Chapter 2

Data Models, Database languages

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- Basics of ER model, relational model and other models
- Database Language types, constraints, keys, design issues,
- Entity-relationship diagram, weak entity sets

Data Model

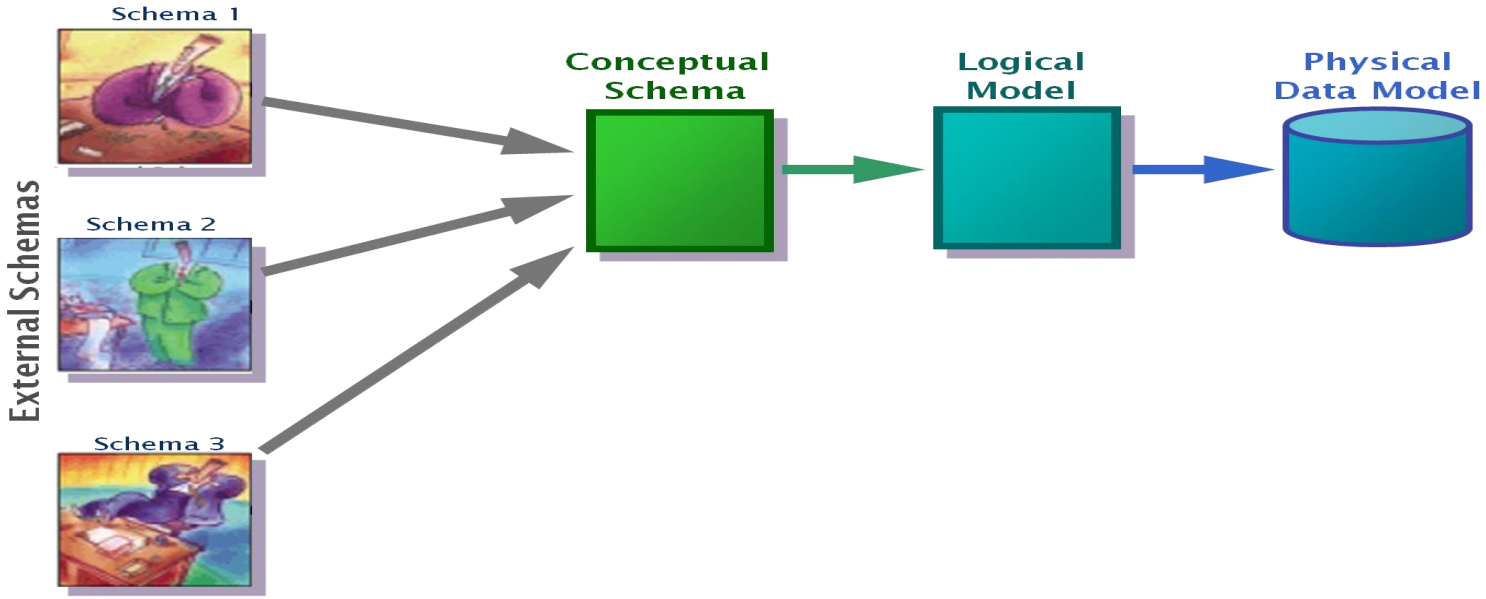
- Data Model is a collection of conceptual tools for describing data, data relationships, data semantics and consistency constraint.
- A data model is a conceptual representation of data structures required for data base and is very powerful in expressing and communicating the business requirements.
- A data model visually represents the nature of data, business rules governing the data, and how it will be organized in the database.

- A data model provides a way to describe the design of a database at the physical, logical and view levels.

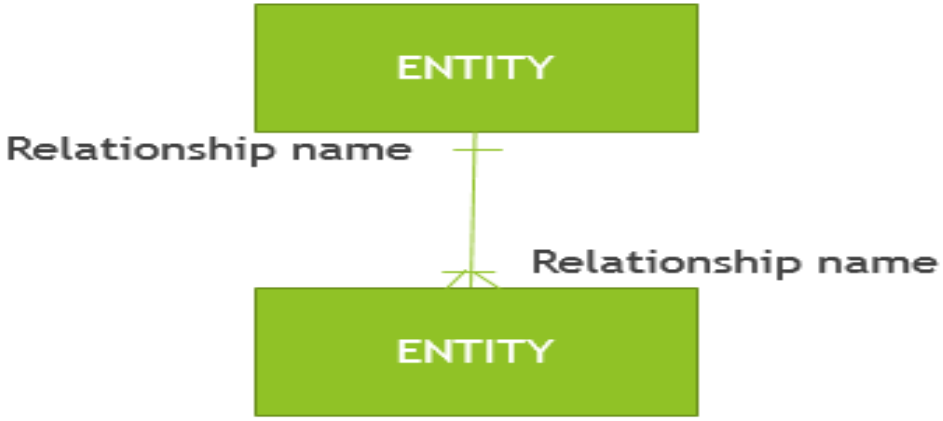
- There are three different types of data models produced while progressing from requirements to the actual database to be used for the information system

Different Data Models

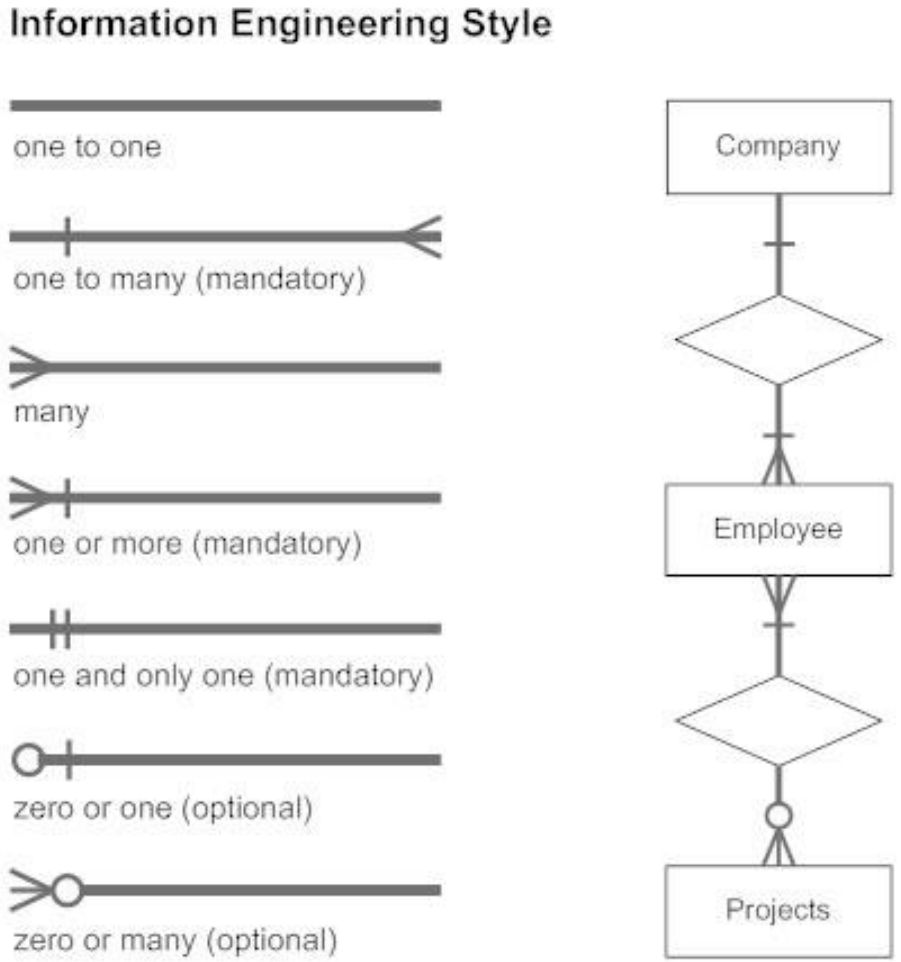
- Conceptual: describes WHAT the system contains.
- Logical: describes HOW the system will be implemented, regardless of the DBMS.
- Physical: describes HOW the system will be implemented using a specific DBMS.



A data model consists of entities related to each other on a diagram:

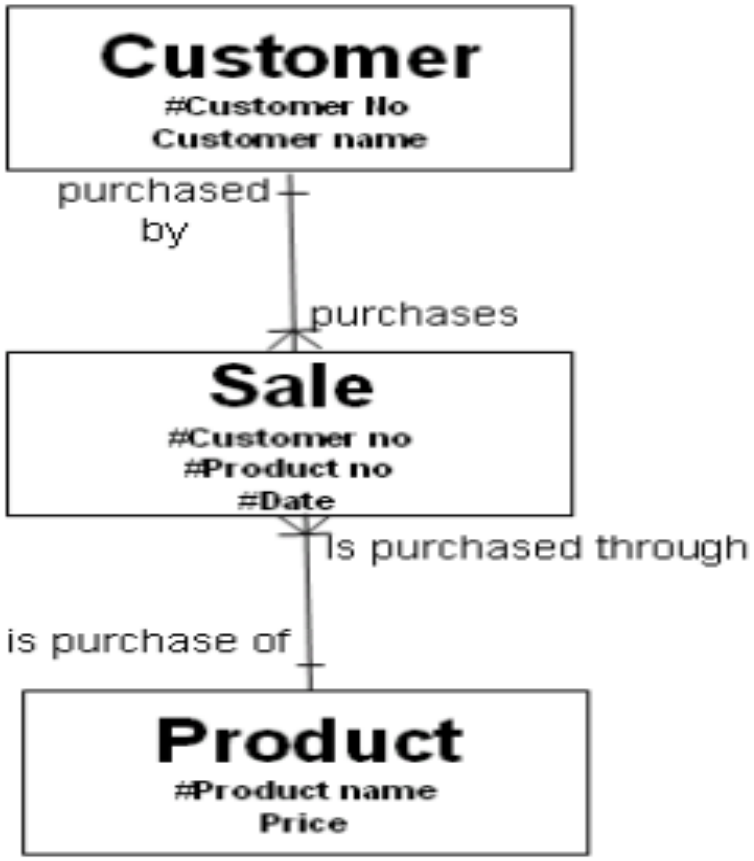


Data Model Element	Definition
Entity	A real world thing or an interaction between 2 or more real world things.
Attribute	The atomic pieces of information that we need to know about entities.
Relationship	How entities depend on each other in terms of why the entities depend on each other (the relationship) and what that relationship is (the cardinality of the relationship).



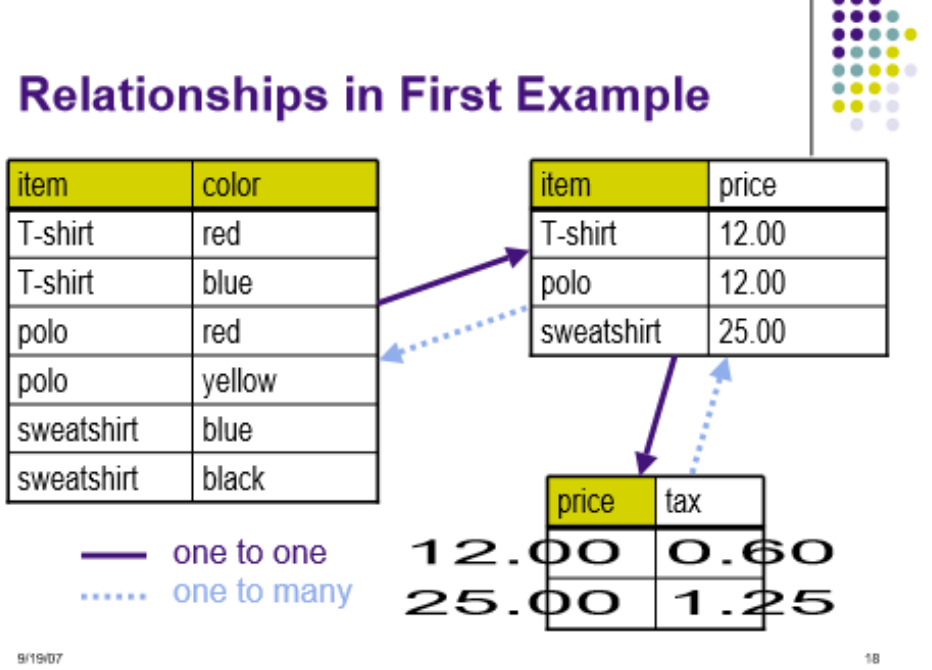
Example:

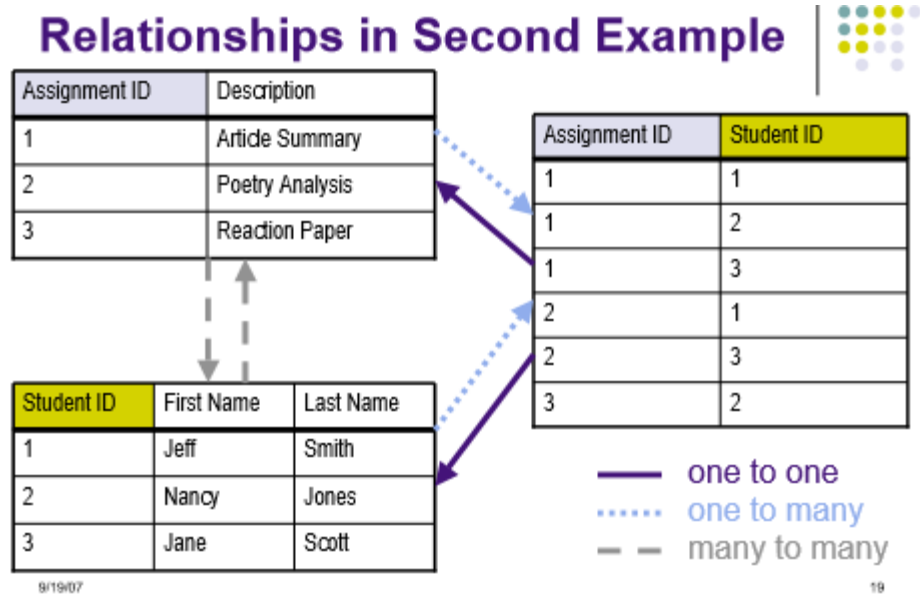
- Given that …
- "Customer" is an entity.
- "Product" is an entity.
- For a "Customer" we need to know their "customer number" attribute and "name" attribute.
- For a "Product" we need to know the "product name" attribute and "price" attribute.
- "Sale" is an entity that is used to record the interaction of "Customer" and "Product".



Relationships

- Relationships are created between tables using the primary key field and a foreign key field
- One to One Relationship One record in a table relates to one record in another table
- One to Many Relationship One record in a table can relate to many records in another table
- Many to Many Relationship Many records in one table can relate to many records in another table





Notes

- By convention, entities are named in the singular.
- The attributes of “Customer” are “Customer No” (which is the unique identifier or primary key of the “Customer” entity and is shown by the # symbol) and “Customer Name”.
- “Sale” has a composite primary key made up of the primary key of “Customer”, the primary key of “Product” and the date of the sale.
- Think of entities as tables, think of attributes as columns on the table and think of instances as rows on that table:

Customer *(entity)*

No *(attribute)*	Name *(attribute)*	
10	Fred Bloggs	*(instance)*
67	Freda Jones	*(instance)*

Sale

Customer No	Product Code	Date
10	101	21/2/2020
67	452	22/2/2020

Product

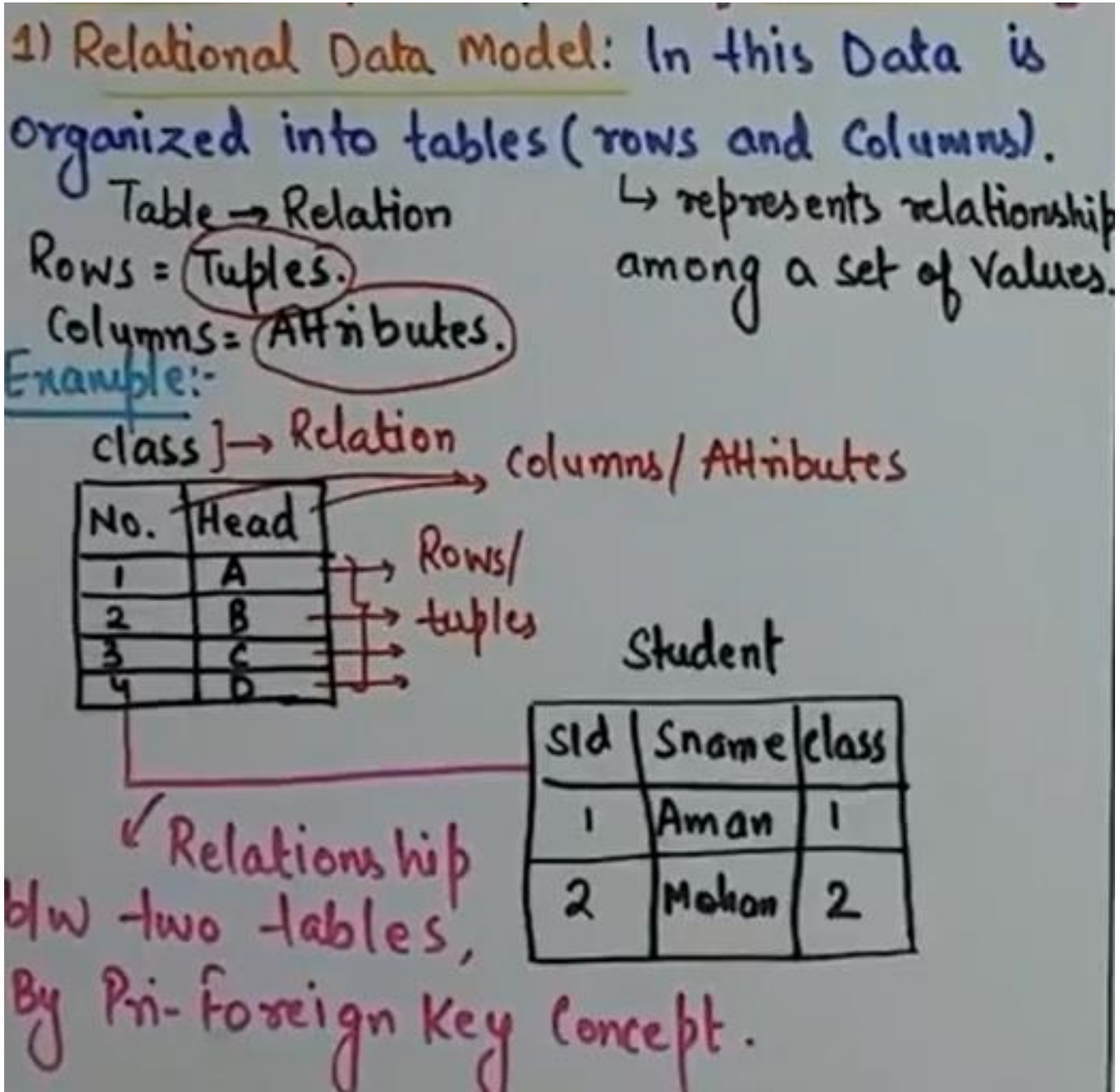
Code	Name	Price
101	Flange	£123.00
452	Blitwort	£34.50

- If we want to know the price of a Sale, we can 'find' it by using the "Product Code" on the instance of "Sale" we are interested in and look up the corresponding "Price" on the "Product" entity with the matching "Product Code".

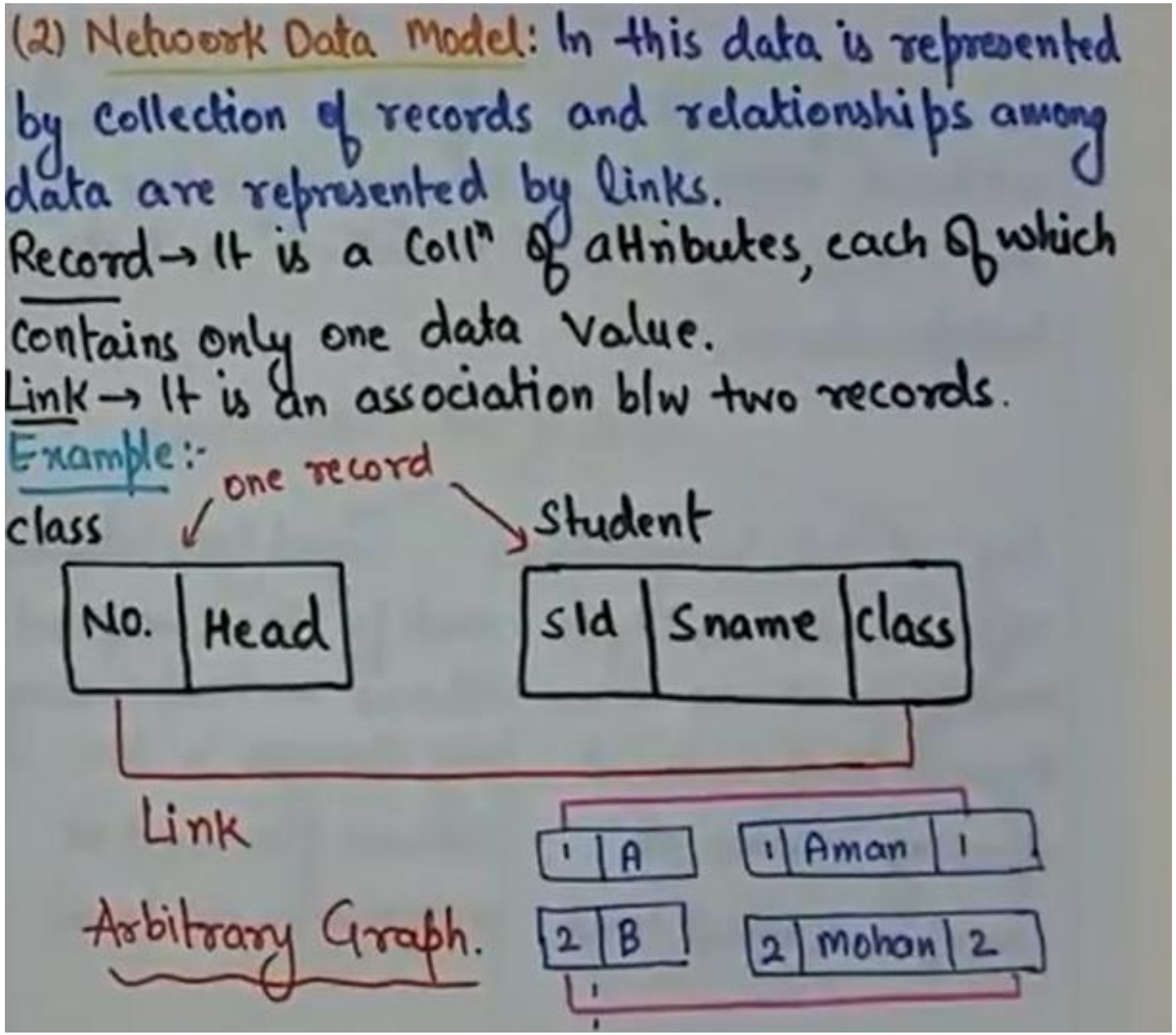
Types of Data Models

- Relational Data Model
- Network Data Model
- Hierarchical Data Model
- Entity-Relationship (E-R) Models

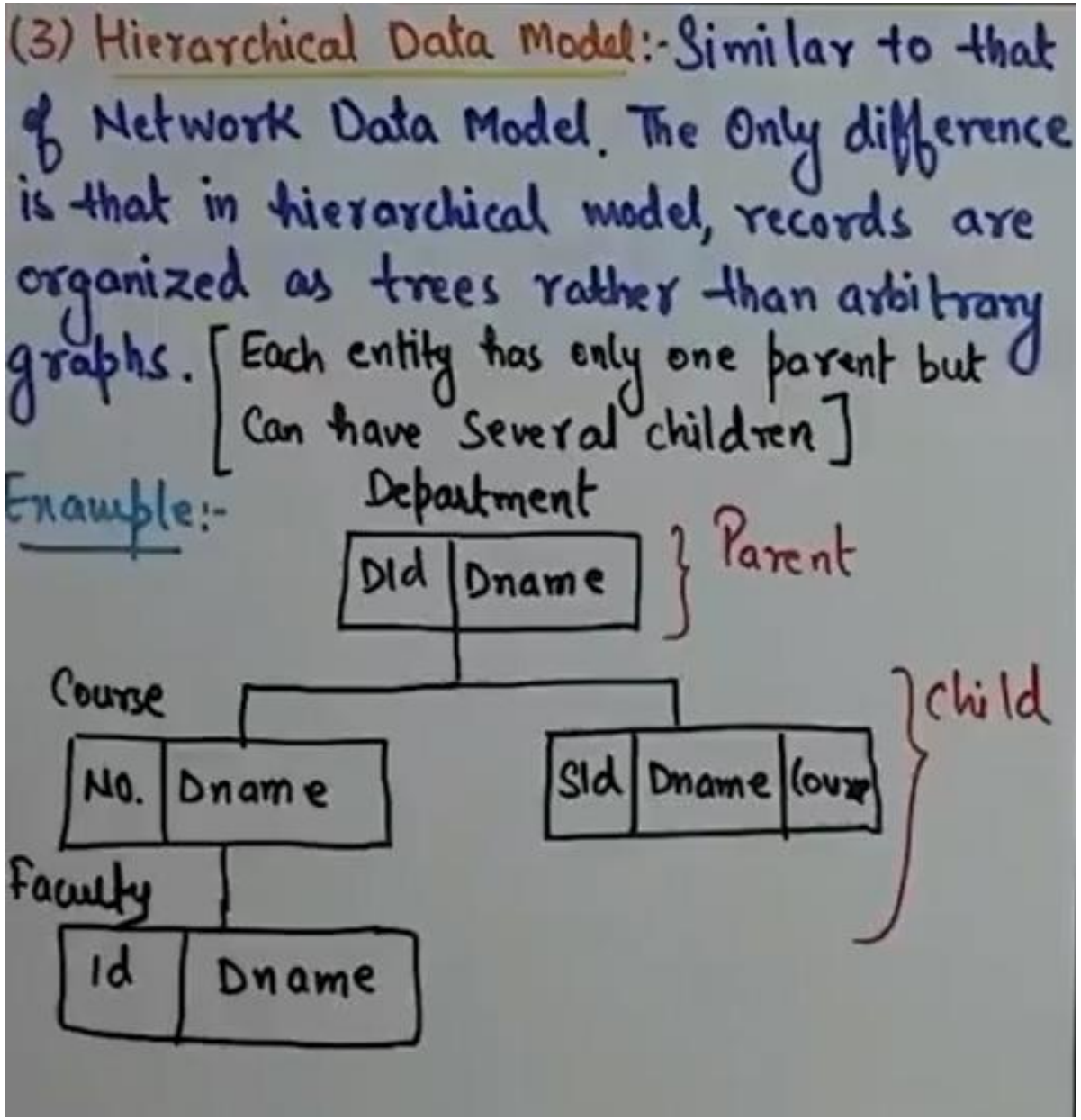
Relational Data Model



Network Data Model

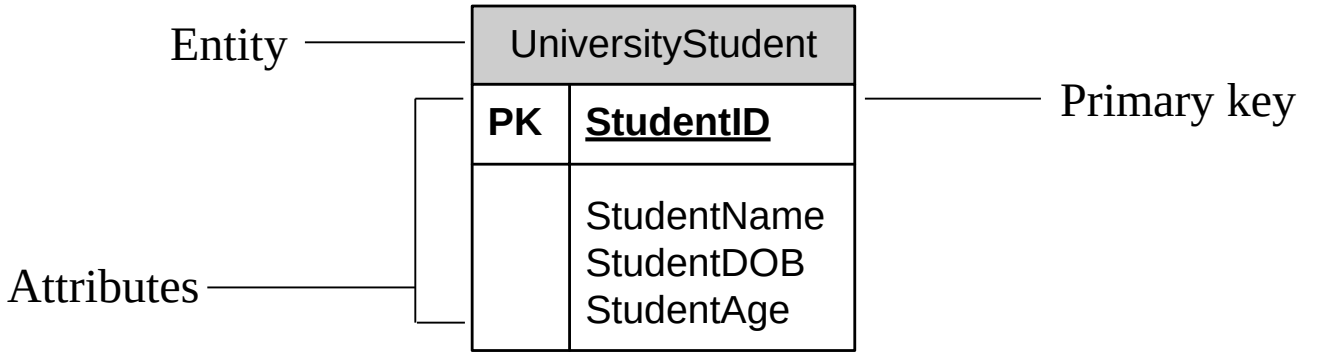


Hierarchical Data Model



Entity-Relationship Model

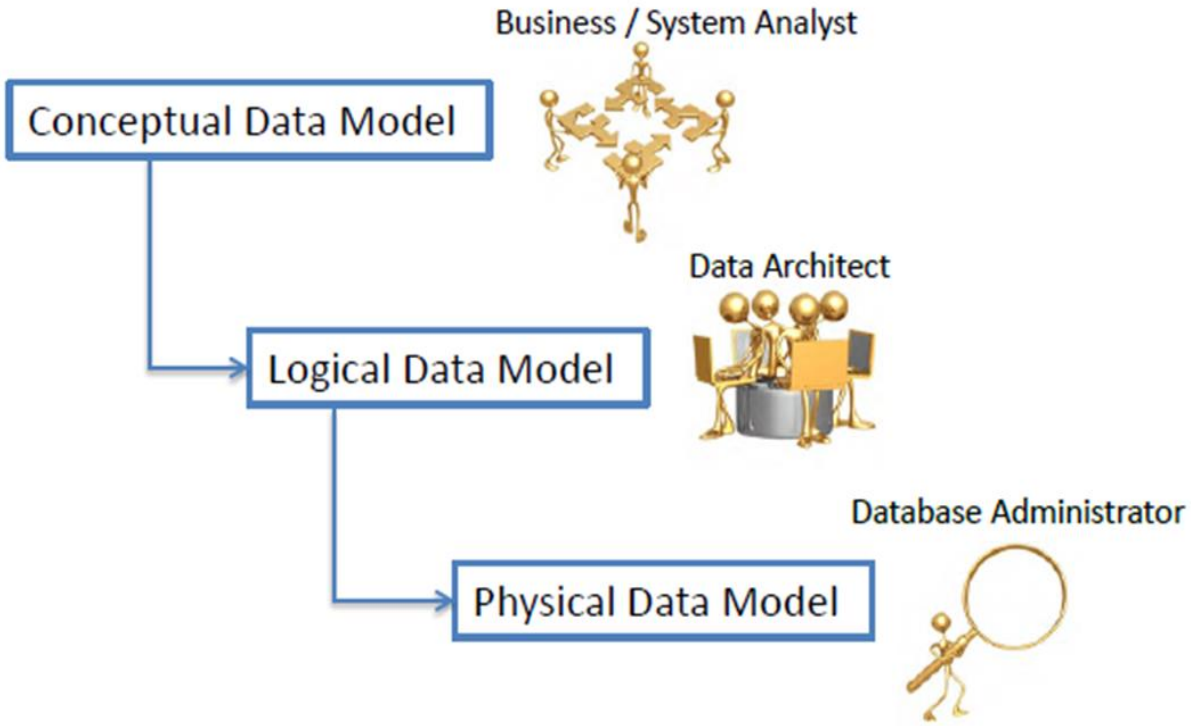
- Entity Relationship Diagrams (ERD) as this is the most widely used
- ERDs have an advantage in that they are capable of being normalized



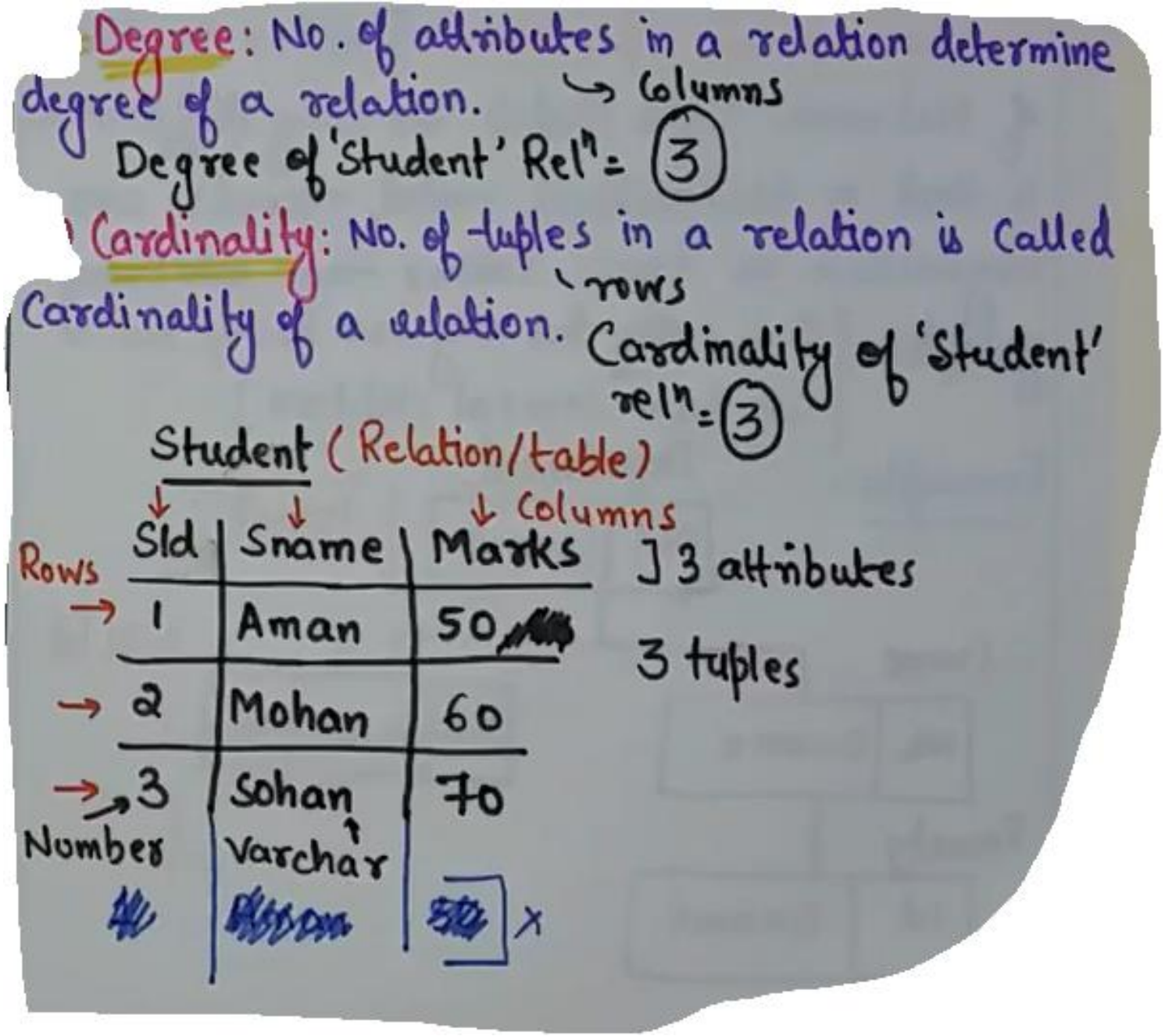
- Represent entities as rectangles
- List attributes within the rectangle

Why and When

- The purpose of a data model is to describe the concepts relevant to a domain, the relationships between those concepts, and information associated with them.



- Used to model data in a standard, consistent, predictable manner in order to manage it as a resource.
- To have a clear picture of the base data that your business needs.
- To identify missing and redundant base data.
- To Establish a baseline for communication across functional boundaries within your organization.
- Provides a basis for defining business rules.
- Makes it cheaper, easier, and faster to upgrade your IT solutions.



Cardinality specifies how many instances of an entity relate to one instance of another entity. Ordinality is also closely linked to cardinality. While cardinality specifies the occurrences of a relationship, ordinality describes the relationship as either mandatory or optional. In other words, cardinality specifies the maximum number of relationships and ordinality specifies the absolute minimum number of relationships.

Primary and Foreign Key Fields

A key is a set of one or more attributes, which is used to uniquely identification with in a table.

Primary Key :

- Primary key fields must be unique and cannot contain a null value.
- Each table should have a primary key field.
- Concatenated keys: using more than one field as a primary key field. **Foreign Key**:
- Fields in a table that refer to the primary key in another table
- The data in this field must exactly match data contained in the primary key field.

Database:

Tables, Primary Keys, Foreign Key and Relationships

Potential relational database for Coca-Cola Bottling Co.

CUSTOMER

Customer ID	Customer Name	Contact Name	Phone
23	Dave's Sub Shop	David Logan	(555)333-4545
43	Pizza Palace	Debbie Fernandez	(555)345-5432
765	T's Fun Zone	Tom Rejecci	(555)565-6655

ORDER

Order ID	Order Date	Customer ID	Distributor ID	Distributor Fee	Total Due
34561	8/4/2008	23	DEN8001	$22.00	$145.75
34562	8/6/2008	23	DEN8001	$12.95	$67.95
34563	8/5/2008	765	NY9001	$29.50	$249.50

ORDER LINE

Order ID	Line Item	Product ID	Quantity
34561	1	12345AA	75
34561	2	12346BB	50
34561	3	12347CC	100
34562	1	12349EE	100
34563	1	12345AA	100
34563	2	12346BB	100
34563	3	12347CC	50
34563	4	12348DD	50
34563	5	12349EE	100

DISTRIBUTOR

Distributor ID	Distributor Name
DEN8001	Hawkins Shipping
OH3001	ABC Trucking
NY9001	Van Distributors

PRODUCT

Product ID	Product Description	Price
12345AA	Coca-Cola	$0.55
12346BB	Diet Coke	$0.55
12347CC	Sprite	$0.55
12348DD	Diet Sprite	$0.55

Order Number: 34562

Coca-Cola Bottling Company of Egypt
Sample Sales Order

Customer: Dave's Sub Shop

Date: 8/6/2008

Quantity	Product	Price	Amount
100	Vanilla Coke	$0.55	$55

Distributor Fee $12.95

Order Total $67.95

Super Key:

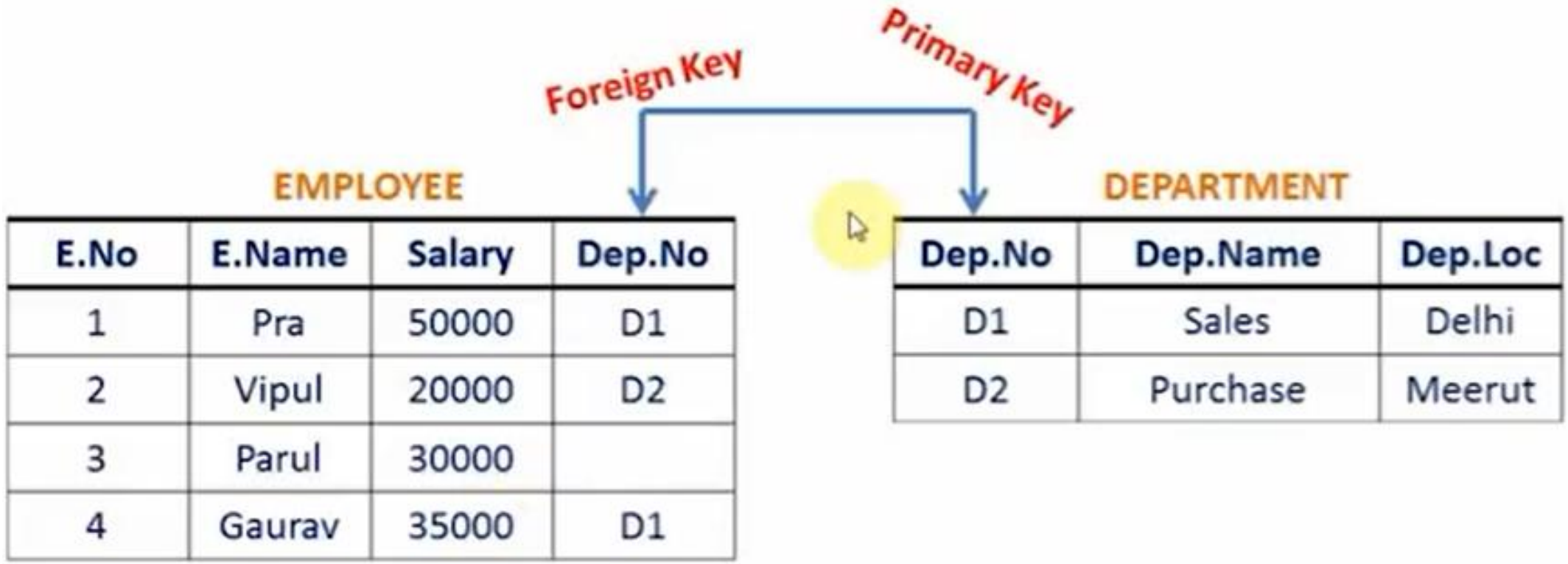
- Super key is a set of one or more attributes that uniquely identifies each record with in a table.
- For example:
  - Roll.no+Name+Course+Address is a super key
  - Roll.no is also a super key

- **Super Key:**

STUDENTS

Roll. No	Name	DOB	Course	Ph.No	Email	Address
1	Prashant	21.1.1993	MCA	1234567	pr@gmail.com	Meerut
2	Vipul	12.5.1994	BCA	456398	vi@gmail.com	Delhi
3	Nalin	10.9.1994	MCA	3692581	na@gmail.com	Punjab
4	Prashant	12.51994	MCA	258369	p@gmail.com	Delhi

- **Candidate Key:**
  - Candidate key is a minimal super key, which contains no extra attributes.
  - It consists of maximum possible attributes, which is uniquely identifies.
  - For example:
    - Roll.no+Ph.no+Email is a candidate key
    - Roll.no is also a candidate key



E.No	E.Name	Salary	Dep.No
1	Pra	50000	D1
2	Vipul	20000	D2
3	Parul	30000	
4	Gaurav	35000	D1

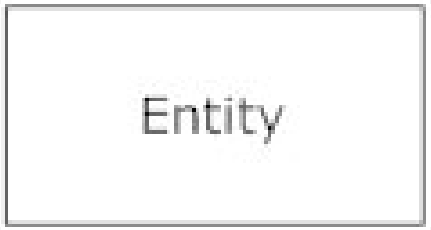
Dep.No	Dep.Name	Dep.Loc
D1	Sales	Delhi
D2	Purchase	Meerut

ERD (Entity Relationship Diagram)

An entity relationship diagram is a means of visualizing how the information a system produces is related.

There are five main components of an ERD:

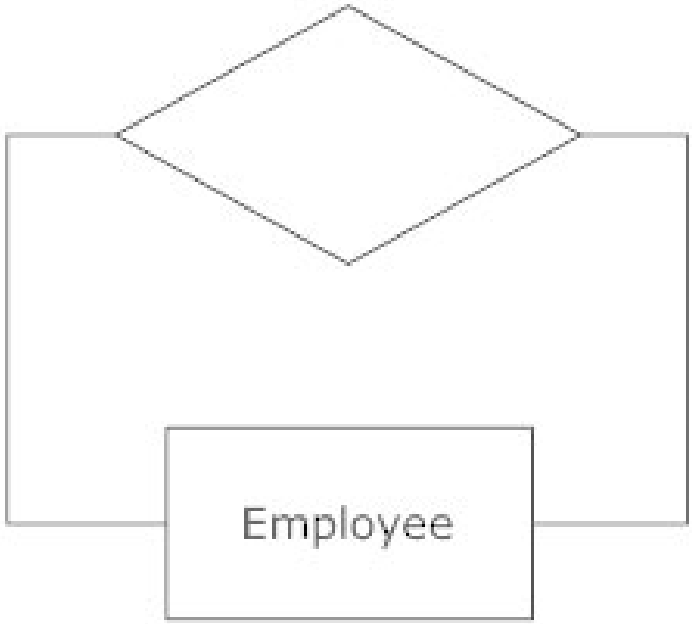
- Entities
- Action
- Attributes
- Connecting lines
- Cardinality

Entities, which are represented by rectangles. An entity is an object or concept about which you want to store information. 

A weak entity is an entity that must defined by a foreign key relationship with another entity as it cannot be uniquely identified by its own attributes alone. 

Actions, which are represented by diamond shapes, show how two entities share

information in the database. In some cases, entities can be self-linked. For example, employees can supervise other employees.



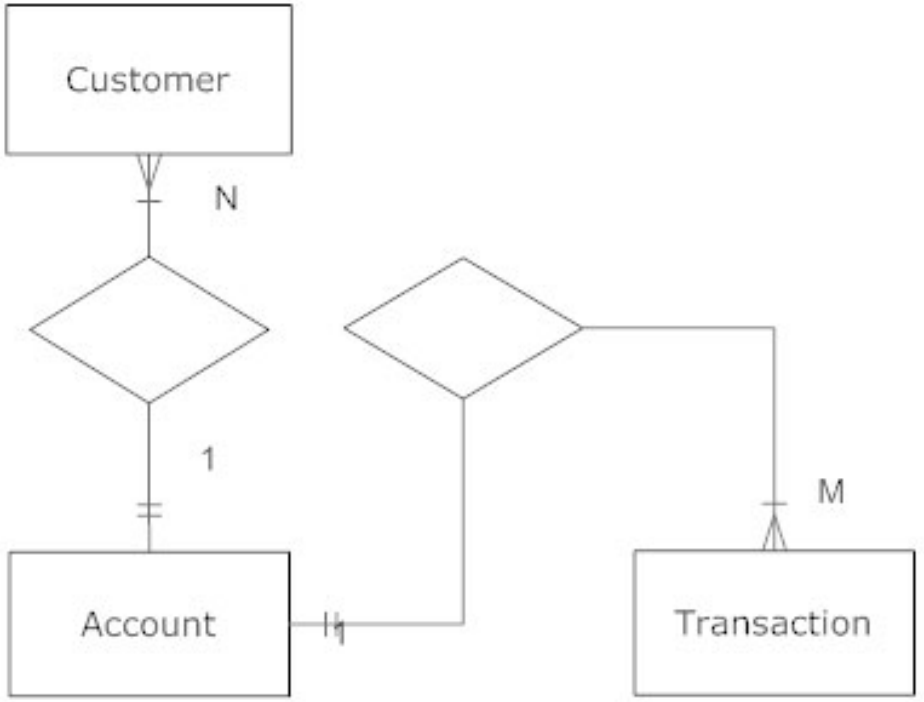
Attributes, which are represented by ovals. A key attribute is the unique, distinguishing characteristic of the entity. For example, an employee's social security number might be the employee's key attribute.

A multivalued attribute can have more than one value. For example, an employee entity can have multiple skill values.

A derived attribute is based on another attribute. For example, an employee's monthly salary is based on the employee's annual salary.

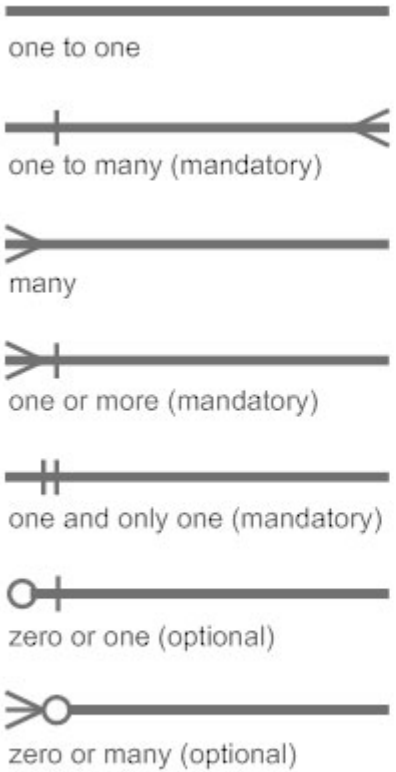
Connecting lines, solid lines that connect attributes to show the relationships of entities in the diagram.

Cardinality specifies how many instances of an entity relate to one instance of another entity. Ordinality is also closely linked to cardinality. While cardinality specifies the occurrences of a relationship, ordinality describes the relationship as either mandatory or optional. In other words, cardinality specifies the maximum number of relationships and ordinality specifies the absolute minimum number of relationships.



There are many nota

styles that express cardinality.



Chen Style

Crow's foot notation

- It is used to represent cardinality in relationships


Indicates a one to (**zero or**) many relationship.


Indicates a one to (**one or**) many relationship.


Indicates a one to (**strictly**) one relationship.

Indicates a one to (**zero or**) one relationship.

Other derivations like '(**zero or**) many to (**zero or**) many', or '(**zero or**) many to (**one or**) many', or '(**one or**) many to (**zero or**) many' or '(**one or**) may to (**one or**) many' are also valid.

Assignment 2

1. What do you understand by relational Database? Describe the need of relation data model for design and implementation of DBMS in detail.
2. What do you understand by data model? Describe the element of data model with suitable example.
3. What do you understand by Entities relationship diagram ? Construct a clean and concise ER diagram for the student tracking database of Paschimanchal Campus using the chain notation. List your assumptions and clearly indicate the cardinality mapping as well as role indicators in your ER diagram.
4. Write Short Notes:
   - Weak Entity Sets
   - Multivalued attributes
   - Derived attributes
   - Crow's Foot notation

Sample for ERD diagram

Practice ER Diagram Question – A Sample Solution

Suppose you are given the following requirements for a simple database for the National Hockey League (NHL):

- the NHL has many teams,
- each team has a name, a city, a coach, a captain, and a set of players,
- each player belongs to only one team,
- each player has a name, a position (such as *left wing* or *goalie*), a skill level, and a set of injury records,
- a team captain is also a player,
- a game is played between two teams (referred to as host_team and guest_team) and has a date (such as *May 11th, 1999*) and a score (such as *4 to 2*).

Construct a clean and concise ER diagram for the NHL database using the Chen notation as in your textbook. List your assumptions and clearly indicate the cardinality mappings as well as any role indicators in your ER diagram.

Here is one sample solution. Note that other diagrams are possible depending on assumptions.