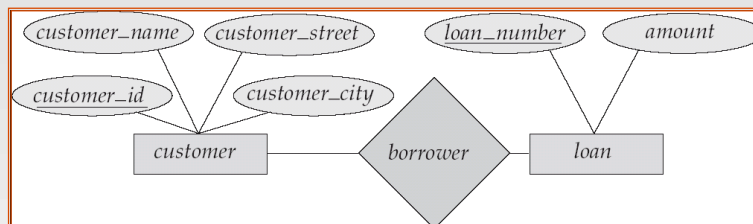


## Chapter 6: Entity-Relationship Model

- A *database* can be modeled as:
  - a collection of entities,
  - relationship among entities.
- An **entity** is an object that exists and is distinguishable from other objects.
  - Example: specific person, company, event, plant
- Entities have *attributes*
  - Example: people have *names* and *addresses*
- An **entity set** is a set of entities of the same type that share the same properties.
  - Example: set of all persons, companies, trees, holidays

1

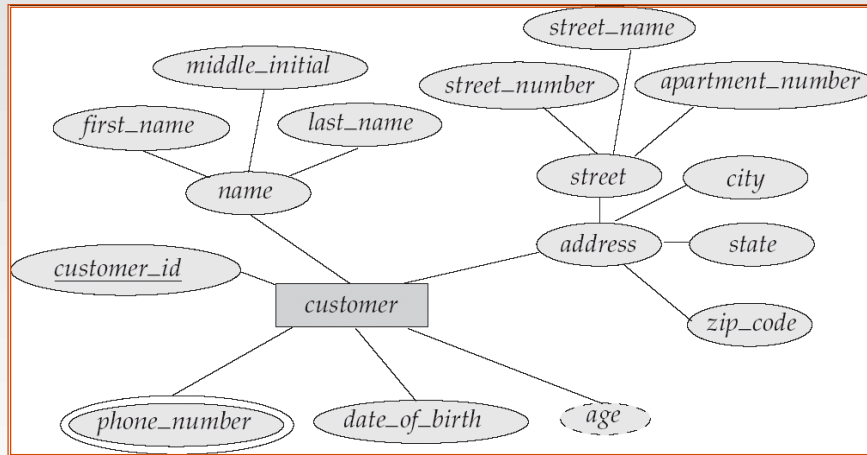
## E-R Diagrams



- Rectangles represent entity sets.
- Diamonds represent relationship sets.
- Lines link attributes to entity sets and entity sets to relationship sets.
- Underline indicates primary key attributes

2

## E-R Diagram With Composite, Multivalued, and Derived Attributes



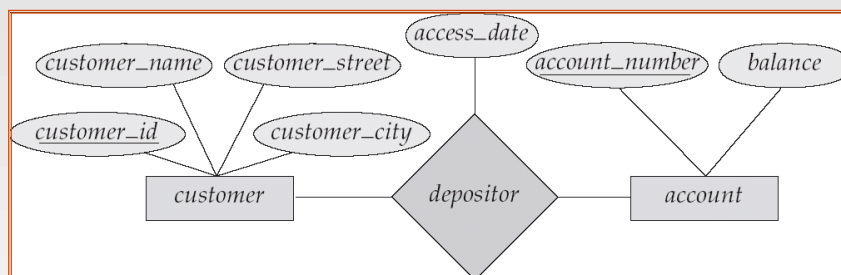
- Ellipses represent attributes
  - Double ellipses represent multivalued attributes.
  - Dashed ellipses denote derived attributes.

3

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSCI1022

## Relationship Sets with Attributes



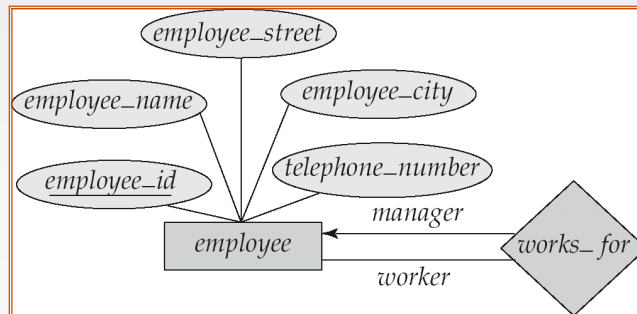
4

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSCI1022

## Roles

- Entity sets of a relationship need not be distinct
- The labels “manager” and “worker” are called **roles**; they specify how employee entities interact via the works\_for relationship set.
- Roles are indicated in E-R diagrams by labeling the lines that connect diamonds to rectangles.
- Role labels are optional, and are used to clarify semantics of the relationship



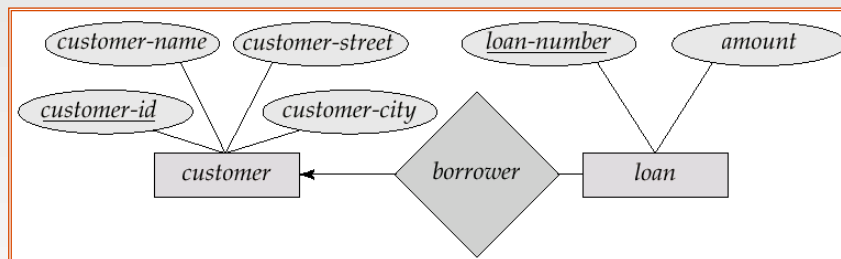
5

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSCI022

## One-To-Many Relationship

- In the one-to-many relationship a loan is associated with at most one customer via *borrower*, a customer is associated with several (including 0) loans via *borrower*



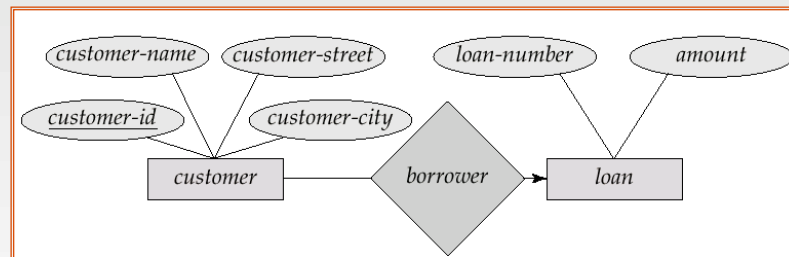
6

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSCI022

## Many-To-One Relationships

- In a many-to-one relationship a loan is associated with several (including 0) customers via *borrower*, a customer is associated with at most one loan via *borrower*



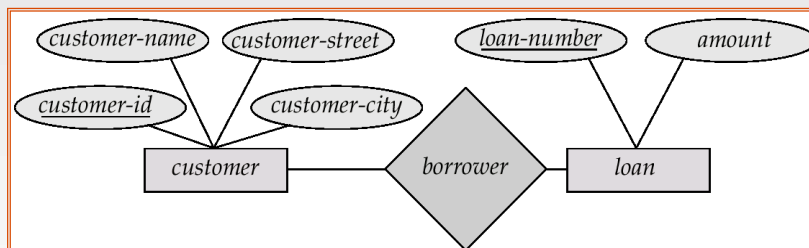
7

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSC1022

## Many-To-Many Relationship

- A customer is associated with several (possibly 0) loans via *borrower*
- A loan is associated with several (possibly 0) customers via *borrower*



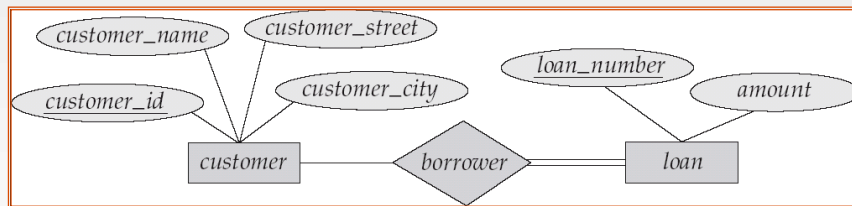
8

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSC1022

## Participation of an Entity Set in a Relationship Set

- Total participation (indicated by double line): every entity in the entity set participates in at least one relationship in the relationship set
  - participation of loan in borrower is total
    - every loan must have a customer associated to it via borrower
- Partial participation: some entities may not participate in any relationship in the relationship set
  - participation of customer in borrower is partial

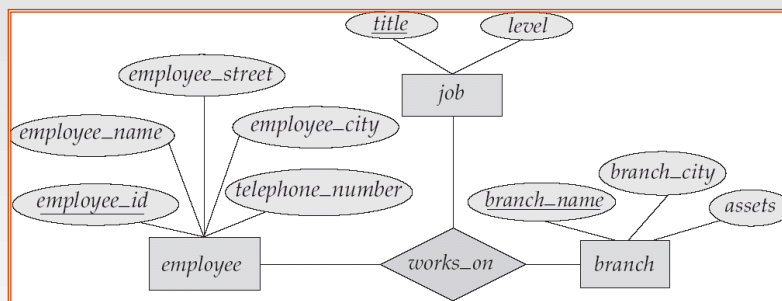


9

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSCI1022

## E-R Diagram with a Ternary Relationship



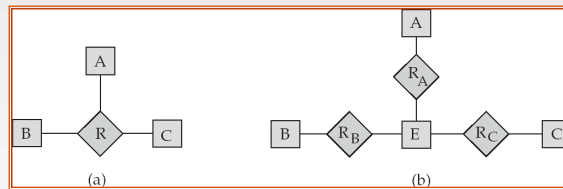
10

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSCI1022

## Converting Non-Binary Relationships to Binary Form

- In general, any non-binary relationship can be represented using binary relationships by creating an artificial entity set.
  - Replace  $R$  between entity sets  $A$ ,  $B$  and  $C$  by an entity set  $E$ , and three relationship sets:
    1.  $R_A$ , relating  $E$  and  $A$
    2.  $R_B$ , relating  $E$  and  $B$
    3.  $R_C$ , relating  $E$  and  $C$



11

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSCI1022

## Weak Entity Sets

- An entity set that does not have a primary key is referred to as a **weak entity set**.
- The existence of a weak entity set depends on the existence of a **identifying entity set**
  - it must relate to the identifying entity set via a total, one-to-many relationship set from the identifying to the weak entity set
  - **Identifying relationship** depicted using a double diamond
- The **discriminator** (or *partial key*) of a weak entity set is the set of attributes that distinguishes among all the entities of a weak entity set.
- The primary key of a weak entity set is formed by the primary key of the strong entity set on which the weak entity set is existence dependent, plus the weak entity set's discriminator.

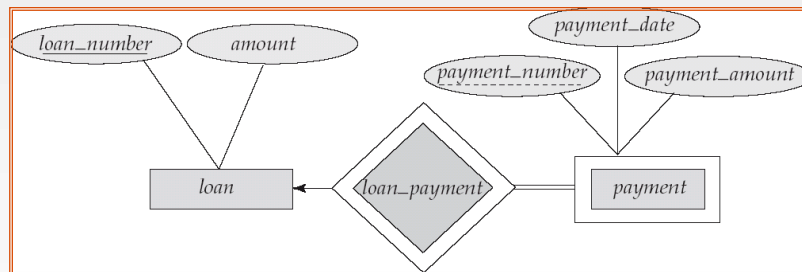
12

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSCI1022

## Weak Entity Sets (Cont.)

- We depict a weak entity set by double rectangles.
- We underline the discriminator of a weak entity set with a dashed line.
- `payment_number` – discriminator of the *payment* entity set
- Primary key for *payment* – (`loan_number`, `payment_number`)



13

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSCI1022

## Extended E-R Features: Specialization

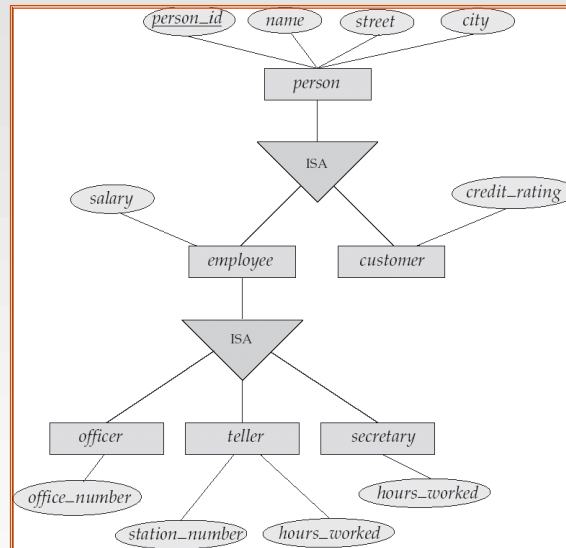
- Top-down design process; we designate subgroupings within an entity set that are distinctive from other entities in the set.
- These subgroupings become lower-level entity sets that have attributes or participate in relationships that do not apply to the higher-level entity set.
- Depicted by a *triangle* component labeled ISA (E.g. *customer* “is a” *person*).
- **Attribute inheritance** – a lower-level entity set inherits all the attributes and relationship participation of the higher-level entity set to which it is linked.

14

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSCI1022

## Specialization Example



15

Textbook: Database System Concepts - 5th Edition, 2005

INFSC1022

## Extended ER Features: Generalization

- **A bottom-up design process** – combine a number of entity sets that share the same features into a higher-level entity set.
- Specialization and generalization are simple inversions of each other; they are represented in an E-R diagram in the same way.
- The terms specialization and generalization are used interchangeably.

16

Textbook: Database System Concepts - 5th Edition, 2005

INFSC1022



## Design Constraints on a Specialization/Generalization

- Constraint on which entities can be members of a given lower-level entity set.
  - condition-defined
    - Example: all customers over 65 years are members of *senior-citizen* entity set; *senior-citizen* ISA *person*.
  - user-defined
- Constraint on whether or not entities may belong to more than one lower-level entity set within a single generalization.
  - **Disjoint**
    - an entity can belong to only one lower-level entity set
    - Noted in E-R diagram by writing *disjoint* next to the ISA triangle
  - **Overlapping**
    - an entity can belong to more than one lower-level entity set

17

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSC1022

## Design Constraints on a Specialization/Generalization (Cont.)

- **Completeness constraint** -- specifies whether or not an entity in the higher-level entity set must belong to at least one of the lower-level entity sets within a generalization.
  - **total** : an entity must belong to one of the lower-level entity sets
  - **partial**: an entity need not belong to one of the lower-level entity sets

18

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSC1022

## E-R Design Decisions

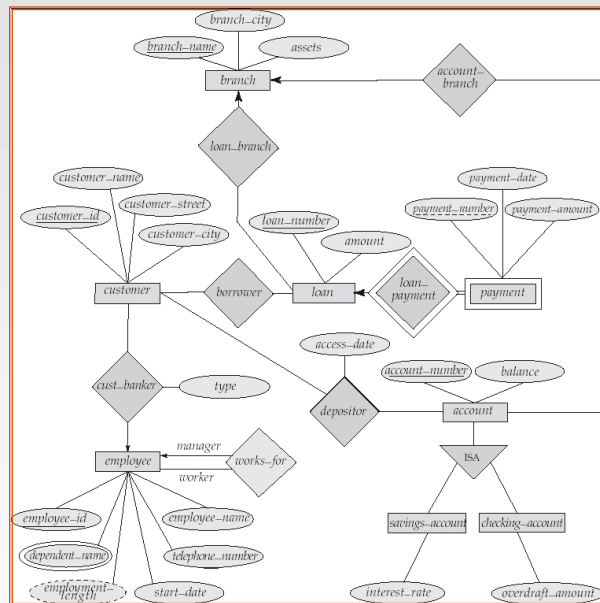
- The use of an attribute or entity set to represent an object.
- Whether a real-world concept is best expressed by an entity set or a relationship set.
- The use of a strong or weak entity set.
- The use of specialization/generalization – contributes to modularity in the design.

19

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSCI1022

## E-R Diagram for a Banking Enterprise



20

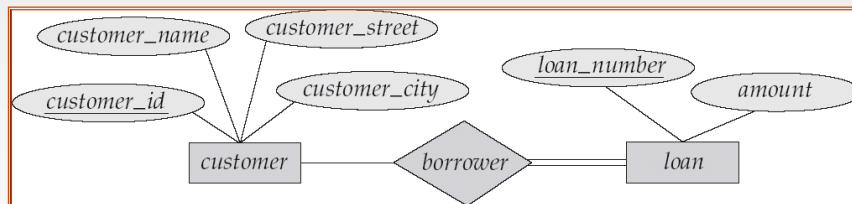
Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSCI1022

## Representing Entity Sets as Relation Schemas

- A strong entity set reduces to a schema with the same attributes.
- A weak entity set becomes a table that includes a column for the primary key of the identifying strong entity set

*loan* = ( loan\_number, amount )



21

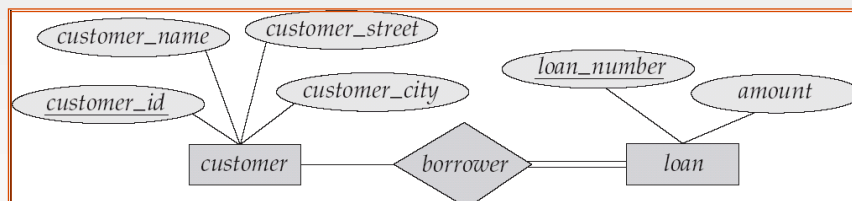
Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSCI1022

## Representing Relationship Sets as Relation Schemas

- A many-to-many relationship set is represented as a schema with attributes for the primary keys of the two participating entity sets, and any descriptive attributes of the relationship set.
- Example: schema for relationship set borrower

*borrower* = ( customer\_id, loan\_number )



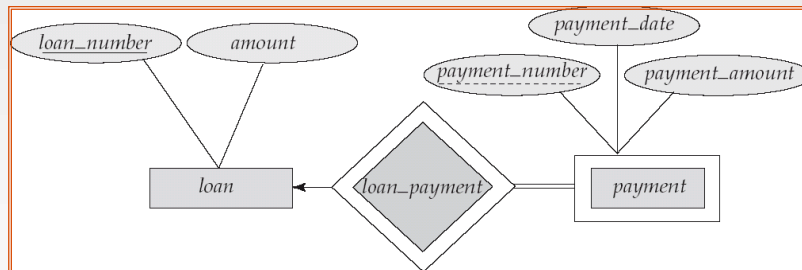
22

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSCI1022

## Representing Weak Entity Sets as Relational Schemas

payment =  
(loan\_number, payment\_number, payment\_date, payment\_amount)



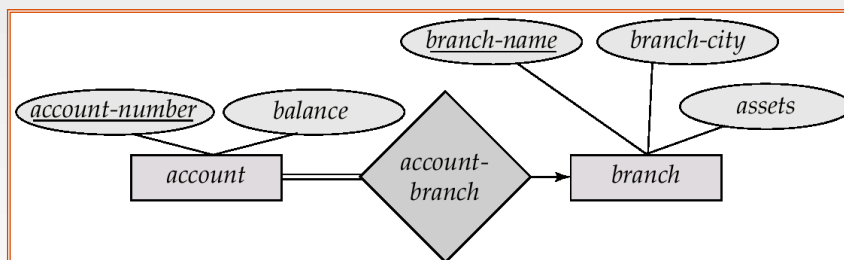
23

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSCI1022

## Redundancy of Schemas

- Many-to-one and one-to-many relationship sets that are total on the many-side can be represented by adding an extra attribute to the "many" side, containing the primary key of the "one" side
- Example: Instead of creating a schema for relationship set *account\_branch*, add an attribute *branch\_name* to the schema arising from entity set *account*



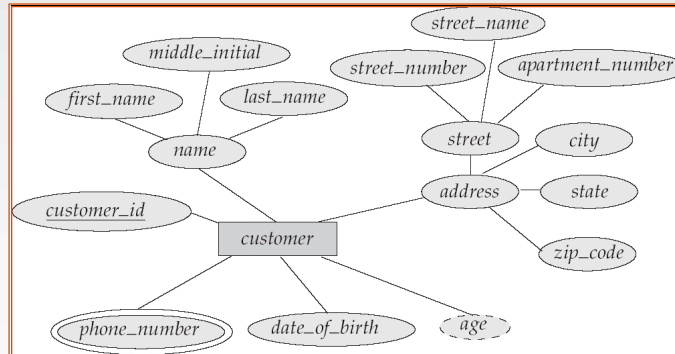
24

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSCI1022

## Composite and Multivalued Attributes

- Composite attributes are flattened out by creating a separate attribute for each component attribute
- A multivalued attribute  $M$  of an entity  $E$  is represented by a separate schema  $EM$
- Each value of the multivalued attribute maps to a separate tuple of the relation on schema  $EM$



25

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSC1022

## Representing Specialization via Schemas

- Method 1:
  - Form a schema for the higher-level entity
  - Form a schema for each lower-level entity set, include primary key of higher-level entity set and local attributes

schema	attributes
<i>person</i>	<i>name, street, city</i>
<i>customer</i>	<i>name, credit_rating</i>
<i>employee</i>	<i>name, salary</i>

- Drawback: getting information about, an *employee* requires accessing two relations, the one corresponding to the low-level schema and the one corresponding to the high-level schema

26

Textbook: Database System Concepts - 5<sup>th</sup> Edition, 2005

INFSC1022

## Representing Specialization as Schemas (Cont.)

### ■ Method 2:

- Form a schema for each entity set with all local and inherited attributes

schema	attributes
<i>person</i>	<i>name, street, city</i>
<i>customer</i>	<i>name, street, city, credit_rating</i>
<i>employee</i>	<i>name, street, city, salary</i>

- If specialization is total, the schema for the generalized entity set (*person*) not required to store information
- Drawback: *street* and *city* may be stored redundantly for people who are both customers and employees

27