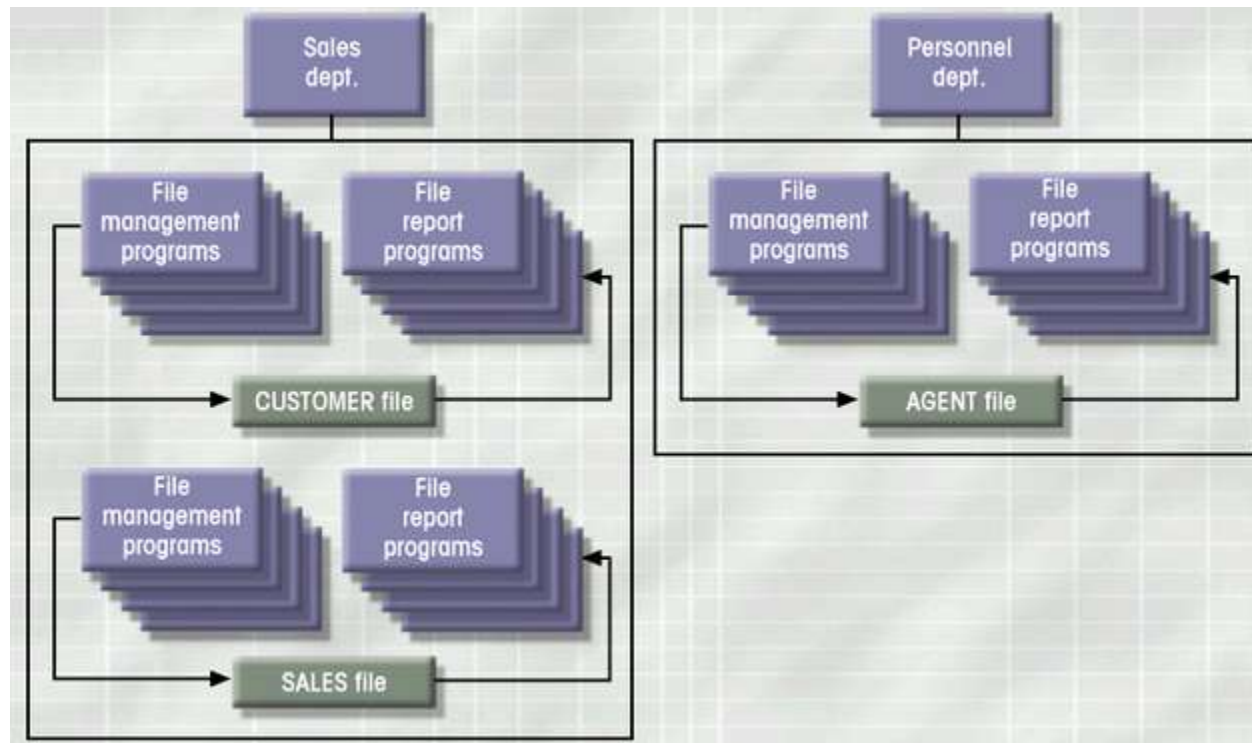


# Data Models

# Data Modeling and Data Models

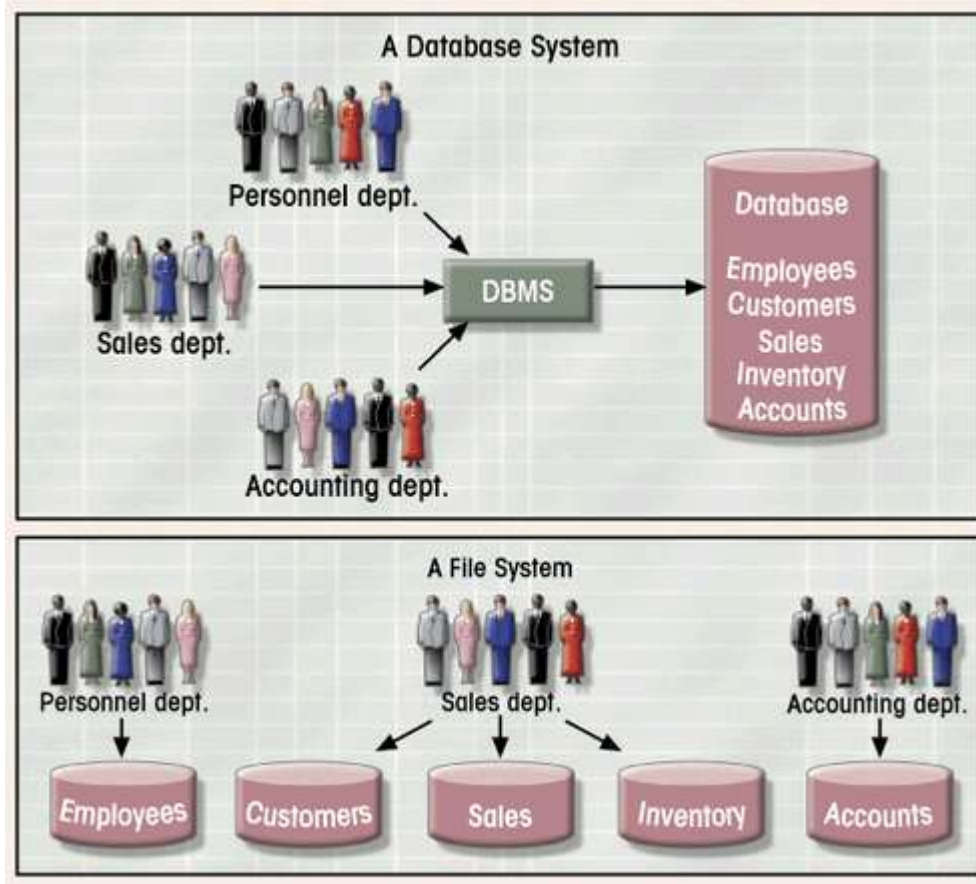
- **Data modeling:** Iterative and progressive process of creating a specific data model for a determined problem domain
- **Data models:** Simple representations of complex real-world data structures

# File System: Example



Database Systems: Design, Implementation, & Management: Rob & Coronel

# Database System vs. File System



Database Systems: Design, Implementation, & Management: Rob & Coronel

# Database Models

- ▶ A Database model defines the logical design and structure of a database and defines how data will be stored, accessed and updated in a database management system.
- ▶ While the **Relational Model** is the most widely used database model, there are other models too:
  - Hierarchical Model
  - Network Model
  - Entity-relationship Model
  - Relational Model

# Implementation Database Models

**Hierarchical Model** : data model based on trees.

**Network Model**: data model based on graphs with records as nodes and relationships between records as edges.

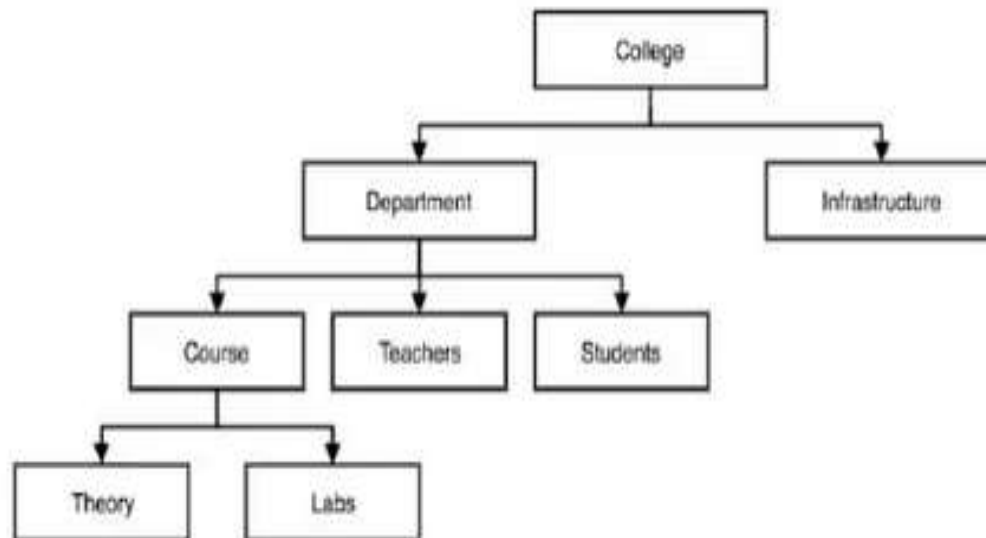
**Relational Model** : data model based on tables

**E-R Model** : data model based on entities and their relationship

# Hierarchical Model

- ▶ This database model organises data into a tree-like-structure, with a single root, to which all the other data is linked.
- ▶ This model efficiently describes many real-world relationships like index of a book, recipes etc
- ▶ In hierarchical model, data is organised into tree-like structure with one one-to-many relationship between two different types of data, for example, one department can have many courses, many professors and of-course many students.

# Hierarchical Model





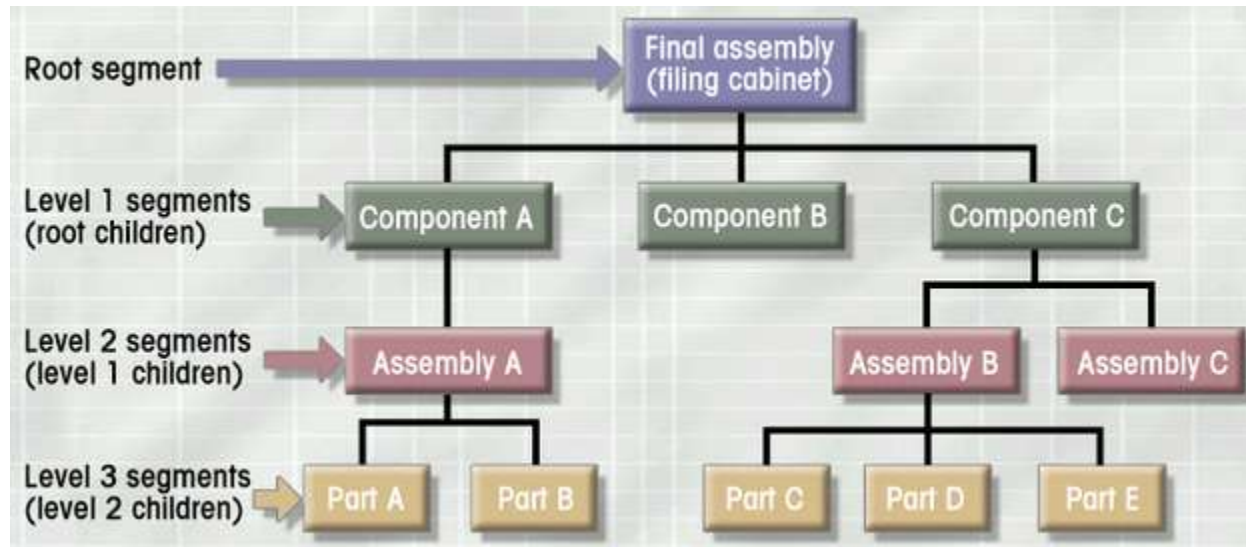
## Pros

- ▶ Simplicity
- ▶ Data integrity
- ▶ Efficiency

## Cons

- ▶ Implementation complexity
- ▶ Lack of structural independency
- ▶ Implementation limitations
- ▶ Program complexity

# Hierarchical Model: Example

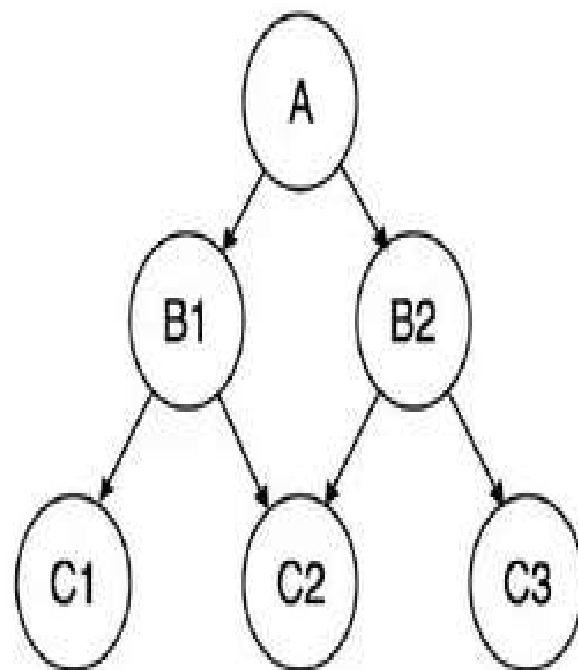


Database Systems: Design, Implementation, & Management: Rob & Coronel

# Network Model

- ▶ This is an extension of the Hierarchical model.
- ▶ In this model data is organised more like a graph, and are allowed to have more than one parent node.
- ▶ In this database model data is more related as more relationships are established in this database model.
- ▶ Also, as the data is more related, hence accessing the data is also easier and fast. This database model was used to map many-to-many data relationships.

## Network Model



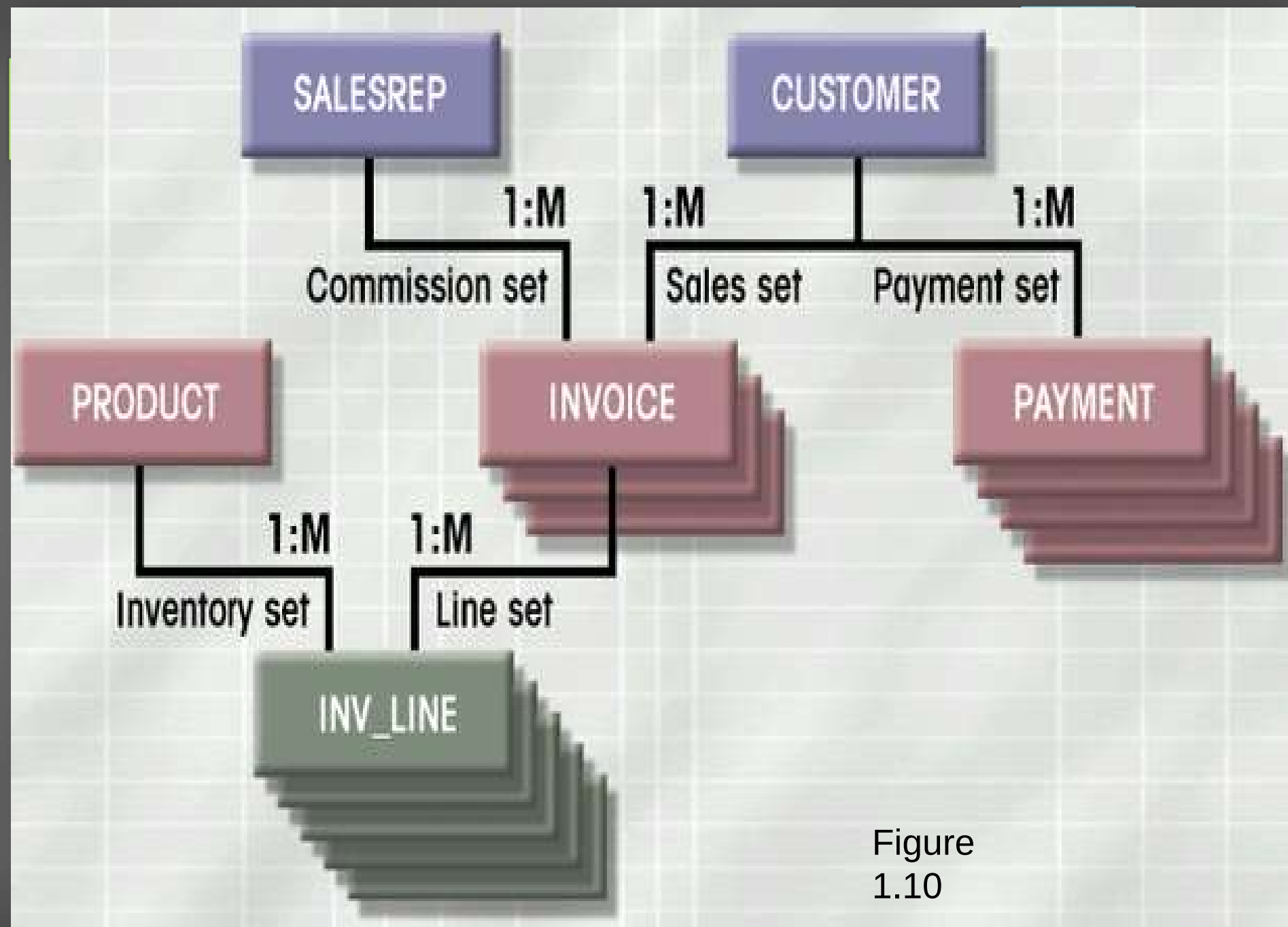


Figure  
1.10

# Pros and Cons

## Pros

- ▶ Capable to handle different relationships
- ▶ Ease in data access
- ▶ Data integrity
- ▶ Database standards
- ▶ Data independence

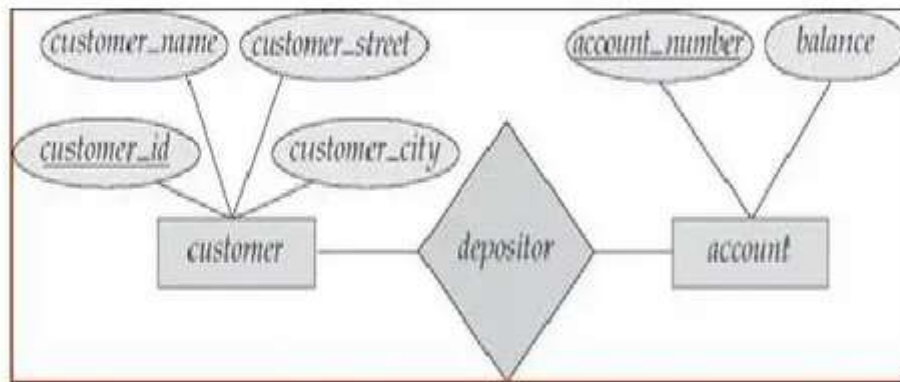
## Cons

- ▶ System complexity
- ▶ Operational anomalies
- ▶ Absence of structural independence

# Entity-relationship Model

- ▶ In this database model, relationships are created by dividing object of interest into entity and its characteristics into attributes.
- ▶ E-R Models are defined to represent the relationships into pictorial form to make it easier for different stakeholders to understand.
- ▶ This model is good to design a database, which can then be turned into tables in relational model

## Entity-relationship Model





# Entity Relationship Model

## Advantages

It is easy to understand and design.

Using the ER model we can represent data structures easily.

As the ER model cannot be directly implemented into a database model, it is just a step toward designing the relational database model.

## Disadvantages

- Limited constraint representation
- Limited relationship representation
- No data manipulation language
- Loss of information content occurs when attributes are removed from entities to avoid crowded displays

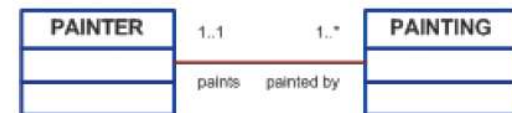
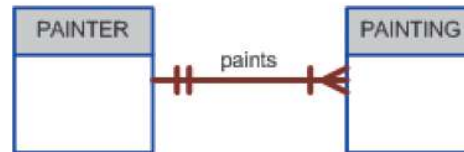
# Figure 2.3 - The ER Model Notations

## Chen Notation

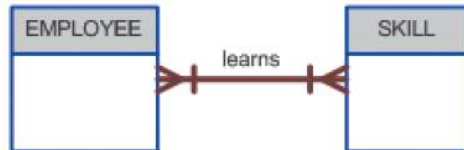
## Crow's Foot Notation

## UML Class Diagram Notation

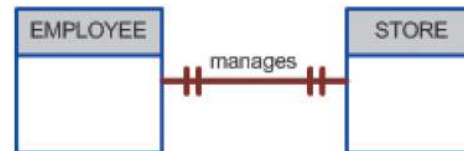
**A One-to-Many (1:M) Relationship:** a PAINTER can paint many PAINTINGs; each PAINTING is painted by one PAINTER.



**A Many-to-Many (M:N) Relationship:** an EMPLOYEE can learn many SKILLs; each SKILL can be learned by many EMPLOYEEs.



**A One-to-One (1:1) Relationship:** an EMPLOYEE manages one STORE; each STORE is managed by one EMPLOYEE.




# Relational Model

- ▶ In this model, data is organised in two-dimensional **tables** and the relationship is maintained by storing a common field.
- ▶ This model was introduced by E.F Codd in 1970
- ▶ The basic structure of data in the relational model is tables. All the information related to a particular type is stored in rows of that table.

student_id	name	age
1	Akan	17
2	Bkan	18
3	Ckan	17
4	Dkan	18

subject_id	name	teacher
1	Java	Mr. J
2	C++	Miss C
3	C#	Mr. C Hash
4	Php	Mr. P H P



The diagram shows two arrows originating from the 'student\_id' column of the first table and the 'subject\_id' column of the second table. These arrows point to the 'student\_id' and 'subject\_id' columns of the third table, respectively, illustrating a join operation.

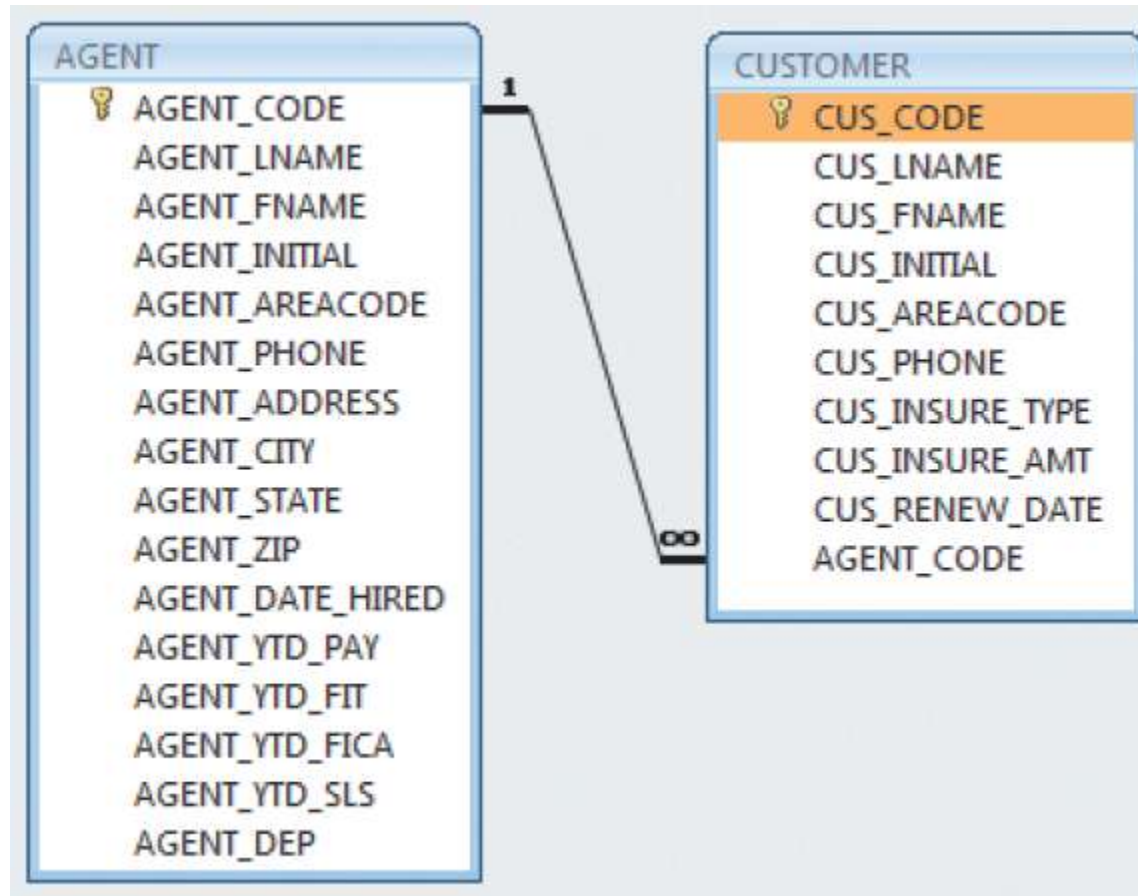
student_id	subject_id	marks
1	1	98
1	2	78
2	1	76
3	2	88

# Relational Model

## Advantages

- It's simple and easy to implement.
- Popular database software is available for this database model.
- It supports SQL using which you can easily query the data.

# Figure 2.2 - A Relational Diagram



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## RE 2.4 LINKING RELATIONAL TABLES

Database name: Ch02\_InsureCo

Table name: AGENT (first six attributes)

	AGENT_CODE	AGENT_LNAME	AGENT_FNAME	AGENT_INITIAL	AGENT_AREACODE	AGENT_PHONE
▶	501	Alby	Alex	B	713	228-1249
	502	Hahn	Leah	F	615	882-1244
	503	Okon	John	T	615	123-5589

Link through AGENT\_CODE

Table name: CUSTOMER

	CUS_CODE	CUS_LNAME	CUS_FNAME	CUS_INITIAL	CUS_AREACODE	CUS_PHONE	CUS_RENEW_DATE	AGENT_CODE
▶	10010	Ramas	Alfred	A	615	844-2573	05-Apr-2004	502
	10011	Dunne	Leona	K	713	894-1238	16-Jun-2004	501
	10012	Smith	Kathy	W	615	894-2285	29-Jan-2005	502
	10013	Olowski	Paul	F	615	894-2180	14-Oct-2004	502
	10014	Orlando	Myron		615	222-1672	28-Dec-2004	501
	10015	O'Brian	Amy	B	713	442-3381	22-Sep-2004	503
	10016	Brown	James	G	615	297-1228	25-Mar-2004	502
	10017	Williams	George		615	290-2556	17-Jul-2004	503
	10018	Farriss	Anne	G	713	382-7185	03-Dec-2004	501
	10019	Smith	Olette	K	615	297-3809	14-Mar-2004	503