



Chapter 6: ER – Entity Relationship Diagram

- Major components of ER diagram
- Practices



ER

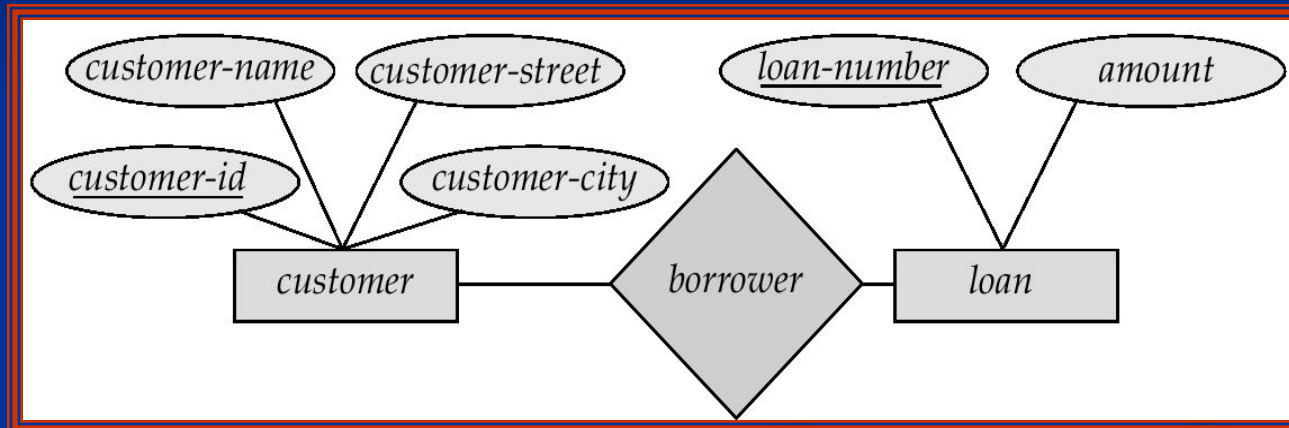
- 1976 proposed by Peter Chen
- ER diagram is widely used in database design
 - Represent conceptual level of a database system
 - Describe things and their relationships in high level



Basic Concepts

- Entity set – an abstraction of similar things, e.g. cars, students
 - An entity set contains many entities
- Attributes: common properties of the entities in a entity sets
- Relationship – specify the relations among entities from two or more entity sets

An Example





Relationship

- A relationship may be thought as a set as well
 - For binary relationship, it enumerates the pairs of entities that relate to each other
 - For example, entity set $M = \{Mike, Jack, Tom\}$ entity set $F = \{Mary, Kate\}$. The relationship set *married* between M and F may be $\{<Mike, Mary>, <Tom, Kate>\}$



Relationship

- A *relationship* set is a mathematical relation among $n \geq 2$ entities, each taken from entity sets

$$\{(e_1, e_2, \dots, e_n) \mid e_1 \in E_1, e_2 \in E_2, \dots, e_n \in E_n\}$$

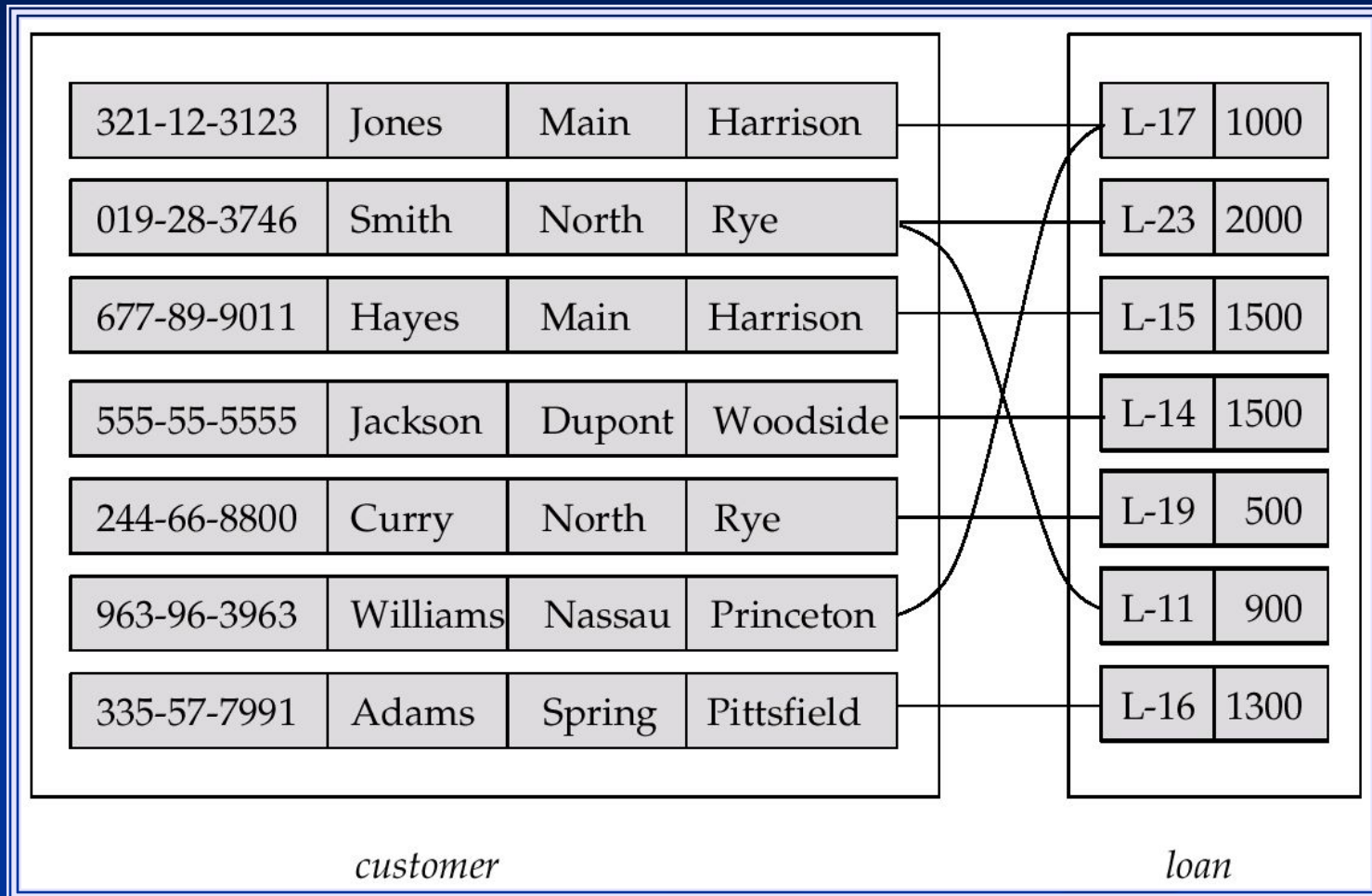
where (e_1, e_2, \dots, e_n) is a relationship

- Example:

$$(\text{Hayes}, \text{A-102}) \in \text{depositor}$$

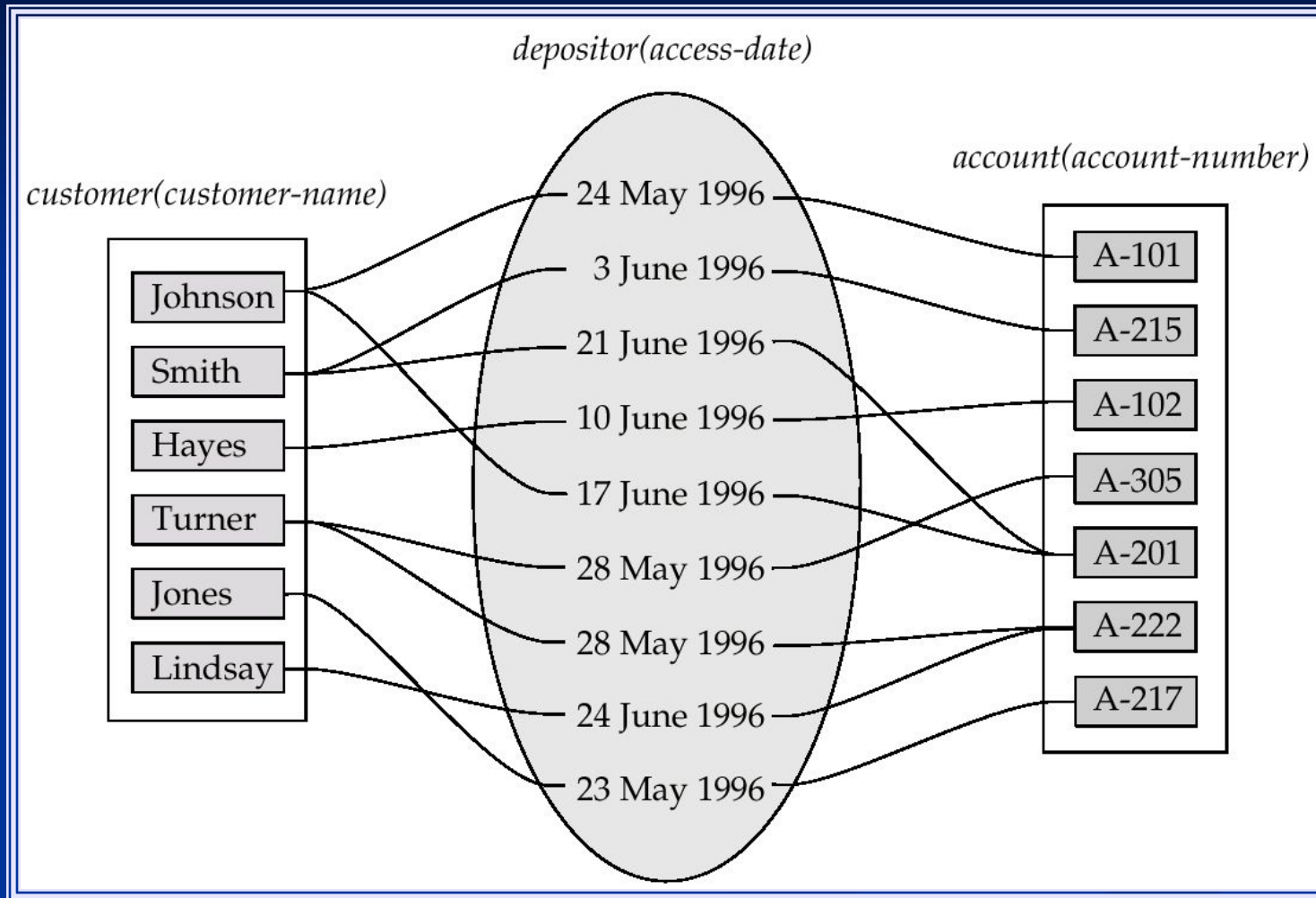


Relationship Example





Attribute of A Relationship Set

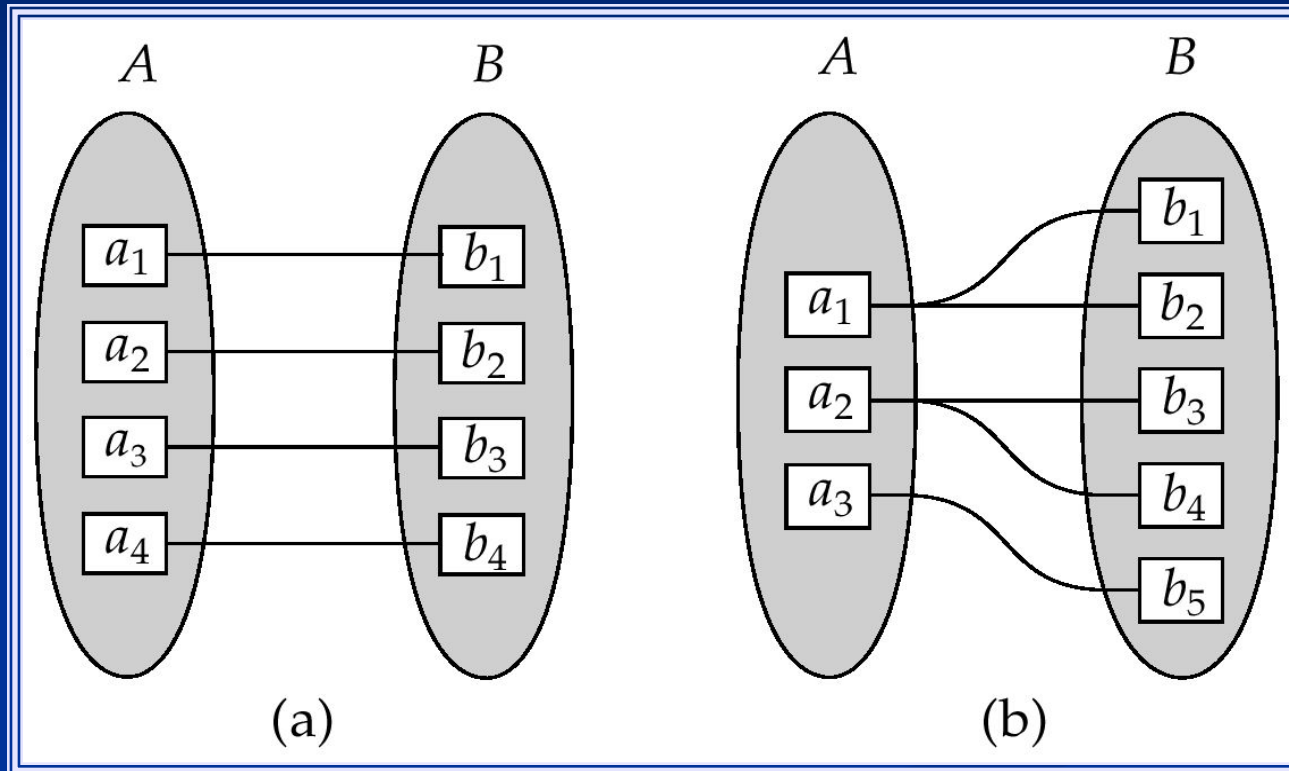




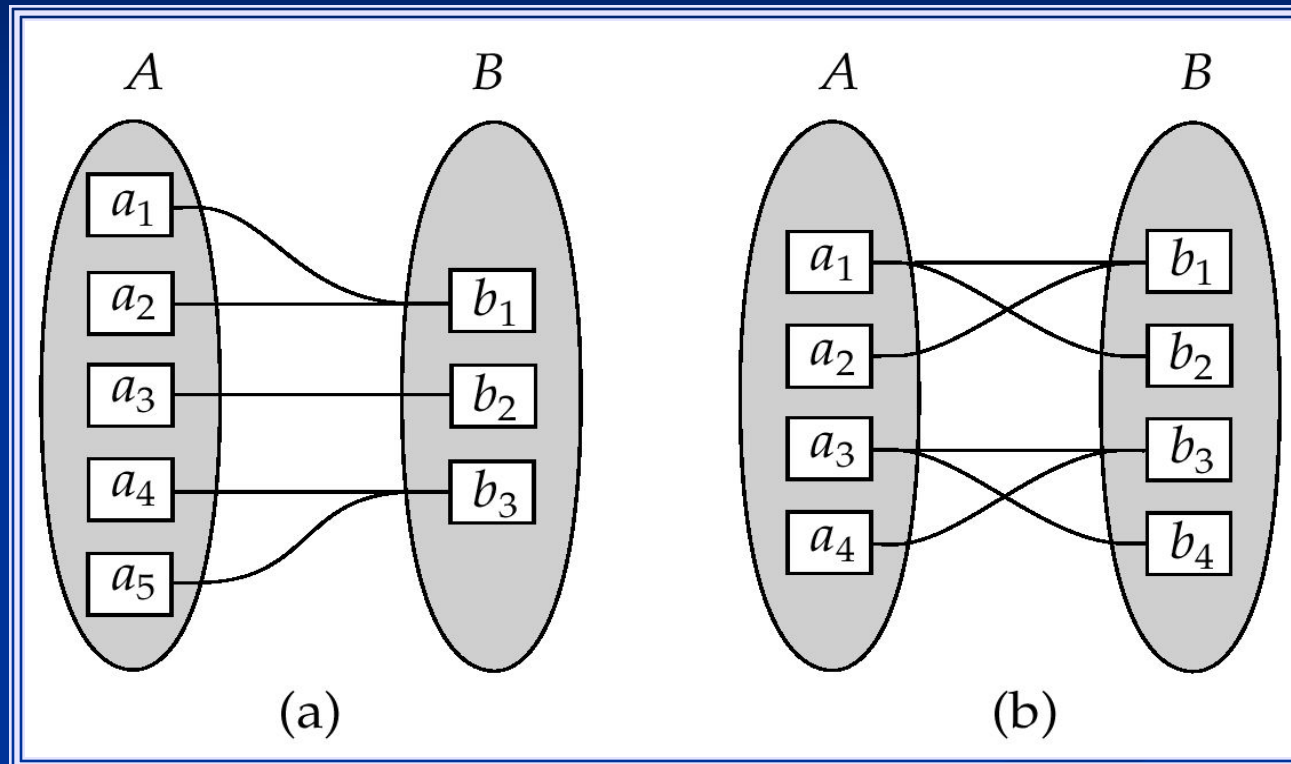
Relationship

- The degree of a relationship = the number of entity sets that participate in the relationship
 - Mostly binary relationships
 - Sometimes more
- Mapping cardinality of a relationship
 - 1 – 1
 - 1 – many
 - many – 1
 - Many-many

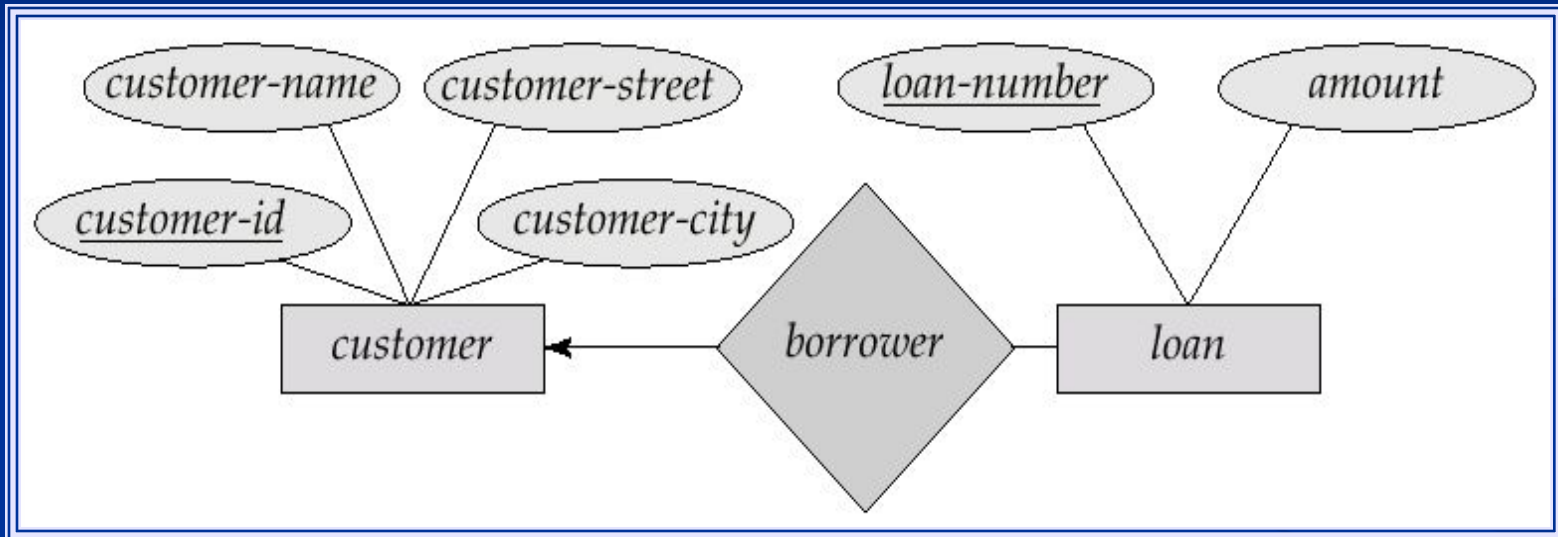
One-One and One-Many



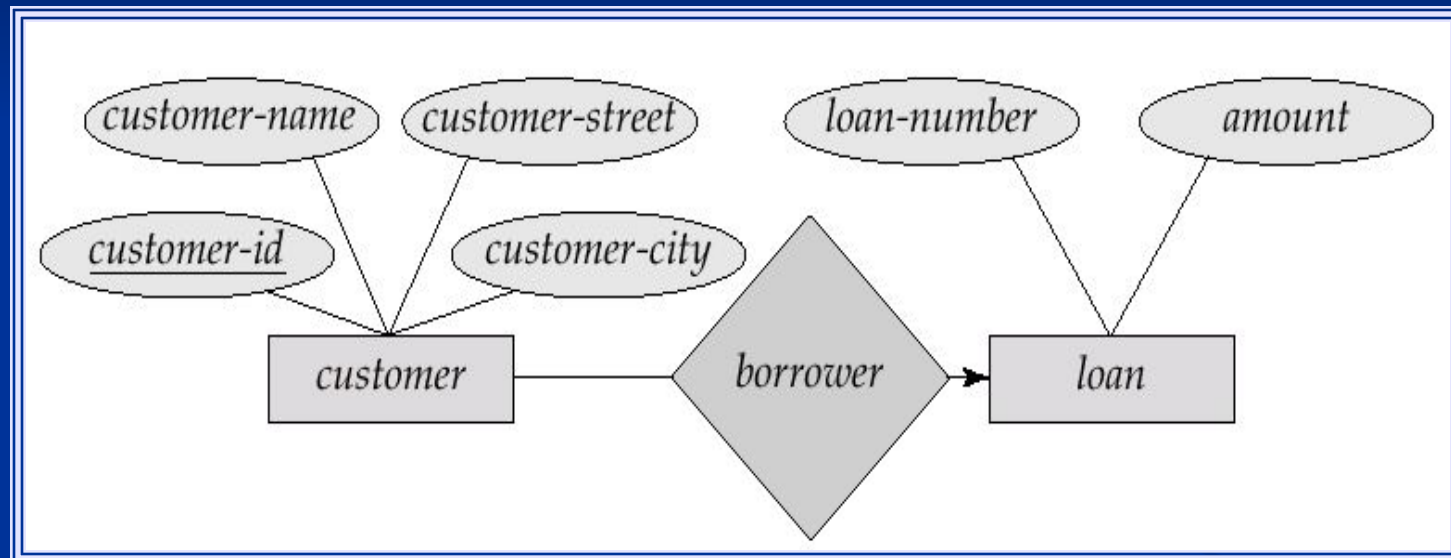
Many-one and many-many



1- many

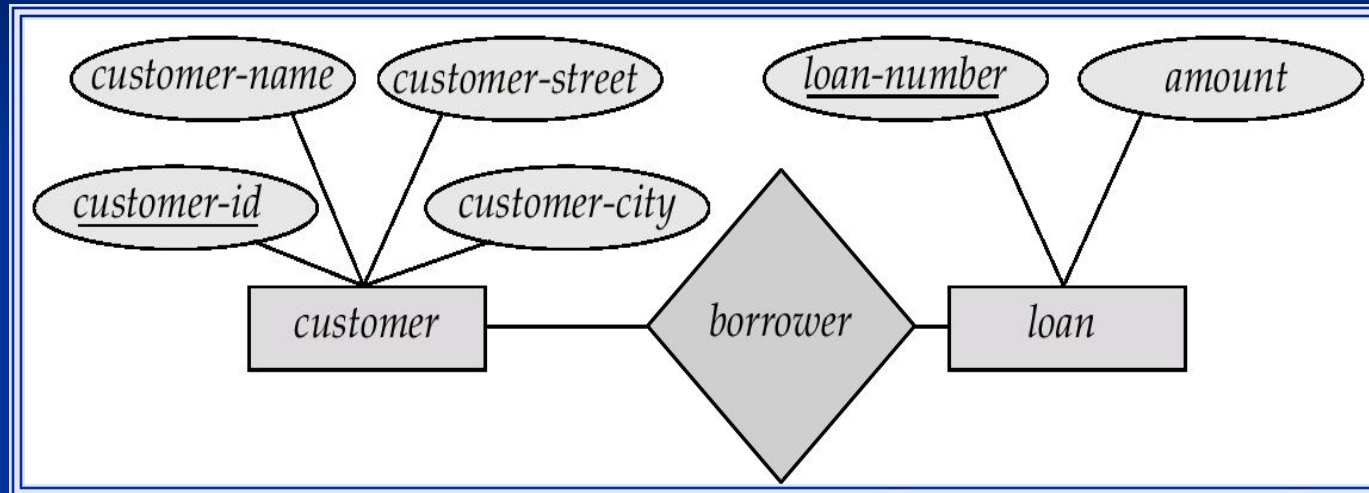


Many - 1

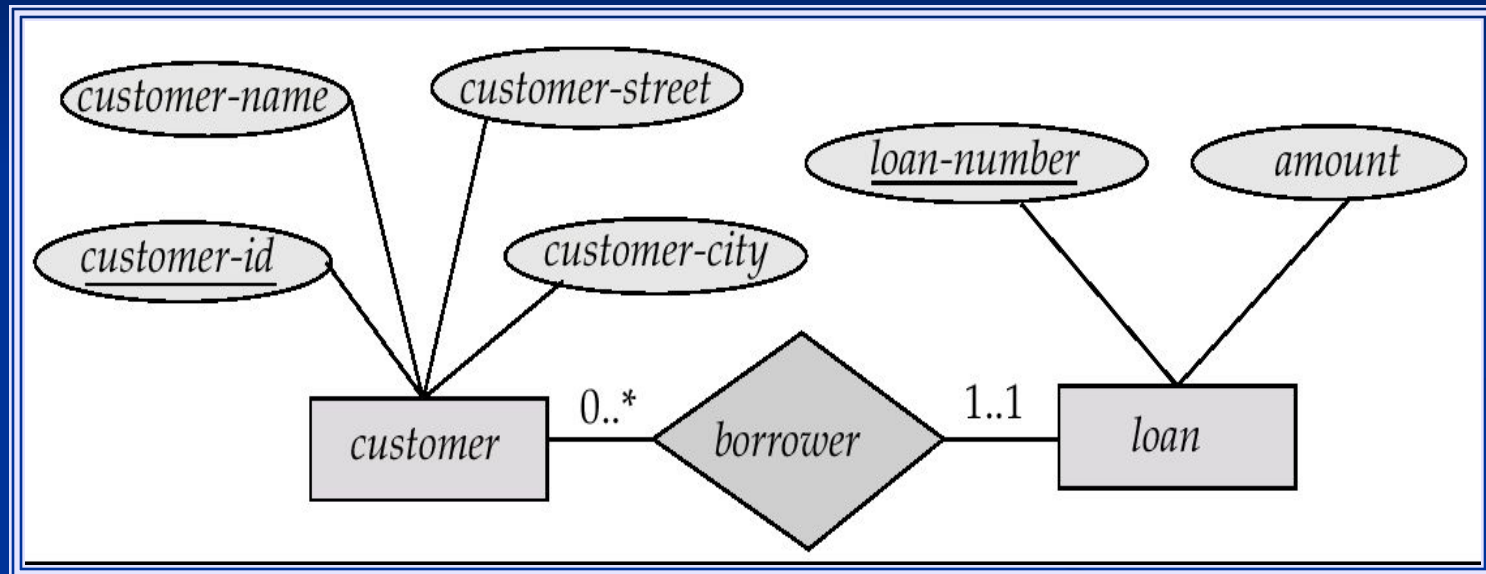




Many - many



Alternative Cardinality Specification



Note on Mapping Cardinality



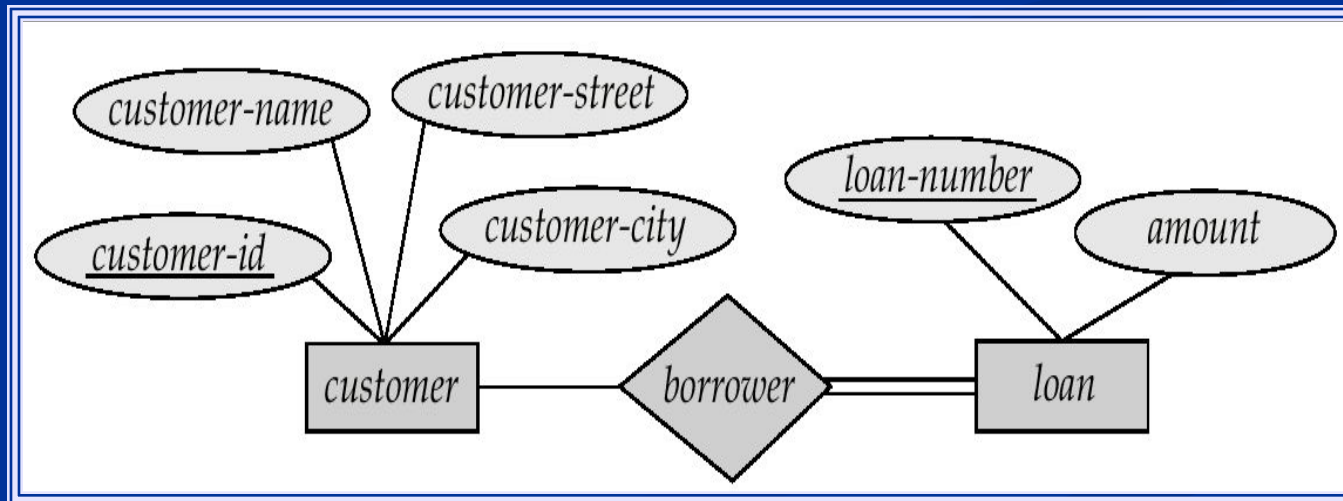
- Both many and 1 include 0
 - Meaning some entity may not participate in the relationship



Total Participation

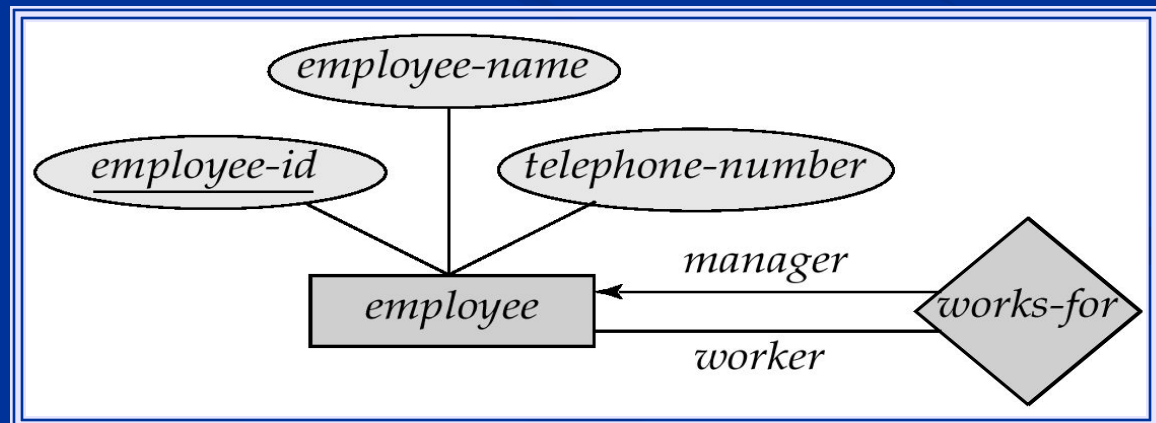
- When we require all entities to participate in the relationship (total participation), we use double lines to specify

Every loan has to have at least one customer



Self Relationship

- Sometimes entities in a entity set may relate to other entities in the same set. Thus self relationship
- Here employees manage some other employees
- The labels "manger" and "worker" are called *roles* the self relationship





More examples on self-relationship

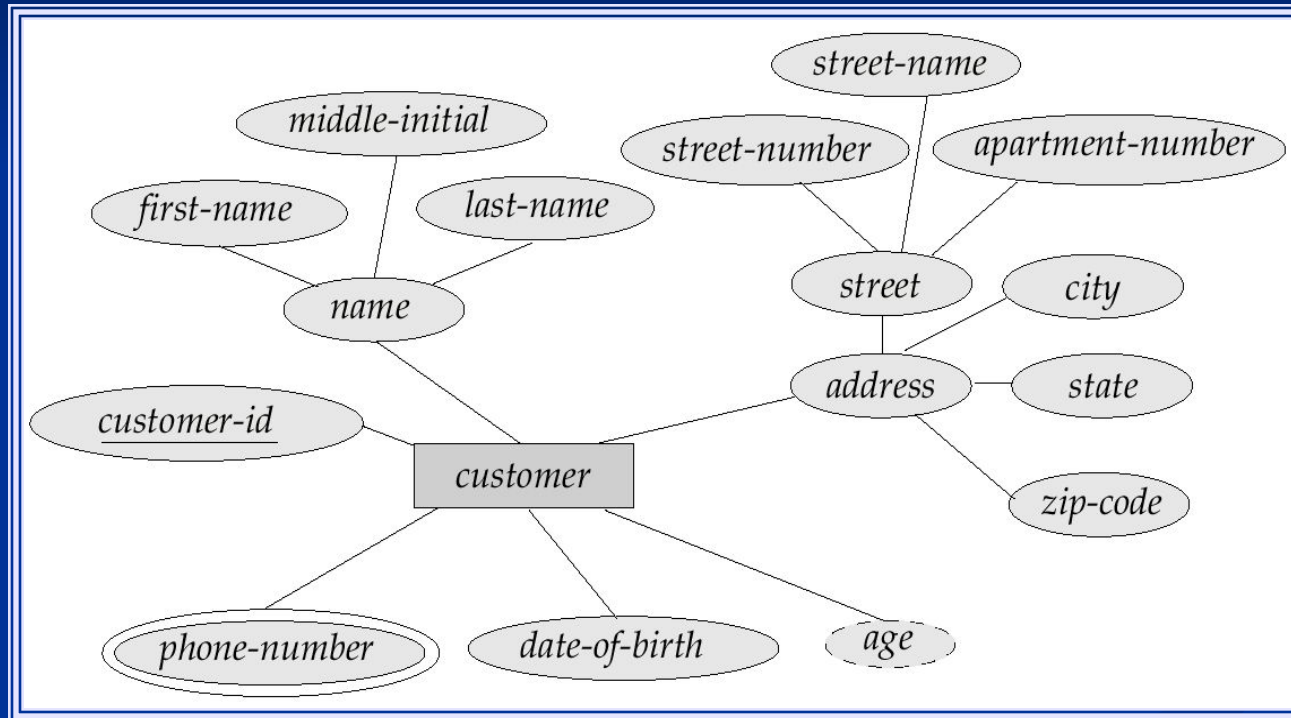
- People to people
 - Parent – children
 - Manager – employee
 - Husband – wife
- Word to word
 - Root – synonym



Attributes

- Both entity sets and relationships can have attributes
- Attributes may be
 - Composite
 - Multi-valued (double ellipse)
 - Derive (dashed ellipse)

Another Example





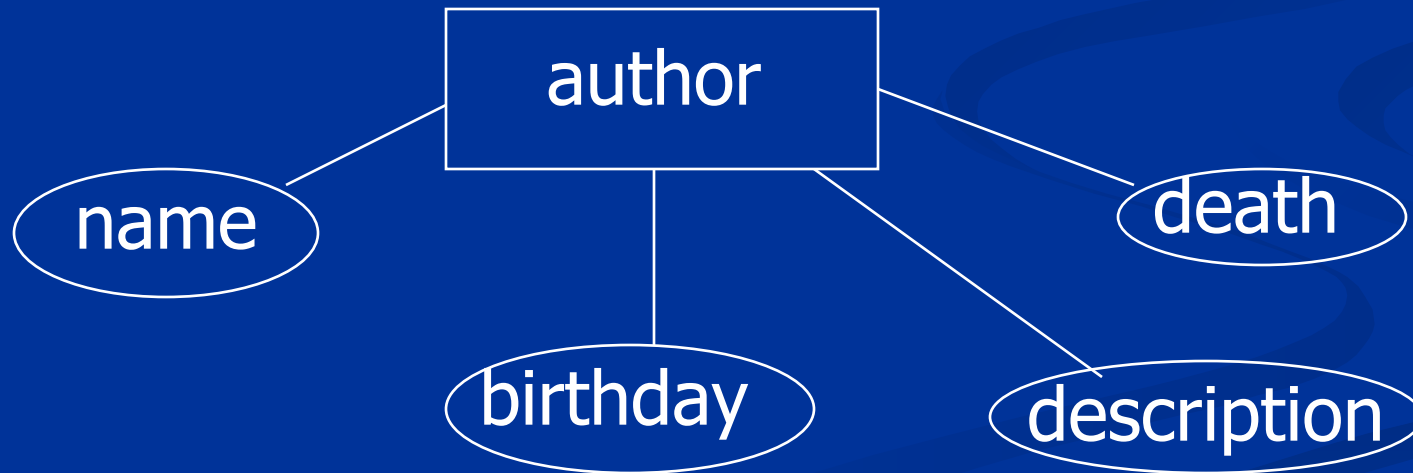
Keys

- A *super key* of an entity set is a set of one or more attributes whose values uniquely determine each entity.
- A *candidate key* of an entity set is a minimal super key
- Although several candidate keys may exist, one of the candidate keys is selected to be the *primary key*.

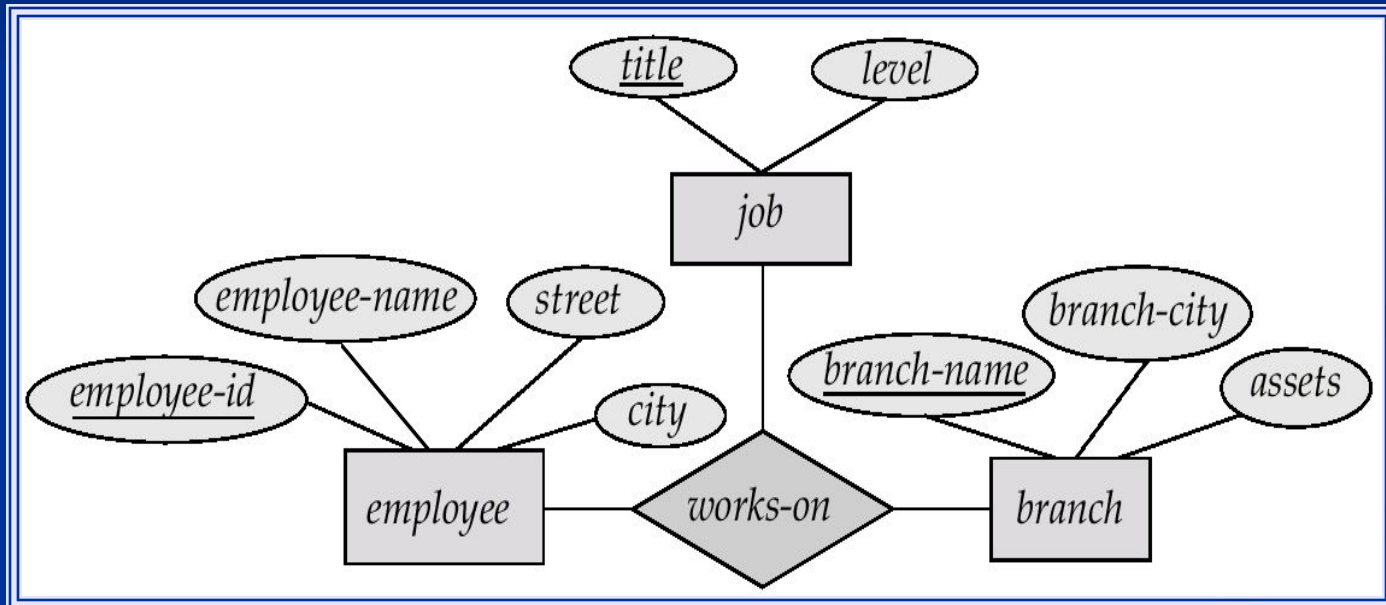


Key Examples

- Suggest super keys for the following entity?
- What are the candidate keys?
- Primary key?



Ternary Relationship



Can We Decompose a Ternary Relationship?



- Some relationships that appear to be non-binary may be better represented using binary relationships
 - E.g. A ternary relationship *parents*, relating a child to his/her father and mother, is best replaced by two binary relationships, *father* and *mother*
 - Using two binary relationships allows partial information (e.g. only mother being know)
 - But there are some relationships that are naturally non-binary
 - E.g. *works-on*, *why?*

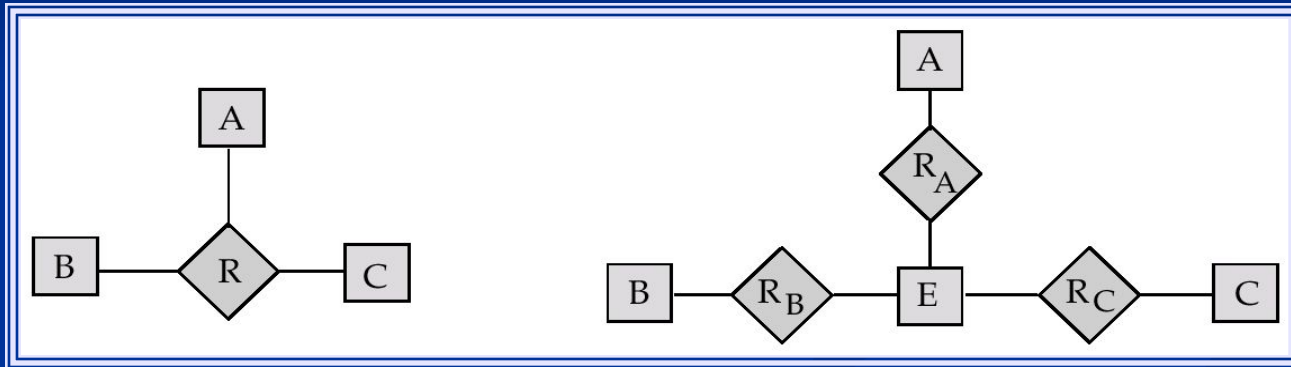


Converting Ternary to binary

- 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
 - Create a special identifying attribute for E
 - Add any attributes of R to E
 - For each relationship (a_i, b_i, c_i) in R , create
 1. a new entity e_i in the entity set E
 2. add (e_i, a_i) to $R_{A'}$
 3. add (e_i, b_i) to $R_{B'}$
 4. add (e_i, c_i) to $R_{C'}$



Converting Ternary to binary





Design an ER Diagram

- Design a database for an on-line reservation system for microscopes in material science lab
- There are two types of users: microscope administrators and microscope end users
- Each microscope is located in a specific lab
- Each request is assigned to an administrator who can authorize or deny the request
- Using of some microscope requires the presence of an administrator
- Time is divided into 1 hour slots. Each reservation can only take one or more time slots



Weak Entity Set

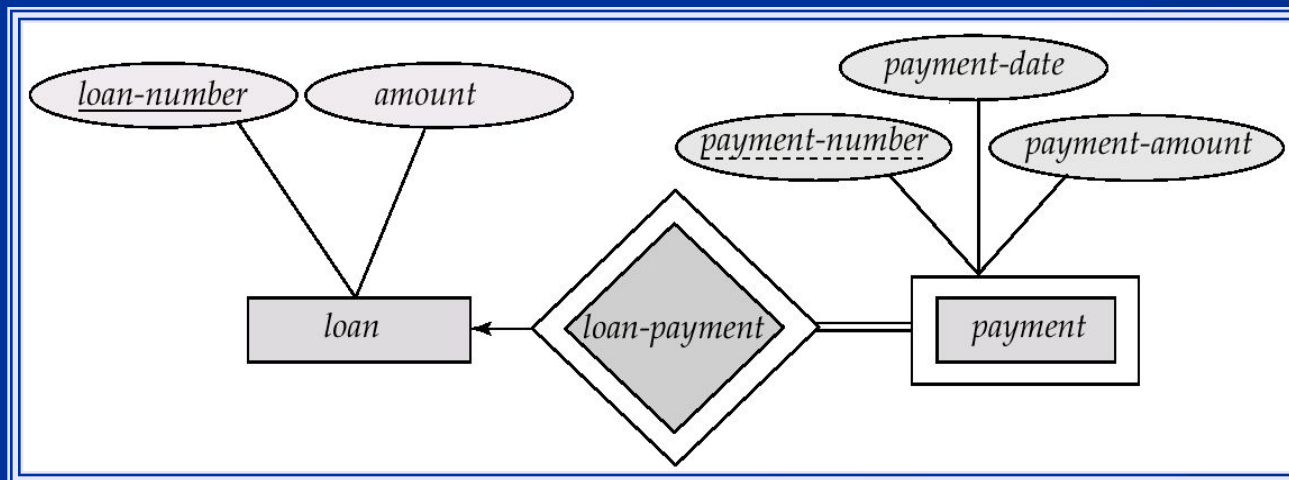
- Some entity sets in real world naturally depend on some other entity set
 - They can be uniquely identified only if combined with another entity set
- Example:
 - section1, section2, ... become unique only if you put them into a context, e.g. csce4350

Weak Entity Set Notations

Double rectangles for weak entity set

Double diamond for weak entity relationship

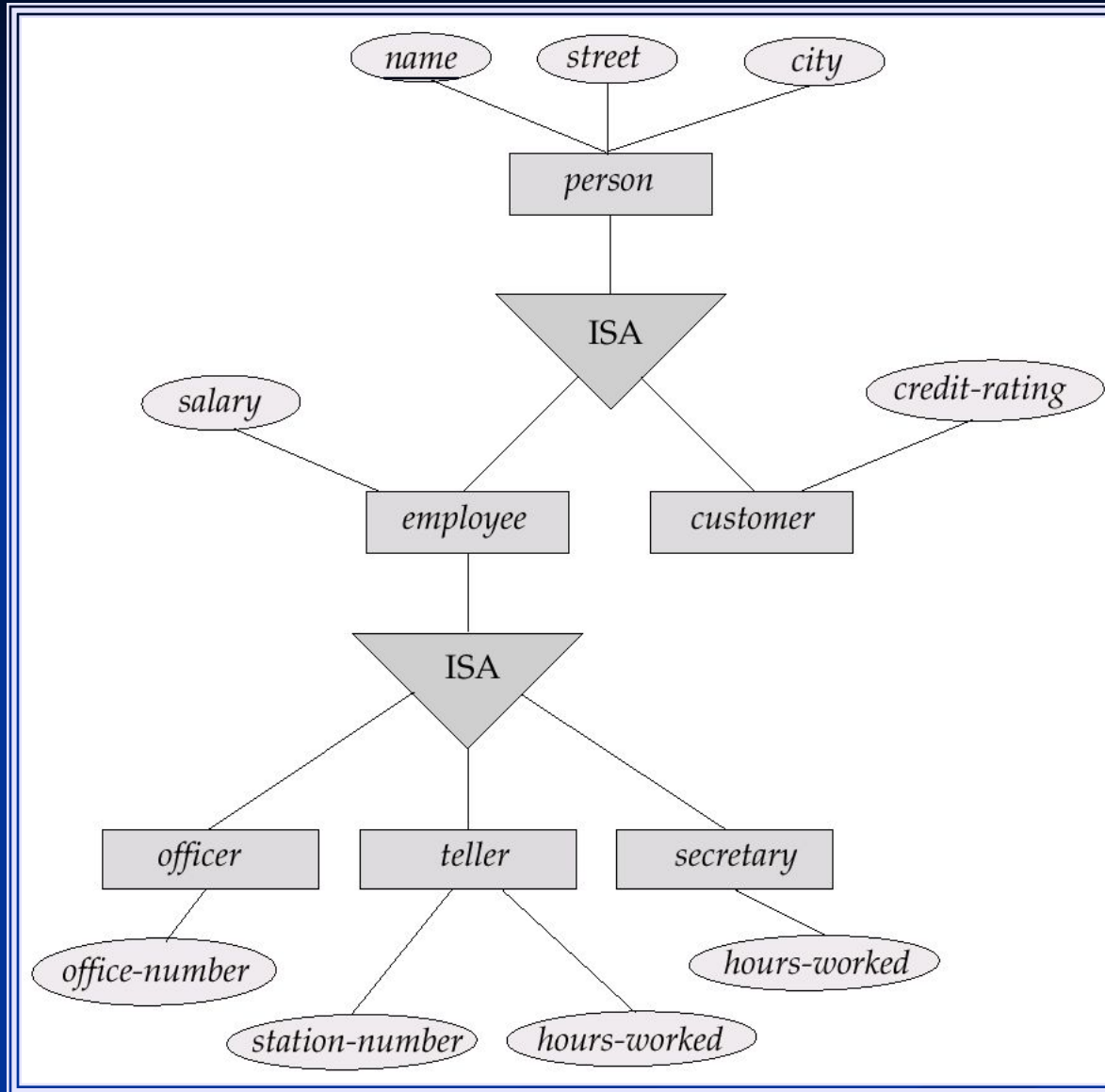
Dashed underscore for **discriminator**





Specialization

- A lower-level entity set inherits all the attributes and relationship participation of the higher-level entity set to which it is linked.
- A lower-level entity set may have additional attributes and participate in additional relationships





Specification


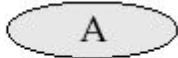

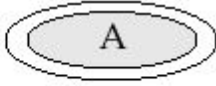
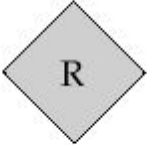


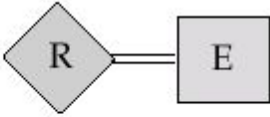
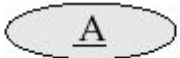
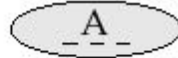
- Disjoint
- Completeness constraint (use double lines)
 - **total** : an entity must belong to one of the lower-level entity sets
 - **partial**: an entity need not belong to one of the lower-level entity sets



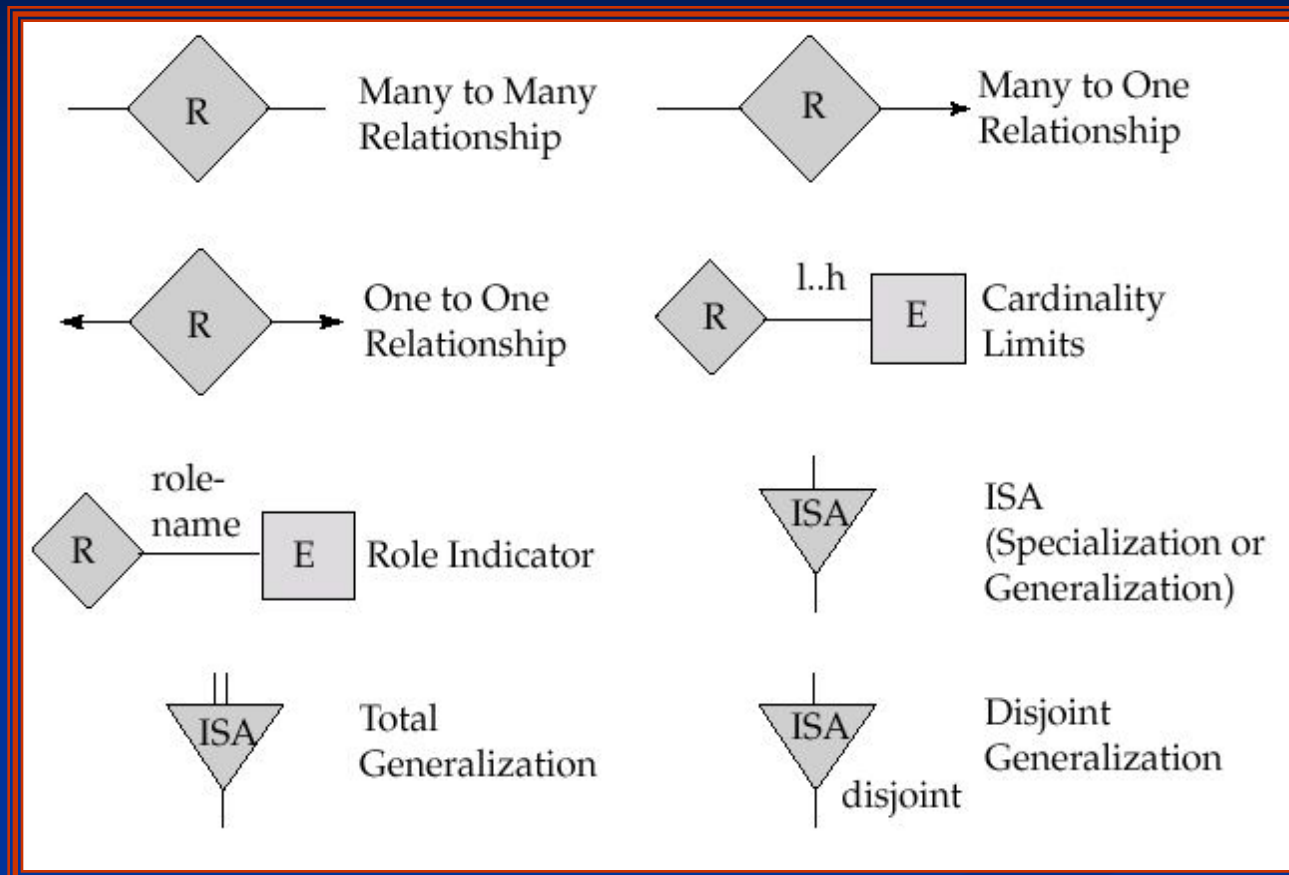
Design Considerations

- Use of entity sets vs. attributes
 - Whether we want to keep additional information
- Use of entity sets vs. relationship sets
 - Actions among entities are usually represented by relationships
- Binary versus n -ary relationship sets
 - N -nary relationships are usually more natural for actions among entity sets
- Weak entity set vs. strong entity set
- Generalization

Notations

	Entity Set		Attribute
	Weak Entity Set		Multivalued Attribute
	Relationship Set		Derived Attribute
	Identifying Relationship Set for Weak Entity Set		Total Participation of Entity Set in Relationship
	Primary Key		Discriminating Attribute of Weak Entity Set

Notations





ER Practice Again

- Design an ER diagram for an online music store. The database will contain at least the following concepts: songs, artists, bands, albums, and genres.
- State your design assumptions you make to support design decisions. Be sure your assumptions are reasonable.



Best Practice Guide for ER Design

- Use of entity sets vs. attributes
- Use of entity sets vs. relationship sets
- Binary versus n -ary relationship sets
- Weak entity set vs. strong entity set
 - Choose the natural one
- Generalization
 - If specialized entities need to keep additional information and participate in additional relationships

ER for Banking Enterprise



- Description handhout



Read ER Diagrams

- Following are some ER diagrams grabbed from the web
- Read to understand/criticize

