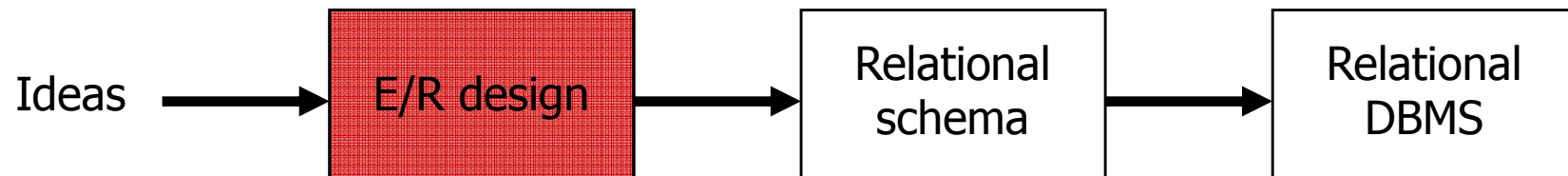

Chapter 2

Entity-Relationship Data Model

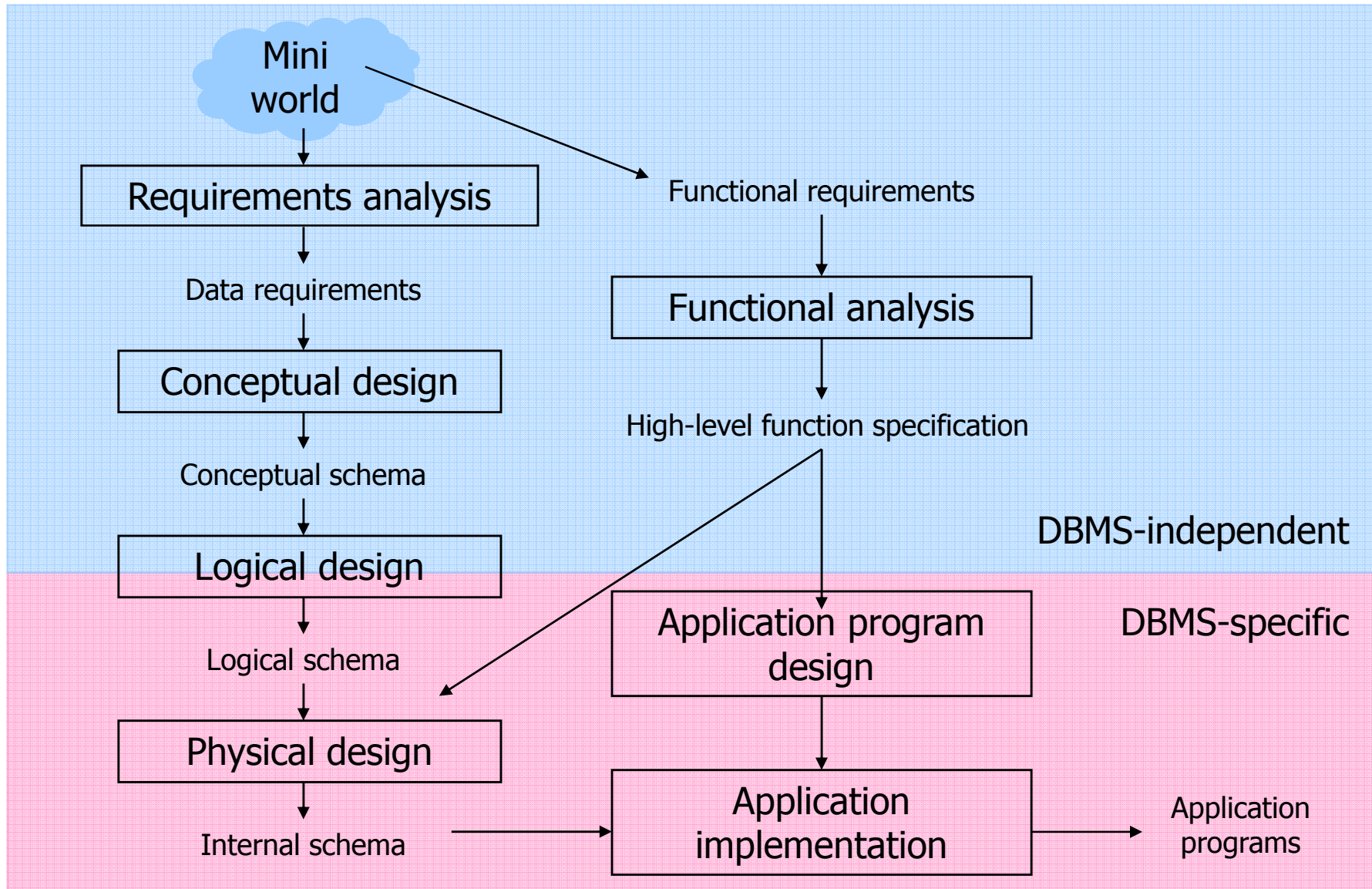
Content

- Process of database design
- E/R model
- E/R model design
- Exercise

Process of database design



Process of database design



Content

- Process of database design
- **E/R model**
 - Entity
 - Attribute
 - Relationship
 - E/R schema
 - Keys in E/R model
 - Weak entity
- E/R model design
- Example

Entity-Relationship model

- Is used to design a DB at the conceptual level
- Abstract representation of the structure of a DB
 - Is represented graphically
- An entity-relationship diagram
 - Entity sets
 - Attributes
 - Relationships

Entity sets

- An entity is an abstract object in the real world
 - Physical existence (person, car, house...)
 - Conceptual existence (company, job, university course...)
- A collection of similar entities forms an entity set
- Note
 - Entity
 - Object
 - Entity set
 - Class of objects

Structure of data

Operations on data



Entity sets

- Example “Company” database
 - An employee is an entity
 - The set of all employees constitutes an entity set
 - Projects are entities
 - The set of projects is an entity set
 - A department is another kind of entity
 - The set of departments is an entity set

Attributes

- The particular properties of the entities
- Example
 - An employee entity may be described by
 - Name
 - Age
 - Address ...
- Assume that attributes are *atomic values*
 - Strings
 - Integers
 - Reals

Relationships

- The connections among two or more entity sets
- Example
 - Relationships between entity sets EMPLOYEE and DEPARTMENT
 - Each employee works for a department
 - Each department has an employee who manages that department

E/R diagrams

- A graph representing entity sets, attributes, and relationships

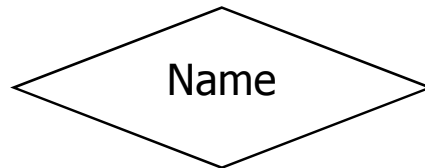
- Nodes



Entity sets



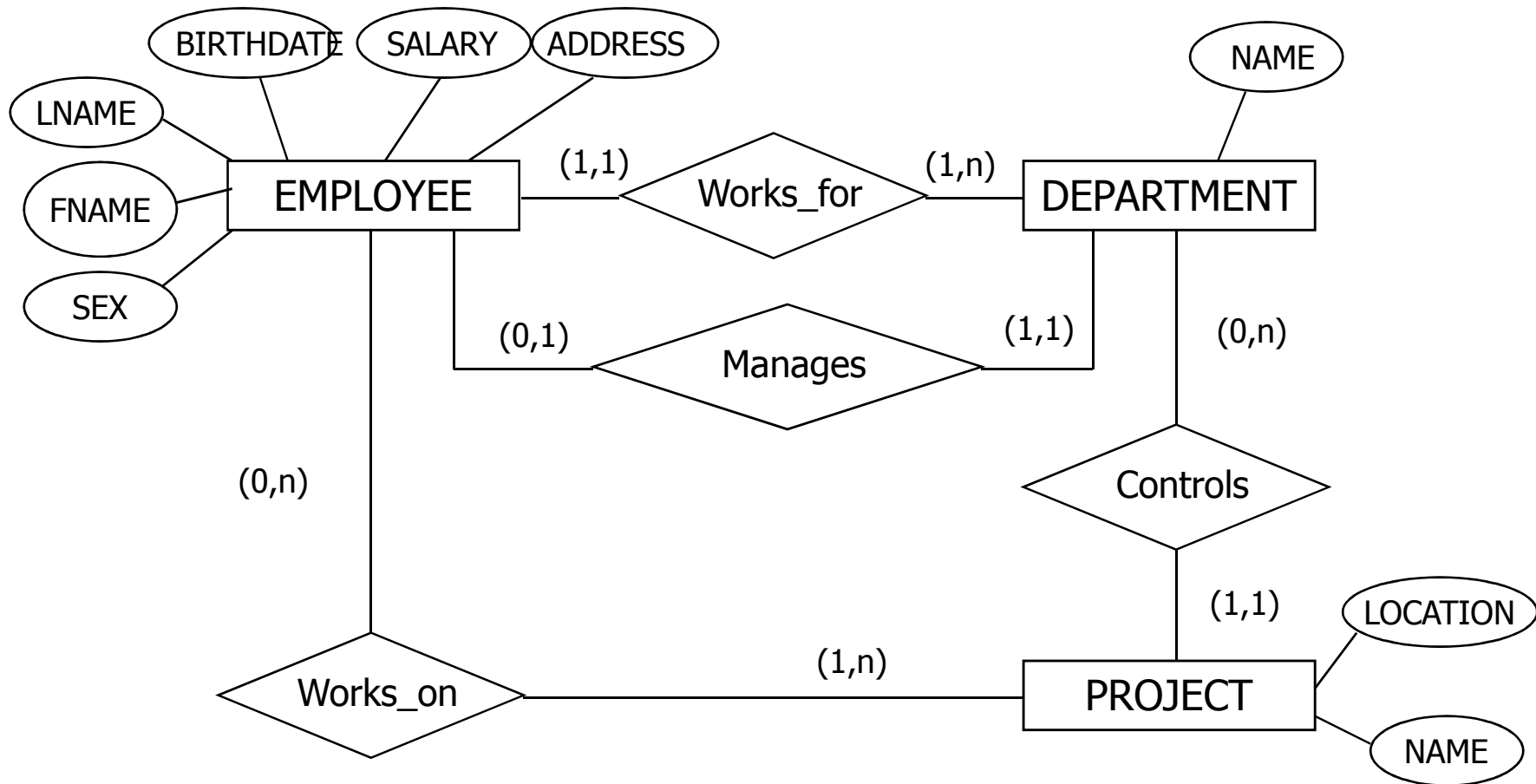
Attributes



Relationships

- Edges connect
 - An entity set and its attributes
 - A relationship and its entity sets

Example of an E/R diagram

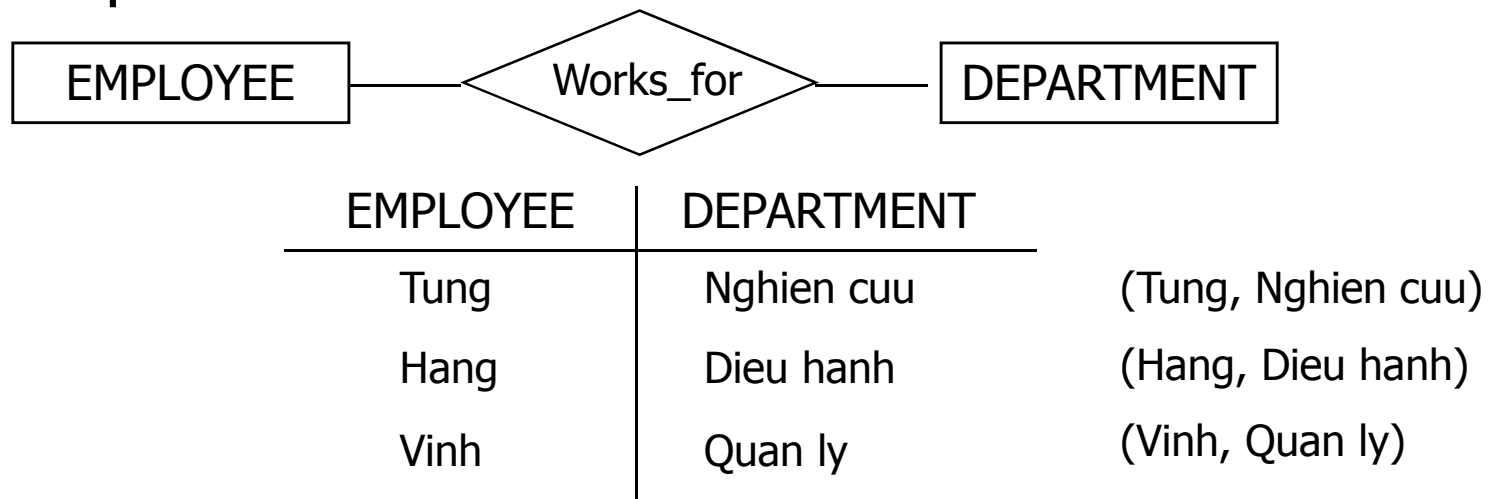


Instances of an E/R diagram

- A DB described by an E/R diagram will contain particular data, which is called the DB instance
 - Each entity set, the instance will have a particular finite set of entities
 - Entity set EMPLOYEE has entities such as E_1, E_2, \dots, E_n
 - Each of entity has particular values for each attribute
 - E_1 has FName= “Tung”, BirthDate= “08/12/1955”, Sex= “Nam”
 - E_2 has FName= “Hang”, BirthDate= “07/19/1966”, Sex= “Nu”
- Note
 - Do not store E/R data directly in a DB
 - Is abstract only
 - Help us to think about the design before we convert to relations

Relationship – Instance

- DB instance includes specific choices of the relationships of the diagram
 - A relationship R connects n entity sets E_1, E_2, \dots, E_n
 - Instance of R consists of a finite set of lists (e_1, e_2, \dots, e_n)
 - Each e_i is chosen from the entities that are in E_i
- Example

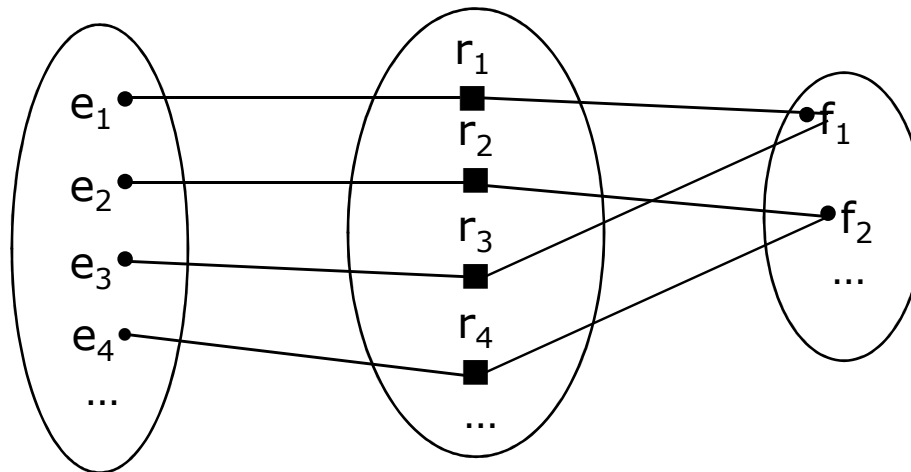
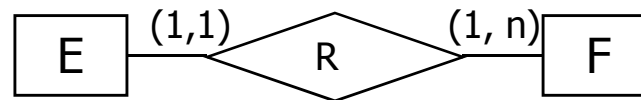


Relationship – Multiplicity

- A binary relationship R connecting entity sets E and F , then
 - Many-One from E to F
 - One-One from E to F
 - Many-Many from E to F

Relationship – Multiplicity

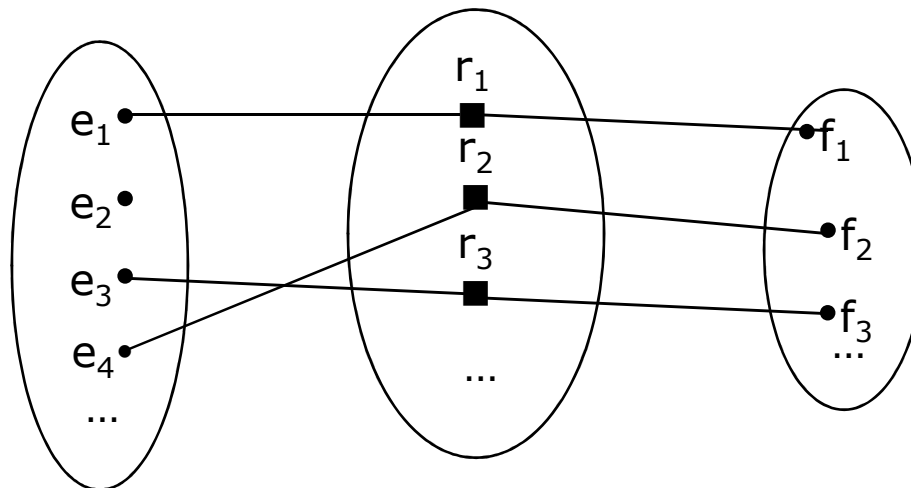
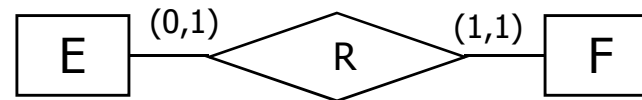
- Many-One from E to F ~ One-Many from F to E
 - Each member of E can be connected at most one member of F
 - Each member in F can be connected to many members of E



Relationship – Multiplicity

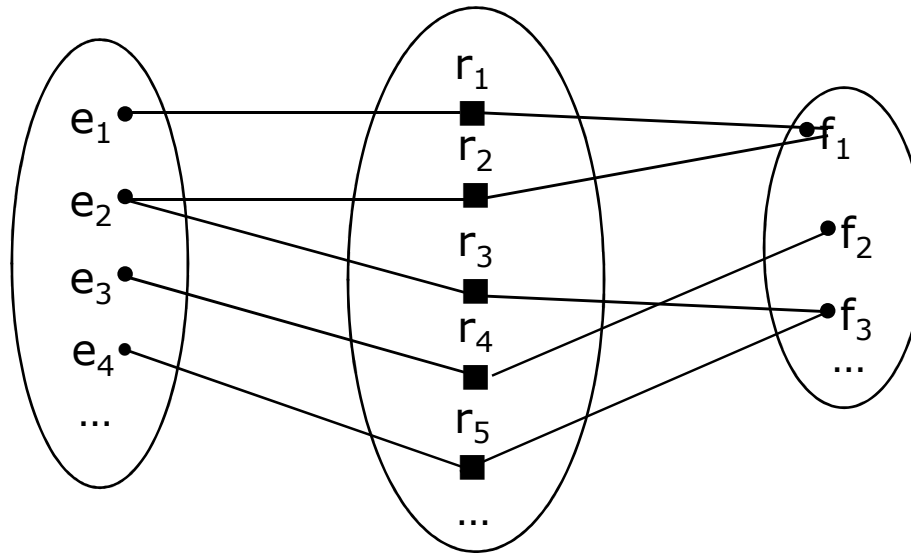
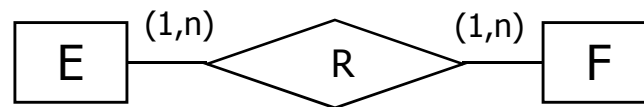
- One-One from E to F

- A member of either entity set can be connected to at most one entity of the other set



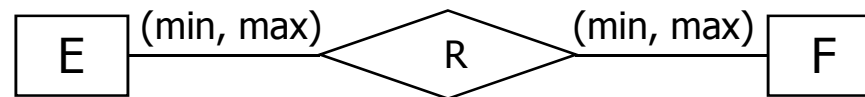
Relationship – Multiplicity

- Many-Many from E to F
 - A member of either entity set can be connected to many entities of the other set



Relationship – Multiplicity

- (min,max) specifies the minimum or maximum number that each entity $e \in E$ can participate in R

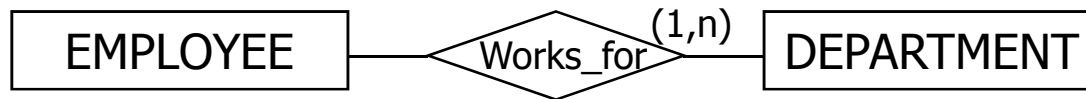


- (0,1) – zero or 1
- (1,1) – at least 1 and at most 1
- (0,n) – zero or many
- (1,n) – 1 or many

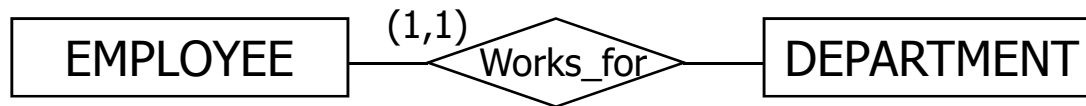
Relationship – Multiplicity

■ Example

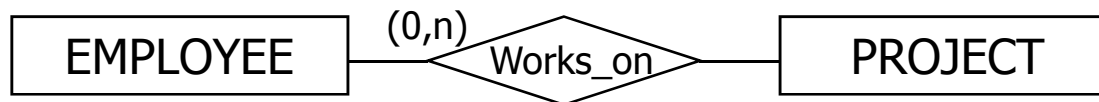
- A department has many employees



- An employee works for a department



- An employee can work on many projects or do not work on any projects

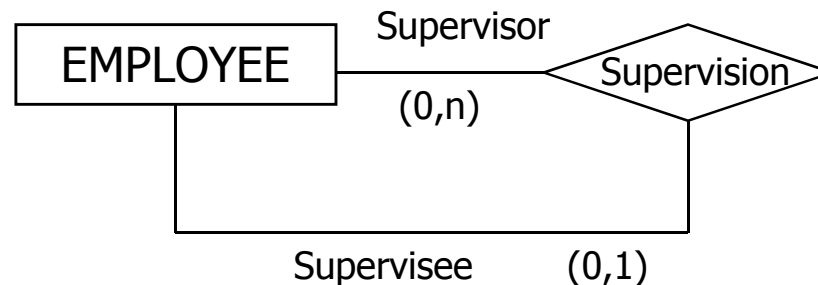


- An employee can manage a certain department



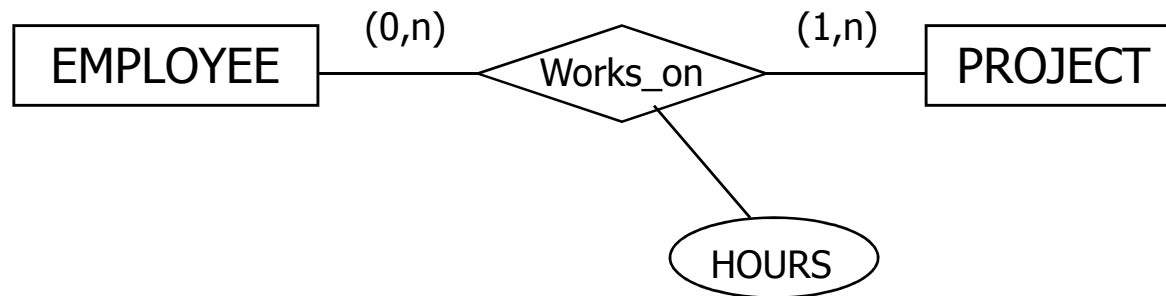
Relationship – Role

- One entity set appears two or more times in a single relationship
 - Draw many lines from the relationship to the entity set
 - Each line represents a different role that the entity set plays in the relationship



Attributes on relationships

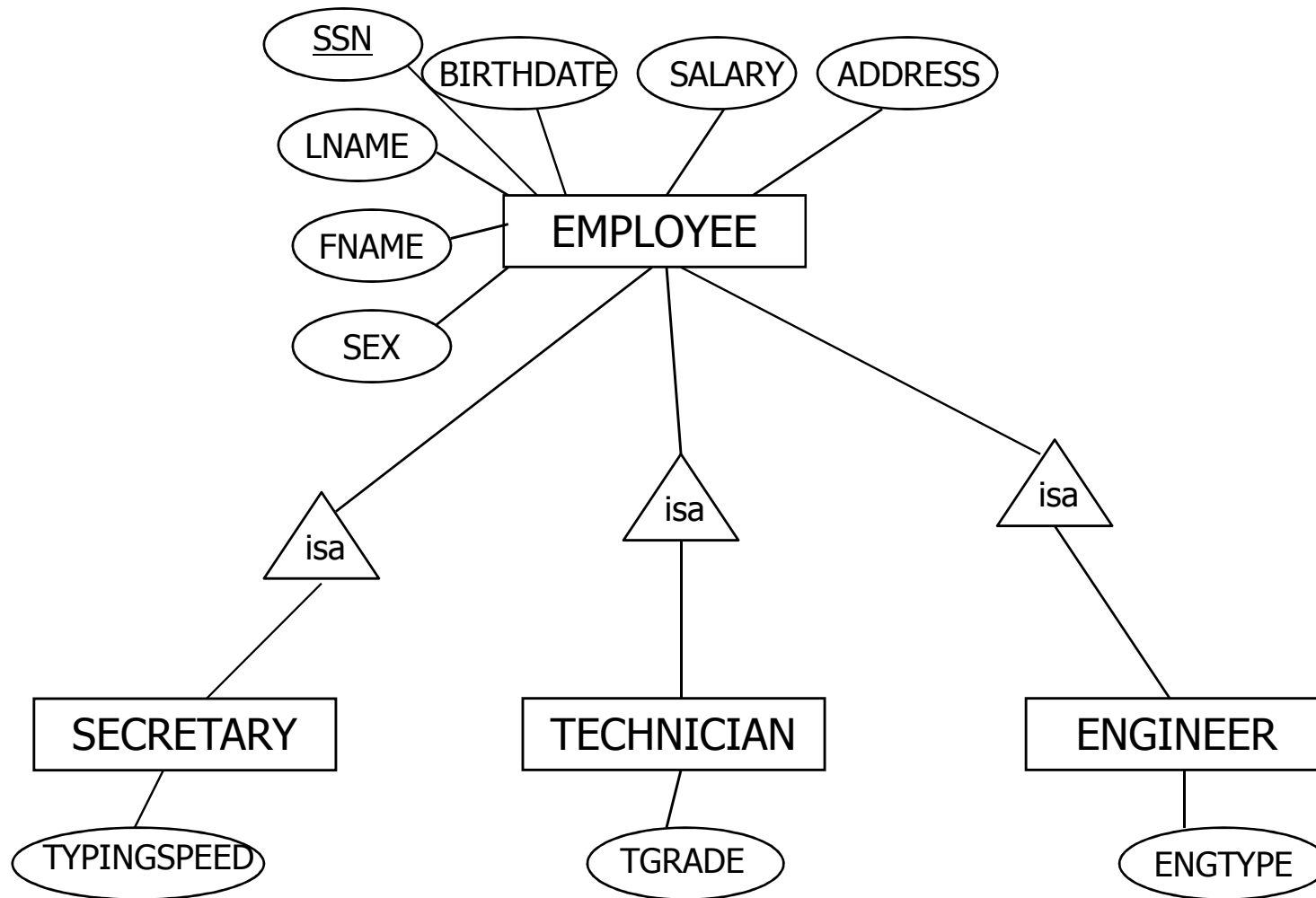
- Attributes on a relationship describe properties for that relationship
- These attributes cannot associate with entity sets that the relationship connects



Relationship “isa”

- An entity set contains certain entities that have special properties not associated with all member of the set
- Then, we define a special-case entity set
 - Subclass
 - Have its own special attributes and/or relationships
 - Connect to its superclass using the “isa” relationship
 - “an A is a B” = “isa” relationship from entity set A to entity set B

Example



Relationship “isa”

■ Note

- The “isa” relationship is the one-one relationship
- One root entity set
- Entity set E is a subclass, entity set F is superclass
 - Entity $e \in E$ has whatever attributes that F has
 - Entity $e \in E$ participates in whatever relationships that F participates in

Key attributes

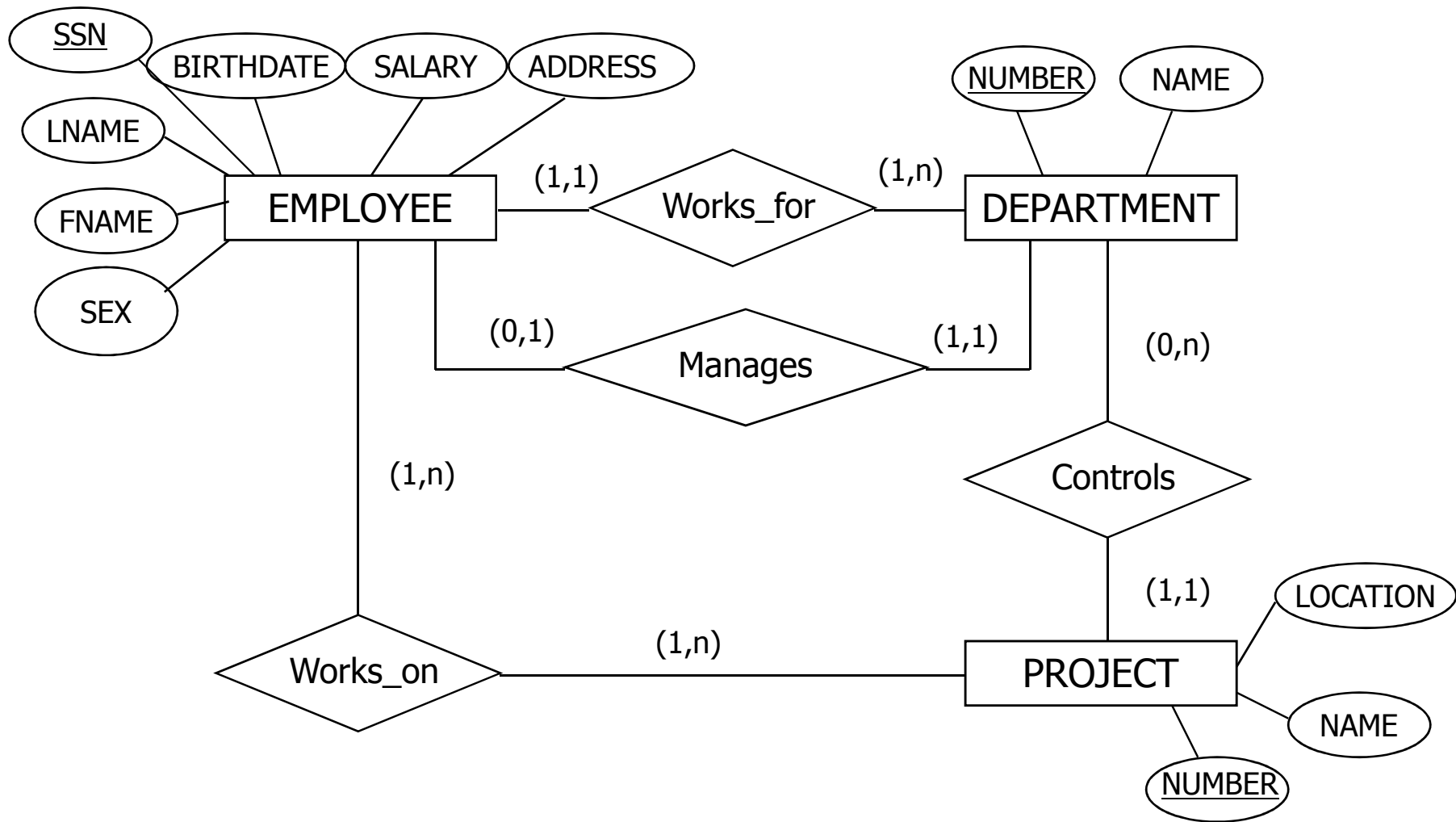
- All entities in an entity set are necessary to be distinguished
- A key K for an entity set E is one or more attributes such that
 - Given any two distinct entities e_1 and e_2 in E , e_1 and e_2 cannot have identical values for each of the attributes in the key K

Key attributes

■ Note

- Every entity set must have a key
- A key can consist of more than one attribute
- There can be more than one possible key for an entity set
 - Pick one key as the “primary key” for that entity set
- In an “isa” relationship, the root entity set needs its own key

Example

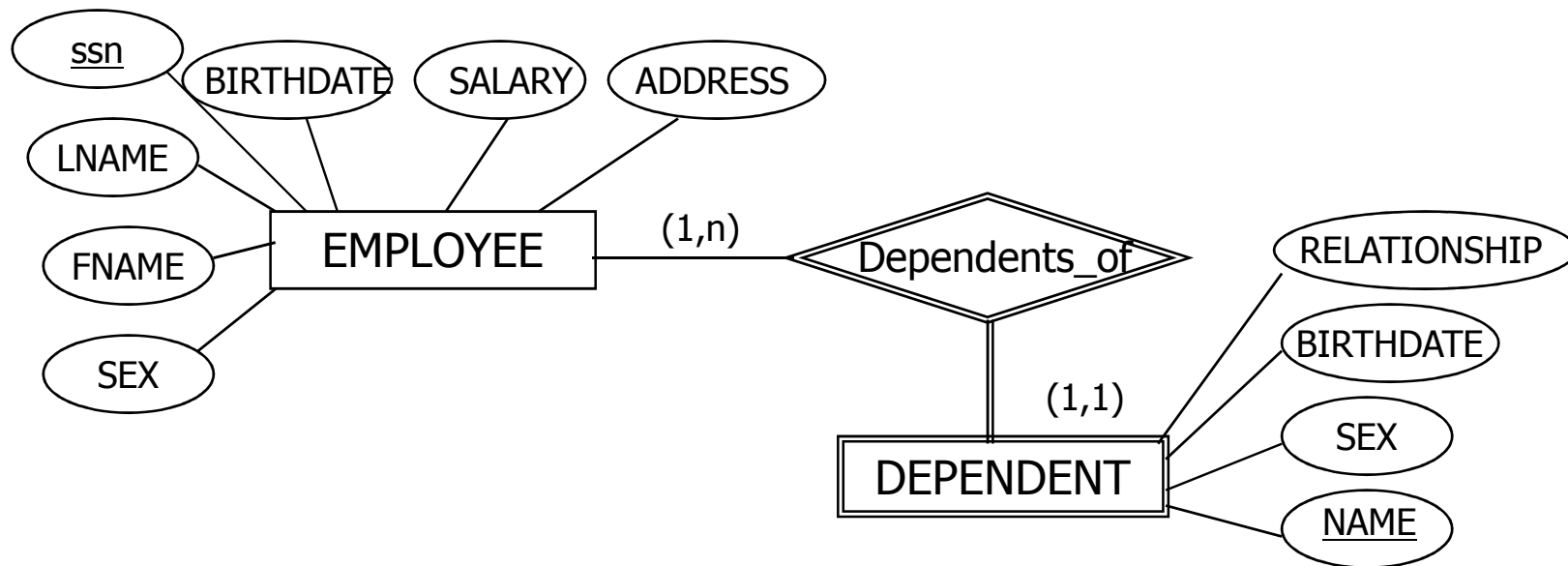


Weak entity set

- An entity set whose key is composed of attributes which belong to another entity set

- Sources of weak entity set
 - Entities of set E are sub-units of entities in set F
 - The names of E entities are not unique until we take into account the name of F entity to which the E entity is subordinate
 - Some entity sets have no attribute for their own
 - Their key is formed from attributes that are the key attributes for the entity sets they connect

Example



Content

- Process of database design
- E/R model
- **E/R model design**
 - Steps of design
 - Design principles
- Exercise

Steps of design

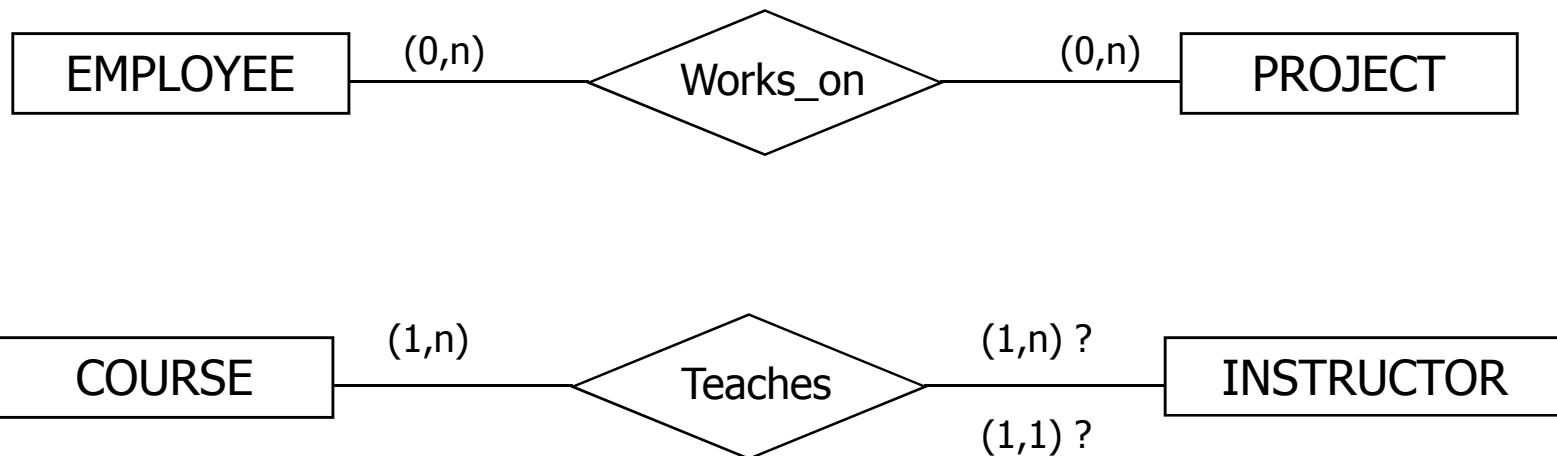
- (1) Determine entity sets
- (2) Determine relationships among entity sets
- (3) Determine attributes and connect them to entity sets and relationships
- (4) Specify the domain for attributes
- (5) Decide key attributes
- (6) Specify (min, max) of relationships

Design principles

■ Faithfulness

- Entity sets and their attributes should reflect reality
- Whatever relationships are asserted should make sense

- Examples



Design principles

- Avoiding redundancy
- Simplicity
 - Avoid introducing more elements into your design than is absolutely necessary
- Choosing the right relationships
 - Adding to our design every possible relationship is not a good idea
 - Redundancy, modifying the DB becomes complex
- Picking the right kind of element
 - Using attributes
 - Using entity set/relationship combinations

Content

- Process of database design
- E/R model
- E/R model design
- **Exercise**
 - “Company”

Exercise

- “Company” database keeps track of a company’s employees, departments, and projects
 - (1) The company is organized into departments. Each department has a unique name, a unique number, and a particular employee who manages the department. We keep track of the start date when that employee began managing the department. A department may have several locations.
 - (2) A department controls a number of projects, each of which has a unique name, a unique number, and a single location.

Exercise

- “Company” database keeps track of a company’s employees, departments, and projects
 - (3) We store each employee’s name, SSN, address, salary, sex, and birth date. An employee is assigned to one department but may work on several projects, which are not necessarily controlled by the same department. We keep track of the number of hours per week that an employee works on each project. We also keep track of the direct supervisor of each employee.
 - (4) We want to keep track of the dependents of each employee for insurance purpose. We keep each dependent’s first name, sex, birth date, and relationship to the employee.

Exercise

- Draw a full ER diagram for example “Company”

