Unit II: Data Modeling

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Overview

- Design of an E-R database schema
  - Design phases
  - Database design for banking enterprise
- Reduction of an E-R schema to tables

Design of an E-R database schema

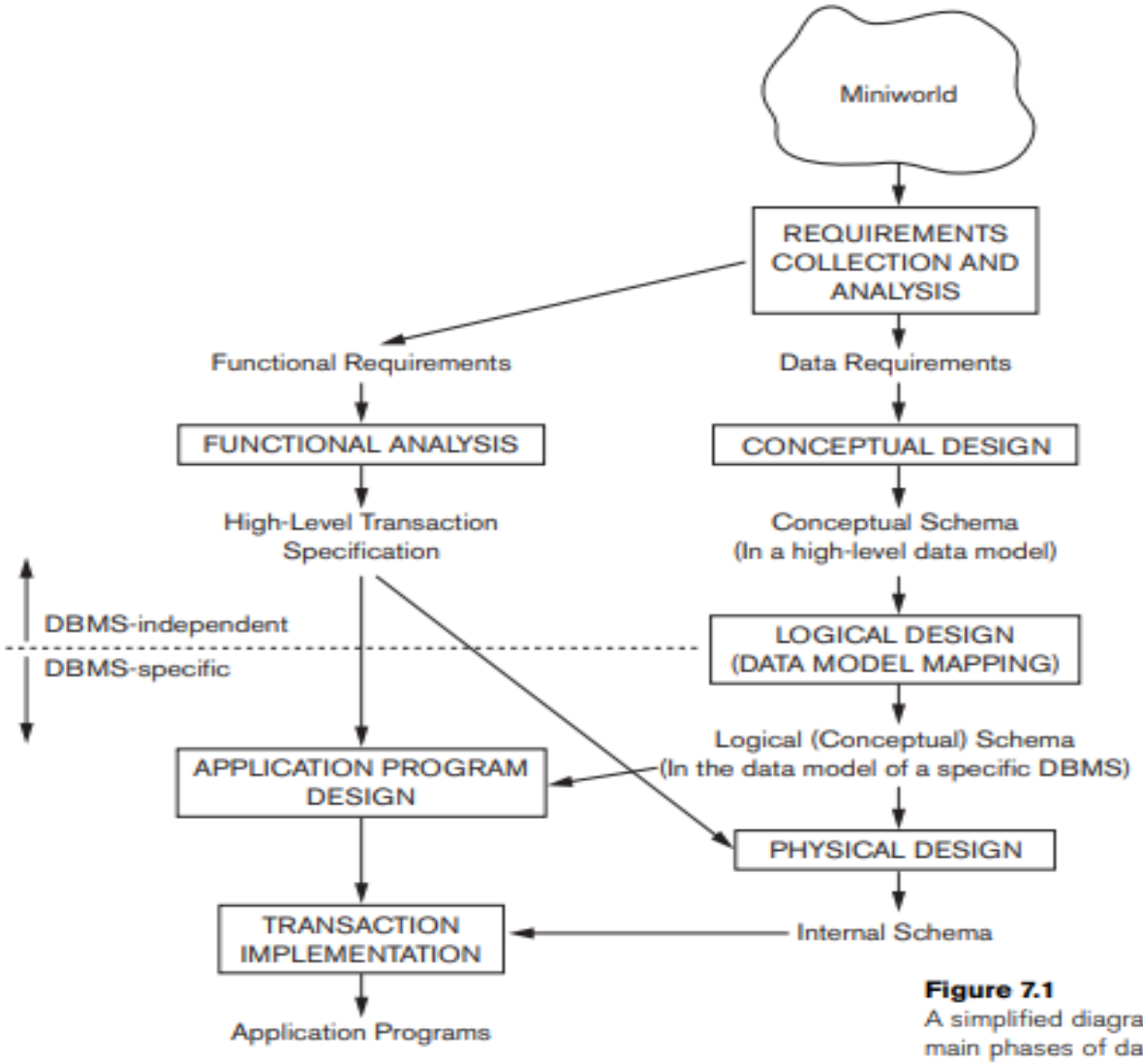
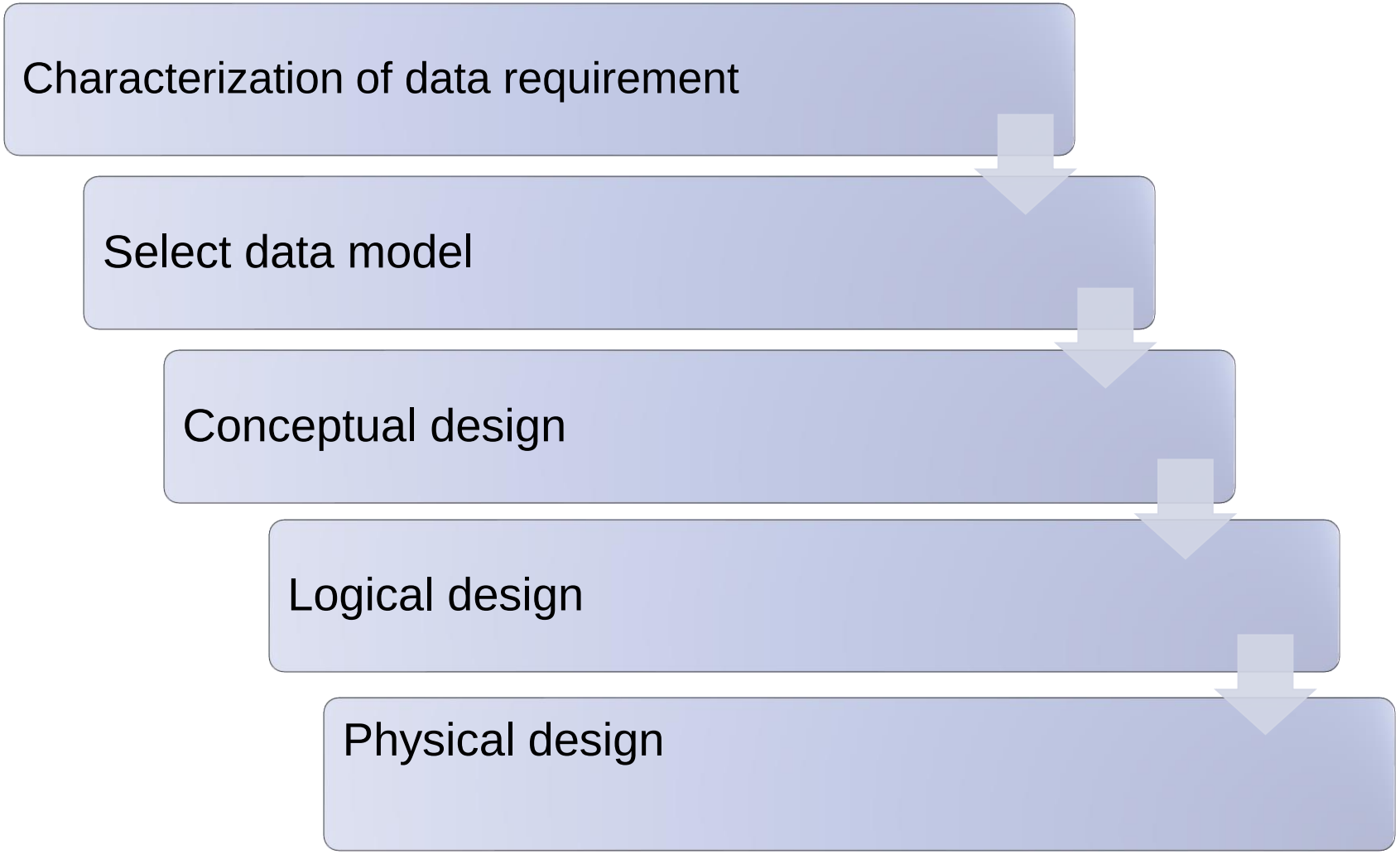
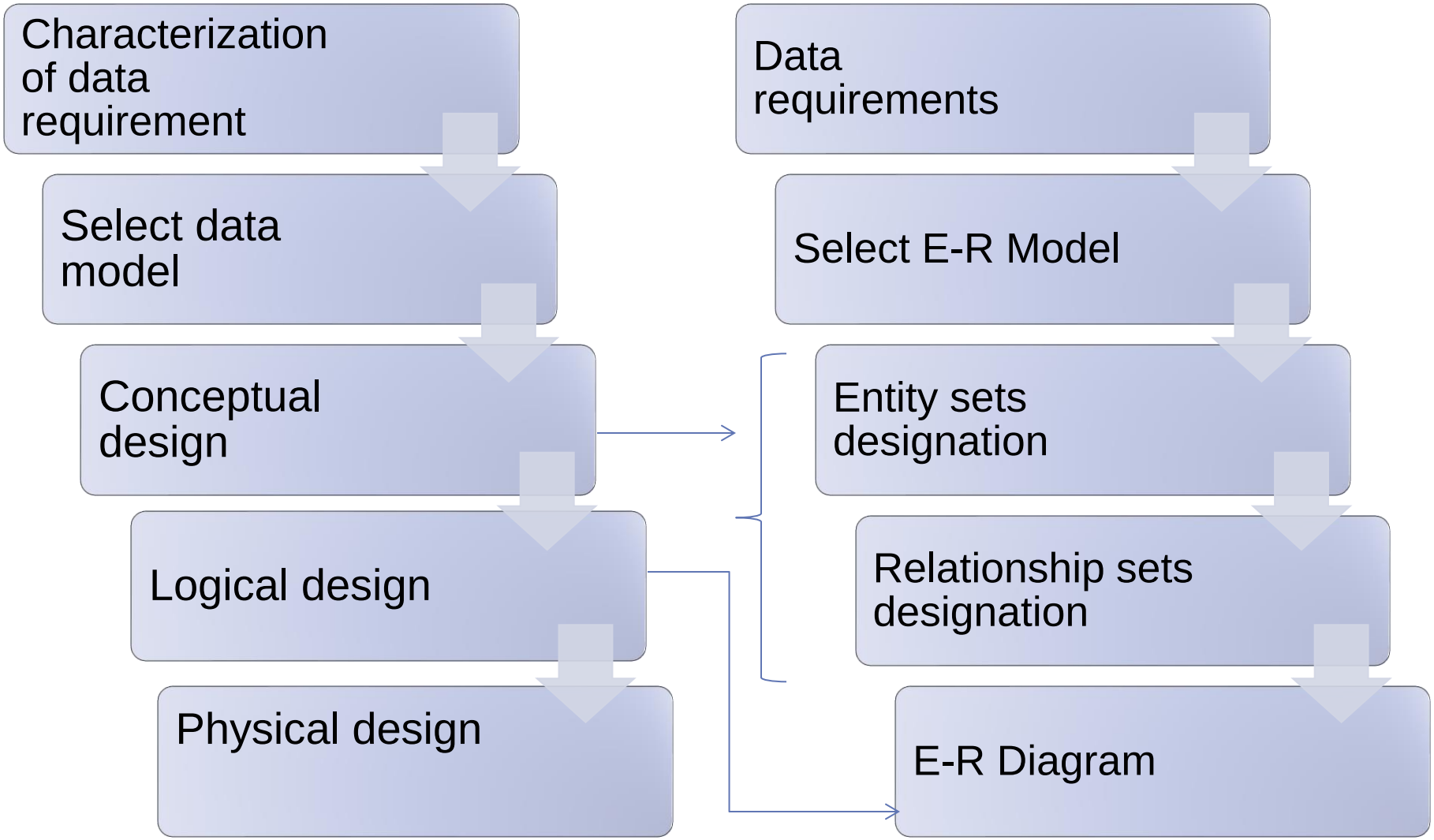


Figure 7.1
A simplified diagram to illustrate the main phases of database design.

Design of an E-R database schema (contd.)



Database design for banking enterprise



Database design for banking enterprise

Data requirements

Characteristics	Bank branches
	Bank customers
	Bank employees
	Bank offers
	Bank loan

Database design for banking enterprise

Entity sets designation

branch

branch_name
branch_city
assets

customer

customer-id,
customer-name,
customer-street,
customer-city

employee

employee-id,
employee-name,
telephone-number
salary
manager

Savings-account
checking-account

Account-number
balance

Loan

loan-number
amount
originating branch

Loan-payment

payment-number
payment-date
payment-amount

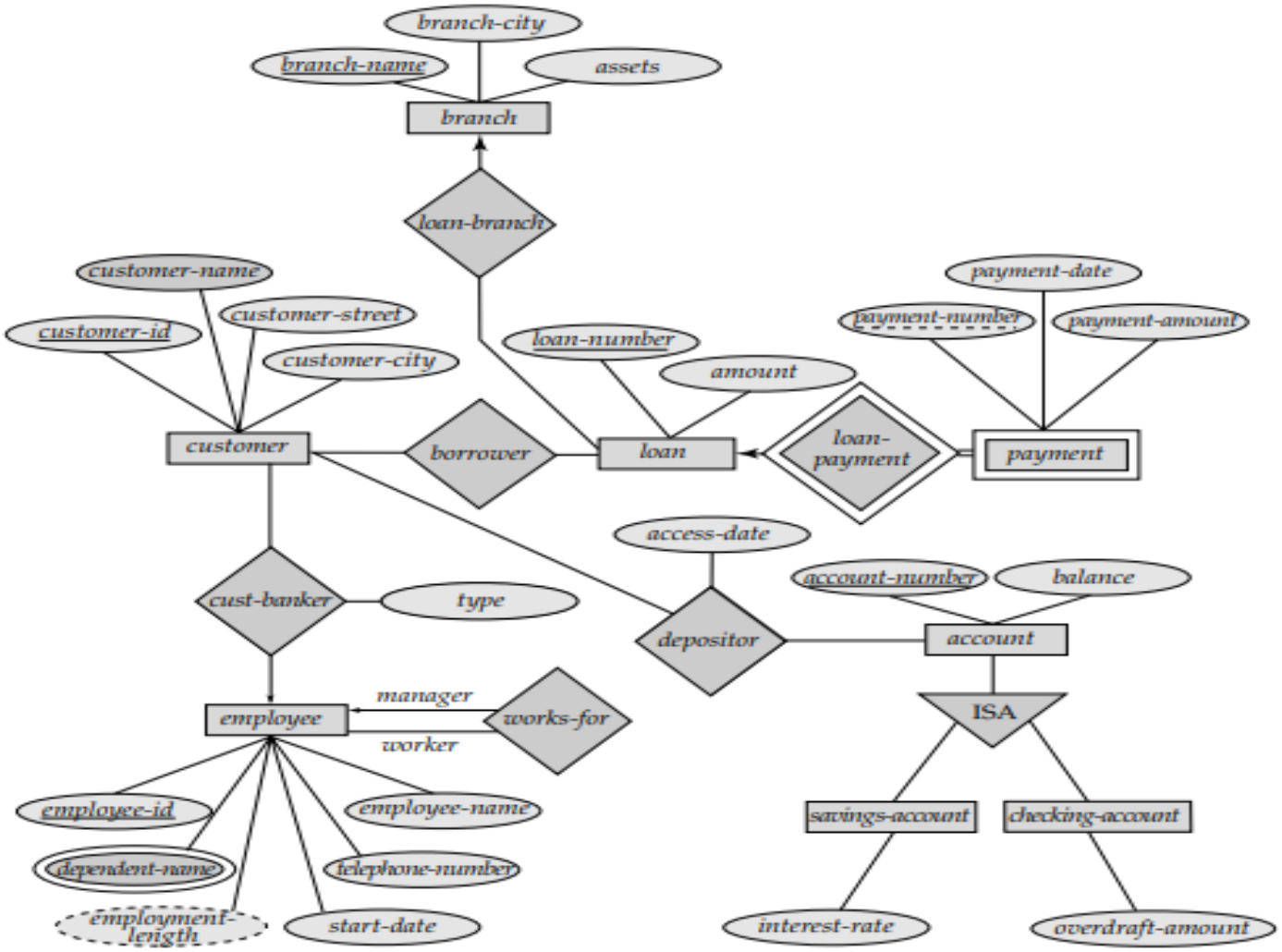
Database design for banking enterprise

Relationship sets designation

Borrower *Many-to many between customer and loan*	*loan-branch* *many-to-one relationship set*	*loan-payment* *one-to-many*
Depositor *Many-to many between customer and account*	*cust-banker* *many-to-one between bank employee and customer*	*works-for*

Database design for banking enterprise

E-R Diagram



Reduction of an E-R schema to tables

- Relational database design from E-R diagram
  - Tabular representation of strong entity sets
  - Tabular representation of weak entity sets
  - Tabular representation of relationship sets
- Redundancy of tables
- Combination of tables
  - Composite attributes
  - Multivalued attributes
  - Tabular representation of generalization
  - Tabular representation of aggregation

Reduction of an E-R schema to tables

Tabular representation of strong entity sets

- E : Strong entity set
  - a_1, a_2,…, $a_{m:}$ Descriptive attributes of E
  - E: Table with n distinct columns
  - Example: *loan* entity has two attributes including *loan-number* and *amount*
- D_1 : Set of all loan numbers
- D_2 : Set of all balances
- Set of all possible rows of loan as cartesian product of D_1 and D_2

  $D_1 \times D_2$
- A table of n columns, *cartesian product* of D_1, D_2,…,D_n

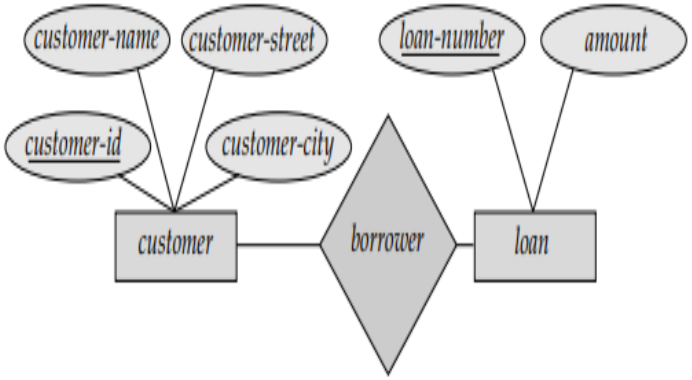
  $D_1 \times D_2 \times \ldots \times D_{n-1} \times D_n$

Reduction of an E-R schema to tables

Tabular representation of strong entity sets (contd.)

- Example of *loan* table

loan-number	*amount*
L-11	900
L-14	1500
L-15	1500
L-16	1300
L-17	1000
L-23	2000
L-93	500



- Example of *customer* table

customer-id	*customer-name*	*customer-street*	*customer-city*
019-28-3746	Smith	North	Rye
182-73-6091	Turner	Putnam	Stamford
192-83-7465	Johnson	Alma	Palo Alto
244-66-8800	Curry	North	Rye
321-12-3123	Jones	Main	Harrison
335-57-7991	Adams	Spring	Pittsfield
336-66-9999	Lindsay	Park	Pittsfield
677-89-9011	Hayes	Main	Harrison
963-96-3963	Williams	Nassau	Princeton

Reduction of an E-R schema to tables

Tabular representation of weak entity sets

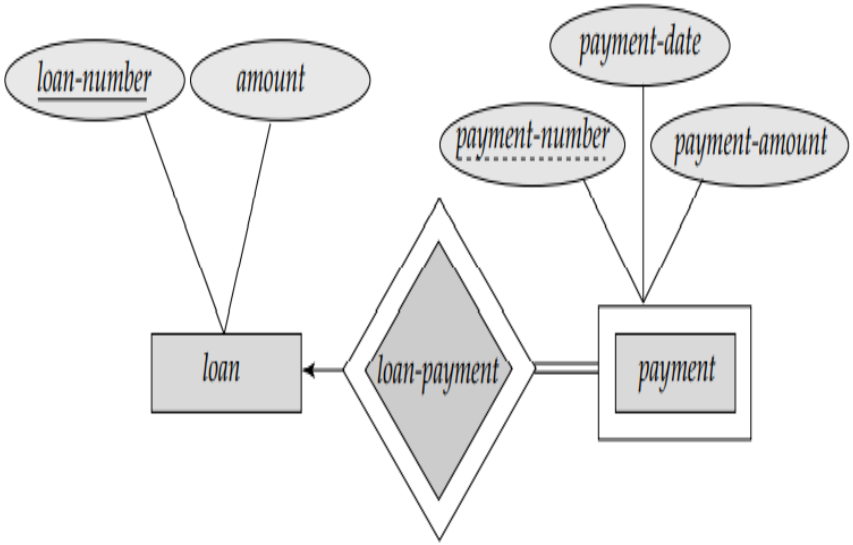
- A: Weak entity set with attributes
- a_1, a_2,…, a_m : Attributes of A
- B: Strong entity set
- b_1, b_2,…, b_n: primary key of attributes of B
- Representation of entity set A by a table A with one column for each attribute of the set:

$$\{a_1, a_2, \ldots, a_m\} \cup \{b_1, b_2, \ldots, b_n\}$$

Reduction of an E-R schema to tables

Tabular representation of weak entity sets

- Loan-number: Primary of loan entity set, on which payment depends
- Payment: four columns, loan number, payment-number, payment-date and payment-amount



loan-number	payment-number	payment-date	payment-amount
L-11	53	7 June 2001	125
L-14	69	28 May 2001	500
L-15	22	23 May 2001	300
L-16	58	18 June 2001	135
L-17	5	10 May 2001	50
L-17	6	7 June 2001	50
L-17	7	17 June 2001	100
L-23	11	17 May 2001	75
L-93	103	3 June 2001	900
L-93	104	13 June 2001	200

Reduction of an E-R schema to tables

Tabular representation of relationship entity sets

- R: relationship set
- a_1, a_2,…, a_m : Set of attributes formed by the union of primary keys of each entity sets participating in R
- b_1, b_2,…, b_n : Descriptive attributes of R if any
- R: Table of relationship set with one column for each attribute of set:

$$\{a_1, a_2, \ldots, a_m\} \cup \{b_1, b_2, \ldots, b_n\}$$

Reduction of an E-R schema to tables

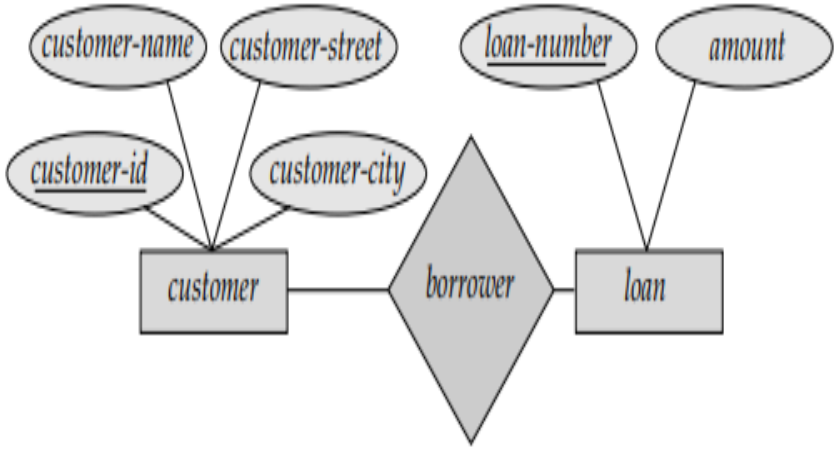
Tabular representation of relationship entity sets (contd.)

Example

borrower involves two entity sets:

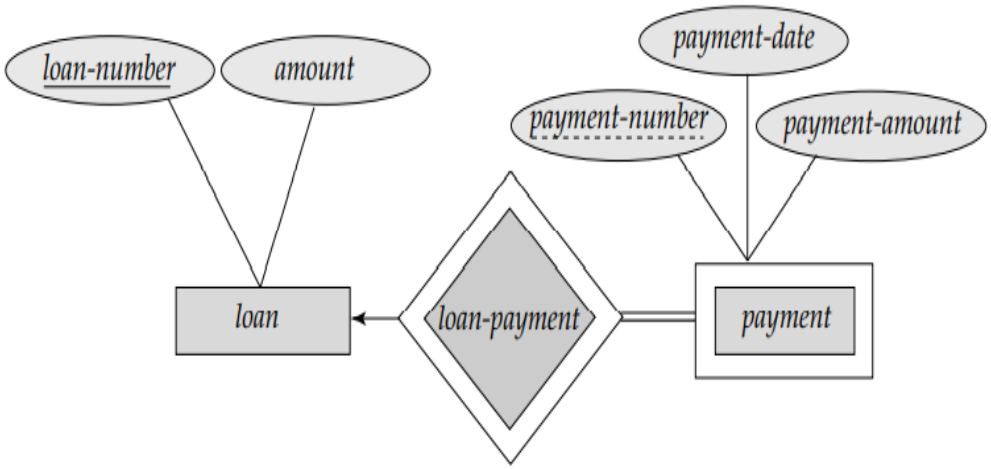
- *customer*, with primary key *customer-id*
- *loan,* with primary key *loan-number*

customer-id	*loan-number*
019-28-3746	L-11
019-28-3746	L-23
244-66-8800	L-93
321-12-3123	L-17
335-57-7991	L-16
555-55-5555	L-14
677-89-9011	L-15
963-96-3963	L-17



Tabular representation of relationship entity sets

Redundancy of tables

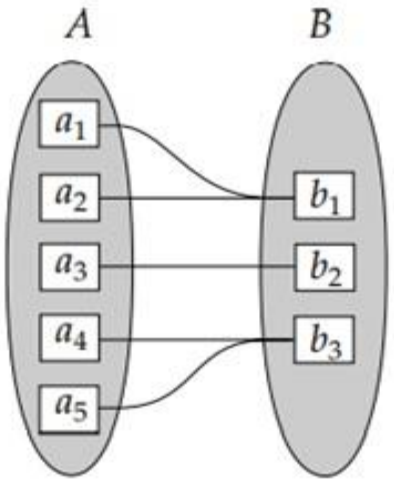


- Primary key of *payment*: {loan-number, payment-number}
- Primary key of *loan*: {loan-number}
- *loan-payment* table: {loan-number, payment-number}
- *Payment* table: {loan-number, payment-number, payment-date, payment-amount}
- Redundancy shown by *loan-payment* table

Relationship set linking weak entity to its corresponding strong entity set is redundant and need not be present in tabular representation

Tabular representation of relationship entity sets
Combination of tables

- Many-to-one relationship set AB from entity set A to entity set B
- Three tables: A,B,AB
- Participation of A in the relationship is total
- Every entity a in the entity set A must participate in the relationship AB
- Combination of tables A and AB to form a single table consisting of union of columns of both tables

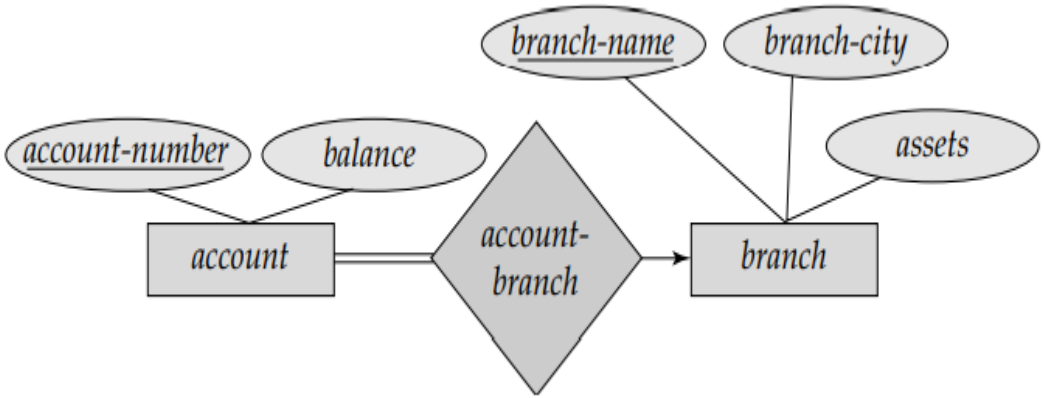


Tabular representation of relationship entity sets
Combination of tables (contd.)

- Total participation of *account* in the *account-branch*
- Relationship set *account-branch* is many-to-one from *account* to *branch*
- Combine *account-branch table* with table for account and require only two tables:

➢ *account: account-number, balance* and *branch-name*

➢ *branch: branch-name, branch-city* and *assets*



Reduction of an E-R schema to tables

Composite attributes

- No separate column is required for composite attribute itself
- Example
  - *address*: Composite attribute of entity set *customer* include columns of *address-street* and *address-city*
  - No separate column is required for *address*

Reduction of an E-R schema to tables

Multivalued attributes

- New tables are created for each multivalued attributes
- For a M, create a T with C that corresponds to M and columns corresponding to primary key of entity set or relationship set of which M is an attribute

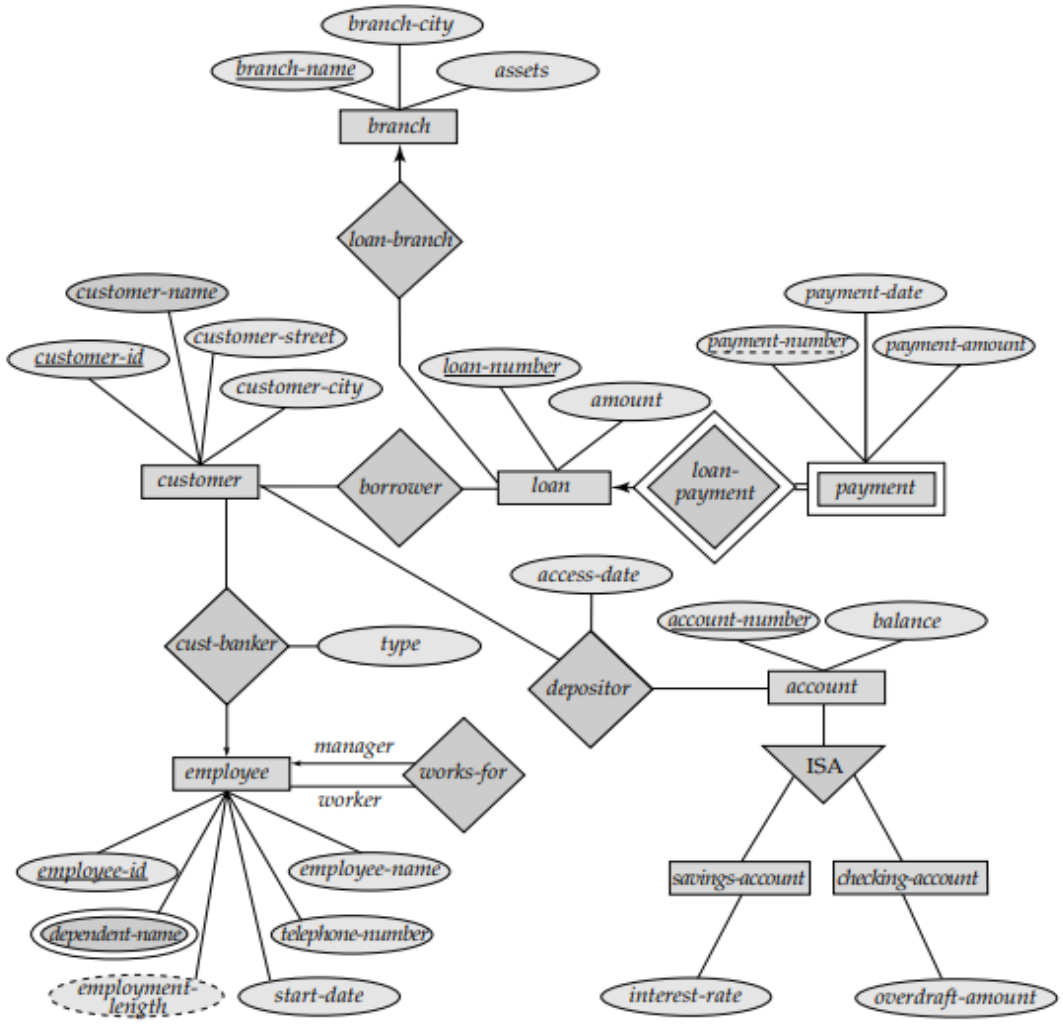
➢ M: Multivalued attribute

➢ T: Table

➢ C: Column

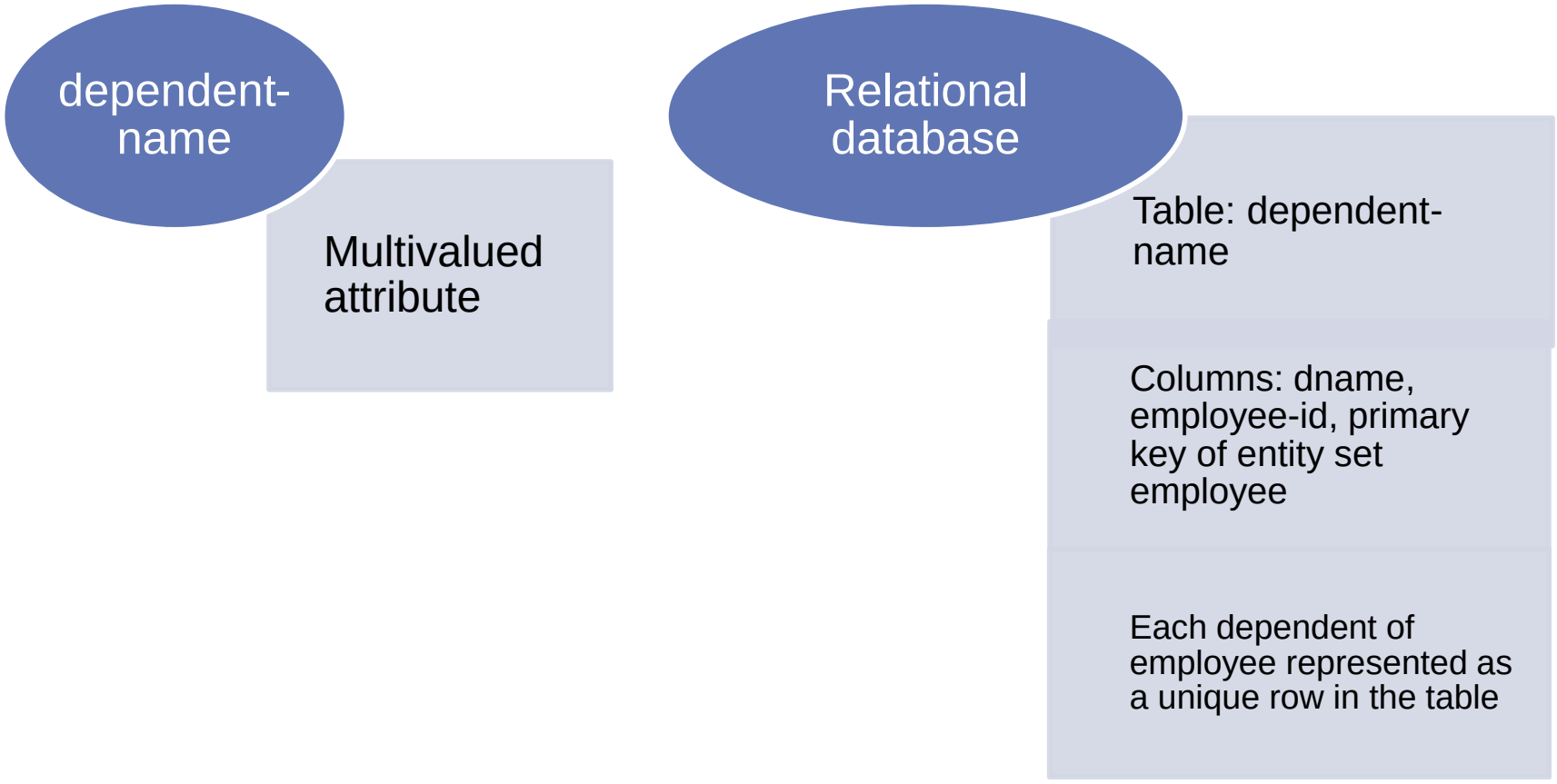
Reduction of an E-R schema to tables

Multivalued attributes



Reduction of an E-R schema to tables

Multivalued attributes



Reduction of an E-R schema to tables

Tabular representation of generalization

Two methods

Create table for higher-level and lower-level entity set. Table includes a column for each of attributes of lower-entity set and a column for each attribute of primary key.

Example:

account: *account-number and balance* (attributes)

savings-account: account-number and interest-rate

checking-account: account-number and overdraft-amount

Create table for lower-level entity set, if generalization is joint and complete. Table includes a column for each of the attributes of that entity set and a column for each attribute of higher-level entity set

Example:

savings-account: account-number, balance and interest-rate

checking-account: account-number, balance and overdraft-amount

Reduction of an E-R schema to tables

Tabular representation of aggregation

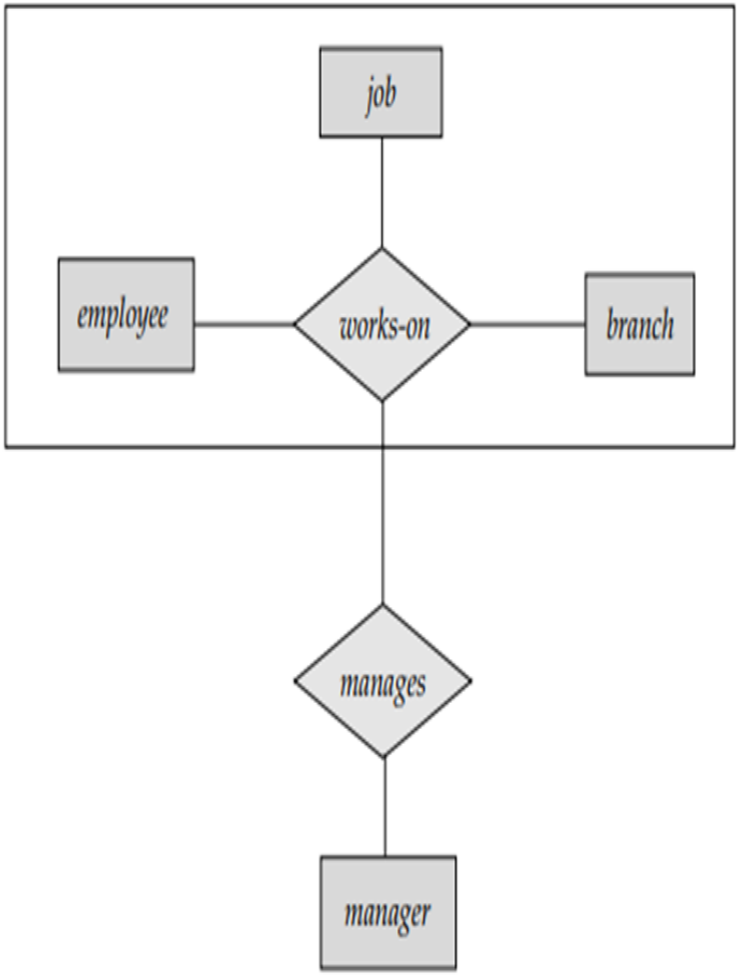


Table for ***manages***

- A column for each attribute in primary keys of entity set *manager* and relationship set *works-on*
- A column for descriptive attribute, if any