Data Modeling using ER Models

Why We Model

- Need to develop a common understanding of the problem and the solution
- to communicate the desired structure and behavior of our systems
- model may be at various levels depending of requirements :
  - logical or physical
  - external, conceptual, internal

Data Model……

- model offers concepts, constructs and operations
- must capture meaning of data (data semantics) which help us in interpreting the data
- a good model
  - is easy to understand, is expressive
  - has a few concepts
  - permits top-down specifications

Data Model……

- semantics captured through data types, inter-relationships and data integrity constraints
  - Proper naming
  - permitted values
  - Integrity constraints

ER MODEL….

- a few concepts
- simple and easy-to-use
- permits top-down approach for controlling details
- useful as a tool for communication between designer and user during requirements analysis and conceptual design

ENTITY

- an object that exists
- distinguishable from other objects (has unique id)
- could be concrete or abstract
- Examples : this course on DBIS, Ganesh as a student, etc

ENTITY SET

- a set of similar entities
- example : set of all books in a library
- need not be disjoint with other entity sets
  - e.g., supplier and customer may have common entities
- entity set also called entity type or entity class
- an entity is an occurrence or an instance of some entity type
- Often use ‘entity’ to mean ‘entity set’ !
- entity sets are named using singular common nouns: Book, Student, Course

ATTRIBUTE

- an entity (type) has a set of attributes
  - entity Book has Price attribute
- it is given a name
- attribute has value for each entity
- value may change over time
- same set of attributes are defined for entities in an entity set

ATTRIBUTE….

- Example : entity set BOOK has the following attributes

  TITLE ISBN

  ACC-NO AUTHOR

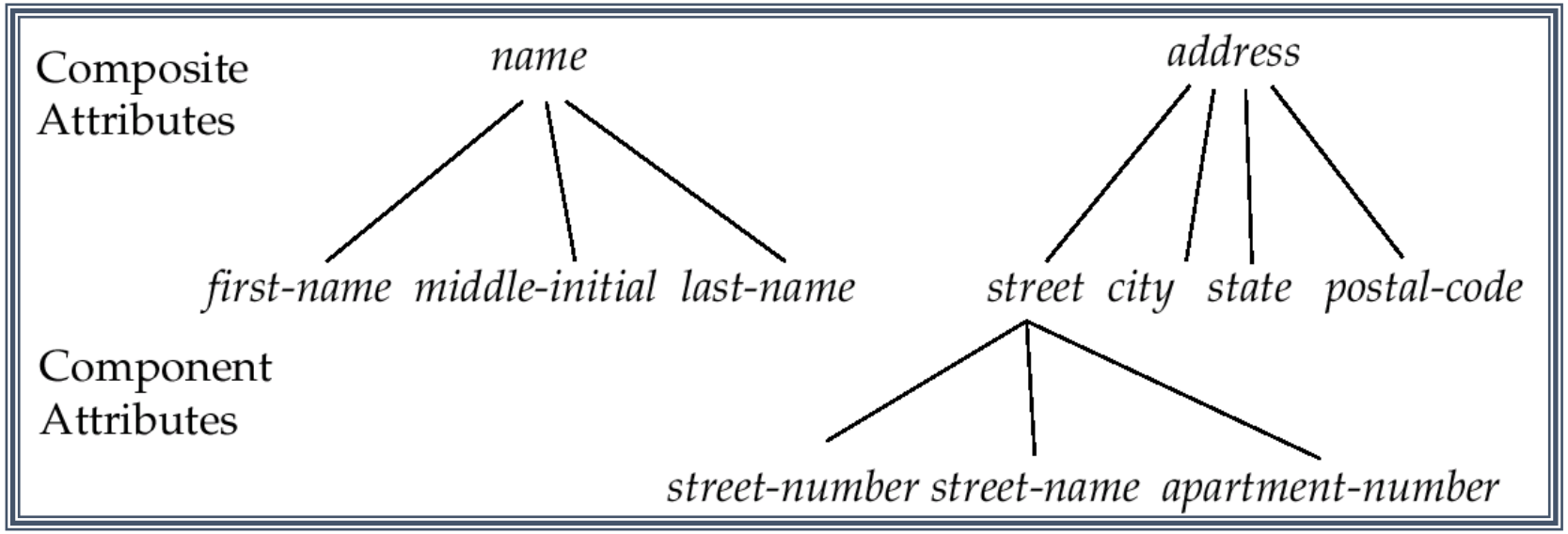
  PUBLISHERYEAR PRICE

- PART : how to define it as an entity
  - Chair is a ‘generic’ part ?
  - Every chair is a part – each has Id
  - One consignment or each design is a part

ATTRIBUTE....

- an attribute may be multi-valued, e.g., a book may have many authors
- an attribute which uniquely identifies entities of a set is called candidate key
- Primary key is a candidate key
- composite attribute : date, address, etc

Composite Attributes



EXAMPLE : University

As we list them, we define scope of application:

- STUDENT : rollno, name, hostel-no., date-of-birth
- COURSE : courseno, name, credits
- TEACHER : empno, name, rank, room-no, tel-phone
- DEPT : name, tel-phone

Ex : identify primary keys of above entities.

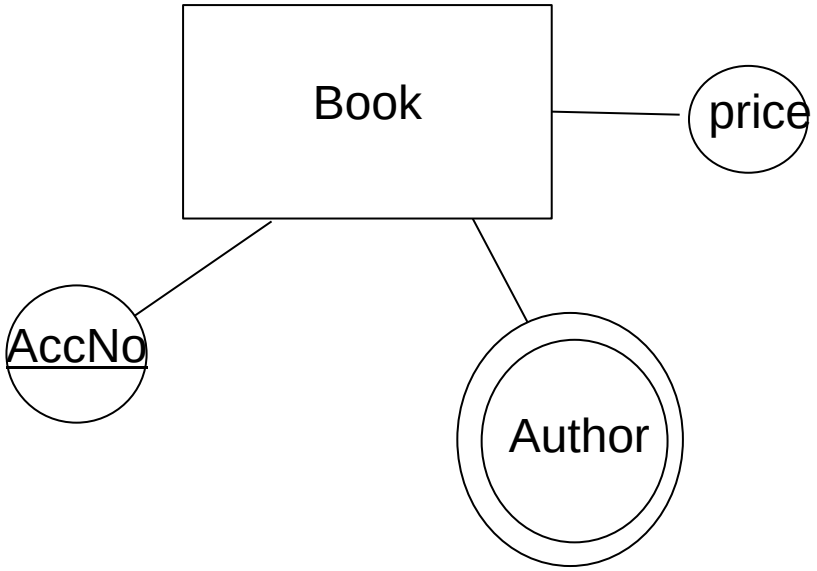
Are attributes meaningful and exist uniformly ?

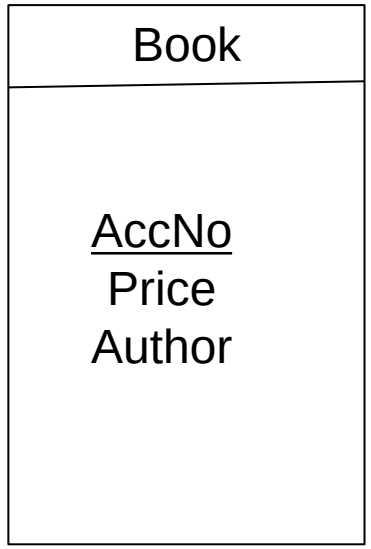
EXAMPLE : University …

- focus of design could have indicated more entities
  - HOSTEL SEMESTER
  - Or, teacher could only be an attribute

Entity notation

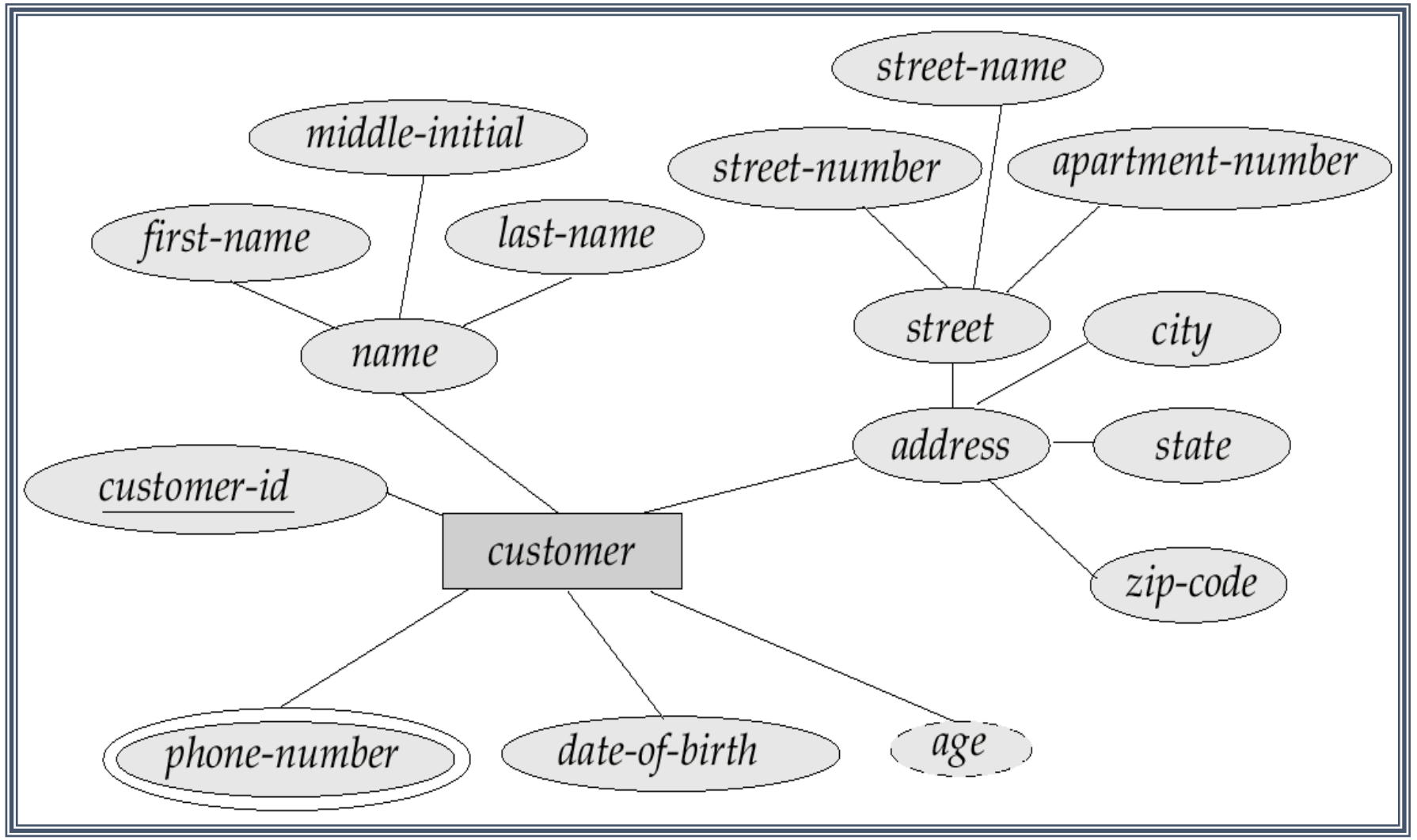
- Rectangle with attributes as small circles connected to it (double circle for repeating, composite)
- Keys are underlined





EXERCISE : identify entities in a hospital and give a few instances of each

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



RELATIONSHIP

- represents association/interaction among entities
  - the book ‘Database Systems’ by S. Sudarshan is text for course identified by code ‘CS644’
  - the student GANESH has enrolled for course CS644

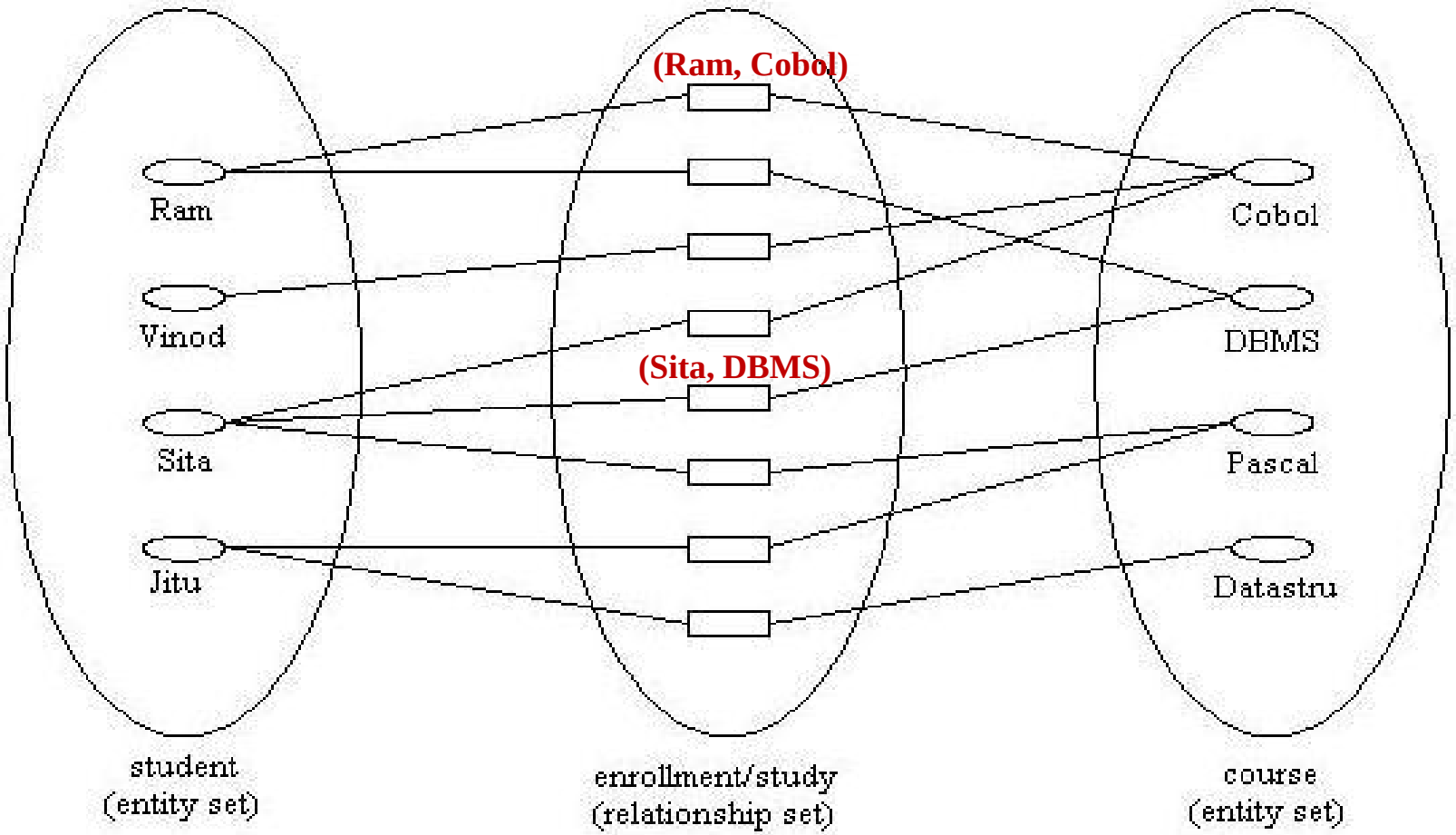
RELATIONSHIP SET

- set of relationships of same type
- words ‘relationship’ and ‘relationship set’ often used interchangeably
- between certain entity sets
  - binary relationship : between two entity sets
  - ternary relationship : among three entity sets
  - N-ary …

RELATIONSHIP SET….

- binary relationship called STUDY between STUDENT and COURSE
- A separate binary relationship called TEACH between COURSE and TEACHER
- relationship STUDY could be ternary among STUDENT, COURSE and TEACHER
- What is the difference ?
- a relationship may have attributes
  - attribute GRADE and SEMESTER for STUDY

DEPICTING A RELATIONSHIP – like a mapping



Mappings may not be ‘total’

PRIMARY KEY FOR RELATIONSHIPS

- made of primary keys of all participating entities
- No need to indicate : implicit

  e.g., primary key of STUDY is

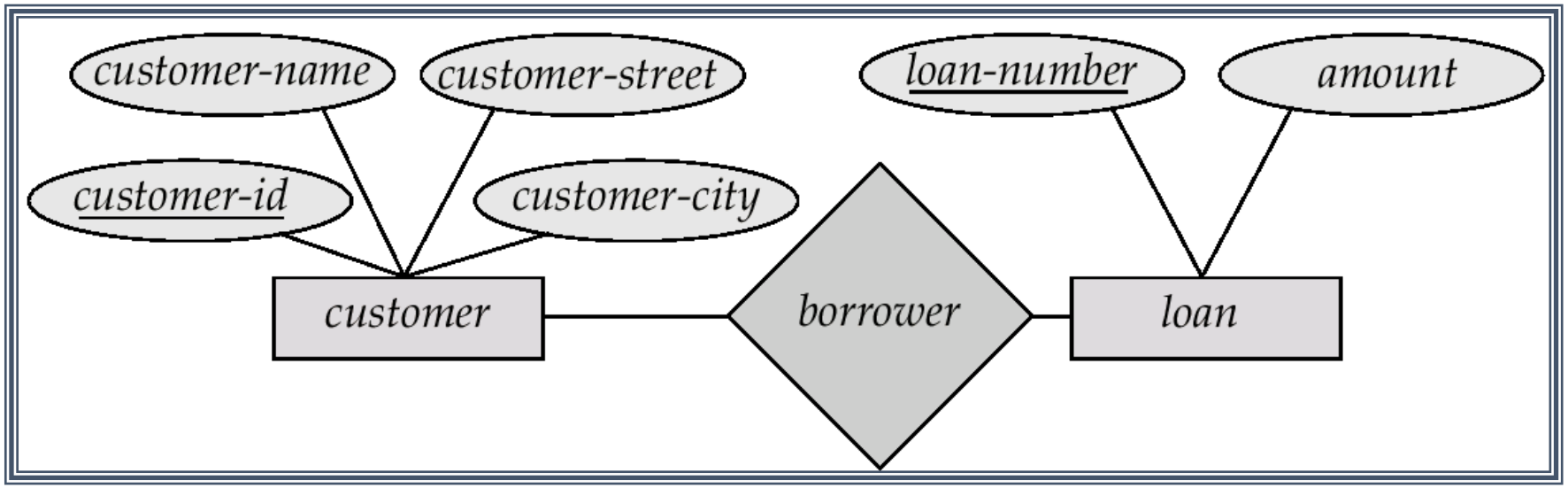
  (rollno, courseno)

RELATIONSHIP SET….

- relationships named using verbs or nouns
  - Study
  - Enroll
  - Order
- Implies a direction from one entity to another

EXERCISE : identify relationships and their attributes in the hospital example and give a few instances of each

E-R Diagram



- **Diamonds** represent relationship sets.
- **Lines** link entity sets to relationship sets.

RELATIONSHIP CARDINALITY

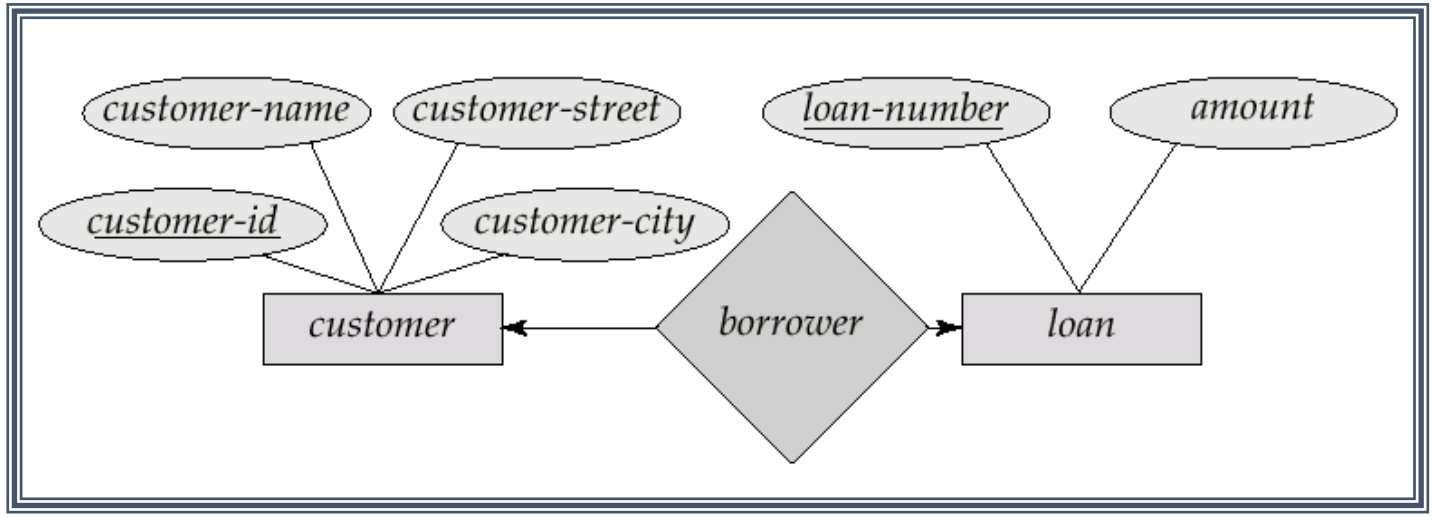
- is a constraint on a relationship
- given by indicating weather zero, one or more entities from one set relate to zero, one or more entities of the other entity set
- especially useful for binary relationships
  - One : one
  - One : many
  - Many : one
  - Many : many

RELATIONSHIP CARDINALITY…

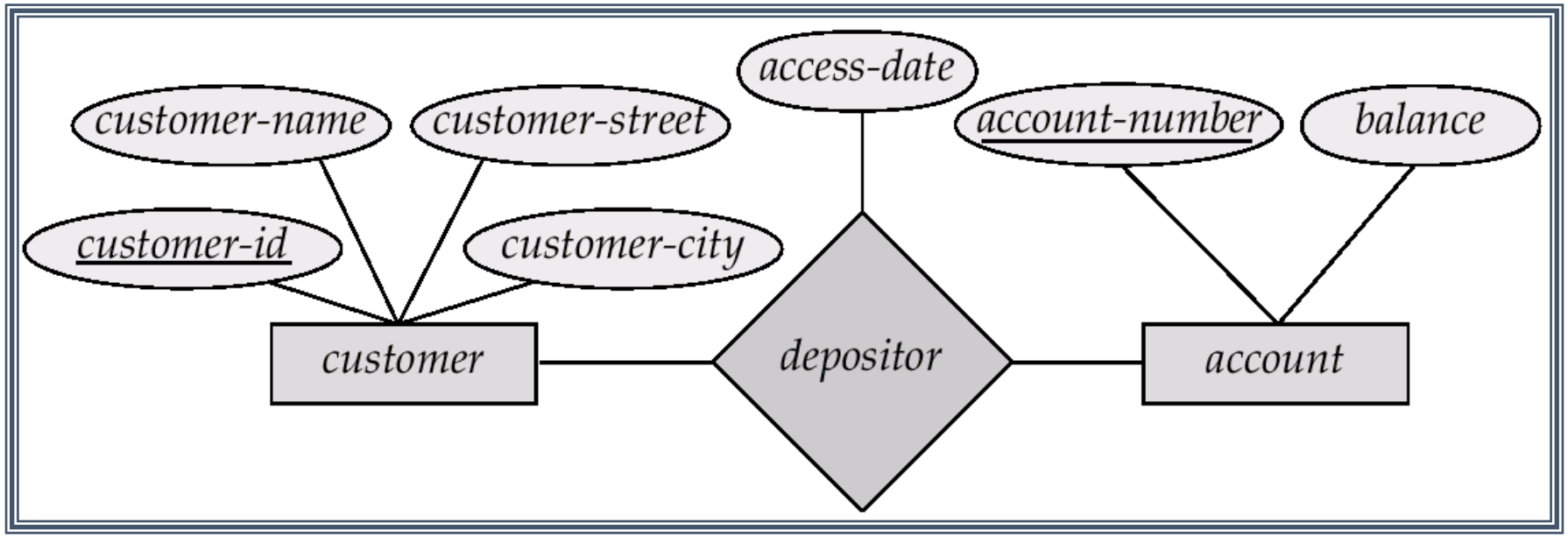
- EXAMPLES :
  - relationship TEACHES from TEACHER to COURSE is one-to-many
    (TAUGHT-BY from COURSE to TEACHER is many-to-one)
  - relationship STUDY between STUDENT and COURSE is many-to-many

Cardinality Constraints

- cardinality constraints by drawing
  - directed line (→) signifying “one,”
  - an undirected line (—) signifying “many,”

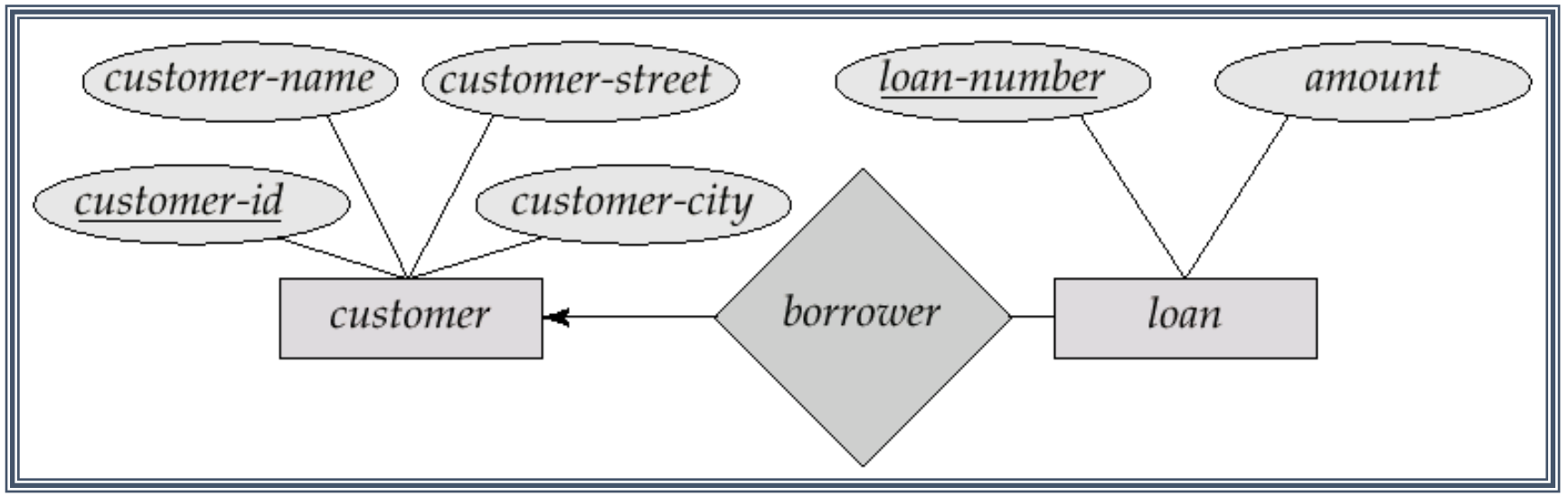


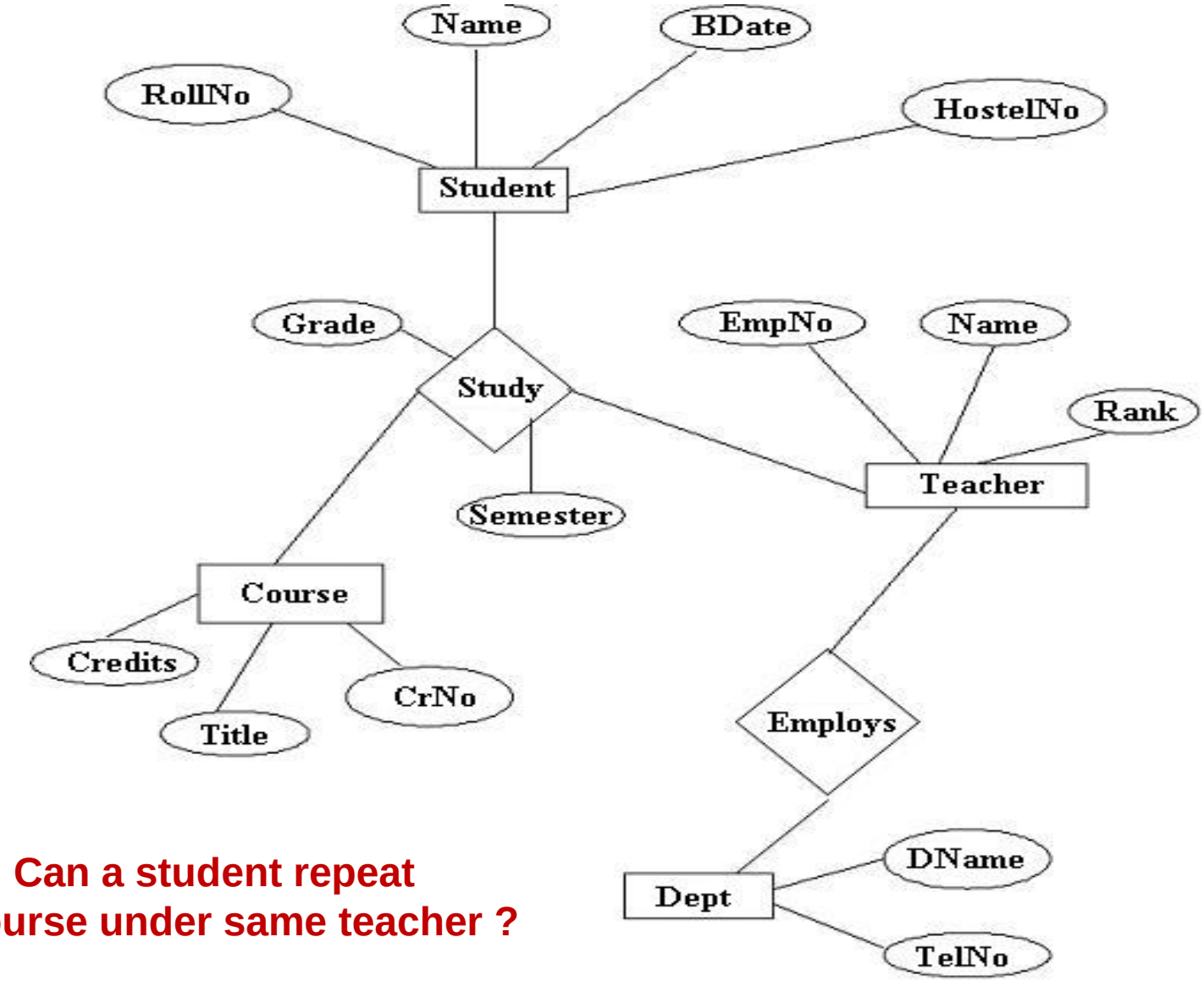
Relationship Sets with Attributes



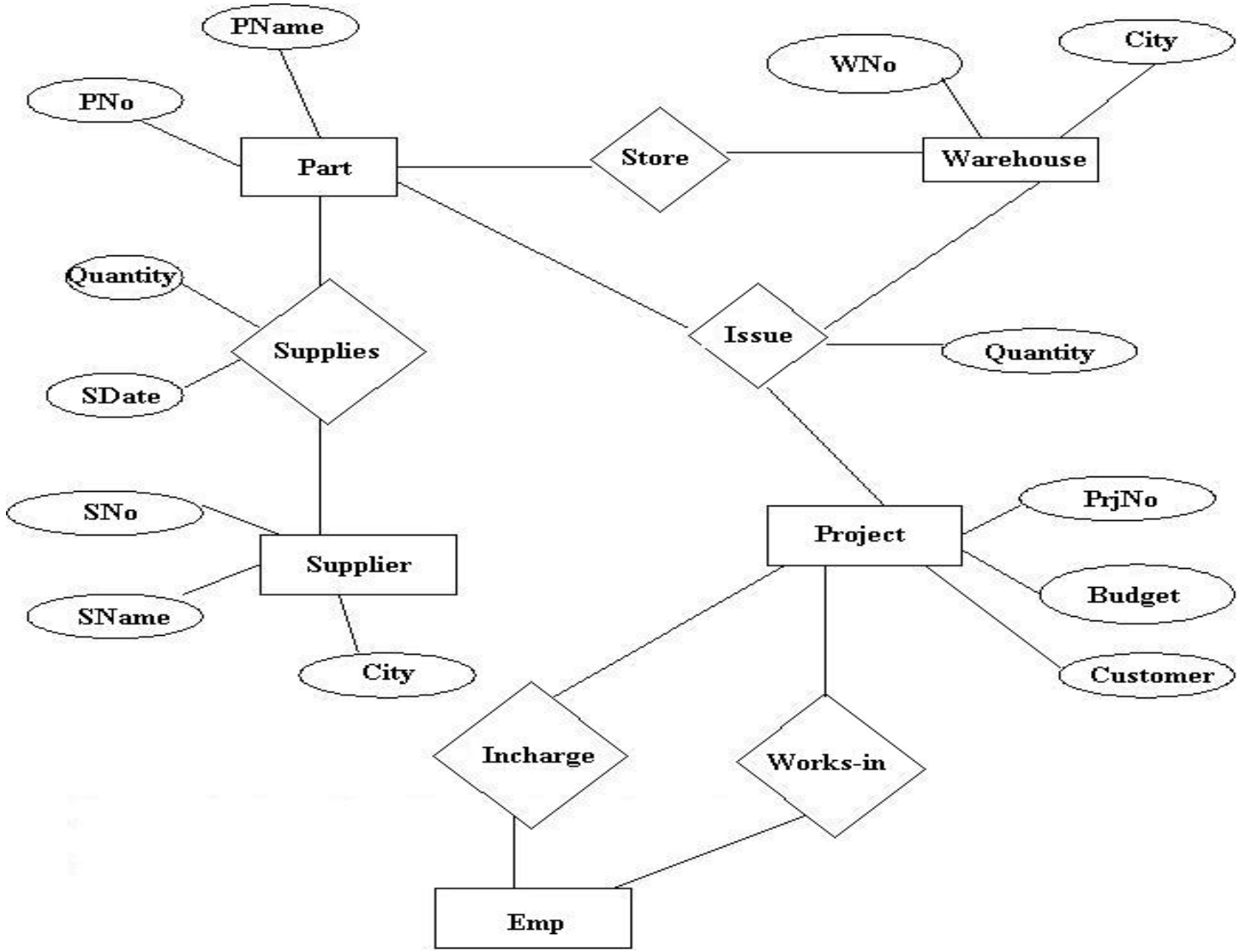
One-To-Many Relationship

- Every loan must have one customer
- Note : all customers need not take loans





Can a student repeat a course under same teacher ?



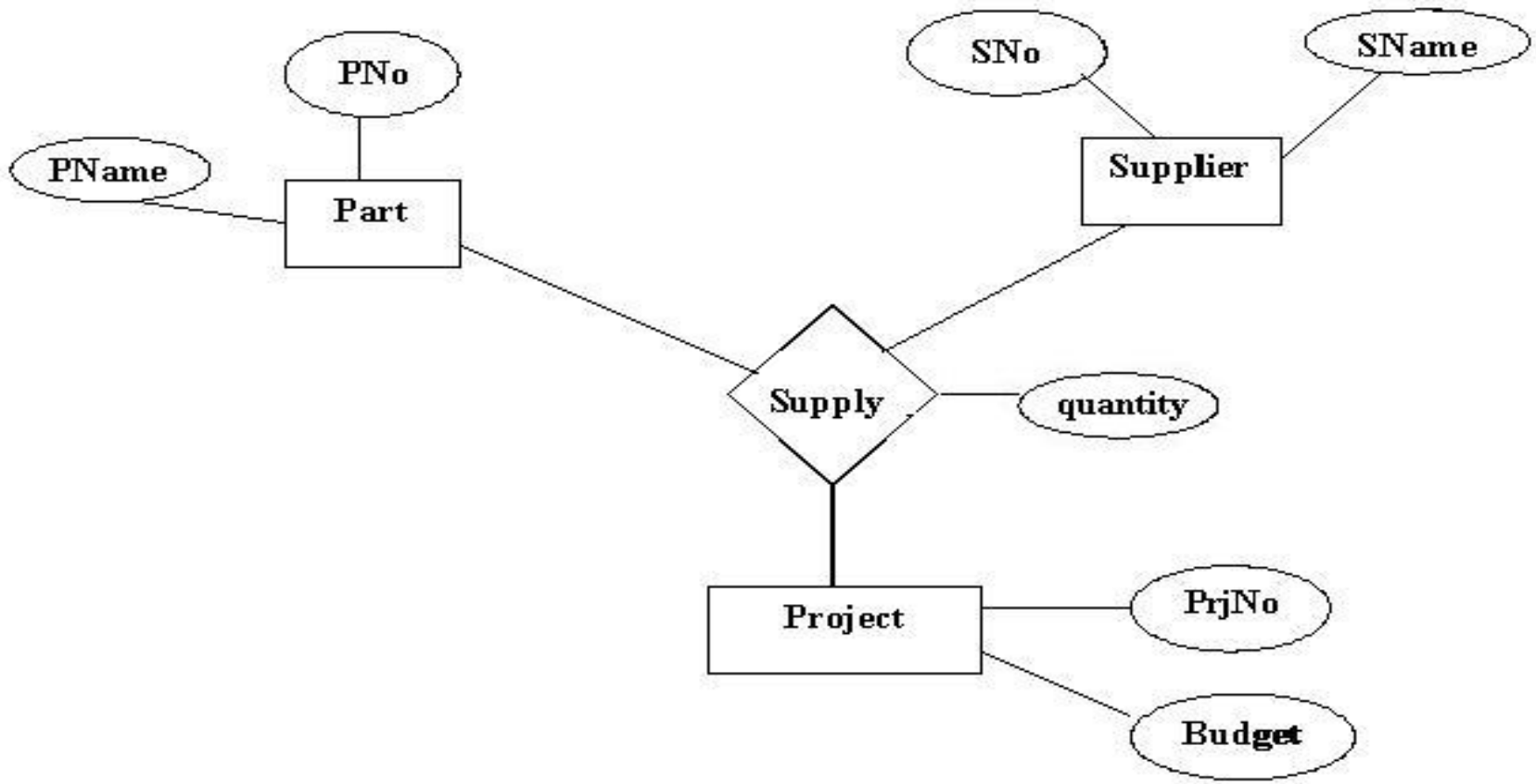
- Can you represents this : a supplier may supply same part many times
. Relationship ‘supplies’ could also be ternary (by involving warehouse)
. Can this model tell us ‘who supplied a part used in a project ?’

TERNARY RELATIONSHIPS

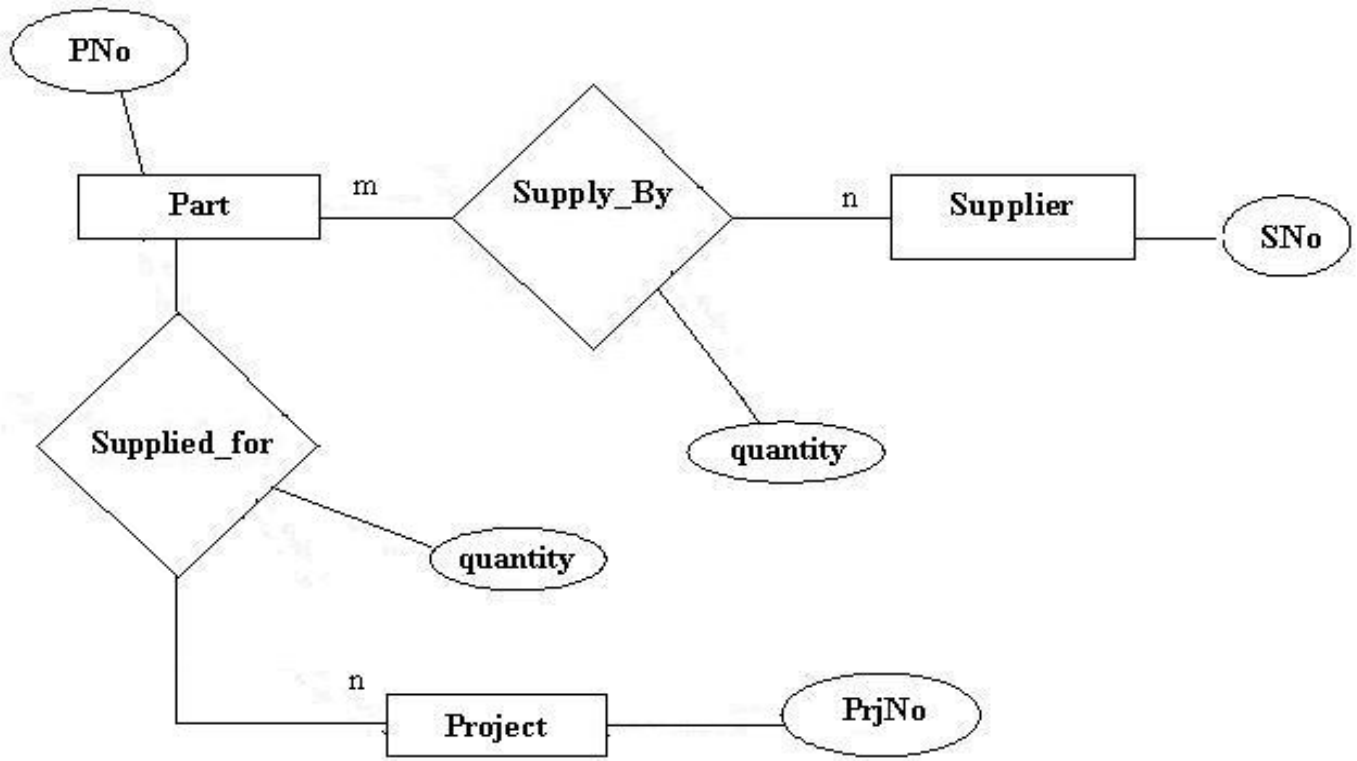
- be sure that your model reflects real-world correctly
- ternary (or, of higher order) relationships are harder to understand
- ternary relationship is not same as two binary relationships

Exercise : Compare the following E-R Diagram with the one on next page using sample data

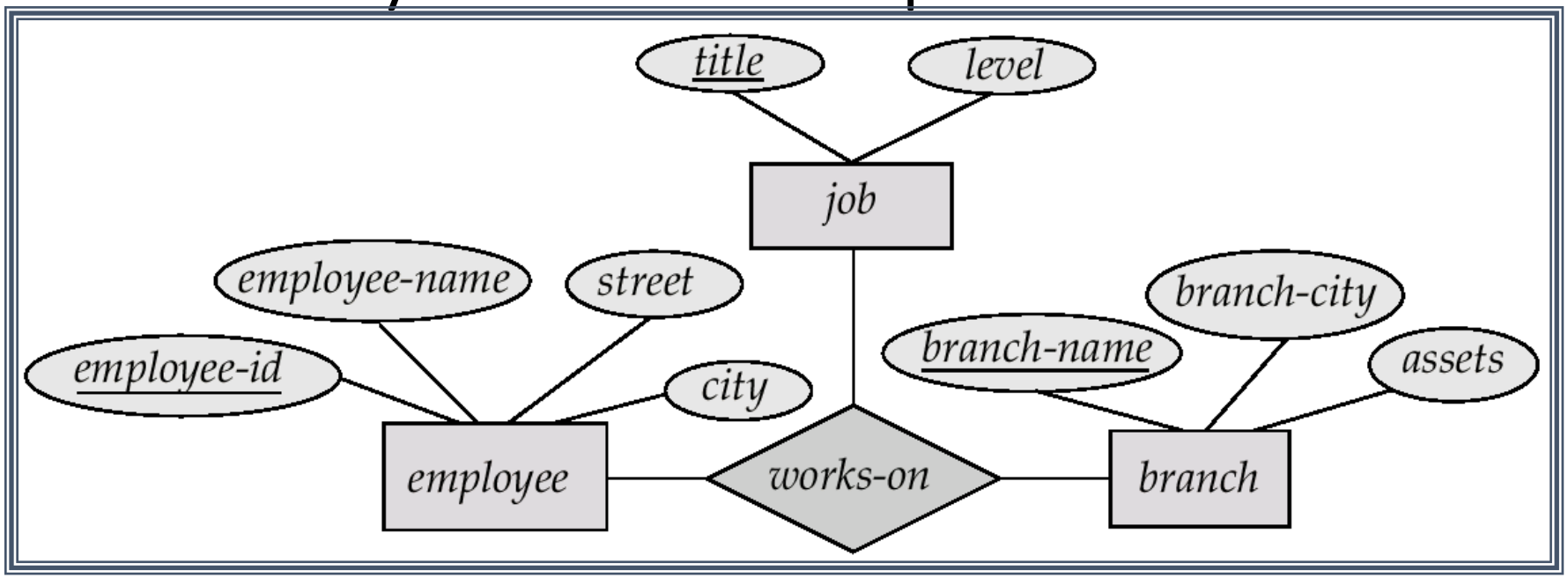
A: Ternary



B: Two Binaries

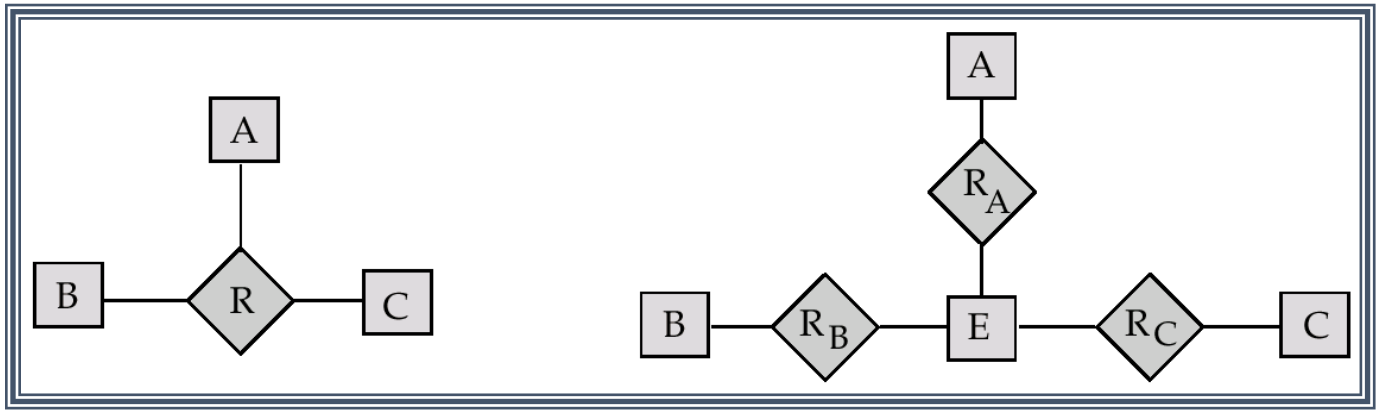


Example : Ternary Relationship



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 *relationship* by an entity set *E*, and three relationship sets as shown
  - Create a special identifying attribute for *E*
  - Add any attributes of *R* to *E*
  - translate constraints



Example/Exercise

Exercise: Airport database

- keeps track of airplanes, their owners, airport employees and pilots
- Each airplane has a registration number, is of a particular plane type and is stored in a particular hanger. Each plane type has a model number, capacity and weight. Each hanger has a number, capacity and location. The database also keeps track of who owns which plane. Persons have name, address and phones. A person buys a plane on a particular date and cost.

Airport database….

- Each plane undergoes service many times. A service information contains date of work, nature, hours spent, cost, etc. Pilots and employees are persons. Pilots have a license number with validity and salary. Employees have a number, rank and salary. Each pilot is authorized to fly certain types of planes. Employees are involved in servicing of planes.
- prepare E-R model

- Library, Hospital, Railway Resrv, …
- Old Car Mart
  - buying and selling of old cars
  - cars, purchases, sales – direct or installment-wise
  - service to sold cars, pre-sale repairs
  - agents
- Cricket Database
  - countries, players, teams
  - matches, results, scores (team, individual level)
  - Prepare sample data

- Summary : the basic concepts : entity, relationship. Attributes, key
  - Compare with relational model
- ER also extended with OO
- Next module