Chapter 6: ER – Entity Relationship Diagram

- Major components of ER diagram
- Practices

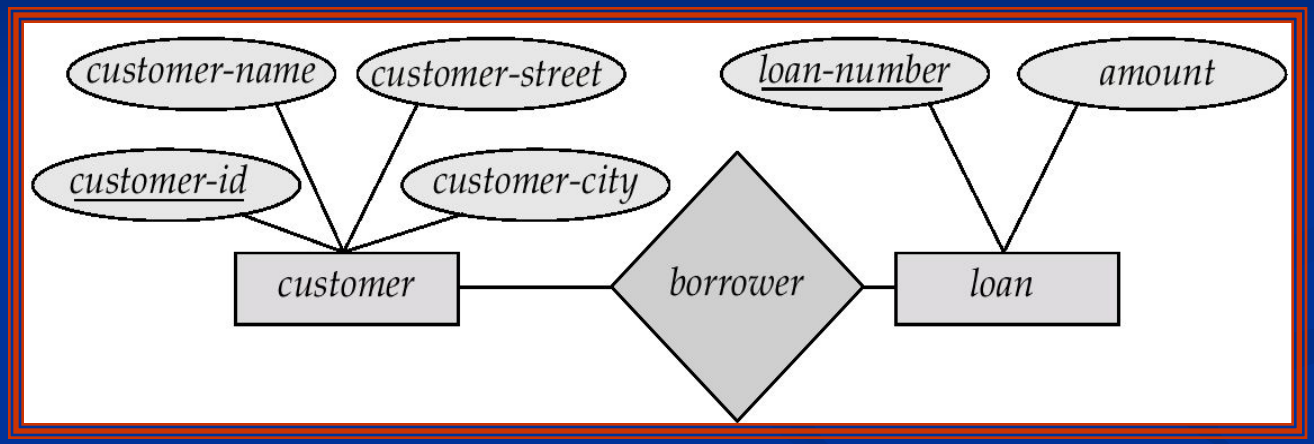
ER

- 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


customer-name
customer-street
loan-number
amount
customer-id
customer-city
customer
borrower
loan

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

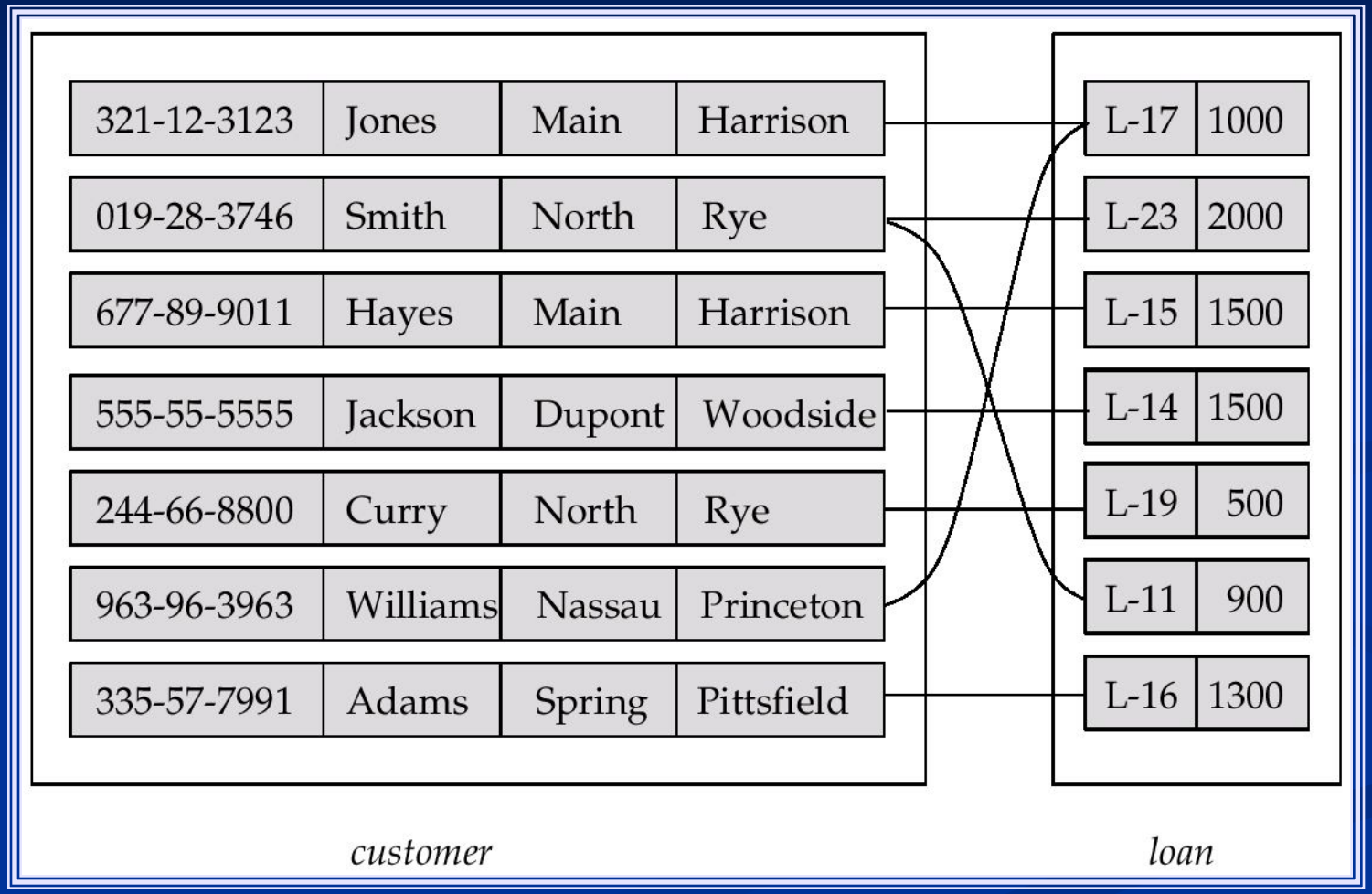
$$\{(e_1, e_2, \ldots e_n) \mid e_1 \in E_1, e_2 \in E_2, \ldots, e_n \in E_n\}$$

where $(e_1, e_2, \ldots, e_n)$ is a relationship

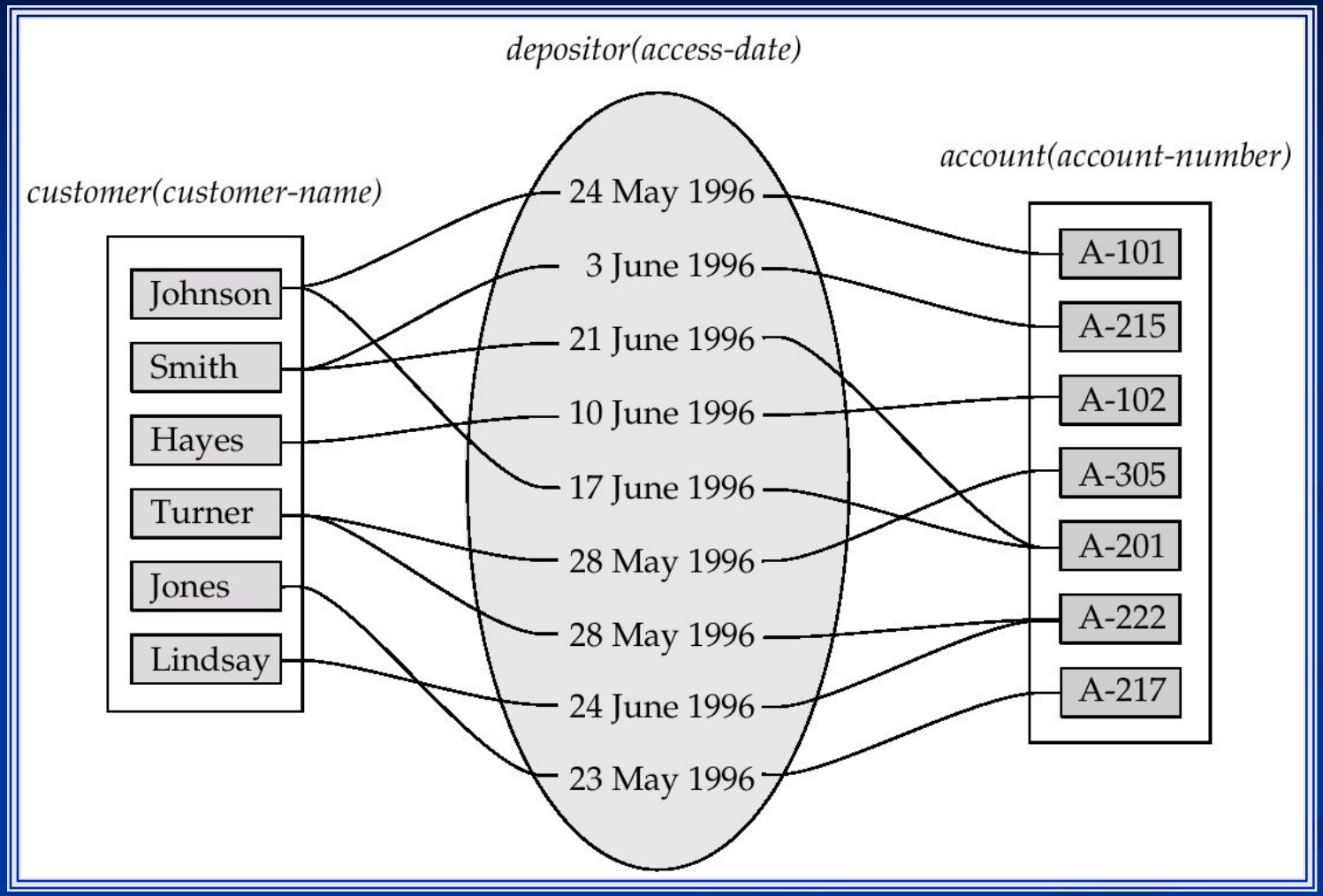
  - Example:

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

Relationship Example



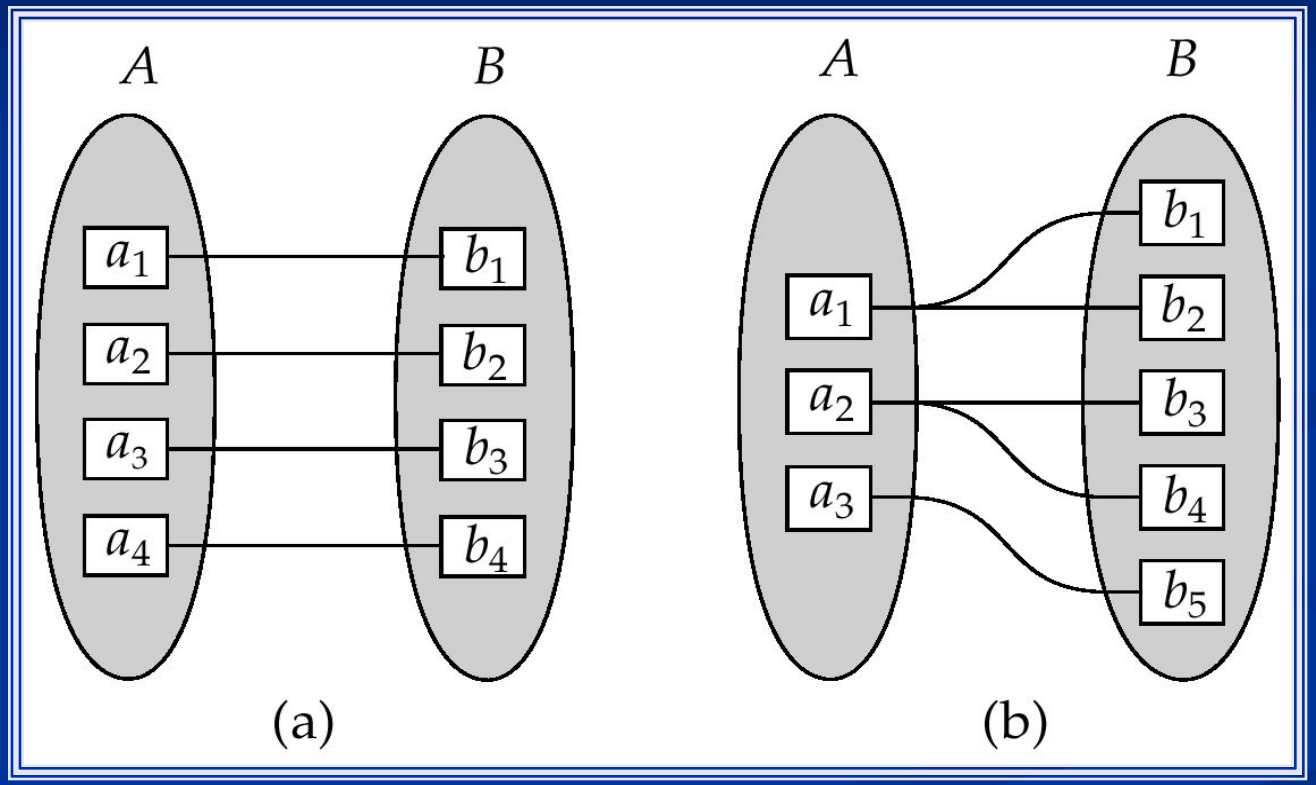
Attribute of A Relationship Set



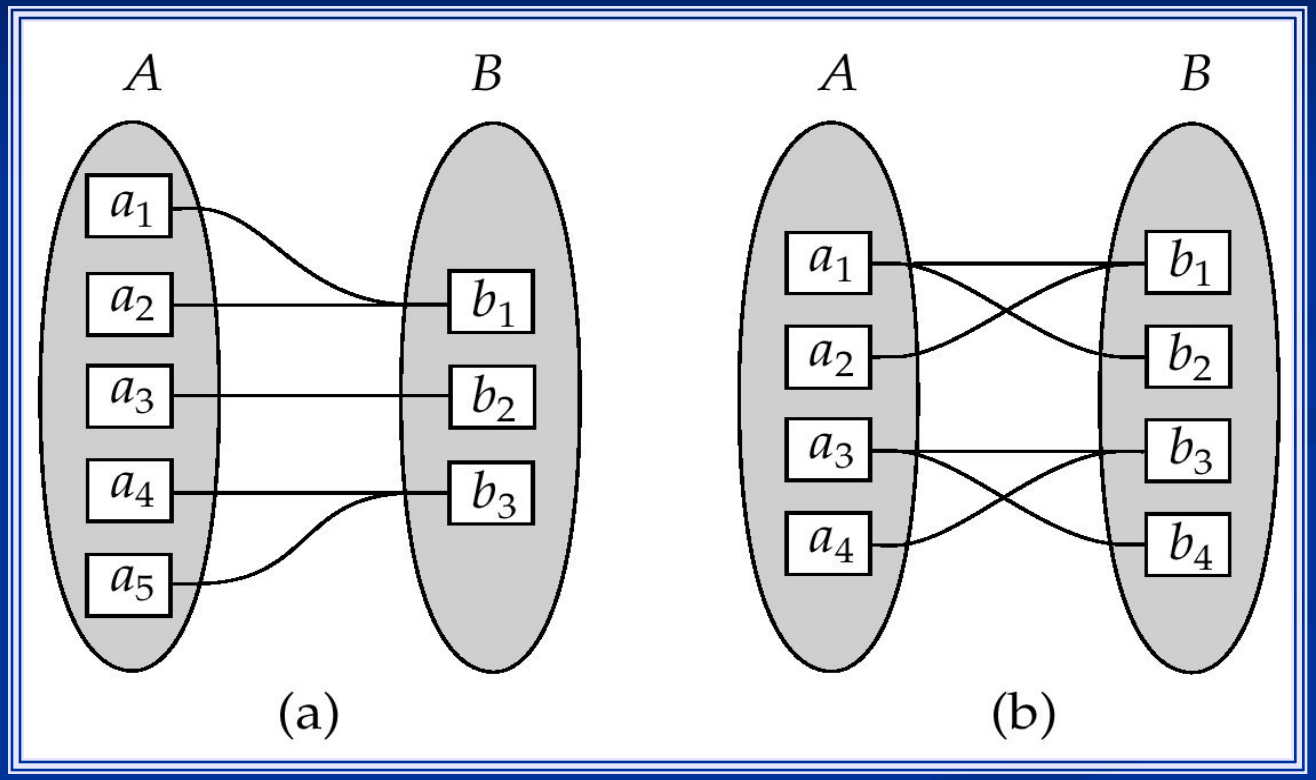
Relationship

- 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

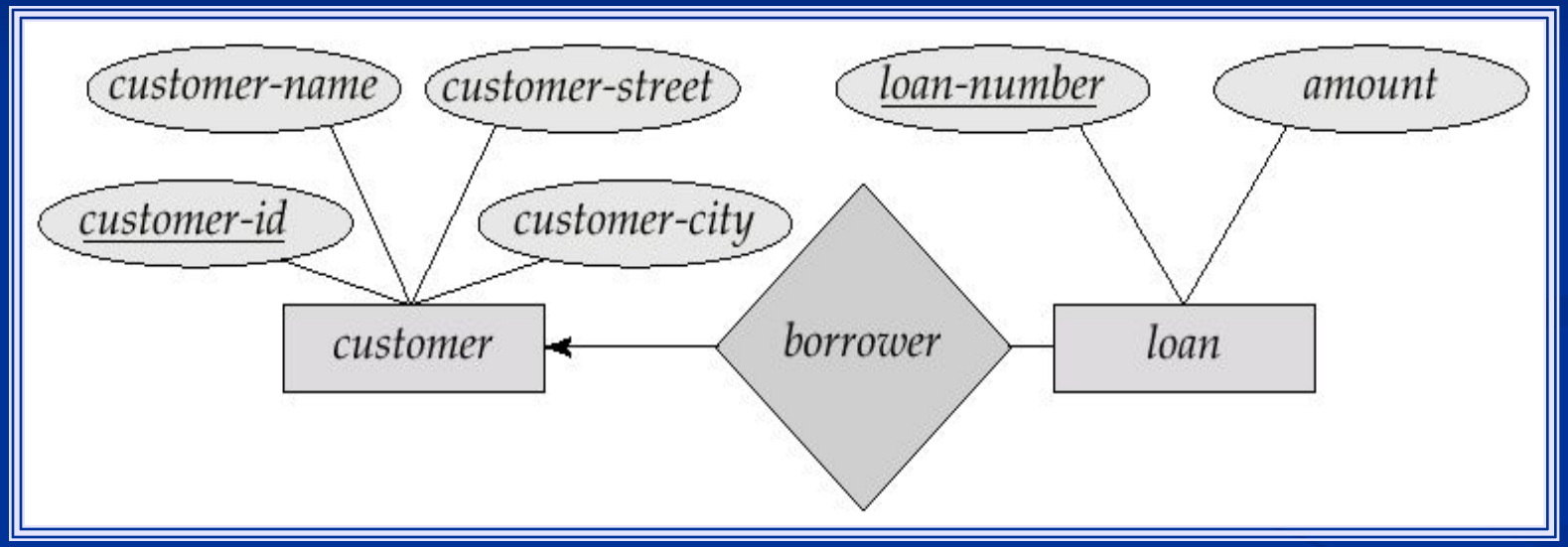
One-One and One-Many



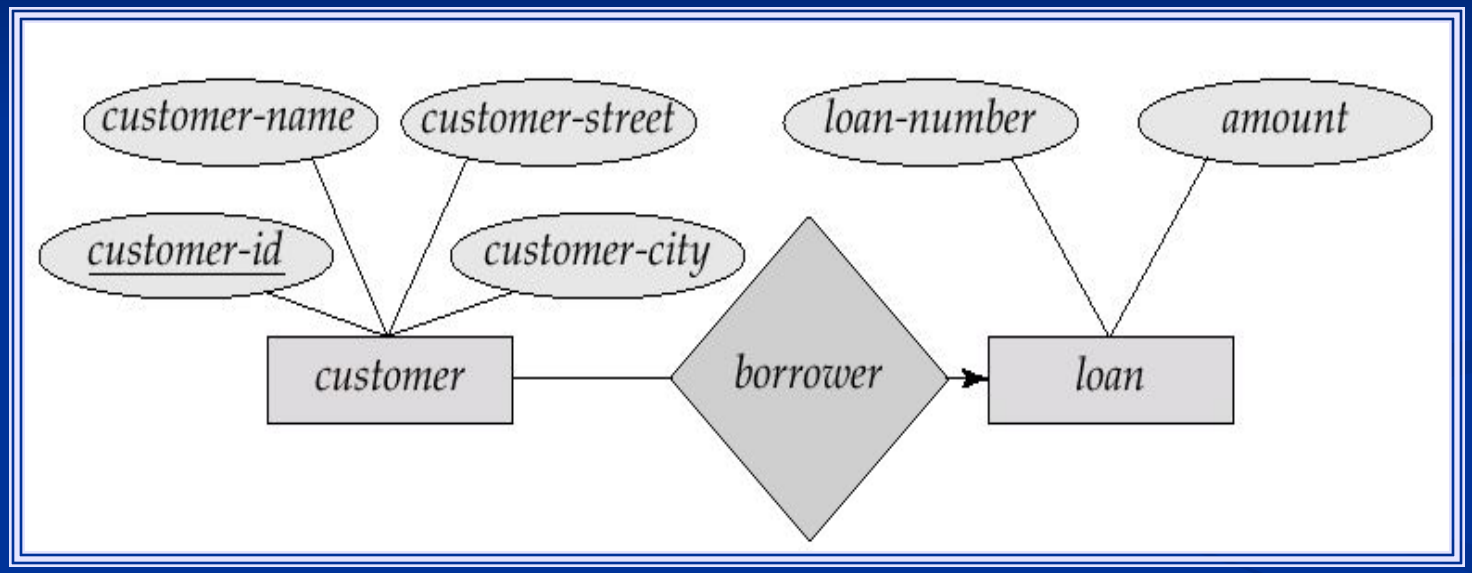
Many-one and many-many



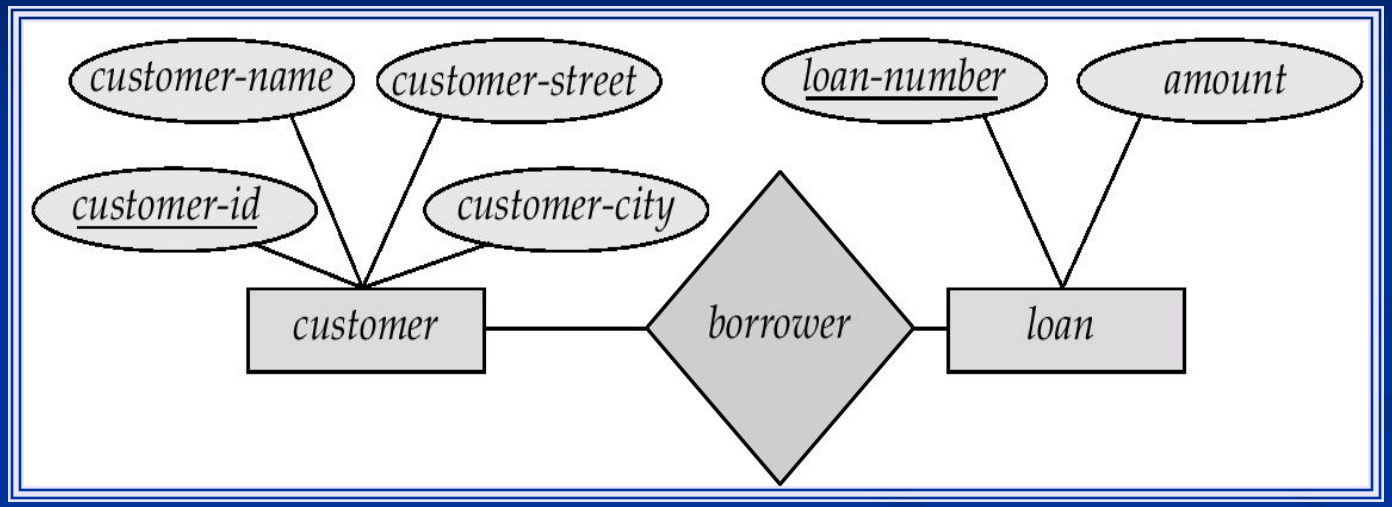
1- many


customer-name
customer-street
loan-number
amount
customer-id
customer-city
customer
borrower
loan

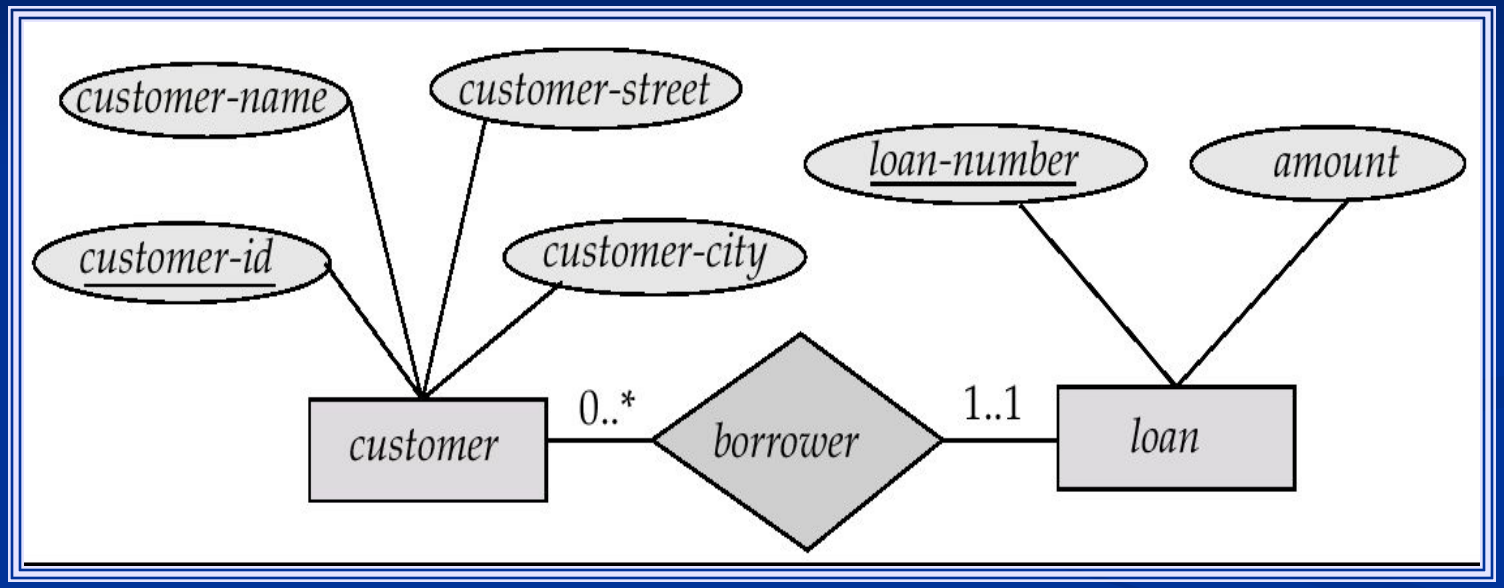
Many - 1


customer-name
customer-street
loan-number
amount
customer-id
customer-city
customer
borrower
loan

Many - many


customer-name
customer-street
loan-number
amount
customer-id
customer-city
customer
borrower
loan

Alternative Cardinality Specification



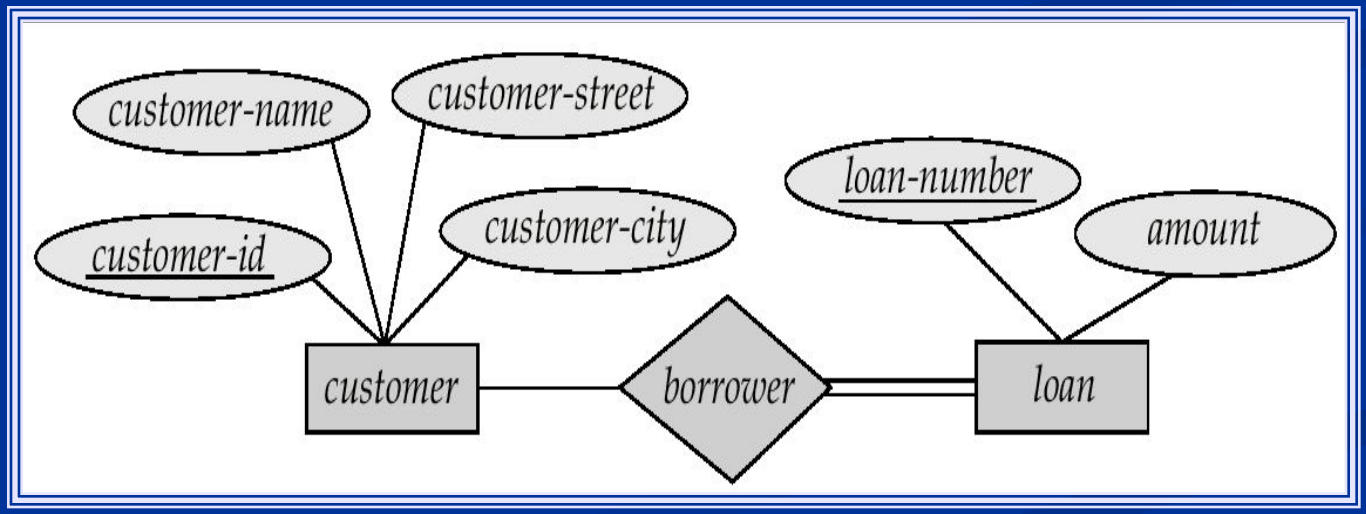
Note on Mapping Cardinality

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

Total Participation

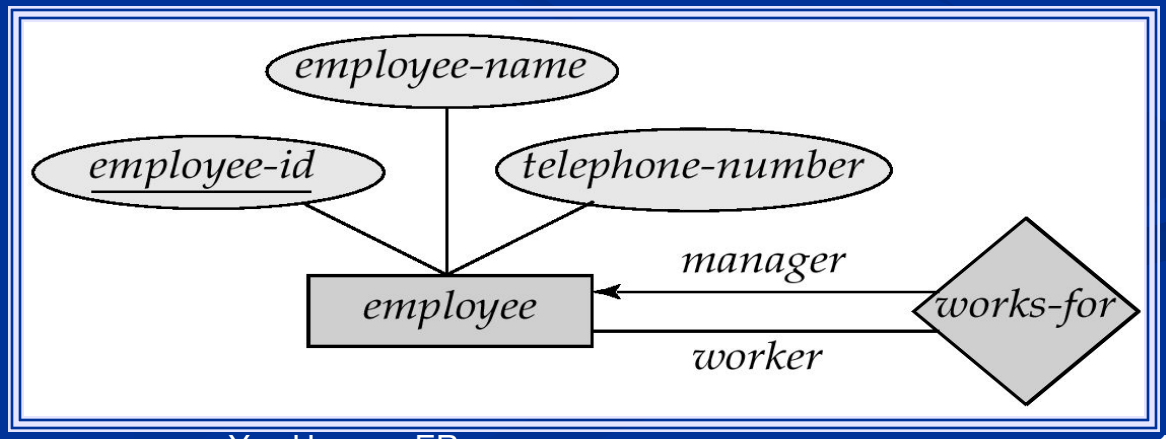
- When we require all entities to participate in the relationship (total participation), we use double lines to specify

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 mange some other employees
- The labels "manger" and "worker" are called *roles* the self relationship



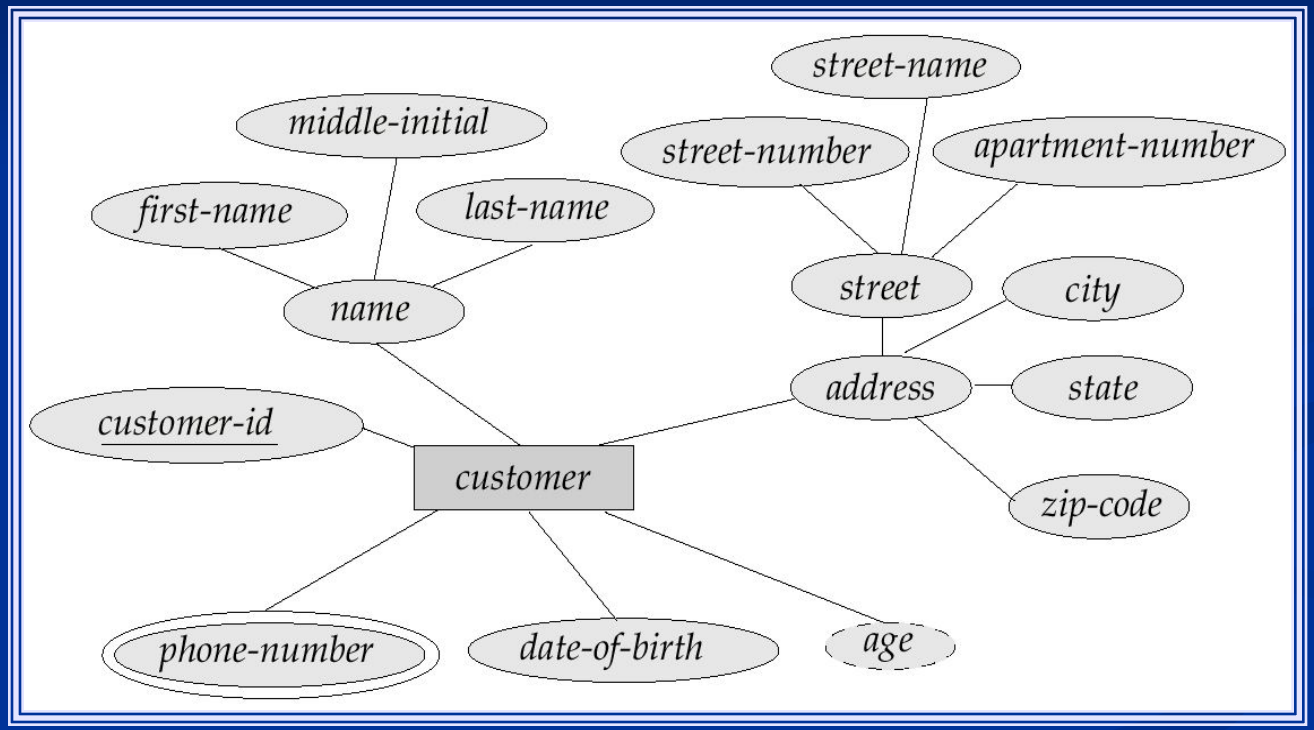
More examples on self-relationship

- 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

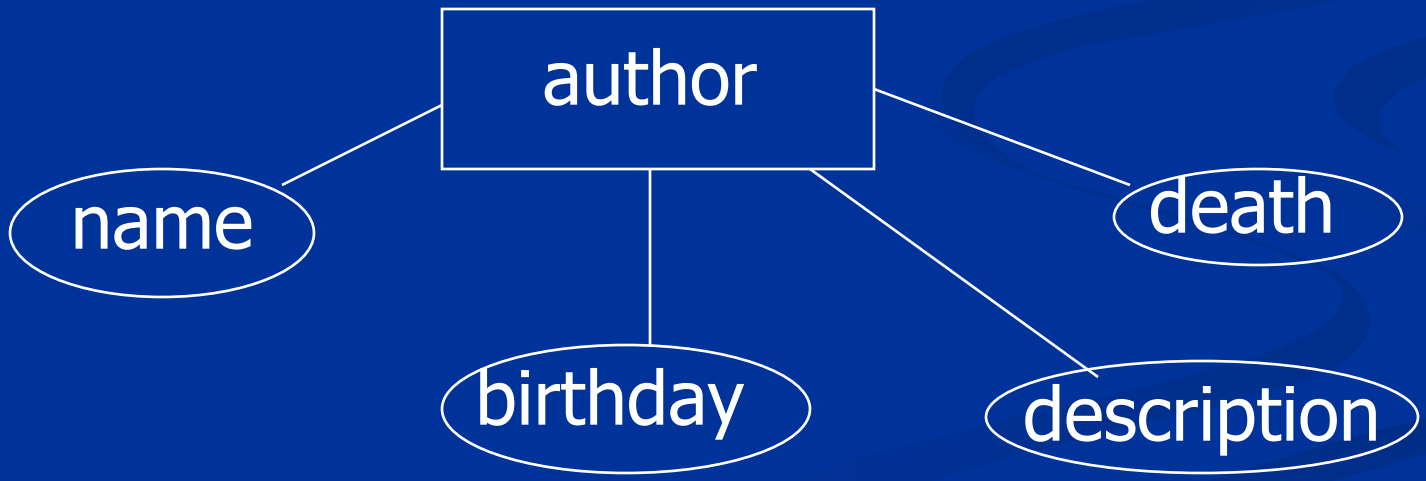


Keys

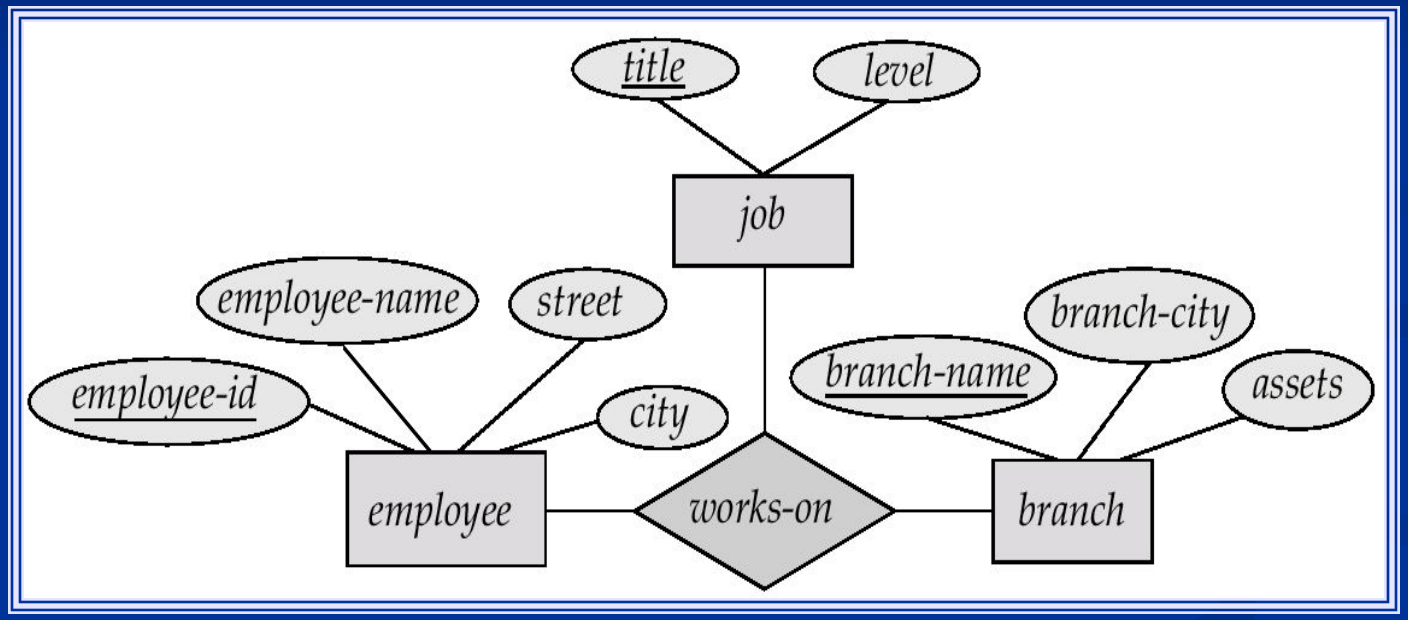
- A *super key* of an entity set is a set of one or more attributes whose values uniquely determine each entity.
- A *candidate key* of an entity set is a minimal super key
- Although several candidate keys may exist, one of the candidate keys is selected to be the *primary key*.

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

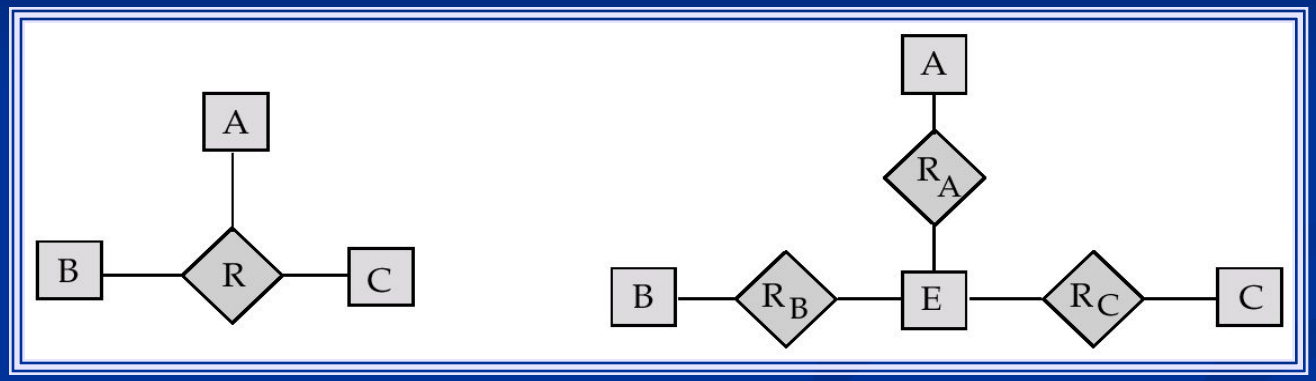
- In general, any non-binary relationship can be represented using binary relationships by creating an artificial entity set.
  - Replace *R* between entity sets A, B and C by an entity set *E*, and three relationship sets:

  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

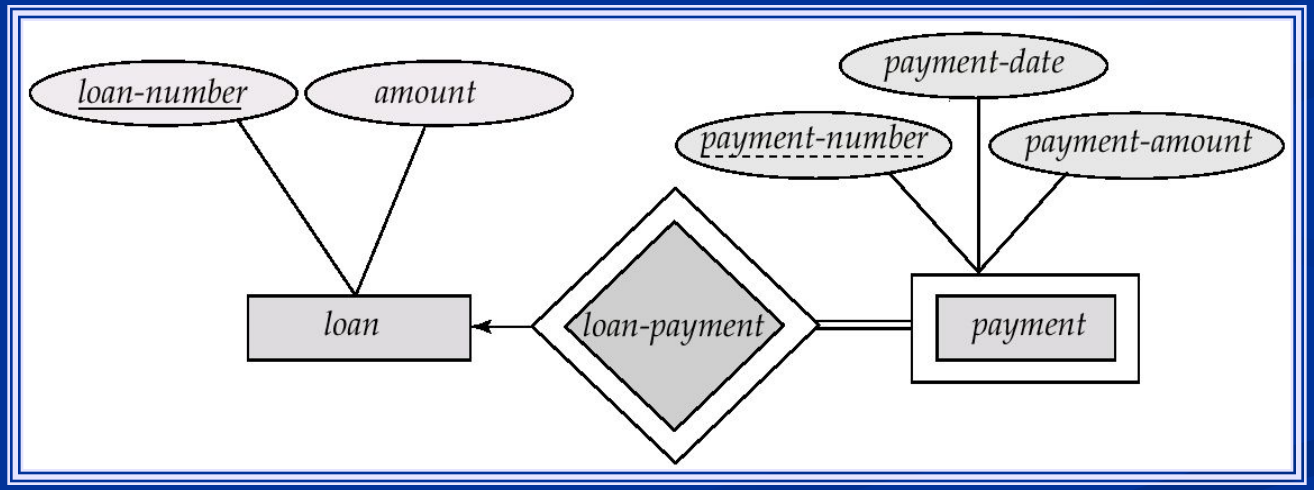
- Some entity sets in real world naturally depend on some other entity set
  - They can be uniquely identified only if combined with another entity set
- Example:
  - section1, section2, … become unique only if you put them into a context, e.g. csce4350

Weak Entity Set Notations

Double rectangles for weak entity set

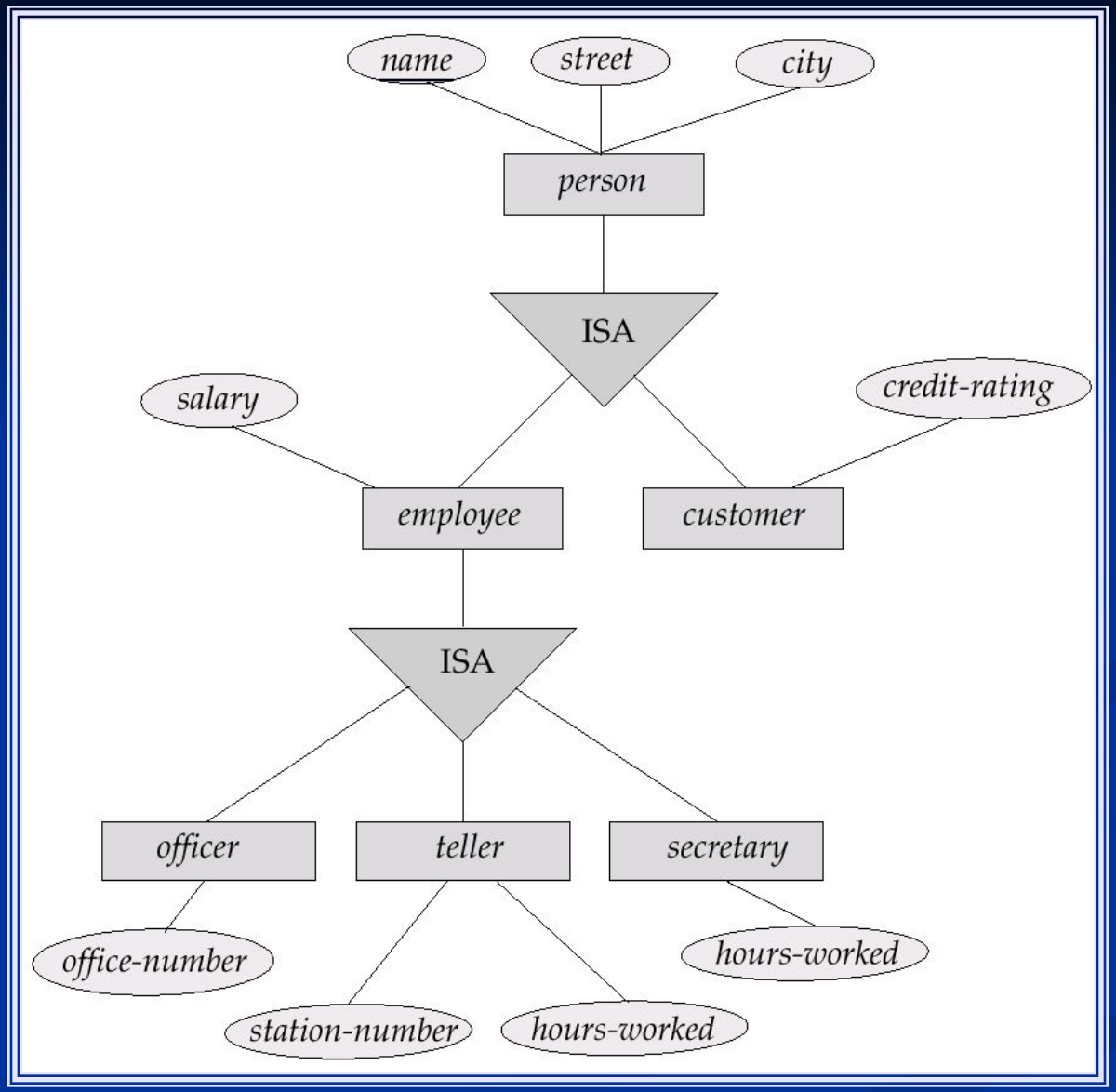
Double diamond for weak entity relationship

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


name
street
city
person
ISA
salary
credit-rating
employee
customer
ISA
officer
teller
secretary
office-number
station-number
hours-worked
hours-worked

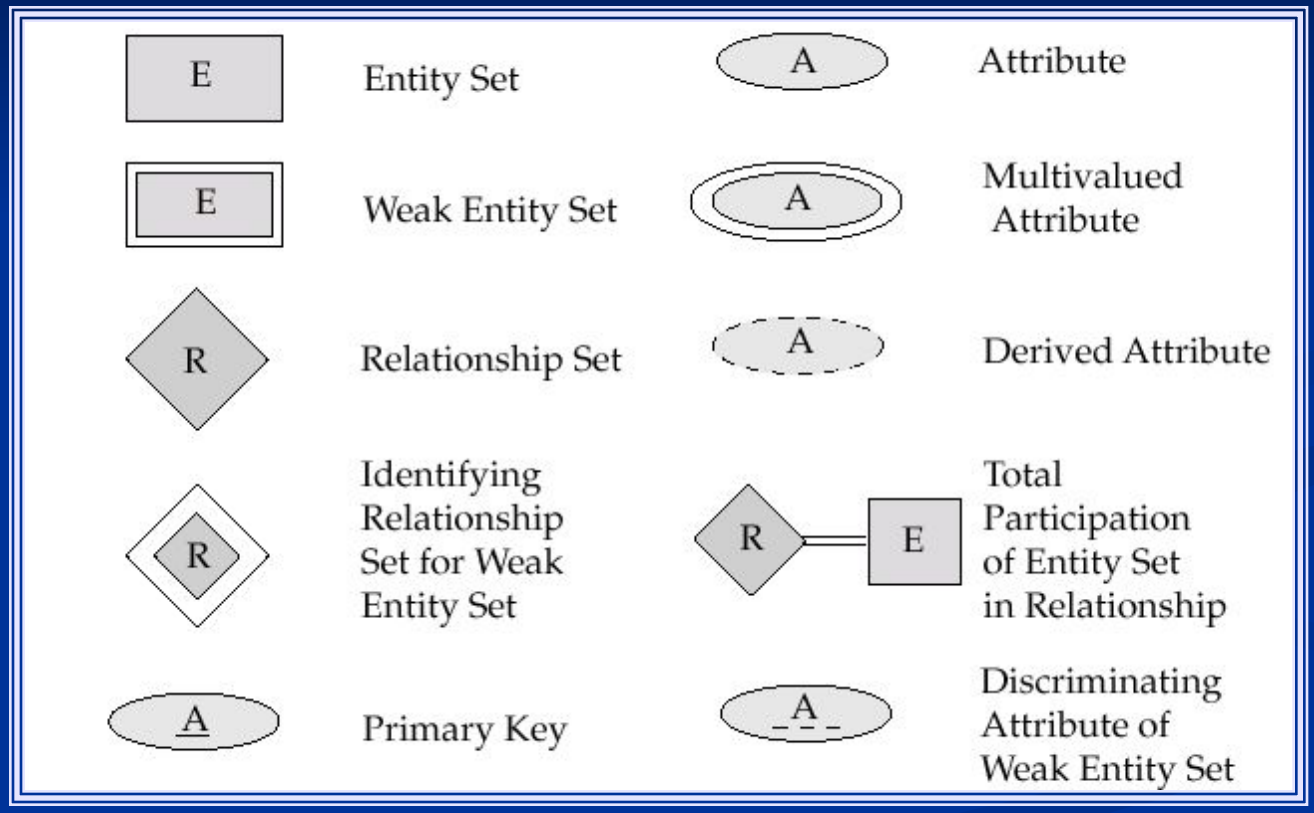
Specification

- 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

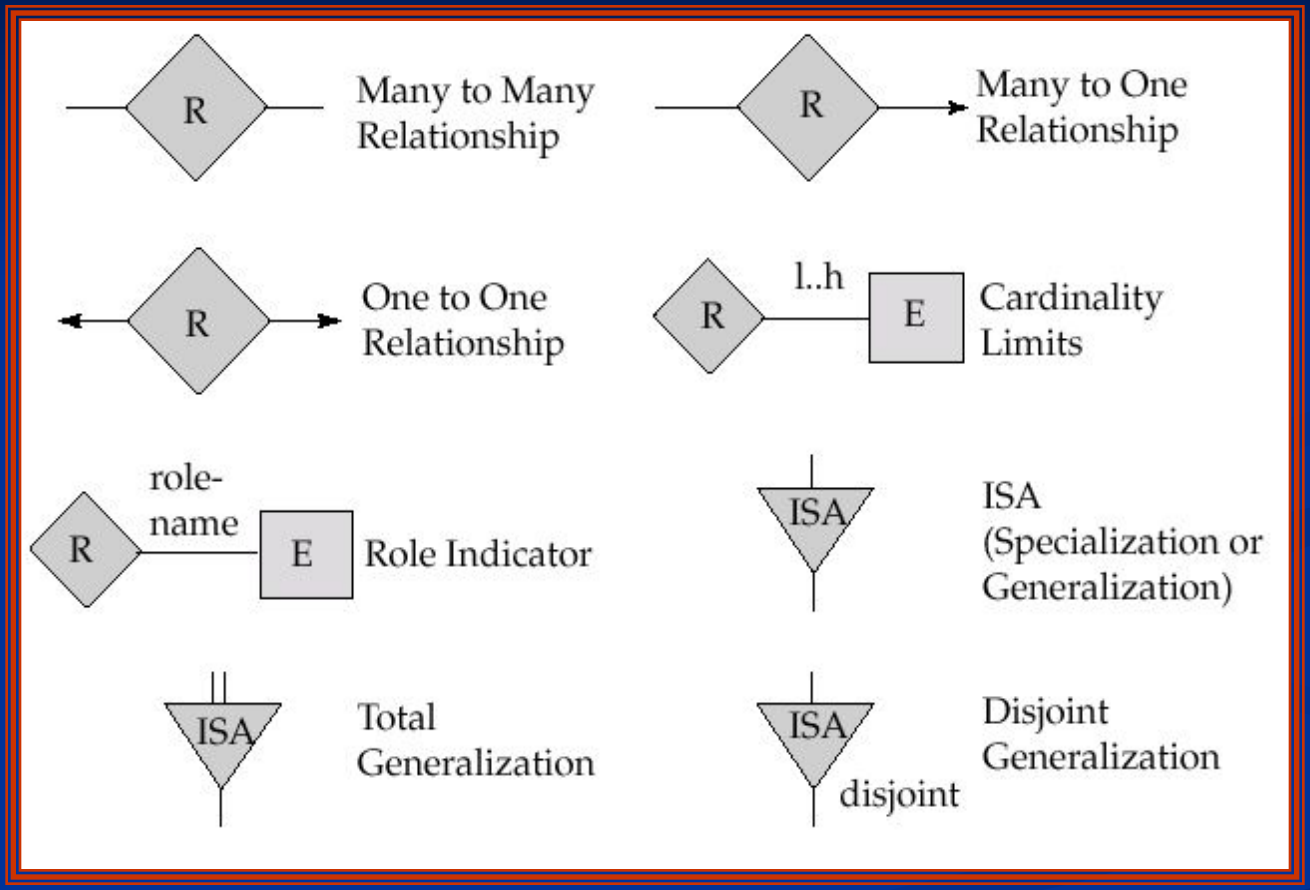
Design Considerations

- 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


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

Notations


R
Many to Many Relationship
R
Many to One Relationship
R
One to One Relationship
R
l..h
E
Cardinality Limits
R
role-name
E
Role Indicator
ISA
ISA (Specialization or Generalization)
ISA
Total Generalization
ISA
disjoint
Disjoint Generalization

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

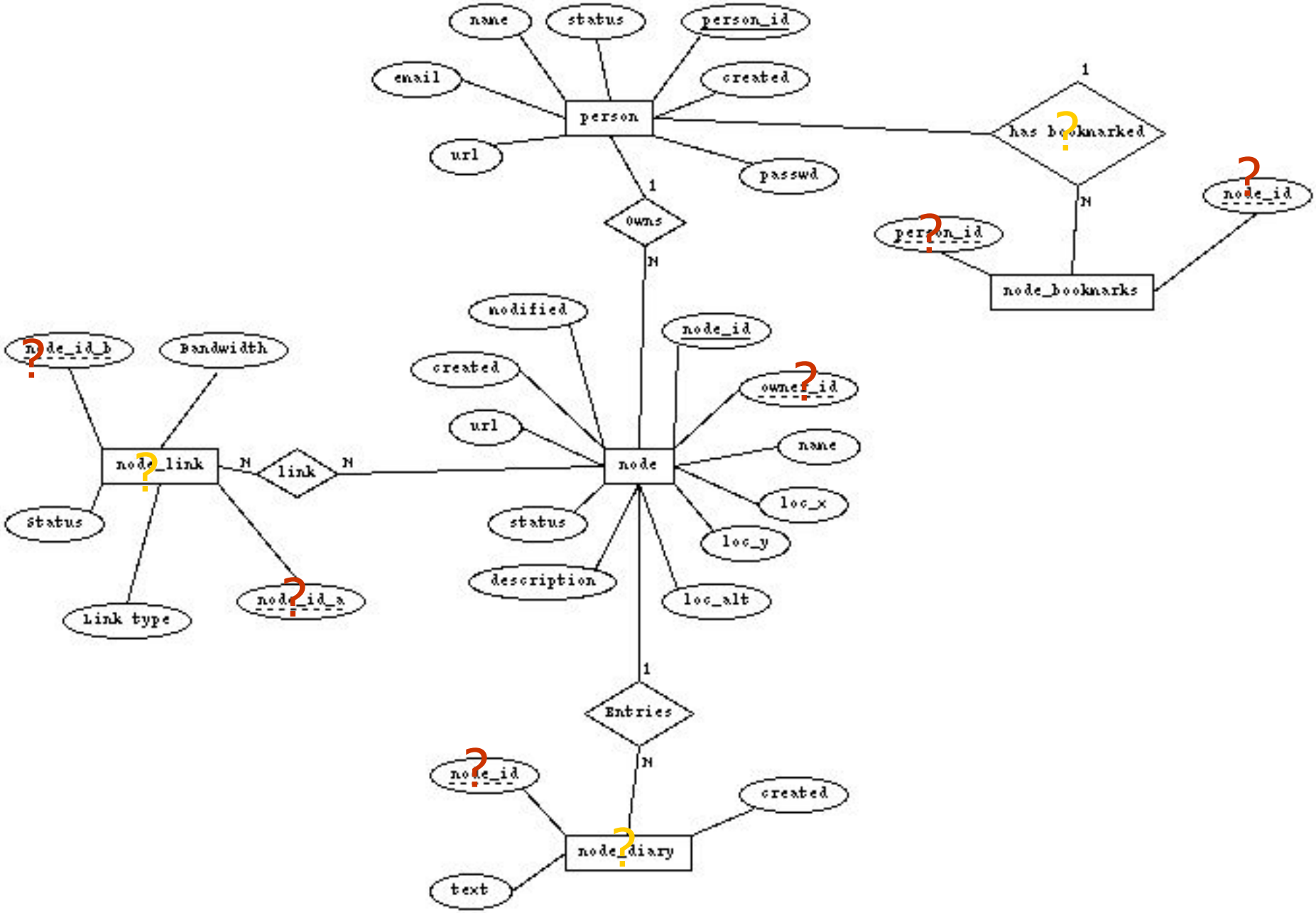
- Use of entity sets vs. attributes
- Use of entity sets vs. relationship sets
- Binary versus *n*-ary relationship sets
- Weak entity set vs. strong entity set
  - Choose the natural one
- Generalization
  - If specialized entities need to keep additional information and participate in additional relationships

ER for Banking Enterprise

- Description handout

Read ER Diagrams

- Following are some ER diagrams grabbed from the web
- Read to understand/criticize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node_id
node_id_b
Bandwidth
created
owner_id
url
node_link
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link
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node
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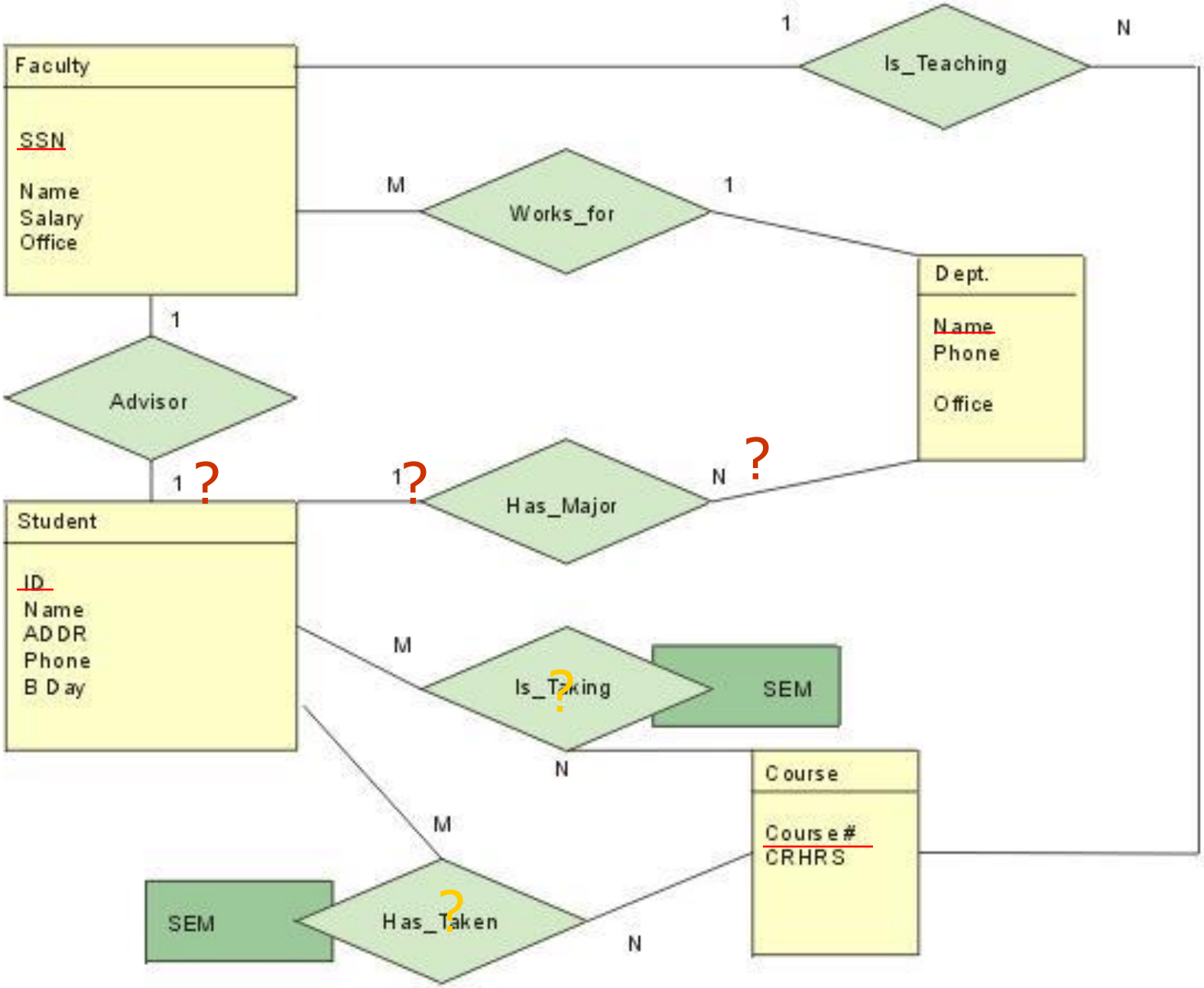
Faculty
SSN
Name
Salary
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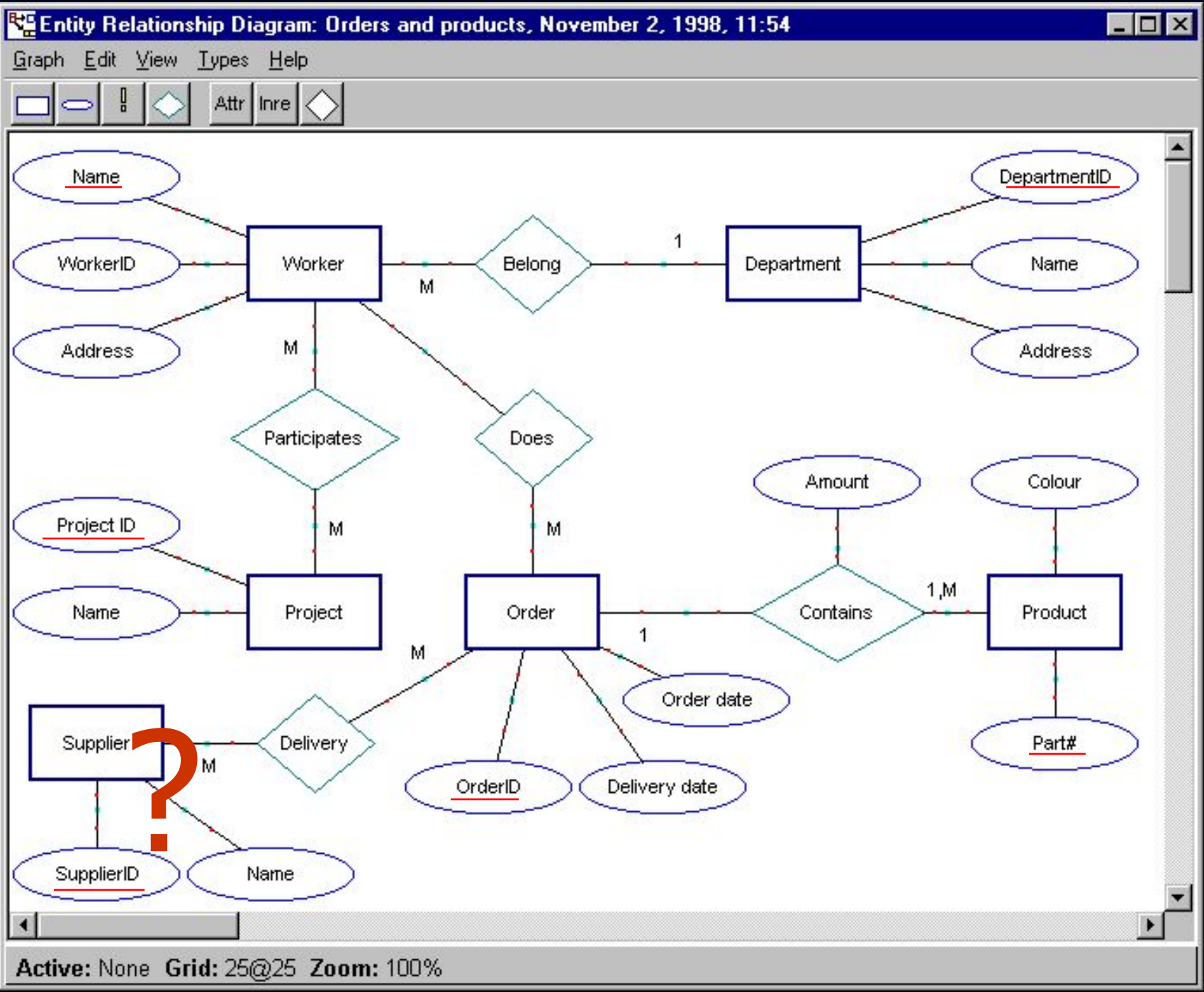
Entity Relationship Diagram: Orders and products, November 2, 1998, 11:54
Graph Edit View Types Help
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Name
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M
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Amount
Colour
Contains
1,M
Product
1
M
Order date
Part#
Supplier
M
Delivery
OrderID
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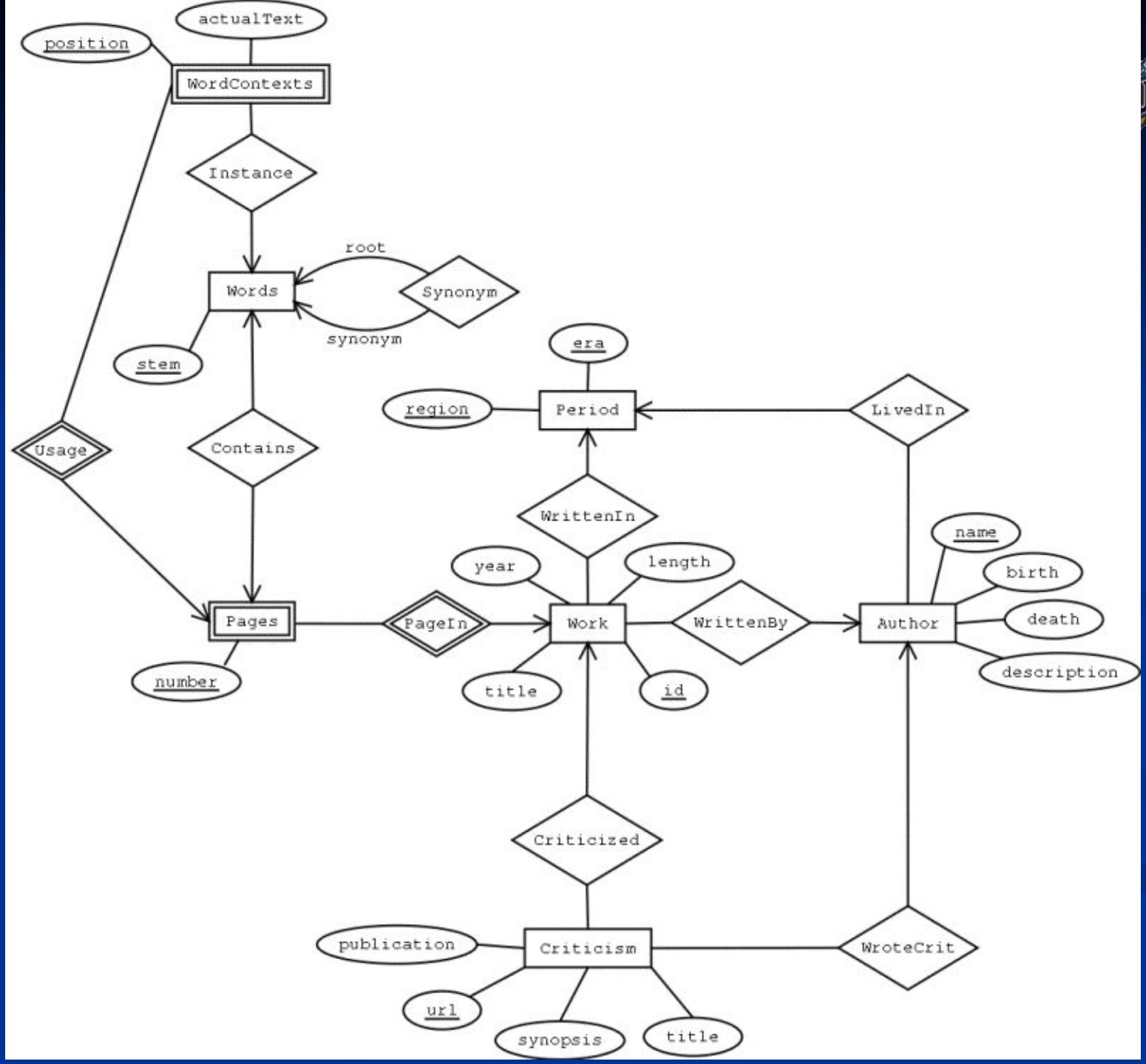
Name
Active: None Grid: 25@25 Zoom: 100%


actualText
position
WordContexts
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region
Period
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year
length
birth
Pages
PageIn
Work
WrittenBy
Author
death
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