E-R Model

E-R Model

- Entities & Attributes
- Types of attributes
- Entity type, Entity sets
- Relationship, Relationship types
- Constraints

E-R Model

- Entity-Relationship (ER) model is a popular high-level conceptual data model and is used for conceptual design of database applications
- This approach enables the database designers to concentrate on specifying the properties of the data without being concerned with storage details
- ER model describes data as entities, relationships, and attributes

Entities & Attributes

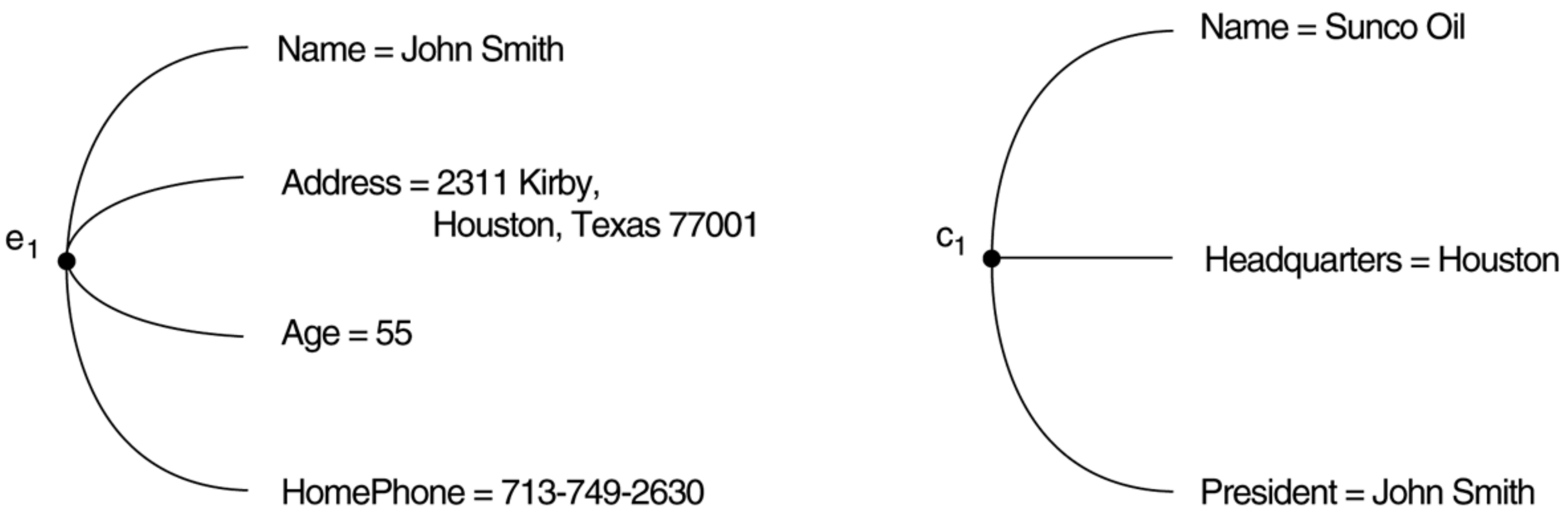
- Entities are specific objects or things in the mini-world that are represented in the database.
  - For example the EMPLOYEE John Smith, the Research DEPARTMENT, the ProductX PROJECT
- Attributes are properties used to describe an entity.
  - For example an EMPLOYEE entity may have a Name, SSN, Address, Sex, BirthDate

Entities & Attributes

- Entities and Attributes
  - A specific entity will have a value for each of its attributes.
    - For example a specific employee entity may have Name='John Smith', SSN='123456789', Address ='731, Fondren, Houston, TX', Sex='M', BirthDate='09-JAN-55'
  - Each attribute has a *value set* (or data type) associated with it – e.g. integer, string, subrange, enumerated type, …

Entities & Attributes

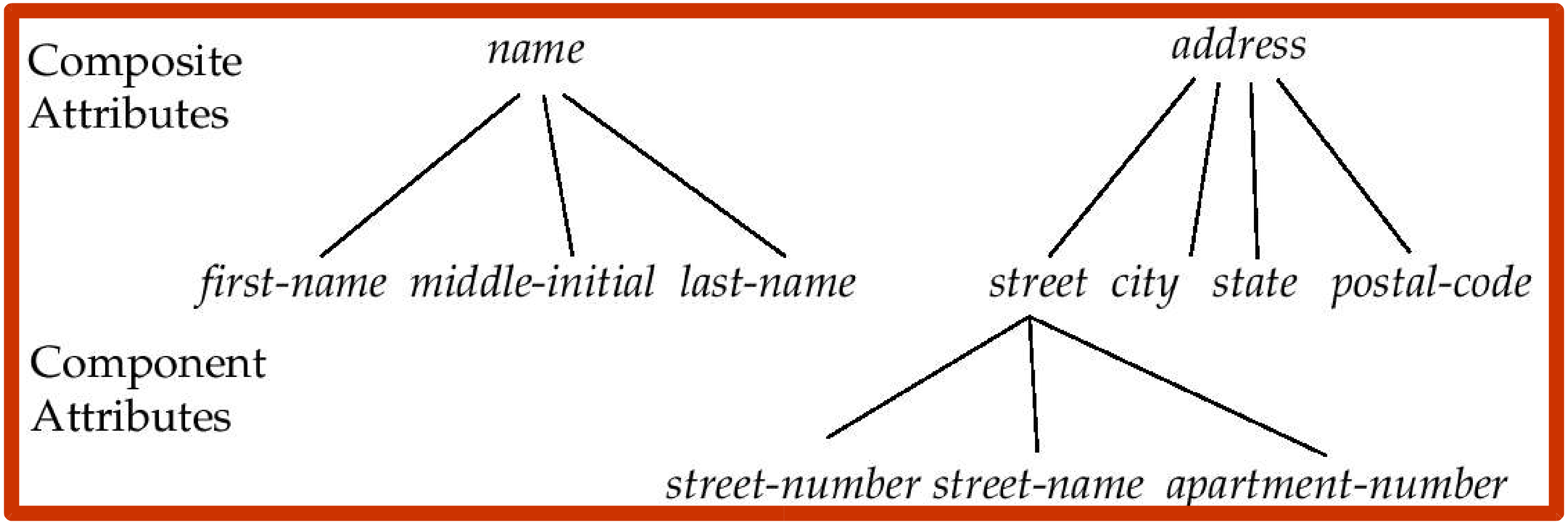
- Two entities employee e, company c and their attributes



Types of Attributes

- Simple Vs Composite
- Simple: Each entity has a single atomic value for the attribute.
    - For example, SSN or Sex.
- Composite: The attribute may be composed of several components.
    - For example, Address (Apt#, House#, Street, City, State, ZipCode, Country) or Name (FirstName, MiddleName, LastName).

Types of Attributes



Types of Attributes

- Single-valued Vs Multi-valued
- Most attributes have a single value for a particular entity.
  - For example: Age is a single-valued attribute of person
- Multi-valued: An entity may have multiple(set of) values for that attribute.
  - For example, Color of a CAR or PreviousDegrees of a STUDENT. Denoted as {Color} or {PreviousDegrees}.

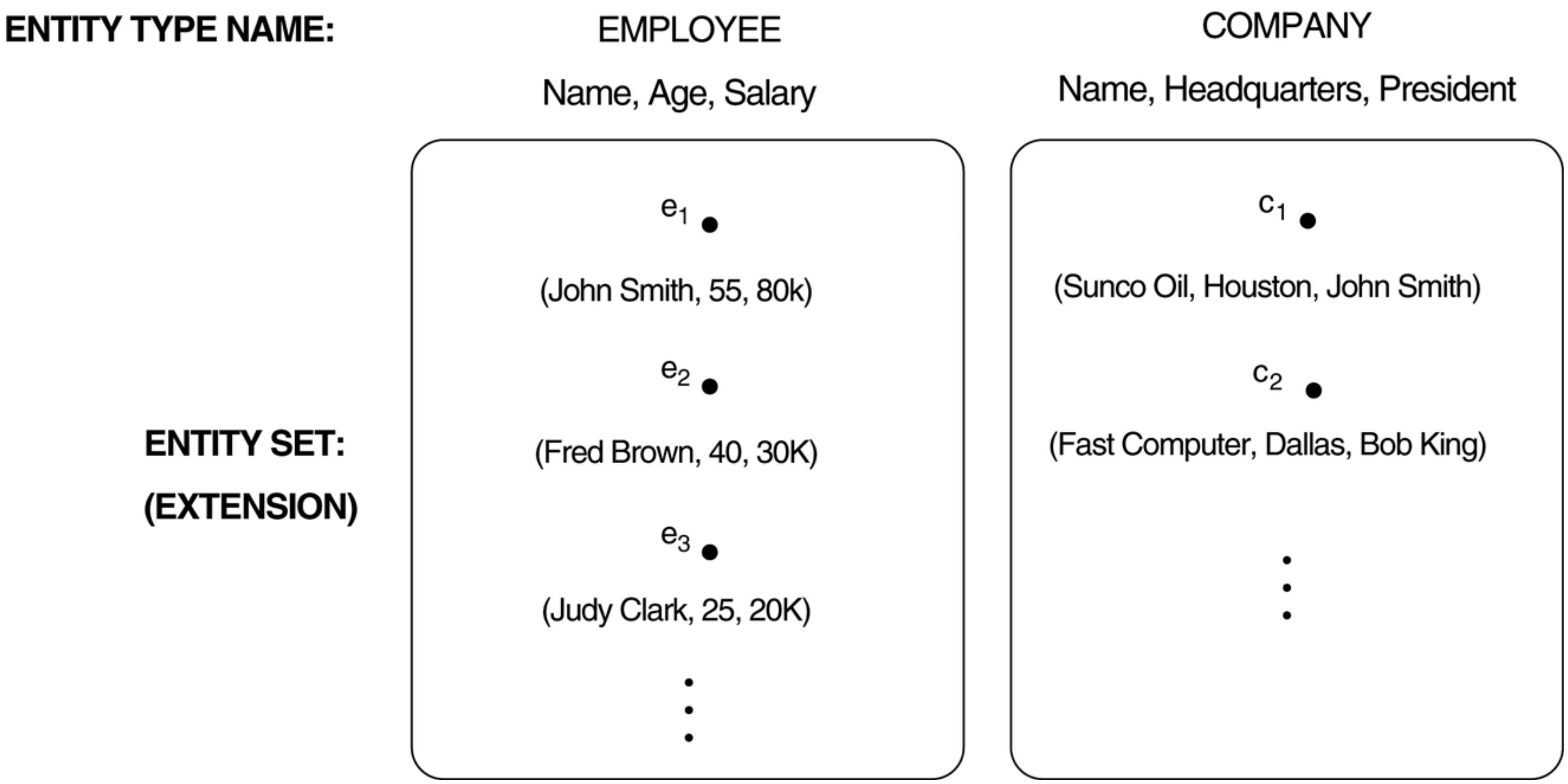
Types of Attributes

- Stored Vs Derived
- Age can be determined from the current date and the value of person's BirthDate
  - Hence the age attribute is derived attribute and BirthDate is called stored attribute
  - number_of_employees can be derived by counting the number of employees related to that department

Entity Types, Entity Sets

- Entities with the same attributes are grouped or typed into an entity type.
  - Example: EMPLOYEE or PROJECT entity type.
- Each entity type is described by its name and attributes
- An entity type is represented as a rectangula box enclosing the entity type name
- Entity Set: The collection of all entities of a particular entity type in the DB at any point in time
- Entity set uses the same name as the entity type

Entity Types, Entity Sets



ENTITY TYPE NAME:

EMPLOYEE

Name, Age, Salary

COMPANY

Name, Headquarters, President

ENTITY SET:

(EXTENSION)

e_1 ●

(John Smith, 55, 80k)

e_2 ●

(Fred Brown, 40, 30K)

e_3 ●

(Judy Clark, 25, 20K)

⋮

c_1 ●

(Sunco Oil, Houston, John Smith)

c_2 ●

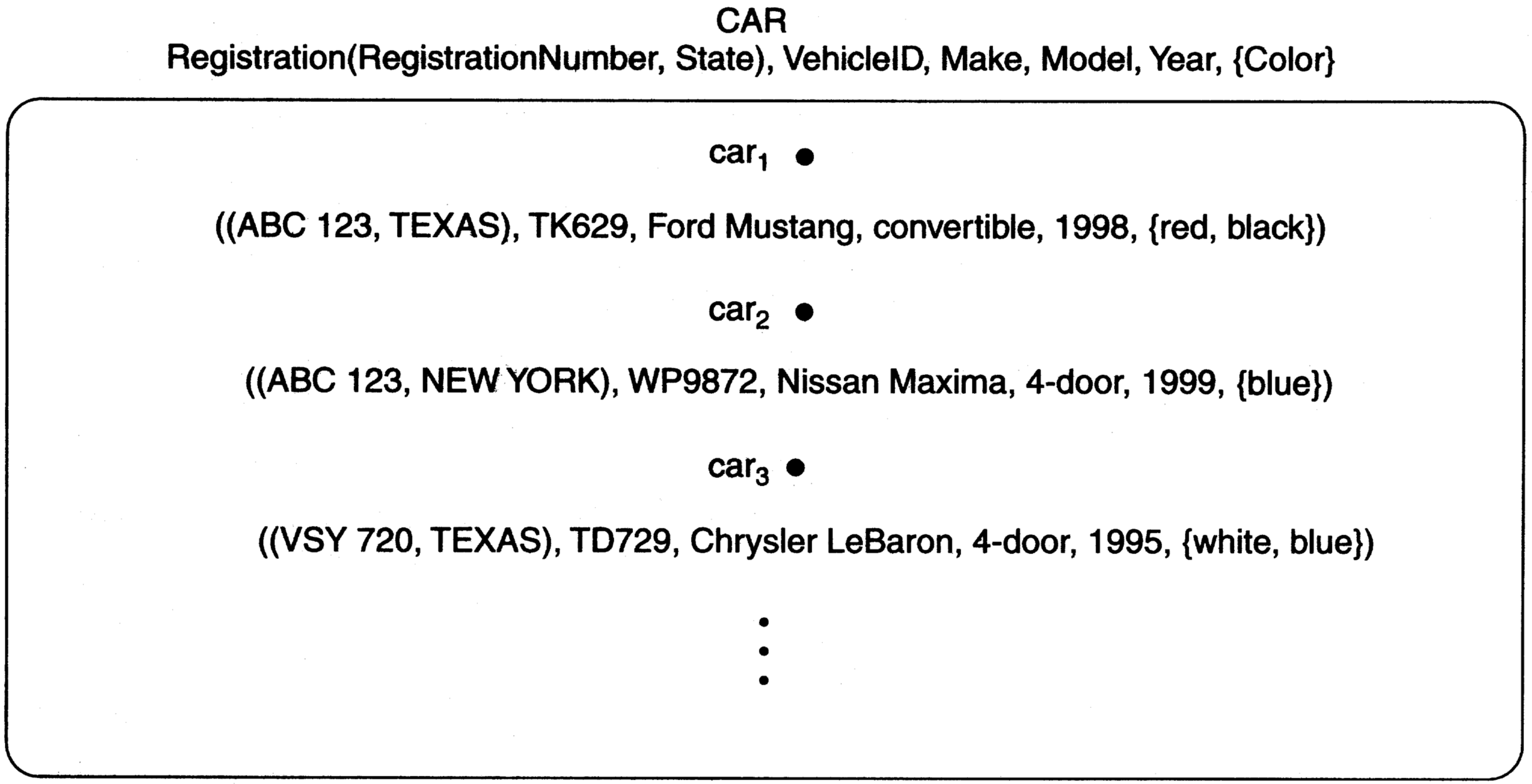
(Fast Computer, Dallas, Bob King)

⋮

Keys

- An attribute whose values are distinct for each individual entity in the collection is called a key attribute
- In ER diagram each key attribute has its name underlined inside the oval
- Value sets of Attributes: Each Attribute is associated with a set of values. Value sets are not displayed in ER diagrams.
- Example: Range of values allowed for employees between 16 and 70.

Keys



CAR

Registration(RegistrationNumber, State), VehicleID, Make, Model, Year, {Color}

car$_1$ ●

((ABC 123, TEXAS), TK629, Ford Mustang, convertible, 1998, {red, black})

car$_2$ ●

((ABC 123, NEW YORK), WP9872, Nissan Maxima, 4-door, 1999, {blue})

car$_3$ ●

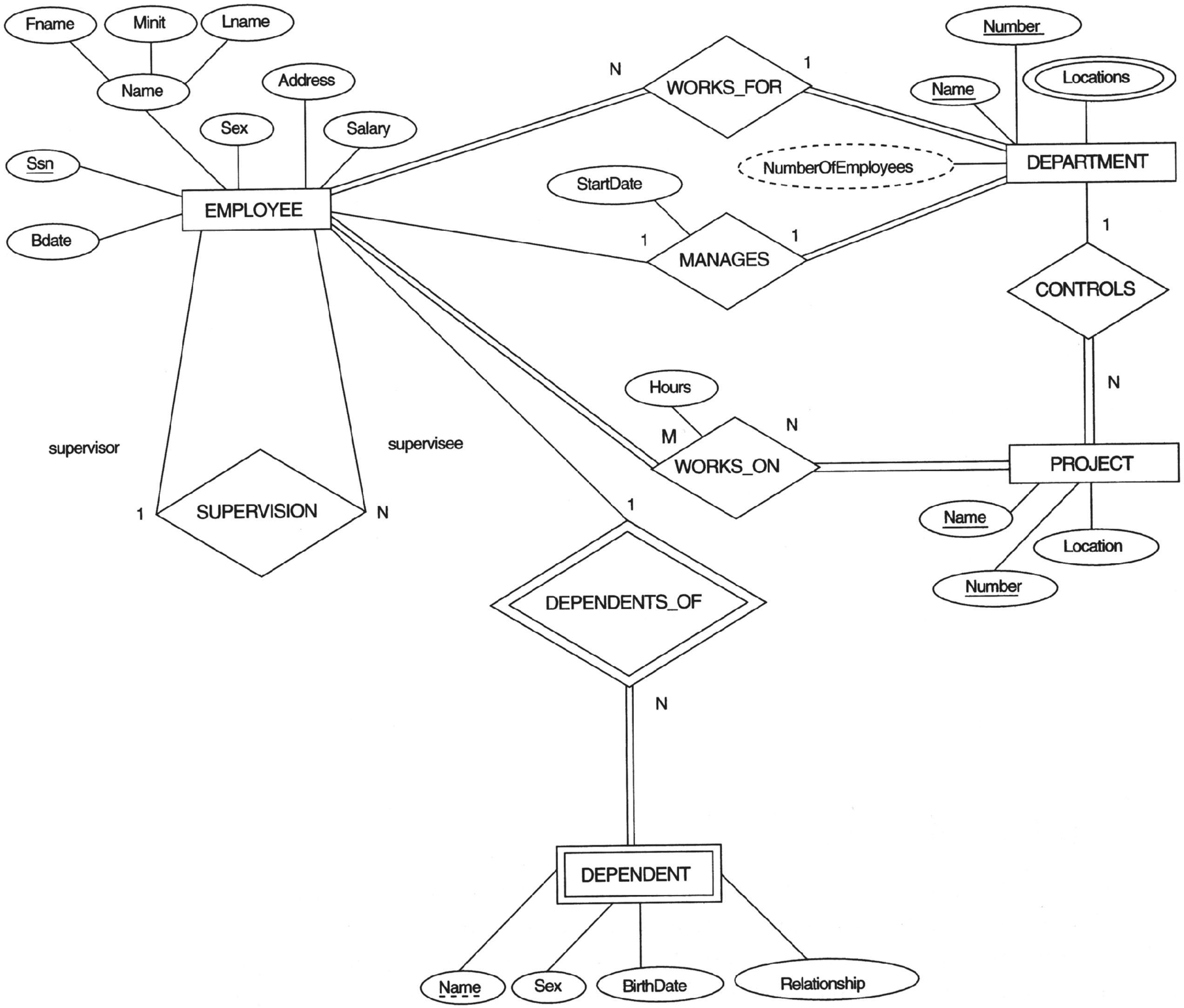
((VSY 720, TEXAS), TD729, Chrysler LeBaron, 4-door, 1995, {white, blue})

⋮

Relationship

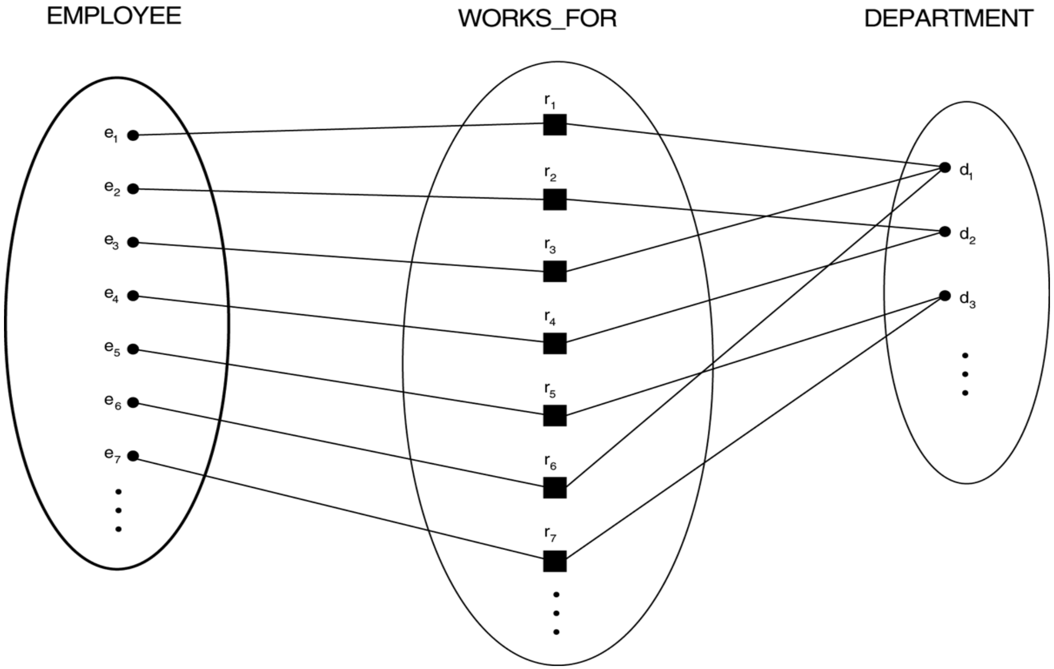
- A relationship relates two or more distinct entities with a specific meaning.
- Example: EMPLOYEE John Smith works on the ProductX PROJECT
- Relationships of the same type are grouped or typed into a relationship type.
- Relationship type – set of associations among entities
- Example: The WORKS_ON relationship type in which EMPLOYEEs and PROJECTs participate

Company ER

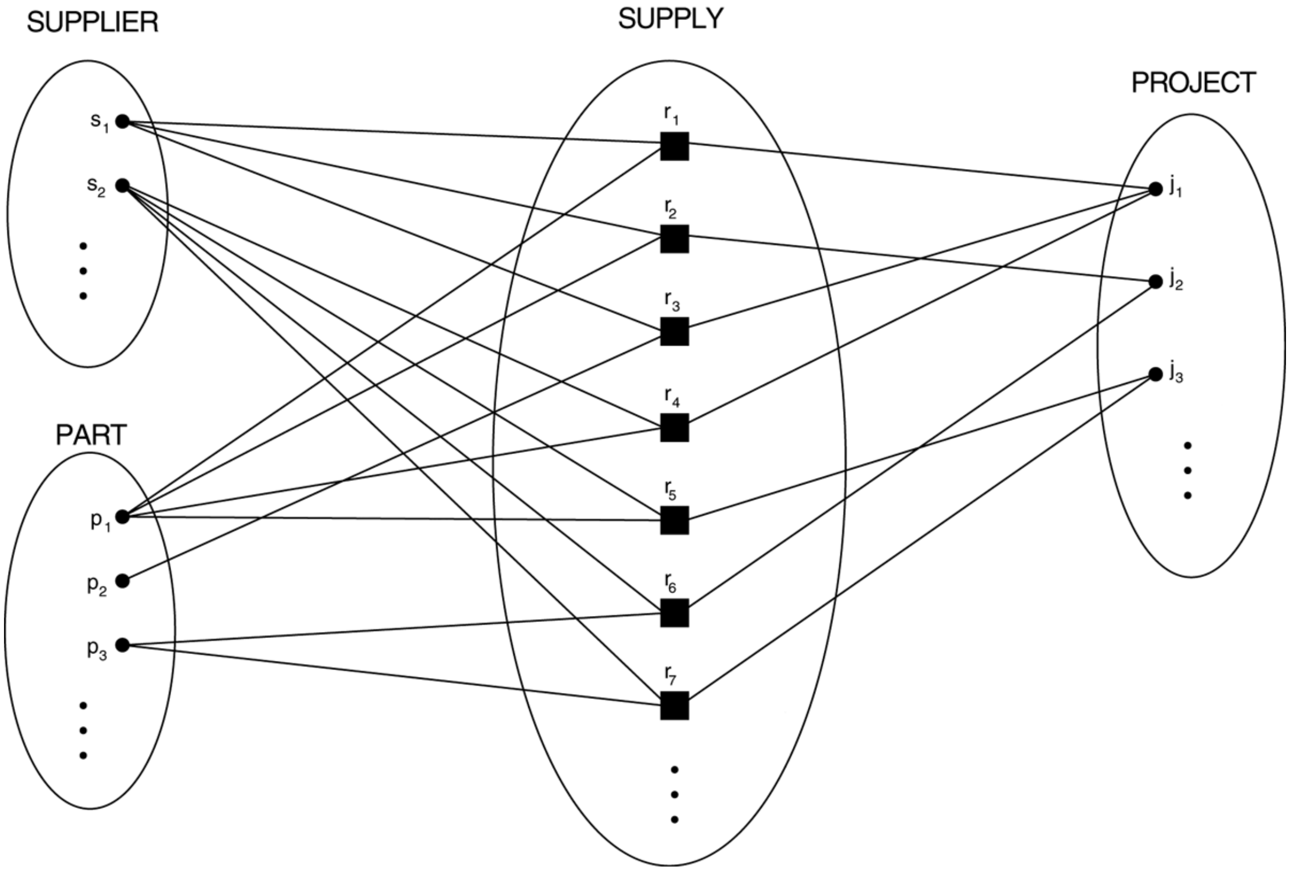

Fname
Minit
Lname
Name
Address
Sex
Salary
Ssn
Bdate
EMPLOYEE
N
WORKS_FOR
1
Number
Name
Locations
DEPARTMENT
NumberOfEmployees
StartDate
1
MANAGES
1
1
CONTROLS
N
Hours
M
WORKS_ON
N
PROJECT
Name
Location
Number
supervisor
supervisee
1
SUPERVISION
N
1
DEPENDENTS_OF
N
DEPENDENT
Name
Sex
BirthDate
Relationship

Degree of Relationship type

- The degree of a relationship type is the number of participating entity types.
- A relationship type of degree two is called binary, and three is called ternary

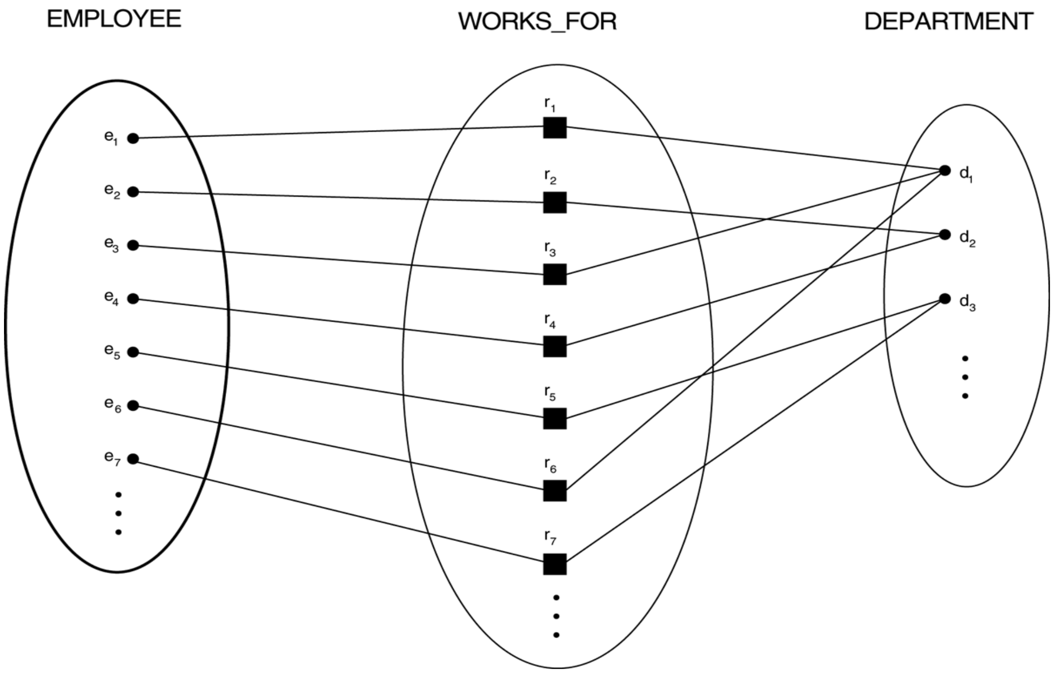


Relationship – ternary



Role Names

- Role names signifies the role that a participating entity from the entity type plays in each relationship instance.
- Example : The WORKS_FOR relationship type, Employee plays the role of *employee* or *worker*.



Recursive Relationships

- Same entity type participates more than once in a relationship type in different roles
- Example : employee entity type participates twice in supervision: once in role of *supervisor* and once in the role of *supervisee*

Recursive Relationships

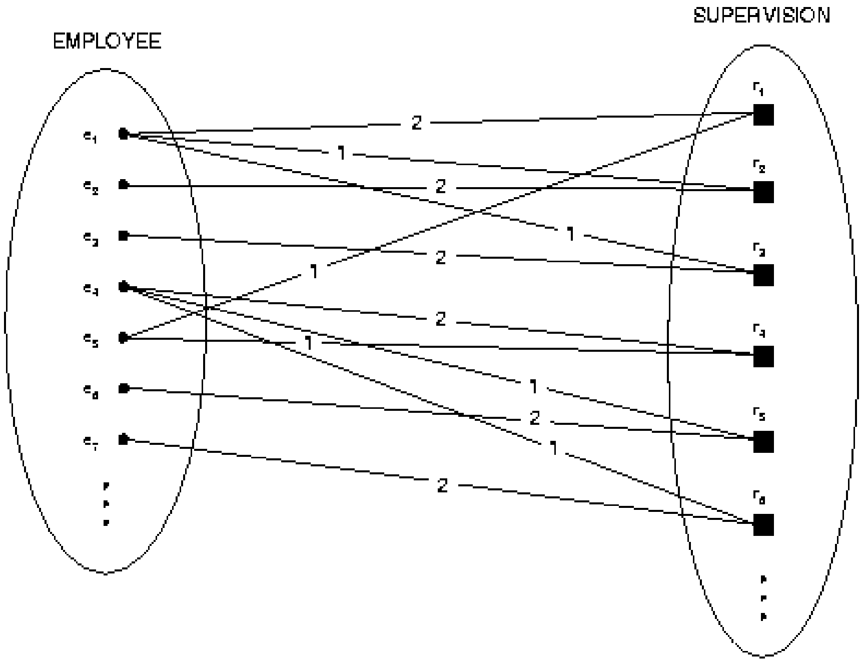


Figure 3.11

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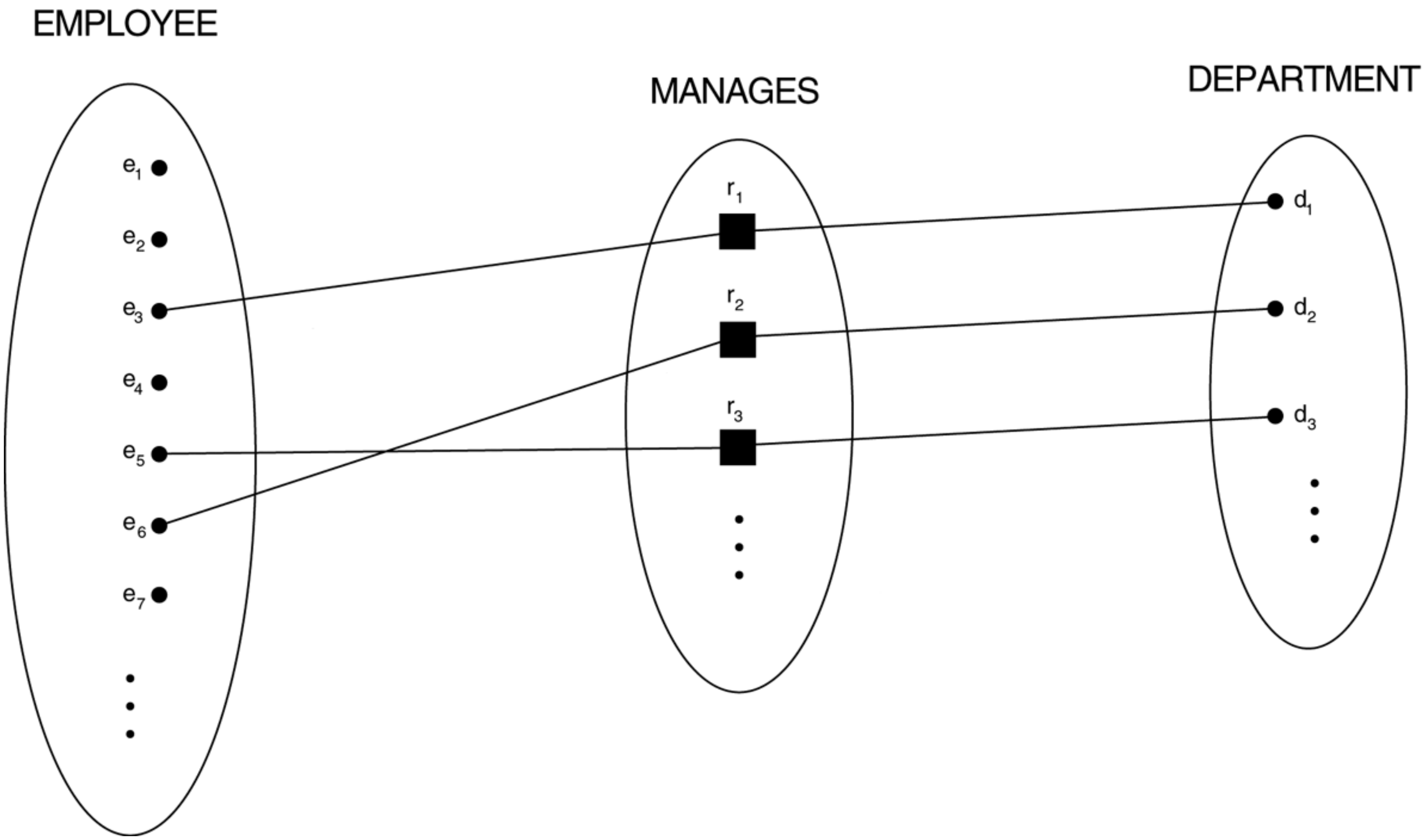
Constraints on Relationship Types

- Relationship types usually have certain *constraints* that limit the possible combinations of entities.
- Two main types of relationship constraints
  - Cardinality Ratio for Binary
  - Participation Constraints
- Cardinality Ratio & Participation --> Structural Constraints
- Cardinality Ratio of binary relationship specifies the number of relationship instances that an entity can participate in.
- The Cardinality Ratio for binary relationship types are 1:1,1:N,N:1 AND M:N

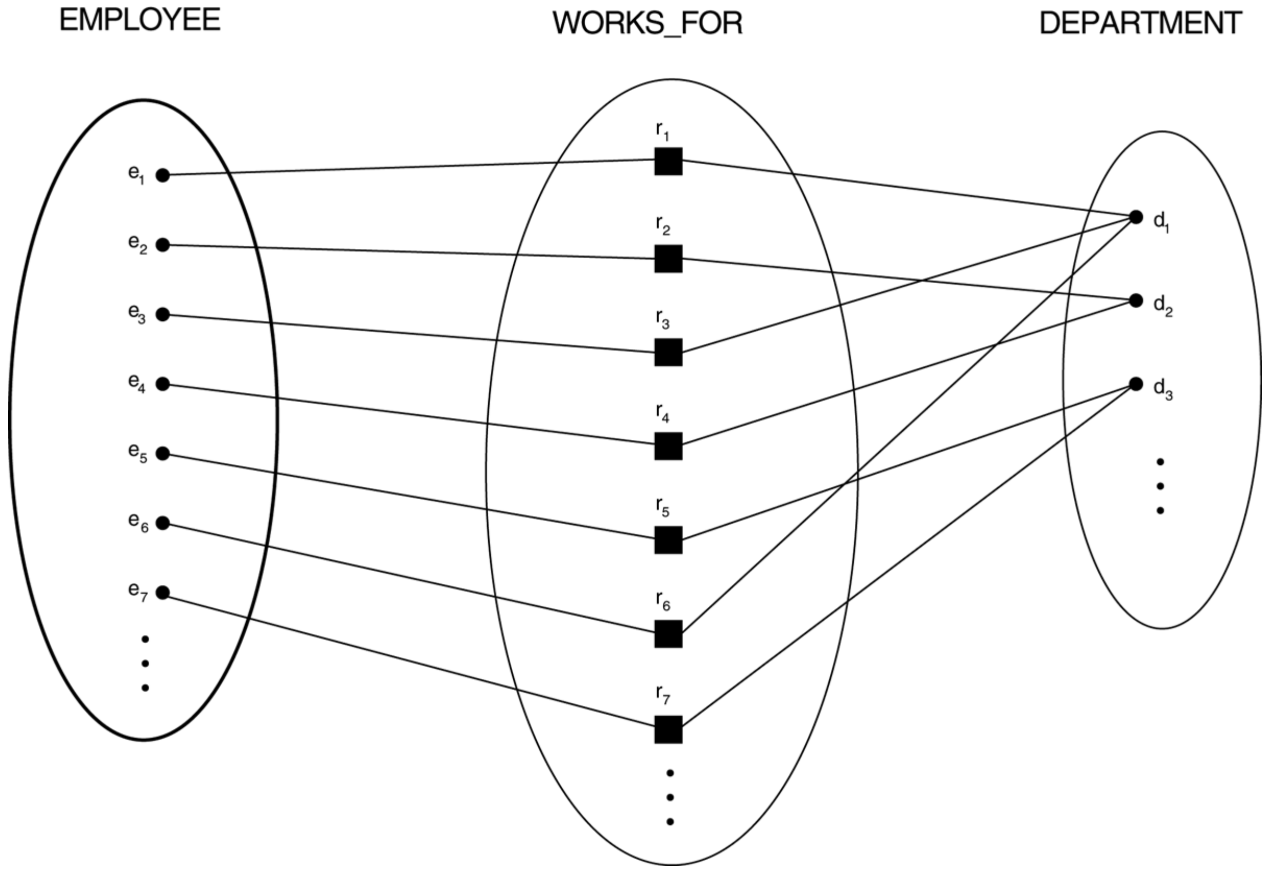
Cardinality Ratio

- A 1:1 relationship : MANAGES



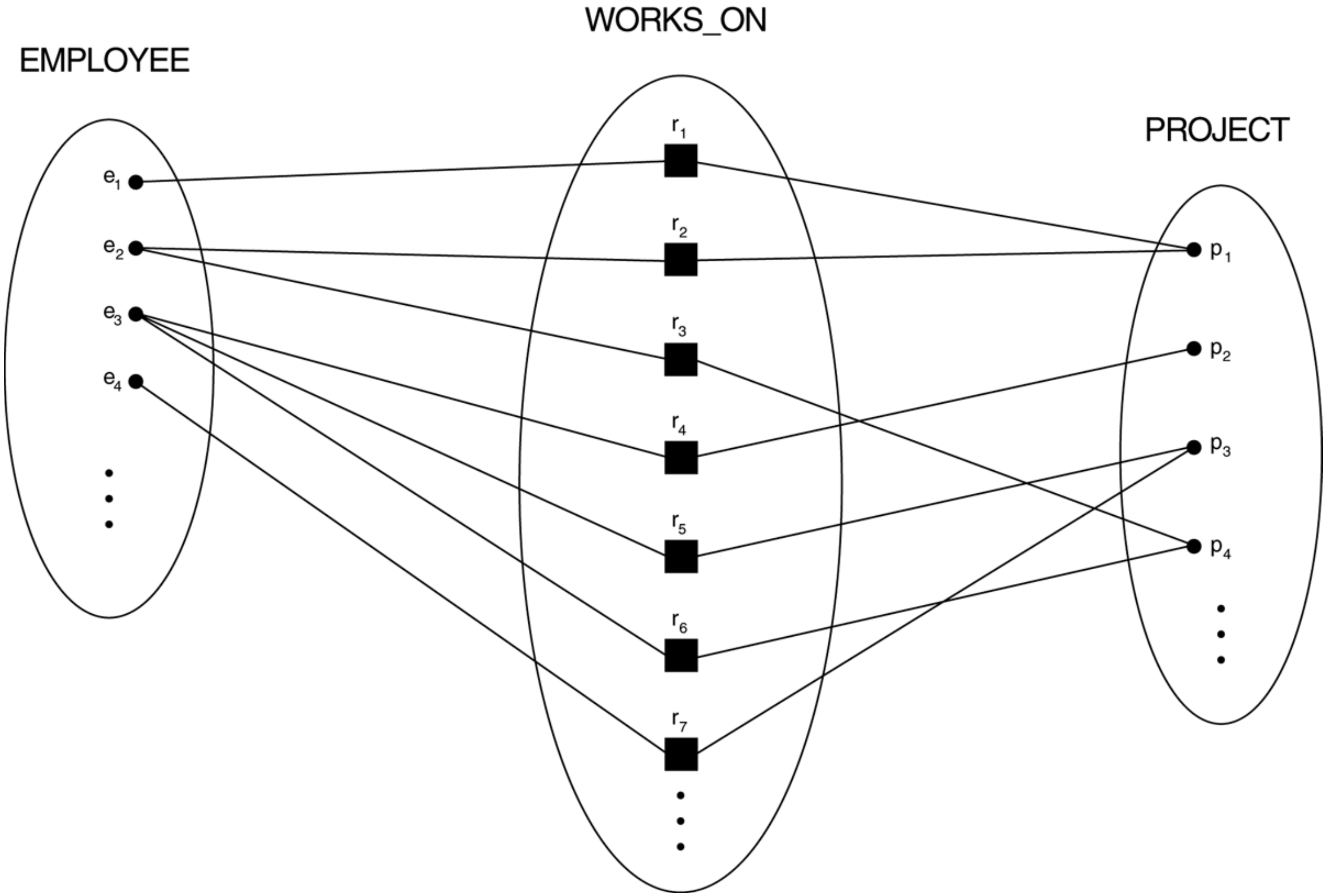
Cardinality Ratio

- The 1:N relationship : WORKS_FOR



Cardinality Ratio

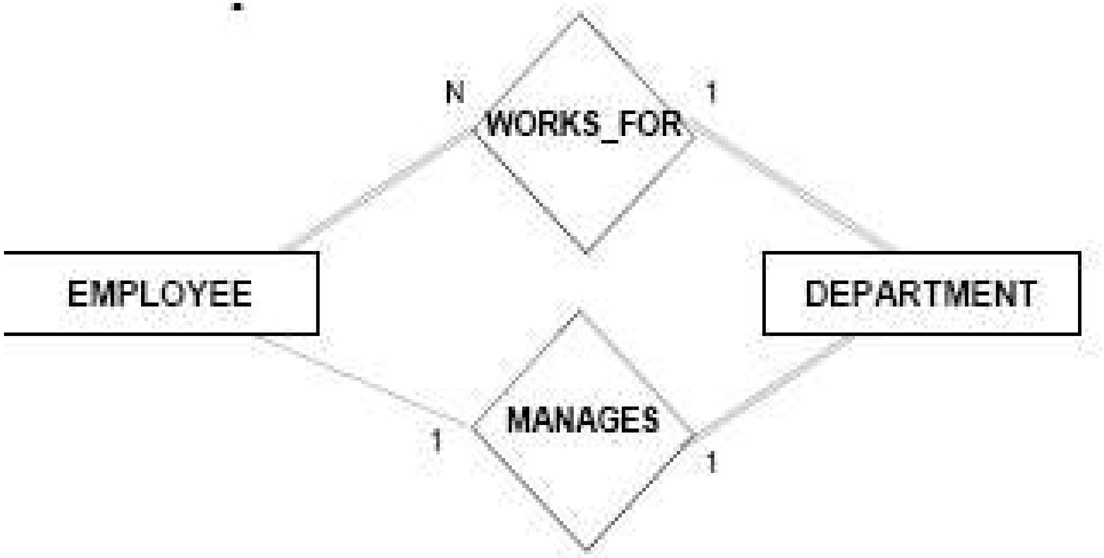
- The M:N relationship : WORKS_ON



Participation Constraints

- Determines whether all or only some entity occurrences participate in a relationship
- Specifies whether the existence of an entity depends on its being related to another entity via relationship type
- Two types of participation constraints
  - Total participation
    - total = every entity needs to be ‘related’
    - e.g. EMPLOYEE works_for DEPARTMENT
  - Partial participation
    - partial = some entities are involved
    - e.g. EMPLOYEE manages DEPARTMENT

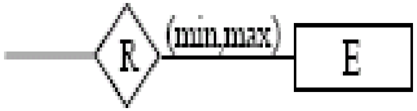
Participation Constraints



Note: double lines represent total participation

Participation Constraints

- Alternative ER notation for structural constraints
- Pair of integer numbers (*min, max*) with each *participation* of an entity type E in a relationship type R
  - Where 0 <= min <= max *and* max >= 1
- For each entity e in E, e must participate in atleast *min* and at most *max* relationship instances in R *at any point of time*
- If *min = 0* implies partial participation *min > 0* implies total participation

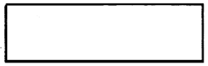
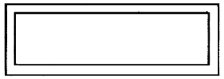
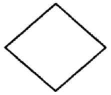
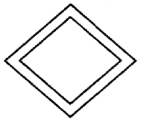
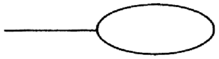
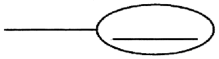
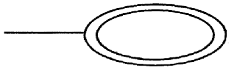
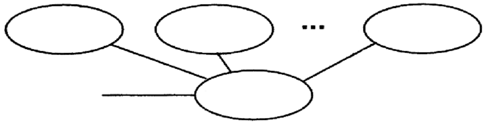
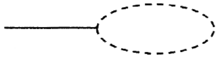
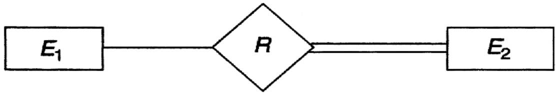
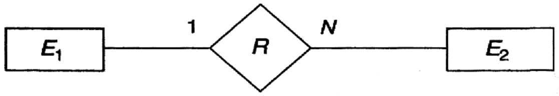
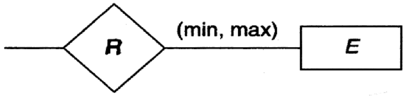


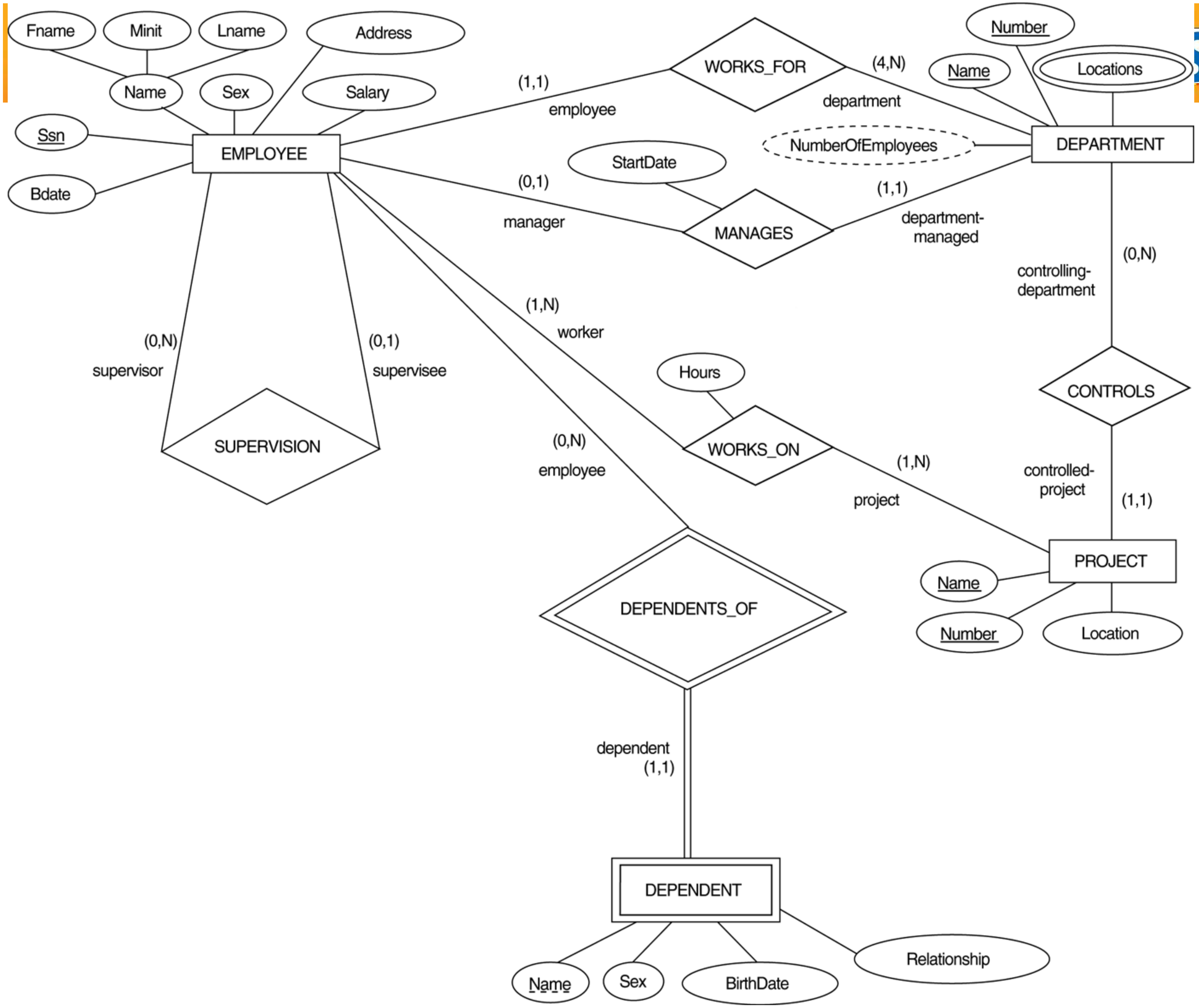
STRUCTURAL CONSTRAINT (min, max) ON PARTICIPATION OF E IN R

Weak Entity Types

- Entity types that do not have key attributes of their own are called *weak entity types*
- Entity types having key attribute --> strong entity types
- Weak entity types are identified by being related to specific entities from another entity type called *identifying* or *owner entity type*
- The relationship type that relates a weak entity type to its owner is called *identifying relationship* of weak entity type
- A weak entity type always has a total participation constraint

ER Notations

Symbol	Meaning
	ENTITY
	WEAK ENTITY
	RELATIONSHIP
	IDENTIFYING RELATIONSHIP
	ATTRIBUTE
	KEY ATTRIBUTE
	MULTIVALUED ATTRIBUTE
	COMPOSITE ATTRIBUTE
	DERIVED ATTRIBUTE
	TOTAL PARTICIPATION OF E_2 IN R
	CARDINALITY RATIO 1: N FOR E_1:E_2 IN R
	STRUCTURAL CONSTRAINT (min, max) ON PARTICIPATION OF E IN R)


Fname
Minit
Lname
Address
Name
Sex
Salary
Ssn
EMPLOYEE
Bdate
WORKS_FOR
(1,1)
employee
(4,N)
department
Number
Name
Locations
DEPARTMENT
NumberOfEmployees
StartDate
(0,1)
manager
MANAGES
(1,1)
department-managed
(0,N)
controlling-department
CONTROLS
controlled-project
(1,1)
(1,N)
worker
Hours
WORKS_ON
(1,N)
project
(0,N)
supervisor
(0,1)
supervisee
SUPERVISION
(0,N)
employee
DEPENDENTS_OF
PROJECT
Name
Number
Location
dependent
(1,1)
DEPENDENT
Name
Sex
BirthDate
Relationship

Thank You