DATABASE FUNDAMENTALS & DESIGN

Presented by
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Outline

- What is a Relational Database?
- Basic Database Structure.
- Entity Relationship Modeling.
- ERD.

What is a Relational Database?

- A data structure through which data is stored in tables that are **related** to one another in some way.

- The way the tables are related is described through a **relationship**

Basic Database Structure

Column

STUDENT

Name	Ssn	Home_phone	Address	Office_phone	Age	Gpa
Dick Davidson	422-11-2320	NULL	3452 Elgin Road	(817)749-1253	25	3.53
Barbara Benson	533-69-1238	(817)839-8461	7384 Fontana Lane	NULL	19	3.25
Rohan Panchal	489-22-1100	(817)376-9821	265 Lark Lane	(817)749-6492	28	3.93
Chung-cha Kim	381-62-1245	(817)375-4409	125 Kirby Road	NULL	18	2.89
Benjamin Bayer	305-61-2435	(817)373-1616	2918 Bluebonnet Lane	NULL	19	3.21

Row

Entity Relationship Modeling

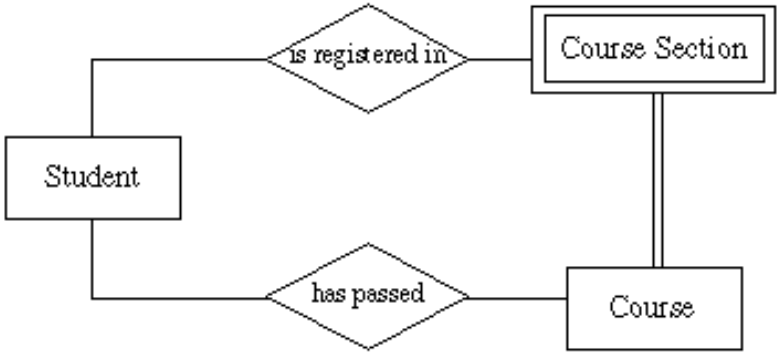
Entity-Relationship Diagram (ERD): identifies information required by the business by displaying the relevant entities and the relationships between them.

Definitions

- **Entity :**

  It is any thing about **which data is collected**

  (any thing a user want to track)



- **Weak Entity :**

  It is an entity whose existence is **dependent** on another entity.

  Existence of course_section depend on Course

Definitions

- **Entity instance:** An instance is a particular occurrence of an entity.

For example:

each Student is an instance of an entity

each car is an instance of an entity, etc.

STUDENT

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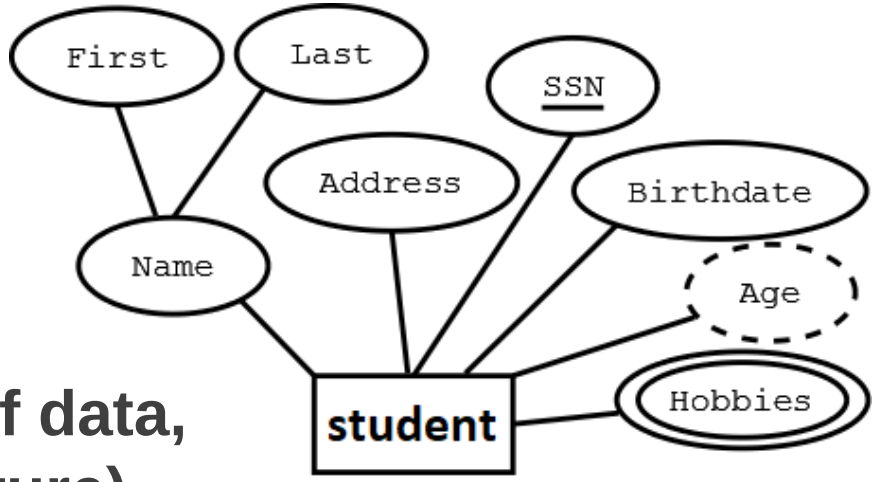
Definitions (cont.)

Attributes :

They are the Characteristics of entities.



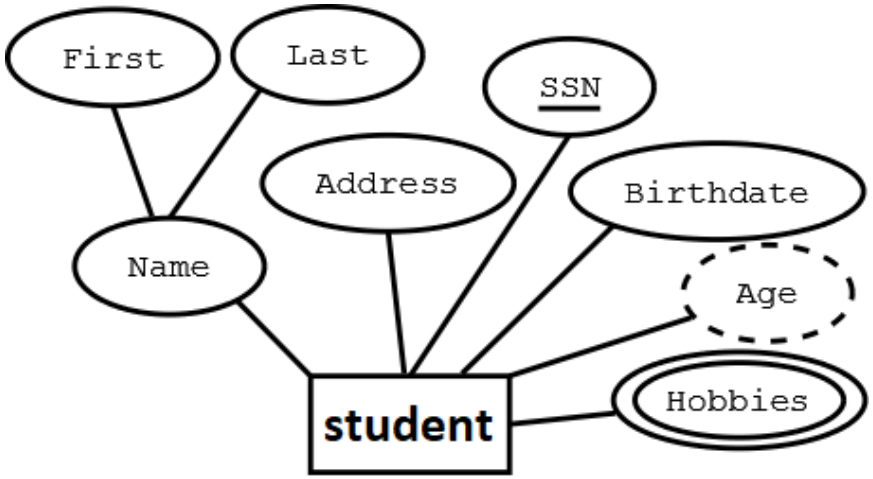
Types of attributes :

- **Simple (Scalars) –**
  - **smallest semantic unit of data,**
  - **atomic (no internal structure)**
  - **singular e.g. ssn,birthdate**

Definitions (cont.)

Types of attributes :

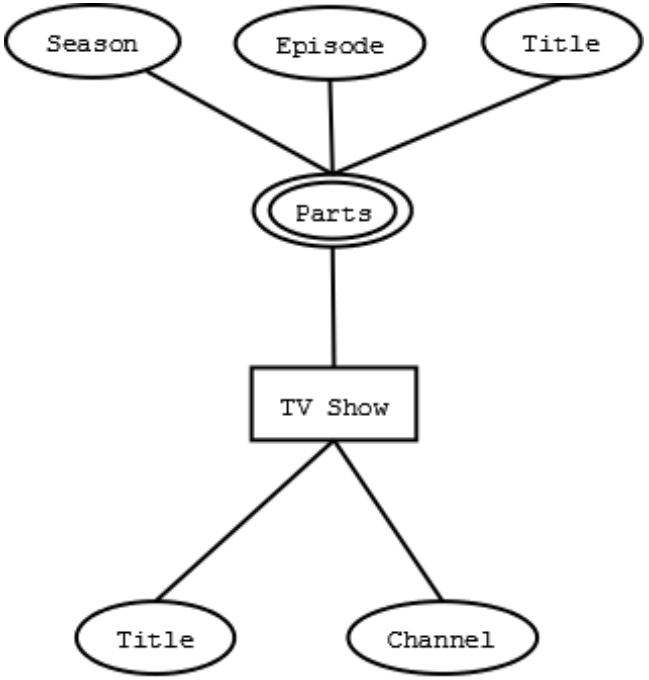
- **Composite - group of attributes**
  - **e.g. address (street, city, state, zip)**
- **Multi-valued (list)**
  - **multiple values e.g. phone numbers.**
- **Derived.**



Definitions (cont.)

Types of attributes :

- **Complex attribute:**
  - **Those attributes, which can be formed by the nesting of composite and multi-valued attributes**



Definitions (cont.)

- **Attribute Values**
  - ✓ **Sometimes attribute values is set to null.**
  - ✓ **There are two meanings of null**
    - **either not applicable**
    - **unknown values.**
  - ✓ **Default Value.**

Definitions (cont.)

- **Primary Key:**

  Identifier used to uniquely identify one particular instance of an entity.

  - ✓ **Can be one or more attributes. (consider substituting a single concatenated key attribute for multiple attribute key).**
  - ✓ **Must be unique .**
  - ✓ **Value should not change over time.**
  - ✓ **Must always have a value .**

Definitions (cont.)

- **Candidate Key :**

  when multiple possible identifiers exist, each is a candidate key.

- **Foreign Keys :**

  Foreign keys reference a related table through the primary key of that related table.

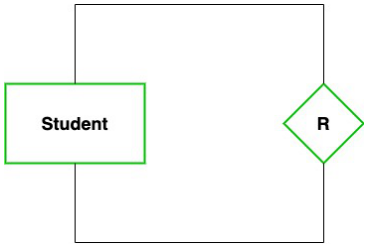
- **Referential Integrity Constraint:**

  For every value of a foreign key there is a primary key with that value in the referenced table e.g.

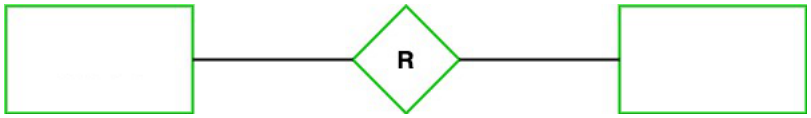
  if student name is to be used in a dormitory table then that name must exist in the student table.

Relationships

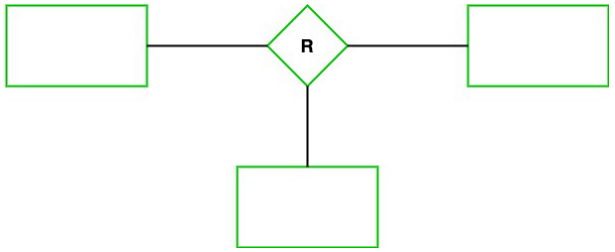
- A relationship is a connection between entity classes.



- Degree of Relationship:
  - ✓ **Unary :**relationships exist when both entity types are the same and we call them the degree of relationship is 1
  - ✓**Binary:**relationship exists when there are two types of entity and we call them a degree of relationship is 2



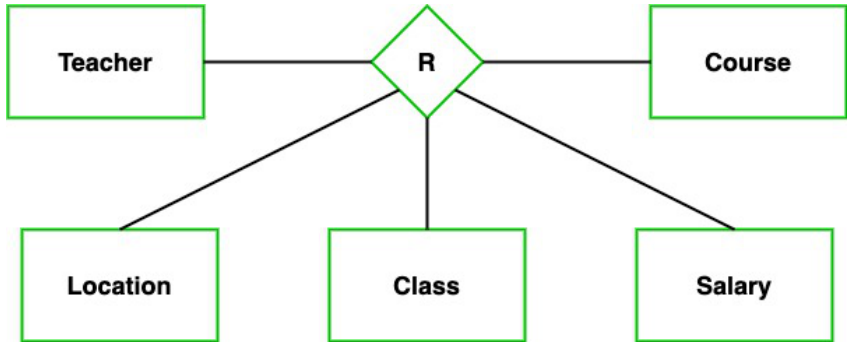
Relationships



- **Degree of Relationship:**

✓**Ternary:** relationship exists when there are three types of entity and we call them a degree of relationship is 3

✓**N-ary:** relationship exists when there are n types of entities. There is one limitation of the N-ary relationship



Relationships

- Cardinality represent **maximum** number of relationships that can occur with these instance .

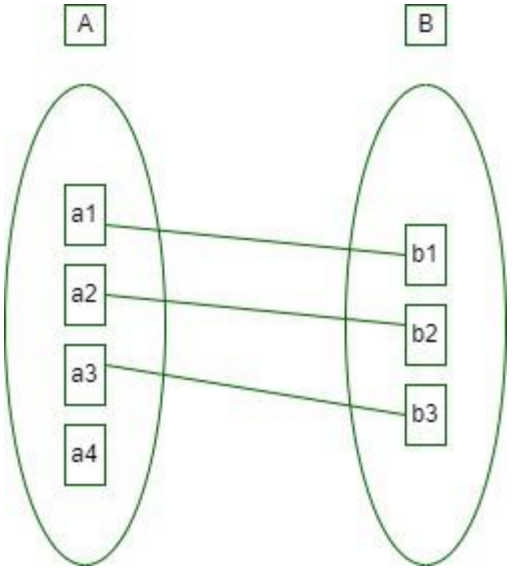
- Types of relationships (cardinality) :
  - ✓ One-to-one relationship (1:1)
  - ✓ One-to-many relationship (1:M)
  - ✓ Many-to-many relationship (N:M)

Relationships (cont.)

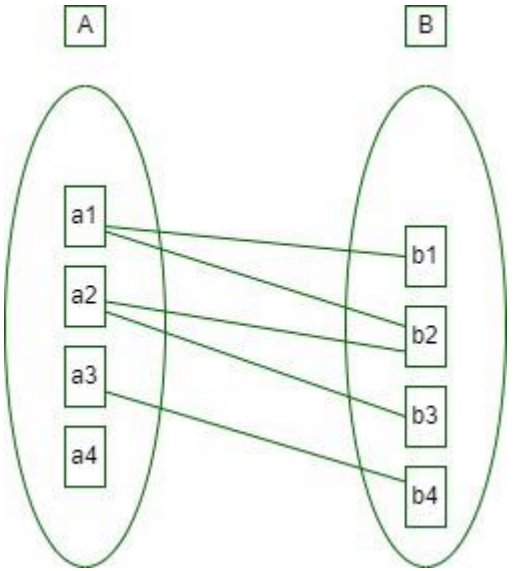
- **One-to-one relationship (1:1) :**

  A single record in table A is related to only one record in table B, and vice versa.

Ex. : **Emp. Uses at most one car, a car is used at most by one emp.**



Relationships (cont.)



- **One-to-many relationship (1:M) :**

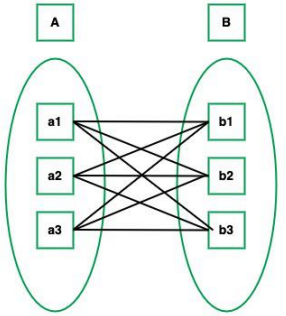
A single record in table (A) can be related to one or more records in table (B), but a single record in table (B) can be related to only one record in table (A).

Ex. : Emp. Uses at most one car, a car is used by many or several employees, student-advisor, customer-order

Relationships (cont.)

- **Many-to-many relationship (M:M) :**

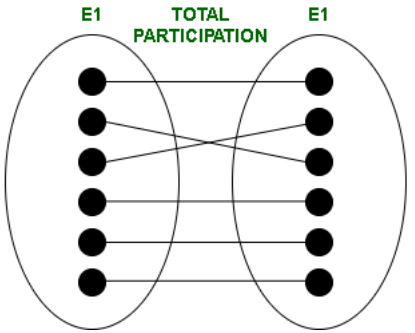
A single record in table A can be related to one or more records in table B, and vice versa.



Ex. An emp. Uses several cars, a car can be used by several employees. Student-Club, order-products.

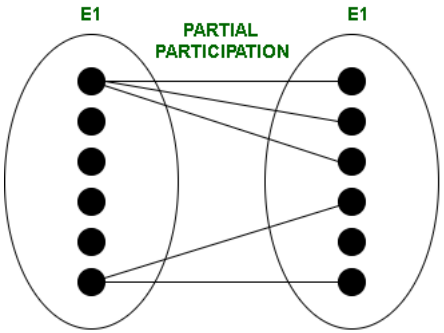
Relationships (cont.)

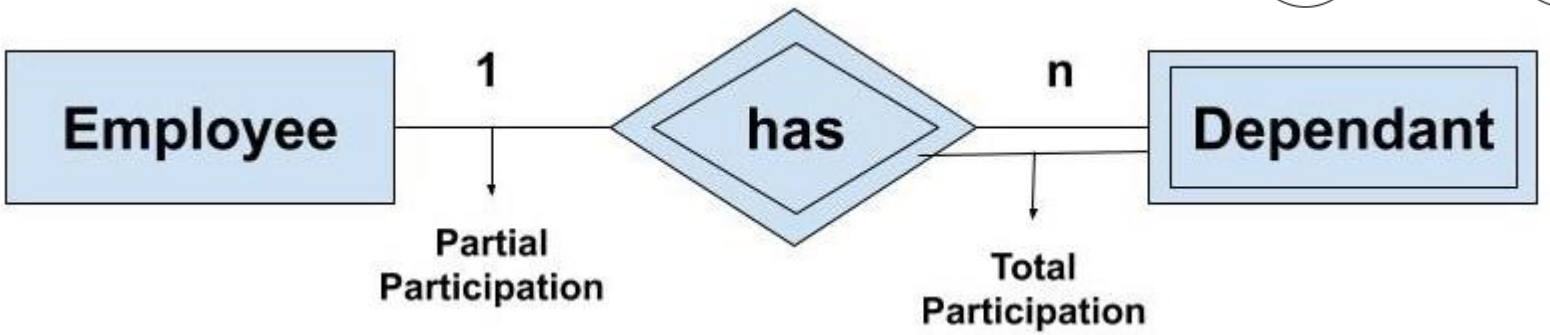
- **Participation Constraints (opposite of cardinality)**
  - Represent **minimum** number of relationships that can occur with these instance .
  - **Total** Participation – **Each Row is involved** in the relationship. Total participation is represented by **double lines**.



Relationships (cont.)

- **Participation Constraints**
  - **Partial participation** − Not all Rows are involved in the relationship. Partial participation is represented by **single lines.**

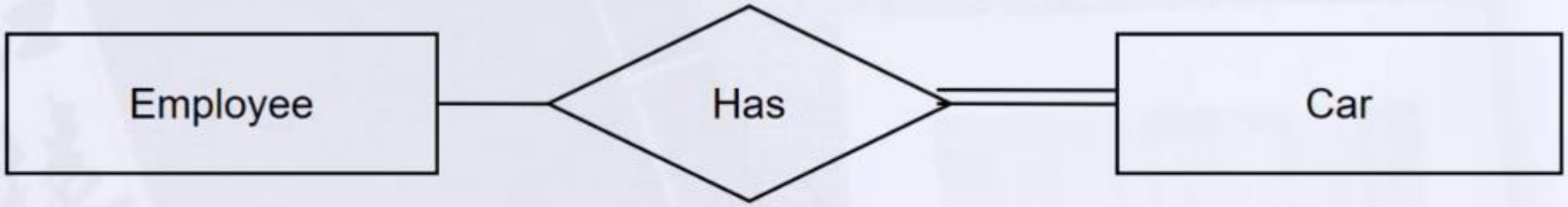




Any weak entity must be totally Participation

Relationships (cont.)

-An Employee may have a car.
-A Car must be assigned to particular employee



-An Employee may have a car.
-A Car must be assigned to particular employee

Relationships (cont.)

- A department may hire many employees (Zero or more)
- An employee must be employed by a department
(Department membership is Optional, Employee membership is Mandatory)

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- An employee must be employed by a department
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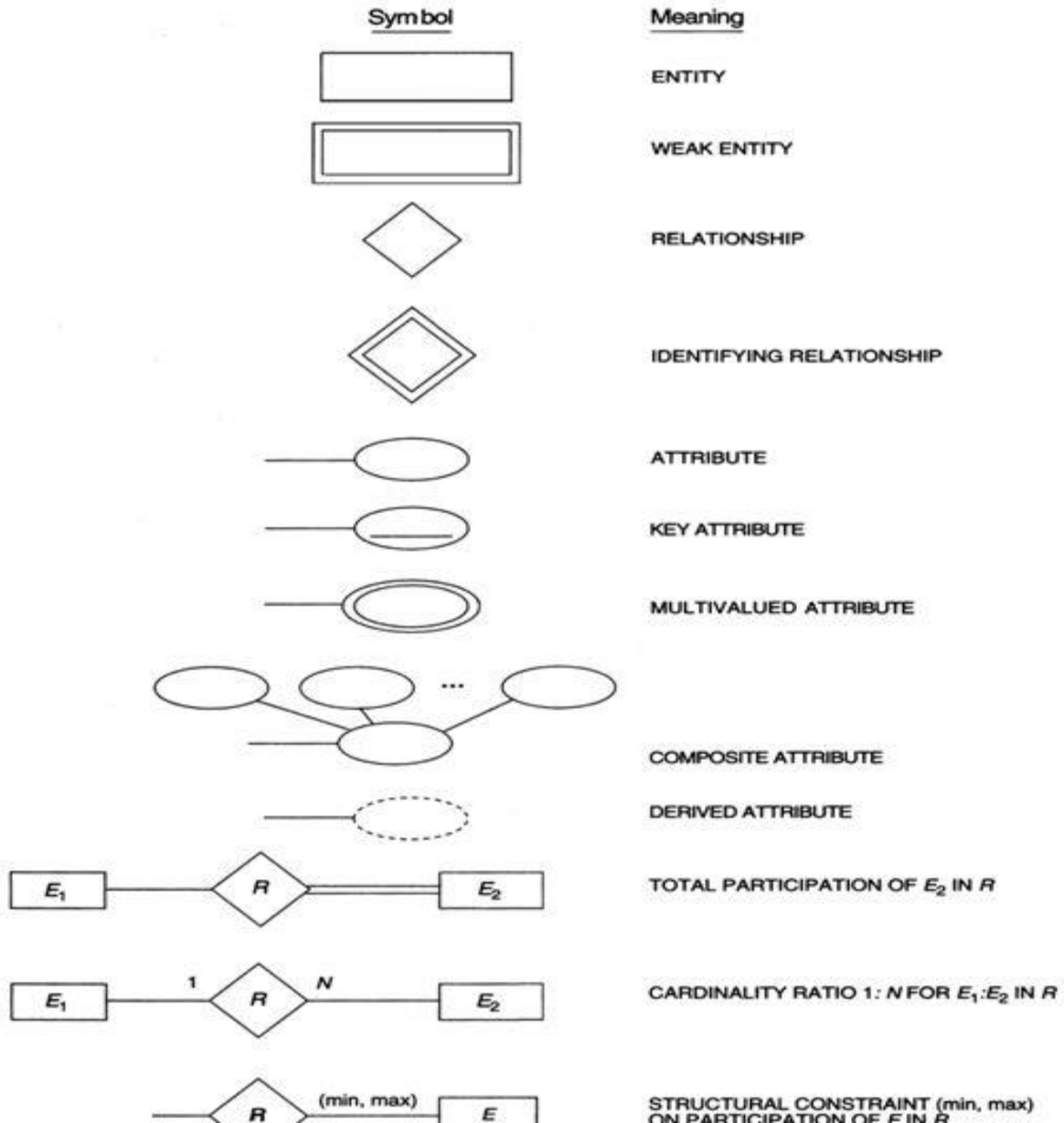
Summary of the Notation for ER Diagrams



Entity Relationship Modeling

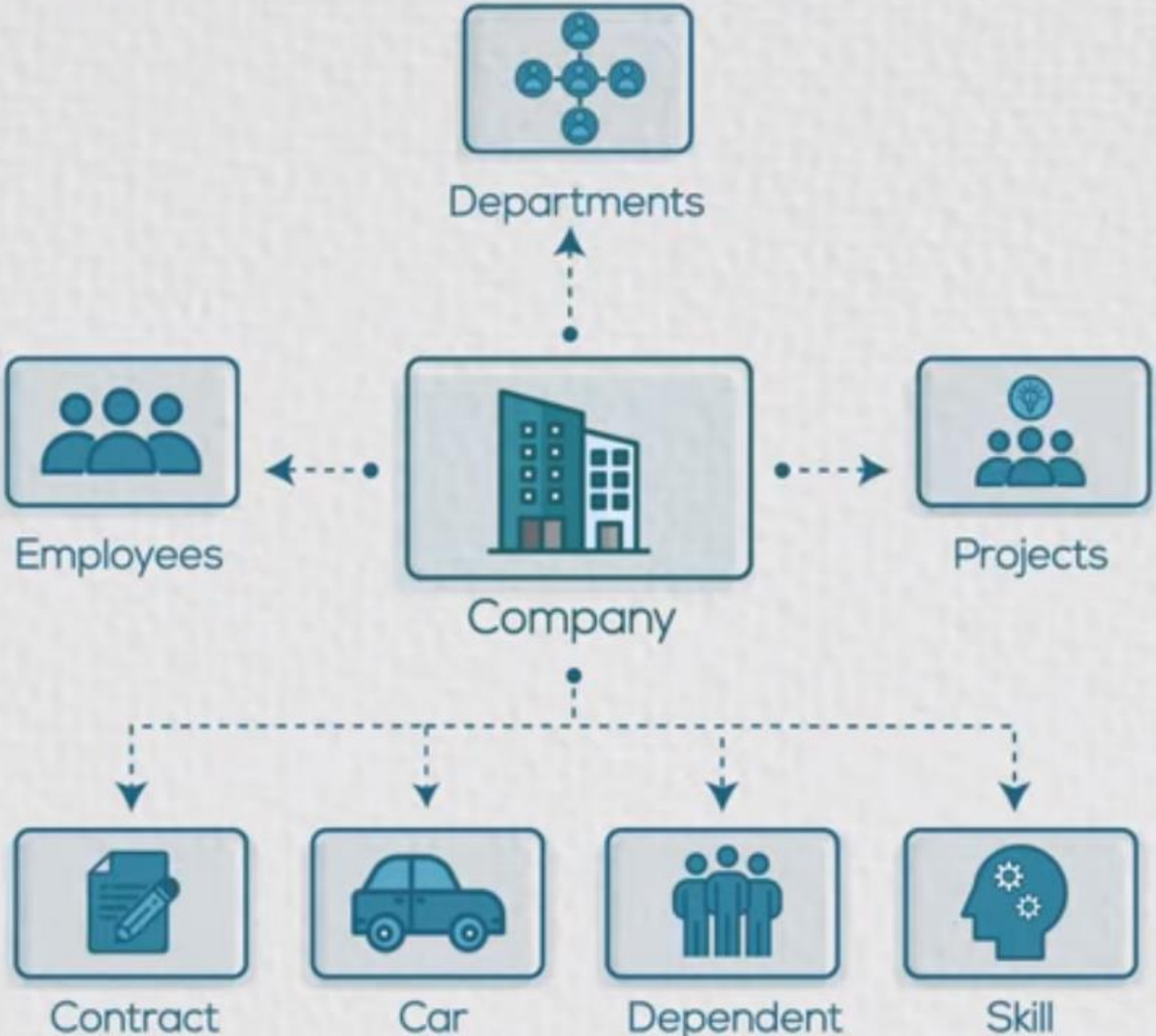
- In building a data model a number of questions must be addressed:

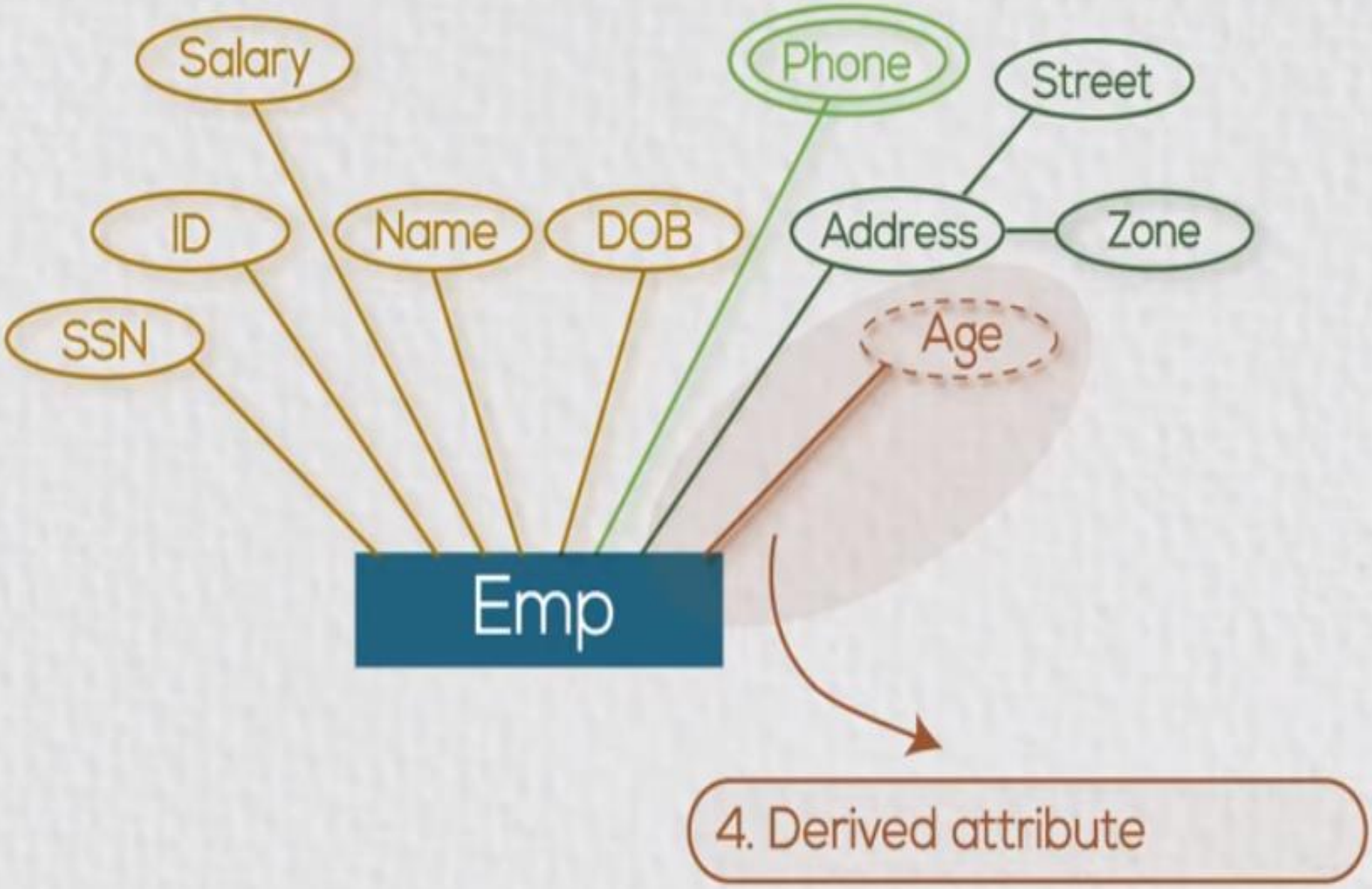
1- What entities need to be described in the model?

2- What characteristics or attributes of those entities need to be recorded?

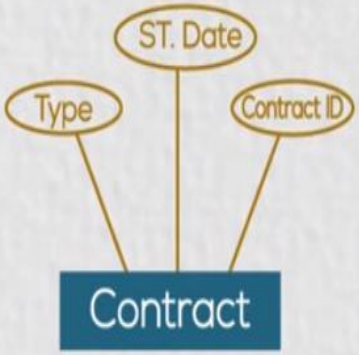
3- Can an attribute or a set of attributes be identified that will uniquely identify one specific occurrence of an entity?

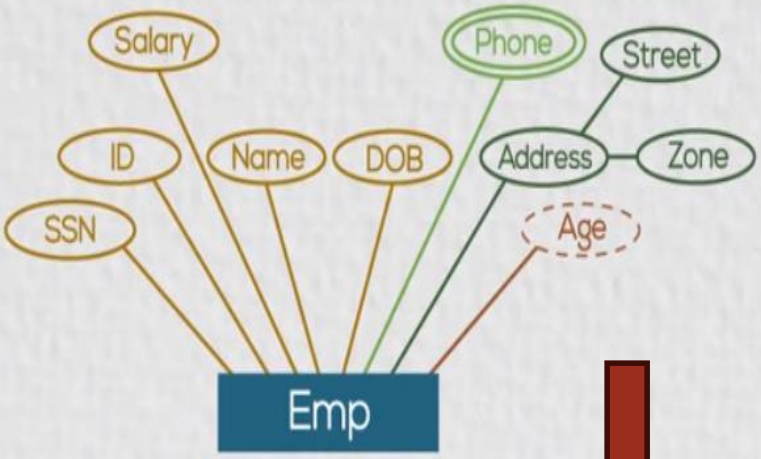
4- What associations or relationships exist between entities?

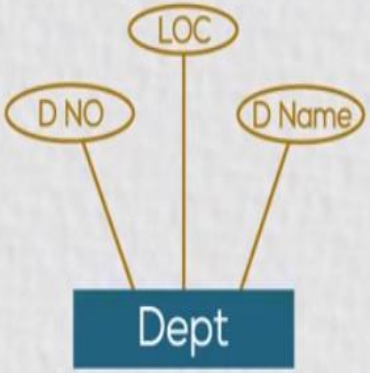

Departments
Employees
Company
Projects
Contract
Car
Dependent
Skill

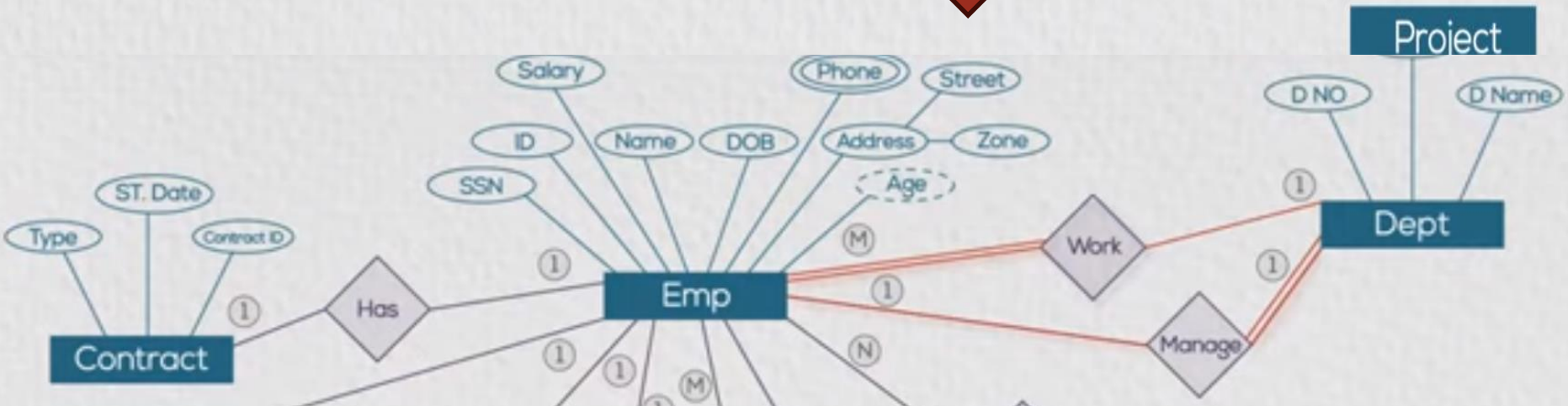

Salary
Phone
Street
ID
Name
DOB
Address
Zone
SSN
Age
Emp
4. Derived attribute

3- Can an attribute or a set of **attributes** be identified that will **uniquely** identify one specific occurrence of an entity?









An Example

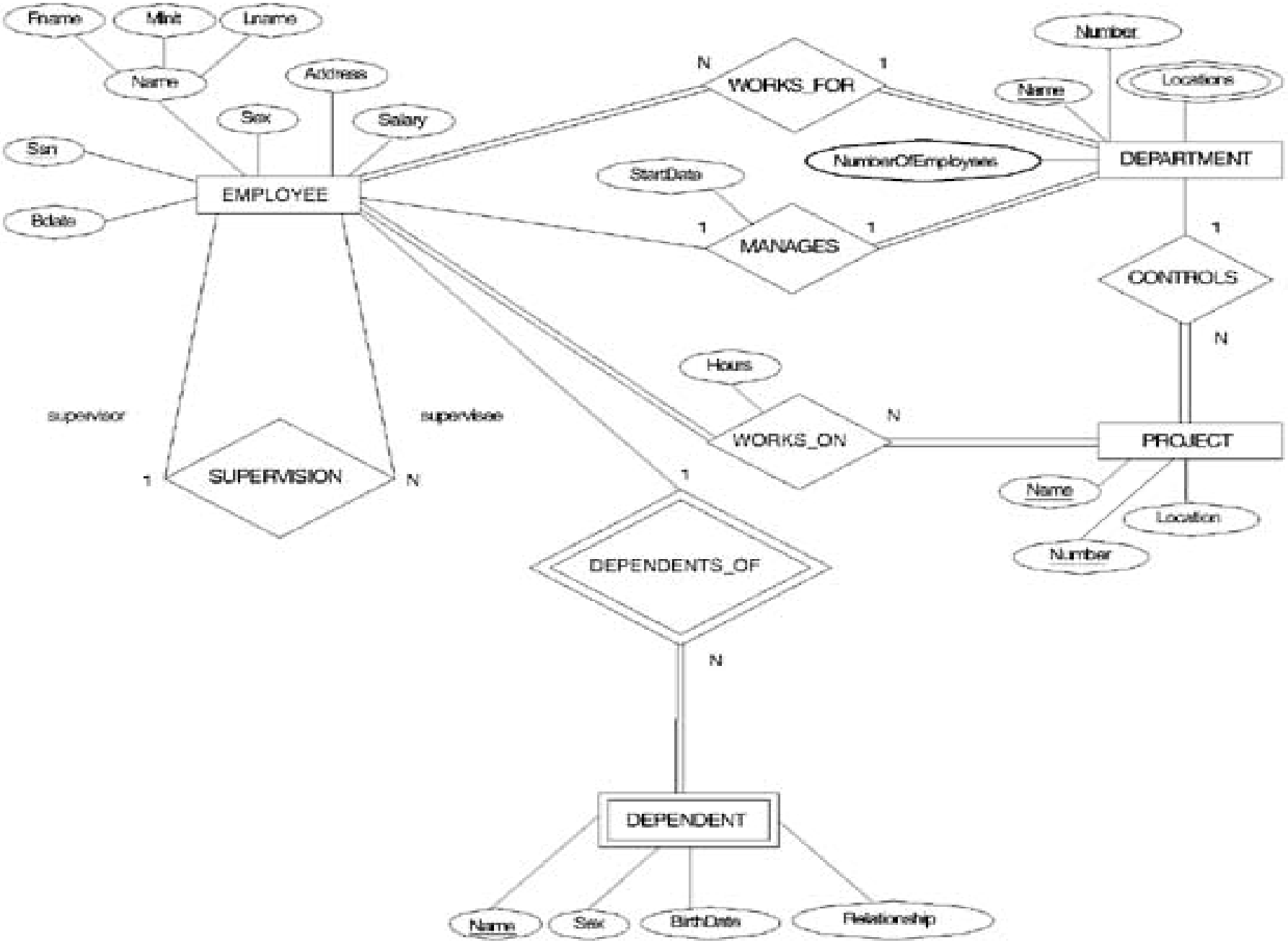
- A company is organized into departments. Each department has a unique name, a unique number, and a particular employee who manages the department. A department may have several locations.

- A department may control a number of projects, each of which has a unique name, a unique number, and a single location. A project must controlled by department

An Example (Cont'd)

- We store employee's name, social security number, address, salary, gender and birth date. An employee must be assigned to one department and must work on one or more 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.

- We want to keep track of the dependents of each employee for insurance purposes. We keep each dependent's first name, gender, birth date and relationship to that employee.


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
WORKS_ON
N
PROJECT
Name
Location
Number
supervisor
supervisee
1
SUPERVISION
N
1
DEPENDENTS_OF
N
DEPENDENT
Name
Sex
BirthDate
Relationship

ERD Case Study

- An organization makes many models of cars, where a model is characterized by a unique name and a suffix (such as GL or XL) and an engine size.
- Each model is made up from many parts and Each part has a description , an id code, production year, and many images.
- each part may be used in the manufacturing of more than one model

ERD Case Study

- Each model must be produced at just one of the firm's factories, which are located in London, Birmingham, Bristol, Wolverhampton and Manchester - one in each city. Each factory has number of machines, capacity, and computer system used (OS , DBMS, Internet).

- A factory produces many models of cars and many types of parts.

ERD Case Study 2

- A country bus company owns a number of buses. A bus is characterized by number, No. of Chairs, Options (AC , Automatic, PS) , and brand-name
- Each bus is allocated to a particular route, although some routes may have several buses . Each route is described by KM, start point, end point and the duration.

ERD Case Study 2

- Each route can passes through a number of towns.
- A town may be situated along several routes. We keep track of unique name and station names in each town.
- One or more drivers are allocated to one route during a period of time. The system keep information about the driver name , mobile number , hire date, basic salary , job grade.
- The system keep information about any changes in the allocations of the drivers to the routes.

ERD Narrative: Lab

- A database for a banking system is used to control withdrawal, deposit and loan transactions with customers.
- Banks which use this system have many branches; each branch has a unique name, unique address and phone.
- The system stores information about customers as unique customer ID, name, address, and phones.

ERD Narrative (Cont'd)

- Each customer has one Account identified by unique Account number, amount, last transaction date (Day, Month and Year).
- The system records Transaction number, Transaction type, Transaction date, Transaction amount and time. The system records the branch name where the transaction occurred.
- A Customer can make any type of transactions (Withdrawal or Deposit) from any branch of the bank.

Questions ?

Exercises