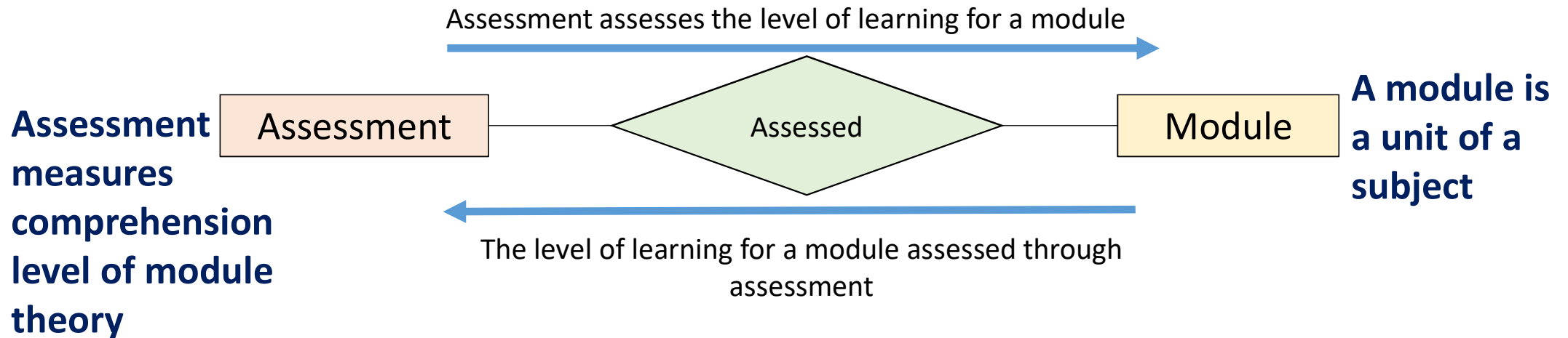
ModuleCode (PK)	ModuleTitle	Tutor
CO621	Database	Wayne
CO623	E-Business	Wayne

Assessment is submitted to measure the level of learning for a module

A module has assessment submitted to measure the level of learning



# Conceptual modelling



**Assessment submitted for a module**



**It represents students submitting assessment**



**Tutors responsible for the module**



**Assessment that as undergone quality control**

# UNF, 1NF & 2NF

UNF	1NF	2NF
ModuleCode	ModuleCode (PK)	ModuleCode (PK)
ModuleTitle	ModuleTitle	ModuleTitle
StudentID	StudentID (PK)	
Course	Course	ModuleCode (FK)
Tutor	Tutor	StudentID (PK)
AssignmentTitle	AssignmentTitle	Course
DateDue	DateDue	Tutor
QualityControl	QualityControl	AssignmentTitle
Comments	Comments	DateDue
		QualityControl
		Comments



## 3NF: Resolving all associations where all non-key attributes are not dependent on any other non-key attributes

ModuleCode (PK)	ModuleTitle	Tutor
CO621	Database	Wayne
CO623	E-Business	Wayne

All non-key attributes are dependant on the PK

ModuleCode (FK)	StudentID (PK)	Course	Assignment Title	DateDue	AssignmentChecklist	Comments
CO621	21012561	Computing	CW2	15/02/13	Not Checked	Blank
CO621	25062041	Computing	CW1	15/02/13	Checked	Blank
CO623	21012561	Computing	CW1	12/05/13	Not Checked	Blank

For this relation do any dependencies exit between non-key attributes?

# 3NF: Resolving all associations where all non-key attributes are not dependent on any other non-key attributes

Everything about the student and the course they are studying

Everything about the student that is submitting

ModuleCode (FK)	StudentID (PK)	Course	Assignment Title	DateDue	Assignment Checklist	Comments
CO621	21012561	Computing	CW2	15/02/13	Not Checked	Blank
CO621	25062041	Computing	CW1	15/02/13	Checked	Blank
CO623	21012561	Computing	CW1	12/05/13	Not Checked	Blank

Everything about the submission

## 3NF: Resolving all associations where all non-key attributes are not dependent on any other non-key attributes

ModuleCode (FK)	AssignmentTitle (PK)	DateDue	AssignmentChecklist	Comments
CO621	CW2	15/02/13	Not Checked	Blank
CO621	CW1	15/02/13	Checked	Blank
CO623	CW1	12/05/13	Not Checked	Late

ModuleCode (FK)	AssignmentTitle (FK)	StudentID (FK)
CO621	CW2	21012561
CO621	CW1	25062041
CO623	CW1	21012561

StudentID (PK)	Course
21012561	Computing
25062041	Computing

**Each relation has a primary key**

# All relations are uniquely named

## Module

Module Code (PK)	Module Title	Tutor
CO621	Database	Wayne
CO623	E-Business	Wayne

## Submission

ModuleCode (FK)	AssignmentTitle (FK)	StudentID (FK)
CO621	CW2	21012561
CO621	CW1	25062041
CO623	CW1	21012561

## Student

StudentID (PK)	Course
21012561	Computing
25062041	Computing



**Assessment submitted for a module**

**It represents students submitting assessment**

**Tutors responsible for the module**

**Assessment that as undergone quality control**

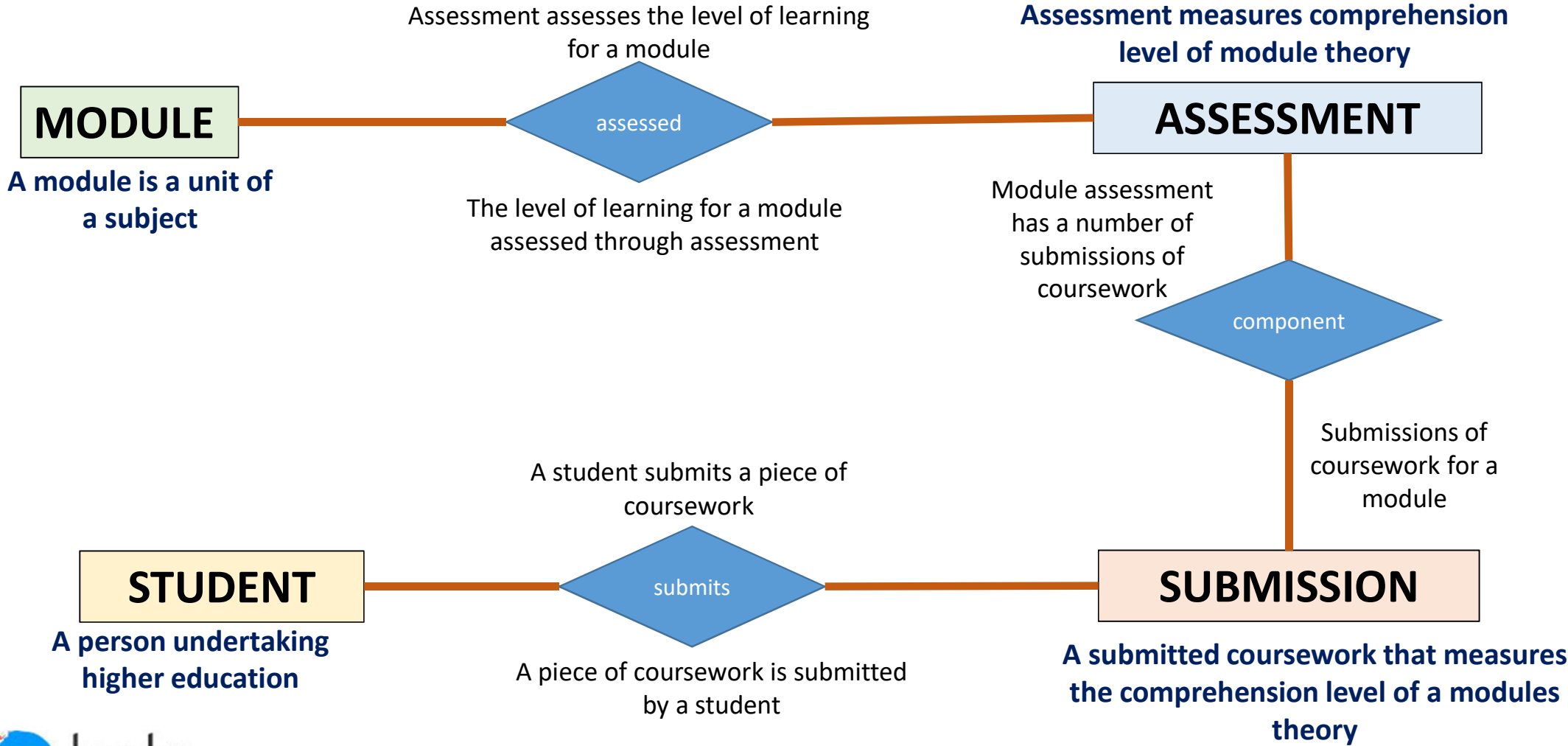
## Assessment

ModuleCode (FK)	AssignmentTitle (PK)	DateDue	AssignmentChecklist	Comments
CO621	CW2	15/02/13	Not Checked	Blank
CO621	CW2	15/02/13	Checked	Blank
CO623	CW1	12/05/13	Not Checked	Late

# UNF, 1NF, 2NF & 3NF

UNF	1NF	2NF	3NF
ModuleCode ModuleTitle StudentID Course Tutor AssignmentTitle DateDue QualityControl Comments	ModuleCode (PK) ModuleTitle StudentID (PK) Course Tutor AssignmentTitle DateDue QualityControl Comments	ModuleCode (PK) ModuleTitle  ModuleCode (FK) StudentID (PK) Course Tutor AssignmentTitle DateDue QualityControl Comments	<b>MODULE</b> ModuleCode (PK) ModuleTitle  <b>STUDENT</b> StudentID (PK) Course  <b>SUBMISSION</b> ModuleCode (FK) AssignmentTitle (FK) StudentID (FK)  <b>ASSESSMENT</b> ModuleCode (FK) AssignmentTitle (PK) DateDue QualityControl Comments

# Conceptual Model



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			

INVOICE NO	Branch	DATE	Name	Address	Pet	PROCEDURE	AMOUNT	TOTAL	TAX (8%)	AMOUNT OWING
987	HILLTOP ANIMAL HOSPITAL	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	HILLTOP ANIMAL HOSPITAL	JAN 13/2002	Mr Richard Cook	123 THIS STREET MY CITY, ONTARIO Z5Z 6G6	MORRIS	RABIES VACCINATION	24.00			

UNF

**UNF**

- InvoiceNo
- Branch
- DATE
- Name
- Address
- PetName
- PROCEDURE
- AMOUNT
- TOTAL
- TAX (8%)
- AMOUNT OWING





# 1NF: Every attribute is single valued & the column names are unique

Invoice No	Branch	Date	CustTitle	CustF Name	CustS Name	AddressLine 1	City	Town	Postcode	PetName	Procedure	Amount	Total	Tax	Amount to win
987	Hilltop Animal Hospital	13/01/2001	Mr	Richard	Cook	123 This Street	My City	Ontario	Z5Z 6G6	Rover	Rabies Vaccination	30.00	54.00	4.32	58.32
987	Hilltop Animal Hospital	13/01/2001	Mr	Richard	Cook	123 This Street	My City	Ontario	Z5Z 6G6	Morris	Rabies Vaccination	24.00	54.00	4.32	58.32

# 1NF: Determining PK

Everything about the pet owner and invoice

Invoice No	Branch	Date	Cust Title	CustF Name	CustS Name	AddressLine 1	City	Town	Postcode	PetName	Procedure	Amount	Total	Tax	AmountOwing
987	Hilltop Animal Hospital	13/01/2001	Mr	Richard	Cook	123 This Street	My City	Ontario	Z5Z 6G6	Rover	Rabies Vaccination	30.00	54.00	4.32	58.32
987	Hilltop Animal Hospital	13/01/2001	Mr	Richard	Cook	123 This Street	My City	Ontario	Z5Z 6G6	Morris	Rabies Vaccination	24.00	54.00	4.32	58.32

Everything about pet and the procedure they had

# 1NF: Determining PK

InvoiceNo (PK)	Branch	Date	Cust Title	CustFName	CustSName	AddressLine1	City	Town	Postcode	Total	Tax	AmountOwing
987	Hilltop Animal Hospital	13/01/2001	Mr	Richard	Cook	123 This Street	My City	Ontario	Z5Z6G6	54.00	4.32	58.32

InvoiceNo (FK)	PetID (PK)	PetName	Procedure	Amount	CustTitle	CustFName	CustSName
987	CKRov001	Rover	Rabies Vaccination	30.00	Mr	Richard	Cook
987	CKMor001	Morris	Rabies Vaccination	24.00	Mr	Richard	Cook

**! To maintain a relationship between owner and pet we have copied owner details (duplication needs to be resolved later).**

**! We have to create a PK for pet**

UNF	1NF
INVOICENO	InvoiceNo (PK)
VetBranch	Date
DATE	Branch
Name	CustTitle
Address	CustFName
PetName	CustSName
PROCEDURE	AddressLine1
AMOUNT	City
TOTAL	Town
TAX	Postcode
AMOUNT OWING	TOTAL
	TAX
	AmountOwing
	Pet_ID (PK)
	PetName
	Procedure
	Amount
	InvoiceNo (FK)
	CustTitle
	CustFName
	CustSName

## UNF & 1NF

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

Everything about the pet owner/customer

! We have no determinate and need to create one

InvoiceNo (PK)	Branch	Date	Cust Title	CustFN ame	CustS Name	AddressLine1	City	Town	Postcode	Total	Tax	AmountOwing
987	Hilltop Animal Hospital	13/01/2001	Mr	Richard	Cook	123 This Street	My City	Ontario	Z5Z 6G6	54.00	4.32	58.32

Everything about the invoice

! We need to maintain the relationship with customer

# 2NF

CustNo (PK)	CustTitle	CustFName	CustS Name	AddressLine1	City	Town	Postcode
CK001	Mr	Richard	Cook	123 This Street	My City	Ontario	Z5Z 6G6

InvoiceNo (PK)	Branch	Date	CustNo	Total	Tax	Amount Owing
987	Hilltop Animal Hospital	13/01/2001	CK001	54.00	4.32	58.32

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

InvoiceNo (FK)	PetID (PK)	PetName	Procedure	Amount	CustTitle	CustFName	CustSName
987	CKRov001	Rover	Rabies Vaccination	30.00	Mr	Richard	Cook
987	CKMor001	Morris	Rabies Vaccination	24.00	Mr	Richard	Cook

Everything about the pet and their procedure

# 2NF

CustNo (PK)	CustTitle	CustFName	CustS Name	AddressLine1	City	Town	Postcode
CK001	Mr	Richard	Cook	123 This Street	My City	Ontario	Z5Z 6G6

Invoice No (PK)	Branch	Date	CustNo (FK)	Total	Tax	Amount Owing
987	Hilltop Animal Hospital	13/01/2001	CK001	54.00	4.32	58.32

InvoiceNo (FK)	PetID (PK)	PetName	Procedure	Amount	CustNo (FK)
987	CKRov001	Rover	Rabies Vaccination	30.00	CK001
987	CKMor001	Morris	Rabies Vaccination	24.00	CK001



UNF	1NF	2NF
INVOICENO VetBranch DATE Name Address PetName Procedure Amount TotalTax AmountOwing	InvoiceNo (PK) Date BranchName CustTitle CustFName CustSName AddressLine1 City Town Postcode Total Tax AmountOwing  Pet_ID (PK) PetName Procedure Amount InvoiceNo (FK) CustTitle CustFName CustSName	InvoiceNo (PK) Date Branch CustID (FK) Total Tax AmountOwing  CustID (PK) CustTitle CustFName CustSName AddressLine1 City Town Postcode  Pet_ID (PK) PetName Procedure Amount InvoiceNo (FK) CustID (FK)

# UNF, 1NF & 2NF

### 3NF: Determining there are no associations between non-key attributes and any other non-key attributes



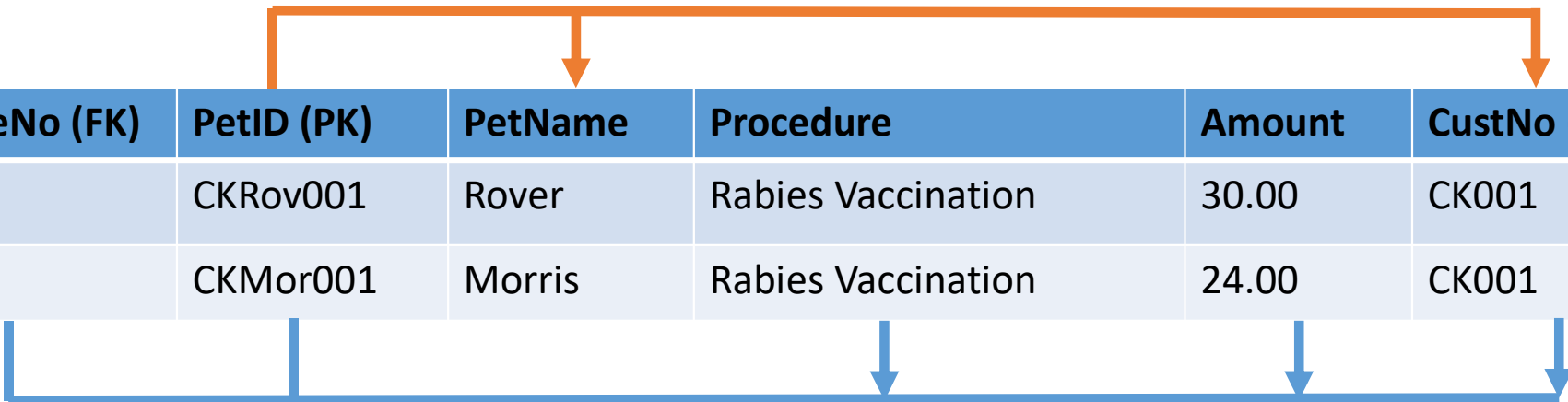
CustNo (PK)	CustTitle	CustFName	CustS Name	AddressLine1	City	Town	Postcode
CK001	Mr	Richard	Cook	123 This Street	My City	Ontario	Z5Z 6G6

Invoice No (PK)	Branch	Date	CustNo (FK)	Total	Tax	Amount Owing
987	Hilltop Animal Hospital	13/01/2001	CK001	54.00	4.32	58.32

Everything about the pet

InvoiceNo (FK)	PetID (PK)	PetName	Procedure	Amount	CustNo (FK)
987	CKRov001	Rover	Rabies Vaccination	30.00	CK001
987	CKMor001	Morris	Rabies Vaccination	24.00	CK001

Everything about procedure and cost



CustNo (PK)	CustTitle	CustFName	CustS Name	AddressLine1	City	Town	Postcode	Customer
CK001	Mr	Richard	Cook	123 This Street	My City	Ontario	Z5Z 6G6	

Invoice No (PK)	Branch	Date	CustNo (FK)	Total	Tax	Amount Owing	Customer_Invoice
987	Hilltop Animal Hospital	13/01/2001	CK001	54.00	4.32	58.32	

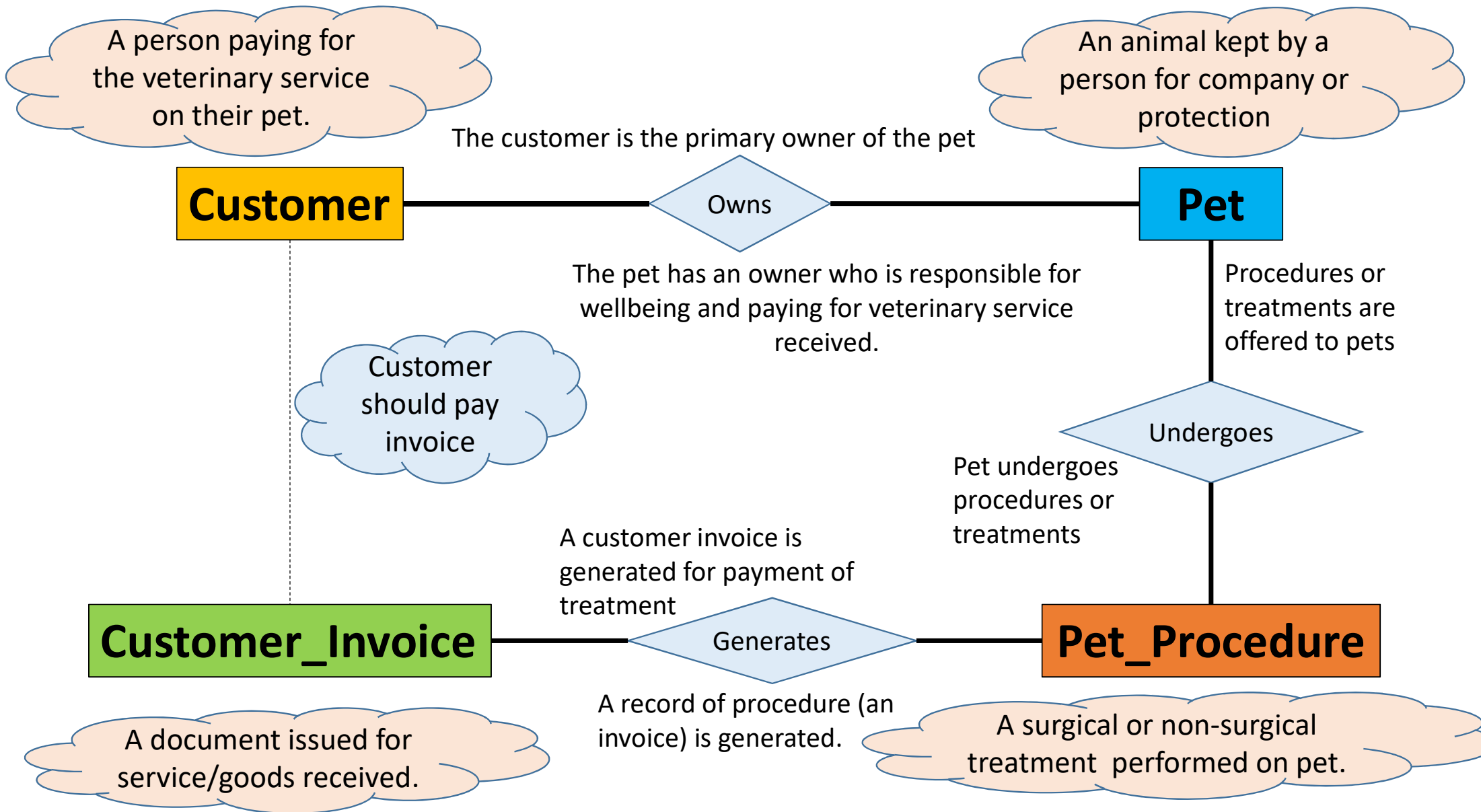
PetID (PK)	PetName	CustNo (FK)	Pet
CKR001	Rover	CK001	
CKM001	Morris	CK001	

**3NF: All relations are uniquely named**

InvoiceNo (FK)	PetID (FK)	Procedure	Amount	CustNo (FK)	Pet_Procedure
987	CKRov001	Rabies Vaccination	30.00	CK001	
987	CKMor001	Rabies Vaccination	24.00	CK001	

UNF	1NF	2NF	3NF	
INVOICENO VetBranch DATE Name Address PetName Procedure Amount TotalTax AmountOwing	InvoiceNo (PK) Date BranchName CustTitle CustFName CustSName AddressLine1 City Town Postcode Total Tax AmountOwing Pet_ID (PK) PetName Procedure Amount InvoiceNo (FK) CustTitle CustFName CustSName	CustID (PK) CustTitle CustFName CustSName AddressLine1 City Town Postcode InvoiceNo (PK) Date BranchName CustID (FK) Total Tax AmountOwing InvoiceNo (FK) Pet_ID (PK) PetName Procedure Amount CustID (FK)	<b>Customer</b> CustID (PK) CustTitle CustFName CustSName AddressLine1 City Town Postcode <b>Customer_Invoice</b> InvoiceNo (PK) Date Branch CustID (FK) Total Tax AmountOwing	<b>Pet</b> Pet_ID (PK) PetName CustID (FK) <b>Pet_Procedure</b> InvoiceNo (FK) Pet_ID (FK) Procedure Amount CustID (FK)

Now model the Hilltop pet tables



For next week convert this data to 3NF

studentid	StudentName	Address	course	modulecode	modulename	tutor	day	room
25000075	Adrian Smith	Beaconsfield	BSc IT Information Technology	CO456	Web	Carlo Lusuardi	Thursday	G5.05
25000075	Adrian Smith	Beaconsfield	BSc IT Information Technology	CO454	Digital Technologies	Hilary Mullen	Wednesday	G5.04
25000075	Adrian Smith	Beaconsfield	BSc IT Information Technology	CO450	Computer Architectures	Justin Luker	Monday	G5.02
25000075	Adrian Smith	Beaconsfield	BSc IT Information Technology	CO457	Business Modelling	Justin Luker	Wednesday	G5.09
25000076	Mohammed Hussain	Milton Keynes	BSc IT Information Technology	CO456	Web	Carlo Lusuardi	Thursday	G5.05
25000076	Mohammed Hussain	Milton Keynes	BSc IT Information Technology	CO454	Digital Technologies	Hilary Mullen	Wednesday	G5.04
25000076	Mohammed Hussain	Milton Keynes	BSc IT Information Technology	CO450	Computer Architectures	Justin Luker	Monday	G5.02
25000076	Mohammed Hussain	Milton Keynes	BSc IT Information Technology	CO457	Business Modelling	Justin Luker	Wednesday	G5.09
25000077	James Miller	Amersham	BSc IT Information Technology	CO456	Web	Carlo Lusuardi	Thursday	G5.05
25000077	James Miller	Amersham	BSc IT Information Technology	CO454	Digital Technologies	Hilary Mullen	Wednesday	G5.04
25000077	James Miller	Amersham	BSc IT Information Technology	CO450	Computer Architectures	Justin Luker	Monday	G5.02
25000077	James Miller	Amersham	BSc IT Information Technology	CO457	Business Modelling	Justin Luker	Wednesday	G5.09
25000078	Jack White	High Wycombe	BSc SFT Software Technologies	CO454	Digital Technologies	Hilary Mullen	Wednesday	G5.04
25000078	Jack White	High Wycombe	BSc SFT Software Technologies	CO450	Computer Architectures	Justin Luker	Monday	G5.02
25000078	Jack White	High Wycombe	BSc SFT Software Technologies	CO452	Programming Concepts	Richard Jones	Tuesday	G5.03
25000078	Jack White	High Wycombe	BSc SFT Software Technologies	CO455	User Experience	Kevin Maher	Tuesday	G5.08
25000079	Michael Cane	Aylesbury	BSc SFT Software Technologies	CO454	Digital Technologies	Hilary Mullen	Wednesday	G5.04
25000079	Michael Cane	Aylesbury	BSc SFT Software Technologies	CO450	Computer Architectures	Justin Luker	Monday	G5.02
25000079	Michael Cane	Aylesbury	BSc SFT Software Technologies	CO452	Programming Concepts	Richard Jones	Tuesday	G5.03
25000079	Michael Cane	Aylesbury	BSc SFT Software Technologies	CO455	User Experience	Kevin Maher	Tuesday	G5.08
25000080	Joe Bloggs	Amersham	BSc SFT Software Technologies	CO454	Digital Technologies	Hilary Mullen	Wednesday	G5.04
25000080	Joe Bloggs	Amersham	BSc SFT Software Technologies	CO450	Computer Architectures	Justin Luker	Monday	G5.02
25000080	Joe Bloggs	Amersham	BSc SFT Software Technologies	CO452	Programming Concepts	Richard Jones	Tuesday	G5.03
25000080	Joe Bloggs	Amersham	BSc SFT Software Technologies	CO455	User Experience	Kevin Maher	Tuesday	G5.08

For next week model the  
pizza and project