ENTITY RELATIONSHIP MODEL
Sep 2023

Databases Model the Real World

- "Data Model" translates real world things into structures computers can store
- Many models:
  - Relational, E-R, O-O, Network, Hierarchical, etc.
- Relational (more next time)
  - Rows & Columns
  - Keys & Foreign Keys to link Relations

Enrolle

d sid	cid	grade
53666	Carnatic101	C
53666	Reggae203	B
53650	Topology112	A
53666	History105	B

Student

Ssid	name	login	age	gpa
53666	Jones	jones@cs	18	3.4
53688	Smith	smith@eecs	18	3.2
53650	Smith	smith@math	19	3.8

Problems with Relational Model

```
CREATE TABLE Enrolled
    (sid CHAR(20),
     cid CHAR(20),
     grade CHAR(2))
```

```
CREATE TABLE Students
    (sid CHAR(20),
     name CHAR(20),
     login CHAR(10),
     age INTEGER,
     gpa FLOAT)
```

With complicated schemas, it may be hard for a person to understand the structure from the data definition.

Enrolled

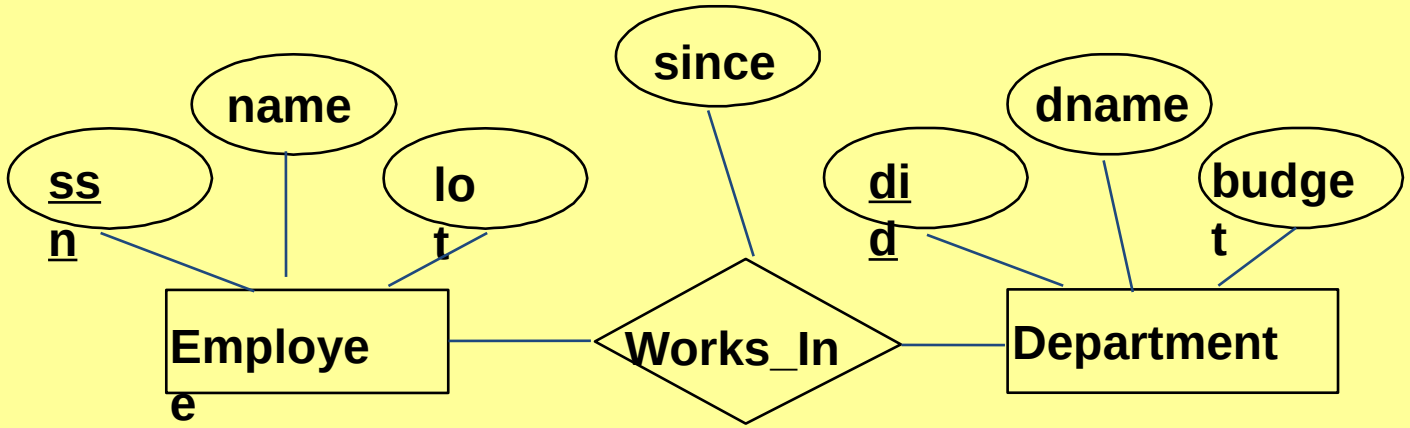
cid	grade	sid
Carnatic101	C	53666
Reggae203	B	53666
Topology112	A	53650
History105	B	53666

Students

sid	name	login	age	gpa
53666	Jones	jones@cs	18	3.4
53688	Smith	smith@eecs	18	3.2
53650	Smith	smith@math	19	3.8

One Solution: The E-R Model

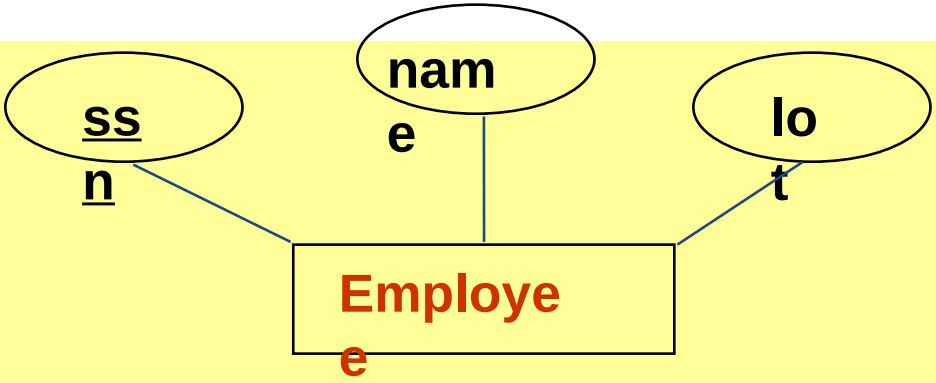
- Instead of relations, it has:
  - Entities and Relationships
- These are described with diagrams
  - both structure, notation more obvious to humans



Steps in Database Design

- **Requirements Analysis**
  - user needs; what must database do?
- **Conceptual Design**
  - high level descr (often done w/ER model)
- **Logical Design**
  - translate ER into DBMS data model
- **Schema Refinement**
  - consistency, normalization
- **Physical Design**
  - indexes, disk layout
- **Security Design**
  - who accesses what, and how

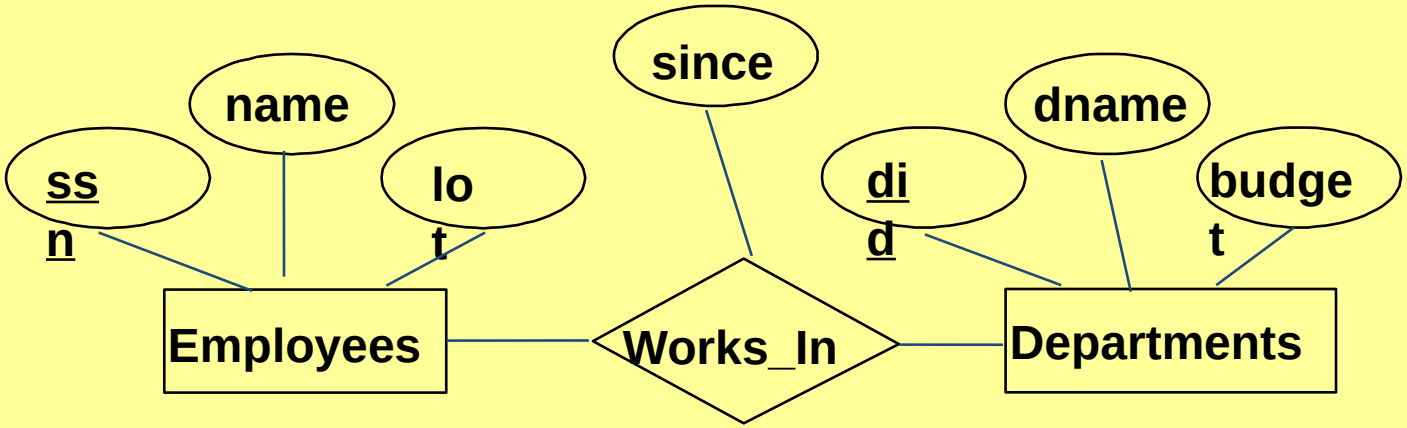
ER Model Basics



- ***Entity:***
  - Real-world thing, distinguishable from other objects.
  - Noun phrase (e.g., Bob Smith, Comm Ave Branch, Account 1234, etc)
  - Entity described by set of *attributes*.

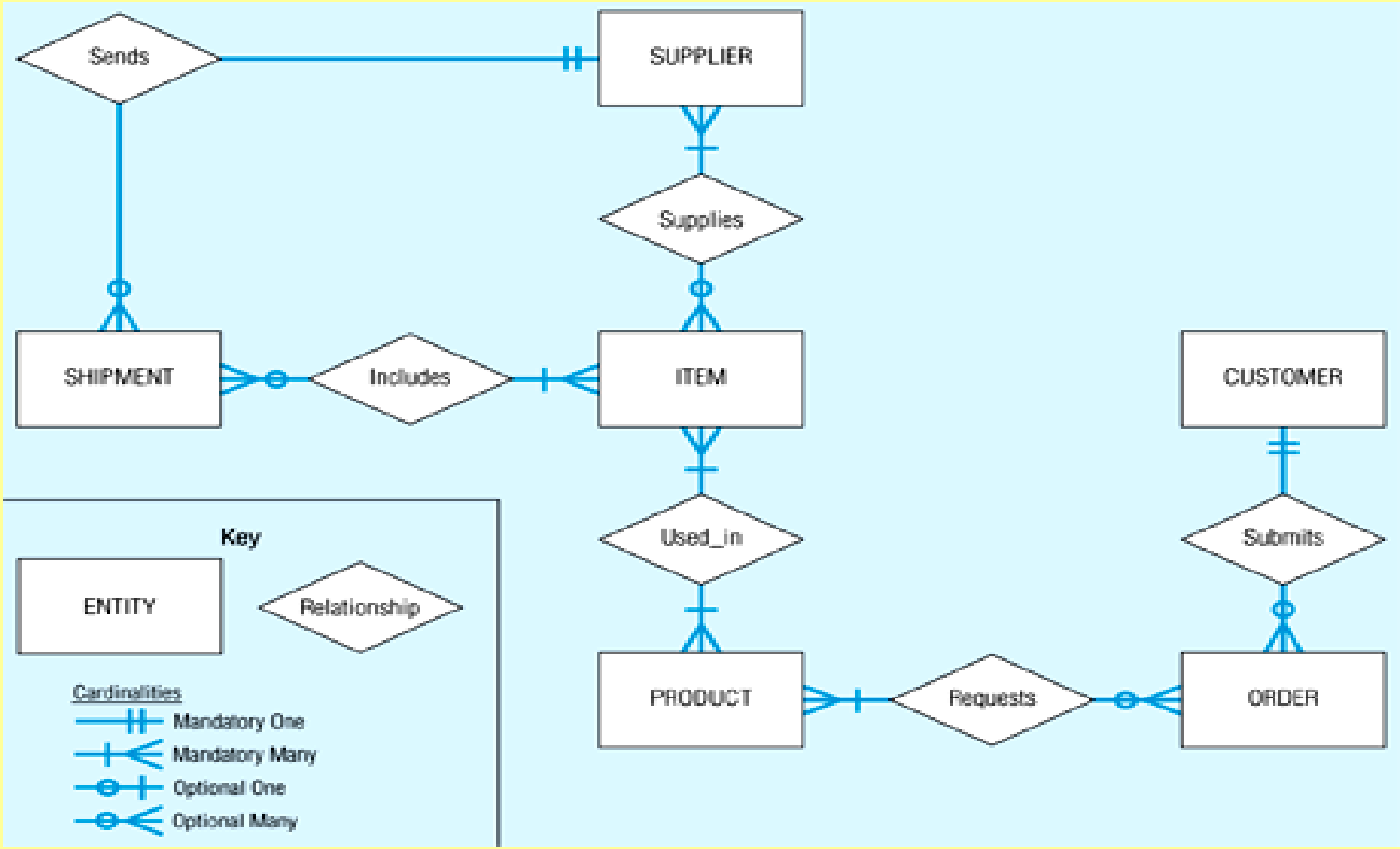
- ***Entity Set*: A collection of similar entities. E.g., all employees.**
  - All entities in an entity set have the same set of attributes. (Until we consider hierarchies, anyway!)
  - Each attribute has a *domain*.

ER Model Basics (Contd.)



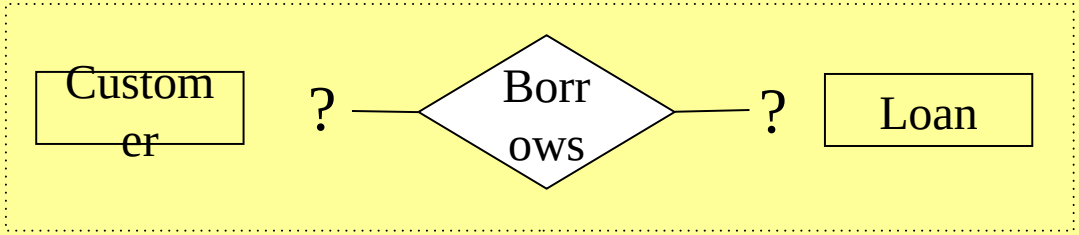
- ***Relationship***: Association among two or more entities. E.g., Bob Smith works in Pharmacy department.
  - relationships can have their own attributes.
  - Verb phrases (e.g., works_at, enrolled_in, etc)

Sample E-R Diagram



E/R Data Model

Design Issue #3: Relationship Cardinalities

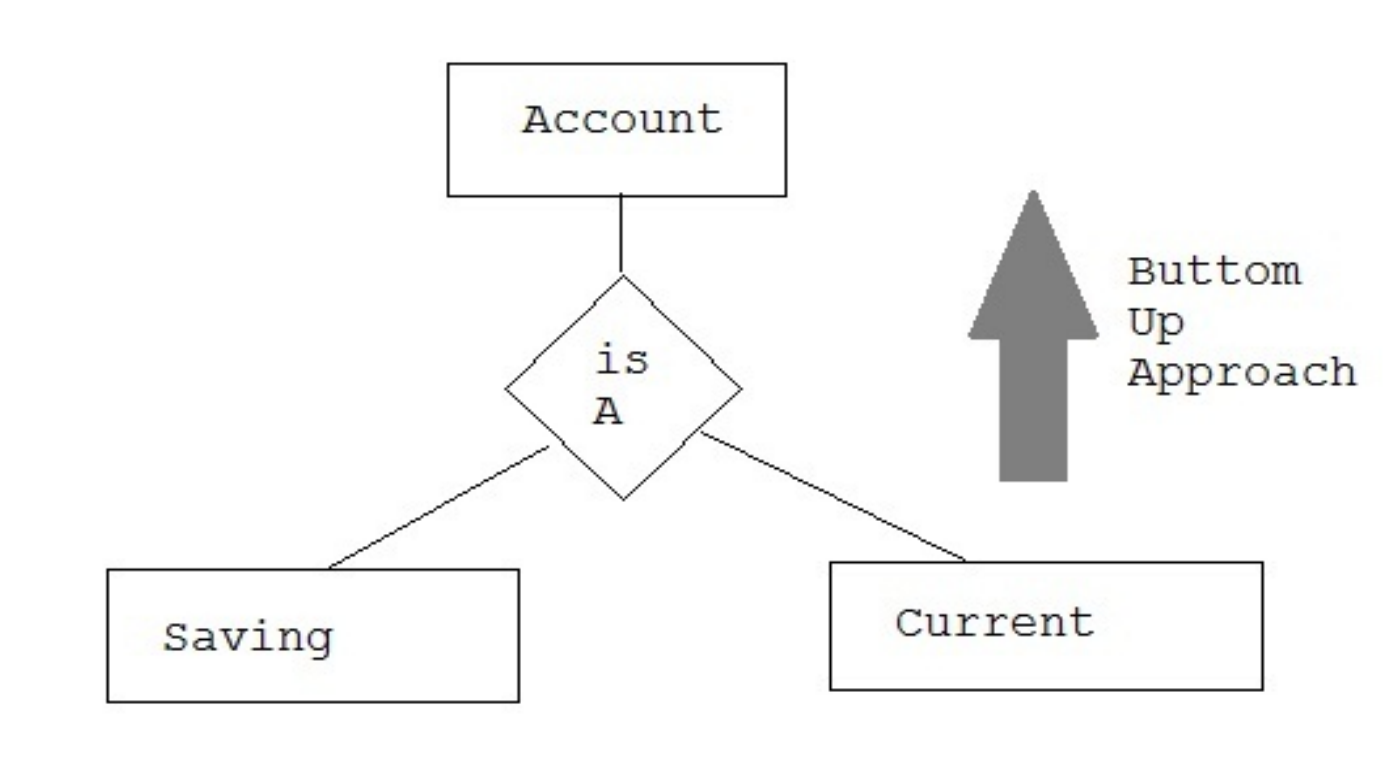


- Cardinalities of Borrows:

Type	Illustrated	Multiple Loans?	Joint Loans?
One-to-One (1:1)		No	No
Many-to-one (n:1)		No	Yes
One-to-many (1:n)		Yes	No
Many-to-many (n:m)		Yes	Yes

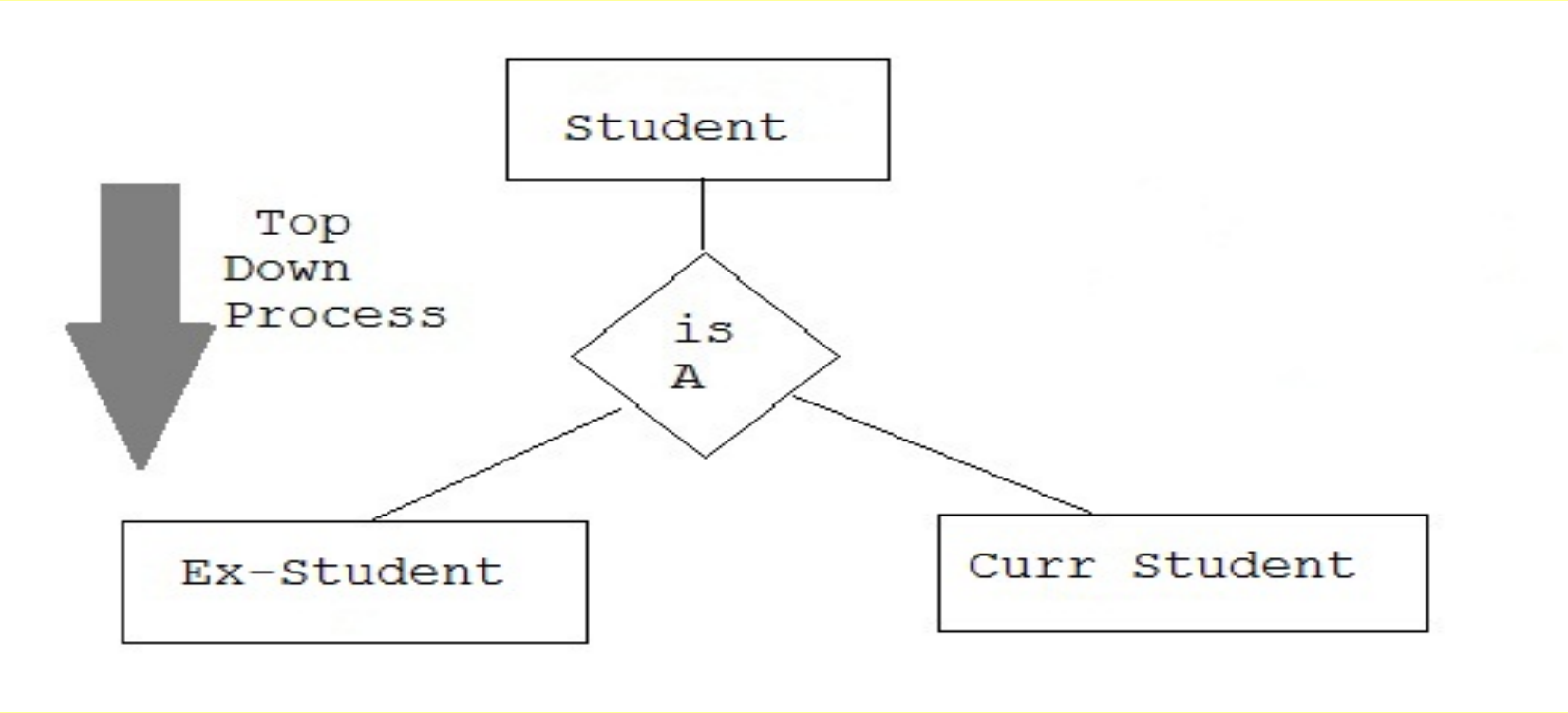
Generalization

- Generalization is a bottom-up approach in which two lower level entities combines to form a higher level entity. In generalization, the higher level entity can also combine with other lower level entity to make further higher level of entity.

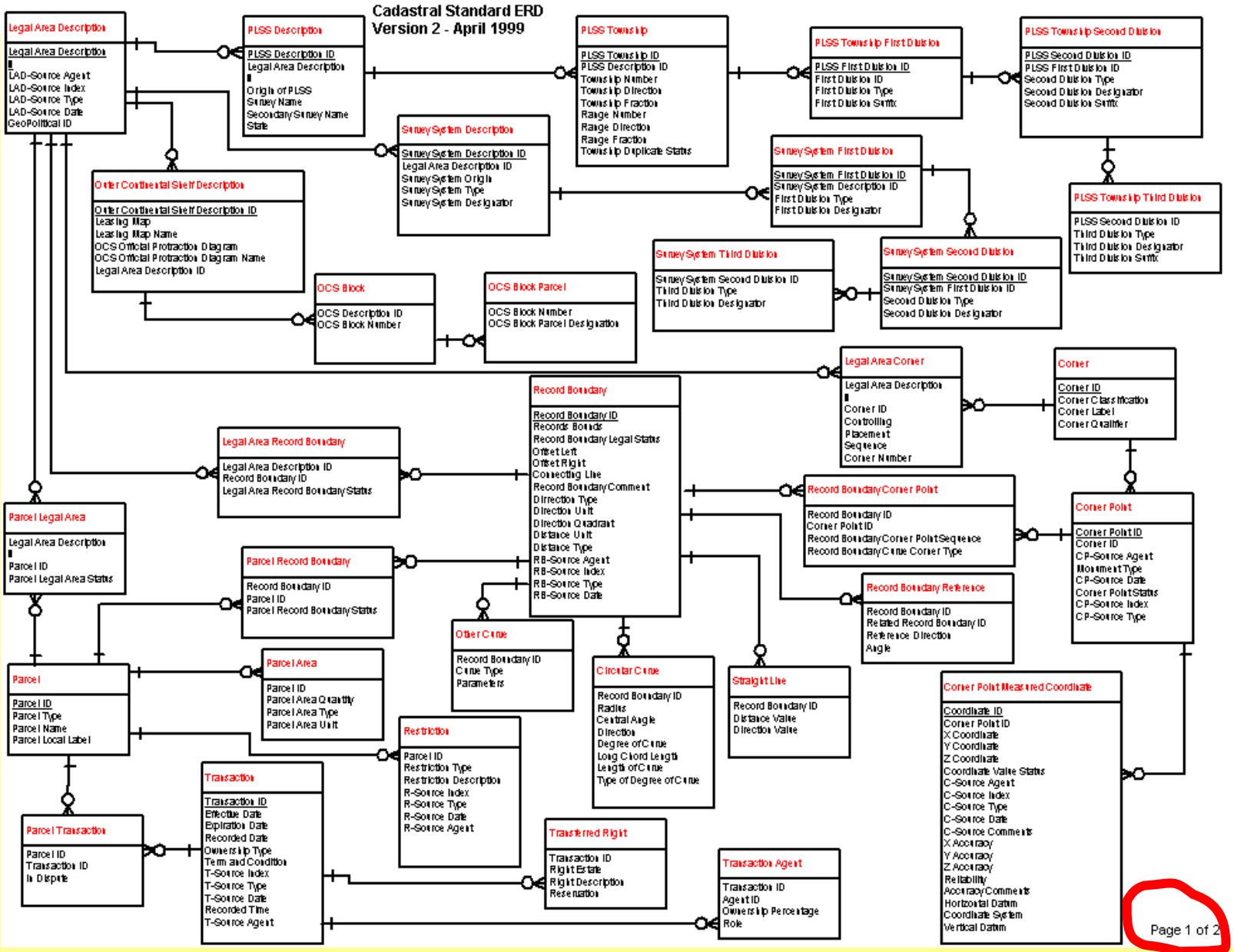


Specialization

- specialization is opposite to generalization. It is a top-down approach in which one higher level entity can be broken down into two lower level entity. In specialization, some higher level entities may not have lower-level entity set at all.



A Cadastral E-R Diagram



Assignmnet On Entity-Relationship Diagram

A **university** consists of several **faculties**. Within each faculty there are several **departments**. Each department may run a number of **courses**. All **teaching staff** are attached to departments, each staff member belonging to a unique department. (Note: see how many meanings you can assign to this ambiguous sentence). Every course is composed of **subcourses**. Some subcourses are part of more than one course. Staff may teach on many subcourses and each subcourse may be taught by a number of staff. **Draw an entity-relationship model for this example**. Show both **cardinalities** and**optionalities**. Put a question mark where the degree is not clear from the text. Don't assume anything; rather, **write a list of questions you would have to find answers to to complete the model.**

ER DIAGRAM : MCTE

Entities : Identify The Entities	Relationship	Relationships With	Optionality	Cardinality	Derived Field	Fields
Faculty	Includes	Departments	Can faculty exist without any dept ? **NO**	How many depts ? **many**		Faculty name, depts
Department	Runs	Courses	Can a dept exist without running a course **??????**	How many course ? **many**		dept_name **courses**, teaching staff attached staff duration of att
	Has attached	Teaching staff	Is it a must that a teaching staff is att … **NO**	How many teachers ? **many**		
	Has on Roll	Teaching Staff	Should a teacher be on roll of a dept ? **YES**	How many teachers ? **Many**		
	Belongs	faculty	Should a dept belong to a faculty ? **YES**	Can belong to how many faculties ? **one**		
Courses	Composed of	Sub courses	Should a course always have a subcourse **YES**	How many subcourses ? **many**		**Course id,** course_name, duration, sub_courses
Sub courses	Part of	courses	Should a sub course be always part of a course ? YES	How many courses can it be part of ? **Many**		**Sub_course_name**, course_name, taught by, no of pds,
	Taught by	Teaching staff	A subcourse always need a teacher ? **YES**	Taught by how many teachers ? **many**		
Teaching staff	Teaches	Sub courses	Can there be a teacher who is not teaching any sub course ? **YES**	Teach how many sub courses ? **many**		**Staffid**, name,sub_courses, parent_dept,
	Belongs	department	Does every teacher belong to a dept ? **YES**	Can belong to how many dept? **one**		
		Attached to	Is every teacher attached to a dept ? **YES**	Can be attached to how many depts ? **????.**	Attachment duration	

Questions to be asked

1. What are the Entities ?

University, Faculty, departments, Courses, sub courses, Teachers, Attached Teachers…..

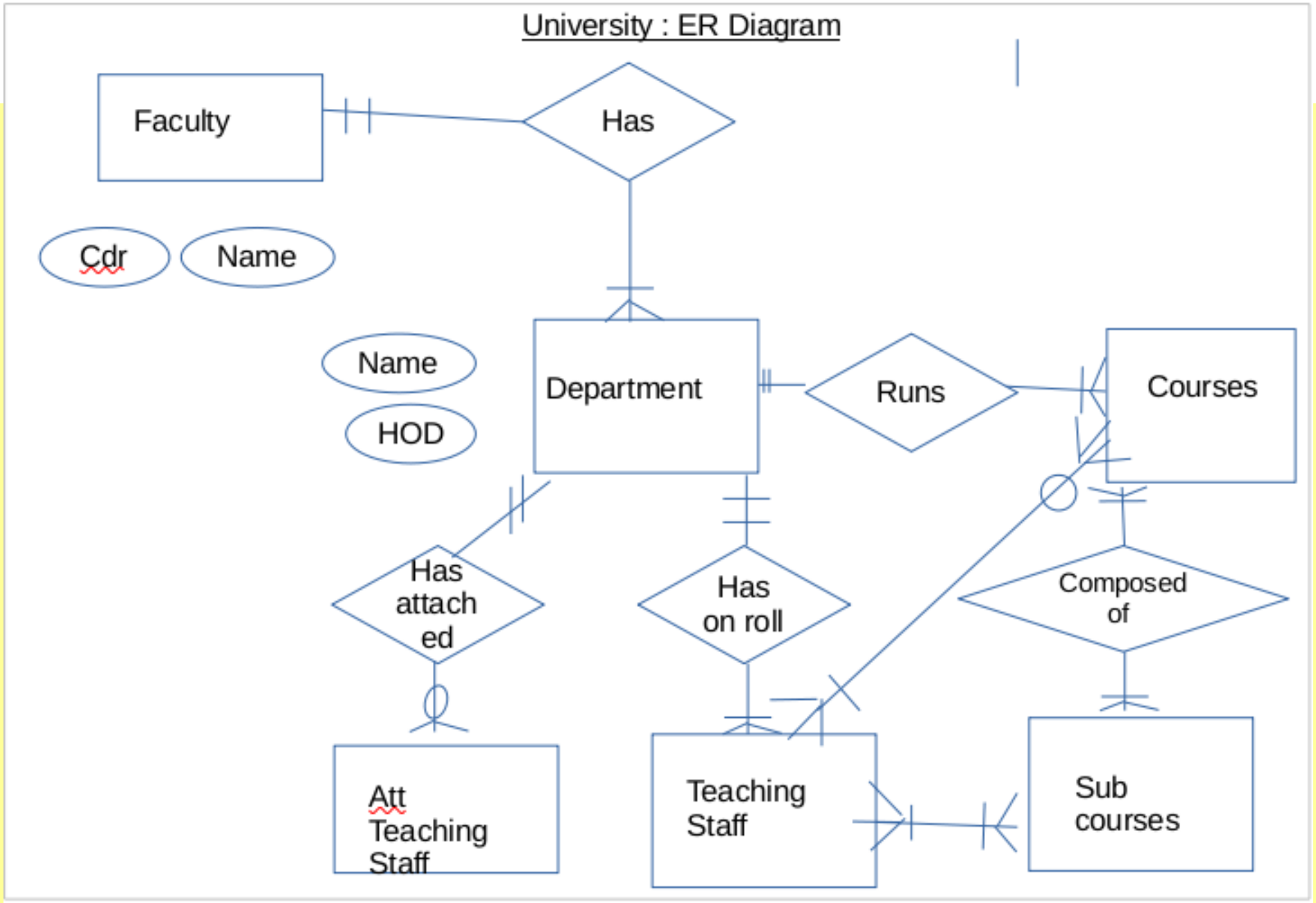
2. How are they related ?

- **Faculties have departments**
- **Departments run courses**
- **Courses are composed of sub courses**
- **Departments have teachers on Roll**
- **Departments have teachers attached.**

3 What are the optionality for each relationship (required or optional) ?

4. What are the cardinality for each relationship ? 1-1 , 1-many, many- 1 or many to many.?

5. Identify attributes for each entity or relation .


University : ER Diagram
Faculty
Has
Cdr
Name
Name
HOD
Department
Runs
Courses
Has attach ed
Has on roll
Composed of
Att Teaching Staff
Teaching Staff
Sub courses