

# Data modelling & Normalization

# Learning outcomes

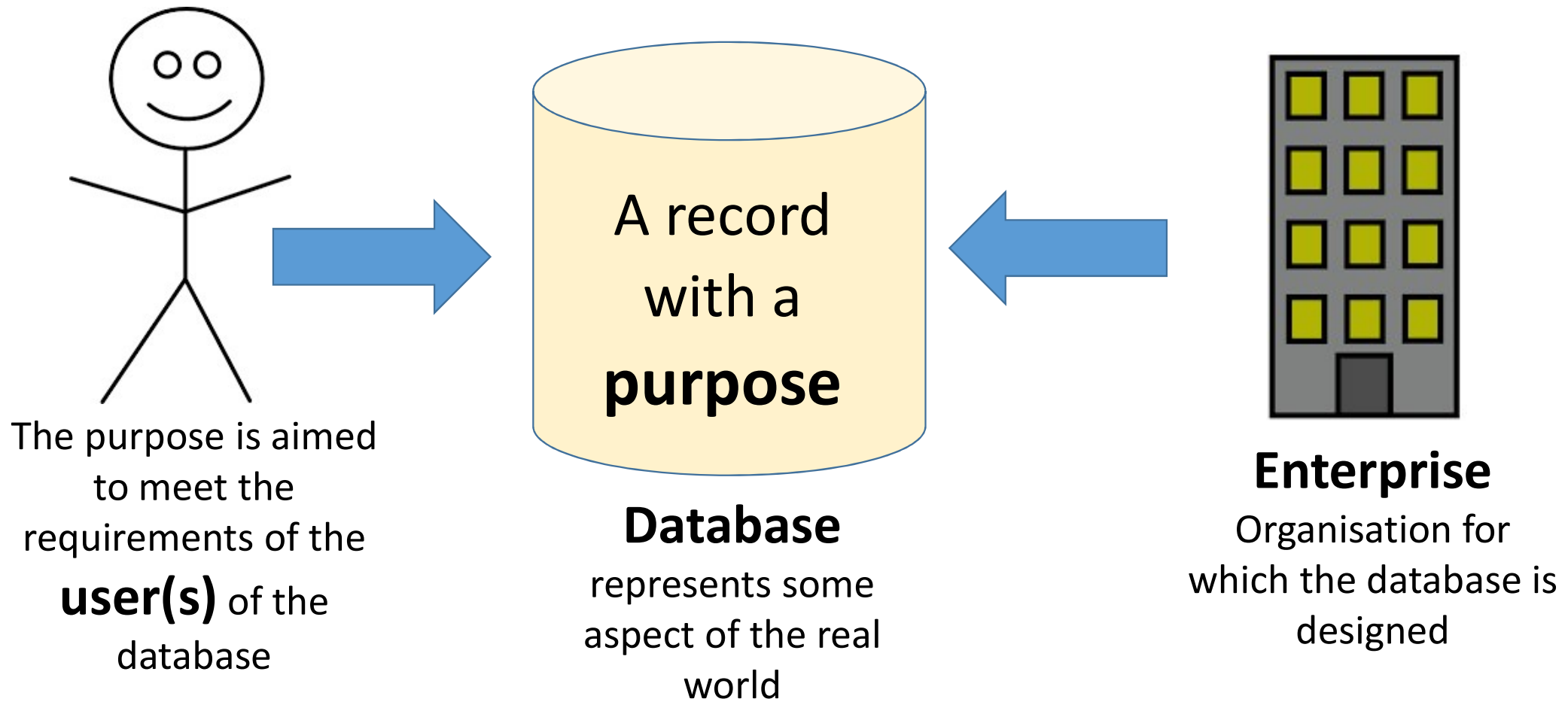
- Understand the database development process
- First step to drawing E-R diagrams for common business situations
- Realize how detailed analysis will produce accurate representations of the database structure
- Continuing with Normalization and affirming your understanding of the process.

# 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

# What is a database?

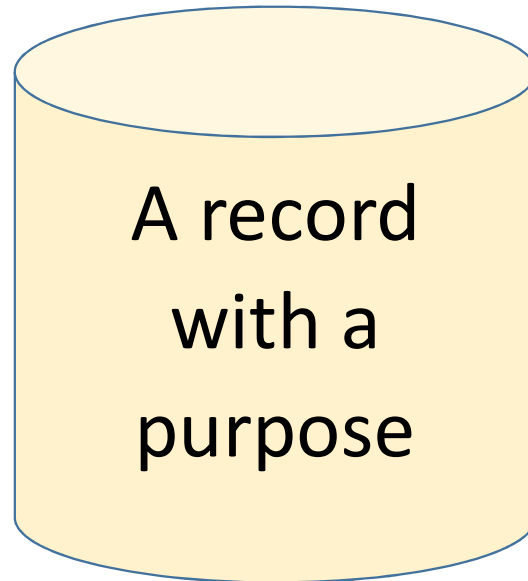
An **employee** works for enterprise



# Types of database

| 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                                  |
| Column family store database |              |  |
| Document database            |              |  |
| Graph database               |              |  |

# Where does the purpose of the database come from?

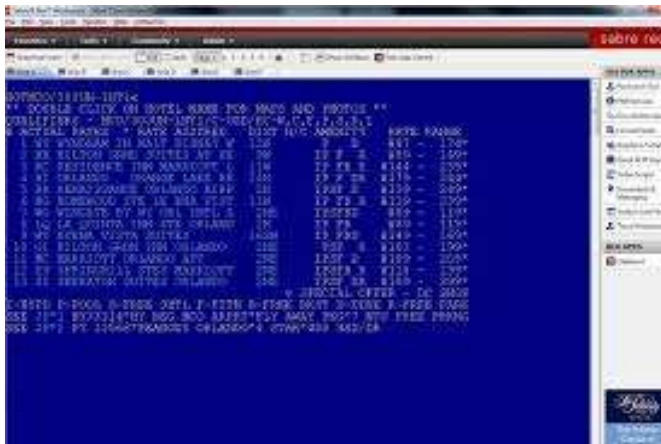


# The need to record... goes back centuries



## Sumerian clay tablets & Cave paintings

The need to record data goes back through prehistory (bronze and iron age)

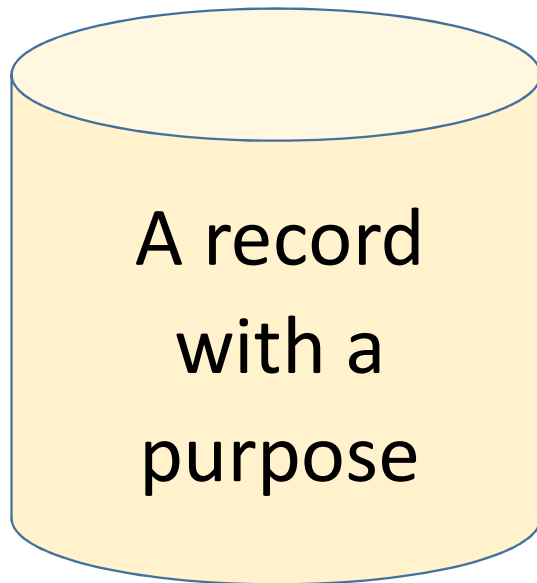


## Computerized databases

1960s: two popular data models in this decade: a network model called CODASYL and a hierarchical model called IMS.

The SABRE system was used by IBM to help American Airlines manage its reservations data.

# Where does the purpose of the database come from?



- The processes taking place in the environment: to record the outcomes
- Triggers in the environment that instigates needing to record data: decisions being made
- A requirement to group coherent data together: produce an output
- Because the data needs to be shared by more than one individual: external views



# Scenario: Need a database



- Imagine you run a fast food restaurant
- You want to automate the food ordering process

**Everyone been to a fast food restaurant?**

**Can you describe food ordering process?**

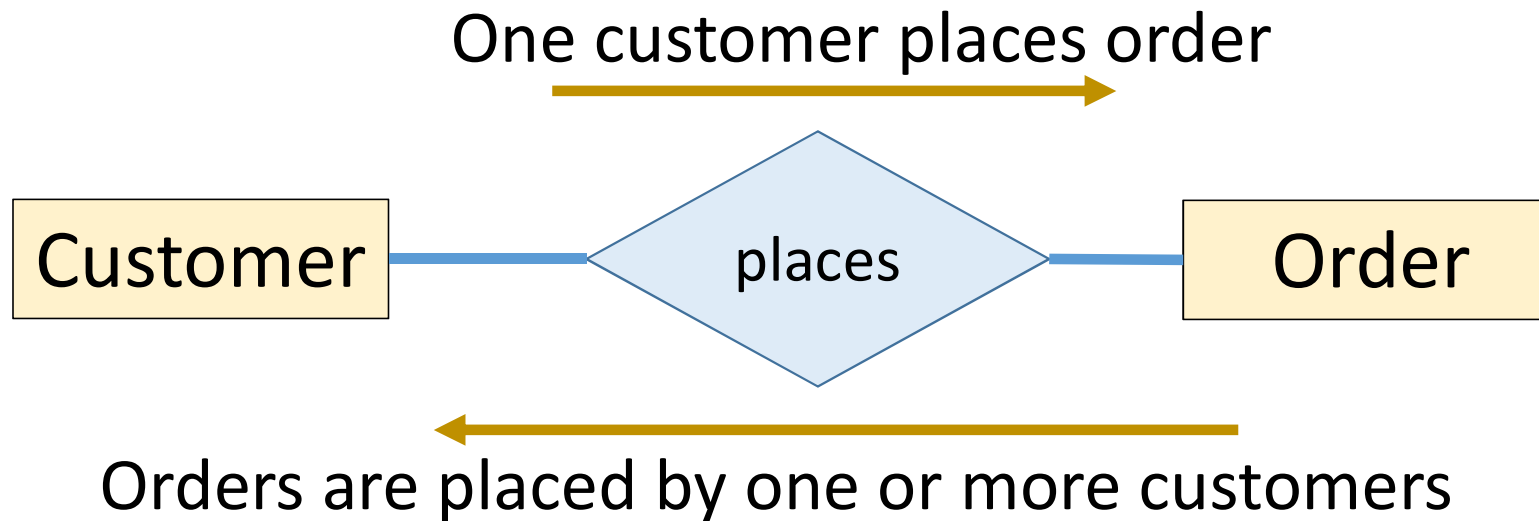
# Scenario: McDonald needs a database



You are Richard McDonald and you run a hamburger and fast food restaurant. Every day customers come in to the restaurant to order food. You employ a number of servers. The servers welcome the customer and take the food order and payment. When ready the customer receives their order

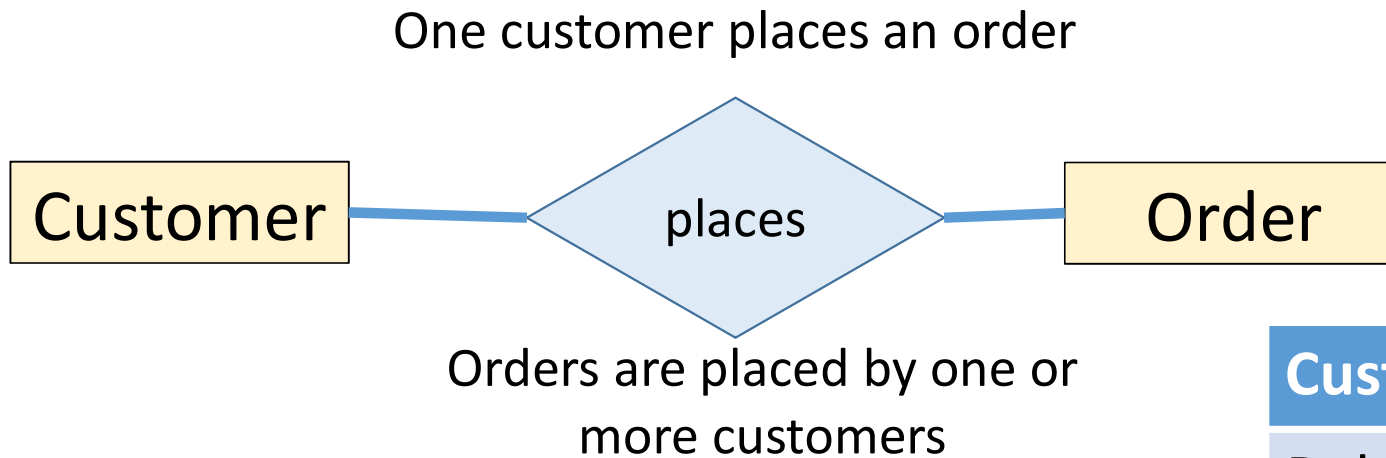
**From this description can you model the database?**

# Scenario: McDonald needs a database



**Does this inform us about the structure of the database?**

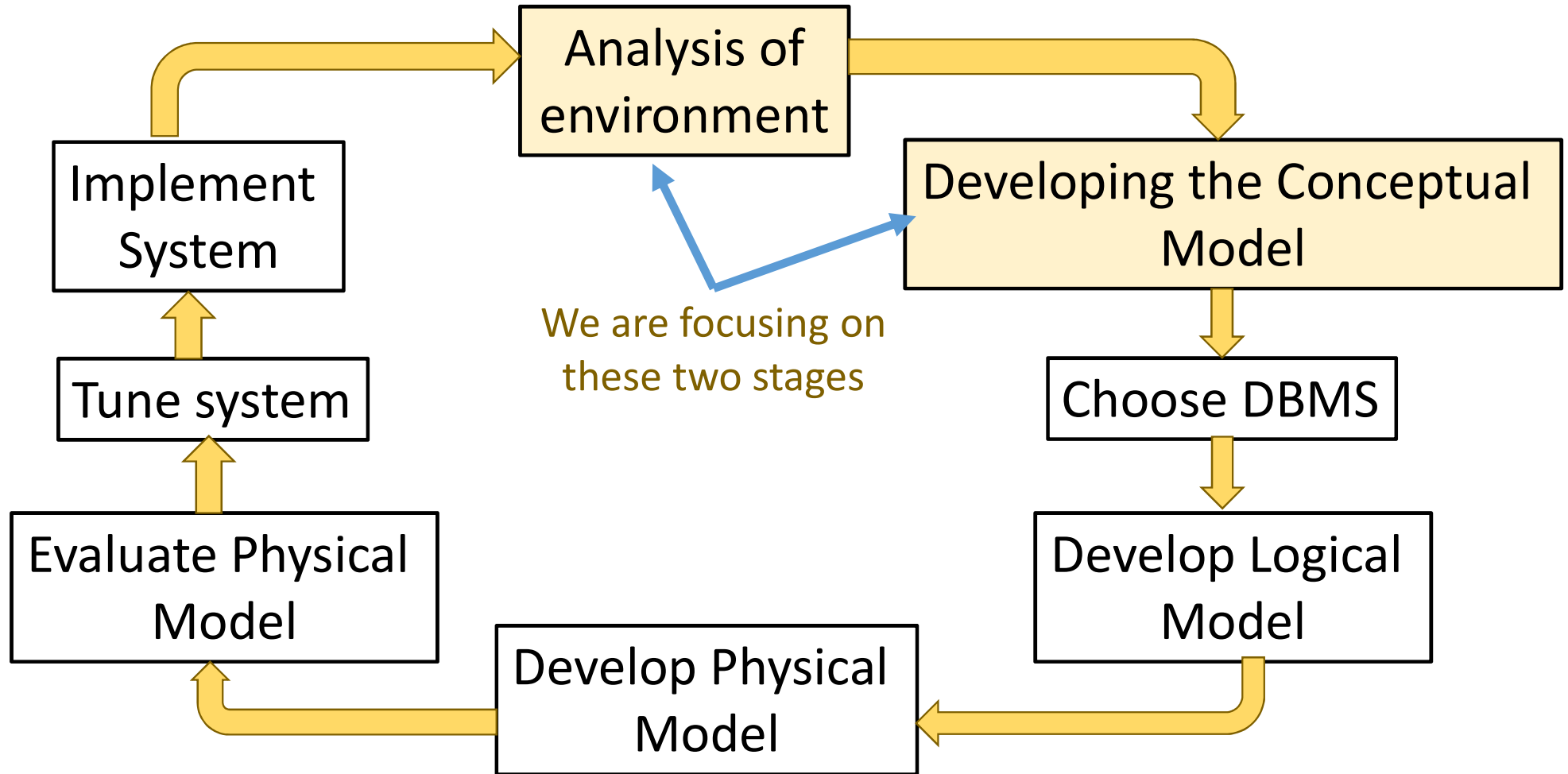
# NO: Because it is not a true representation of the database structure

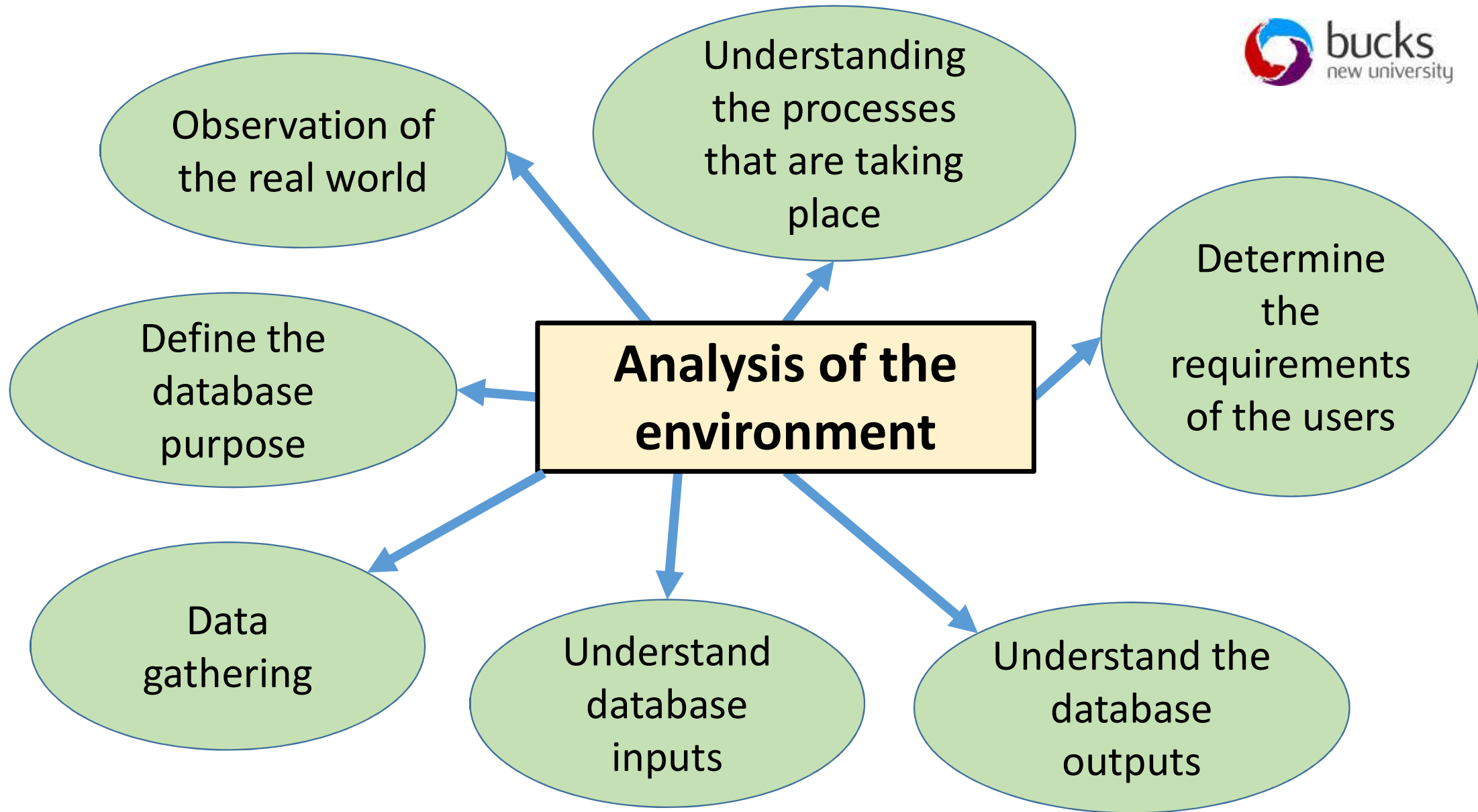


Is this this the database?

| Customer | Order                  |
|----------|------------------------|
| Bob      | Cheeseburger & Fries   |
| Fred     | Chicken Burger & Fries |
| Aryan    | Milkshake              |

# Database development process



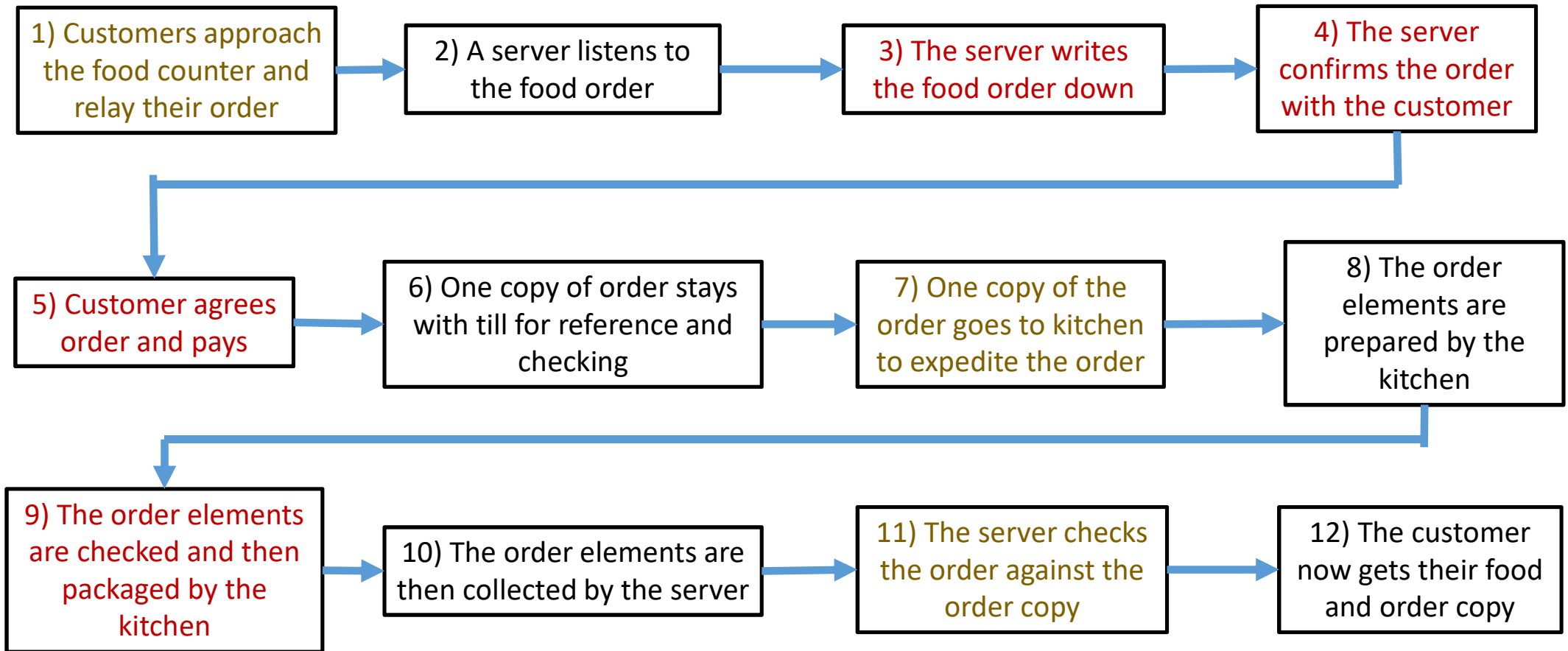


# Observation: McDonald needs a database



- The customer informs the server of their order
- The server records the order
- Takes a payment
- The server sends the order to the kitchen
- When order ready the server gives the order to the customer

# Understanding of the processes that are taking place: McDonald needs a database





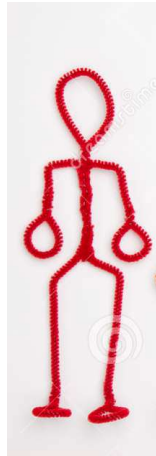
# Requirements of the users: McDonald needs a database

## Forefront functions of our design



### Customers

- Place food order
- Pays for food order
- Eats food order



### Servers

- Accept order
- Expedite order
- Receive Payment
- Quality control

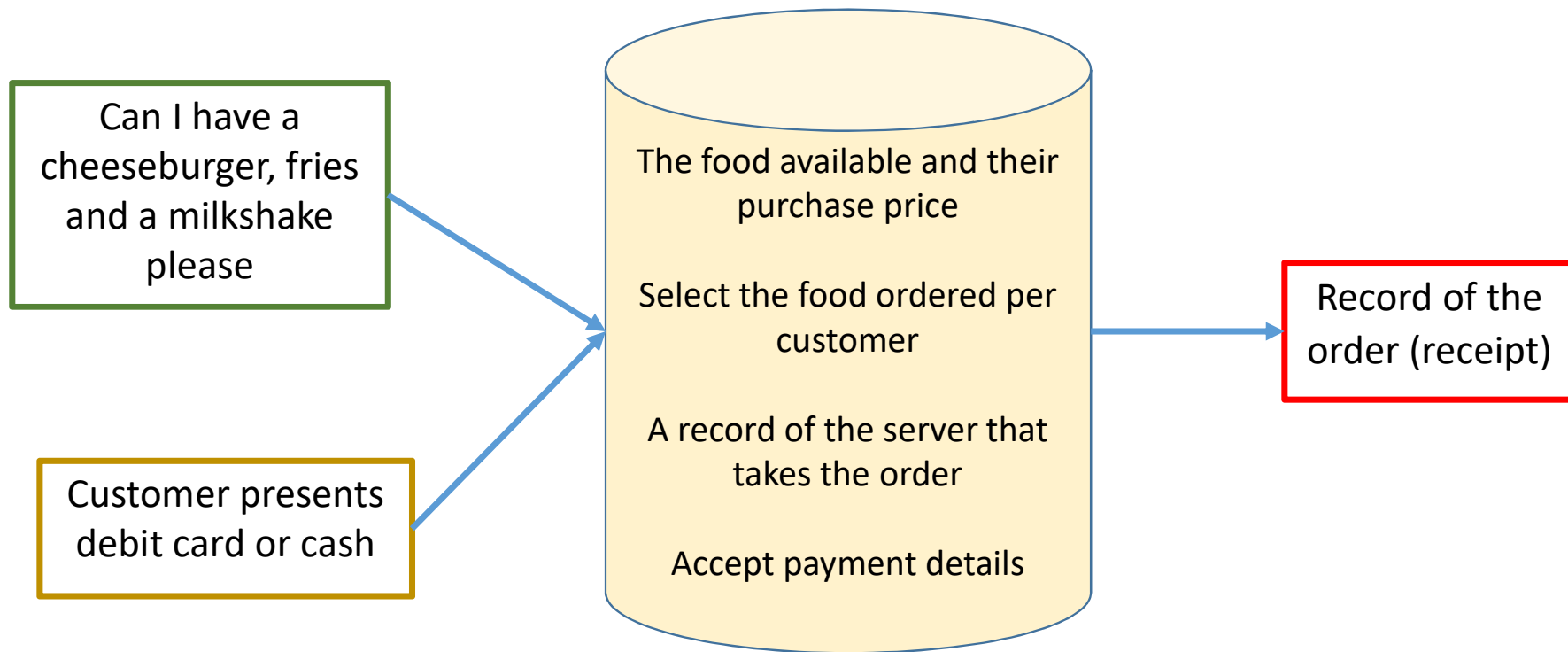
## Background functions we need to be aware of



### Kitchen

- Accept the order
- Make the order elements
- Quality control

# Understand database inputs & outputs: McDonald needs a database



**Can you visualise what the data looks like in the database?**

# Data gathering: McDonald needs a database



| Customer Name | Sort Code | Account Number    | Card Expiry Date | Transaction Date | Order Number | Order Items                       | Order Price | Total | Order Saver Meal Deal | Take Out Total | Server Number | Server Initial | Server Name |
|---------------|-----------|-------------------|------------------|------------------|--------------|-----------------------------------|-------------|-------|-----------------------|----------------|---------------|----------------|-------------|
| B Smith       | 123456    | 5149 1234<br>5678 | 12/12/21         | 05/10/17         | 39           | BM Big Mac                        | £2.99       | £7.26 | Big Mac Meal Deal     | £6.26          | #1001         | JB             | Jack Black  |
|               |           |                   |                  |                  |              | LF Large Fries                    | £1.39       |       |                       |                |               |                |             |
|               |           |                   |                  |                  |              | LM Large Chocolate Milkshake      | £1.89       |       |                       |                |               |                |             |
|               |           |                   |                  |                  |              | MC Mcflurry                       | £0.99       |       |                       |                |               |                |             |
| R Hussain     | 171819    | 9865 6949<br>1874 | 01/01/18         | 06/10/17         | 56           | CLC Chicken Legend with Cool Mayo | £3.59       | £6.27 | Chicken Legend Deal   | £5.27          | #1002         | TH             | Tom Hunt    |
|               |           |                   |                  |                  |              | LF Large Fries                    | £1.39       |       |                       |                |               |                |             |
|               |           |                   |                  |                  |              | LCD Large Cold Drink              | £1.29       |       |                       |                |               |                |             |
| D Tan         | 262728    | 6339 5577<br>9874 | 01/08/20         | 07/10/17         | 44           | SEB Sausage, Egg and Cheese Bagel | £2.29       | £4.18 | Breakfast Bagel Deal  | £3.18          | #1001         | JB             | Jack Black  |
|               |           |                   |                  |                  |              | LC Large Cappuccino               | £1.89       |       |                       |                |               |                |             |
| S Sam         | 293031    | 1000 2333<br>1597 | 01/05/19         | 07/10/17         | 69           | CS5 Chicken Selects 5 Pieces      | £4.19       | £6.87 | Chicken Select Deal   | £5.87          | #1002         | TH             | Tom Hunt    |
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|               |           |                   |                  |                  |              | LCD Large Cold Drink              | £1.29       |       |                       |                |               |                |             |

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| OrderNumber (PK) | OrderItems                    | OrderPrice | Total | OrderSaverMealDeal  | TakeOutTotal | ServerNumber (FK) |
|------------------|-------------------------------|------------|-------|---------------------|--------------|-------------------|
| 39               | Big Mac                       | £2.99      | 7.26  | Big Mac Meal Deal   | £6.26        | #1001             |
|                  | Large Fries                   | £1.39      |       |                     |              |                   |
|                  | Large Chocolate Milkshake     | £1.89      |       |                     |              |                   |
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|                  | Large Fries                   | £1.39      |       |                     |              |                   |
|                  | Large Cold Drink              | £1.29      |       |                     |              |                   |
| 44               | Sausage, Egg and Cheese Bagel | £2.29      | 4.18  | BreakfastBagalDeal  | £3.18        | #1001             |
|                  | Large Cappuccino              | £1.89      |       |                     |              |                   |
| 69               | Chicken Selects 5 Pieces      | £4.19      | 6.87  | Chicken Select Deal | £5.87        | #1002             |
|                  | Large Fries                   | £1.39      |       |                     |              |                   |
|                  | Large Cold Drink              | £1.29      |       |                     |              |                   |

**Order**

| ServerNumber (PK) | ServerInitial | ServerName |
|-------------------|---------------|------------|
| #1001             | JB            | Jack Black |
| #1002             | TH            | Tom Hunt   |

**Server**



## Transaction

| CustomerName | SortCode | AccountNumber (PK) | CardExpiryDate | TransactionDate | OrderNumber (FK) | TakeOutTotal |
|--------------|----------|--------------------|----------------|-----------------|------------------|--------------|
| B Smith      | 123456   | 5149 1234 5678     | 12/12/21       | 05/10/17        | 39               | £6.26        |
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| S Sam        | 293031   | 1000 2333 1597     | 01/05/19       | 07/10/17        | 69               | £5.87        |

For this example no further normalizing needed to model the database structure

## McDonald needs a database: First steps conceptual model

- Transaction is a record of the payment for a food order
- An order is a record of the items of food requested by a customer
- The server is the person that processes the food order and transaction

**Transaction**

**Order**

**Server**

- Entities represent real objects in the mini-world



# Entities represent real objects



Server

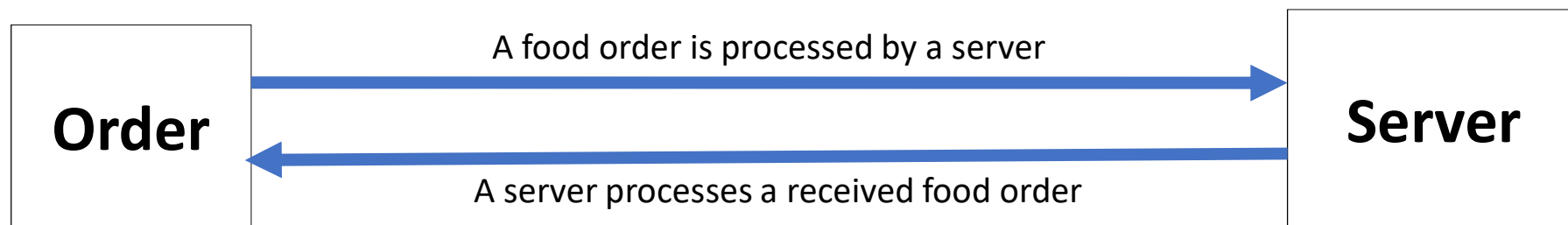
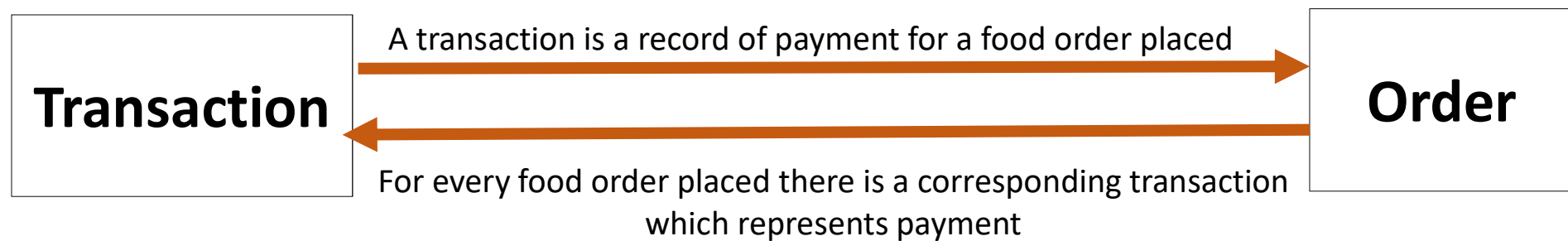
Transaction



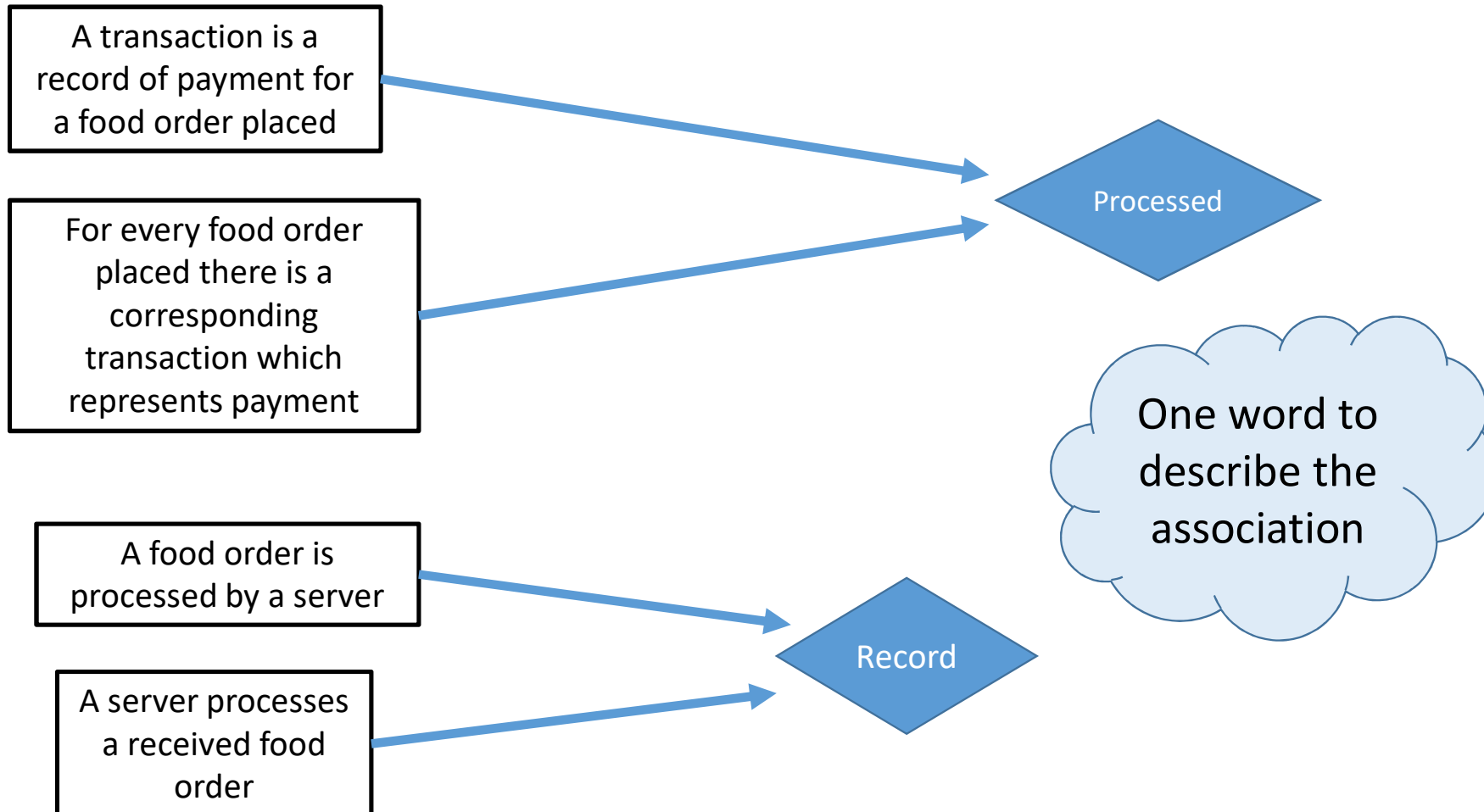
Order

# Understanding entity association

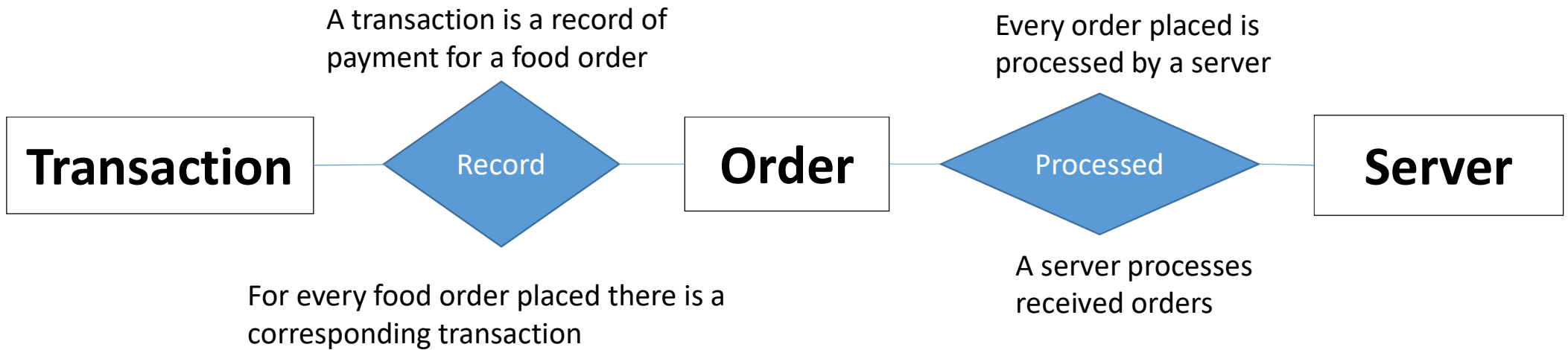
- Entities are linked by their relationship/association
- The links denote the interaction between the entities
- We define the relationship type



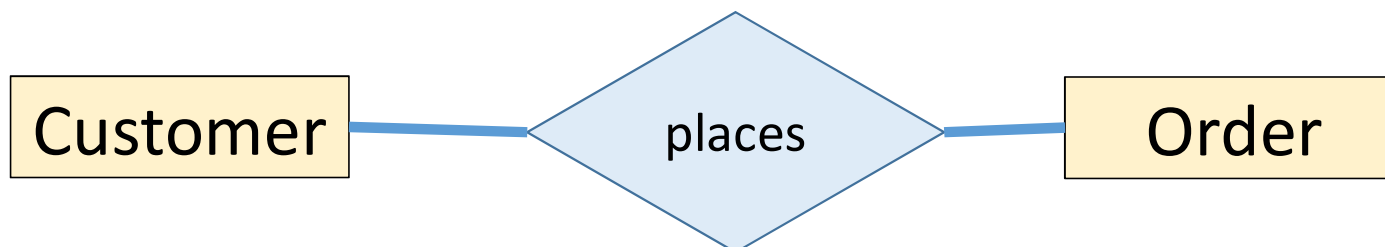
# Understanding entity association



# Understanding entity association

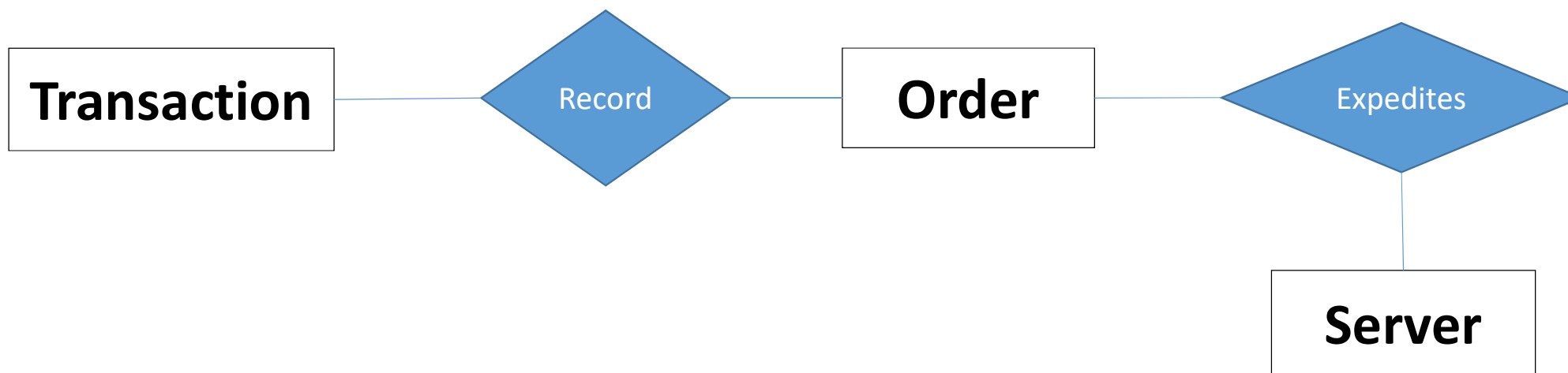


One customer places an order



Orders are placed by one or more customers

**Which model better represents our database structure?**

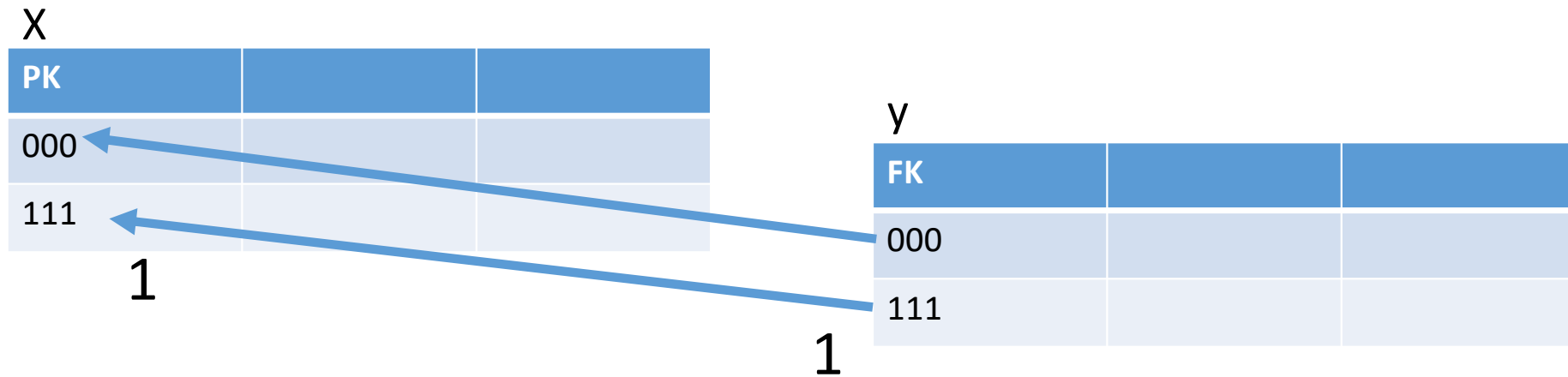
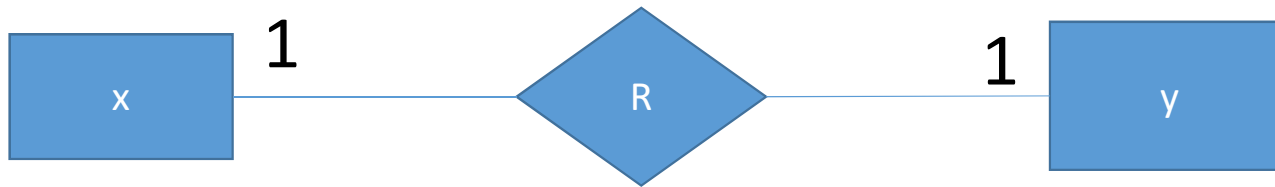


# Understanding constraints

- Two types of constraints: participation and cardinality
- To identify restrictions or constraints on relationship so that there is consideration or an extension to the real world – how it is actually in real life
- The cardinality of a binary relationship is the number of entity instances to which another entity instance can map under that relationship

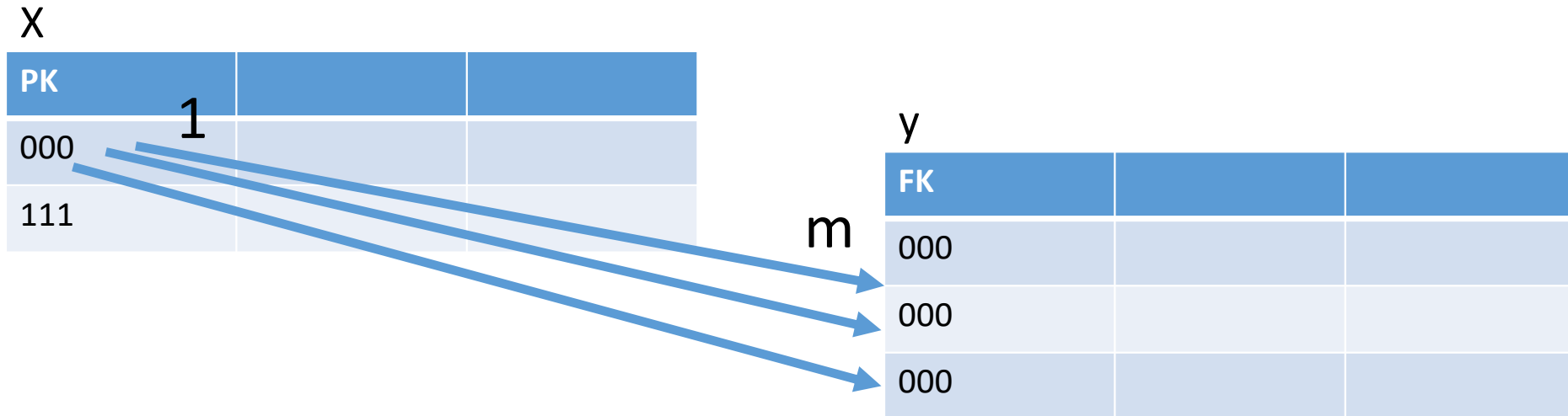
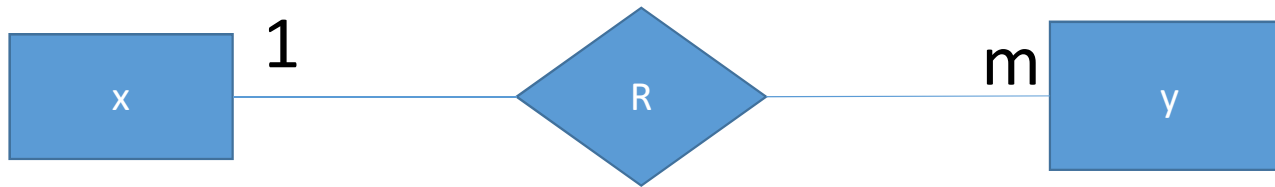
# Understanding constraints: Cardinality

- 1:1: A relationship R from entity X to entity Y, each instance in X is associated with at most one entity instance of Y



# Understanding constraints: Cardinality

- 1:m: A relationship R from entity X to entity Y, each instance in X is associated with many instances of Y





# Understanding constraints (cardinality)



| Transaction <b>1</b> |          |                    |                |                 |             |              |
|----------------------|----------|--------------------|----------------|-----------------|-------------|--------------|
| CustomerName         | SortCode | AccountNumber (PK) | CardExpiryDate | TransactionDate | OrderNumber | TakeOutTotal |
| B Smith              | 123456   | 5149 1234 5678     | 12/12/21       | 05/10/17        | 39          | £6.26        |
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| Order          |                               |            |       |                     |              |              |
|----------------|-------------------------------|------------|-------|---------------------|--------------|--------------|
| Order Number   | OrderItems                    | OrderPrice | Total | OrderSaverMealDeal  | TakeOutTotal | ServerNumber |
| 39<br><b>1</b> | Big Mac                       | £2.99      | 7.26  | Big Mac Meal Deal   | £6.26        | #1001        |
|                | Large Fries                   | £1.39      |       |                     |              |              |
|                | Large Chocolate Milkshake     | £1.89      |       |                     |              |              |
|                | Mcflurry                      | £0.99      |       |                     |              |              |
| 56             | Chicken Legend with Cool Mayo | £3.59      | 6.27  | Chicken Legend Deal | £5.27        | #1002        |
|                | Large Fries                   | £1.39      |       |                     |              |              |
|                | Large Cold Drink              | £1.29      |       |                     |              |              |
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|                | Large Cappuccino              | £1.89      |       |                     |              |              |
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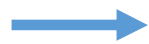
# Proving constraints (cardinality)



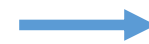
Customer A



Orders meal and  
pays by cash



Cash transaction



1 order  
1 transaction



Customer B



Orders meal and pays  
by debit card



Debit card  
transaction



1 order  
1 transaction



Customer C



Orders meal, but error in  
order and given order for  
free



Would there be a  
transaction?



1 order  
1 transaction £0

# Representing binary relationships (cardinality)



# Understanding constraints (cardinality)

| Order        |                               |            |       |                     |              |              |
|--------------|-------------------------------|------------|-------|---------------------|--------------|--------------|
| Order Number | OrderItems                    | OrderPrice | Total | OrderSaverMealDeal  | TakeOutTotal | ServerNumber |
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|              | Large Cold Drink              | £1.29      |       |                     |              |              |

M

1

| Server       |               |            |
|--------------|---------------|------------|
| ServerNumber | ServerInitial | ServerName |
| #1001        | JB            | Jack Black |
| #1002        | TH            | Tom Hunt   |

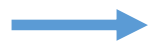
# Proving constraints (cardinality)



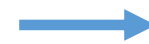
Customer A



Orders meal and  
pays by cash



Cash transaction



1 order  
1 transaction



Customer B



Orders meal and pays  
by debit card



Debit card  
transaction



1 order  
1 transaction



Customer C



Orders meal, but error in  
order and given order for  
free

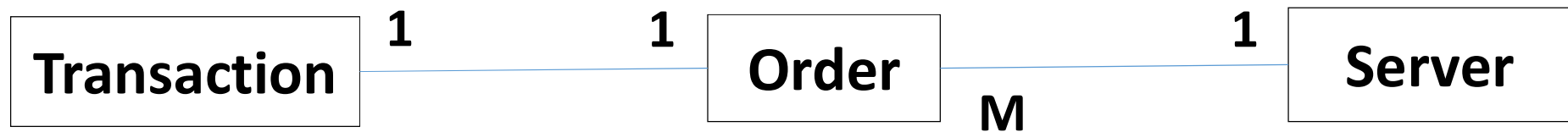


Would there be a  
transaction?



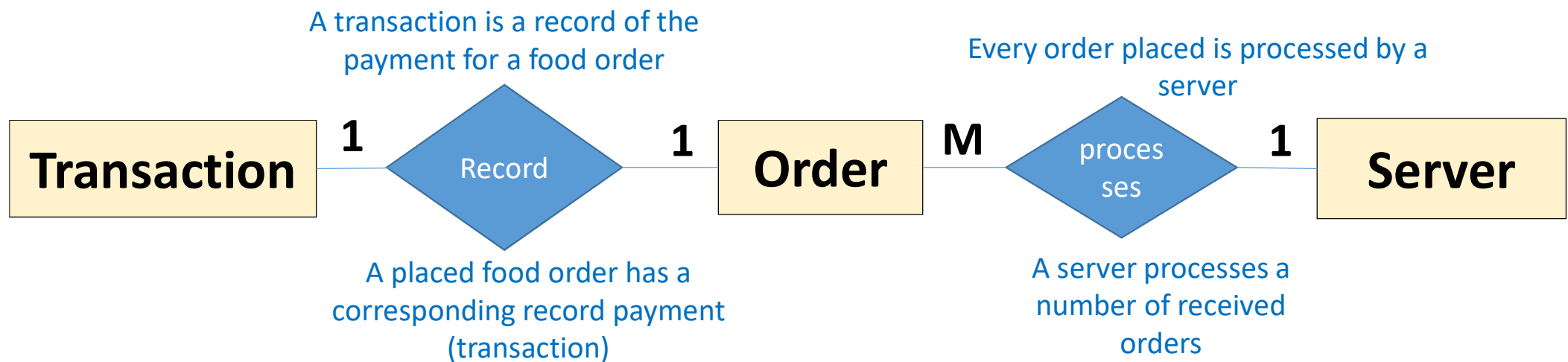
1 order  
1 transaction £0

# Representing binary relationships (cardinality)



# Representing entity association & Representing binary relationships (cardinality)

- Transaction is a record of the payment for a food order
- An order is a record of the items of food requested by a customer
- The server is the person that processes the food order and transaction



**1: 1** For every order there can only be one transaction payment and therefore one transaction can only correspond to one payment.

**1:M** One server can only deal with one order at a time. However, a server in a working day can deal with a number of orders

# Normalization

- Continuing with Normalization and affirming your understanding of the process.



# Normalization steps

| <b>1NF</b>   | <b>2NF</b>  | <b>3NF</b>  |
|--|---|---|
| <p>1) Each cell in the table contains one value.</p> <p>2) Each attribute has a unique name – the column names are unique</p> <p>3) Each Table/Relation has a primary key (PK) which uniquely identifies each row/tuple in the relation.</p> | <p>1) If the relation is in first normal form (1NF)</p> <p>2) If all non-key attributes are fully dependent on the primary key</p> <p>3) If each relation has a primary key</p> | <p>1) If the relation is in second normal form (2NF)</p> <p>2) If all associations where all non-key attributes are not dependent on any other non-key attributes are resolved</p> <p>3) If each relation has a primary key</p> <p>4) If all relations are uniquely named</p> |

## Questions One: Can you convert the following table to 1NF?

| Student Number | StudentName | Address   | Module Details  |
|----------------|-------------|---|---|
| 210458897      | Bob Jones   | 31 New Street ,<br>High Wycombe,<br>Buckinghamshire<br>HP12 7CV | CO560 Databases<br>CO550 Web Development<br>CO555 Research Methods<br>CO565 Mobile Technology |

## Question Two: Can you convert the following table to 2NF?

| CNO (PK)    | C569         | C258         |
|-------------|--------------|--------------|
| Title       | Ms           | Mr           |
| Initials    | L            | M            |
| SName       | Page         | Book         |
| Street      | High Street  | New Street   |
| City        | High Wycombe | High Wycombe |
| PCode       | HP55 9PQ     | HP56 7KL     |
| CreditLimit | £5000.00     | £10000.00    |
| AccBal      | £3500.00     | £5500.00     |
| InvNo       | C569TYHR     | C258RFGB     |
| InvDate     | 21/06/2015   | 03/01/2015   |
| InvAmount   | £1500.00     | £2300.00     |

## Question Three: Can you convert the following table to 3NF?

| ProdNo (PK) | ProDesc | ProdPrice | QTYinStock | SuppNo | SuppName   | Street       | City    | PCode    |
|-------------|---------|-----------|------------|--------|------------|--------------|---------|----------|
| PO123       | Widget  | £5.00     | 5          | W564   | Widget Ltd | High Street  | Croydon | CO12 8GH |
| PO582       | Bolts   | £10.00    | 1000       | B789   | Bolts Ltd  | Steel Street | London  | SW1 9KJ  |
| PO895       | Widget  | £5.00     | 15         | W564   | Widget Ltd | High Street  | Croydon | CO12 8GH |