Topics Covered in Todays Class

Unit 2: Data Modeling using the Entity-Relationship(ER) diagram
- Entity Types, Entity Sets, Attributes and Keys

Sample Database Application

- **Example:** HOD of CSE department calls you and asks to develop the following application

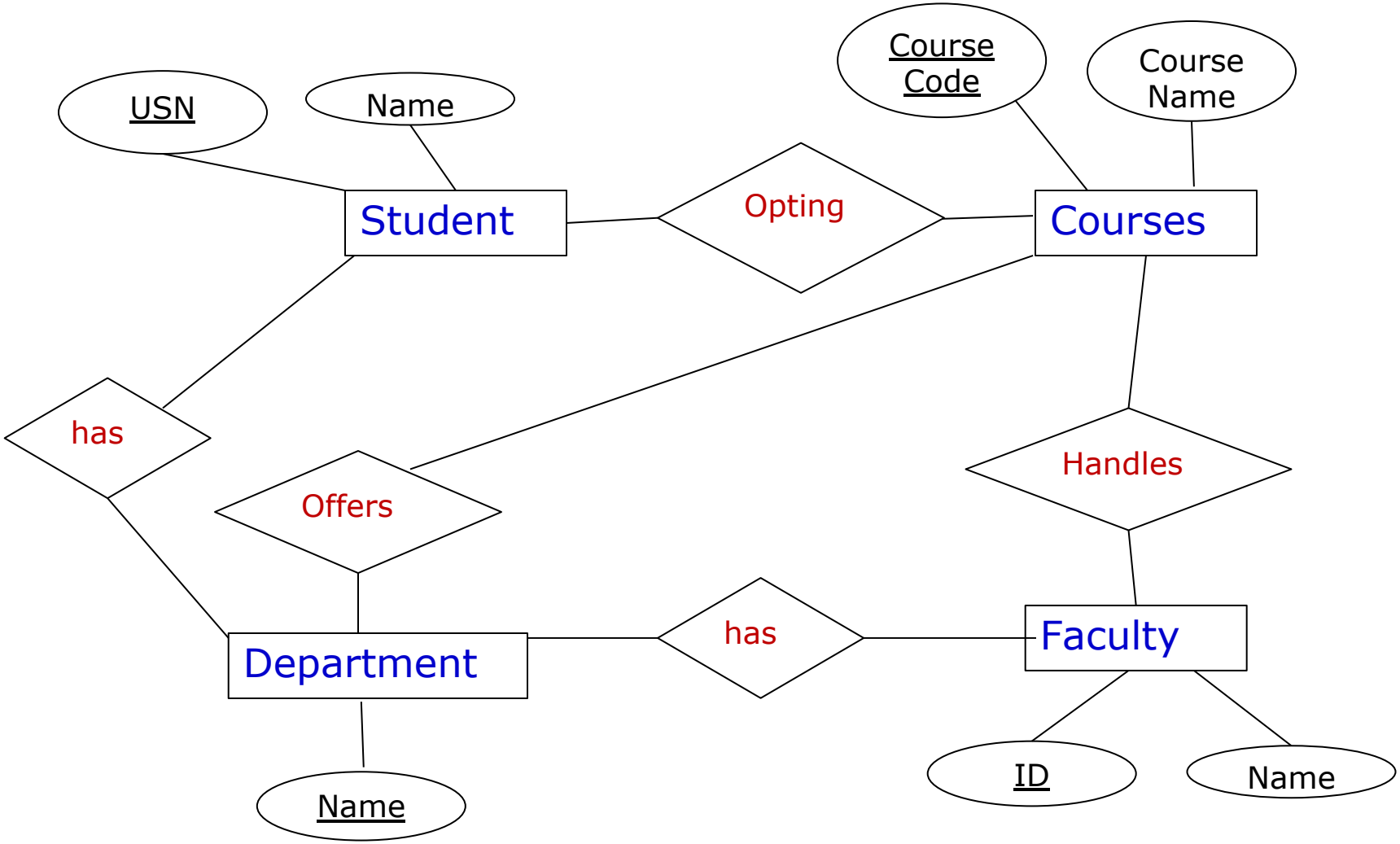
"Develop a database application to automate the process of course registration"

- Your **first task** should be to have a discussion with your client i.e HOD, to identify the requirements of the application.
  - Requirements are as follows
    - Department has students and faculty
    - Department will offer a set of courses during each semester
    - Each student in the department during course registration will be opting for courses offered by the department
    - Faculty will be handling courses
- Your **second task** should be to prepare a ER diagram which shows the Design plan of the database application to be developed.

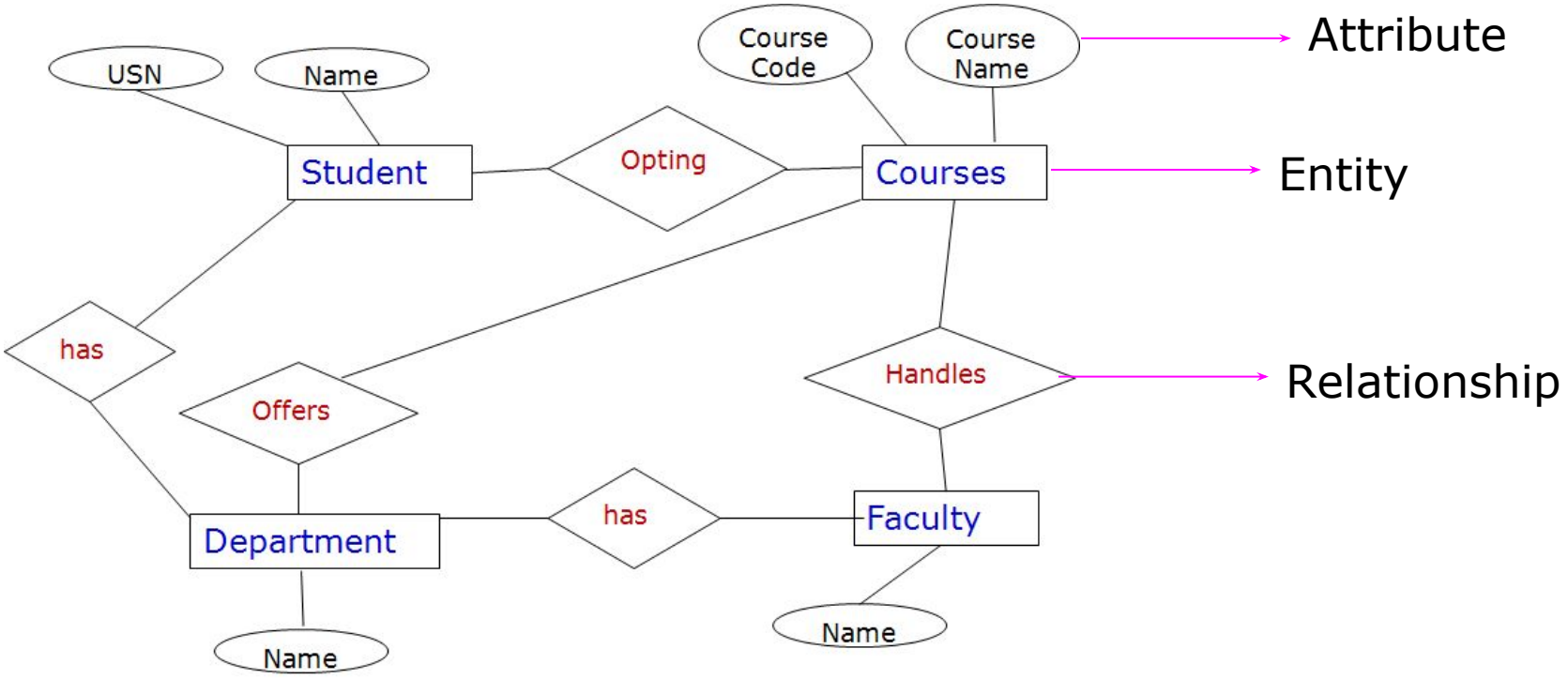
Example: House design plan

During plan preparation
Various notations and
Terminologies

Design plan or ER diagram before actual development of the application



Design plan or ER diagram before actual development of the application



Requirements Were

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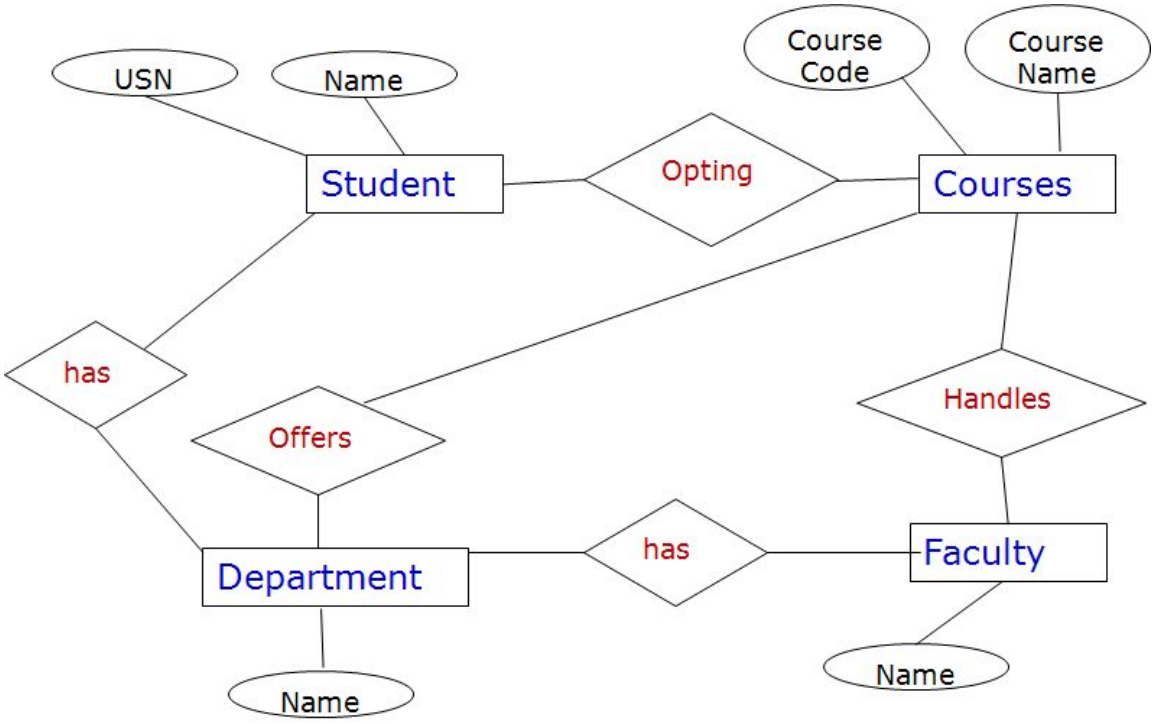
Design plan or ER diagram before actual development of the application



Constraints

- Each semester student should register for minimum of 20 credits and maximum of 30 credits
- Each faculty can handle a maximum two courses During each semester

Requirements Were

- Department has students and faculty
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What is Entity, Entity Types, Entity sets ?

- **Entity** is object in real world which has independent existence.
  - Example: Student, Course, Faculty, Car, House, College, Book, Food

ER Diagram Notation for Entity: Rectangle

Activity - Questionnaire

List out the Entities which you will come across in real world.

What is Entity Types, Entity sets ?

- Entity type is collection of entities with common attributes
- Entity set collection of one or more attributes

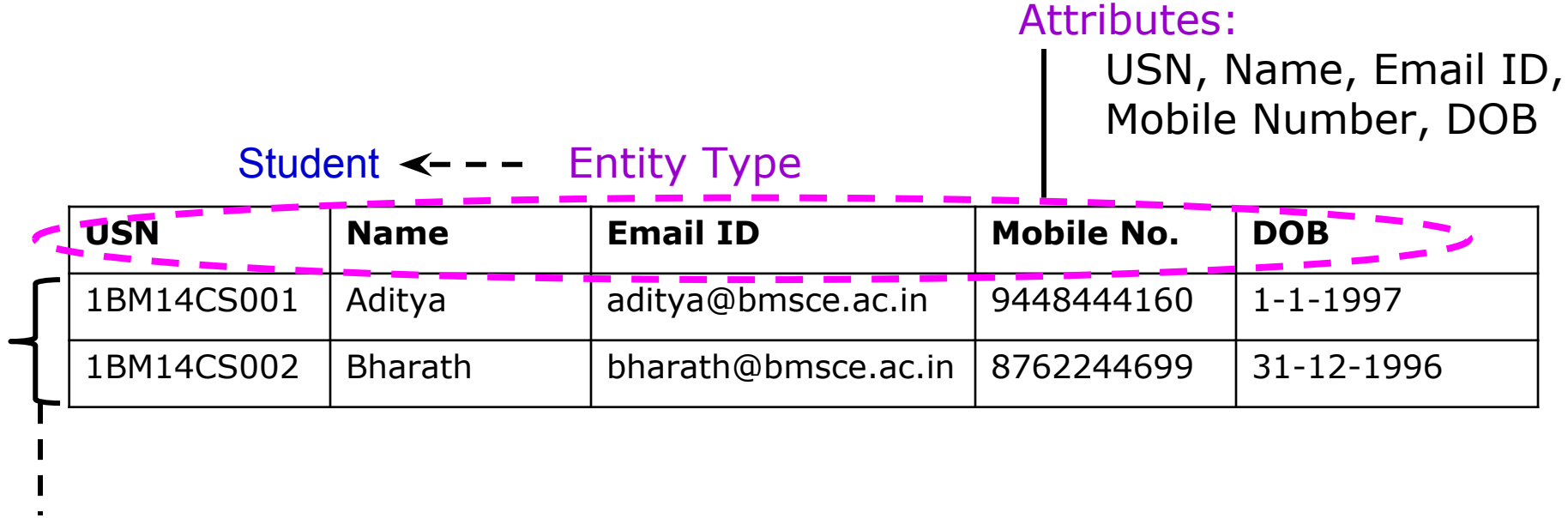
Student ← - - - Entity Type

USN	Name	Email ID	Mobile No.	DOB
1BM14CS001	Aditya	aditya@bmsce.ac.in	9448444160	1-1-1997
1BM14CS002	Bharath	bharath@bmsce.ac.in	8762244699	31-12-1996

Entity Set

What is Attribute ?

- Attribute is a property that describes Entity.



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What is **Domain** ?
Set of permitted values for an Attribute.

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Attributes:
USN, Name, Email ID, Mobile Number, DOB

Student ← Entity Type

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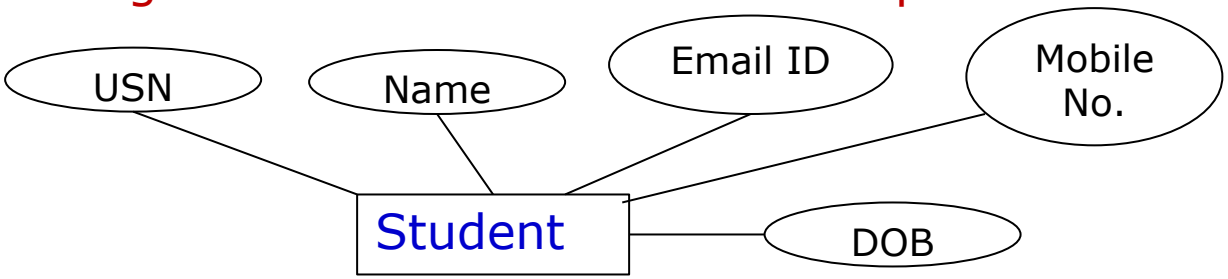
Entity Set

ER Diagram Notation for Attribute: Ellipse



Activity - Questionnaire

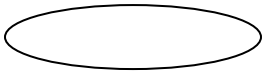
List attributes for

1. Car
2. Book

Different categories of attributes

- Simple (Atomic) vs Composite
  - Attributes that are not divisible are called **Simple**.
  - Attributes that can be divided into smaller parts are called **Composite**.
  - Ex.: Simple- USN, Composite- Name(First Name, Last Name), Address(Street name, Area Name, Place)
- Single value vs Multiple valued
  - Ex.: Single – USN, Multiple – Mobile numbers
- Stored vs Derived
  - Ex.: Stored – DOB, Derived – Age
- Complex Attributes
  - Ex.: {Address(Street name, Area Name, Place)} ☐ Office address and Residence Address
- Null values
  - Ex. : Middle Name is Optional i.e. Gautham Sharma or Gautham K Sharma

Attribute: ER diagram notations



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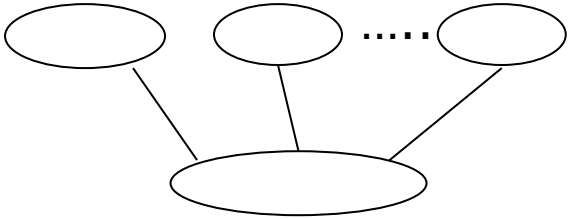
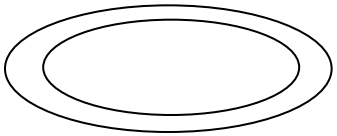


Composite Attribute



Multivalued Attribute

Derived Attribute

What is Key ?

- Key attribute is a attribute or a combination of attributes which will uniquely identify remaining attributes of entity.
- What are the Key attributes in the following student table ?

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1BM14CS003	Dinesh K	dineshk@bmsce.ac.in	8444160944	6-6-1998
1BM14CS004	Dinesh K	Dineshk_4@bmsce.ac.in	7446998762	6-6-1998

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- What are the Key attributes in the following student table ?

Faculty	Department	Salary
A	CSE	20K
B	CSE	21K
A	EC	30K
B	EC	27K
C	CSE	22K

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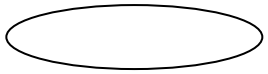
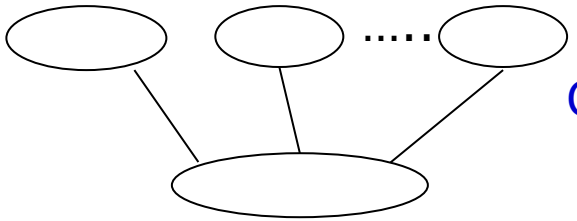
Note:
Before determining the Key attribute, look at the values present but it will
not be consistent

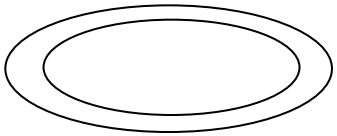
Activity To DO



Attribute



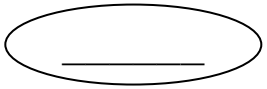
Composite Attribute



Multivalued Attribute

Derived Attribute

Entity



Key Attribute

Represent Employee entity using ER diagram notation Which has following attributes

- Employee ID (Key)
- Name
- Address(House No., Street name, Area name, Place)
- Mobile Number (Can have more than one)
- DOB
- Age

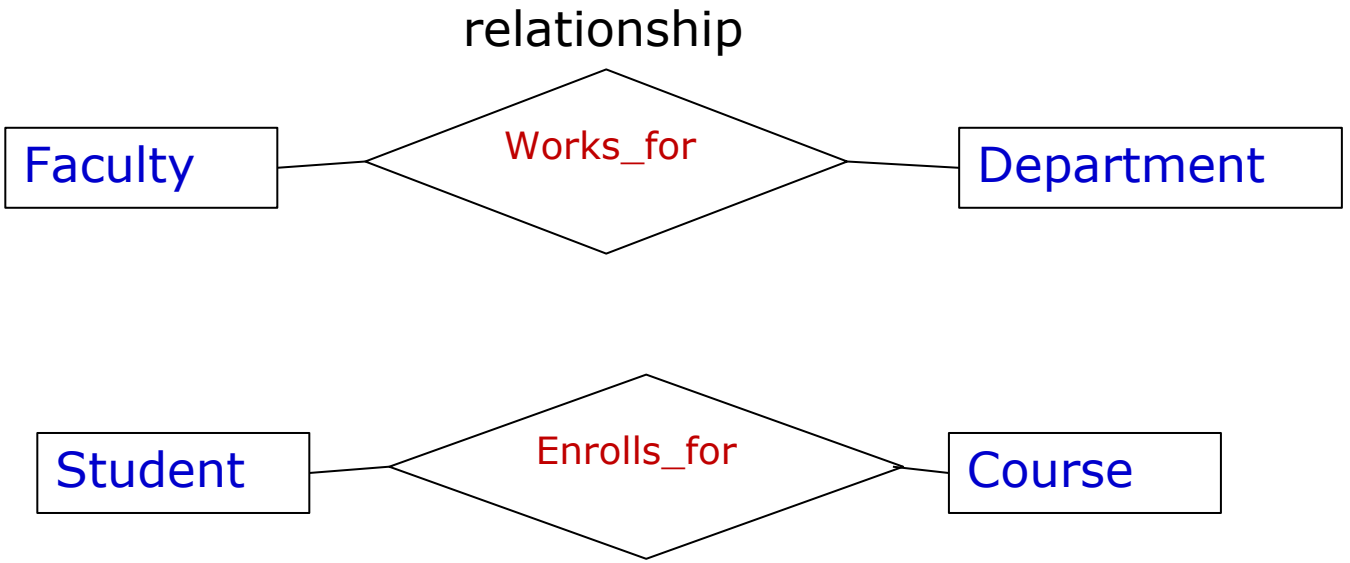
Topics Covered in Todays Class

Unit 2:

- Relationship Types, Relationship sets, Roles and Structural Constraints
- Weak Entity Types

Relationship Type

- A Relationship Type defines a relationship set among entities of certain entity types.
- Example, an Faculty works_for a department, a student enrolls_for in a course. Here, works_for and enrolls_for are called relationships.



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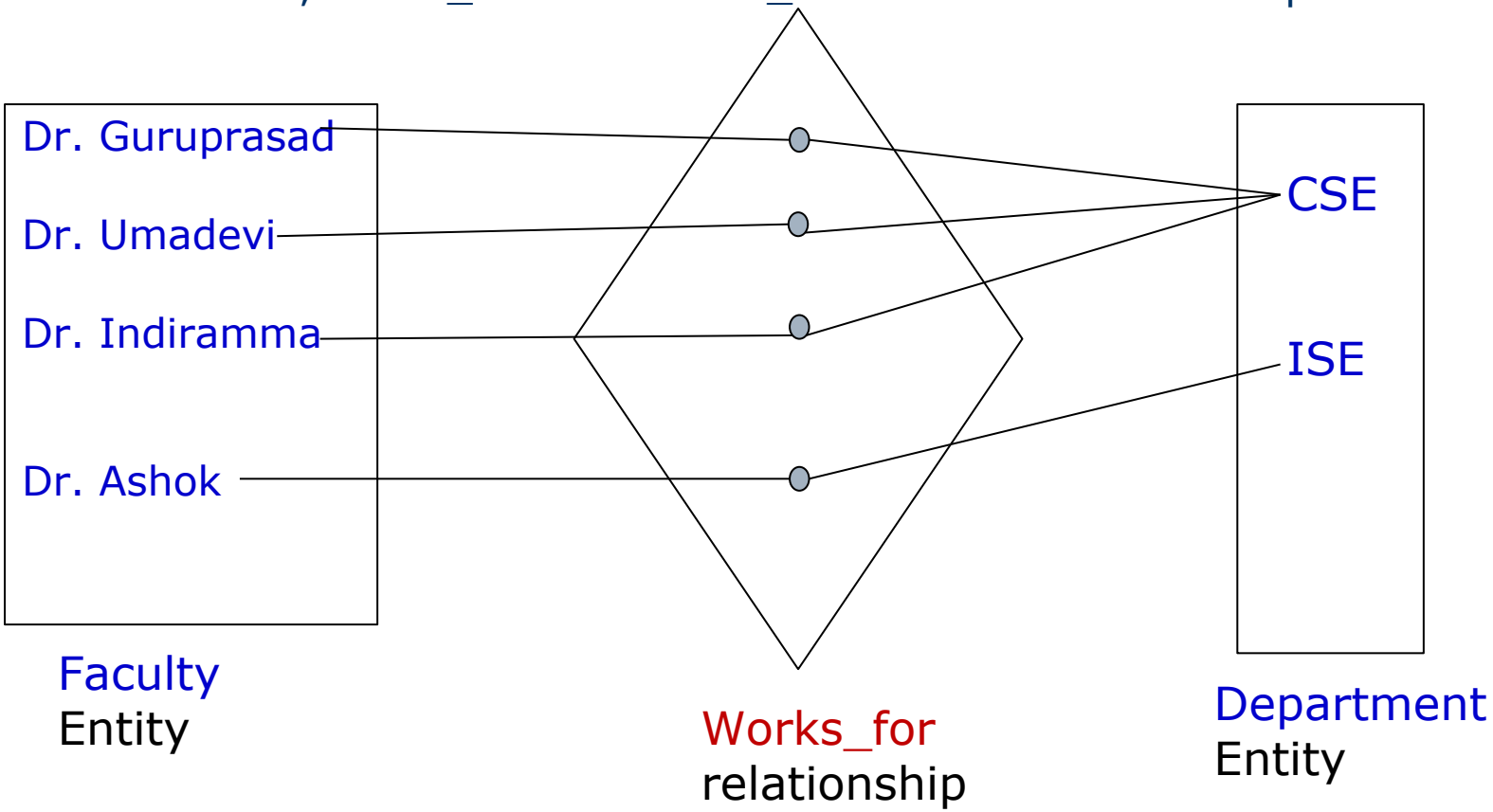

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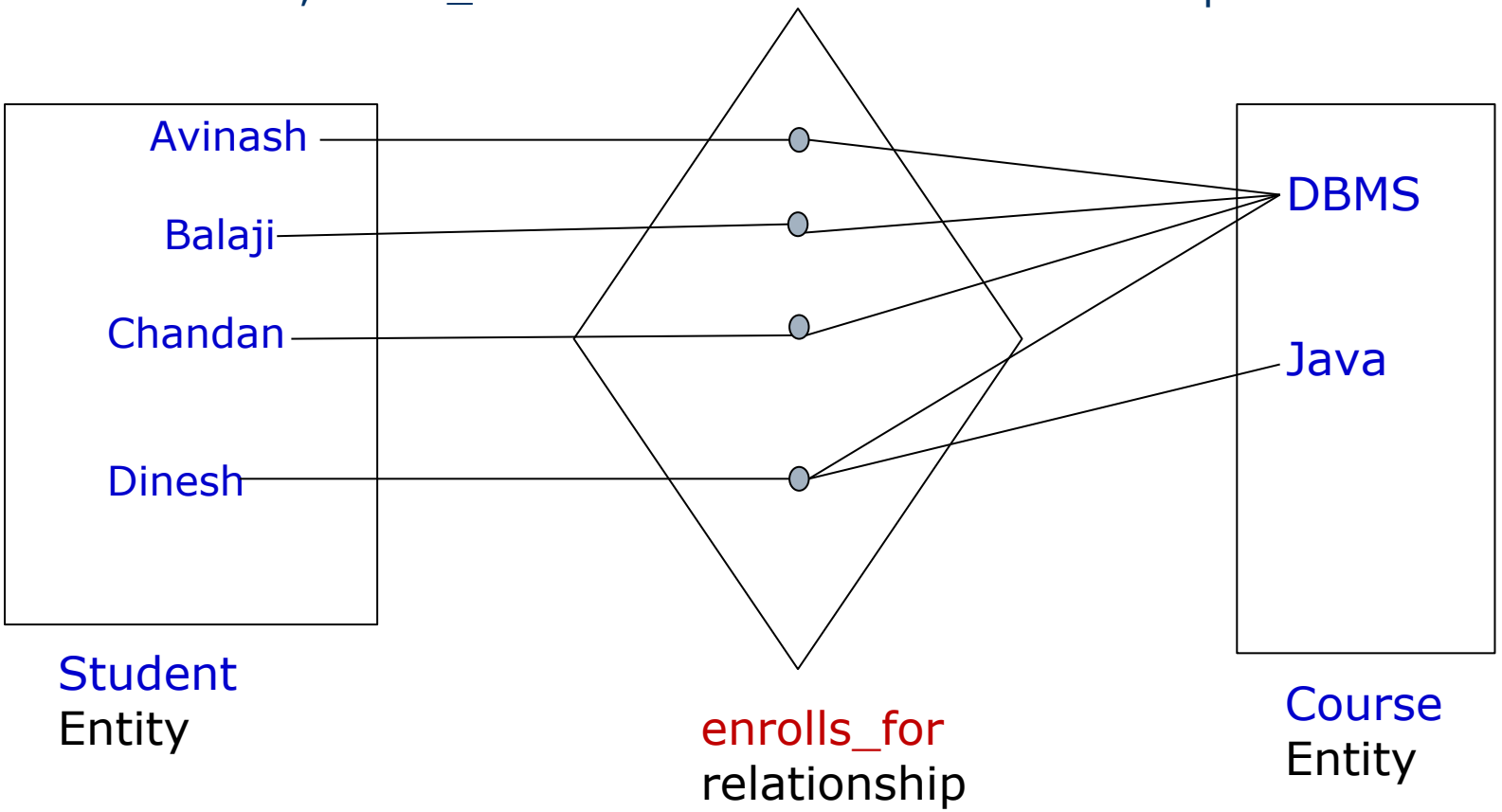
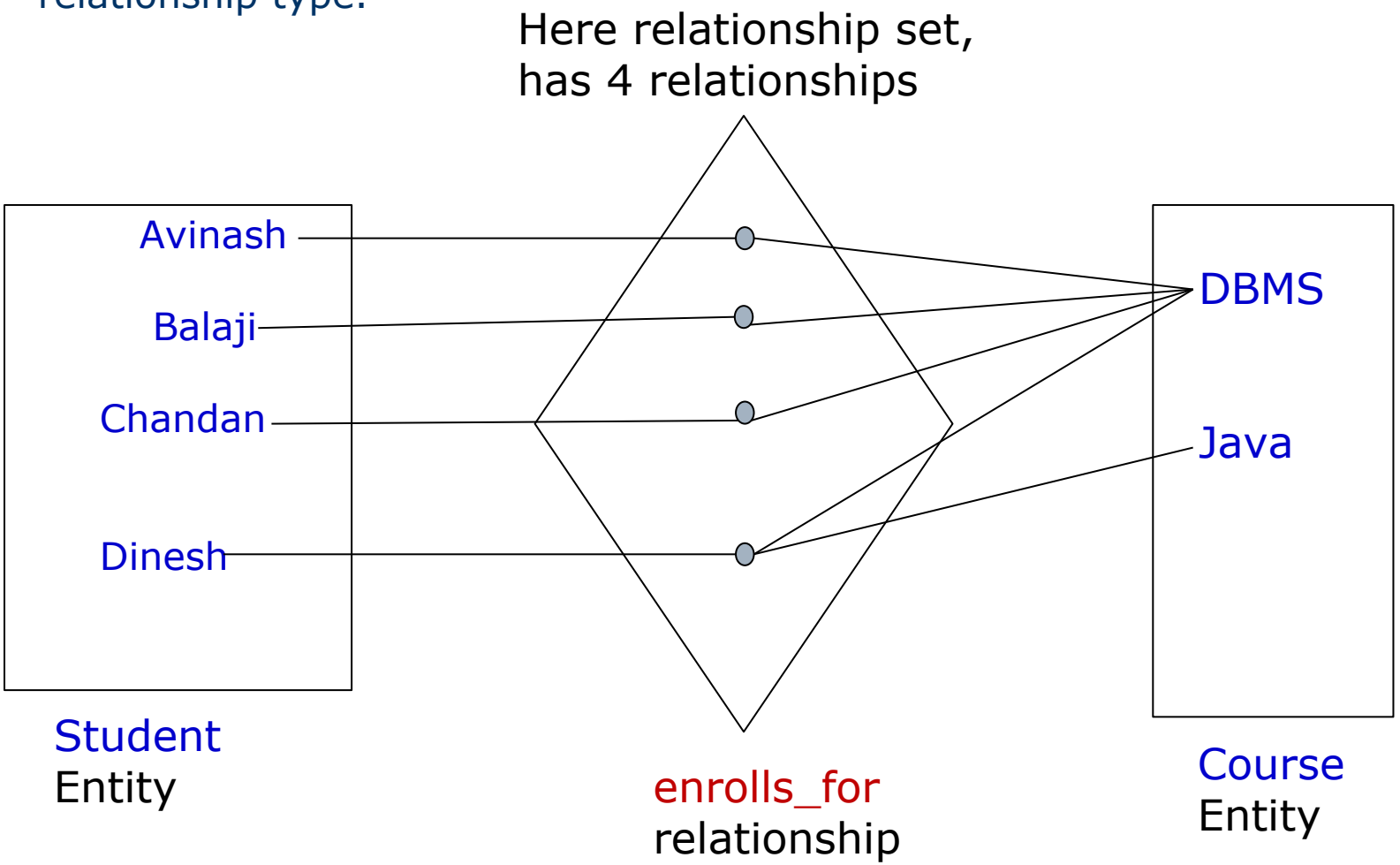


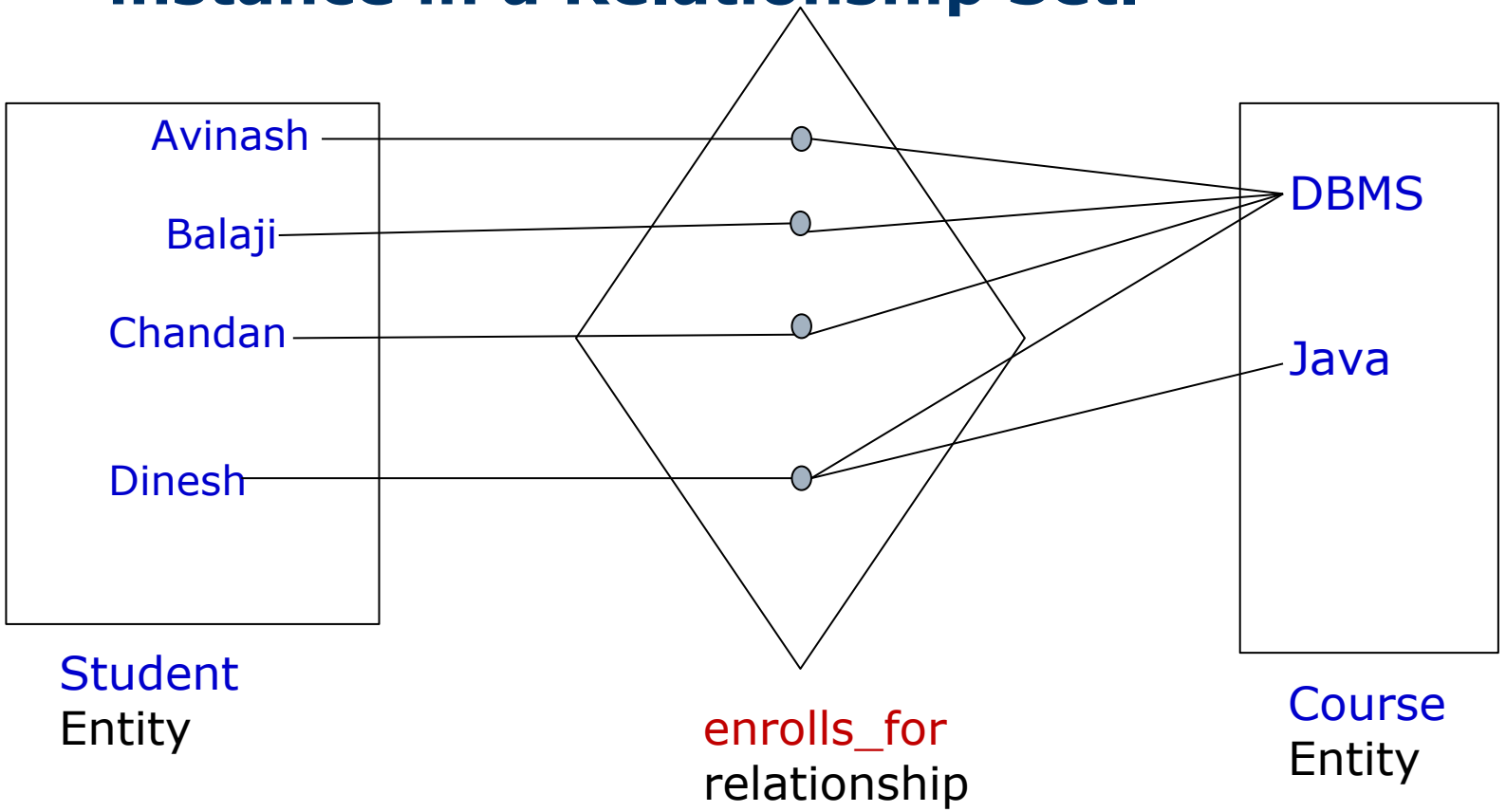
Relationship Set

- An Relationship Set is a collection of relationships all belonging to one relationship type.



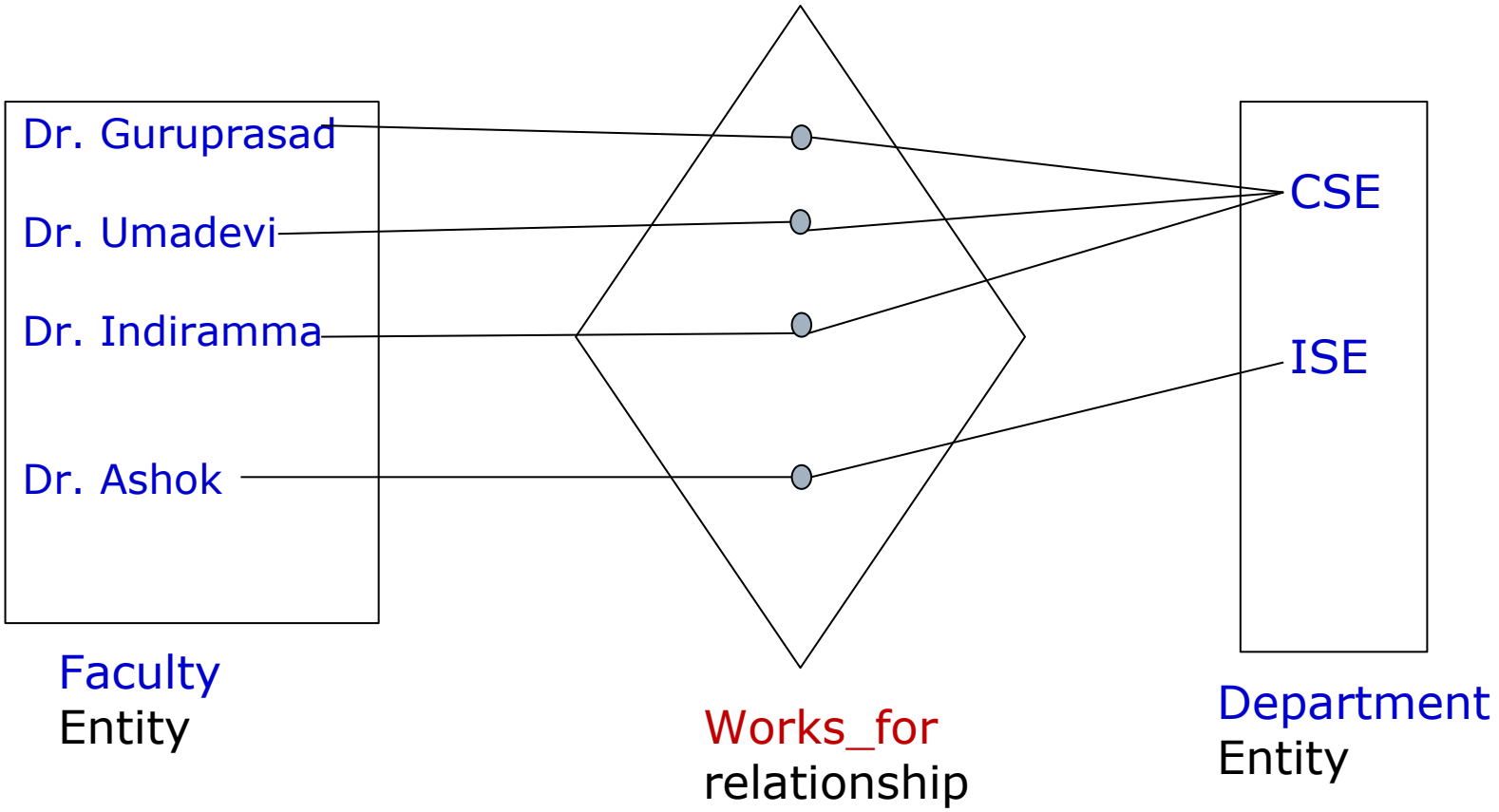
Relationship

- The association among entities is called a relationship. or **A Relationship is one instance in a Relationship Set.**



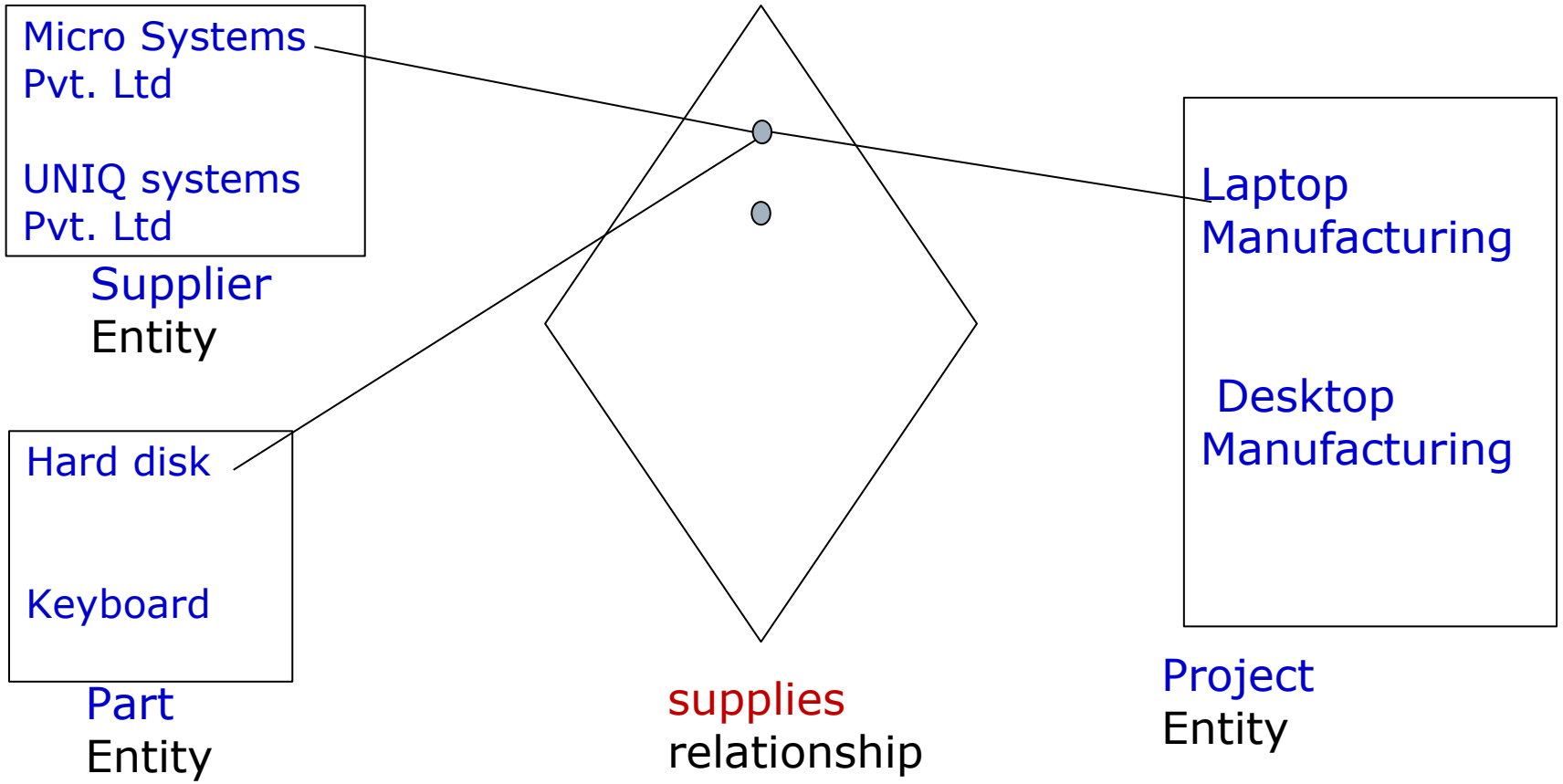
Relationship Degree

- Binary Relationship: Degree two, two entities are participating



Relationship Degree

- Ternary Relationship: Degree three, three entities are participating



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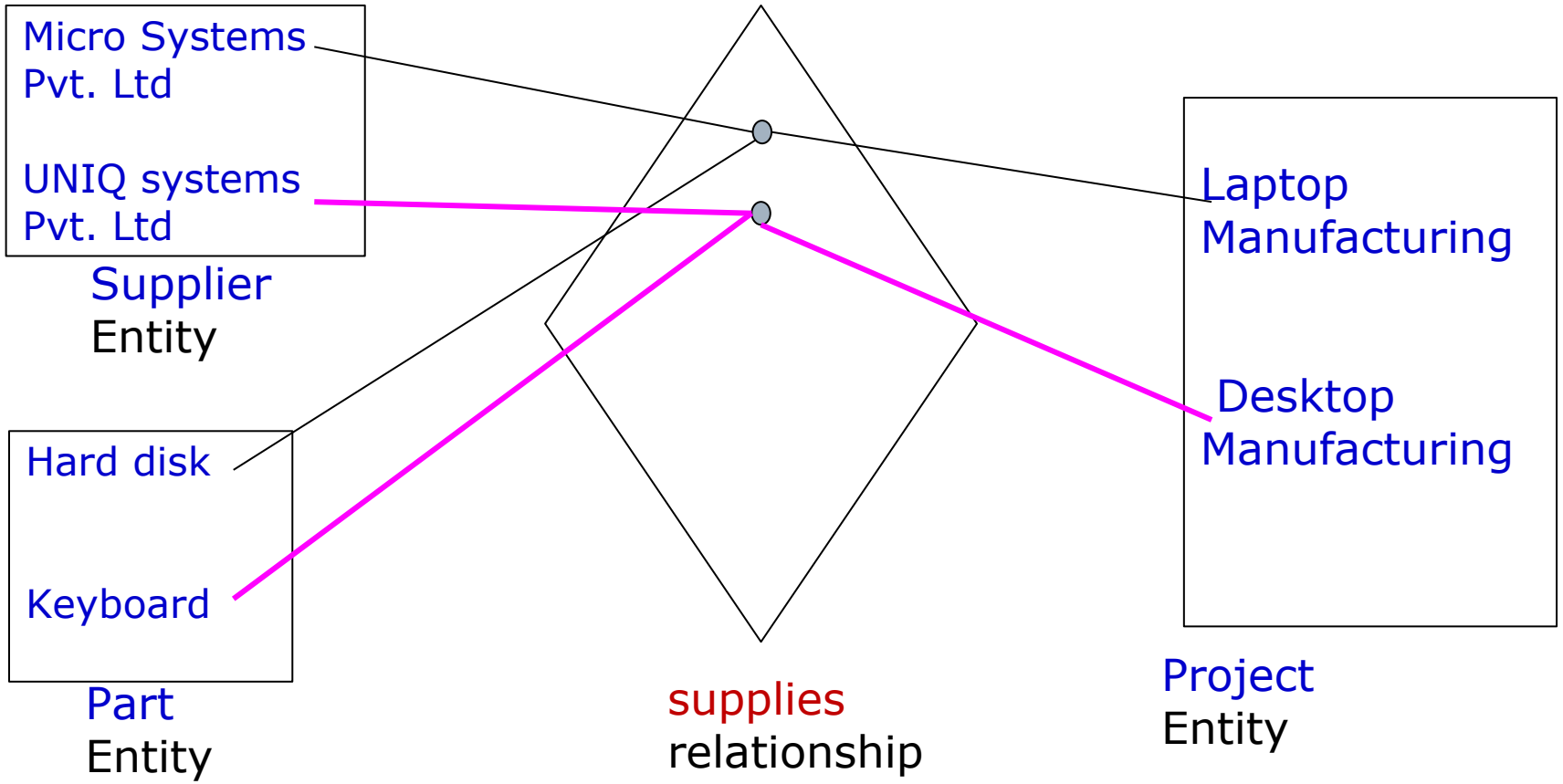
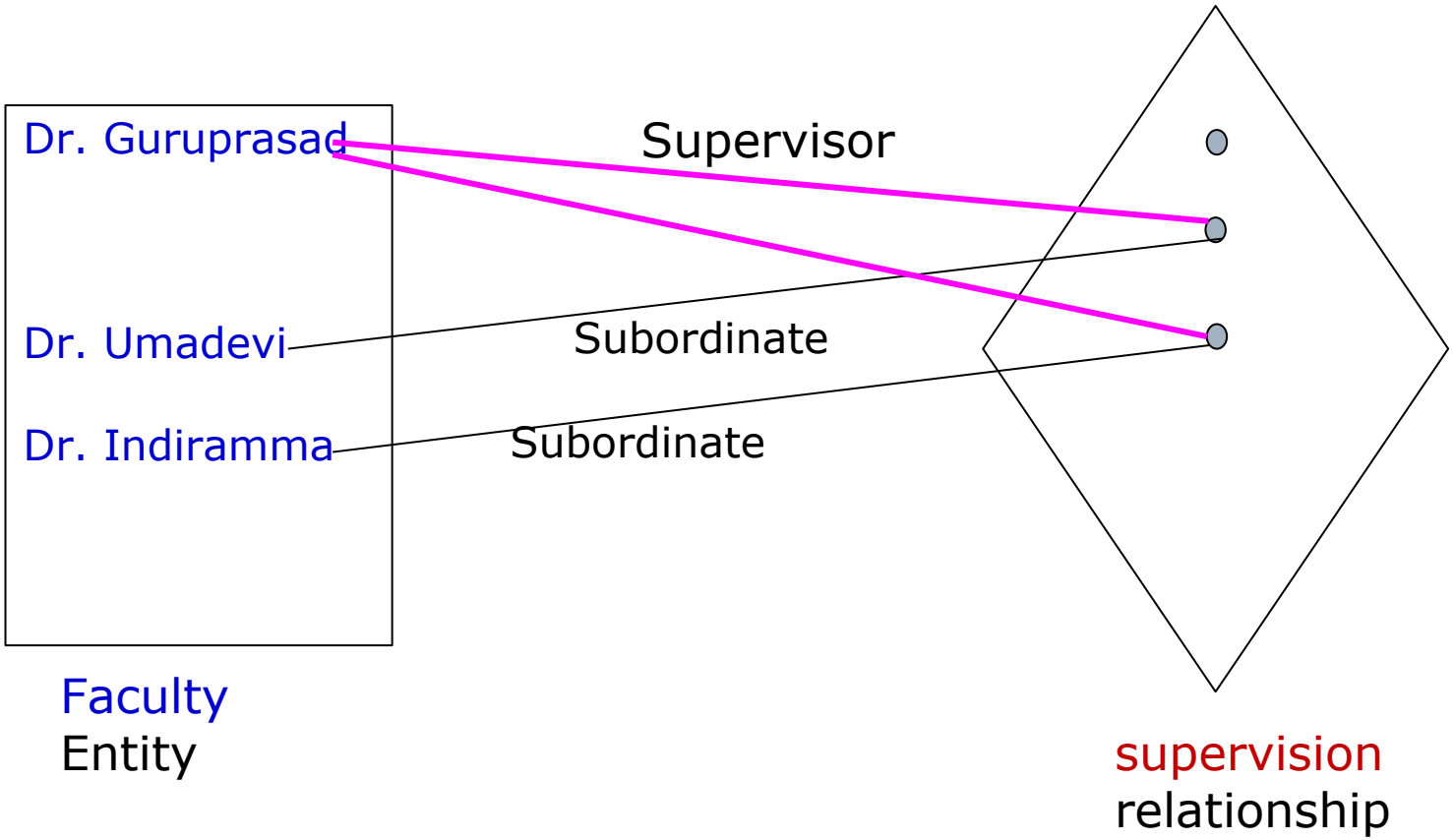


Recursive Relationship

- In some cases the **same entity** type **participates** in **more than once** in a relationship type in **different roles**.



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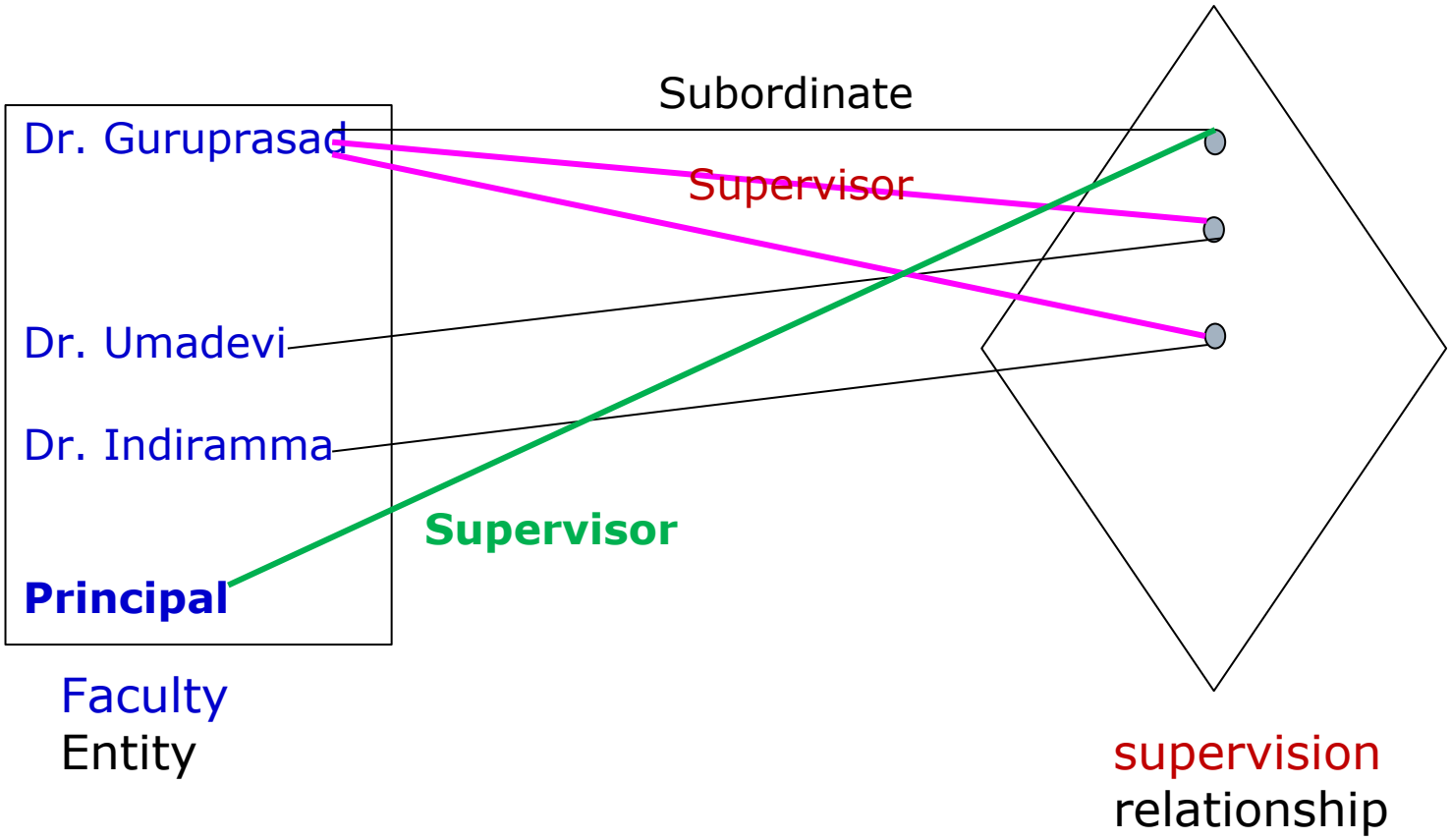


Relationship Constraints or Structural Constraints

Two Types

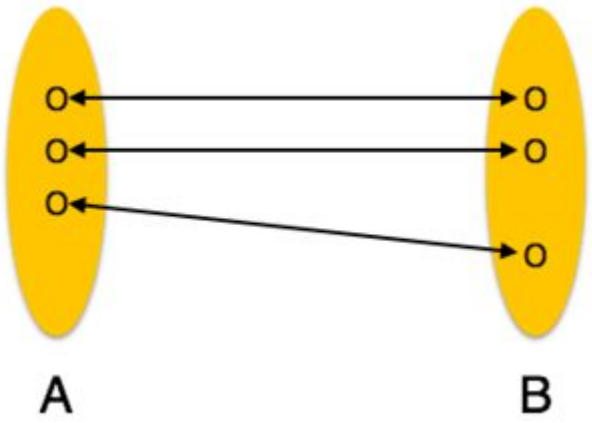
1. Cardinality Ratios
   a. One to one (1:1)
   b. One to Many (1:M)
   c. Many to Many (N:M)
2. Participation Constraints
   a. Total
   b. Partial

Cardinality Ratios

- Cardinality is a constraint on a relationship specifying the number of entity instances that a specific entity may be related to via the relationship.

One to One:

One entity from entity set A can be associated with at most one entity of entity set B and vice versa.



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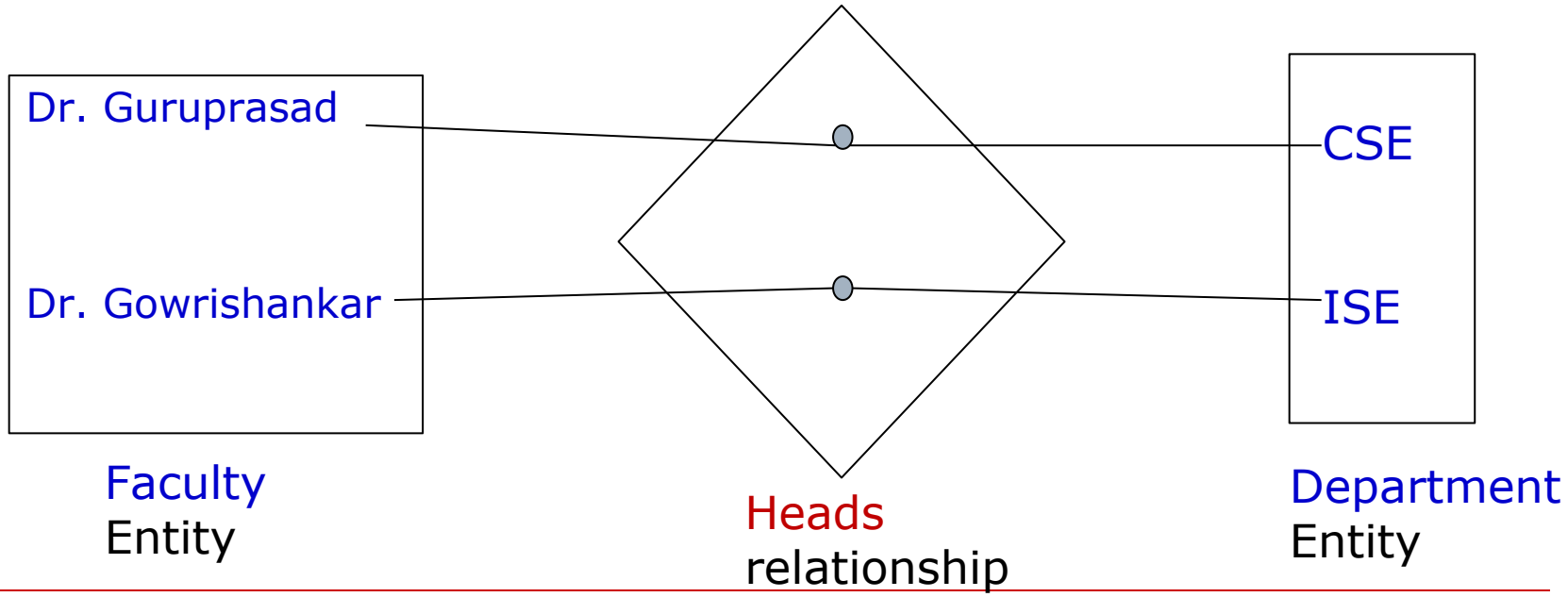

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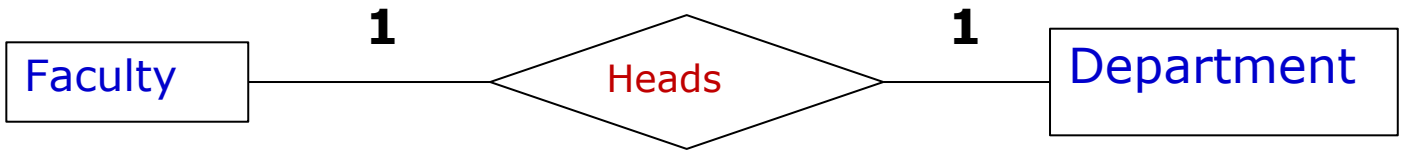

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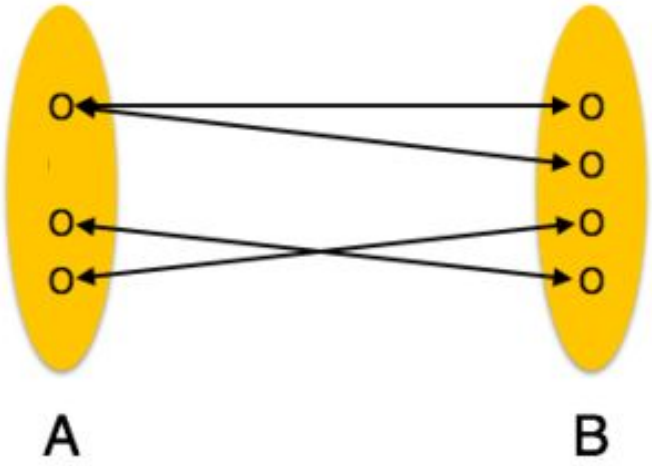

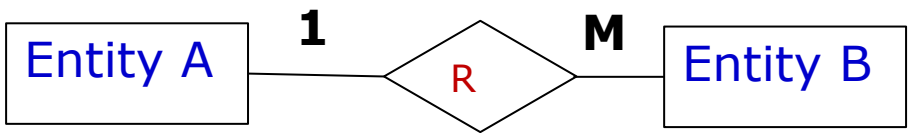

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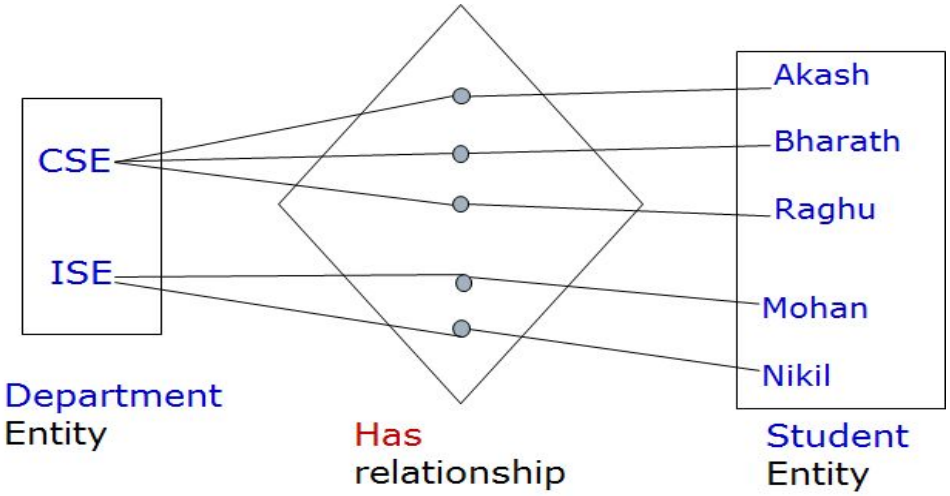

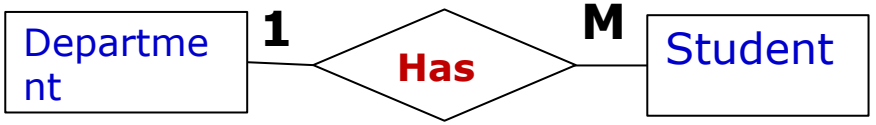

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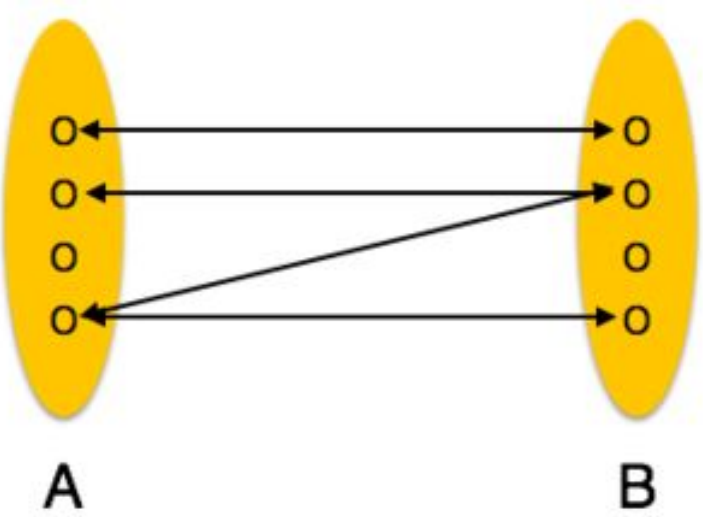

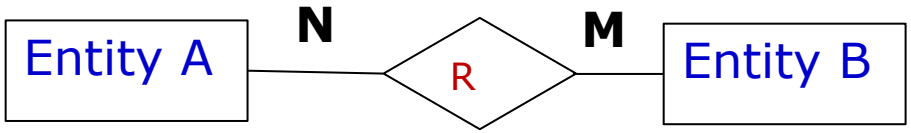

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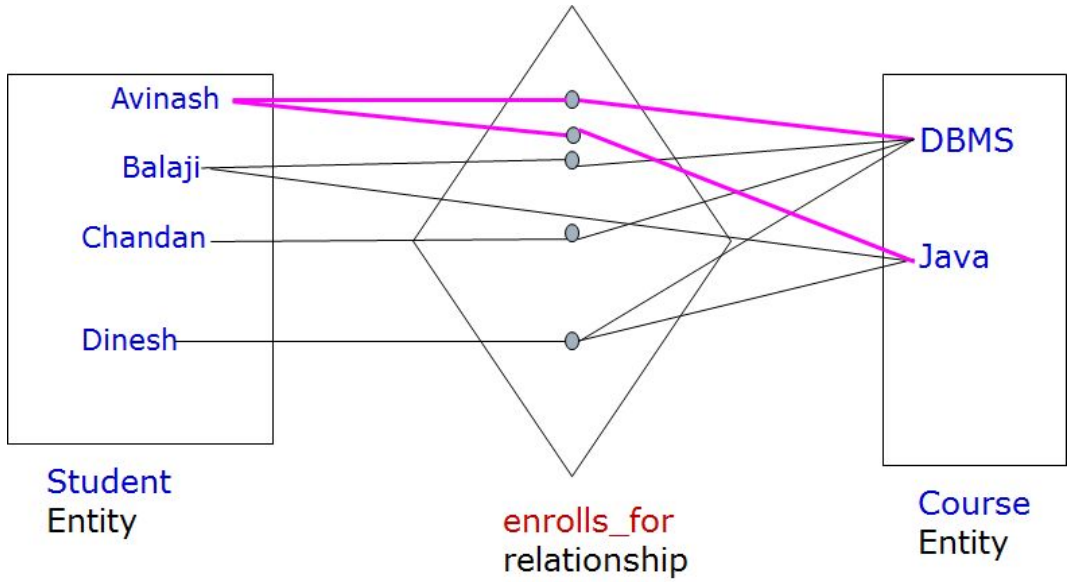

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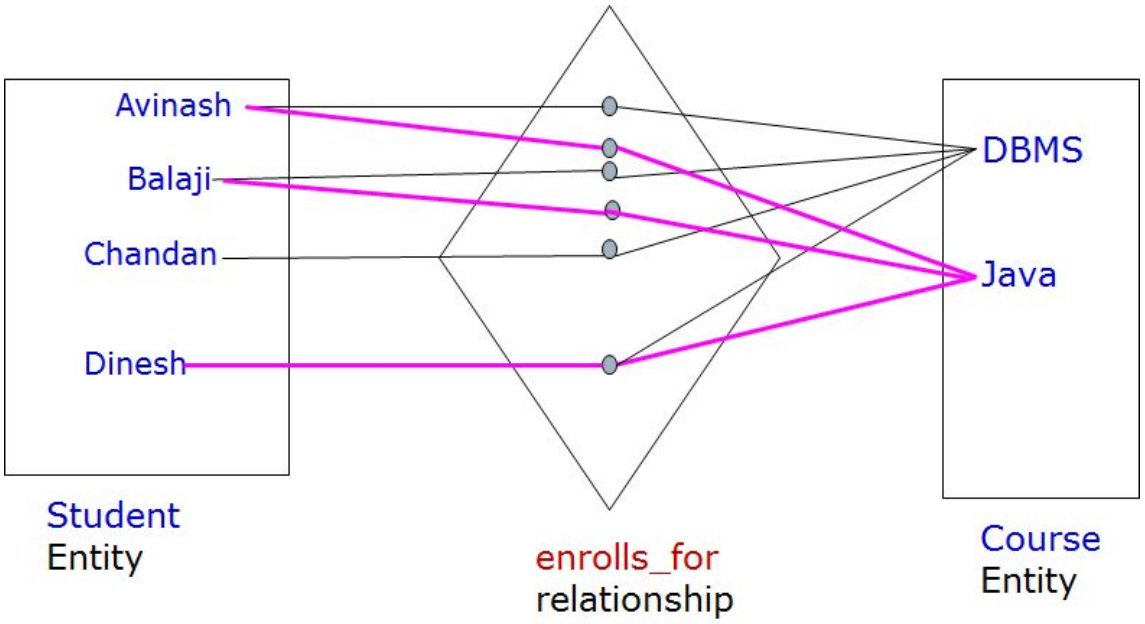
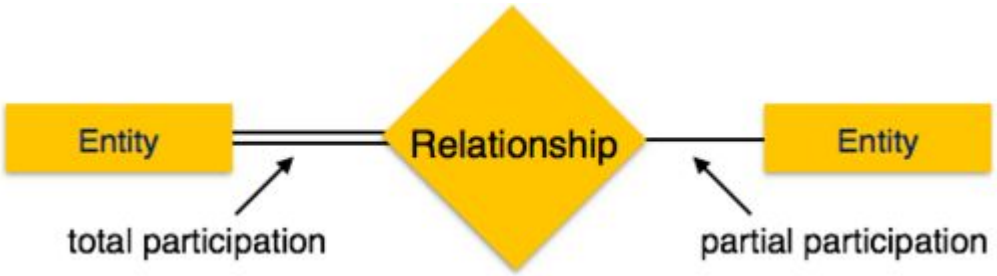


Participation Constraint

- Minimum number of relationship instance that each entity can participate in.
- **Total Participation** – Each entity is involved in the relationship. Total participation is represented by double lines.
- **Partial participation** – Not all entities are involved in the relationship. Partial participation is represented by single lines.



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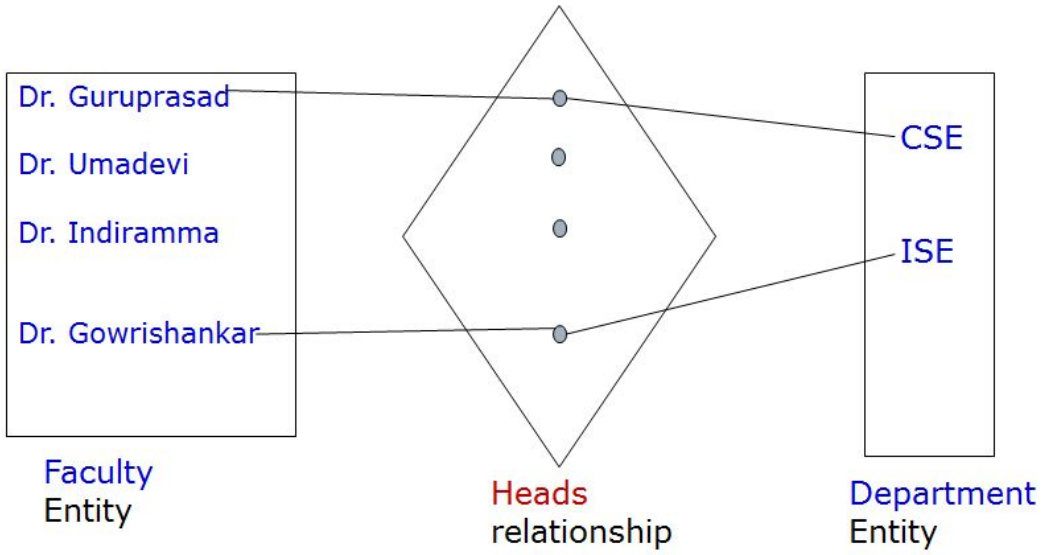

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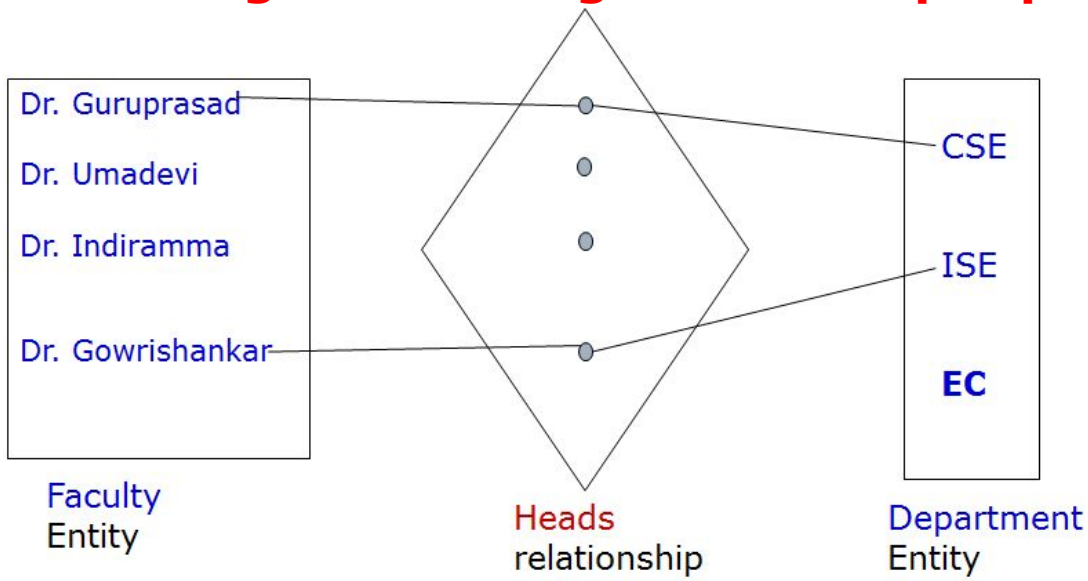
What is wrong in following relationship representation ?



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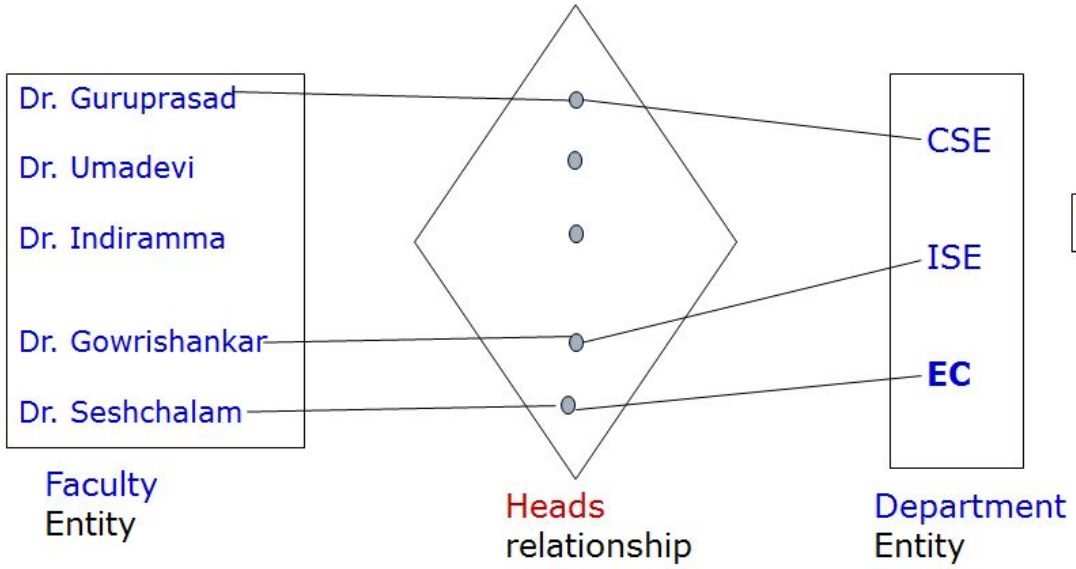
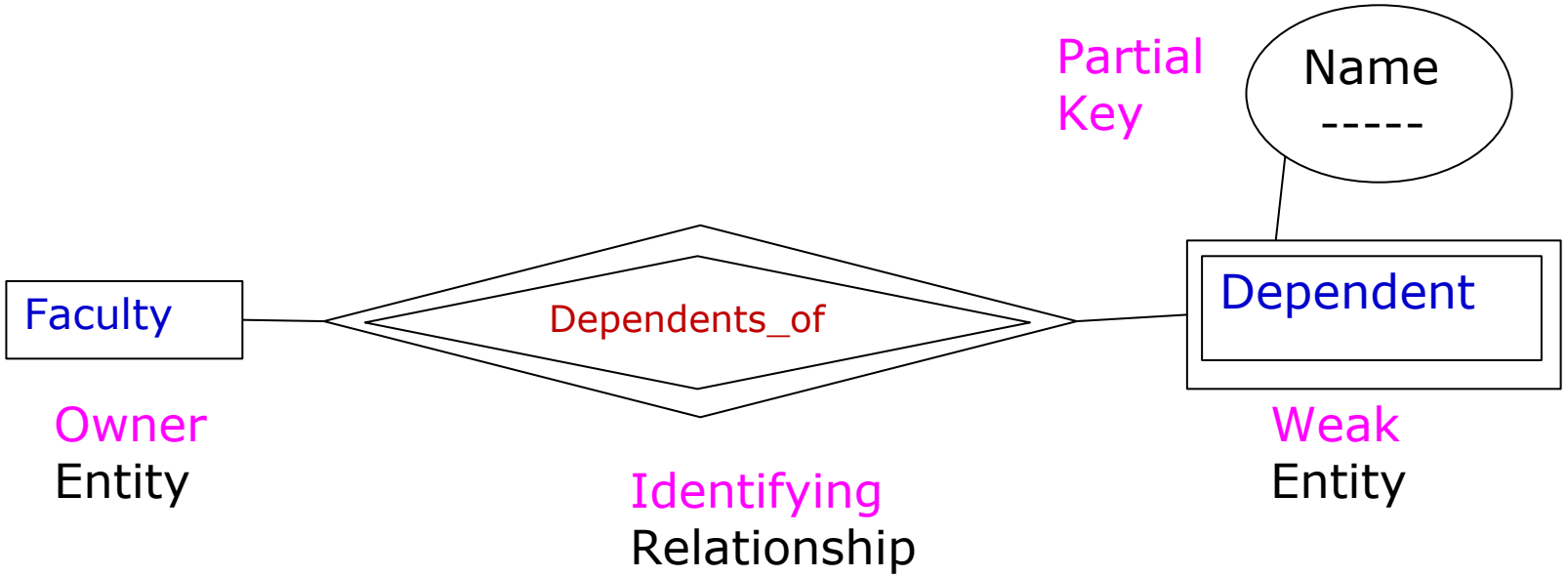


Weak Entity

- A weak entity set is one which **does not have any primary key** associated with it.
- A weak entity type normally has partial key which is the set of attributes that can uniquely identify weak entities that are related to same owner entity.



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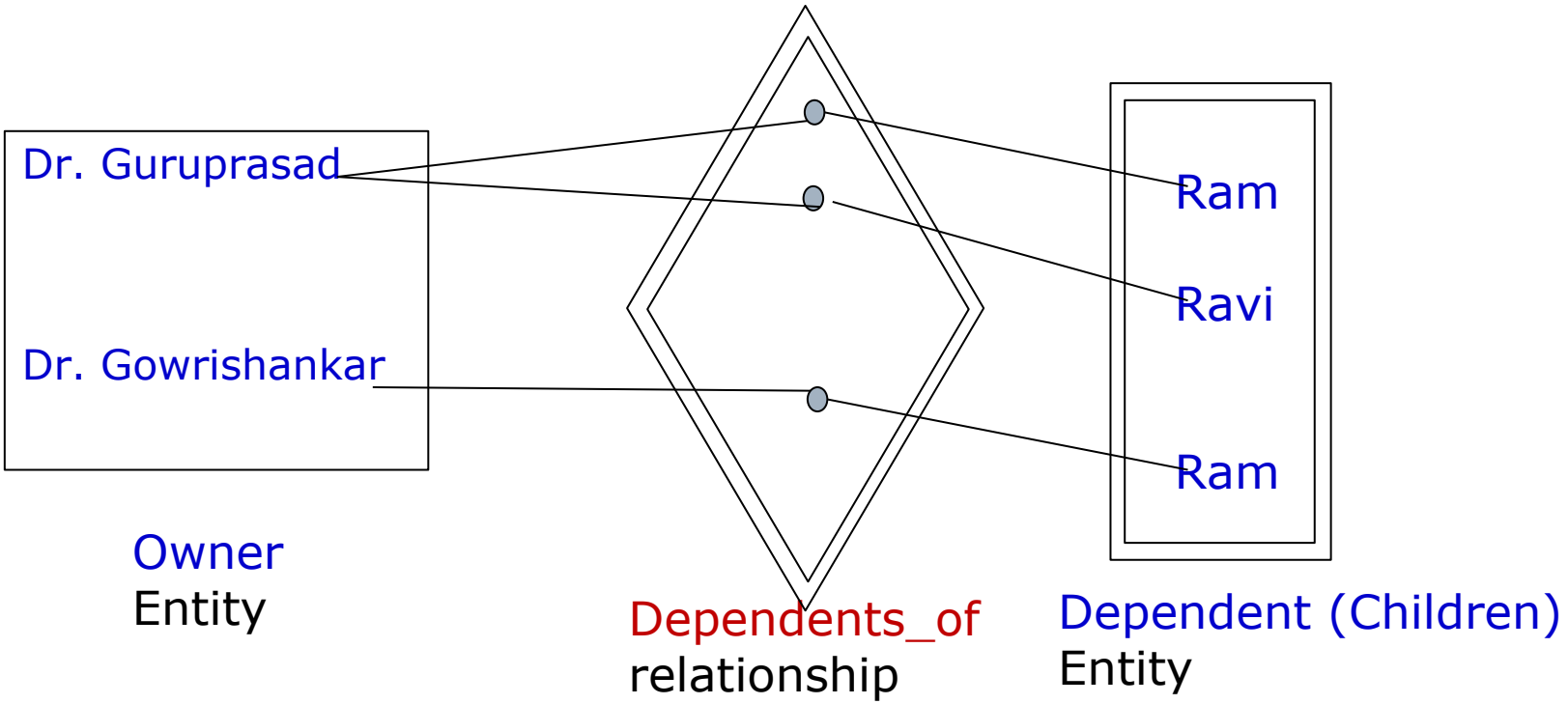
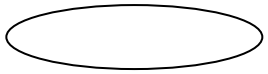
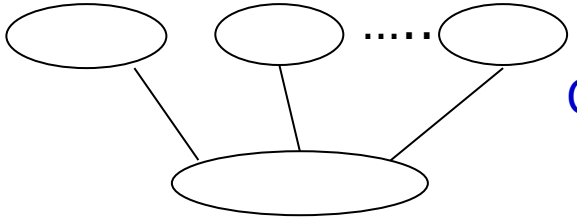


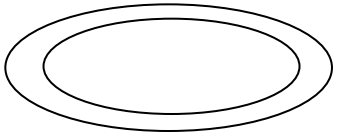
ER Diagram Symbols



Attribute



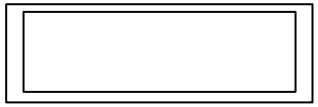
Composite Attribute



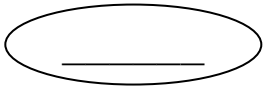
Multivalued Attribute

Derived Attribute

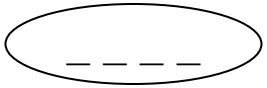
Entity



Weak Entity

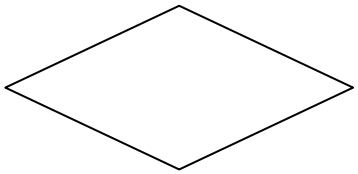


Key Attribute

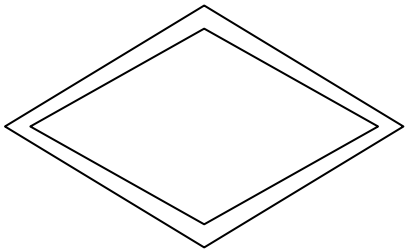


Partial Key

ER Diagram Symbols



Relationship



Identifying Relationship

Total Participation of Entity A in R

Cardinality Ratio 1:N for Entity A : B in R

Topics Covered in Todays Class

Unit 2:
ER diagram design for a given requirements

Database Design

Database design: Why do we need it ?

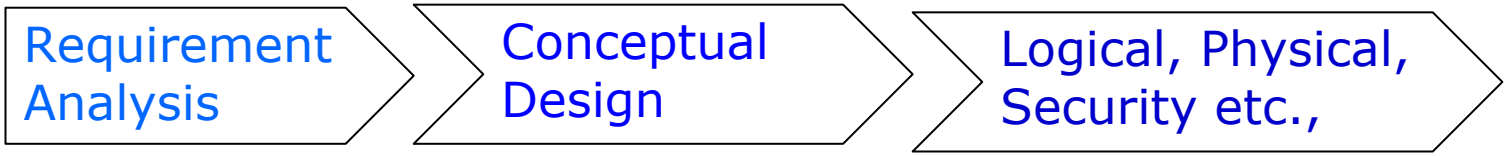
- Agree on structure of the database before deciding on a particular implementation

Consideration Issues such as:

- What entities to model
- How entities are related
- What constraints exist in the domain
- How to achieve good design

ER diagram is a conceptual design of database

Database Design Process

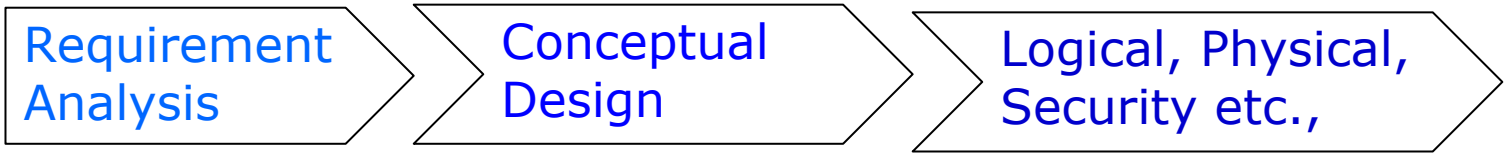


Requirement Analysis

- What is going to be stored ?
- How is it going to be used ?
- What are we going to do with the data ?
- Who should access the data ?

Technical and Non-technical people are involved

Database Design Process

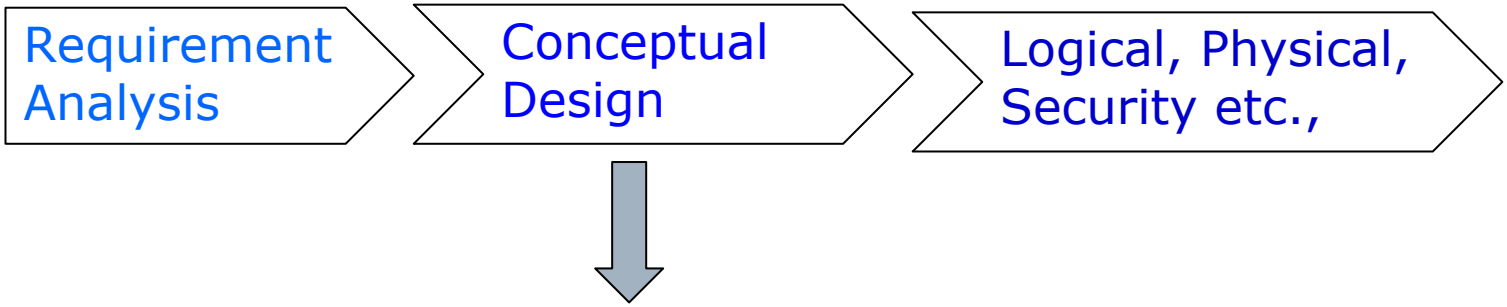


Conceptual Design

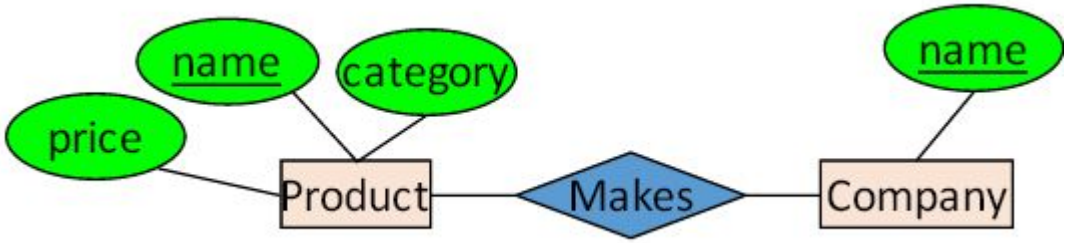
- A high-level description of the database.
- Sufficiently precise that technical people can understand it.
- But, not so precise that non-technical can not participate.

This is were Entity-Relationship (ER) Diagram fits in.

Database Design Process



ER diagram is **visual syntax for DB design** which is precise enough for technical points, but abstracted enough for non-technical people.



Main phases of Database Design

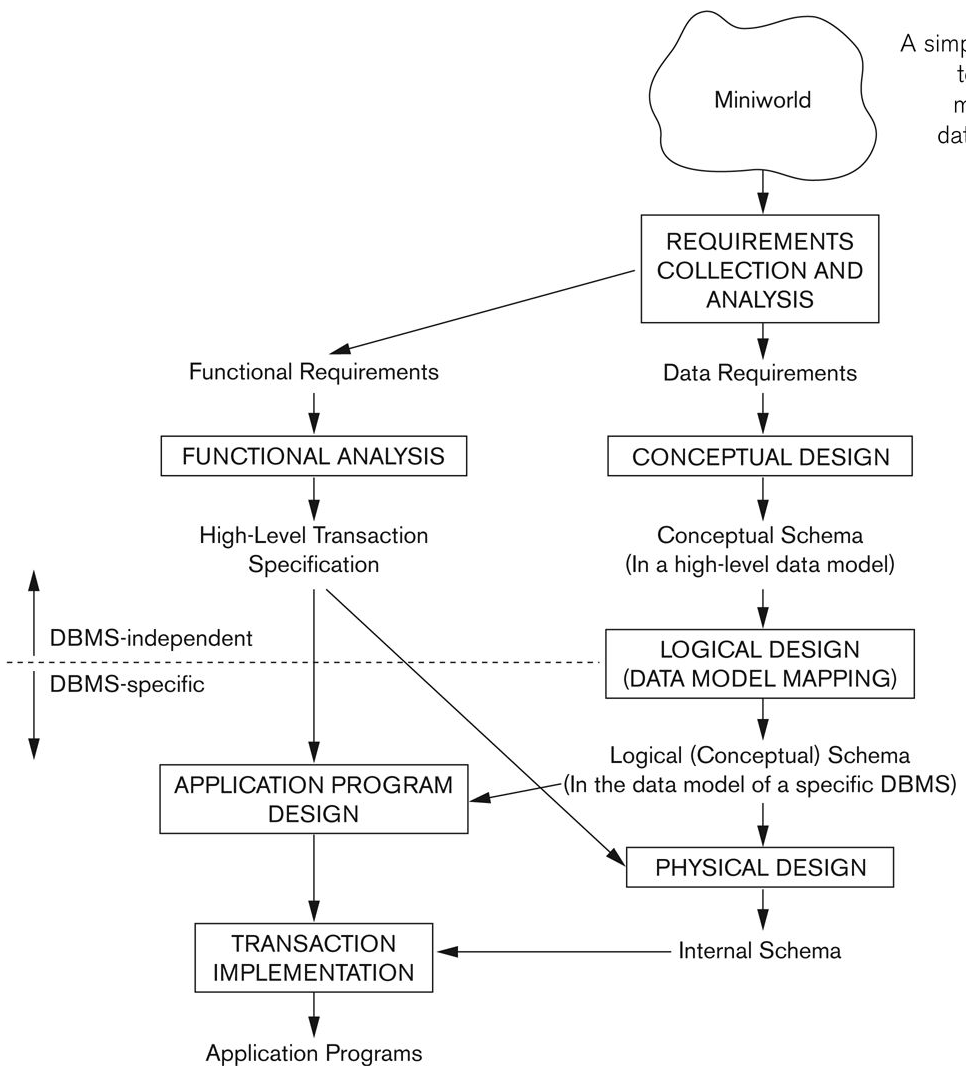
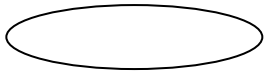
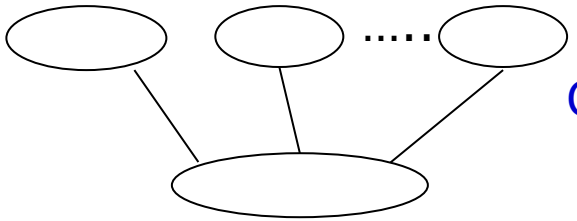


Figure 3.1
A simplified diagram to illustrate the main phases of database design.

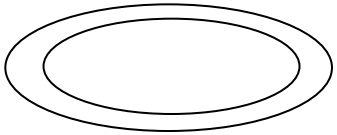
ER Diagram Symbols



Attribute



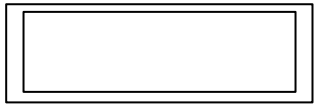
Composite Attribute



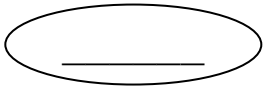
Multivalued Attribute

Derived Attribute

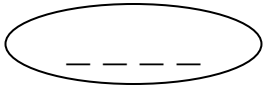
Entity



Weak Entity

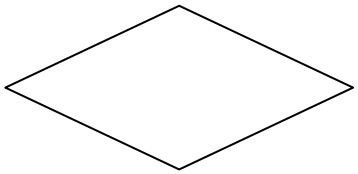


Key Attribute

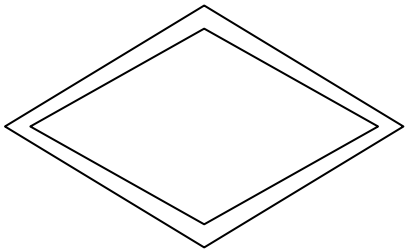


Partial Key

ER Diagram Symbols



Relationship



Identifying Relationship

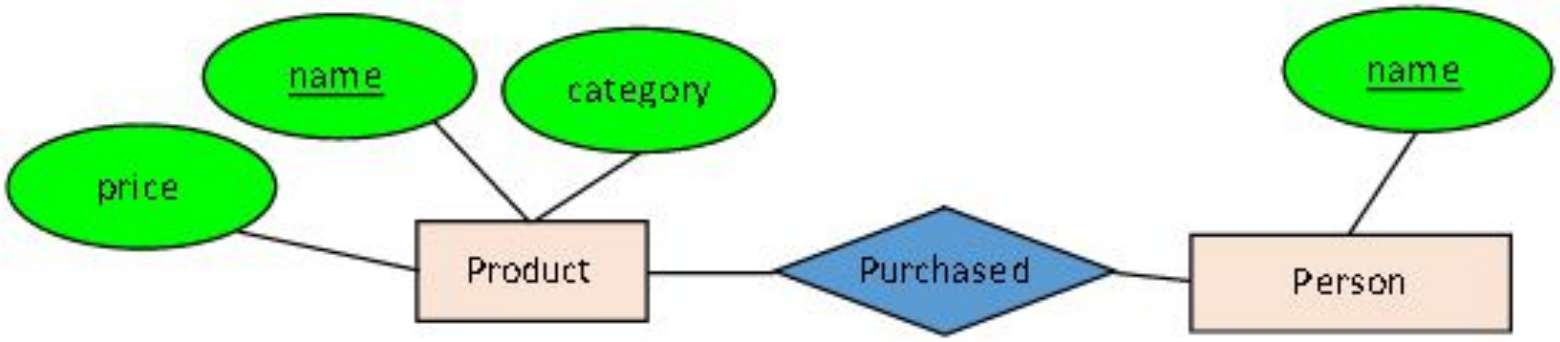
Total Participation of Entity A in R

Cardinality Ratio 1:N for Entity A : B in R

Activity: ER diagram

Decision: Relationship vs Empty

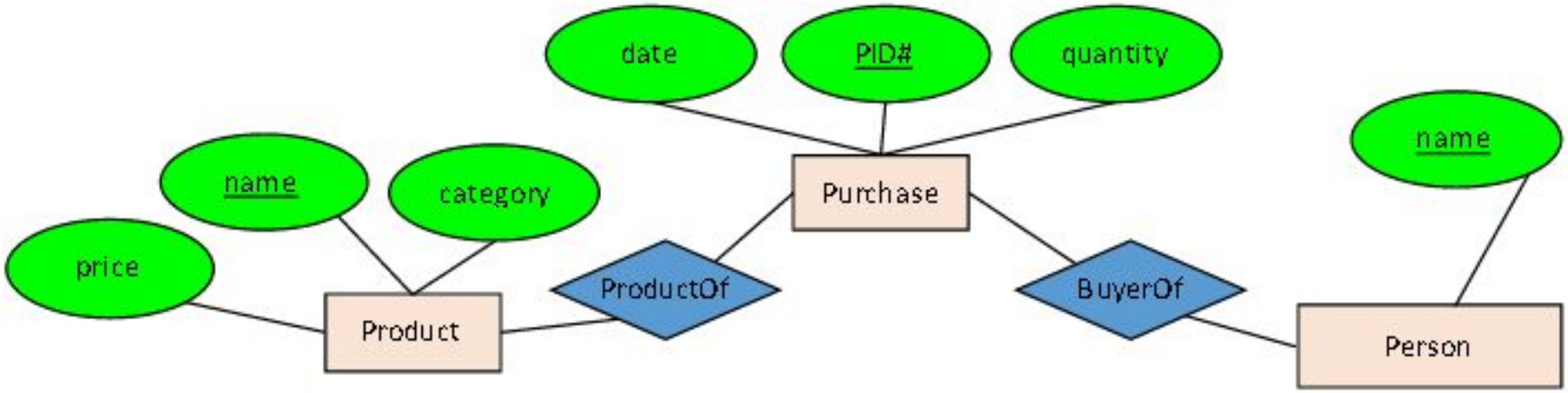
Question 1: What does the following ER diagram say ?



Activity: ER diagram

Decision: Relationship vs Empty

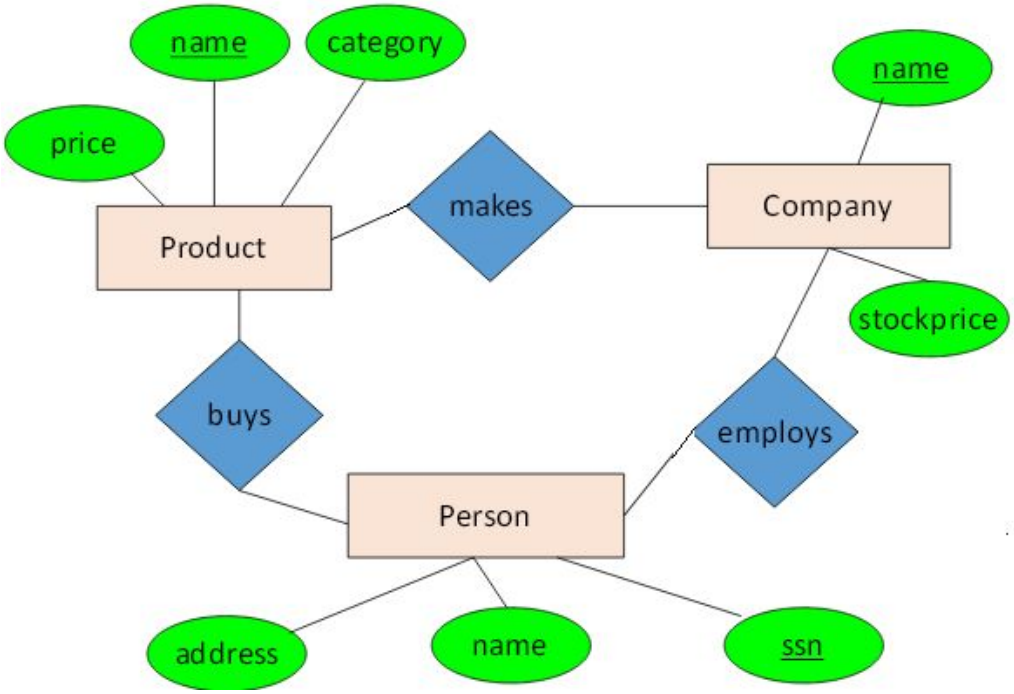
Question 2: What does the following ER diagram say ?



Activity: ER diagram

Decision: Relationship vs Empty

Question 3: What does the following ER diagram say ?



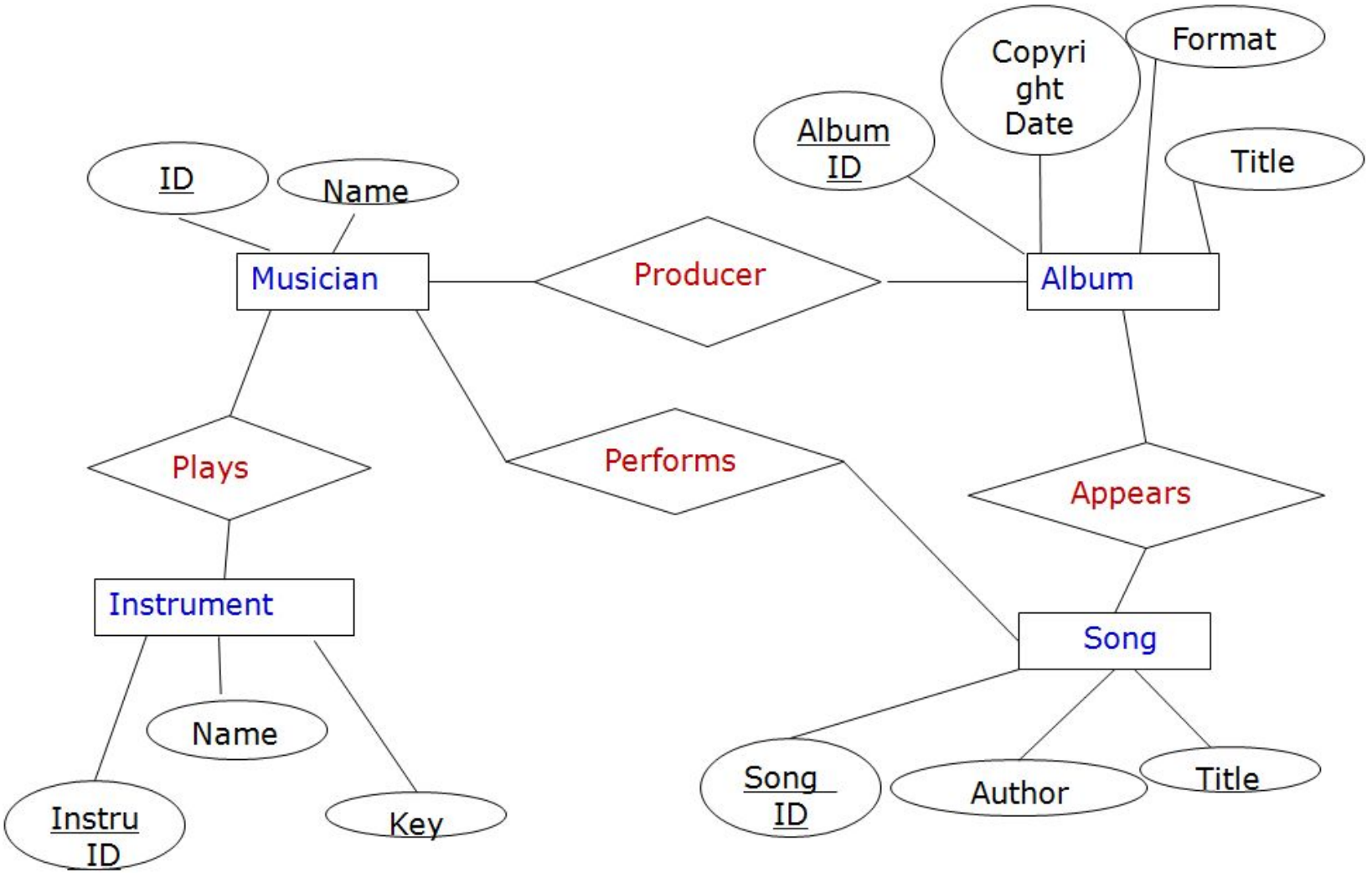
Activity: ER diagram design

Draw ER diagram for the following requirements

Universal Records has decided to store information about musicians who perform on its albums (as well as other company data) in a database.

- Each musician that records at Universal has an ID(Key) and name.
- Each instrument used in songs recorded at Universal has a unique identification number (Key) , a name and a musical key.
- Each album recorded on the Universal label has a unique identification number (Key) , a title, a copyright date and a format.
- Each song recorded at Universal has a Song ID (Key), a title and an author.
- Each musician may play several instruments, and a given instrument may be played by several musicians.
- Each album has a number of songs on it, but no song may appear on more than one album.
- Each song is performed by one or more musicians, and a musician may perform a number of songs.
- Each album has exactly one musician who acts as its producer. A musician may produce several albums, of course.

Each musician that records at Universal has an ID (Key) and name.



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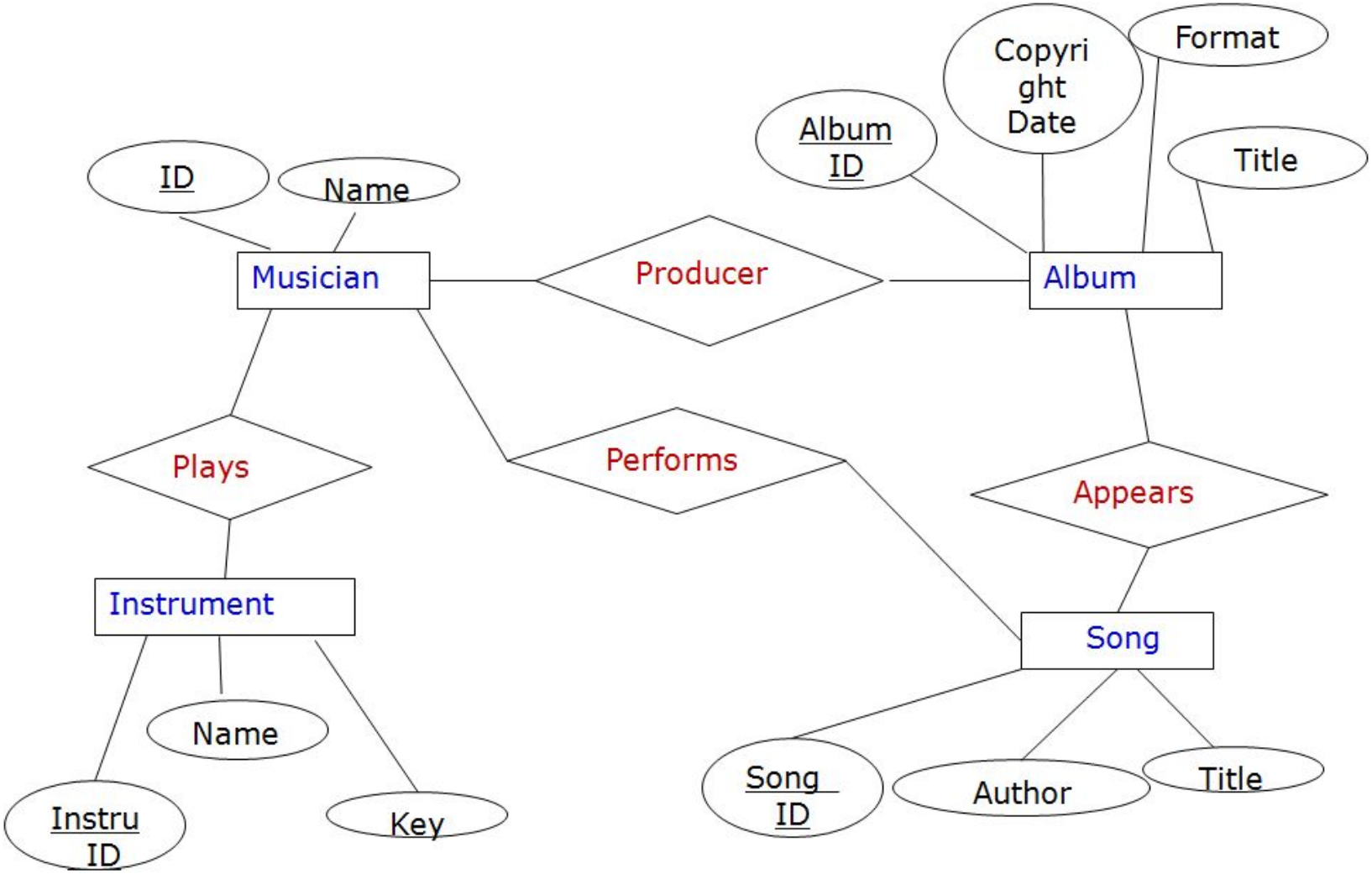

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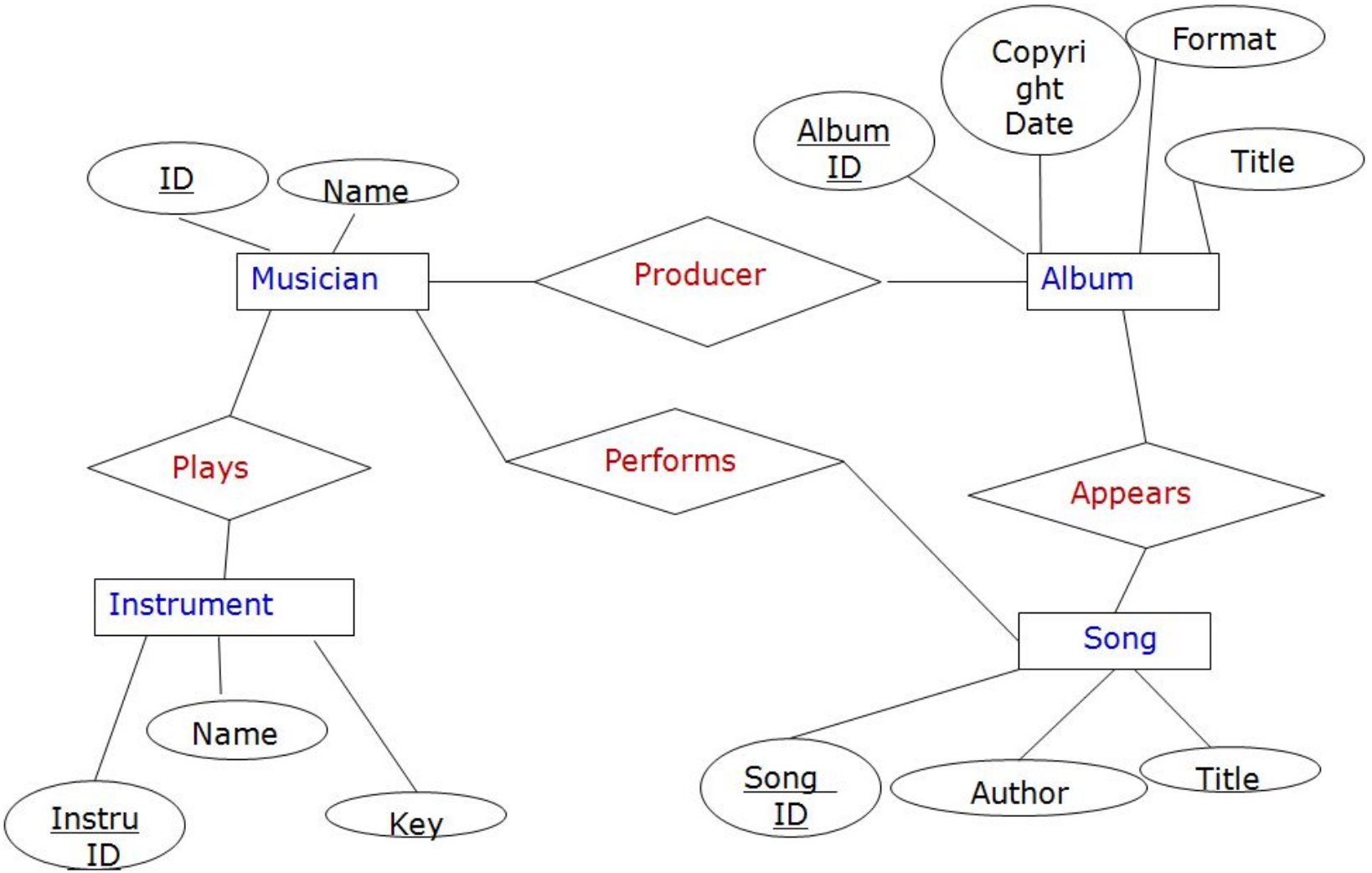

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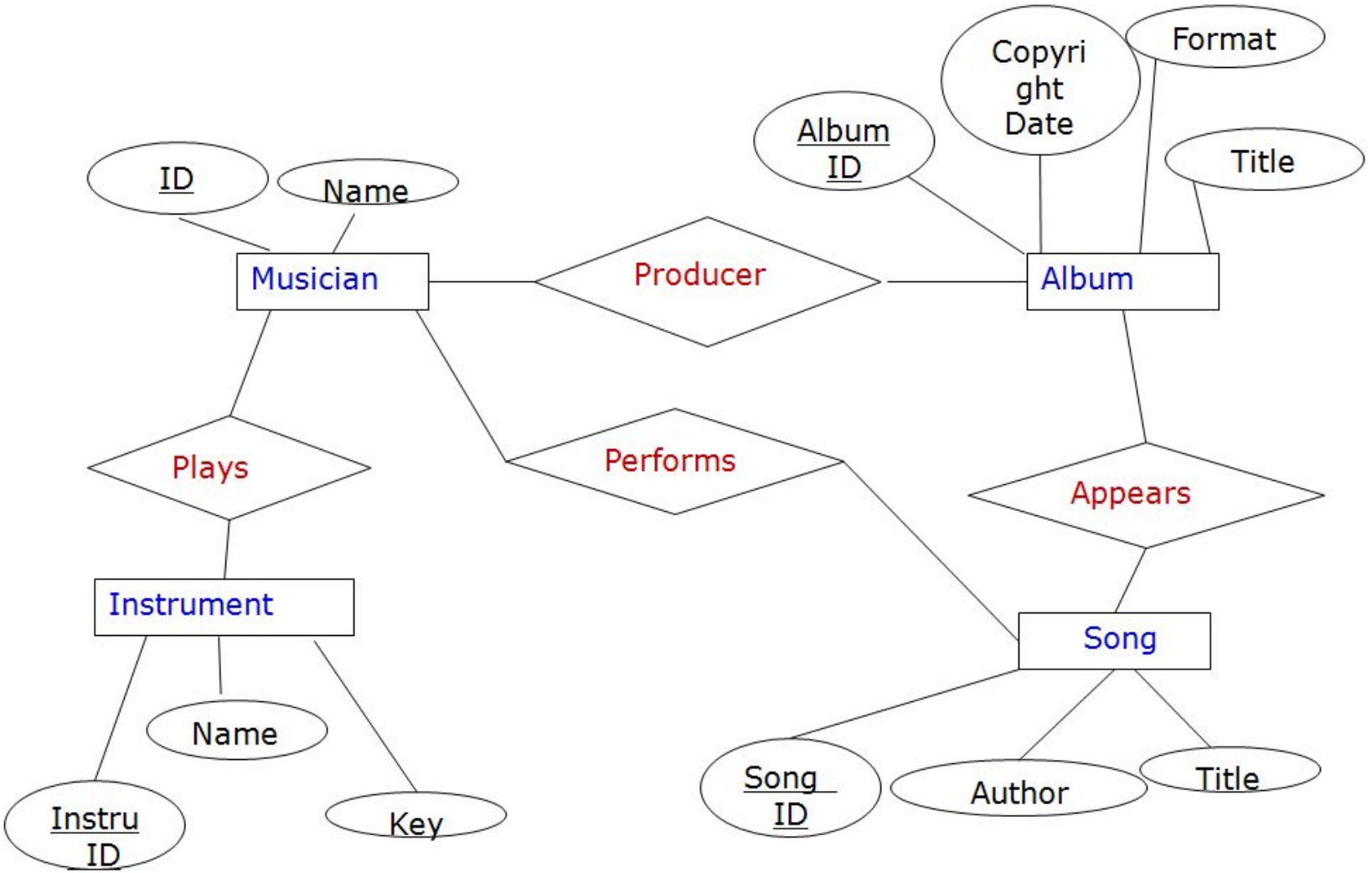
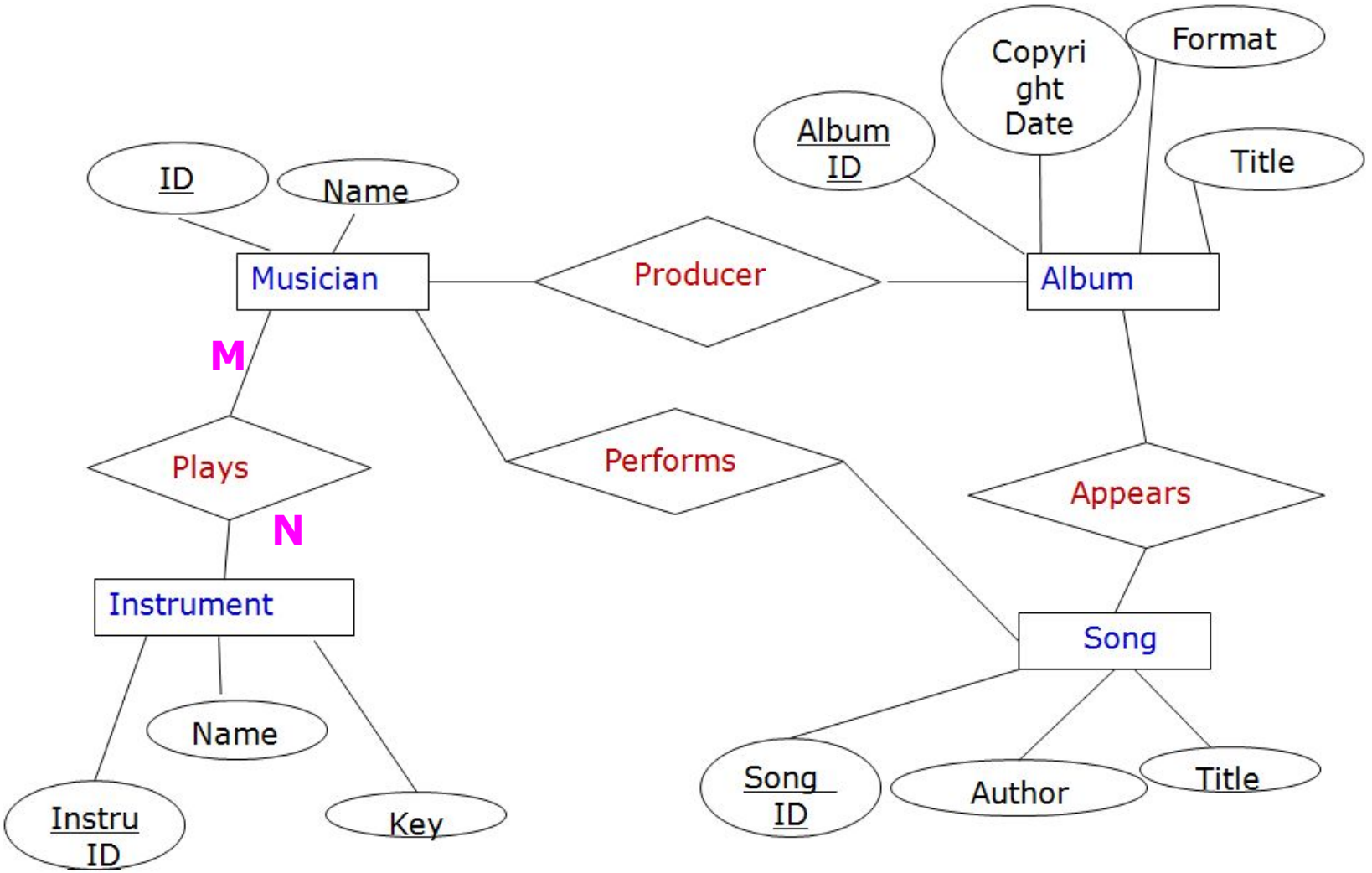


Each musician may play several instruments, and a given instrument may be played by several musicians.



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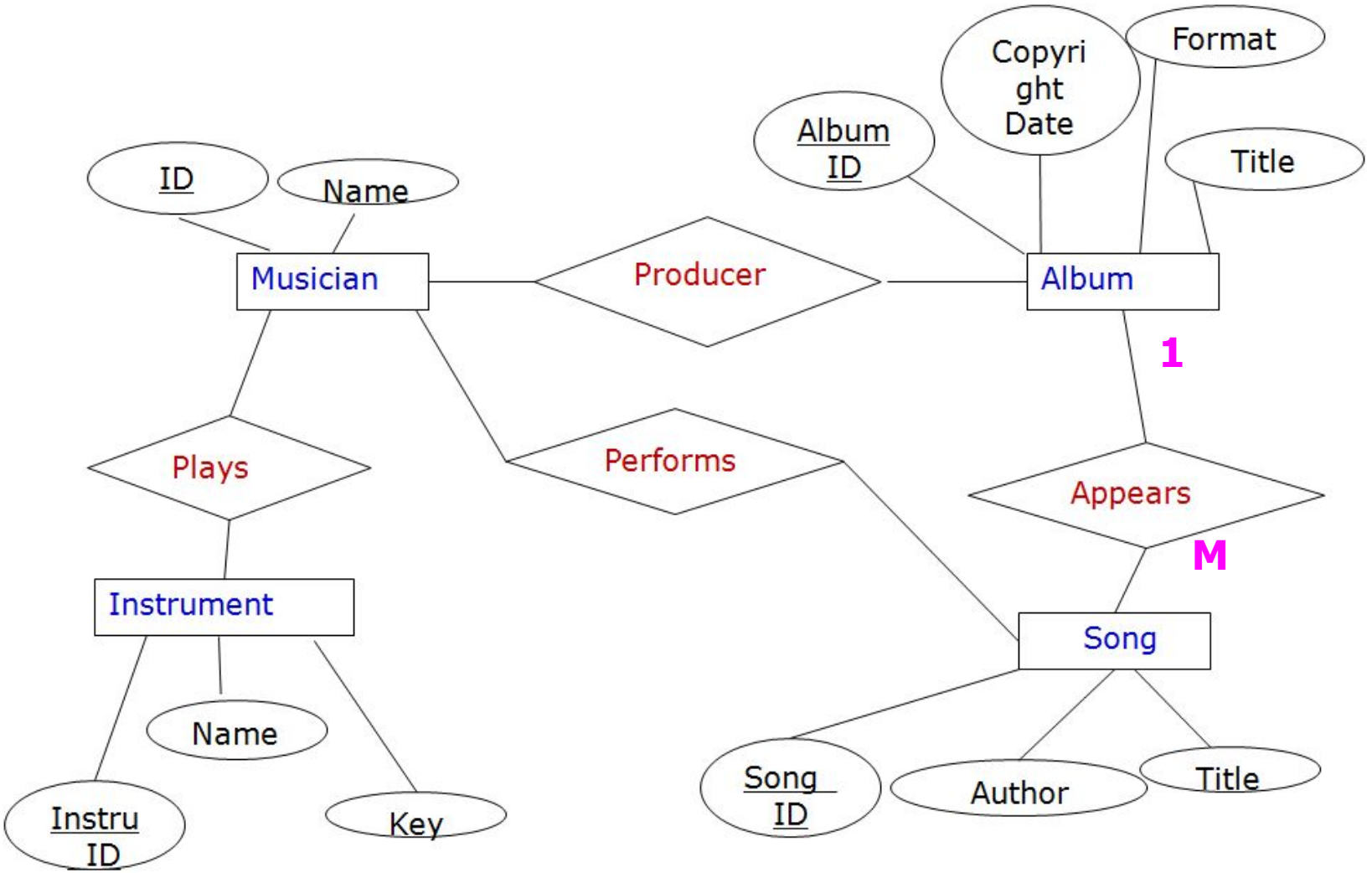

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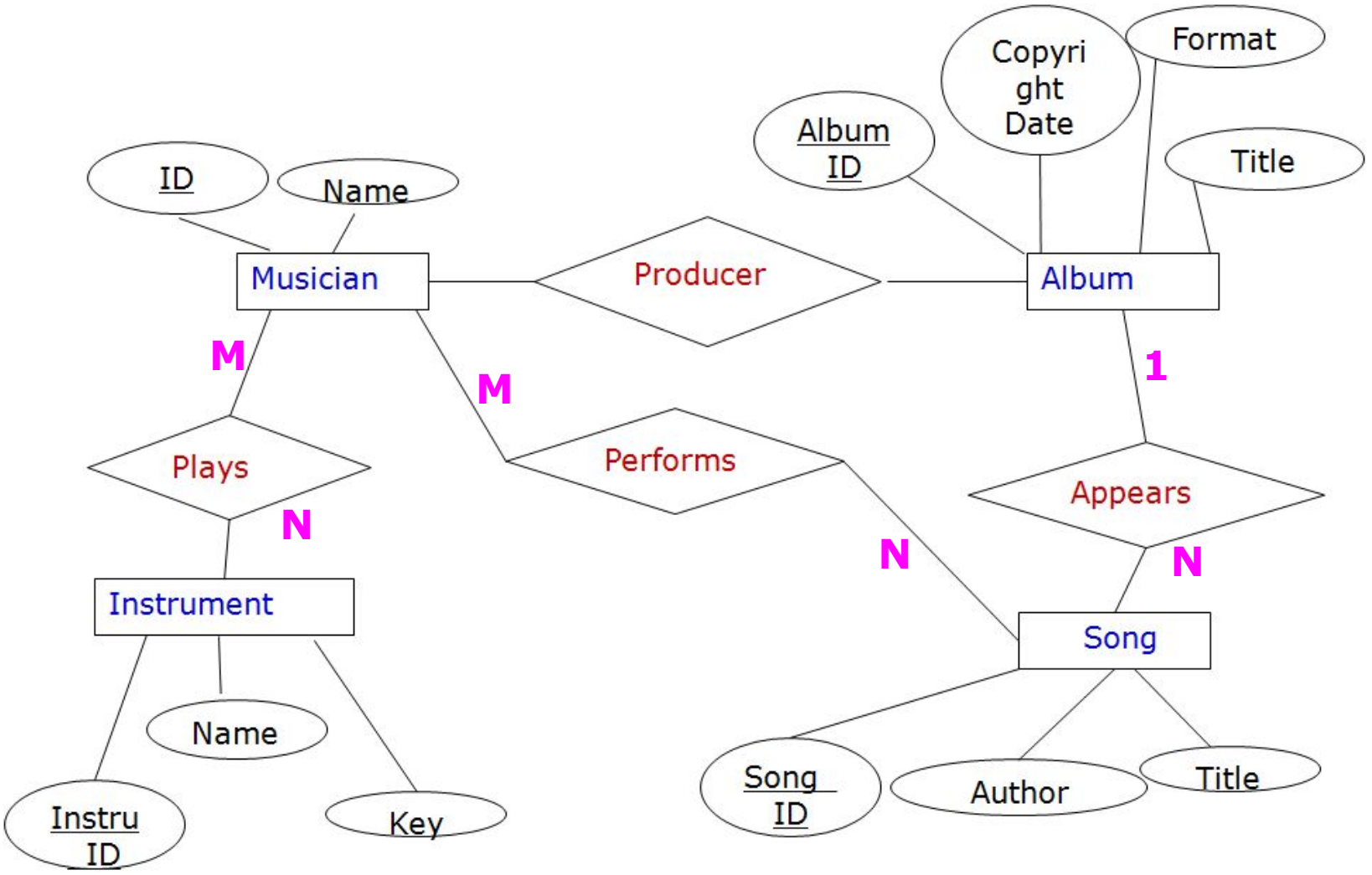

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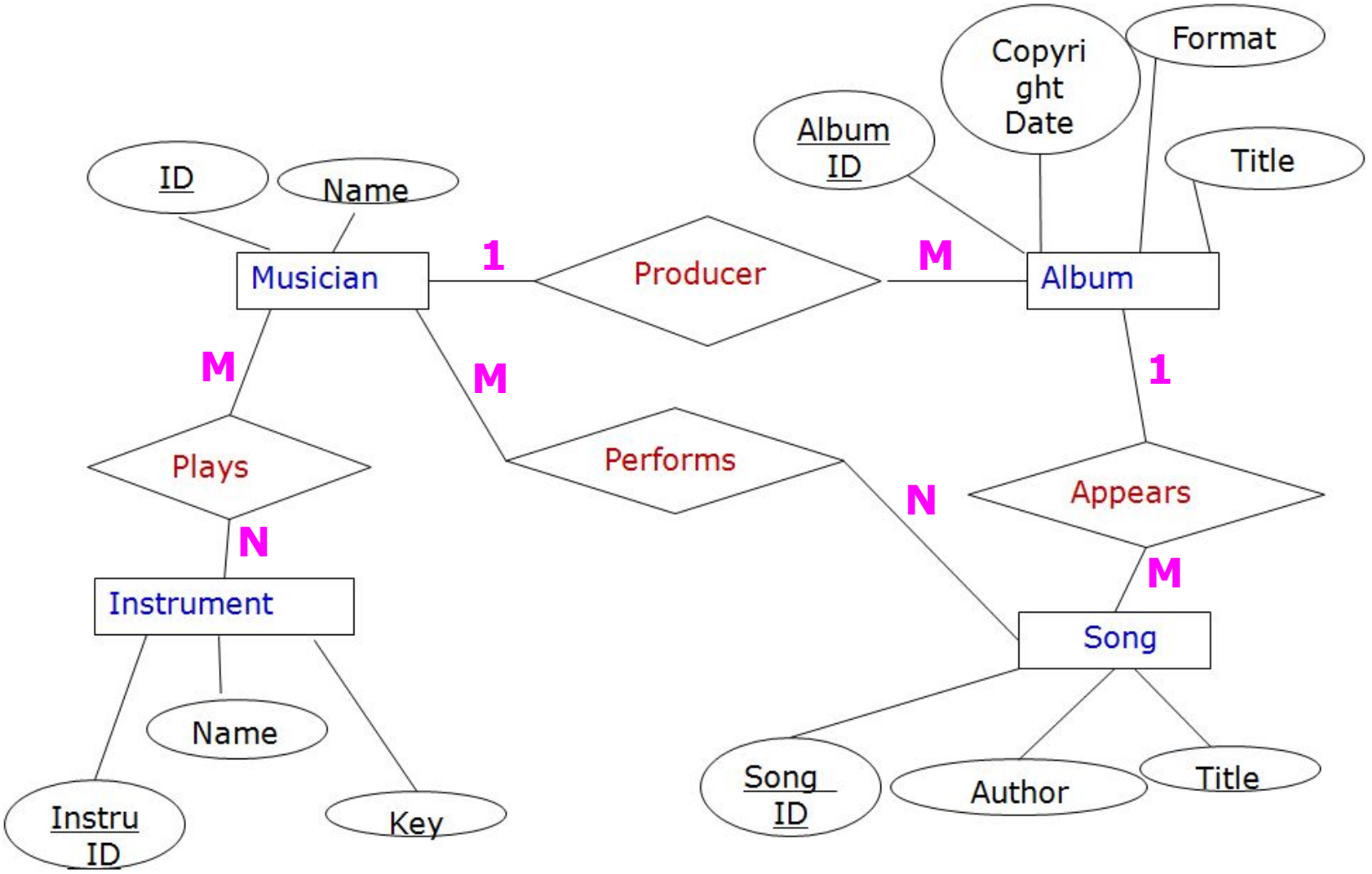


Topics Covered in Todays Class

Unit 2:

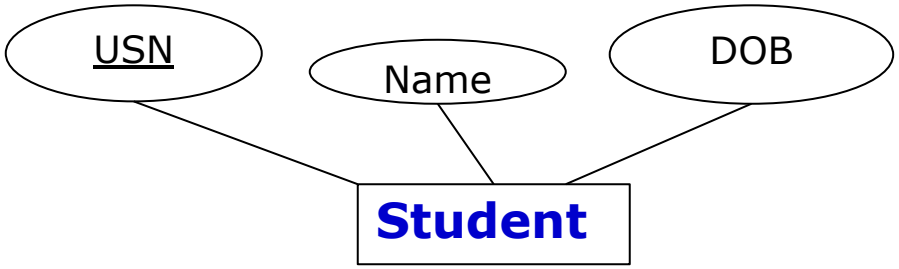
- Converting ER Diagrams to Tables

or Database design using ER-to-Relational Mapping

- An ER diagram is a pictorial representation of the information that can be captured by a database. Such a "picture" serves two purposes:
  - It allows database professionals to describe an overall design concisely yet accurately.
  - (Most of) it can be easily transformed into the relational schema.
- The ER diagram represents the conceptual level of database design meanwhile the relational schema (or database table) is the logical level for the database design.

Converting ER diagram to Tables

- Entities and Simple Attributes
  - An entity type within ER diagram is turned into a table.
  - Each attribute turns into a column (attribute) in the table. The key attribute of the entity is the **primary key** of the table which is usually underlined.



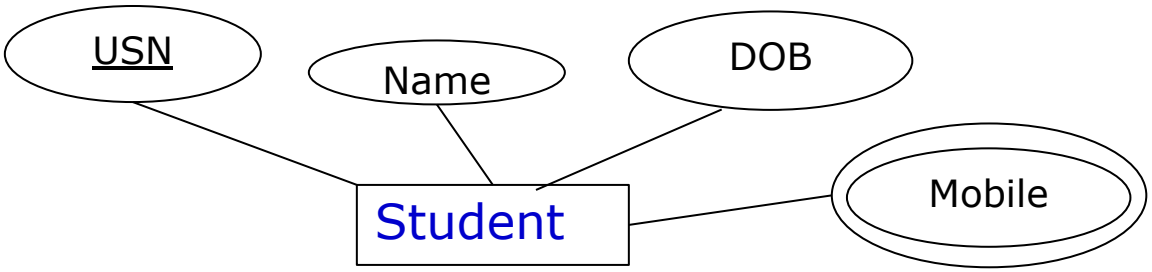
Student Table

Primary Key →

USN	Name	DOB
1BM14CS001	Aditya	1-1-1997
1BM14CS002	Bharath	31-12-1996

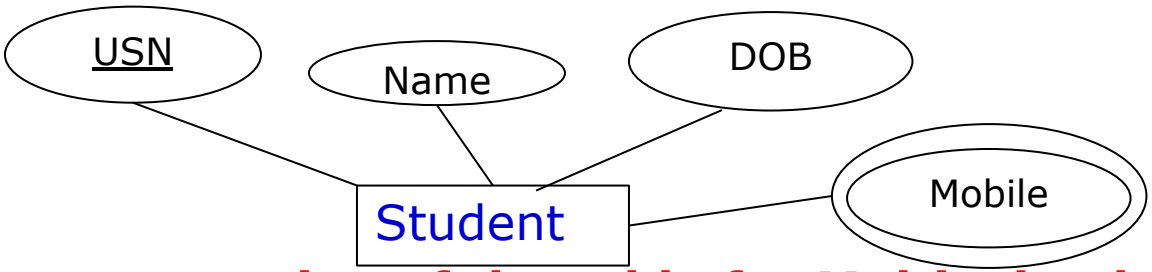
Converting ER diagram to Tables

- Multi-Valued Attributes



Converting ER diagram to Tables

- Multi-Valued Attributes



Which of the following representation of the table for Multivalued Attribute is best ?

USN	Name	DOB	Mobile 1	Mobile 2
1BM14CS001	Aditya	1-1-1997	8766655433	
1BM14CS002	Bharath	31-12-1996	9762255433	7066722433

Student Table

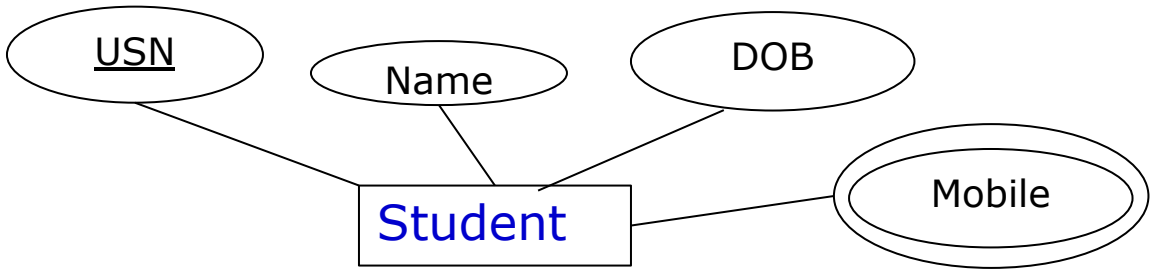
USN	Name	DOB
1BM14CS001	Aditya	1-1-1997
1BM14CS002	Bharath	31-12-1996

Mobile Table

USN	Mobile
1BM14CS001	8766655433
1BM14CS002	9762255433
1BM14CS002	7066722433

Converting ER diagram to Tables

- Multi-Valued Attributes



Primary Key

Student Table

USN	Name	DOB
1BM14CS001	Aditya	1-1-1997
1BM14CS002	Bharath	31-12-1996

Foreign Key

Mobile Table

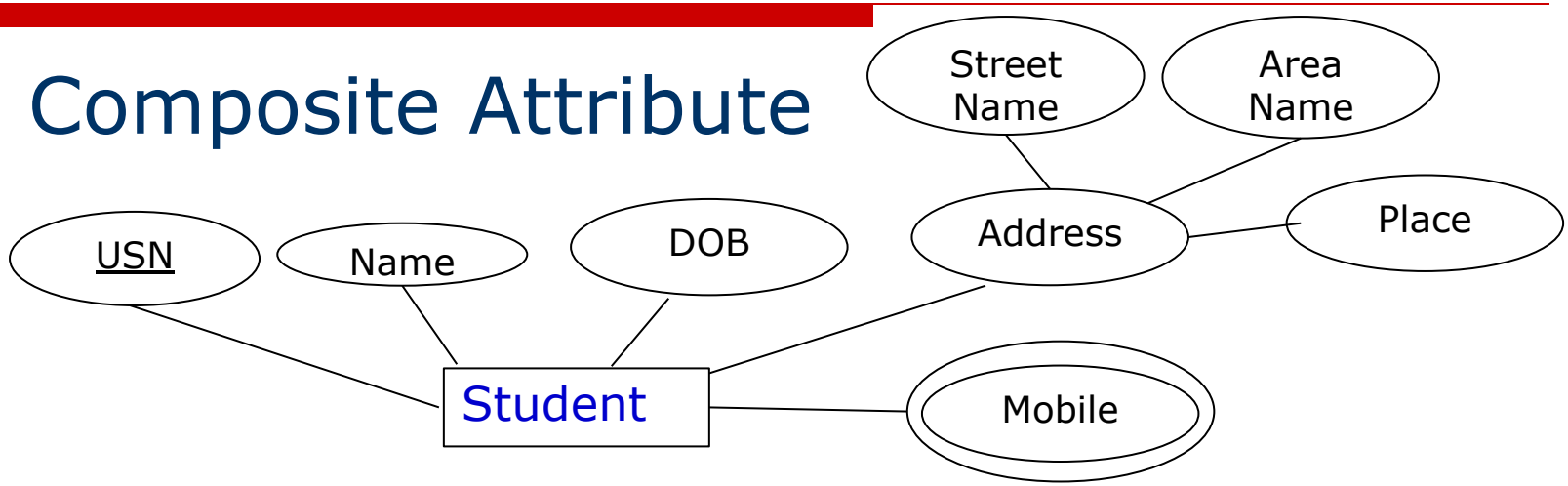
USN	Mobile
1BM14CS001	8766655433
1BM14CS002	9762255433
1BM14CS002	7066722433

If you have a multi-valued attribute, take the attribute and turn it into a new entity or table of its own. Then make a 1:N relationship between the new entity and the existing one. In simple words,

1. Create a table for the attribute.
2. Add the primary (id) column of the parent entity as a foreign key within the new table

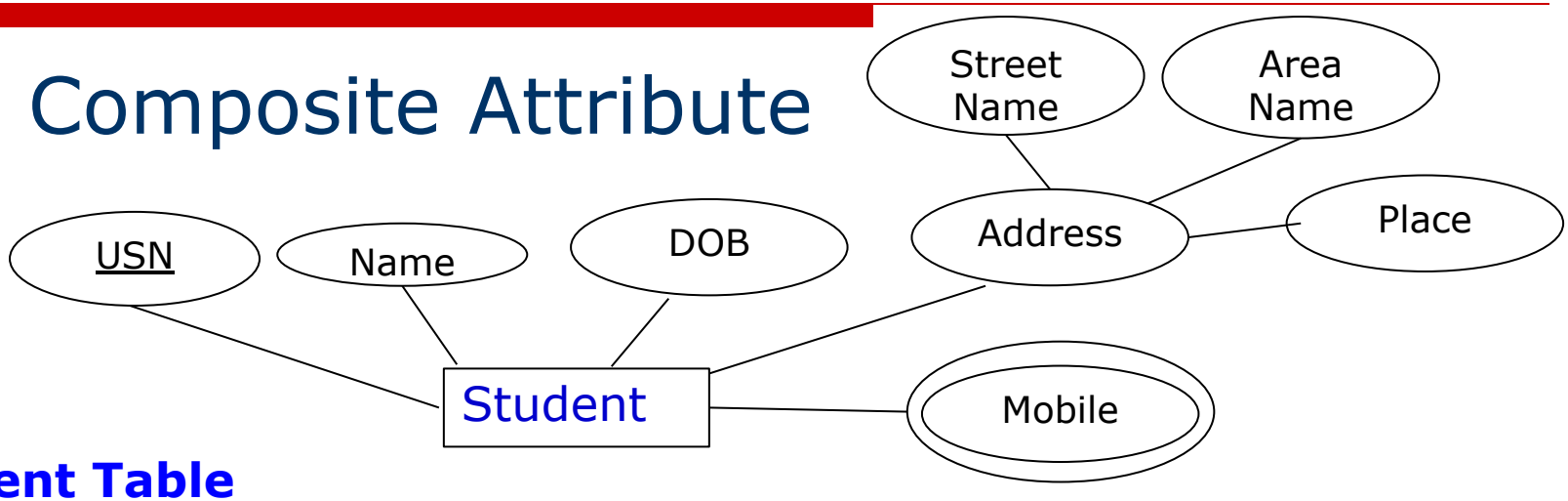
Converting ER diagram to Tables

- Composite Attribute



Converting ER diagram to Tables

- Composite Attribute



Student Table

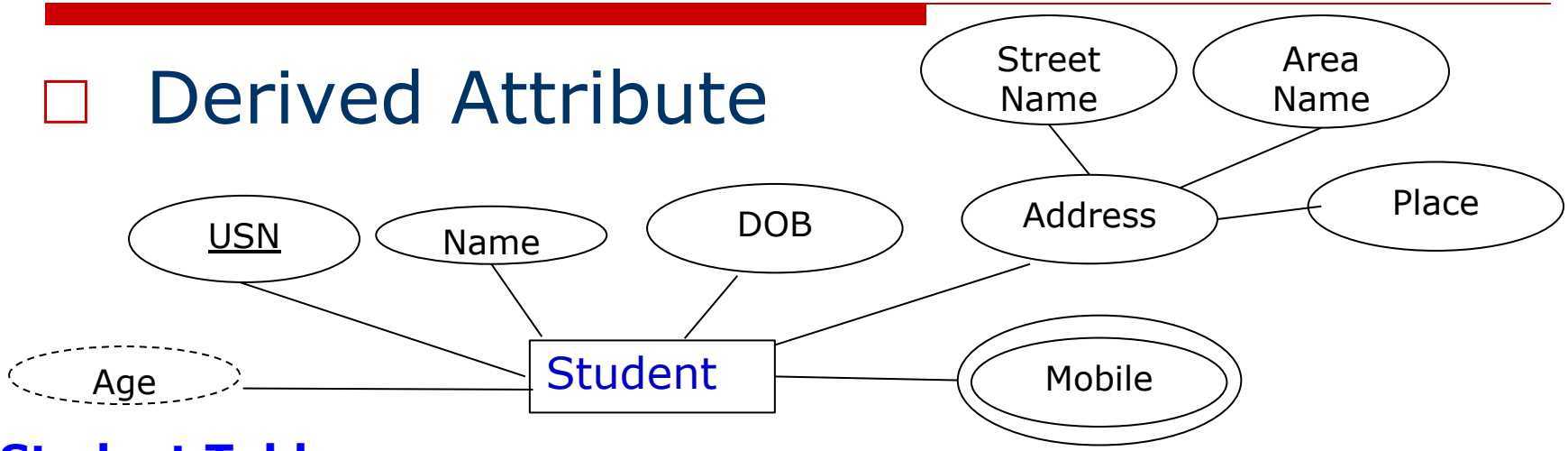
USN	Name	DOB	Street	Area	Place
1BM14CS001	Aditya	1-1-1997	RK Road	Nagar	Mandya
1BM14CS002	Bharath	31-7-1996	S V Road	Layout	Kolar

Mobile Table

USN	Mobile
1BM14CS001	8766655433
1BM14CS002	9762255433
1BM14CS002	7066722433

Converting ER diagram to Tables

- Derived Attribute



Student Table

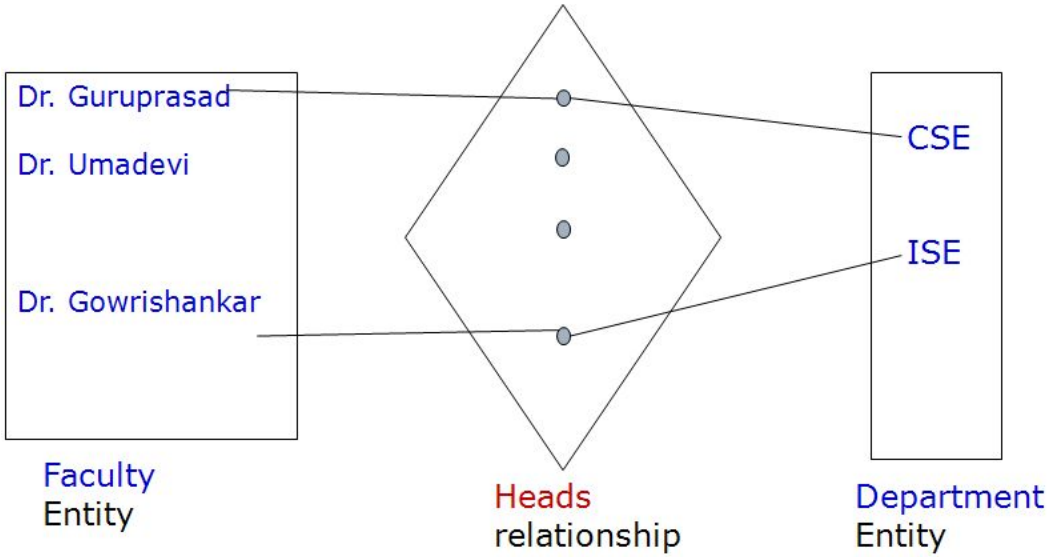
USN	Name	DOB	Street	Area	Place
1BM14CS001	Aditya	1-1-1997	RK Road	Nagar	Mandya
1BM14CS002	Bharath	31-7-1996	S V Road	Layout	Kolar

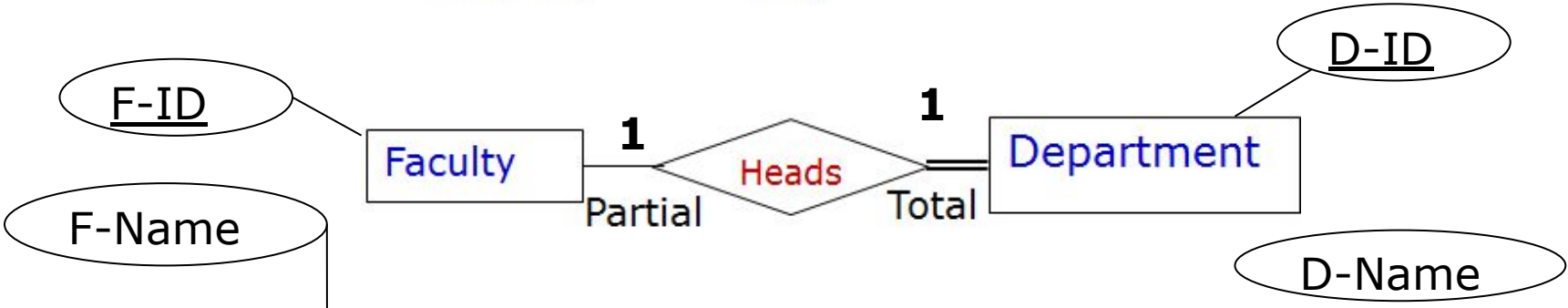
Mobile Table

USN	Mobile
1BM14CS001	8766655433
1BM14CS002	9762255433
1BM14CS002	7066722433

Converting ER diagram to Tables

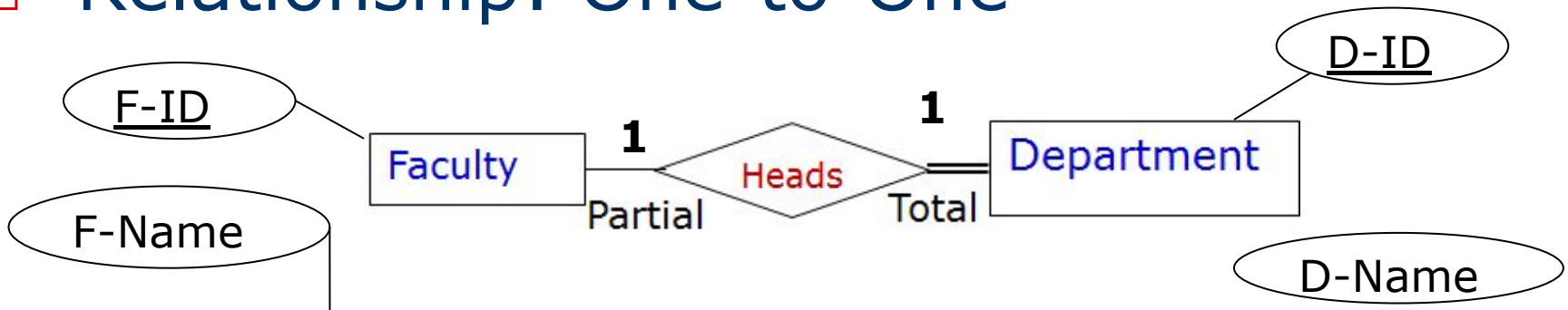
- Relationship: One-to-One





Converting ER diagram to Tables

- Relationship: One-to-One



Approach 1: Foreign Key

Faculty Table

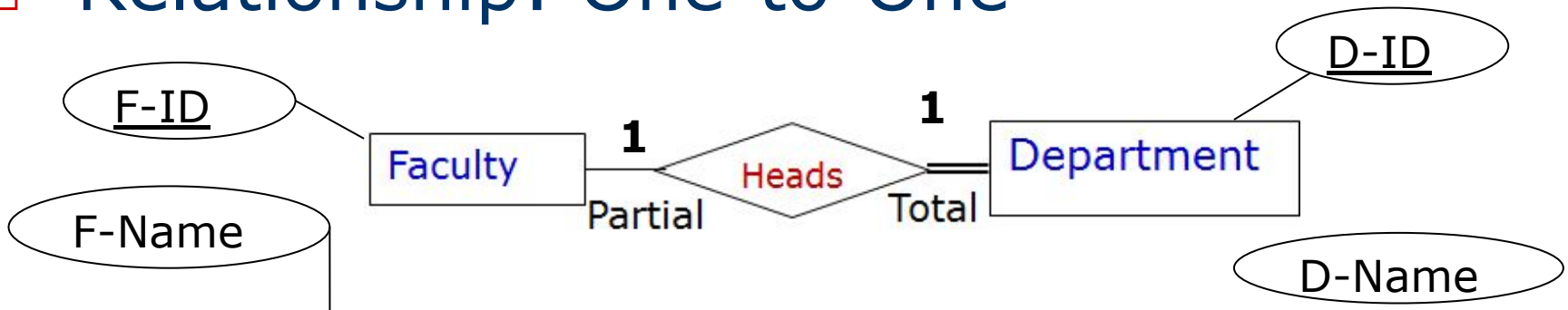
F-ID	F-Name
1	Dr. H S Guruprasad
2	Dr. Umadevi V
3	Dr. Gowrishankar

Department Table

D-ID	D-Name	Heading F-ID
10	CSE	1
20	ISE	3

Converting ER diagram to Tables

- Relationship: One-to-One



Approach 1: Foreign Key

Faculty Table

Primary Key

F-ID	F-Name
1	Dr. H S Guruprasad
2	Dr. Umadevi V
3	Dr. Gowrishankar

Department Table

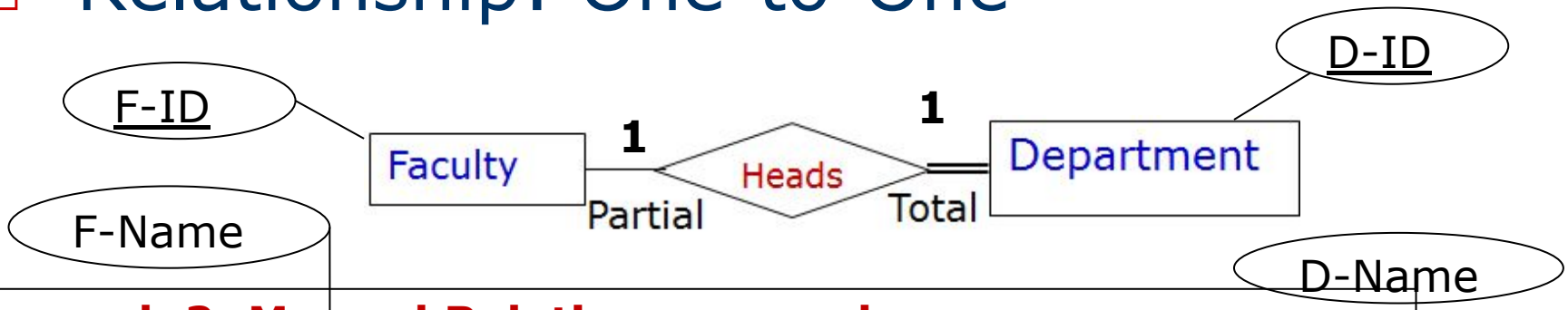
Primary Key

Foreign Key

D-ID	D-Name	Heading F-ID
10	CSE	1
20	ISE	3

Converting ER diagram to Tables

Relationship: One-to-One



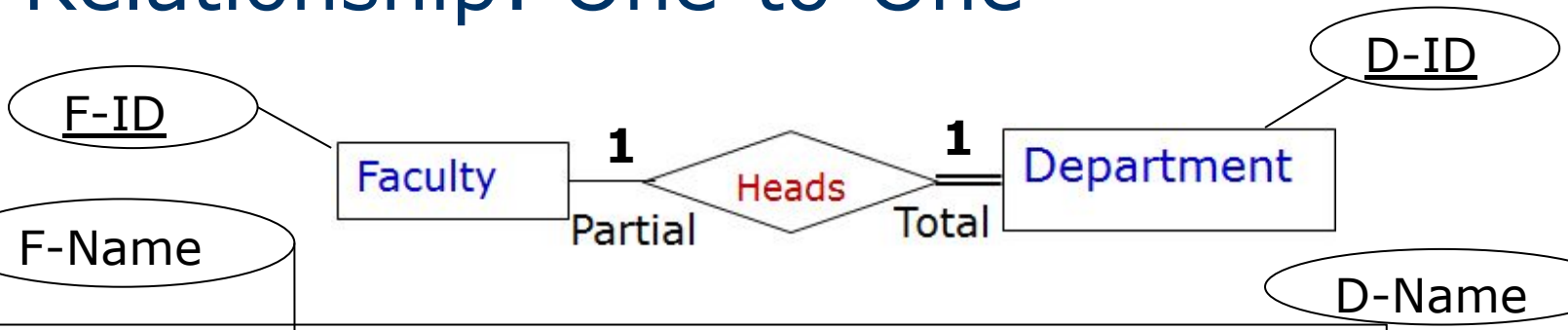
Approach 2: Merged Relation approach
Merging two entity types and relationship into one single relation.
This may be appropriate when **both participations are total**

Faculty –Department Table

F-ID	F-Name	D-ID	D-Name	HOD
1	Dr. H S Guruprasad	10	CSE	Yes
2	Dr. Umadevi V	10	CSE	No
3	Dr. Gowrishankar	20	ISE	Yes

Converting ER diagram to Tables

- Relationship: One-to-One



Approach 3: Cross-reference or relationship relation approach

Faculty Table

F-ID	F-Name
1	Dr. H S Guruprasad
2	Dr. Umadevi V
3	Dr. Gowrishankar

Department Table

D-ID	D-Name
10	CSE
20	ISE

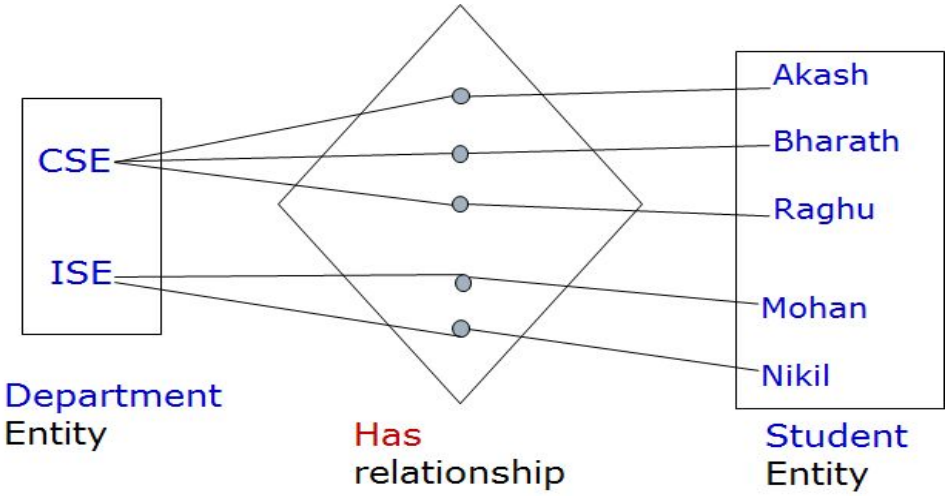
HOD Table

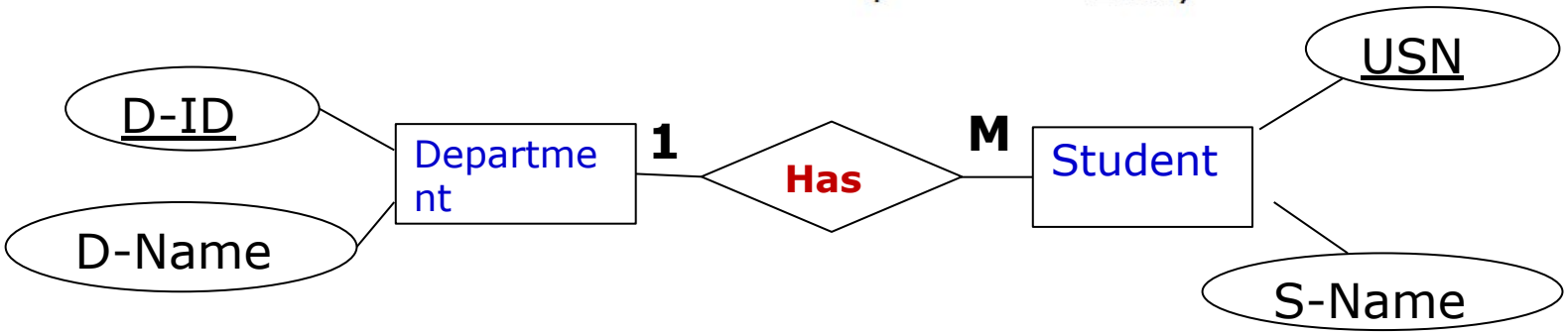
D-ID	F-ID
10	1
20	3

Lookup Table

Converting ER diagram to Tables

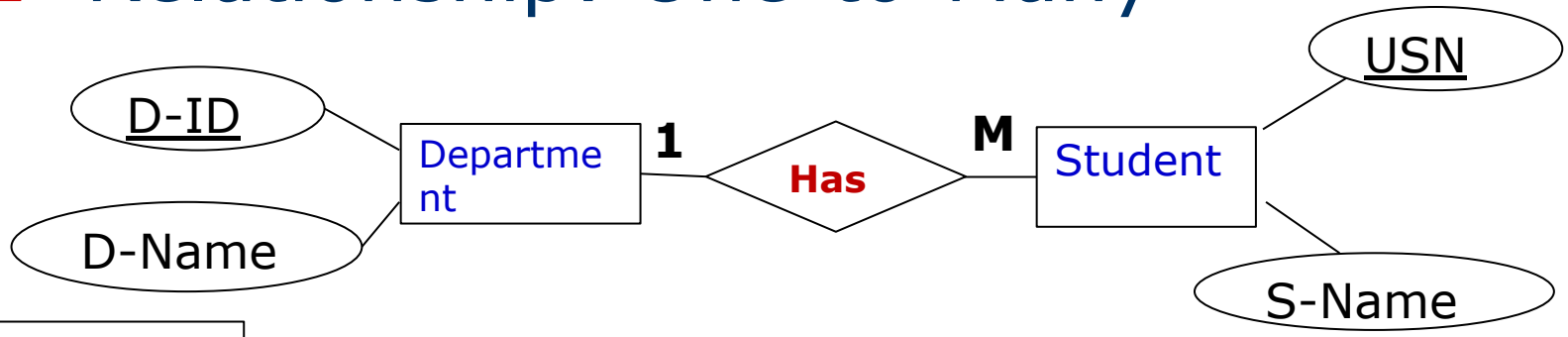
- Relationship: One-to-Many





Converting ER diagram to Tables

- Relationship: One-to-Many



Approach 1

Department Table

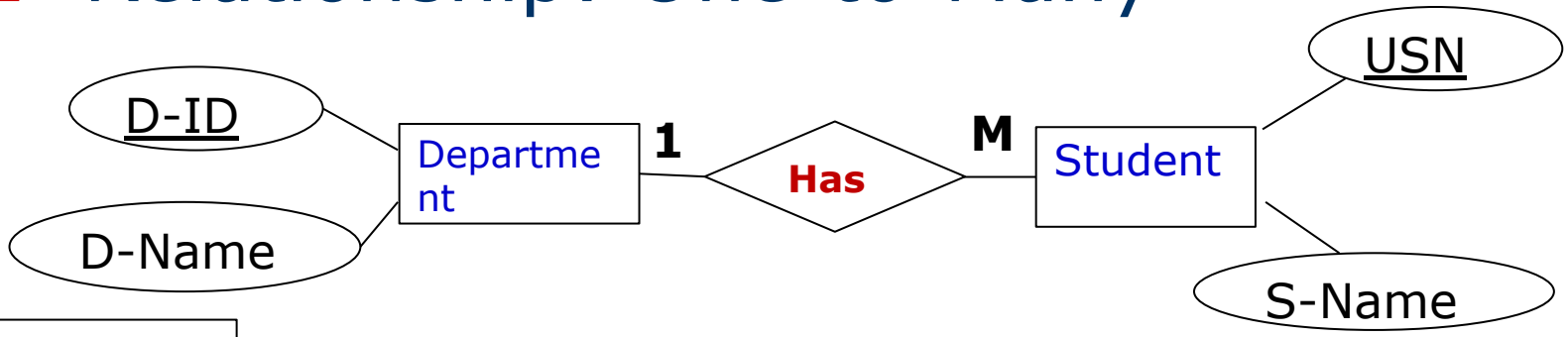
D-ID	D-Name
10	CSE
20	ISE

Student Table

USN	S-Name	D-ID
1BM14CS001	Akash	10
1BM14CS002	Bharath	10
1BM14CS003	Ragu	10
1BM14CS004	Mohan	20
1BM14CS005	Nikil	20

Converting ER diagram to Tables

- Relationship: One-to-Many



Approach 2

Department Table

D-ID	D-Name
10	CSE
20	ISE

Student Table

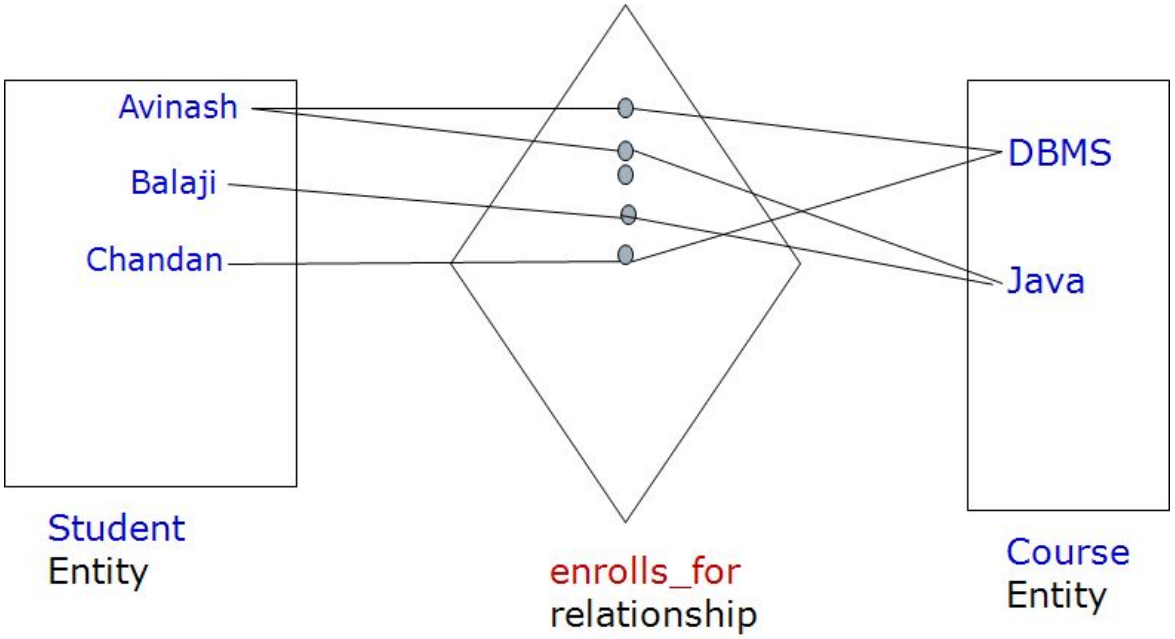
USN	S-Name
1BM14CS001	Akash
1BM14CS002	Bharath
1BM14CS003	Ragu
1BM14CS004	Mohan
1BM14CS005	Nikil

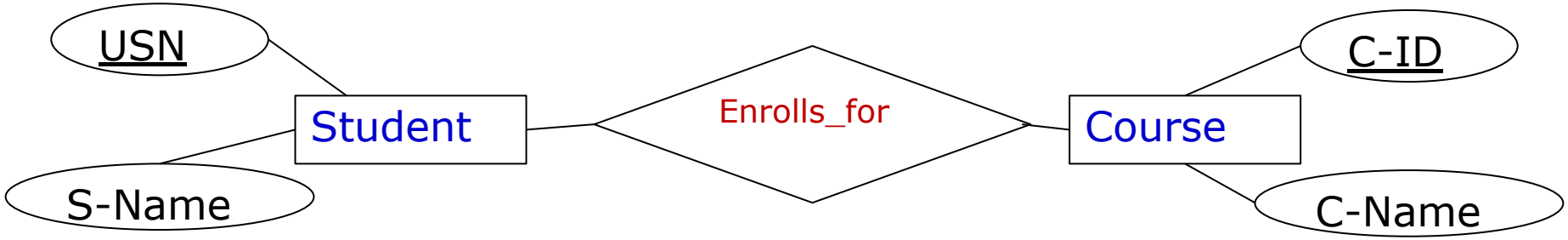
Department Student Table

USN	D-ID
1BM14CS001	10
1BM14CS002	10
1BM14CS003	10
1BM14CS004	20
1BM14CS005	20

Converting ER diagram to Tables

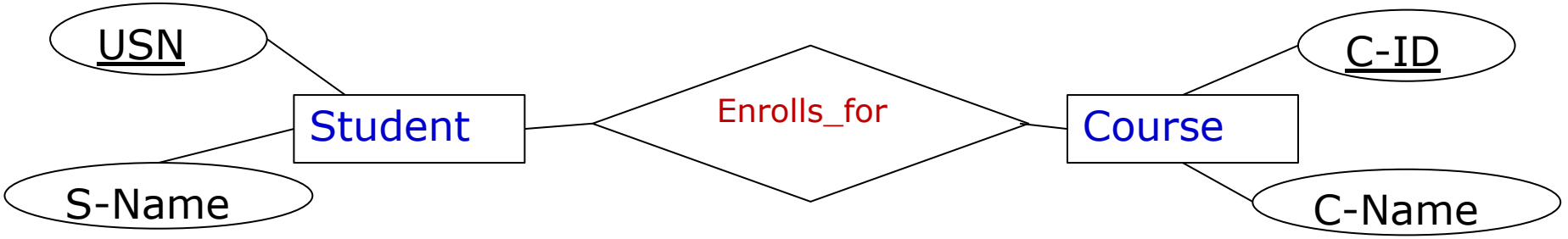
- Relationship: Many-to-Many





Converting ER diagram to Tables

- Relationship: Many-to-Many



Student Table

USN	**S-Name**
1BM14CS001	Avinash
1BM14CS002	Balaji
1BM14CS003	Chandan

Course Table

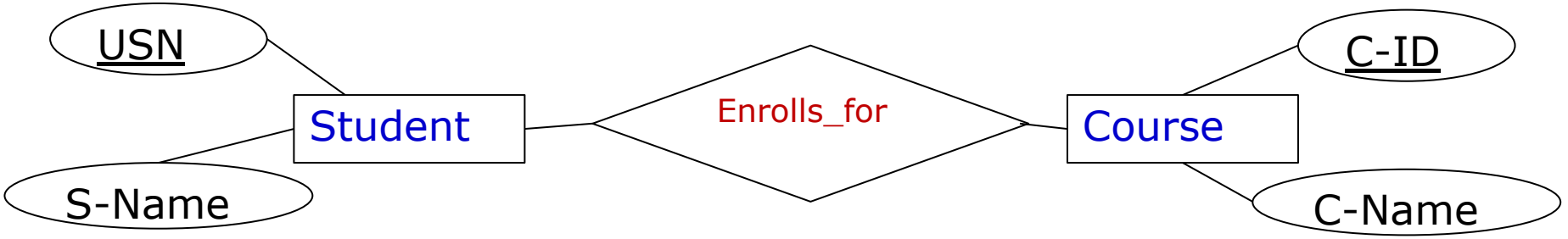
C-ID	**C-Name**
10	DBMS
20	Java

Student Course Table

USN	**C-ID**
1BM14CS001	10
1BM14CS001	20
1BM14CS002	20
1BM14CS003	10

Converting ER diagram to Tables

- Relationship: Many-to-Many



Student Table

USN	S-Name
1BM14CS001	Avinash
1BM14CS002	Balaji
1BM14CS003	Chandan

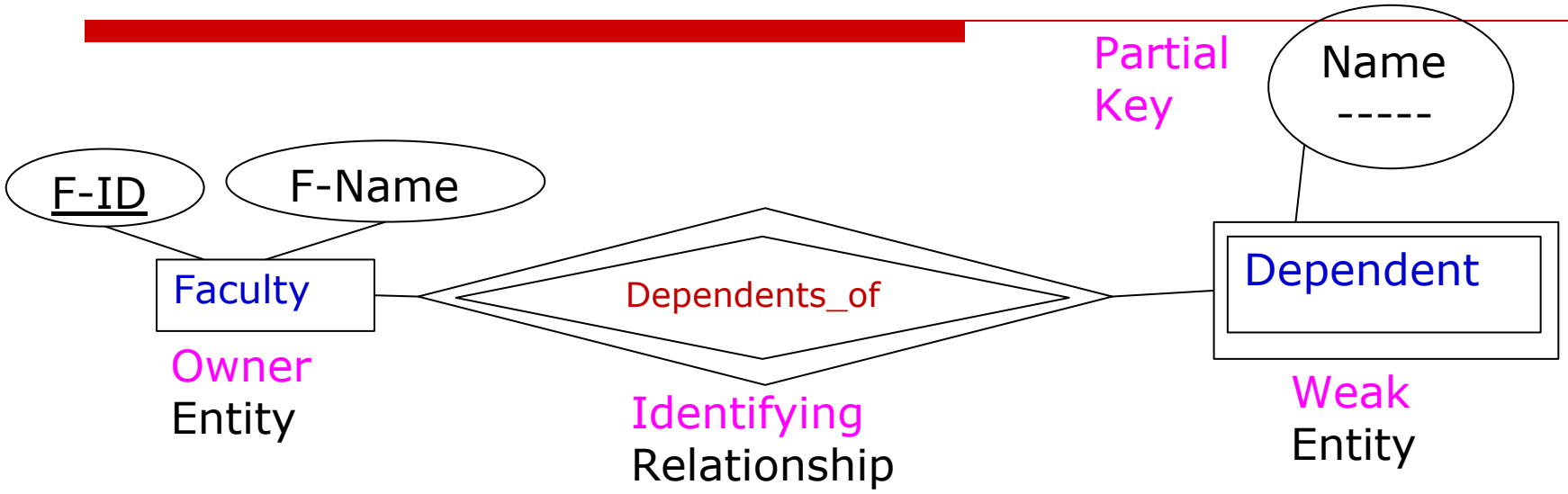
Course Table

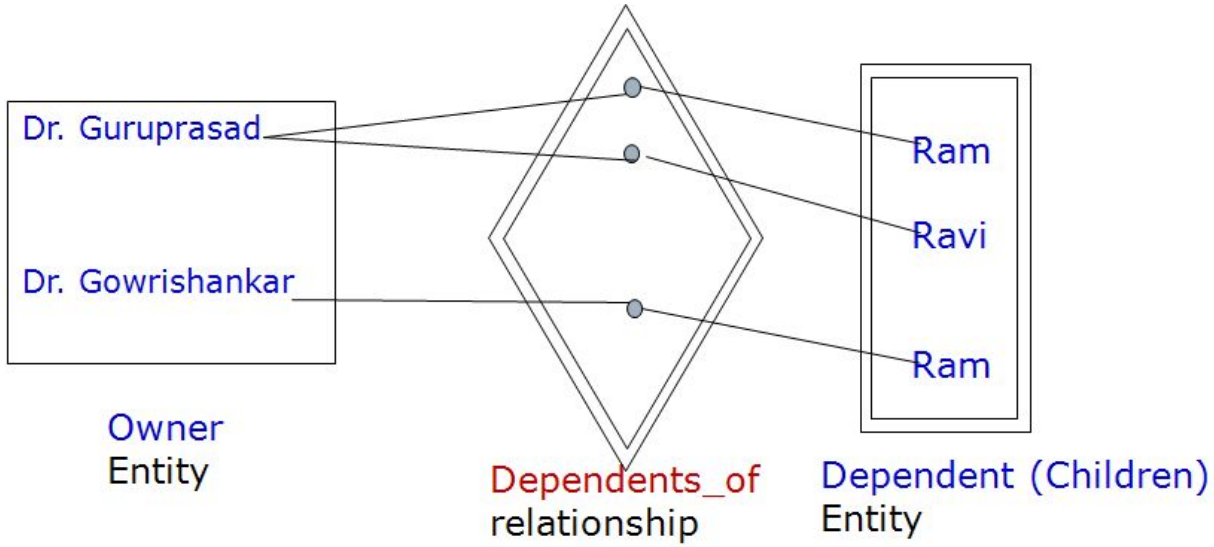
C-ID	C-Name
10	DBMS
20	Java

Student Course Table

USN	C-ID
1BM14CS001	10
1BM14CS001	20
1BM14CS002	20
1BM14CS003	10

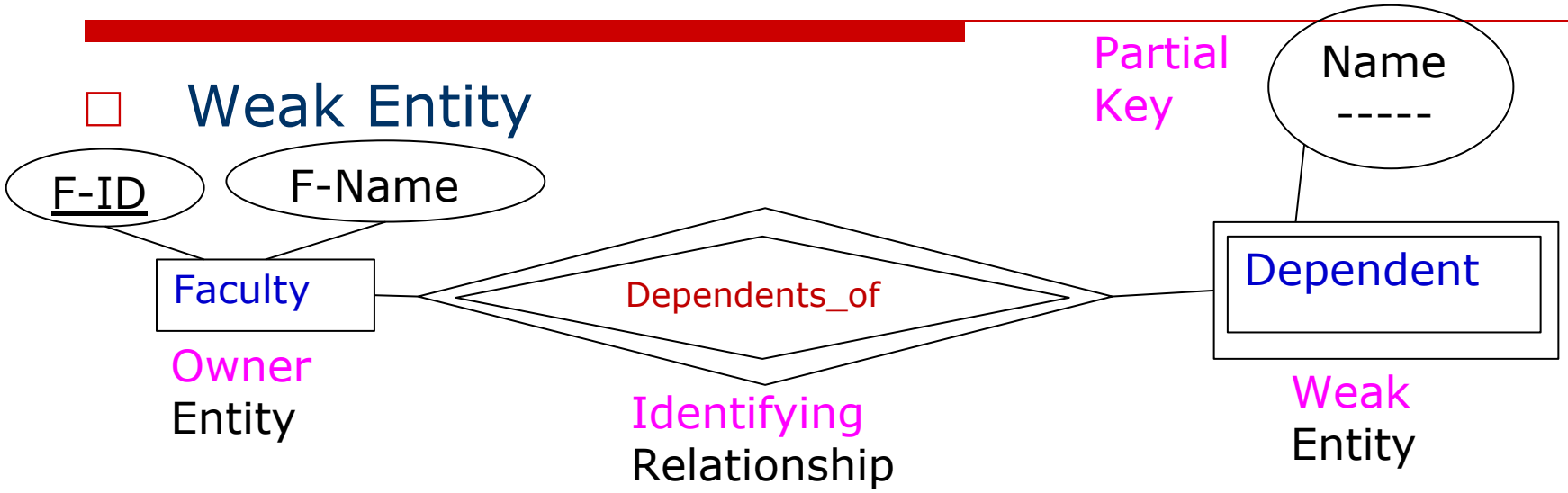
Converting ER diagram to Tables





Converting ER diagram to Tables

- Weak Entity



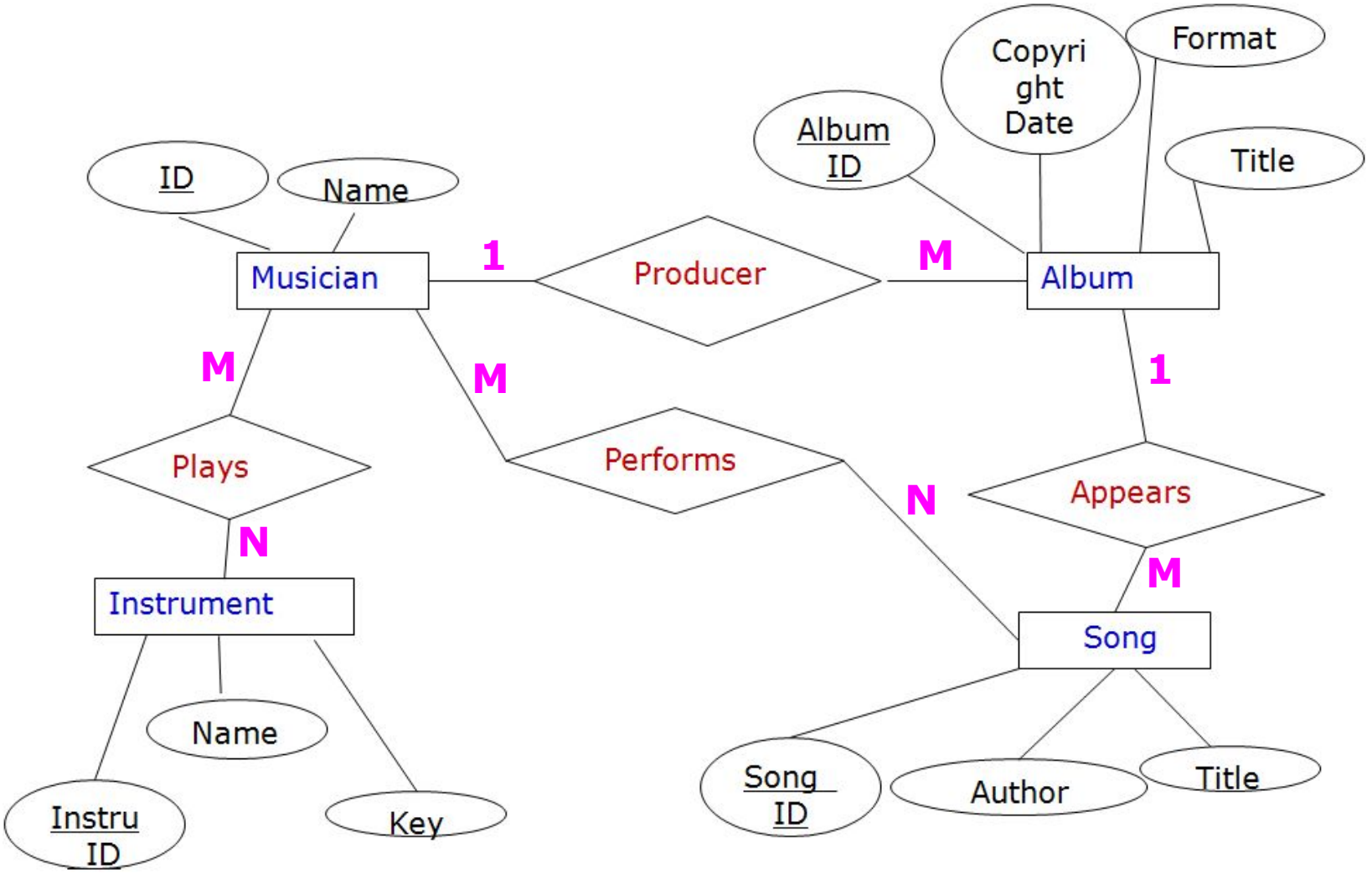
Faculty Table

F-ID	F-Name
10	Dr. Guruprasad
20	Dr. Gowrishankar

Dependent Table

F-ID	Dependent Name
10	Ram
10	Ravi
20	Ram

Activity To Do
Convert the Following ER diagram to Database table schema



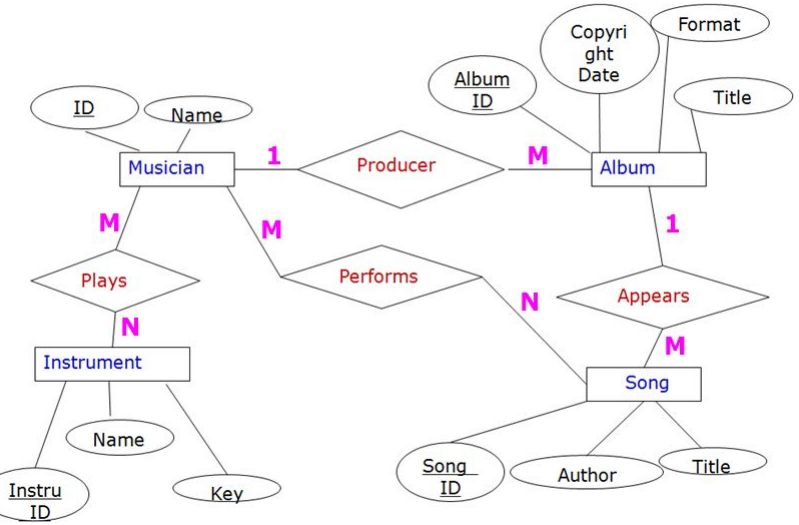
Database tables or Schema Diagram

Musician Table

Name	Muscian-ID

Album Table

Album-ID	Copyright Date	Format	Title	Producer ID



Song Table

Song-ID	Author	Title	Album-ID

Performing Table

Muscian-ID	Song-ID

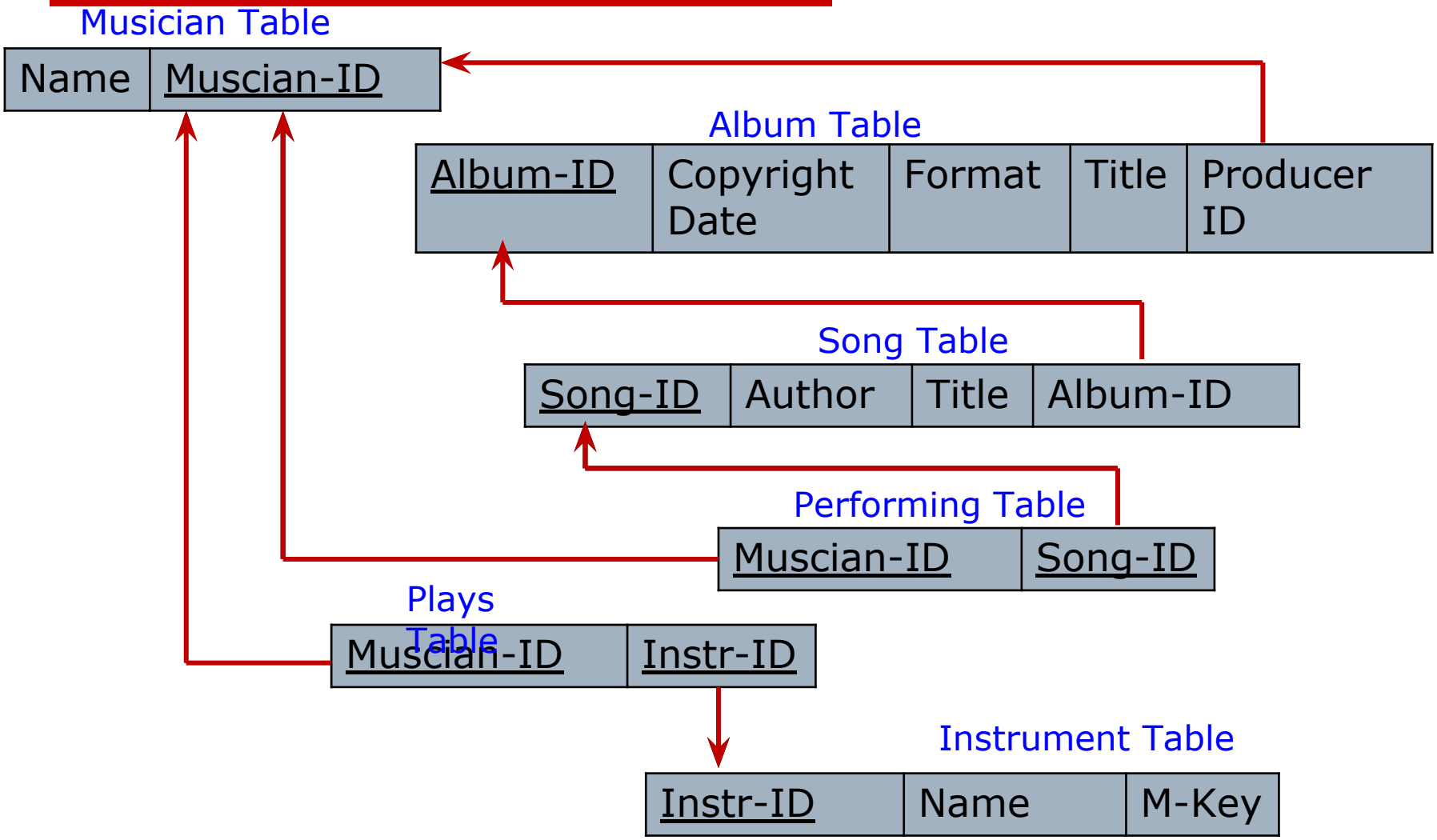
Plays Table

Muscian-ID	Instr-ID

Instrument Table

Instr-ID	Name	M-Key

Database tables or Schema Diagram



Thanks for Listening

Cardinality Ratios

- Cardinality is a constraint on a relationship specifying the number of entity instances that a specific entity may be related to via the relationship.

Many to One:

More than one entities from entity set A can be associated with at most one entity of entity set B, however an entity from entity set B can be associated with more than one entity from entity set A.