Data Models

Learning Objectives

- In this chapter, you will learn:
  - About data modeling
  - Why data models are important

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: Weakness

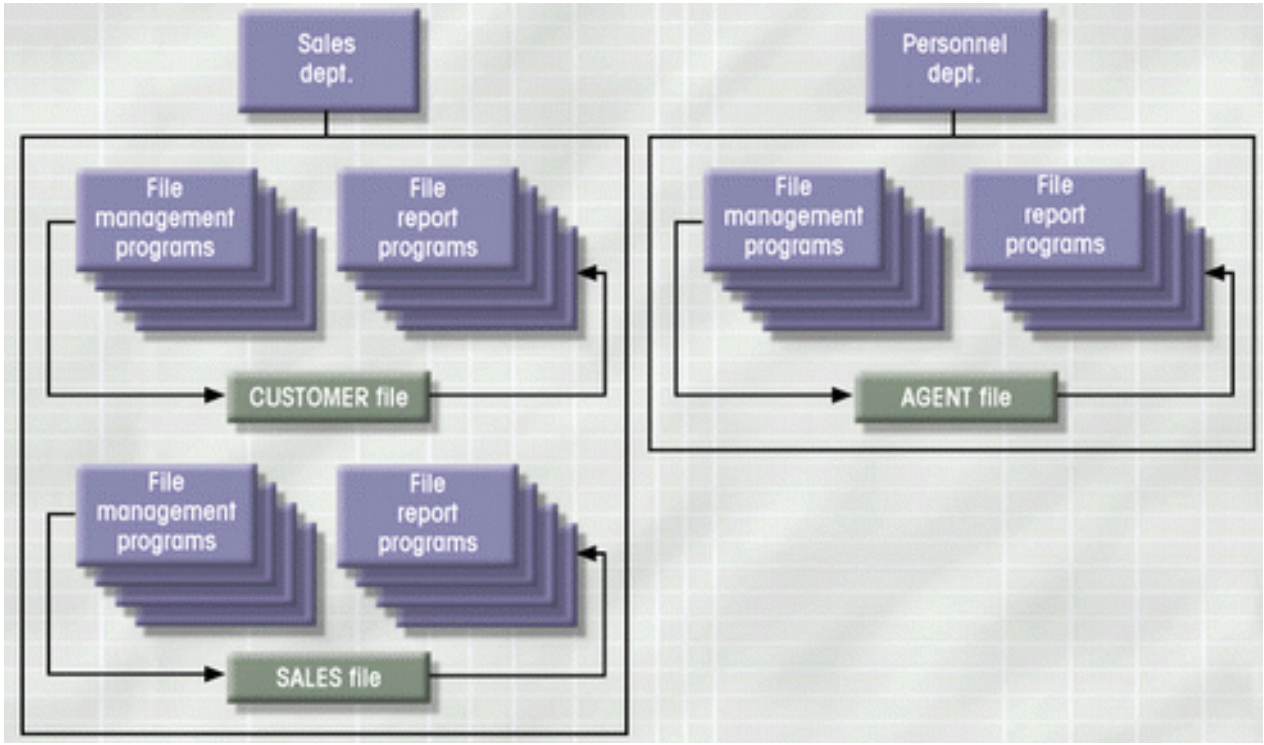
- Weakness

"Islands of data" in scattered file systems.

- Problems
  - Duplication
    - same data may be stored in multiple files
  - Inconsistency
    - same data may be stored by different names in different format
  - Rigidity
    - requires customized programming to implement any changes
    - cannot do ad-hoc queries

- Implications
- Waste of space
- Data inaccuracies
- High overhead of data manipulation and maintenance

File System: Example



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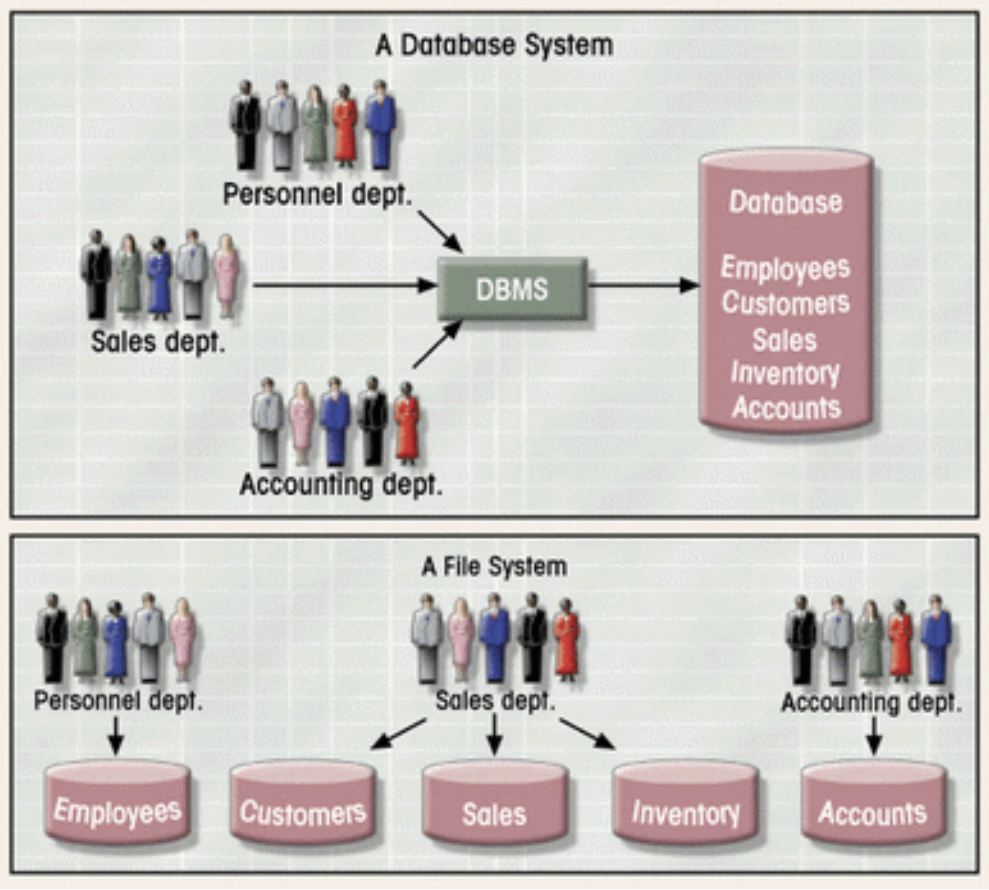
Database System vs. File System



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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 entiities and their relationship

Hierarchical Model

- Manage large amounts of data for complex manufacturing projects
- Logically represented by an upside down tree
  - Each parent can have many children
  - Each child has only one parent
- The hierarchical structure contains levels
- This model depicts a set of one to many (1:M) relationship.

Hierarchical Model

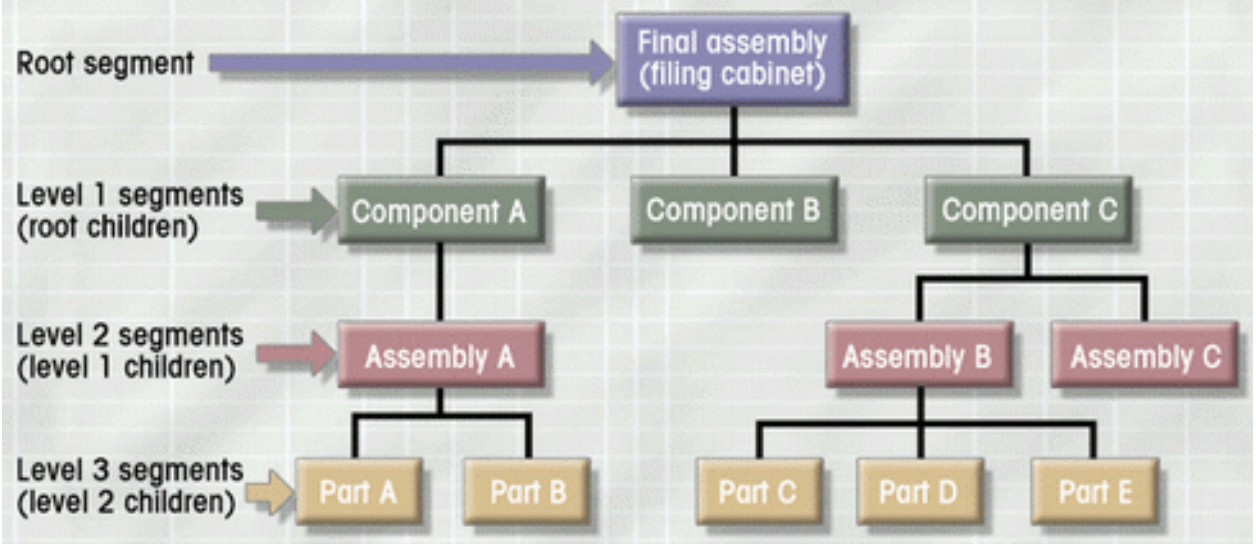
Advantages

- Promotes data sharing
- Parent/child relationship promotes conceptual simplicity and data integrity
- Database security is provided and enforced by DBMS
- Efficient with 1:M relationships

Disadvantages

- Requires knowledge of physical data storage characteristics
- Navigational system requires knowledge of hierarchical path
- Changes in structure require changes in all application programs
- Implementation limitations
- No data definition
- Lack of standards

Hierarchical Model: Example



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Network Database Model

- Each record can have multiple parents
  - Composed of sets
  - Each set has owner record and member record
  - Member may have several owners

- Was created to represent complex data relationship more effectively than the hierarchical model , to improve database performance , and to impose a database standards.

- This model is generally not used today.

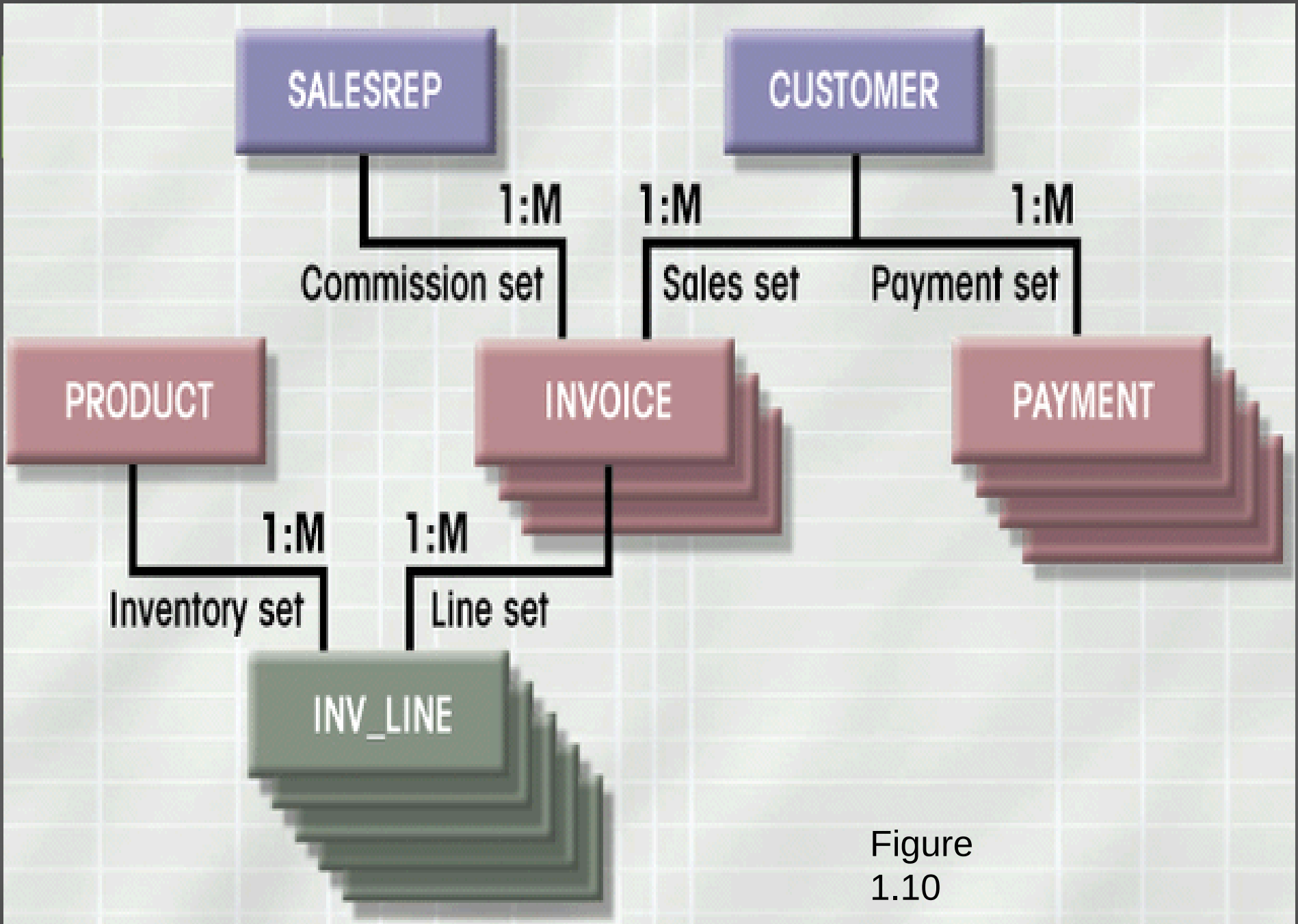

SALESREP
CUSTOMER
1:M
1:M
1:M
Commission set
Sales set
Payment set
PRODUCT
INVOICE
PAYMENT
1:M
1:M
Inventory set
Line set
INV_LINE

Figure 1.10

Network Model

Advantages	Disadvantages
▪ Conceptual simplicity ▪ Handles more relationship types ▪ Data access is flexible ▪ Data owner/member relationship promotes data integrity ▪ Conformance to standards ▪ Includes data definition language (DDL) and data manipulation language (DML)	▪ System complexity limits efficiency ▪ Navigational system yields complex implementation, application development, and management ▪ Structural changes require changes in all application programs

Standard Database Concepts

Schema

- Conceptual organization of the entire database as viewed by the database administrator

Subschema

- Portion of the database seen by the application programs that produce the desired information from the data within the database

Standard Database Concepts

Data manipulation language (DML)

- Environment in which data can be managed and is used to work with the data in the database

Schema data definition language (DDL)

- Enables the database administrator to define the schema components

Hierarchical and Network Models

Hierarchical Models

- Manage large amounts of data for complex manufacturing projects
- Represented by an upside-down tree which contains segments
  - **Segments**: Equivalent of a file system's record type
- Depicts a set of one-to-many (1:M) relationships

Network Models

- Represent complex data relationships
- Improve database performance and impose a database standard
- Depicts both one-to-many (1:M) and many-to-many (M:N) relationships

The Relational Model

- Produced an automatic transmission database that replaced standard transmission databases
- Based on a relation
  - **Relation** or **table**: Matrix composed of intersecting tuple and attribute
    - **Tuple**: Rows
    - **Attribute**: Columns
- Describes a precise set of data manipulation constructs

Relational Model

Advantages

- Structural independence is promoted using independent tables
- Tabular view improves conceptual simplicity
- Ad hoc query capability is based on SQL
- Isolates the end user from physical-level details
- Improves implementation and management simplicity

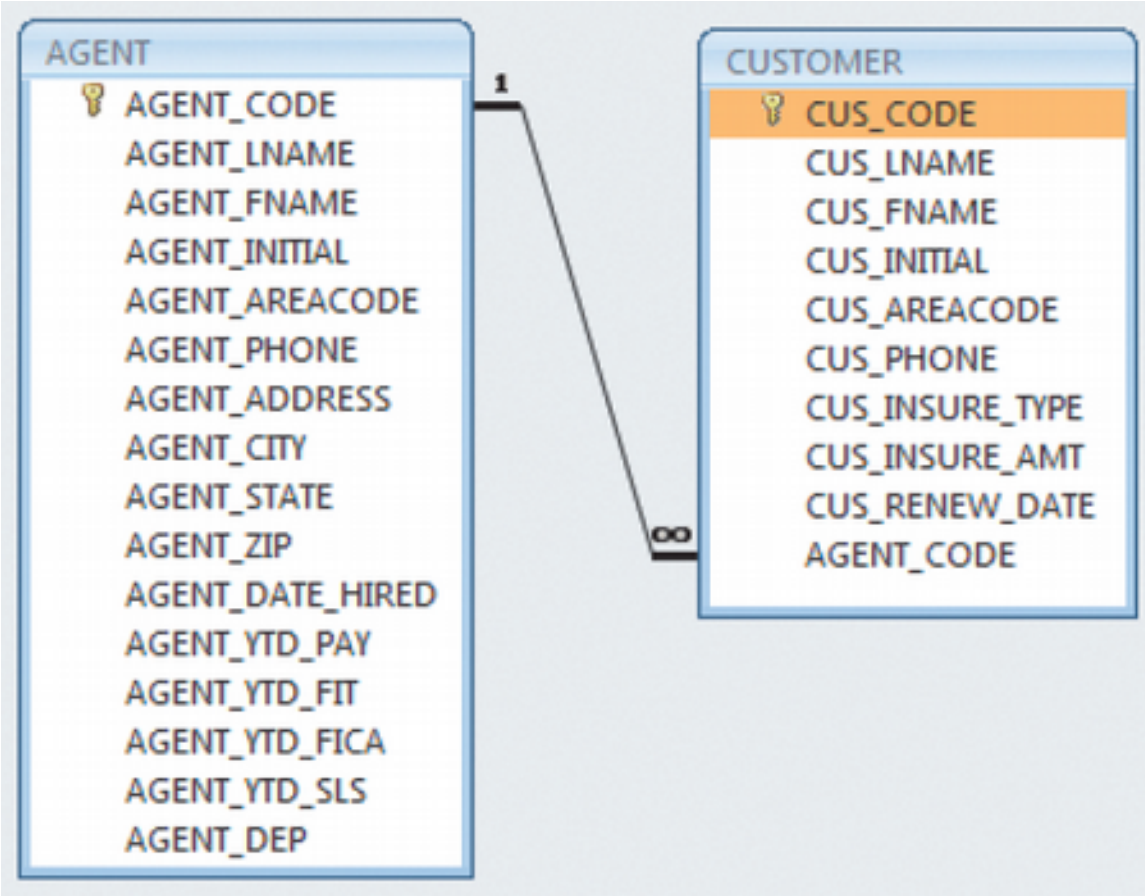
Disadvantages

- Requires substantial hardware and system software overhead
- Conceptual simplicity gives untrained people the tools to use a good system poorly
- May promote information problems

Relational Database Management System(RDBMS)

- Performs basic functions provided by the hierarchical and network DBMS systems
- Makes the relational data model easier to understand and implement
- Hides the complexities of the relational model from the user

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

The Entity Relationship Model

- Graphical representation of entities and their relationships in a database structure
- **Entity relationship diagram (ERD)**
  - Uses graphic representations to model database components
- **Entity instance or entity occurrence**
  - Rows in the relational table
- **Connectivity**: Term used to label the relationship types

Entity Relationship Model

Advantages

- Visual modeling yields conceptual simplicity
- Visual representation makes it an effective communication tool
- Is integrated with the dominant relational 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