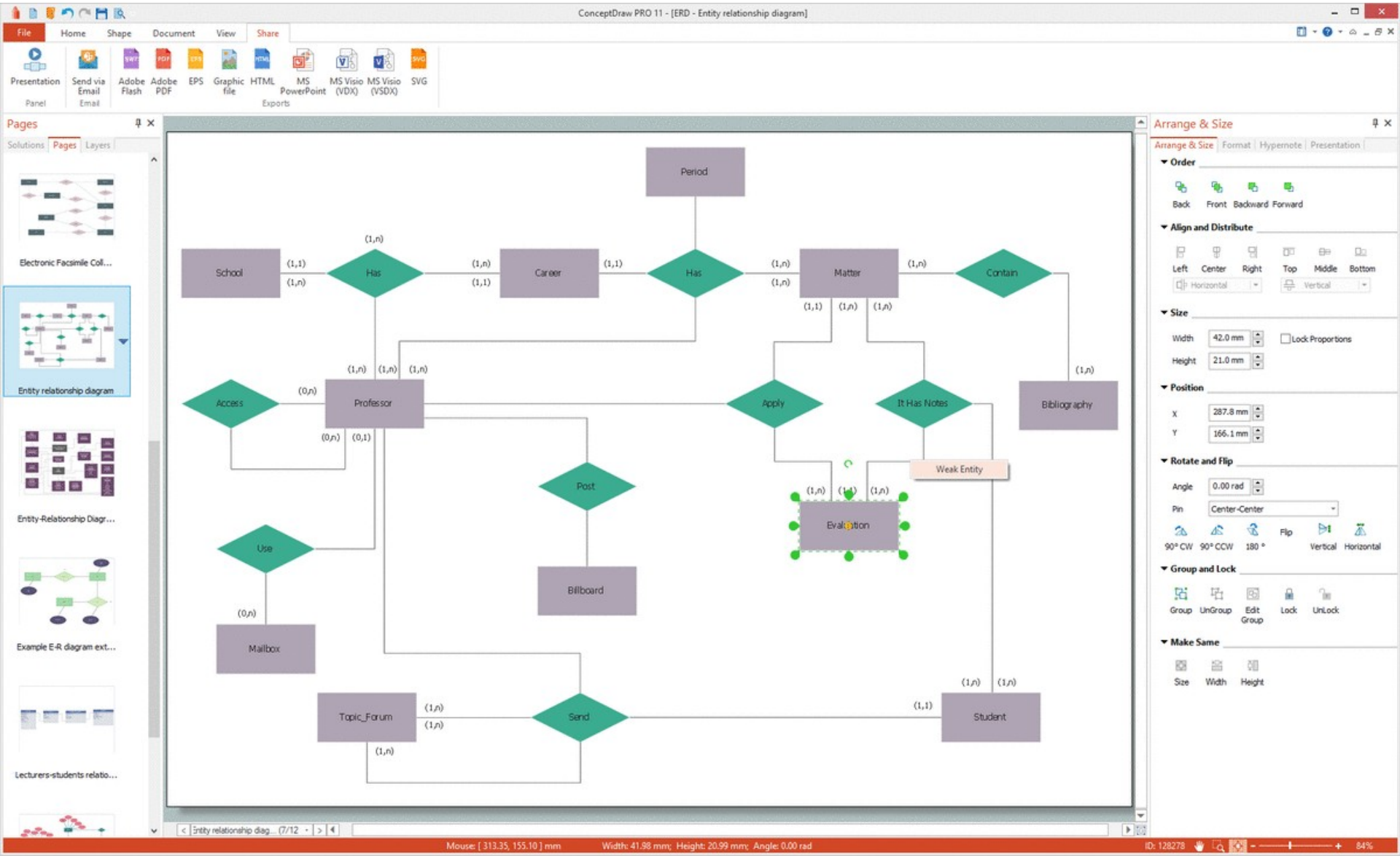
ConceptDraw PRO 11 - [ERD - Entity relationship diagram]
File
Home
Shape
Document
View
Share
Presentation
Send via Email
Adobe Flash
Adobe PDF
EPS
Graphic file
HTML
MS PowerPoint
MS Visio (VDX)
MS Visio (VSDX)
SVG
Panel
Email
Exports
Pages
Solutions
Pages
Layers
Electronic Facsimile Coll...
Entity relationship diagram
Entity-Relationship Diagr...
Example E-R diagram ext...
Lecturers-students relatio...
Period
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Has
Career
Has
Matter
Contain
Bibliography
Access
Professor
Apply
It Has Notes
Weak Entity
Evaluation
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Use
Billboard
Mailbox
Topic_Forum
Send
Student
(1,n)
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(0,1)
Arrange & Size
Arrange & Size
Format
Hypernote
Presentation
Order
Back
Front
Backward
Forward
Align and Distribute
Left
Center
Right
Top
Middle
Bottom
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Vertical
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42.0 mm
Height
21.0 mm
Lock Proportions
Position
X
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Y
166.1 mm
Rotate and Flip
Angle
0.00 rad
Pin
Center-Center
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90° CCW
180 °
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Vertical
Horizontal
Group and Lock
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Entity relationship diag... (7/12
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84%

Recap

- Check syllabus
- Sign on Piazza (piazza.com/iastate/spring2020/coms363)
- Course improvement project: call for participants

Database History

- What do you visualize when you hear the term “database”?
- Spreadsheet like Excel table (1982), google sheet (2006)?
- Several spreadsheets?

Why not spreadsheet?

- You have a registration sheet
- Your instructors also have registration sheets
- You change yours
- Your instructors should be “informed”
- Management is a problem

Why not spreadsheet?

- Size matters
  - Out of memory
- Security features
  - You can’t see other students’ records

Data Model History

- Navigational (60’s)
  - linked list of free-form records
  - Hard to implement, but if you can implement it well, it has high performance
- Relational (80’s, proposed in 1970)
  - Remain dominant
  - "table" of fixed-length records, with each table used for a different type of entity
- Post-relational
  - Object-oriented (90’s)
  - NoSQL (late 2000)

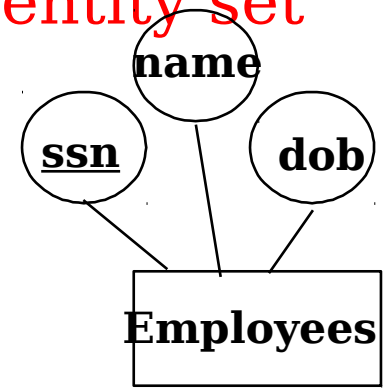
Database Design

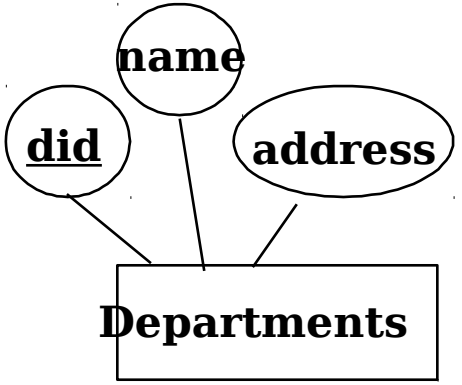
- Before we can design a database to represent a mini-world, we need to understand what this mini-world is about
- If we can get these two questions answered, we have a rather good understanding
  1. What entities does this mini-world have?
  2. What relationships exist among these entities?

Entity-Relationship (ER) model is a high level conceptual data model

Basic terms and notations

- An entity is a uniquely identifiable object that exists on its own (e.g., an employee, a department)
- Entities have attributes
- An attribute is a key attribute if its values are distinct for each individual entity.
- Similar entities (having same attributes) form an entity set

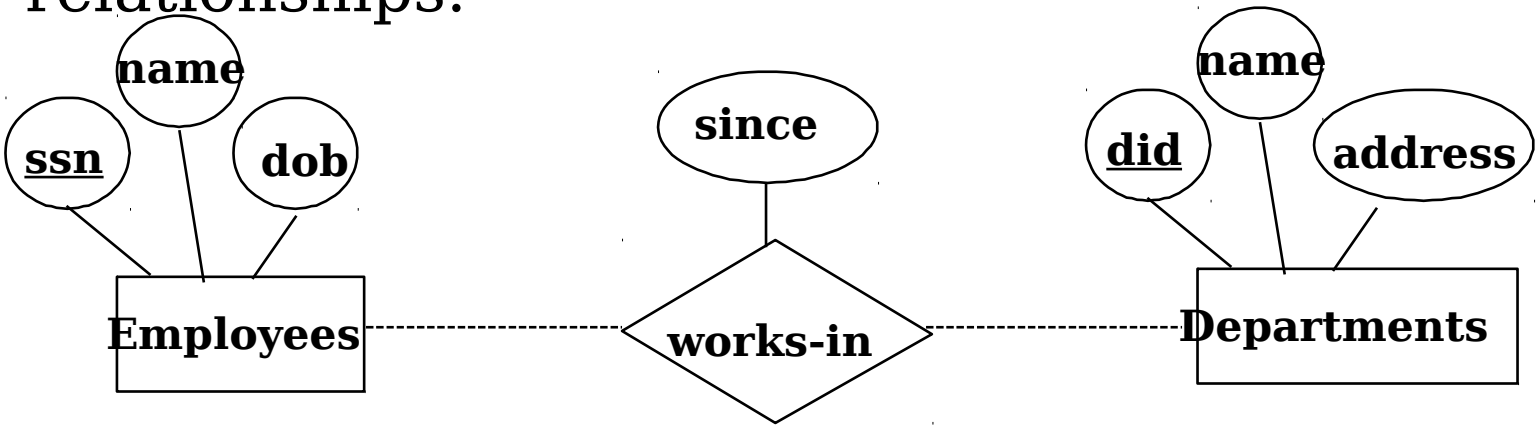




Notation

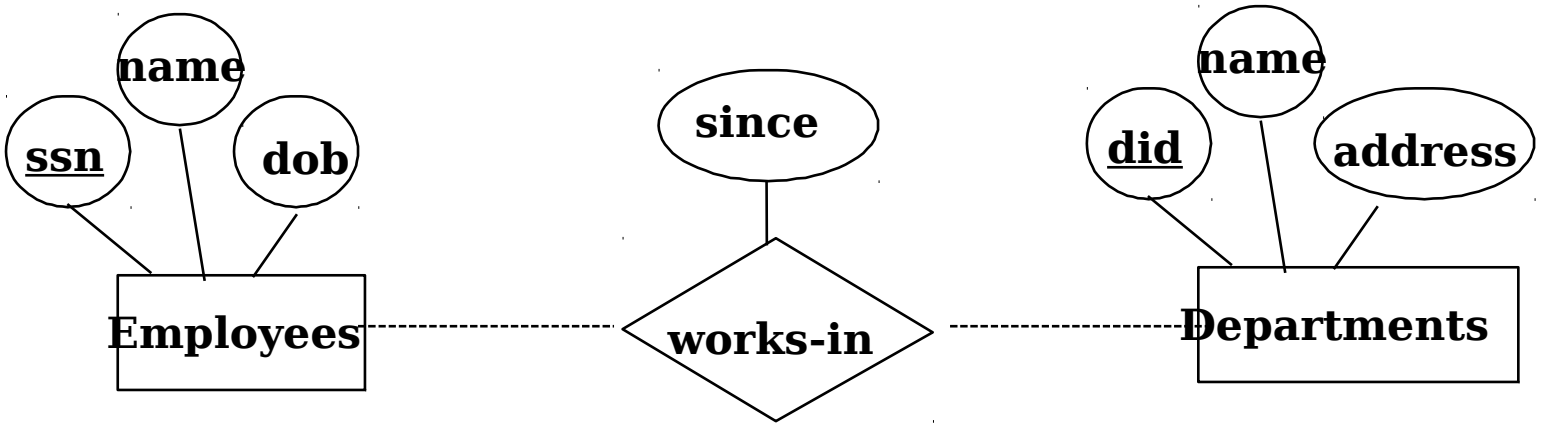
- an entity set : a rectangle
- an attribute: a circle and a line connected to a rectangle
- a key attribute: underlined

- Relationship: Association among two or more entities.
  - Example: Attishoo works in the Pharmacy department.
- Relationship Set: Collection of similar relationships.



Notation

- a relationship set is represented by a diamond
  - Every participating entity is connected to it by a dotted edge
  - Every attribute is also connected to it by an edge
- an attribute: a circle and a line connected to a rectangle

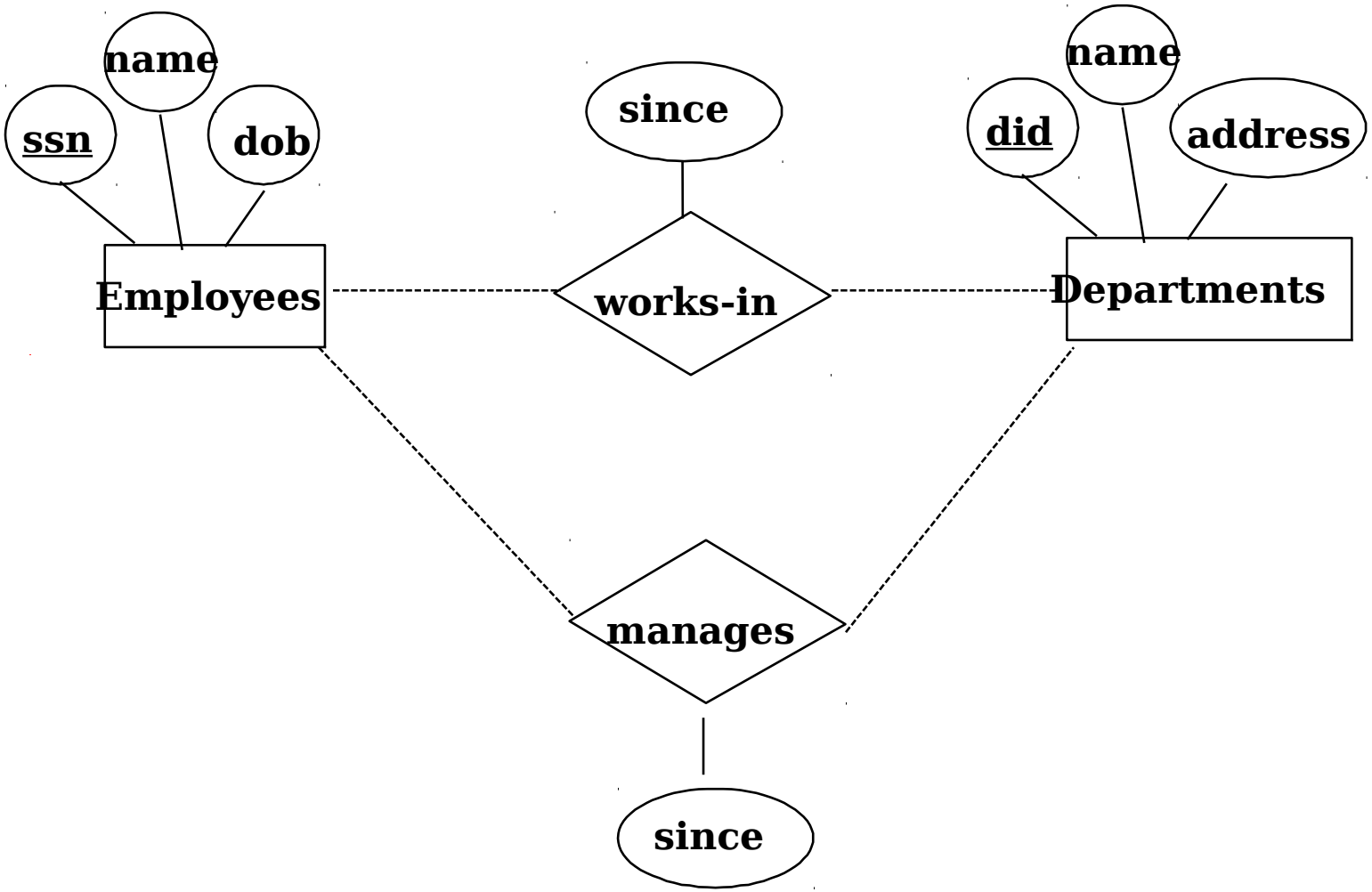


e1
e2
e3
e4
e5

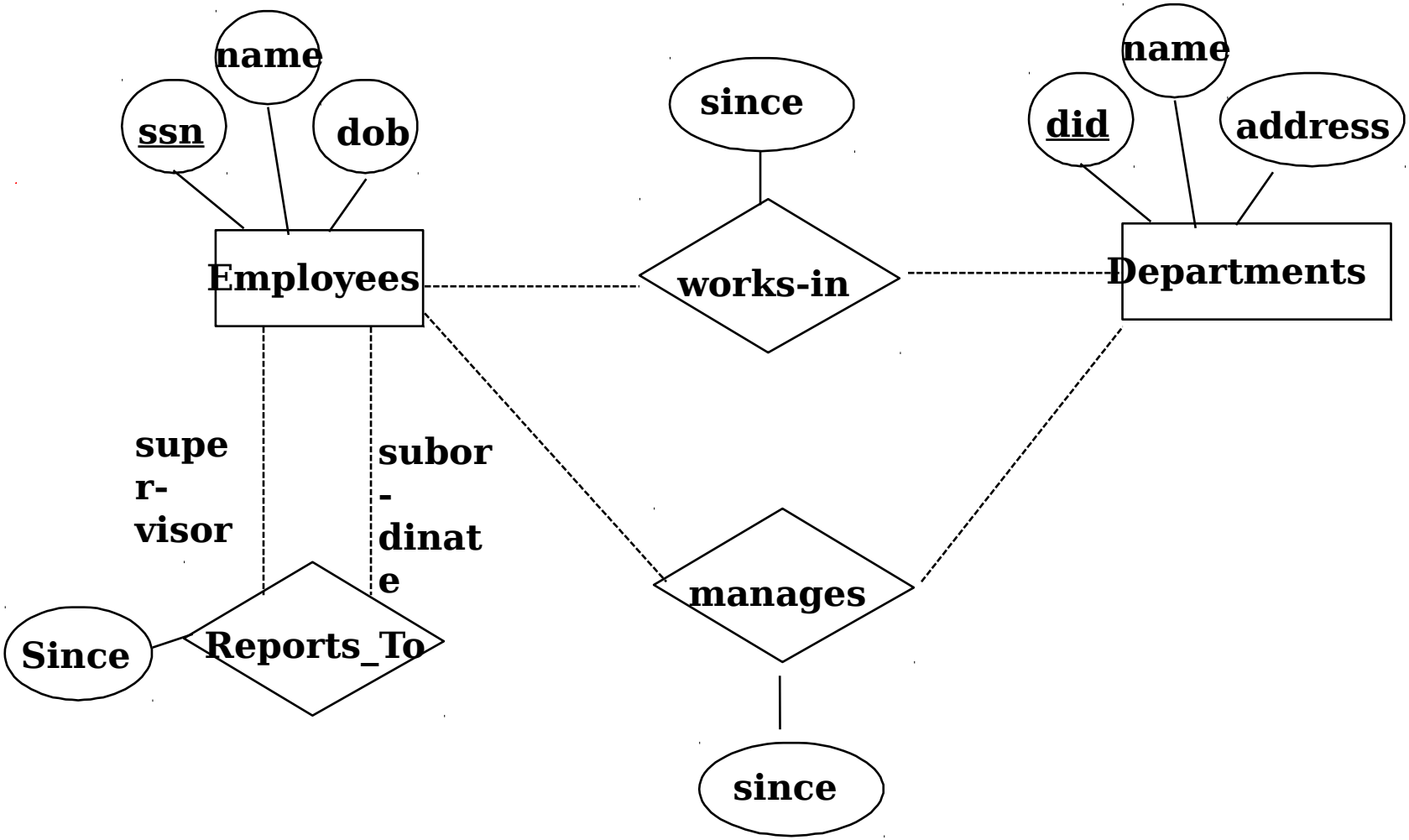
e1, d1, 01/01/1998
e3,d3, 01/05/1985

d1
d2
d3

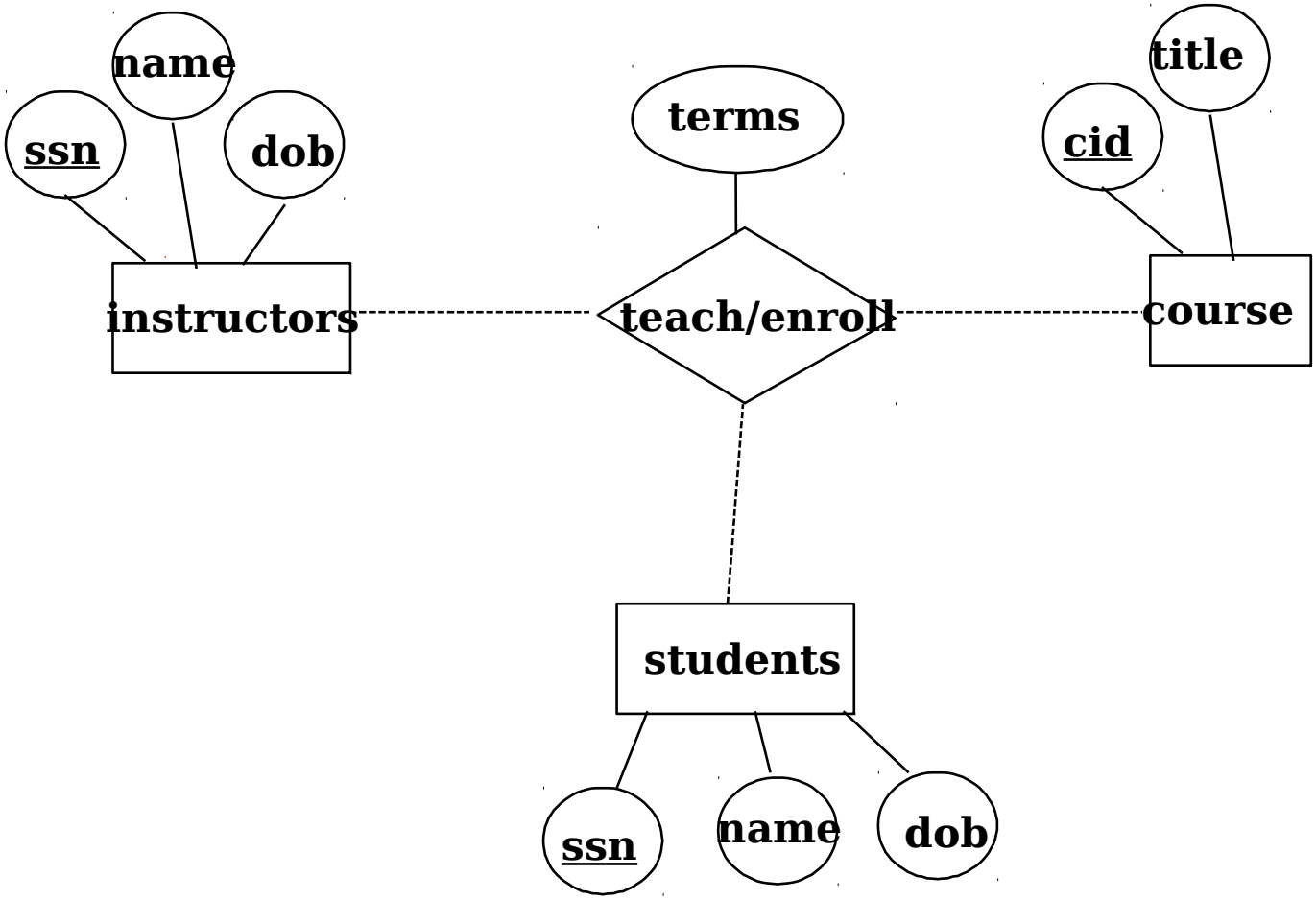
two entity sets may have different relationships



Entities in a same set can participate in some relationship



more than two entity sets may participate in a same relationship set



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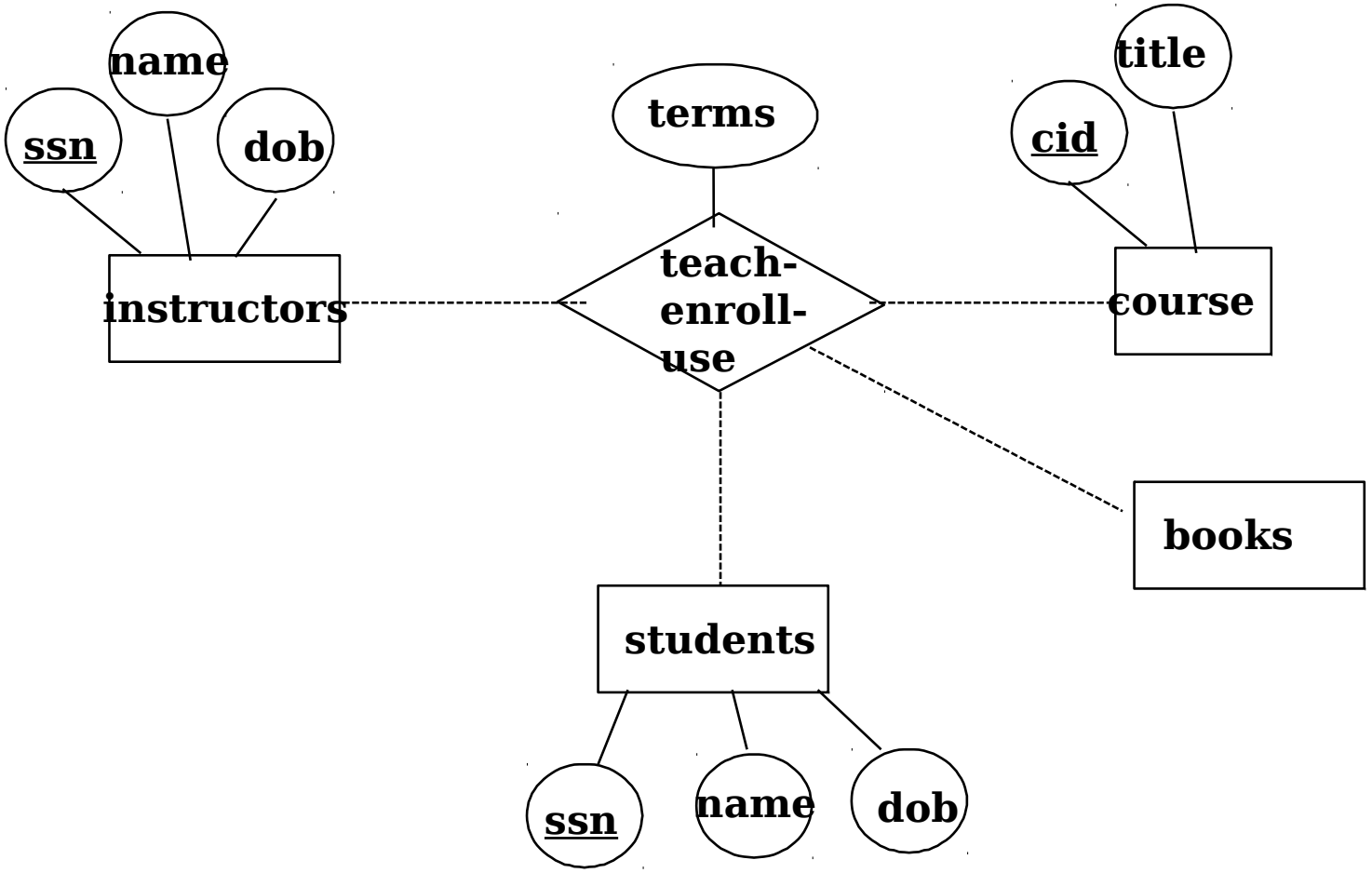

So far, only two notations E and R, but they are so powerful in describing a “world”. When designing a database, think about these two questions

1) What entities it has
2) What relationships exist among these entities

Example: A database for university

1) E: faculty, students, courses, buildings, vehicles, research projects, departments, parking lots ...
2) R: A faculty teaches some students in buildings...

- The two questions are fundamental, but we often need more information and therefore need to ask more questions
- Question 3: Is there any participation constraint on relationships?
  - Uni-participation: An entity can participate in a relationship at most once
  - Total-participation: Every entity in an entity set must participate in a relationship
  - A combination of both: Every entity in an entity set must participate in a relationship but only once

Uni-participation (also called key constraint)

- Each entity in an entity set can participate in at most one relationship in a relationship set
- Notation: u
- If there is no such constraint, then it is called multi-participation, denoted as m

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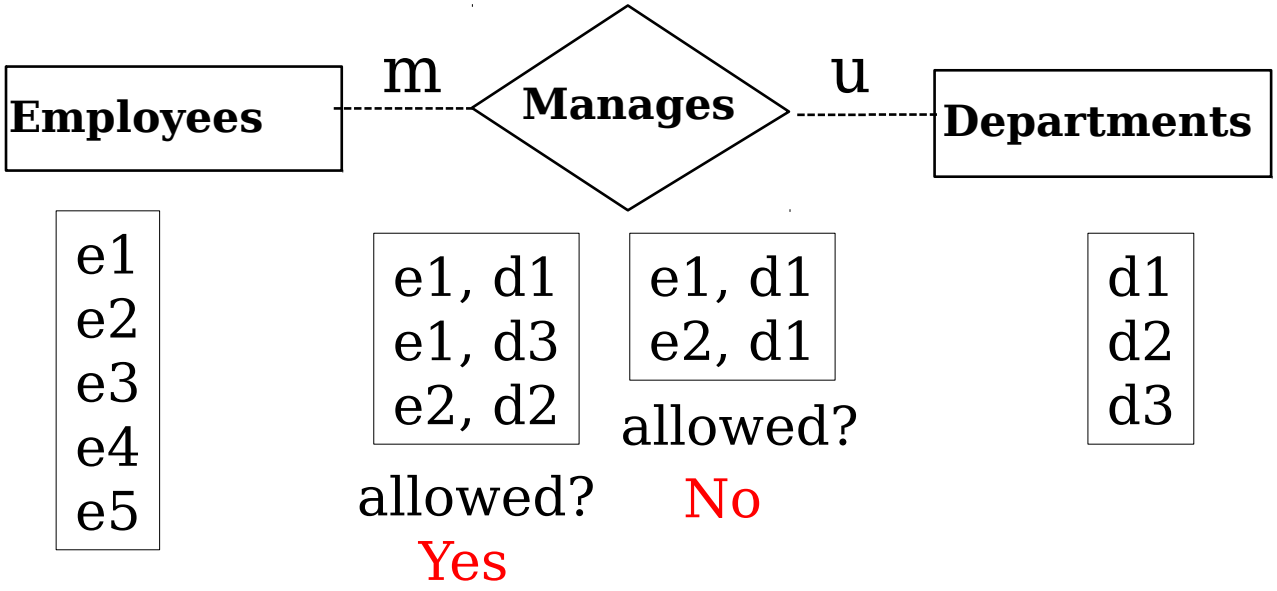
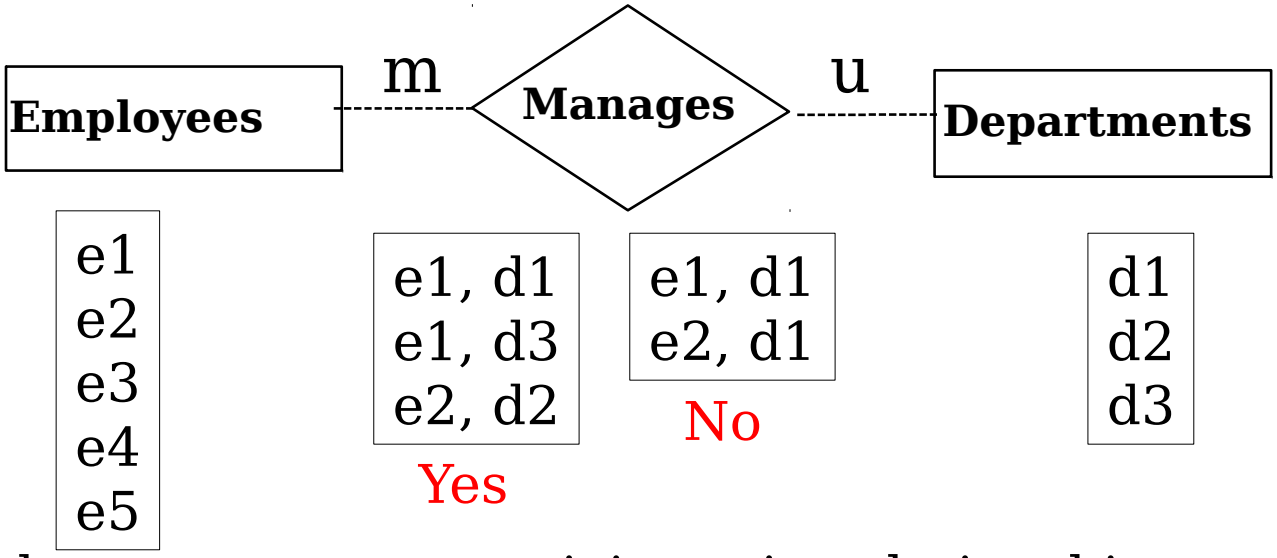


What does this mean?

Uni-participation (also called key constraint)

- Each entity in an entity set can participate in at most one relationship in a relationship set
- Notation: u
- If there is no such constraint, then it is called multi-participation, denoted as m

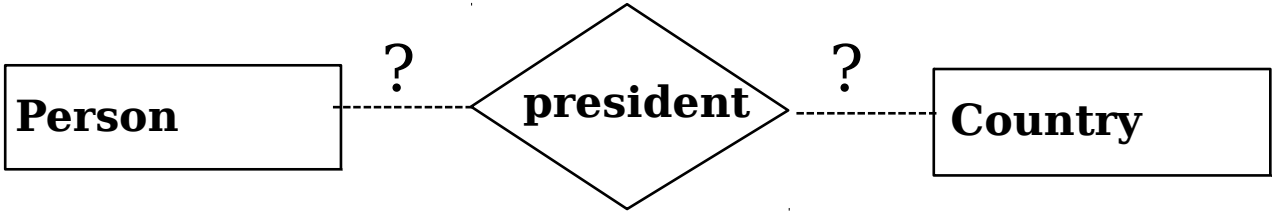


A department can participate in relationship "manages" at most one time

- Every department can have at most one manager (but does not have to)
- Every Employee can manage several departments (but does not have to)

Can you think of another example?

- How about



  - Each person can be president in at most one country?
  - Each country can have at most one president (currently)?
  - Each country can have several presidents (over history)?

Total participation

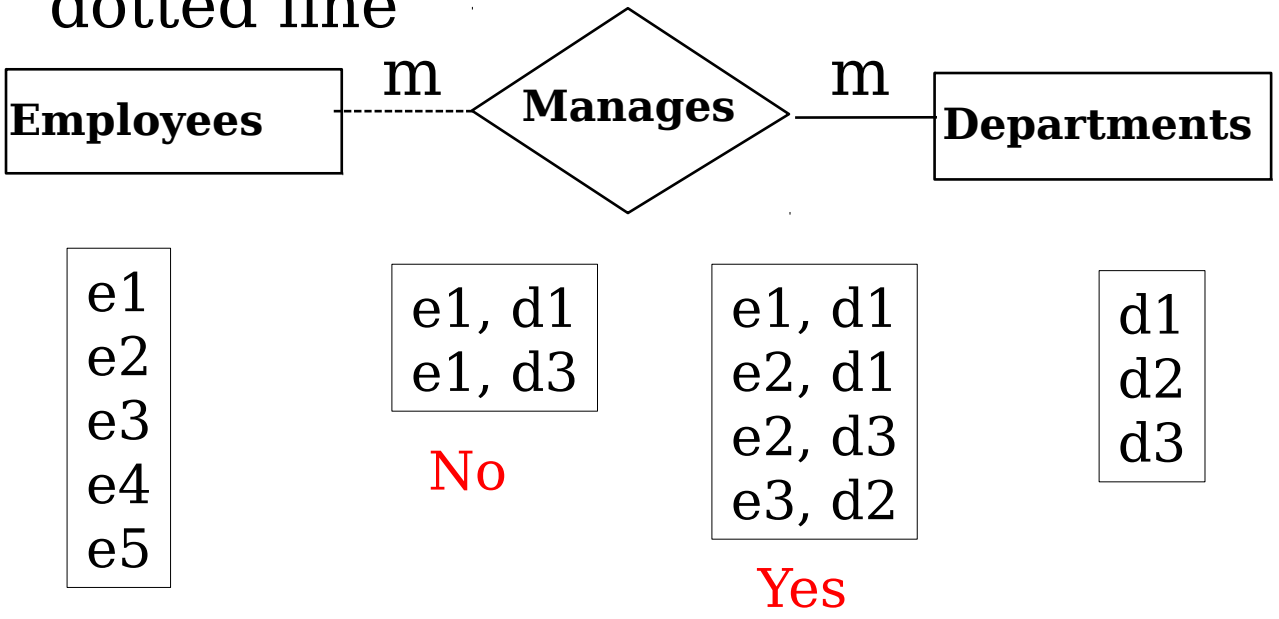
- Every entity in an entity set must participate in a relation set
- Notation: solid line
- If there is no such constraint, then it is called partial-participation, denoted as dotted line

e1 e2 e3 e4 e5	e1, d1 e1, d3	e1, d1 e2, d1 e2, d3 e3, d2	d1 d2 d3
	allowed? No	allowed? Yes	

What does this mean?

Total participation

- Every entity in an entity set must participate in a relation set
- Notation: solid line
- If there is no such constraint, then it is called partial-participation, denoted as dotted line

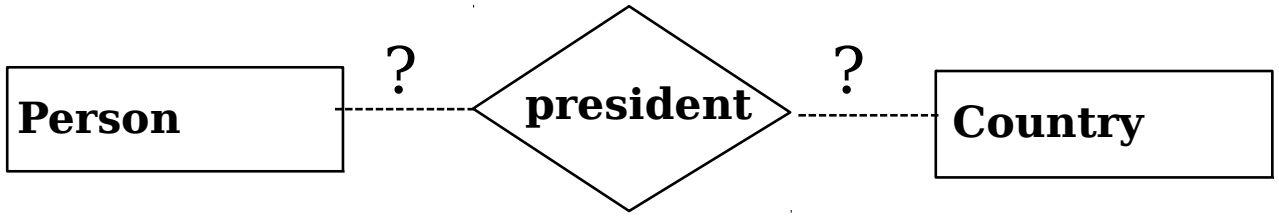


Every department must participate in relationship "manages"

 Every department must have at least one manager

Can you think of another example?

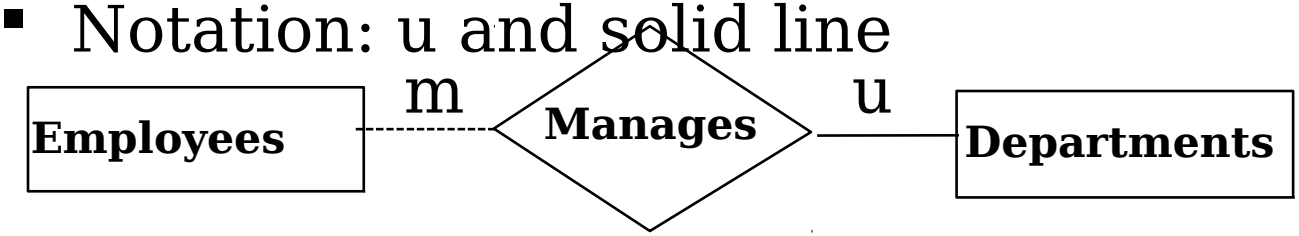
- How about



  - Each person can be president in at most one country?
  - Each country can have at most one president (currently)?
  - Each country can have several presidents (over history)?

Uni-participation and total participation

- Every entity in an entity set must participate in a relation set and participate only once
- Notation: u and solid line



e1 e2 e3 e4 e5	e1, d1 e1, d3	e1, d1 e2, d3 e3, d2	d1 d2 d3

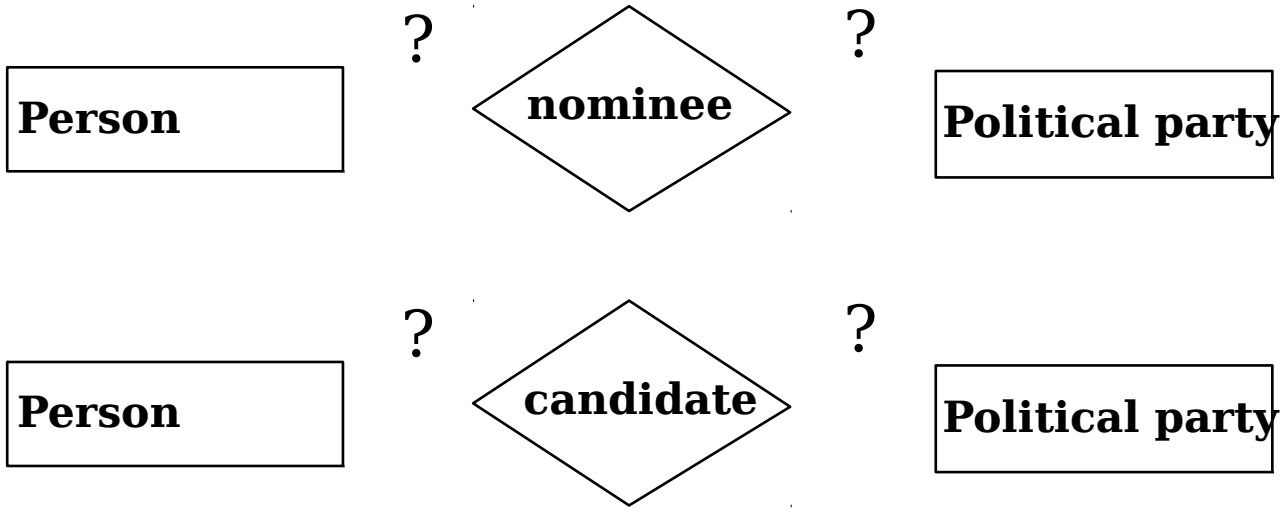
which one allowed?

Every department must participate in relationship "manages" and only once

⇒Every department must have one and only one manager

Can you think of another example?

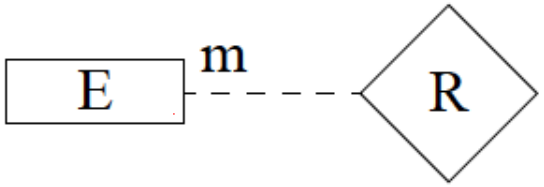
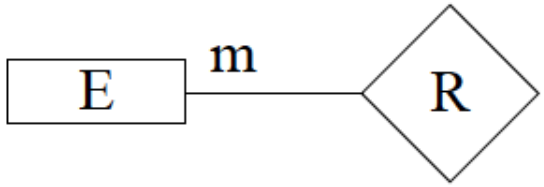
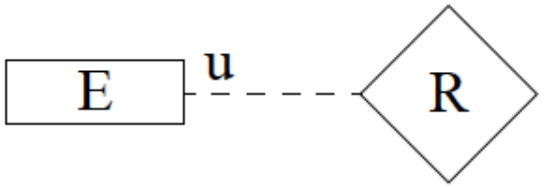
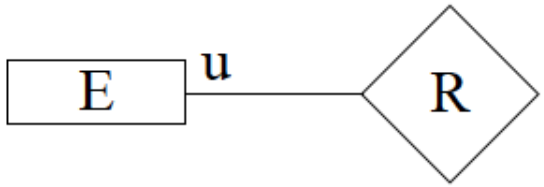
- How about



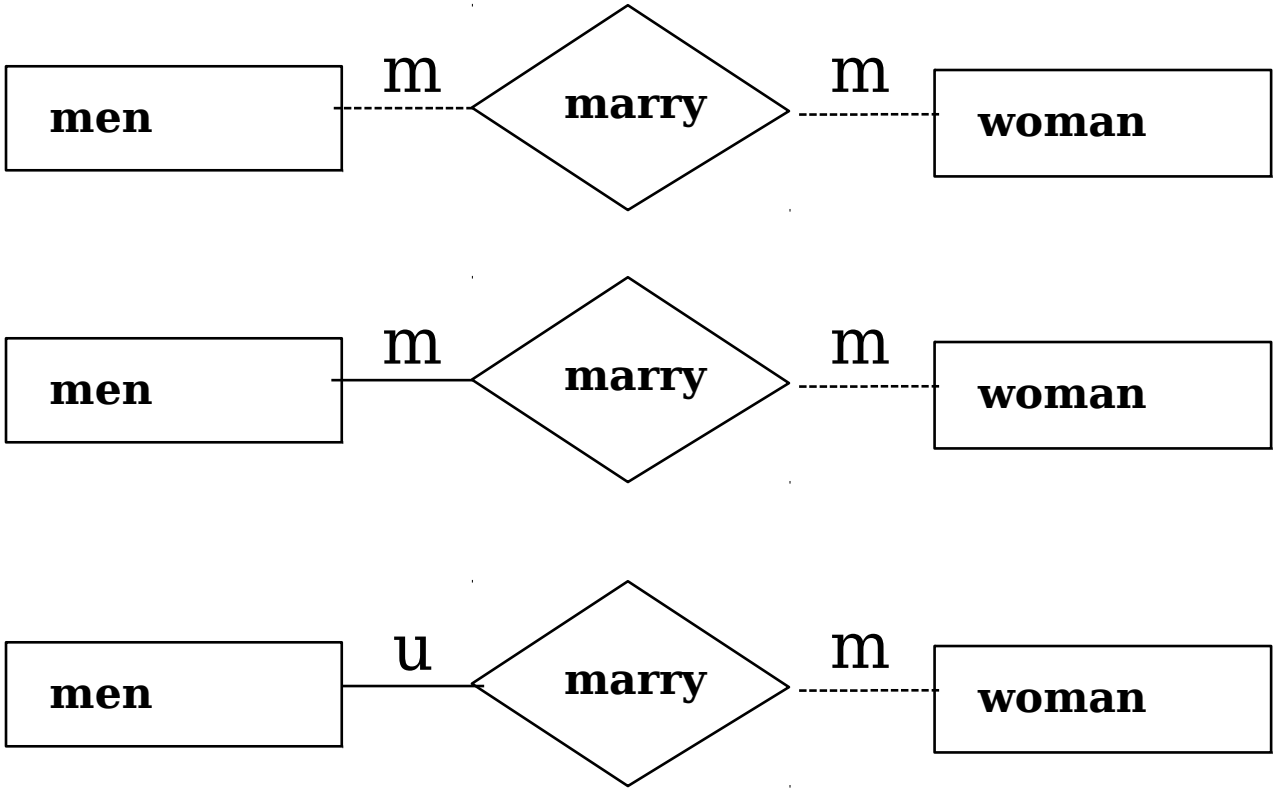
  - Suppose only “Republican” and “Democratic” for “Political party”

Partial vs.total participation: shown by dotted vs. solid edges

Multi vs. uni participation: shown by labels “m” vs. “u”
“m” for multi or many; “u” for uni or unique

	Partial (Dotted)	Total (Solid)
Multi (“m”)	 Key(E) cannot be key of R Some E may not occur in R	 Key(E) cannot be key of R Every E occurs in R
Uni (“u”)	 Key(E) is a key of R Some E may not occur in R	 Key(E) is a key of R Every E occurs in R

More examples



A quick review

- What does E have?
- What does R have?
- Any constraints on R?
  - Uni-participation vs. multi-participation
  - Total-participation vs. partial-participation

A quick review

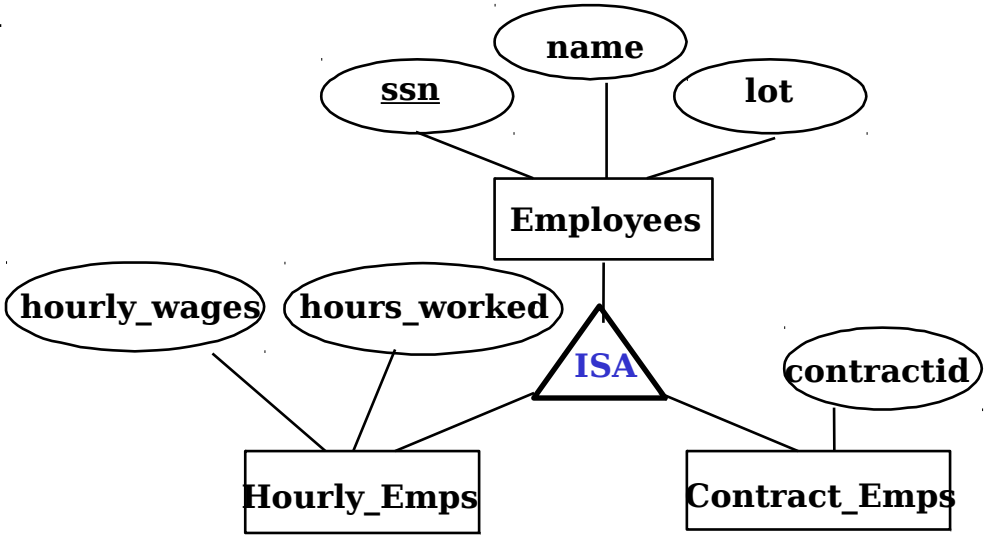
- Q1: What does E have?
- Q2: What does R have?
- Q3: Any constraints on R?
  - Uni-participation vs. multi-participation
  - Total-participation vs. partial-participation

One more question, a special kind of relationship :

Q4: Is there any relationship that is ISA?

ISA (`is a') Hierarchies

- If we declare A **ISA** B, every A entity is also considered to be a B entity.
- Reasons for using ISA:
  - To add attributes specific to a subclass.
  - To identify entities that participate in a relationship.



- Overlap constraints:
  - Can Joe be an Hourly_Emps as well as a Contract_Emps entity? (Allowed/disallowed)
    - Default value: no overlap;
    - Otherwise, write Hourly_Emps OVERLAPS Contract_emps
- Covering constraints:
  - Does every Employees entity also have to be an Hourly_Emps or a Contract_Emps entity? (Yes/no)
    - Default value: no;
    - Otherwise write Hourly_Emps and Contract_Emps COVER Employees

- ER design is *subjective*. There are often many ways to model a given scenario!
- Analyzing alternatives can be tricky, especially for a large enterprise. Common choices include:
  - Entity vs. attribute, entity vs. relationship, binary or n-ary relationship, whether or not to use ISA hierarchies, and whether or not to use aggregation.

- ER diagrams can use different notations, but use the same concept.
- Several software tools are available for creating ER diagrams: IBM Rational Rose, Microsoft Visio

Key Concepts of ER Model

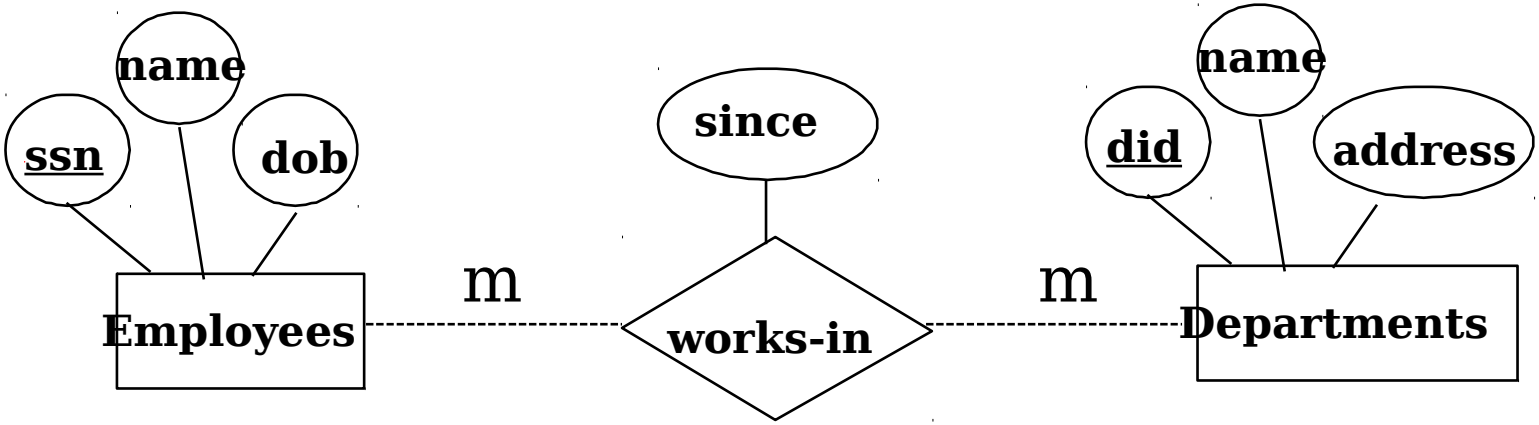
- Entity set
- Relationship set
- Constraints
  - uni-constraint
  - Total participation constraint
- A special kind of relationship: ISA

Question to think

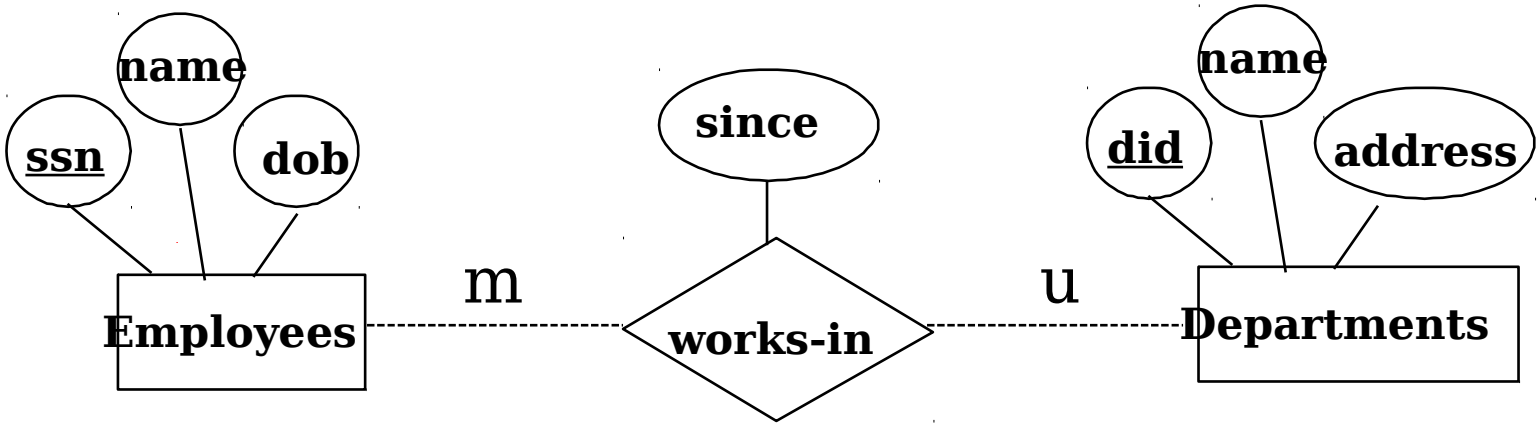
Is there anything that cannot be described by ER model?

E-R Model Exercises

- Read an ER diagram
- Draw an ER diagram



1. Two entity sets:
   - Employees and Departments
2. One relationship set
   - “works-in” between Employees and Departments
3. Constraint
   - An employee can participate in “works-in” one or more times, or does not participate at all
     - multi- and partial participation
   - A department can participate in “works-in” one or more times, or does not participate at all
     - multi- and partial participation



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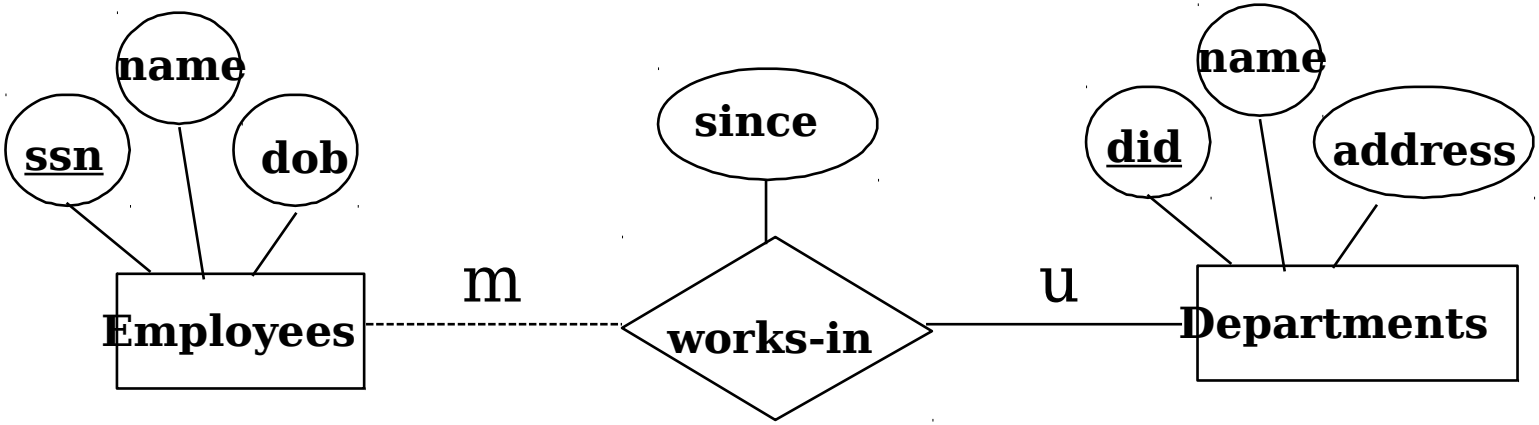
3. Constraint
   - An employee can participate in “works-in” one or more times, or does not participate at all
     - multi- and partial participation
   - A department can participate in “works-in” at most once
     - uni- and partial participation
     - Semantically: a department can have at most one employee



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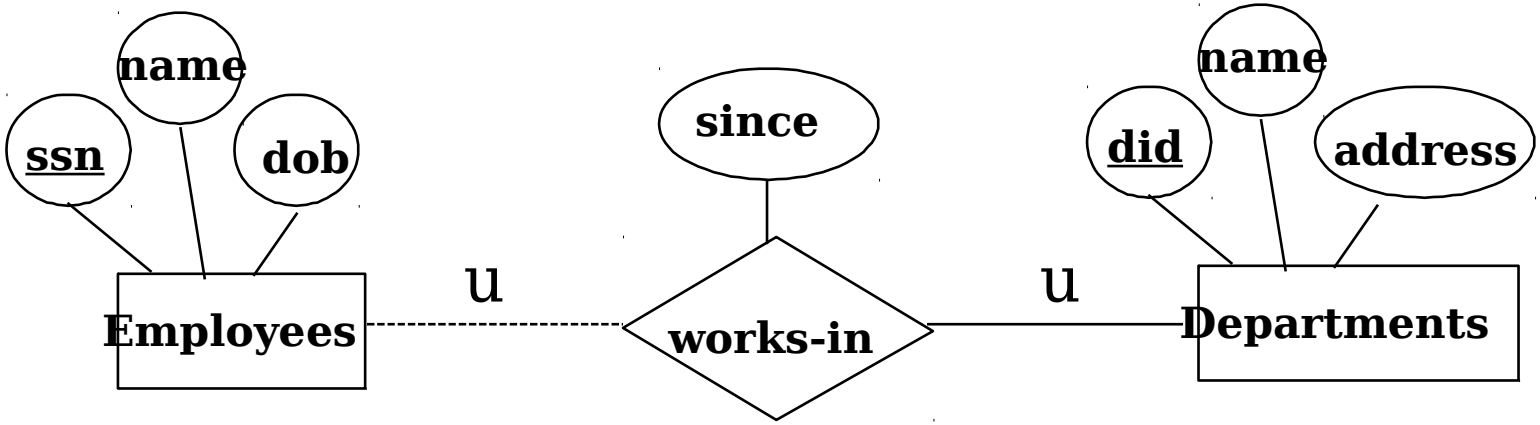
     - uni- and total participation
     - Semantically: a department can have at most one employee and only one employee



1. Two entity sets:
   - Employees and Departments
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3. Constraint
   - An employee can participate in “works-in” at most one time
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     - Semantically: an employee can work in at most one department
   - Every department must participate in “works-in” once and only once
     - uni- and total participation
     - Semantically: a department can have at most one employee and only one employee

Full answer

1. Two entity sets:
   - Employees and Departments
   - Employees have attributes ssn, name and dob. SSN is the key attribute
   - Departments have attributes did, name and address. DID is the key attribute
2. One relationship set
   - “works-in” between Employees and Departments
   - “works-in” has attribute “since”.
3. Constraint
   - An employee can participate in “works-in” at most one time
     - uni- and partial participation
     - Semantically: an employee can work in at most one department
   - Every department must participate in “works-in” once and only once
     - uni- and total participation
     - Semantically: a department can have at most one employee and only one employee

Drawing ER diagram

- What entity sets?
  - attributes, key attribute
- What relationship sets?
  - attributes
  - ISA?
- What constraints?
  - uni- vs. multi-participation
  - total vs. partial participation

Exercise 1

- A company has a number of employees. The attributes of EMPLOYEE include Employee_ID (identifier), Name, Address, and Birthdate.
- The company also has several projects. Attributes of PROJECT include Project_ID (identifier), Project_Name, and Start_Date.
- Each Employee may be assigned to one or more projects, or may not be assigned to a project.
- A project must have at least one employee assigned, and may have any number of employees assigned.
- An employee's billing rate may vary by project, and the company wishes to record the applicable billing rate (Billing_Rate) for each employee when assigned to a particular project.

Exercise 1

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Exercise 1

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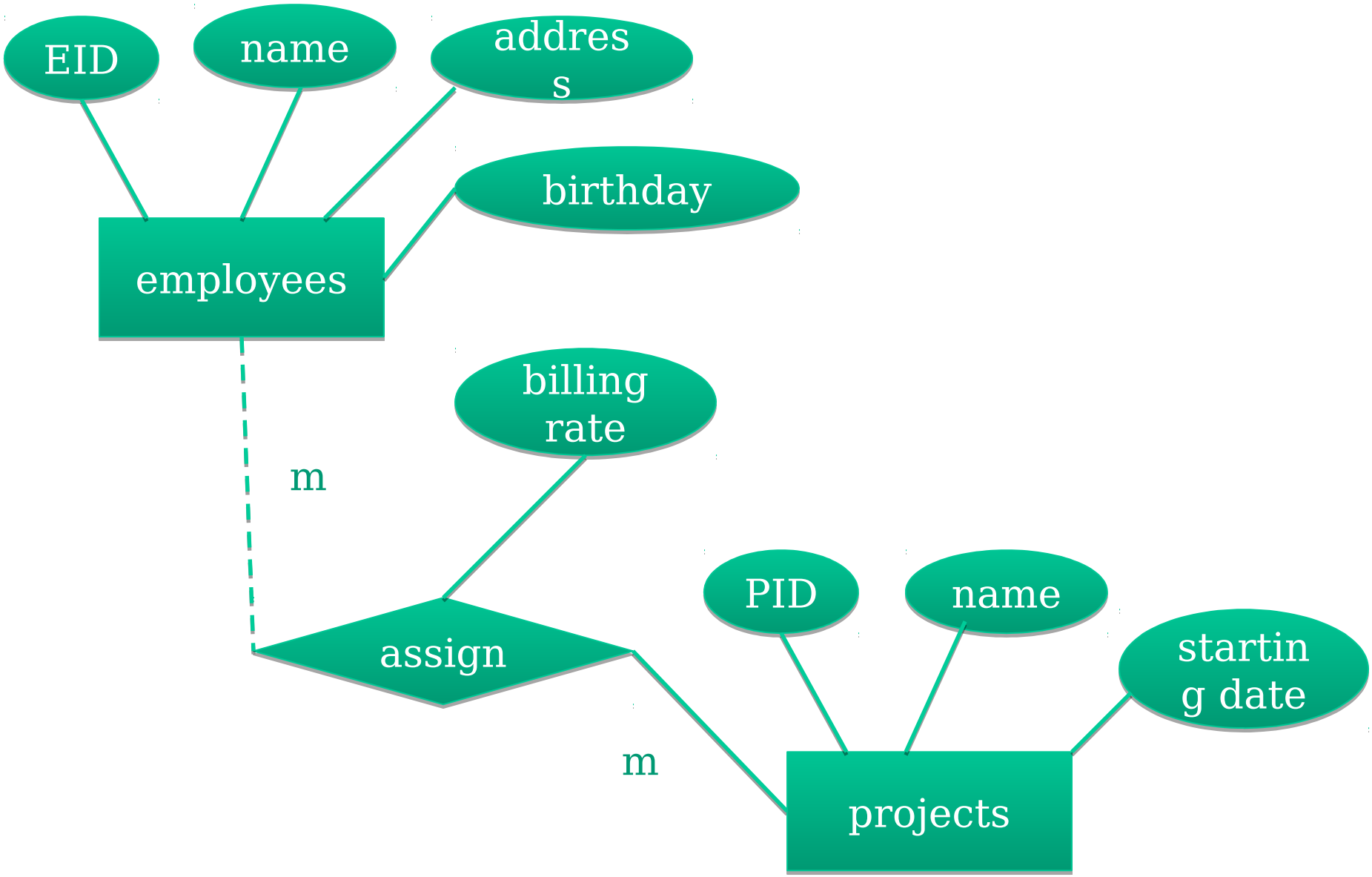
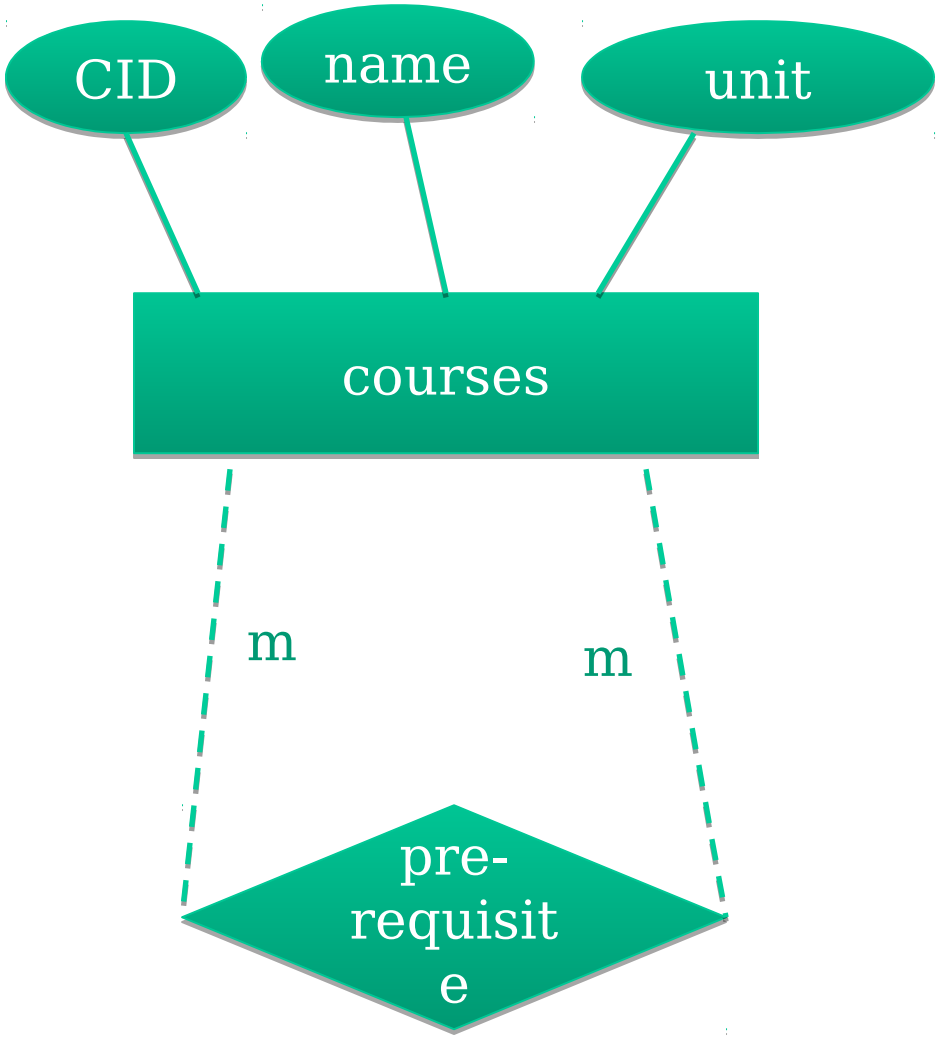

EID
name
addres
s
birthday
employees
billing
rate
m
assign
PID
name
startin
g date
m
projects

Exercise 2

- A university has a large number of courses in its catalog. Attributes of COURSE include Course_number (identifier), Course_name, and Units.
- Each course may have one or more different courses as prerequisites, or may have no prerequisites. Similarly, a particular course may be a prerequisite for any number of courses, or may not be prerequisite for any other course.


CID
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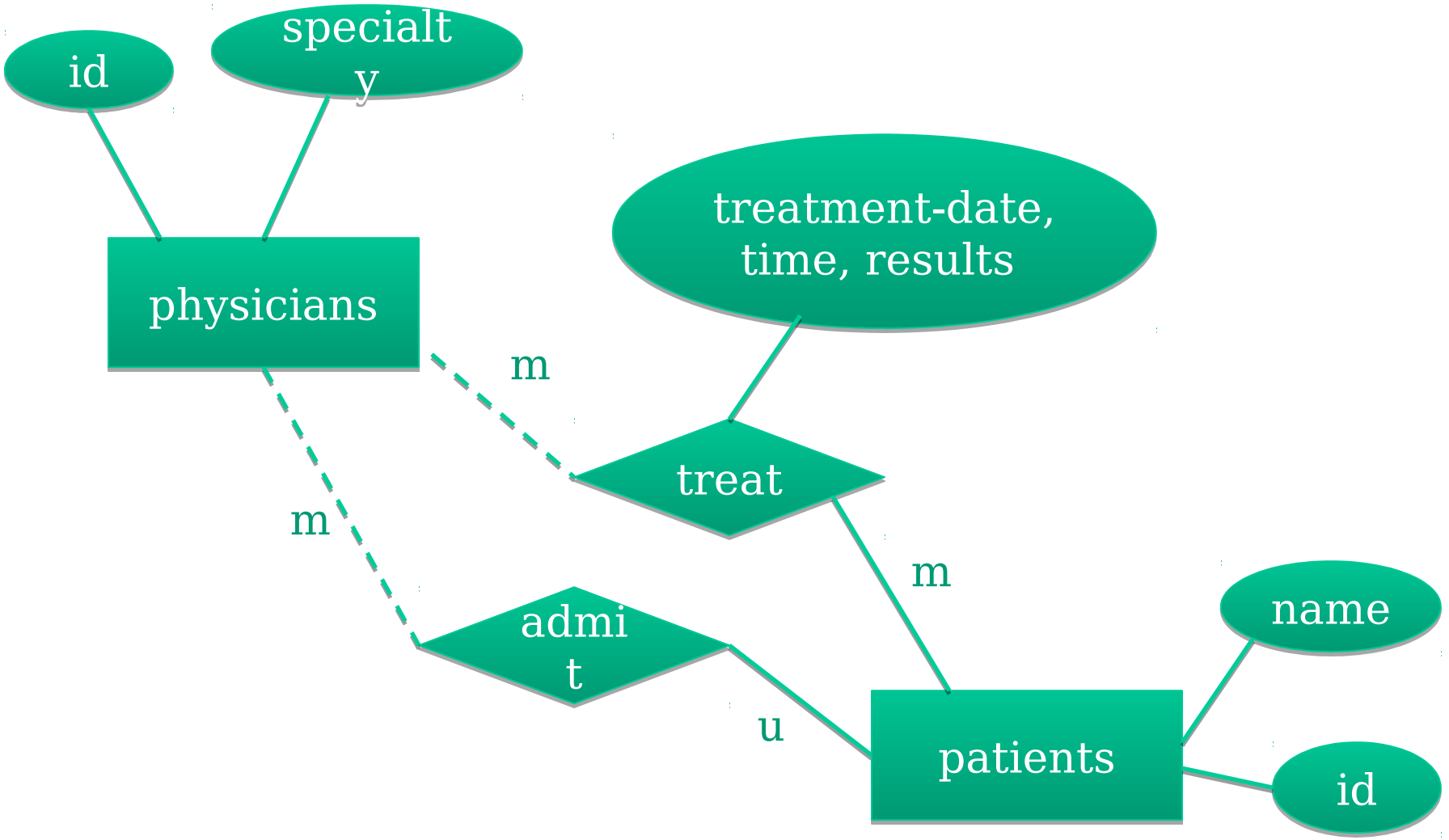
Exercise 3

1. A hospital has a large number of registered physicians and patients.
2. Attributes of PHYSICIAN include Physician_ID (identifier) and Specialty.
3. Attributes of Patients include Patient_ID (identifier) and Patient_Name.
4. Any patient who is admitted must have exactly one admitting physician. A physician may optionally admit any number of patients.
5. Once admitted, a given patient must be treated by at least one physician. A particular physician may treat any number of patients, or may not treat any patients.
6. Whenever a patient is treated by a physician, the hospital wishes to record the details of the treatment (Treatment_Detail). Components of Treatment_Detail include Date, Time, and Results.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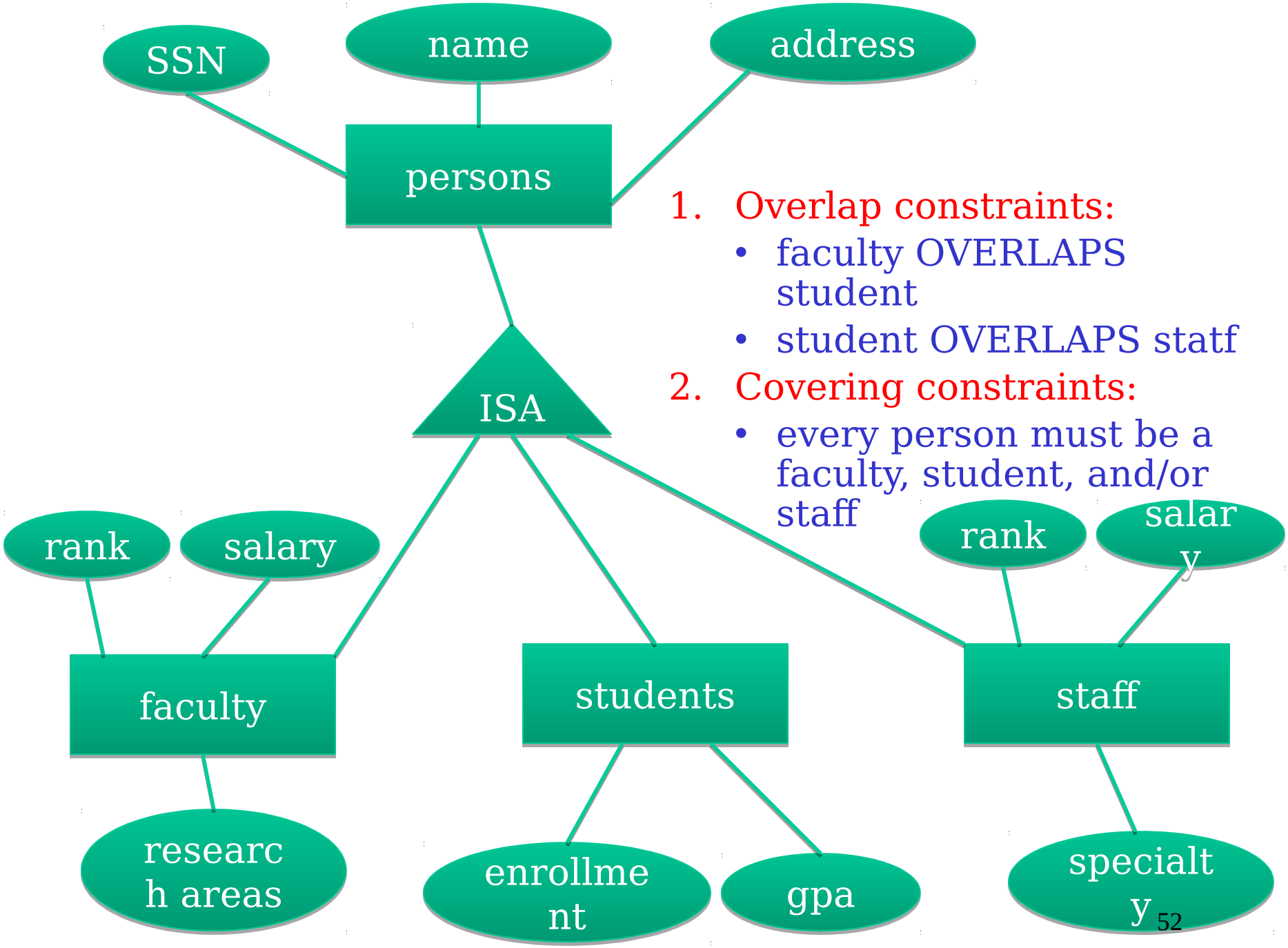
Exercise 4

- A university has a number of people
  - attributes: SSN, name, address
- A person can be a faculty, a student, a staff
  - faculty attributes: rank, salary, research areas, grants
  - student attributes: first enrollment date, gpa
  - staff attributes: rank, salary, specialty
- A person must be either a faculty, a student, and/or a staff
  - A student can be a staff and vice versa
  - A facutly can be a student and vice versa



1. Overlap constraints:
   - faculty OVERLAPS student
   - student OVERLAPS statf
2. Covering constraints:
   - every person must be a faculty, student, and/or staff

My shopping assistant

- I have a lot of things purchased from different stores
- I own several credit cards from some stores
- What do I want:
  - Get rid of very old, rarely used items
  - Keep track of what I have
  - Keep notes on what I need to buy
  - Keep track of my credit card usage
  - Keep a budget

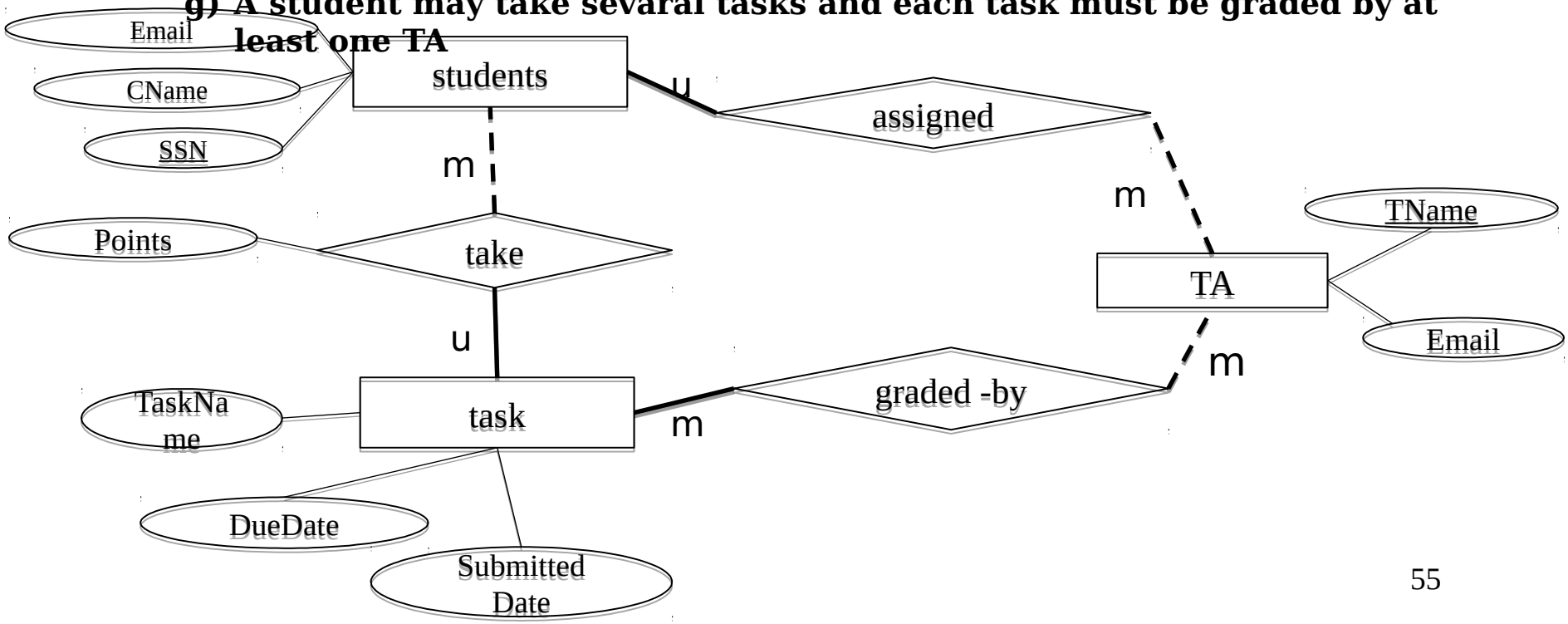
Exercise 5

1. (10 points) Construct an E-R diagram for the instructor of COMS 363 to record the following information.
   1) The instructor has a number of students and a number of teaching assistants (TAs)
   2) Each student has SSN, CName, and Email
   3) Each TA has a TName and Email
   4) Each student is assigned with one and only one TA as his/her primary TA
   5) A TA may or may not have any student
   6) The course has a number of tasks (e.g., homework, project, exam), each of which has a TaskName, DueDate, SubmitedDate, and Points
   7) A student may take sevaral tasks and each task must be graded by at least one TA

Exercise 5

1. (10 points) Construct an E-R diagram for the instructor of COMS 561 to record the following information.

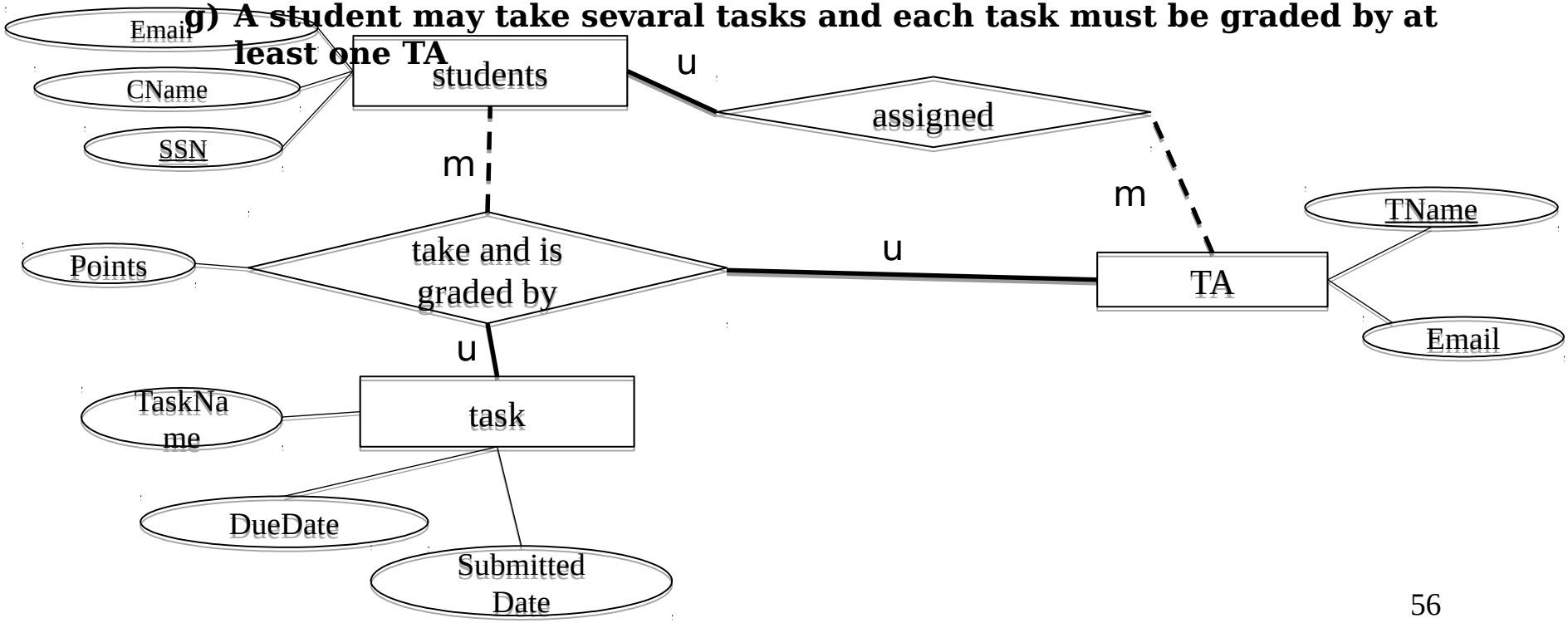
- **a) The instructor has a number of students and a number of teaching assistants (TAs)**
- **b) Each student has SSN, CName, and Email**
- **c) Each TA has a TName and Email**
- **d) Each student is assigned with one and only one TA as his/her primary TA**
- **e) A TA may or may not have any student**
- **f) The course has a number of tasks (e.g., homework, project, exam), each of which has a TaskName, DueDate, SubmitedDate, and Points**
- **g) A student may take sevaral tasks and each task must be graded by at least one TA**



Exercise 5

1. (10 points) Construct an E-R diagram for the instructor of COMS 561 to record the following information.

- **a) The instructor has a number of students and a number of teaching assistants (TAs)**
- **b) Each student has SSN, CName, and Email**
- **c) Each TA has a TName and Email**
- **d) Each student is assigned with one and only one TA as his/her primary TA**
- **e) A TA may or may not have any student**
- **f) The course has a number of tasks (e.g., homework, project, exam), each of which has a TaskName, DueDate, SubmitedDate, and Points**
- **g) A student may take sevaral tasks and each task must be graded by at least one TA**



Exercise 5

1. (10 points) Construct an E-R diagram for the instructor of COMS 561 to record the following information.

- **a) The instructor has a number of students and a number of teaching assistants (TAs)**
- **b) Each student has SSN, CName, and Email**
- **c) Each TA has a TName and Email**
- **d) Each student is assigned with one and only one TA as his/her primary TA**
- **e) A TA may or may not have any student**
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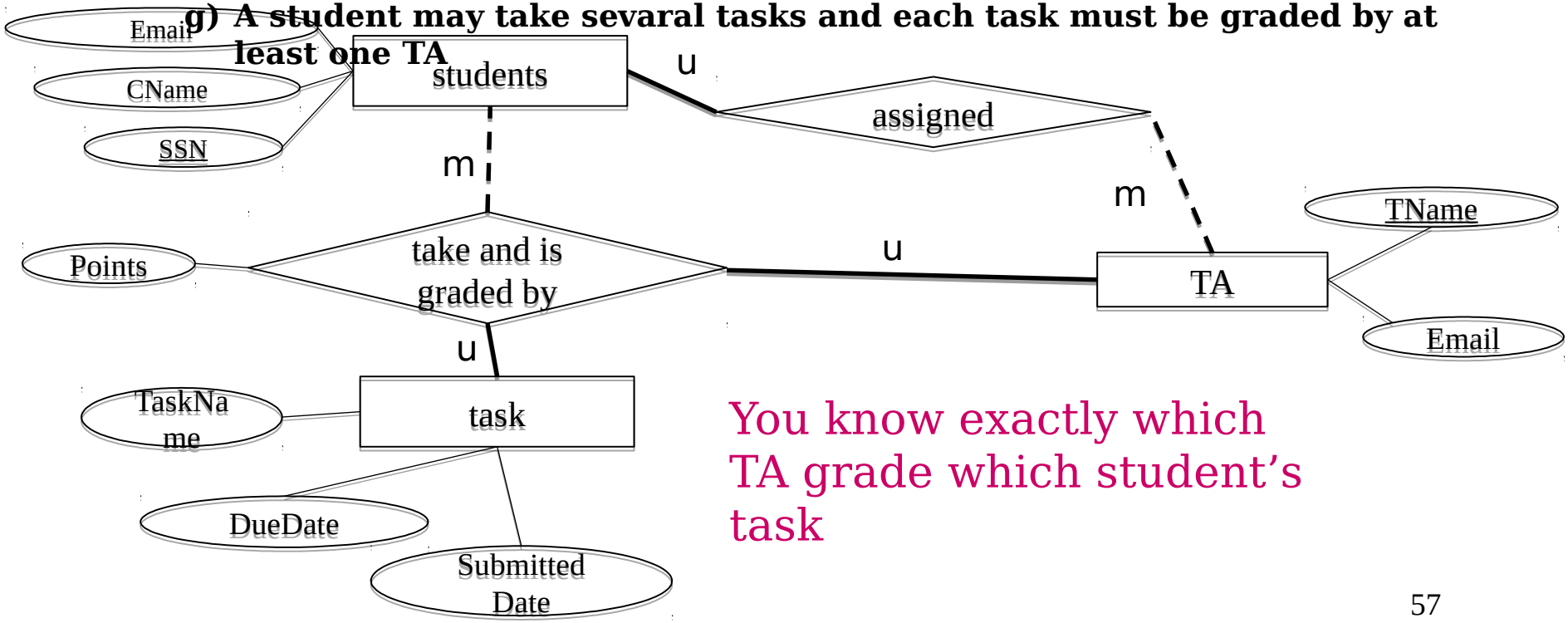
- **g) A student may take sevaral tasks and each task must be graded by at least one TA**



You know exactly which TA grade which student's task