Unit 4

ER MODEL

ER-Model

- Used for Conceptual Modeling of the Database schema
- Meant for Human comprehension
- To tell End User, what is understood about their Domain
- High-level database design without implementation details
- DBMS independent.
- Building Blocks: Entity, Attribute and Relationship

Entity

- An **entity** is an object that exists in the real world and is distinguishable from other objects.
- In real world, an entity has a set of properties and the values for those properties identify it.
  - Example: Faculty, Student, company, event, plant ,Course, Account
  - Properties of Student –RegNo, Name, Course, Phone.
  - Values of these property-(180370123,'Rajesh','MCA',9876999756) is an **entity**

Entity Sets

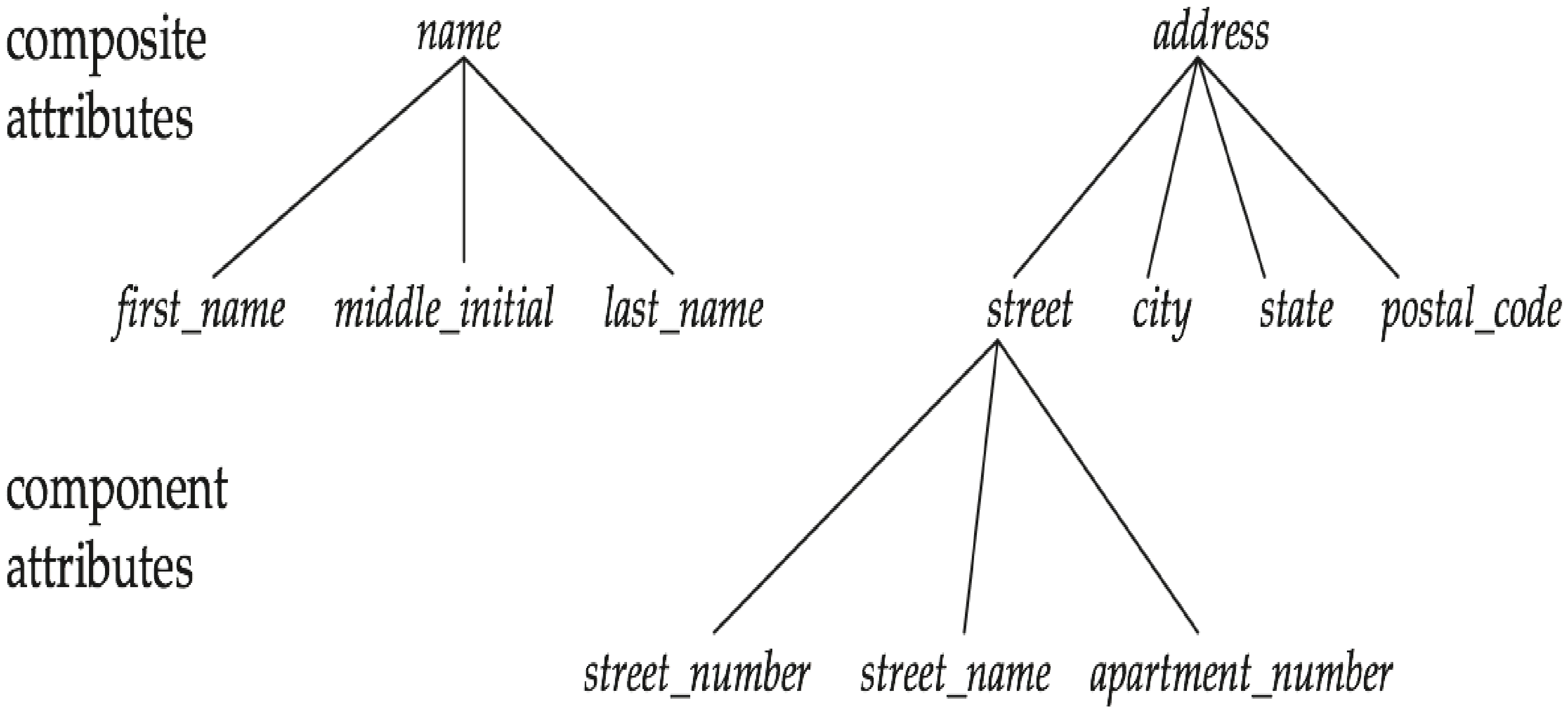
- An **entity set** is a set of entities of the same type that share the same properties.
  - Example: set of all students who share same properties.
  - {(180370123,'Rajesh','MCA',9876999756) , (180370124,'Ramesh','MCA',8876999756),........}
- Example:
  - Student entity set –Collection of all student entities.
  - Faculty entity set –Collection all faculties in a college

Attributes

- An entity is represented by a set of attributes, that is descriptive properties possessed by all members of an entity set.
  - Example:

    instructor = (ID, name, street, city, salary)
    course= (course_id, title, credits)
- **Domain** – the set of permitted values for each attribute
- **Attribute types:**
  - **Simple** and **composite** attributes.
    - **Simple-** having atomic or indivisible values.
      - Example: Department_Name , State, city
    - **Composite-** having several components in the value.
      - Example: Contact_number attribute further having components- Name and address of a person

Composite Attributes



Composite Attributes

Single-valued and **multivalued** attributes

Single- having only one value rather than a set of values.

Example: Birth_Place

Multivalued - having a set of values rather than a single value

Example: *phone_numbers ,Emails of a person , Degrees acquired by a faculty*

Derived attributes

Can be computed from other attributes

Example: *Age, given date_of_birth*

Entity Sets instructor and student

ID	name
76766	Crick
45565	Katz
10101	Srinivasan
98345	Kim
76543	Singh
22222	Einstein

instructor

ID	name
98988	Tanaka
12345	Shankar
00128	Zhang
76543	Brown
76653	Aoi
23121	Chavez
44553	Peltier

student

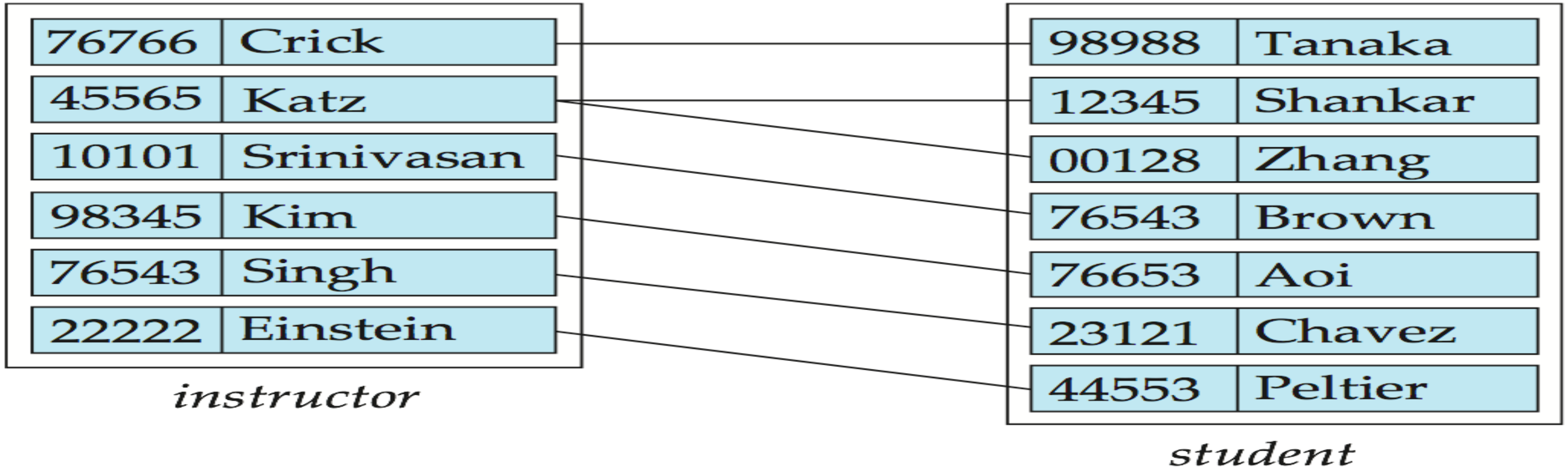
Instructor={ (76766,Crick),(45565,Katz),(10101,Srinivasan),...(22222, Einstein)}

Student={ (98988,Tanaka),(12345,Shankar),(00128,Zhang),....(44553,Peltier) }

Relationship Sets

Assume that – we want to model the information such as – ***Crick is advisor for Tanaka ; Katz is advisor for Shankar & Zhang ; Srinivasan is advisor for Brown***; and so on.

In other words, we are interested in representing information that Some instructor will be advisor for Some Student/Students(Association between Instructor & Student).



Relationship set ={ (76766,Crick - 98988,Tanaka) ,(45565,Katz- 12345,Shankar), (45565,Katz-00128,Zhang),(10101,Srinivasan),...(22222, Einstein-44553,Peltier) }

Relationship Sets

Consider formal definition of Relationship set.

- A **relationship** is an association among several entities

  Example:

  (22222 ,Einstein) *advisor* (44553 ,Peltier)

  instructor entity relationship set *student* entity

Collection of such relationship is Relationship set

- A **relationship set** is a mathematical relation among $n \geq 2$ entities, each taken from entity sets $\boldsymbol{E_1, E_2, .. E_n}$.

$$\{(e_1, e_2, \ldots e_n) \mid e_1 \in E_1, e_2 \in E_2, \ldots, e_n \in E_n\}$$

where $(e_1, e_2, \ldots, e_n)$ is a relationship

i.e. (44553 ,Peltier, 22222, Einstein) a relationship set element(instance)

Relationship Sets (Cont.)

- *Every instance in a entity set is distinguishable from other entities using primary key , in the same way every relationship in a relationship set is distinguishable.*

Primary Key of relationship set is – $PK(E_1) \cup PK(E_2) \ldots . PK(E_n)$

Example:

(44553,22222) $\in$ *advisor.*

Relationship Sets (Cont.)

- The association between entity sets is referred to as **participation**
- A **relationship instance** (**ex:** **(45565,Katz-00128,Zhang)**) in an E-R schema represents an association between the named entities (**ex**: **(45565,Katz) an Instructor entity & (00128,Zhang) a Student entity**) in the real-world enterprise that is being modeled.
- The function that an entity plays in a relationship is called entity's role

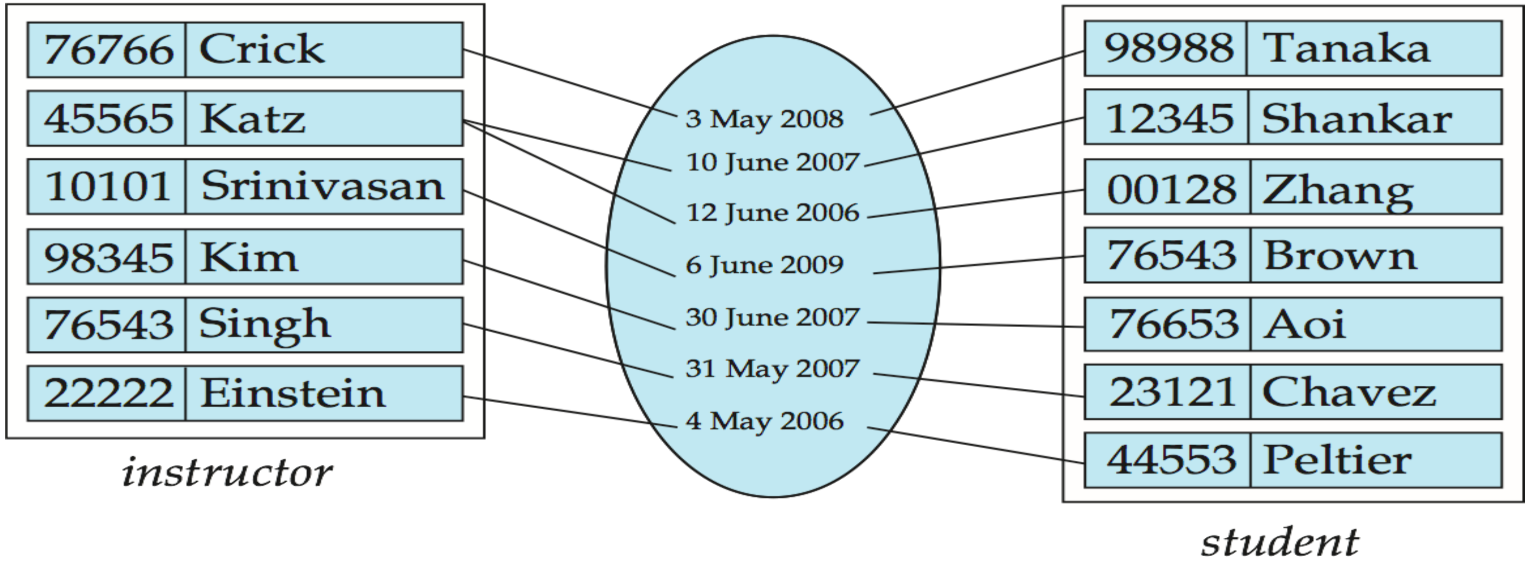
Relationship set **={ (76766,Crick - 98988,Tanaka) ,(45565,Katz- 12345,Shankar), (45565,Katz-00128,Zhang),...,...(22222, Einstein-44553,Peltier) }**

Relationship Sets (Cont.)

- A relationship may also have attributes called **descriptive attributes**.

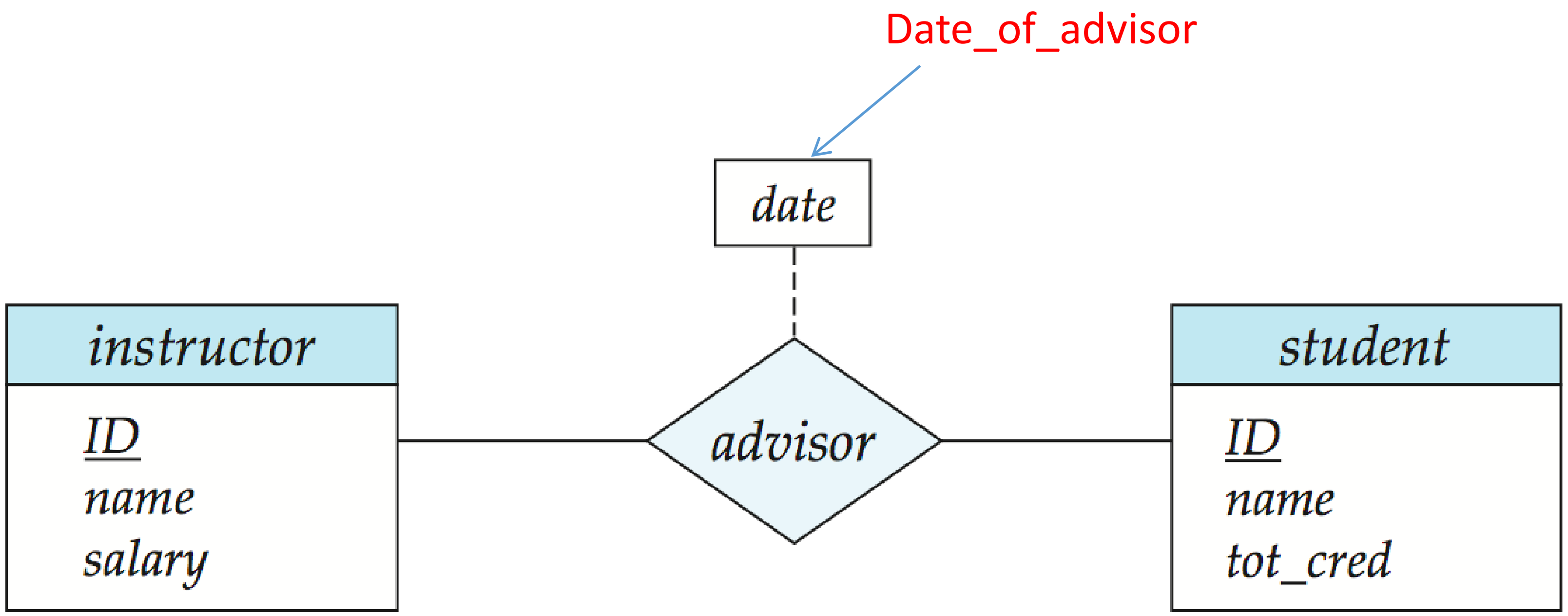
Assume that we want to store information that –An Instructor **I** became an Advisor to Student **S** on the date D.

Ex: (76766,Crick) became Advisor to a Student (98988,Tanaka) on 3rd May 2008.



3rd May 2008 date is property of neither Instructor nor Student, but it has meaning when referred w.r.t Advisor relation ship between Instructor & Student.

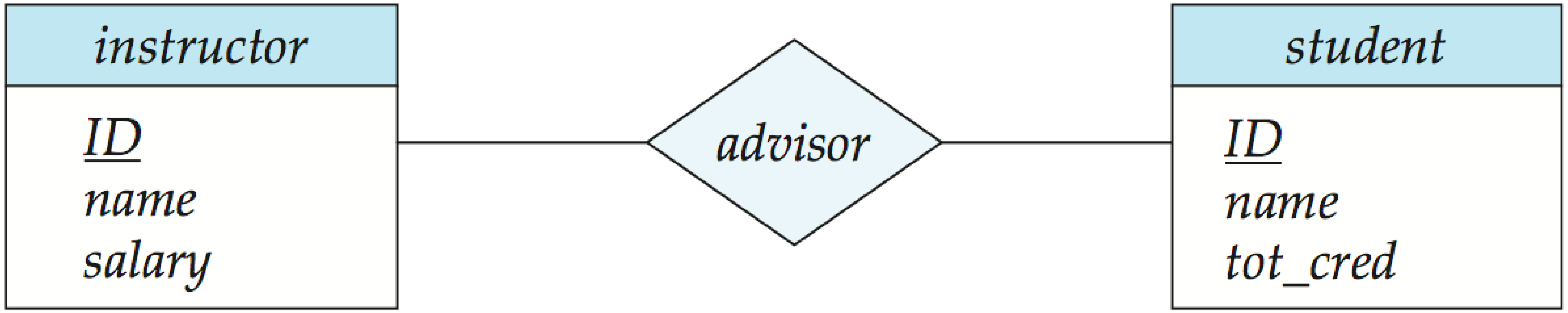
Relationship Sets with Attributes



The design decision of where to place descriptive attributes in such cases—as a relationship or entity attribute—should reflect the characteristics of the enterprise being modeled.

E-R Diagrams

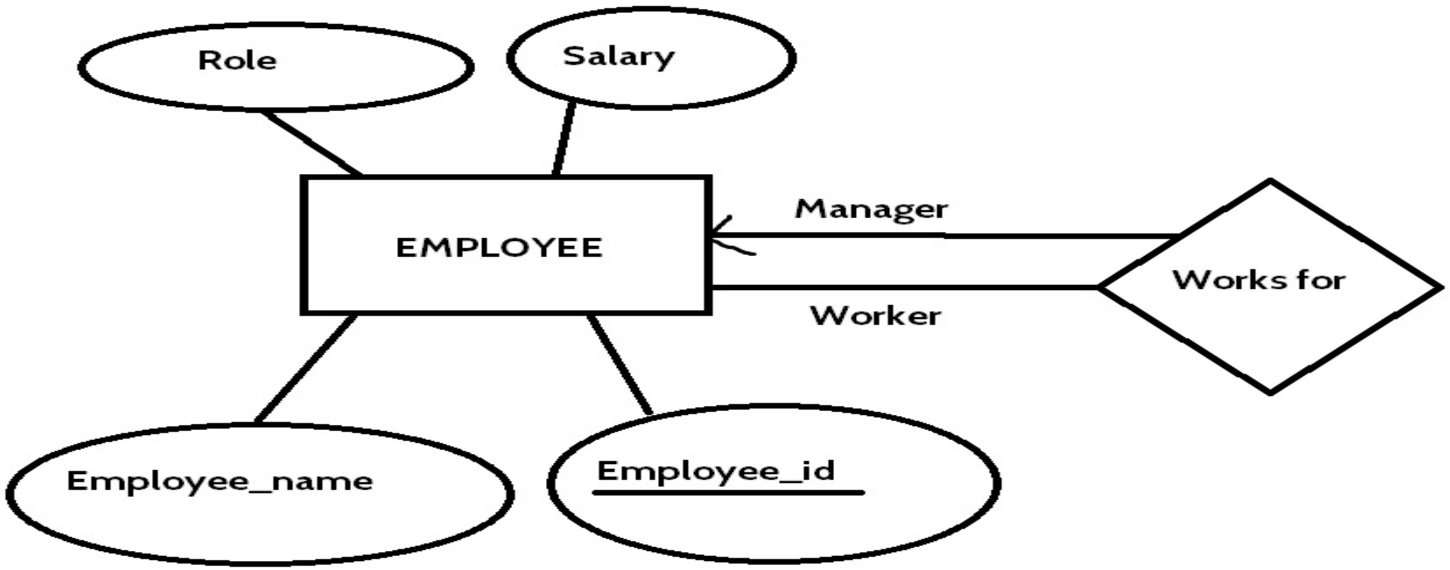
Following is the diagrammatic representation of Relationship in ER Model



- Rectangles represent entity sets.
- Diamonds represent relationship set.
- Attributes listed inside entity rectangle
- Underline indicates primary key attributes

Recursive Relationship set

➢If the same entity sets participates in a relationship set more than once in different **roles- Recursive relationship**



Recursive Relationship..

- Example: Sample relationship between EMP entities.

Emp_ID	Ename	Job	Salary
100		Clerk	
101		Manager	
103		S.Clerk	
108		Accountant	
105		O.Assitant	
108		C.Manager	
109		R.Manger	

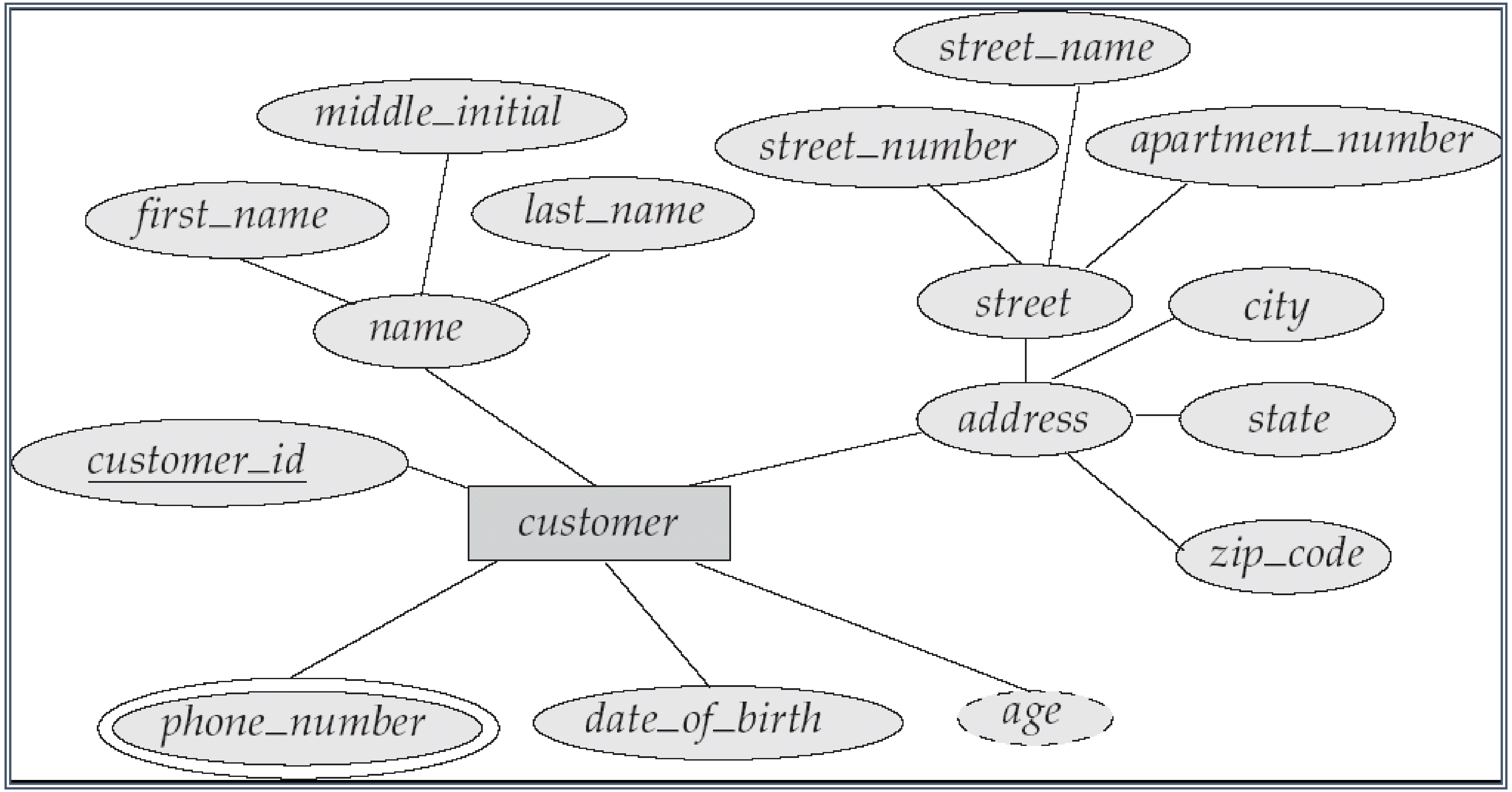
(100,..,Clerk,..) is an entity in EMP entity set and is having relationship (association) with another entity (101,..,Manger,..) in the same Entity set(i.e. EMP)

Entity With Composite, Multivalued, and Derived Attributes

instructor

- *ID*
- *name* — composite
  - *first_name*
  - *middle_initial*
  - *last_name*
- *address*
  - *street*
    - *street_number*
    - *street_name*
    - *apt_number*
  - *city*
  - *state*
  - *zip*
- *{ phone_number }* — multivalued
- *date_of_birth*
- *age ( )* — derived

Entity With Composite, Multivalued, and Derived Attributes



Degree of a relationship

- ***Degree*:** the number of participating entity sets in a relationship.
  - Degree 2: *binary*

    involve two entity sets
  - Degree 3: *ternary*
  - Degree n: *n-ary*
- Binary relationships are very common and widely used.

Mapping Cardinality Constraints

- Express the number of entities to which another entity can be associated via a relationship set.
- Most useful in describing binary relationship sets.
- For a binary relationship set the mapping cardinality must be one of the following types:
  - One to one
  - One to many
  - Many to one
  - Many to many

Mapping Cardinalities(cont'd)

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

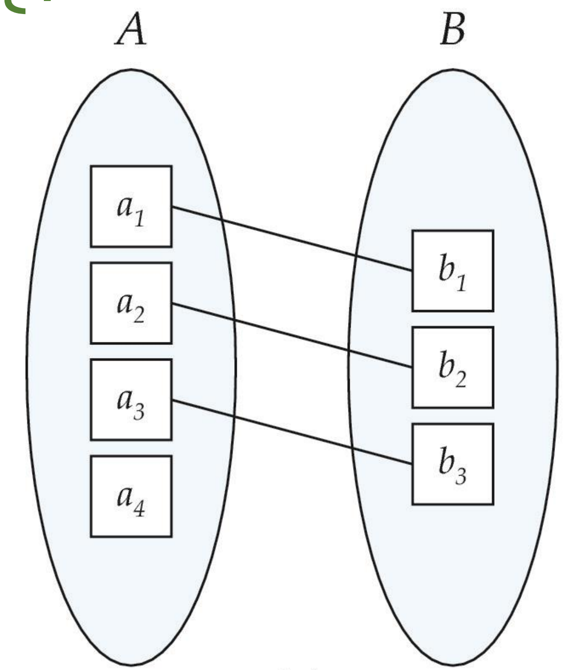
- **One-to-many:** One entity from entity set A can be associated with more than one entities of entity set B but from entity set B one entity can be associated with at most one entity.

Mapping cardinalities

- **Many-to-one:** More than one entities from entity set A can be associated with at most one entity of entity set B but one entity from entity set B can be associated with more than one entity from entity set A

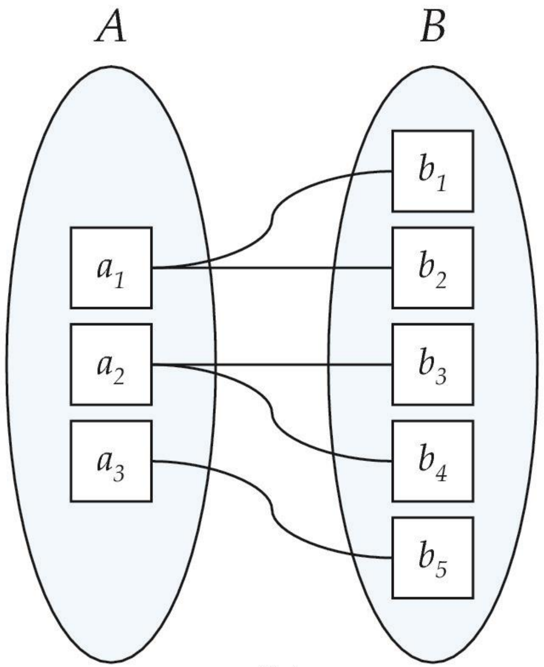
- **Many-to-many:** one entity from A can be associated with more than one entity from B and vice versa.

Mapping Cardinalities



(a)

One to one

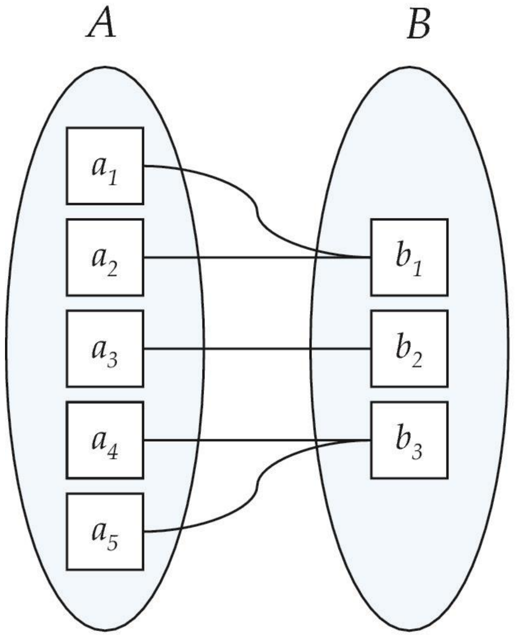


(b)

One to many

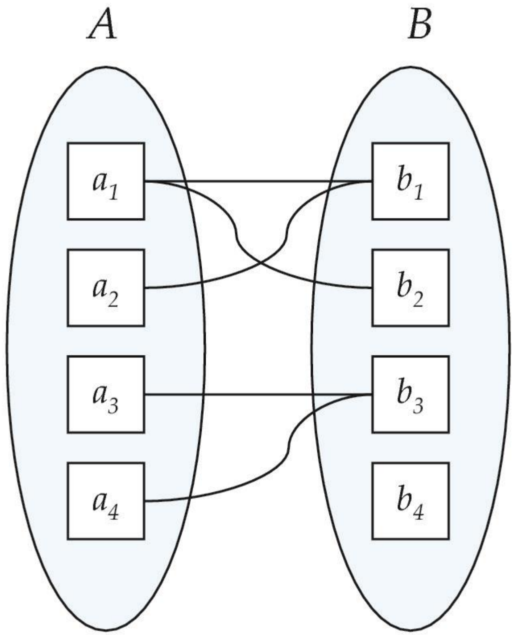
Note: Some elements in *A* and *B* may not be mapped to any elements in the other set

Mapping Cardinalities



(a)

Many to one



(b)

Many to many

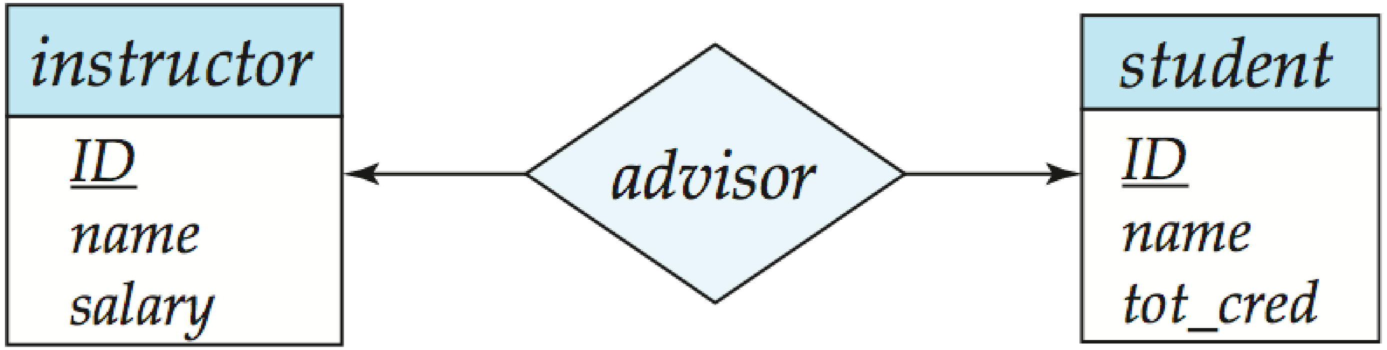
Note: Some elements in A and B may not be mapped to any elements in the other set

Cardinality Constraints

- We express cardinality constraints by drawing either a directed line (→), signifying "one," or an undirected line (—), signifying "many," between the relationship set and the entity set.

One-to-One Relationship

- one-to-one relationship between an *instructor* and a *student*
  - an instructor is associated with at most one student via *advisor*
  - and a student is associated with at most one instructor via *advisor*



Example one-one

Institute	
Institute Name	Location
ABC Tech	Mangalore
AAA Engg College	Bangalore
BBB Technology	Hyderabad
VTU	Belgaum

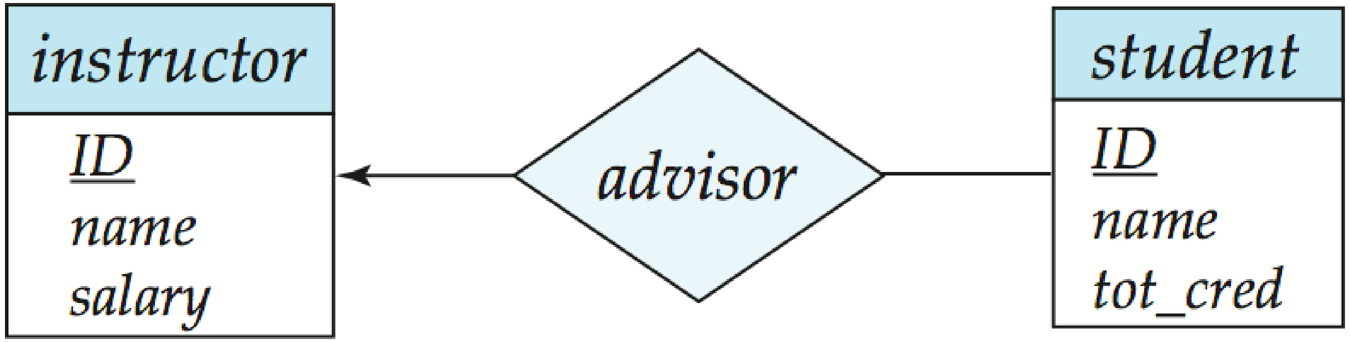
Head_Of_Institute		
Head_Name	Experience	Qualification
Rajesh	28	Mtech PhD
Ravi	30	MSc PhD
Blake	19	MS PhD
Mukhesh	25	Mtech PhD

A sample **one-to-one** relationship between an ***Institute*** and a ***Head_Of_Institute***

1 Institute will have only 1 Head of Institute –*Therefore exactly one Head_Of_Institute entity is associated with exactly one Institute Entity*

One-to-Many Relationship

- one-to-many relationship between an *instructor* and a *student*
  - **an instructor is associated with several (including 0) students via *advisor***
  - a student is associated with **at most one** instructor via advisor,



Example one- Many

Customers

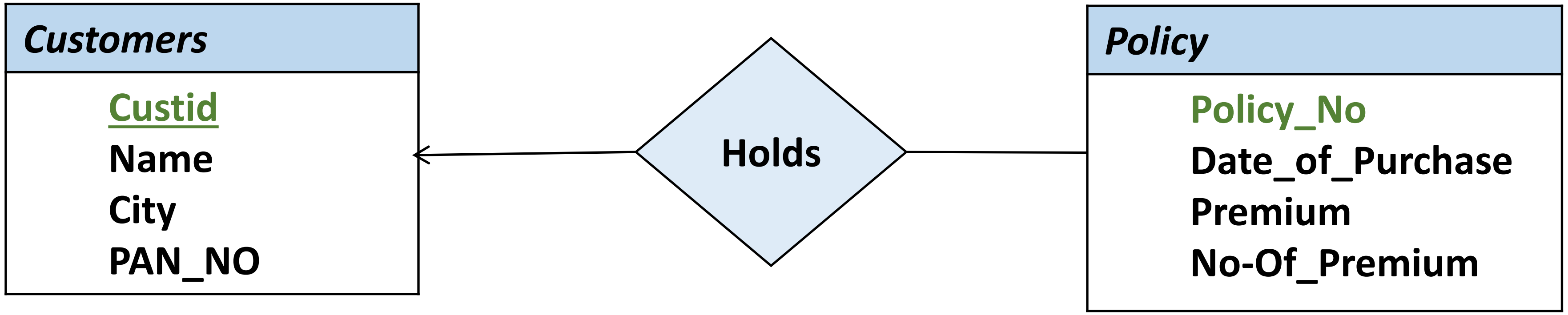
CustID	Name	City	PAN_NO
C101	Rajesh	Manipal	ABC1028
C102	Ravi	Mangalore	AFC1097
C103	Blake	Bangalore	BSD2013
C104	Mukhesk	Udupi	RES2001
C105	Ram	Udupi	FGU7629

Policy

Policy_No	Date_of_Purchase	Premium	No_of_Premium
LIC101	10-10-2001	4000	40
LIC102	1-1-1990	5000	30
LIC107	2-5-2012	7000	20
LIC102	2-9-2012	7000	25
LIC105	10-4-2001	8000	40
LIC202	2-3-2003	9000	30
LIC321	2-5-1998	3000	25
LIC312	4-4-2001	4000	28
LIC383	9-1-2004	5000	15

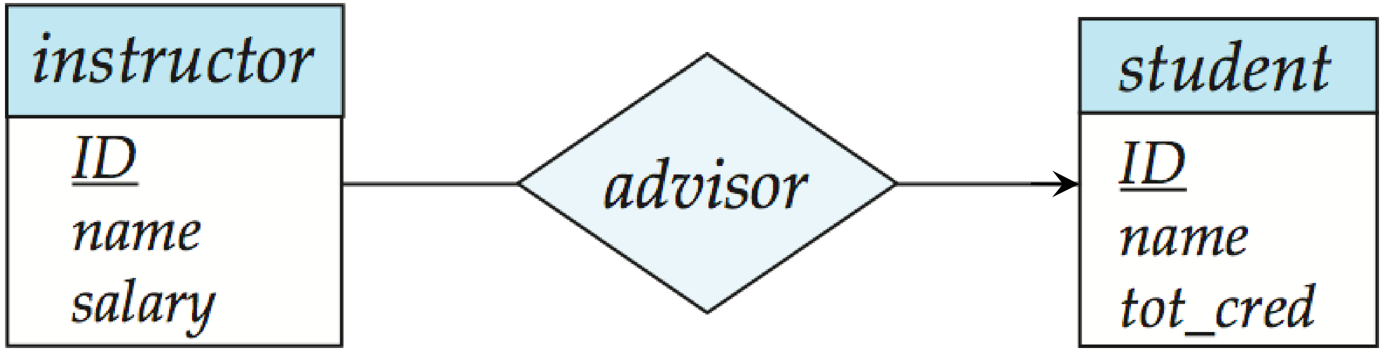
a sample one-to-many relationship between an ***Customers*** and a ***Policy***

1 Customer may take 1 or More LIC policies



Many-to-One Relationships

- In a many-to-one relationship between an ***instructor* and a *student*,**
  - an instructor is associated with at most one student via *advisor*,
  - and a student is associated with several (including 0) instructors via *advisor*



Example Many-one

Employee

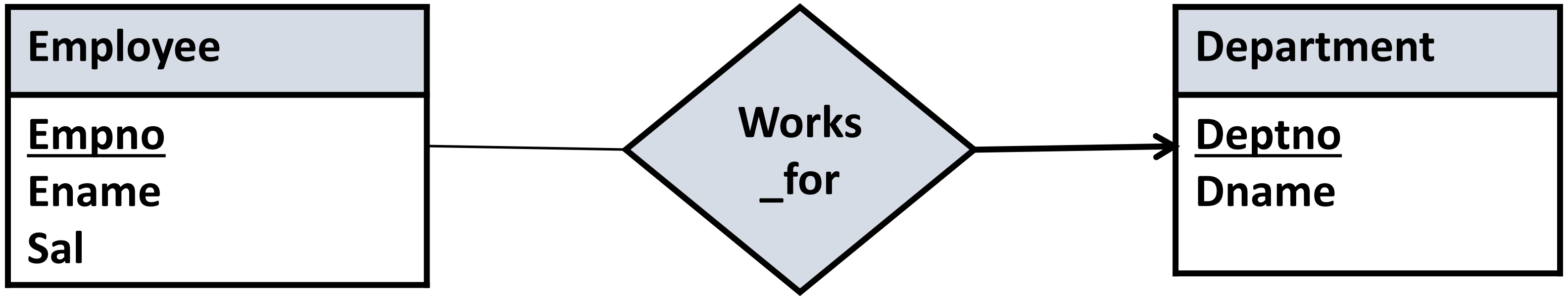
Empno	Ename	Sal
100	Ravi	2000
101	Raj	3000
102	Vikram	5000
103	Santhosh	4000
104	Ajay	7000
105	Anoop	8000
106	Sanoop	9000
107	Rakesh	7000

Department

Deptno	Dname
D1	MCA
D2	CS
D3	IT

A sample many-to-one relationship between an ***Employee*** and a ***Department***

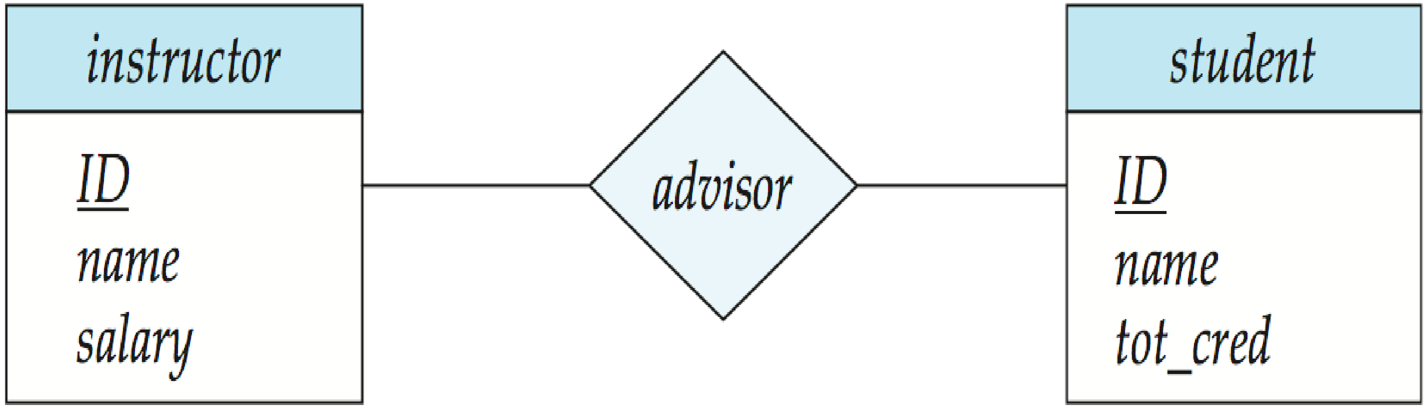
More than 1 employees work in 1 Department



One Department entity may be associated with one or more Employee entities

Many-to-Many Relationship

- An instructor is associated with several (possibly 0) students via *advisor*
- A student is associated with several (possibly 0) instructors via *advisor*



Example Many - Many

STUDENTS

RegNo	Name	Phone
MCA101	Rajesh	124478
MCA102	Ravi	344535
MCA103	Blake	473456
MCA104	Mukhesk	445987
MCA105	Ram	896949
MCA106	Vijay	800543

SUBJECTS

SubjectID	SubjectName	Credits
S101	OS	4
S102	OT	3
S103	INS	3
S104	ADBMS	4
S105	OOPD	4
S106	DS	4

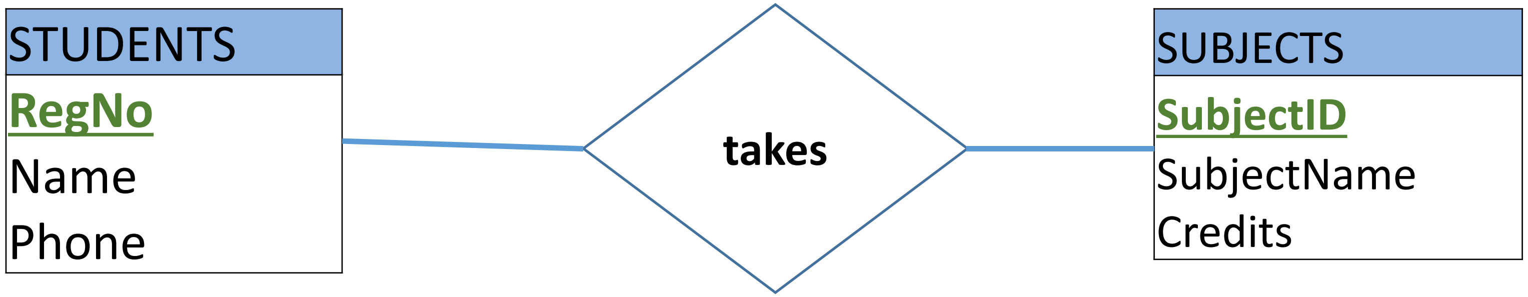
A many-to-many relationship between an ***STUDENTS*** and a ***SUBJECTS***

More than 1 Student can take 1 subject – therefore Many-1

More than 1 Subject cab be take by 1 students – therefore 1-Many

Equivalently

Multiple students can take Multiple Subjects. Therefore **Many-Many**



Example

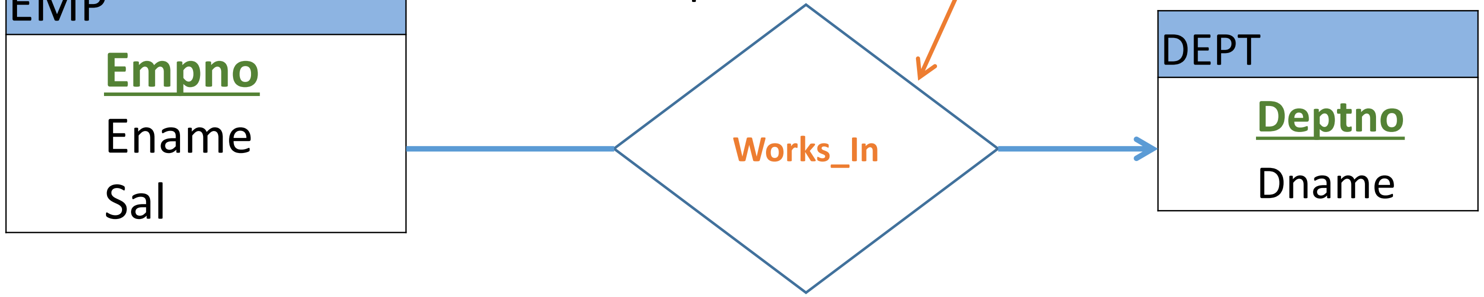
- Assume that we want model the data requirements of an Institute using ER modeling.
- The Institute is comprised of several departments such as –CA(Computer Applications),CS,IT etc.. and each department has a Department Number such as D1,D2,.. used to identify each department. In every department many employees work. Each employee is identified by a unique Employee Number. Information about each employee we need is employee name and salary.

Entity Sets ,Sample Entities and relationship

Empno	Ename	Sal
100	Ravi	2000
101	Raj	3000
102	Vikram	5000
103	Santhosh	4000
104	Ajay	7000
105	Anoop	8000
106	Sanoop	9000
107	Rakesh	7000

Deptno	Dname
D1	MCA
D2	CS
D3	IT

A sample Employee and Department entities association is the Relationship set.
and it is modelled as **Works _In** Relationship below



- The relationship is having Many-1 Cardinality
- An employee can work at most in only 1 department.
- **Note** that If you are adding **Deptno** as another column in EMP to represent Employee working in a department association, it becomes redundant information as **Works_In** implicitly represents it.

Assume that we want model following data requirements of Institute using ER modeling.

The college is comprised of several departments such as –CA(Computer Applications),CS,IT etc.. and each department has a Department Number such as D1,D2,.. used to identify each department. In every department many employees work. Each employee is identified by a unique Employee Number. Information about each employee we need is employee name and salary.

Extend previous ER diagram with following Data Requirements:
Assume appropriate attributes.

We also want to record information related to the courses offered by each department such as courses names, Number of semesters, Total Credits etc.

For example– IT department offers – Inform. & Tech., Computer & Comm. , CA offers Inform. Security ,Computer Science, MSc in CS.

Entity Sets ,Sample Entities and relationship

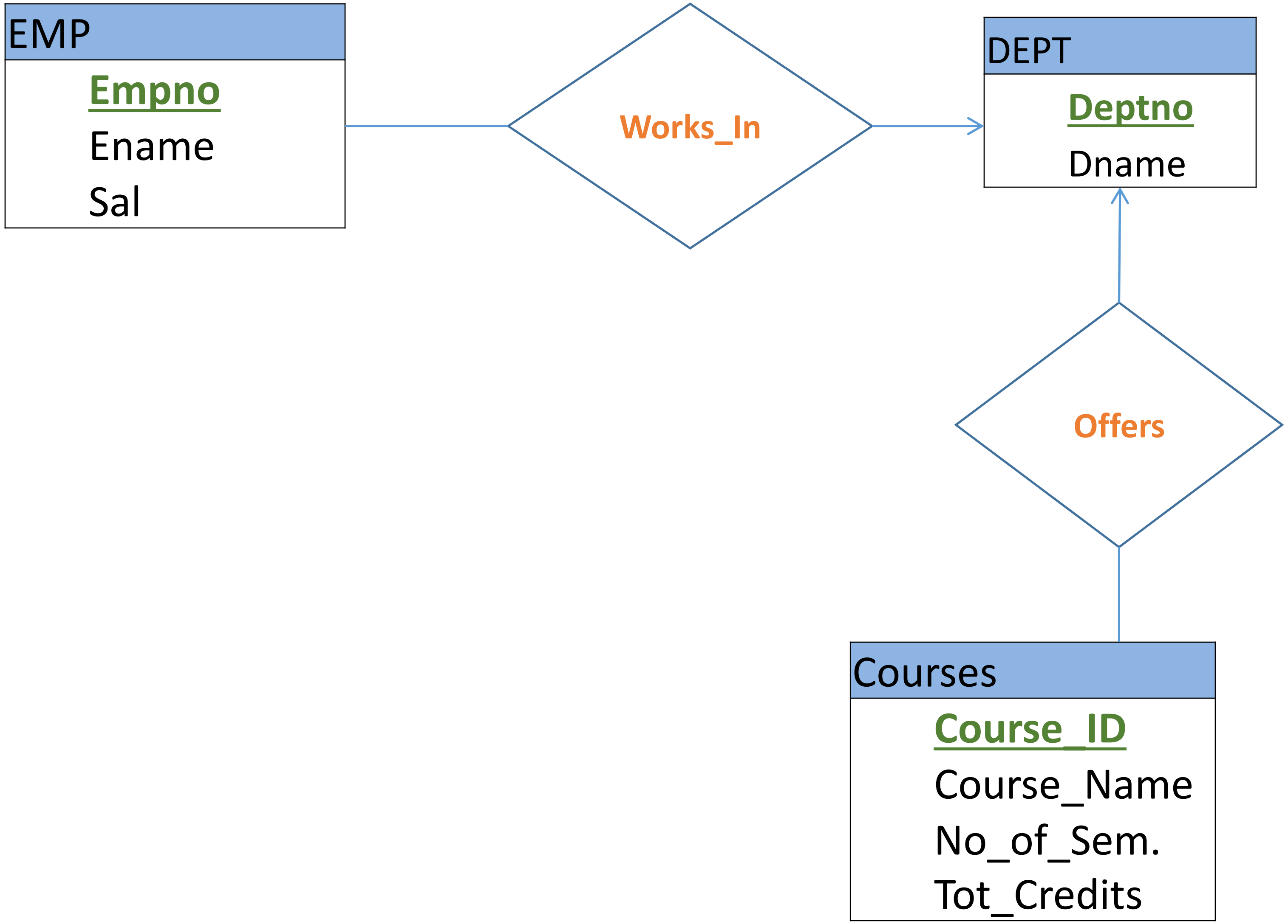
Department Entity Set

Deptno	Dname
D1	CA
D2	CS
D3	IT

Course Entity Set

Course_ID	Course_name	No-Of Sem	Credits
100	Info & Tech		
101	Comp&Com		
102	Info.Security		
103	Comp Science		
104	MSC-CS		
106	MCA		

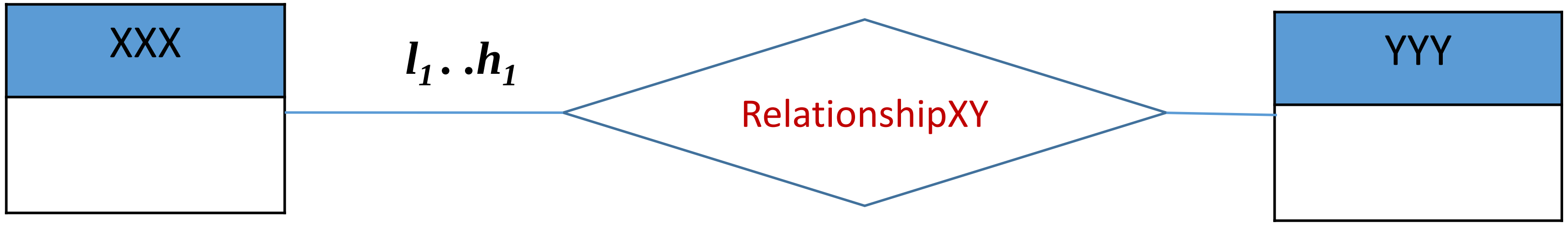
A sample association between Department entities and Course entities


EMP
Empno
Ename
Sal
Works_In
DEPT
Deptno
Dname
Offers
Courses
Course_ID
Course_Name
No_of_Sem.
Tot_Credits

Notation for Expressing More Complex Constraints

- Along with Cardinality constraints such as 1-1, 1-M & M-M, Cardinality limits can also be used express participation constraints.
- Cardinality limits tells about-
  - The number of times (Minimum & Maximum) each entity participates in relationships in a relationship set.
  - A line may have an associated minimum and maximum cardinality, shown in the form *l..h*
    - where ***l*** is the minimum and ***h*** the maximum cardinality

A **XXX** entity may be associated with a minimum of ***l*** *number of YYY entities* or at the maximum h_1 number of **YYY entities through RelationshipXY relationship.**



Notation for Expressing More Complex Constraints

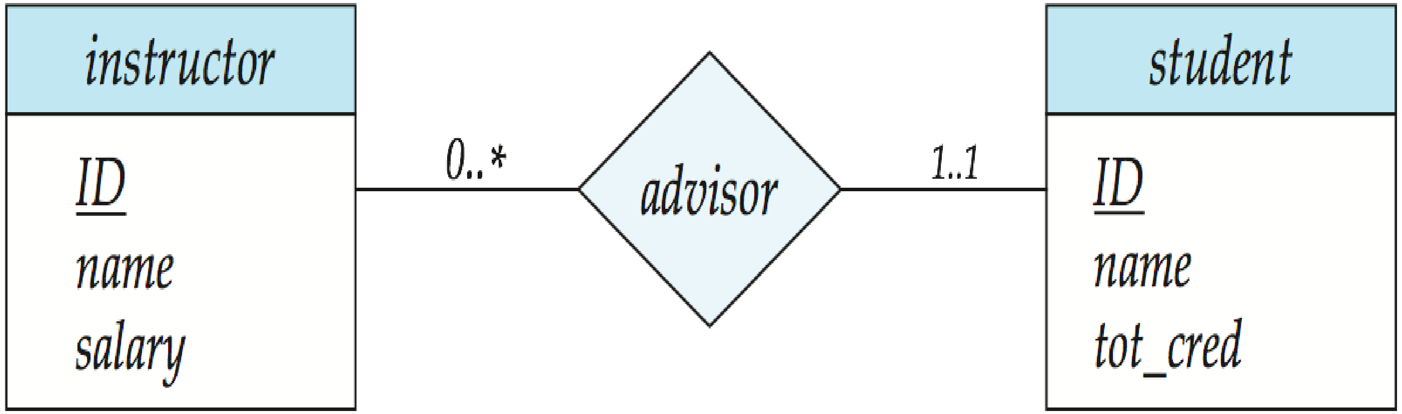
Example:

- The line between advisor and student has a cardinality constraint of **1..1**, meaning the **minimum** and the **maximum** cardinality are both 1.

  A student entity is associated with max & min 1 instructor entity only.
  Means each student must have exactly one advisor.

- The limit **0..*** on the line between *Instructor* and *Advisor* indicates that an instructor may be associated with **zero or more students**.

  Means instructor can be advisor for **zero or more** students.



Instructor

ID	Name	Salary
I1		
I2		
I3		
I4		

Advisor

Student

ID	Name	Total_Credit
S1		
S2		
S3		
S4		
S5		

An Instructor may or may not be an Advisor.

Hence **Minimum** number of Instructor entity that can be associated with student entities through advisor is **0.**

An Instructor may be Advisor to any number of Students.

Hence **Maximum** number of Instructor entity that can be associated with student entities through advisor is ***.**

0..*

Minimum-0 means every Instructor need not participate in Advisor.

i.e. Partial participation

Each student must have exactly one advisor.

Every student entity is Associated with an Instructor via Advisor Relationship.

Maximum=1 & Minimum=1 Student entity that can participate in Advisor is **1..1**

Minimum-1 means every Student must participate in Advisor.

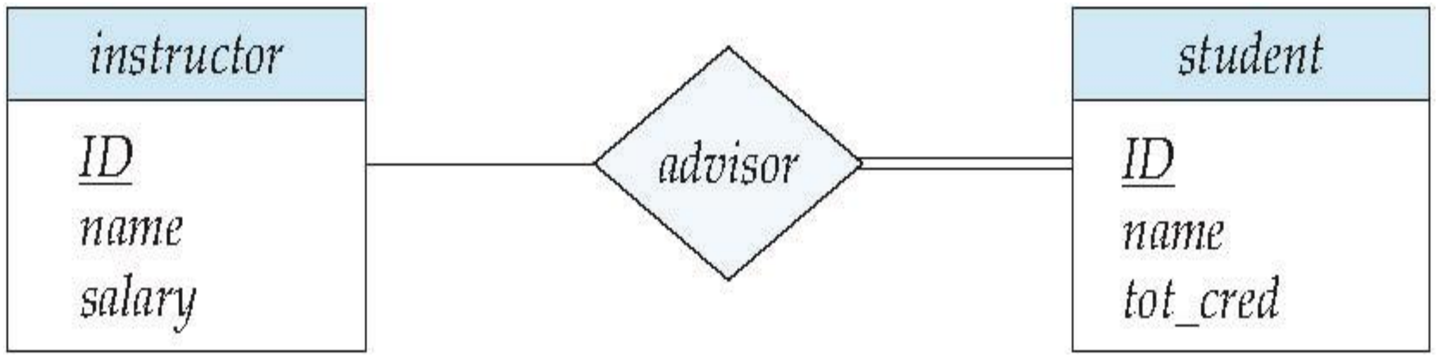
Total participation

Participation of an Entity Set in a Relationship Set

- **Total participation** (indicated by double line):

  every entity in the entity set participates in at least one relationship in the relationship set

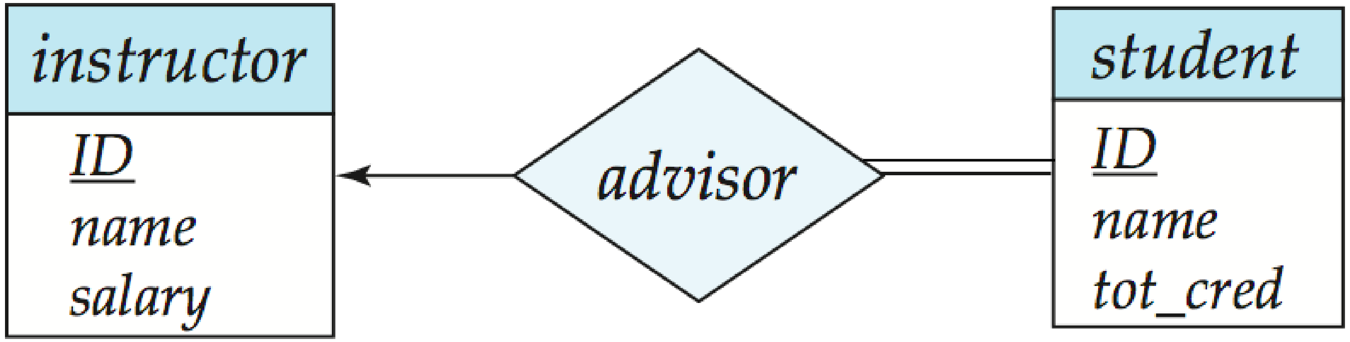
  - E.g., participation of *Student* in *advisor* is total
    - every *Student* must be associated with *instructor*

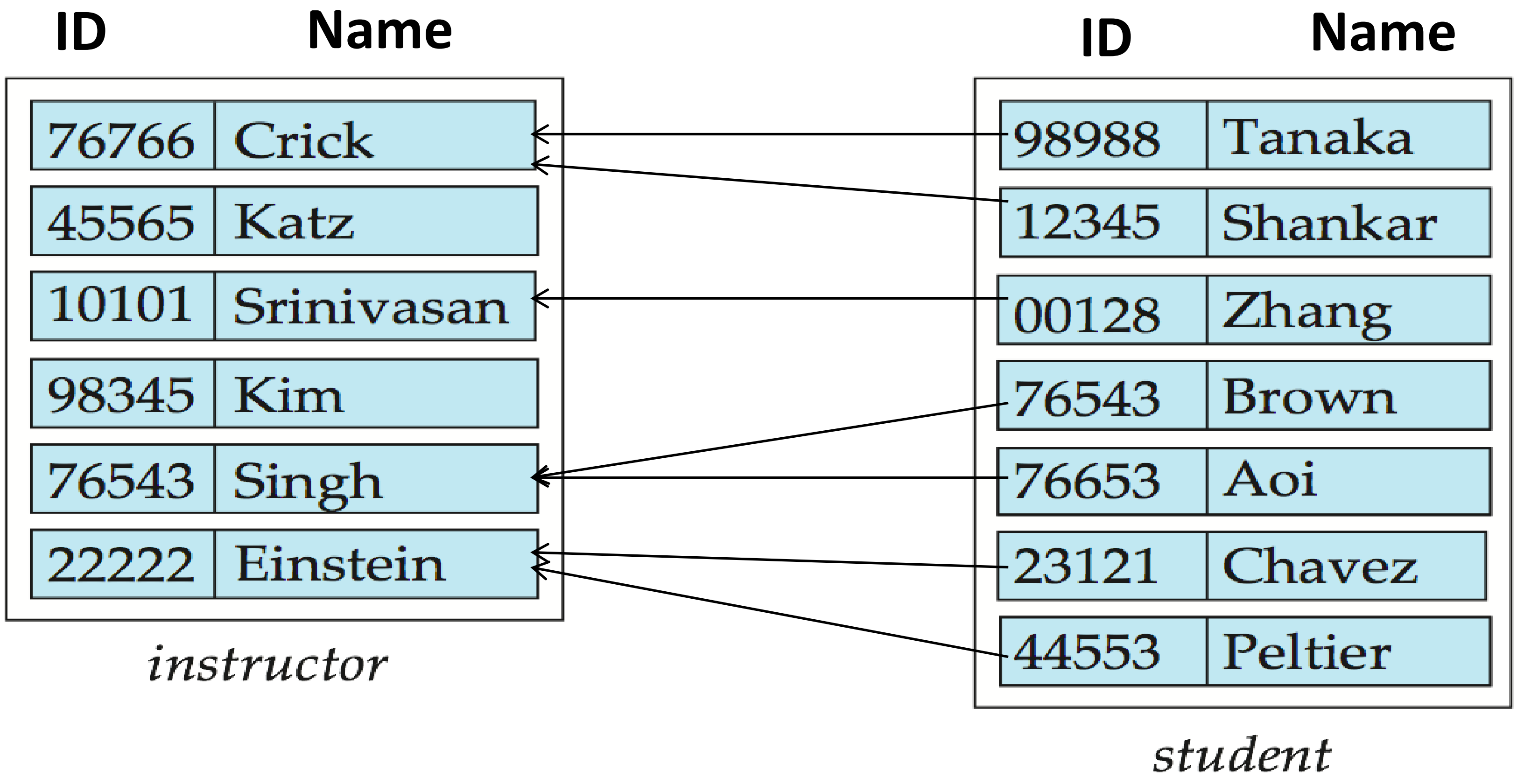


- **Partial participation:**

  some entities may not participate in any relationship in the relationship set

  - Example: participation of ***instructor* in *advisor* is partial** (see next slide)





For an Instructor being an Advisor is optional –

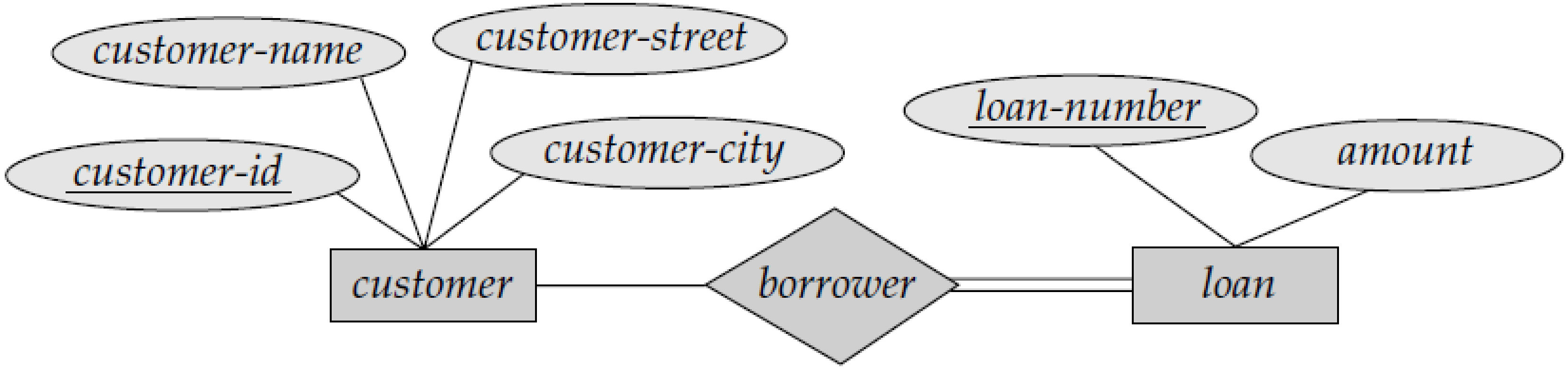
Therefore **Instructor** entity participation is **PARTIAL**

Note: (45565,Katz) and (98345,Kim) are not participating in advisor relationship

but Every student must have an Advisor –

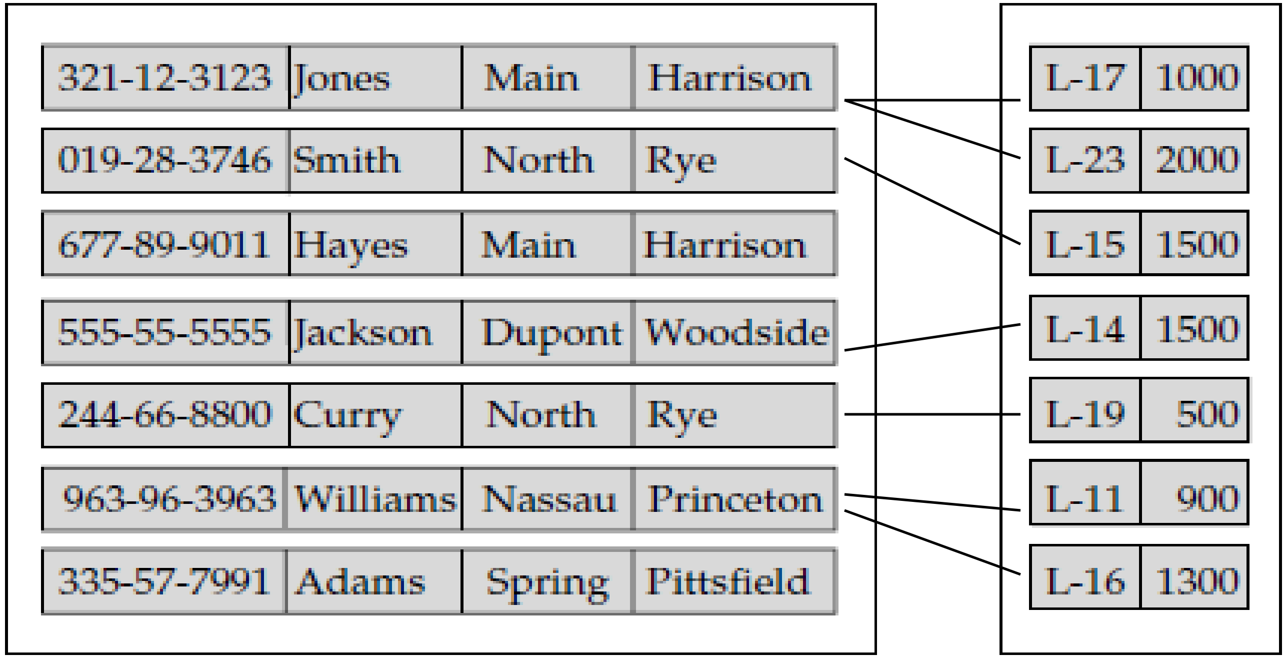
Therefore **Student** entity participation is **TOTAL.**

Total and Partial participation …



- participation of *loan* in *borrower* is total
  - In loan (entity type), every loan entity has to be associated with 1 or more customers, because a loan can't be given if there do not exist customer taking loan.
- participation of *customer* in *borrower* is Partial
  - In Customer, there may be some customers not taking loan and so do not participate in borrower relationship

Total and Partial participation …



customer *loan*

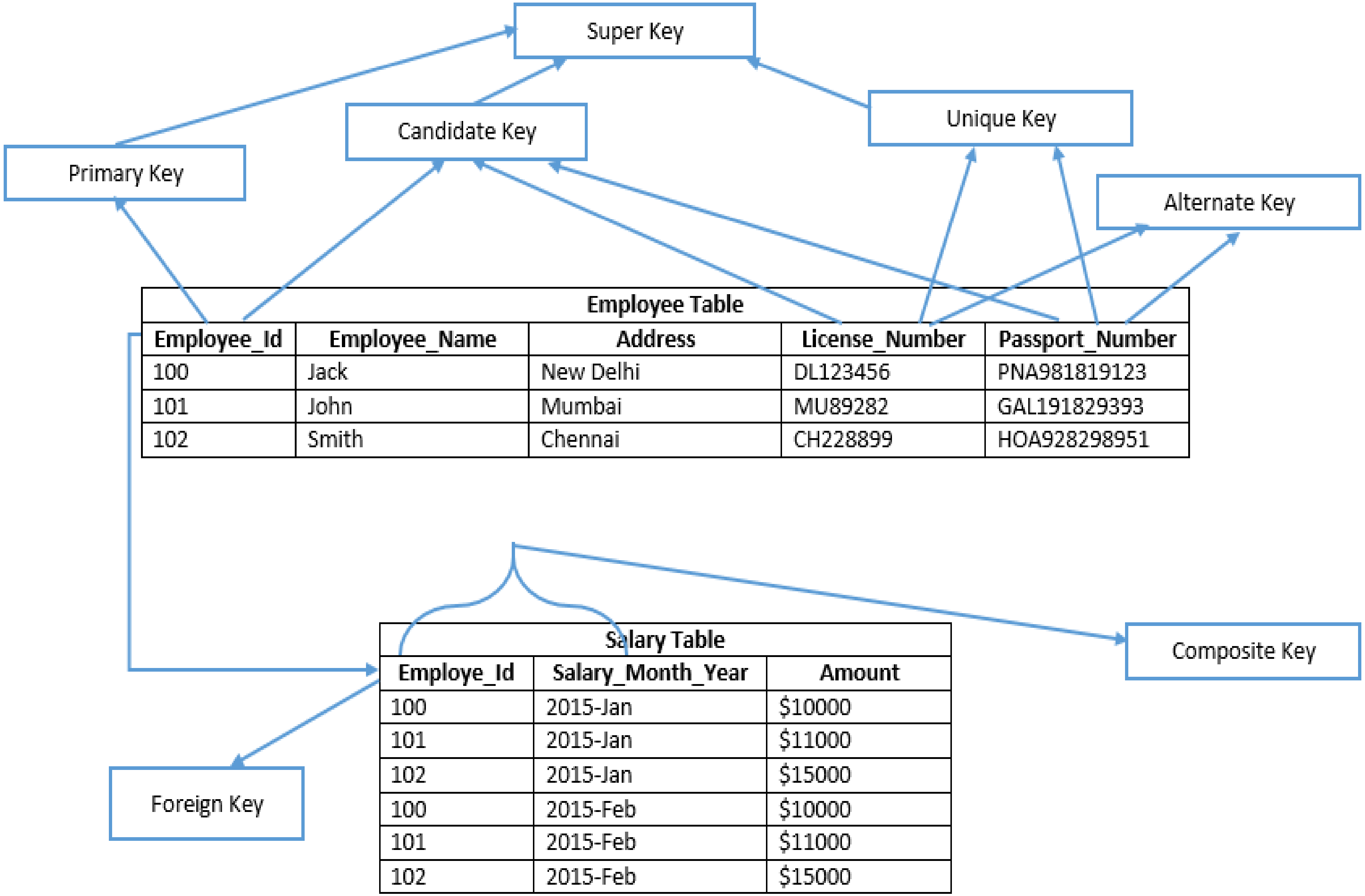
Note that Customers- Hayes & Curry haven't taken any loan , therefore Customer participation is Partial in Borrower relationship.

But, a Loan has to be given to a customer only , so a Loan entity can not exist without being associated with Customer . So Loan participation is Total in Borrower relationship

Keys

- A **super key** of an entity set is a set of one or more attributes, allow us to identify uniquely every entity in the entity set.
- A **candidate key** of an entity set is a minimal super key.
  - *ID* is candidate key of *instructor*
  - *course_id* is candidate key of *course*
- Although several candidate keys may exist, one of the candidate keys is selected to be the **primary key**.
- Need to consider semantics of Entity set in selecting the ***primary key*** in case of more than one candidate key.

Types of Keys



Employee Table				
Employee_Id	**Employee_Name**	**Address**	**License_Number**	**Passport_Number**
100	Jack	New Delhi	DL123456	PNA981819123
101	John	Mumbai	MU89282	GAL191829393
102	Smith	Chennai	CH228899	HOA928298951

Salary Table		
Employe_Id	**Salary_Month_Year**	**Amount**
100	2015-Jan	$10000
101	2015-Jan	$11000
102	2015-Jan	$15000
100	2015-Feb	$10000
101	2015-Feb	$11000
102	2015-Feb	$15000

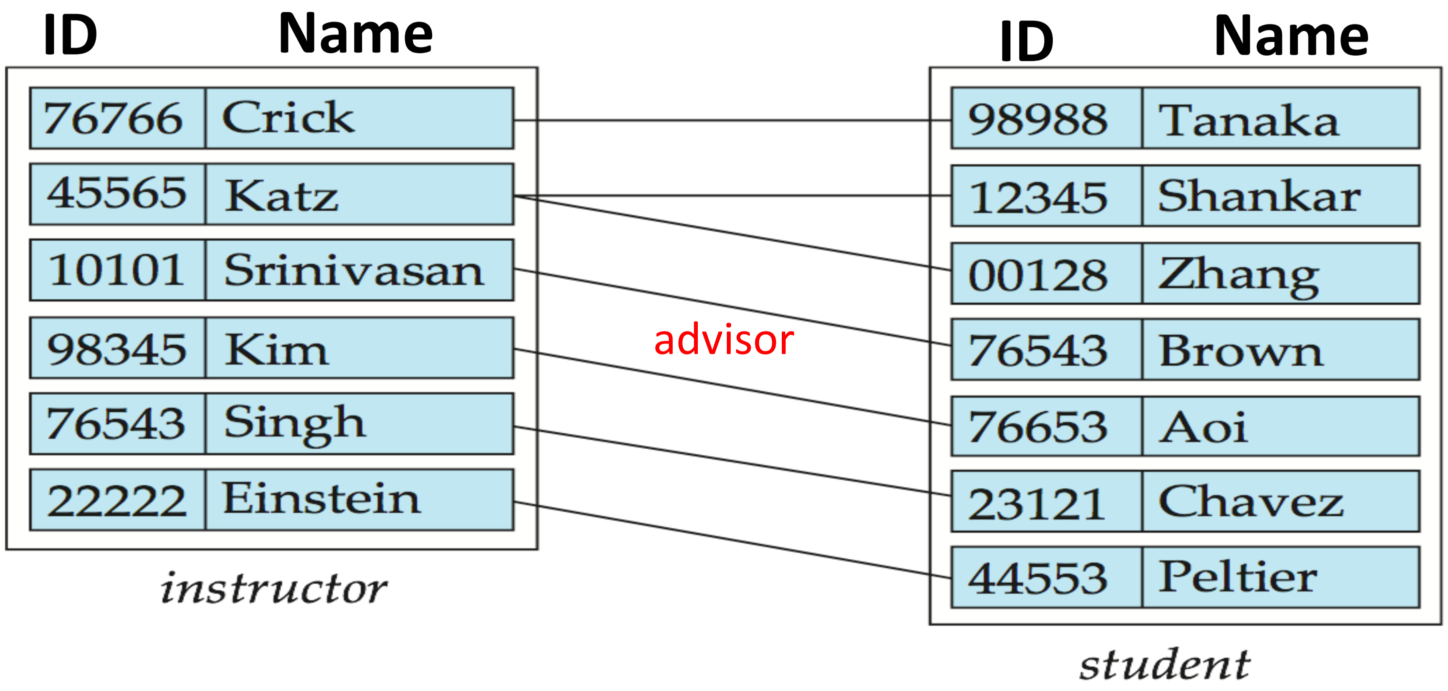
Example

- Consider **Instructor(ID, Name, Dept_Name, Salary, email)**,
- We know ID is unique for every entity (Instructor) in the relation Instructor, therefore ID is Super Key
- Name is not unique, because there may be multiple Instructor with same Name , so Name is not Super key.
- (ID, Name) is also unique for every Instructor , so (ID, Name) is super key.
- **Is (ID, Name) a minimal Super Key ?**
- If we have to find at least one proper subset of **(ID,Name)** which is super key then it implies that **(ID,Name)** is only superkey , but not minimal super key

Example

- Proper subsets of **(ID,Name)** are (ID) and (Name)
- We know (Name) is not super key but, (ID) is super key , so we found a proper subset (ID) of **(ID, Name)** which is super key , hence **(ID,Name)** is only super key but not minimal super key.
- (ID) is also minimal super key because , we can't find any proper subset of (ID) being super key.
- **Therefore ID is minimal super key (means candidate key)**
- Similarly there is another **candidate key** -**email.**
- Among **ID** and **email candidate keys,** Semantically **ID** is the one used to identify each Instructor ,hence semantically ID is to be taken as Primary Key

Keys for Relationship Sets



Relationship set advisor ={ (76766,Crick - 98988,Tanaka) ,(45565,Katz- 12345,Shankar), (45565,Katz-00128,Zhang),(10101,Srinivasan),... (22222, Einstein-44553,Peltier) }

Every element(Relationship instance) in Relationship Set is to be identified uniquely, therefore we need a primary key for relationship set too.

Keys for Relationship Sets

- The combination of primary keys of the participating entity sets forms the Primary key of a relationship set.

- Let R be a relationship set involving entity sets $\mathbf{E_1,E_2,\ldots,E_n}$. Let **primary-key($E_i$)** denote the set of attributes that forms the primary key for entity set E_i.

- If the relationship set R has no descriptive attributes associated with it, then the set of attributes.

  primary-key(E_1) U primary-key(E_2) U…primary-key(E_n)

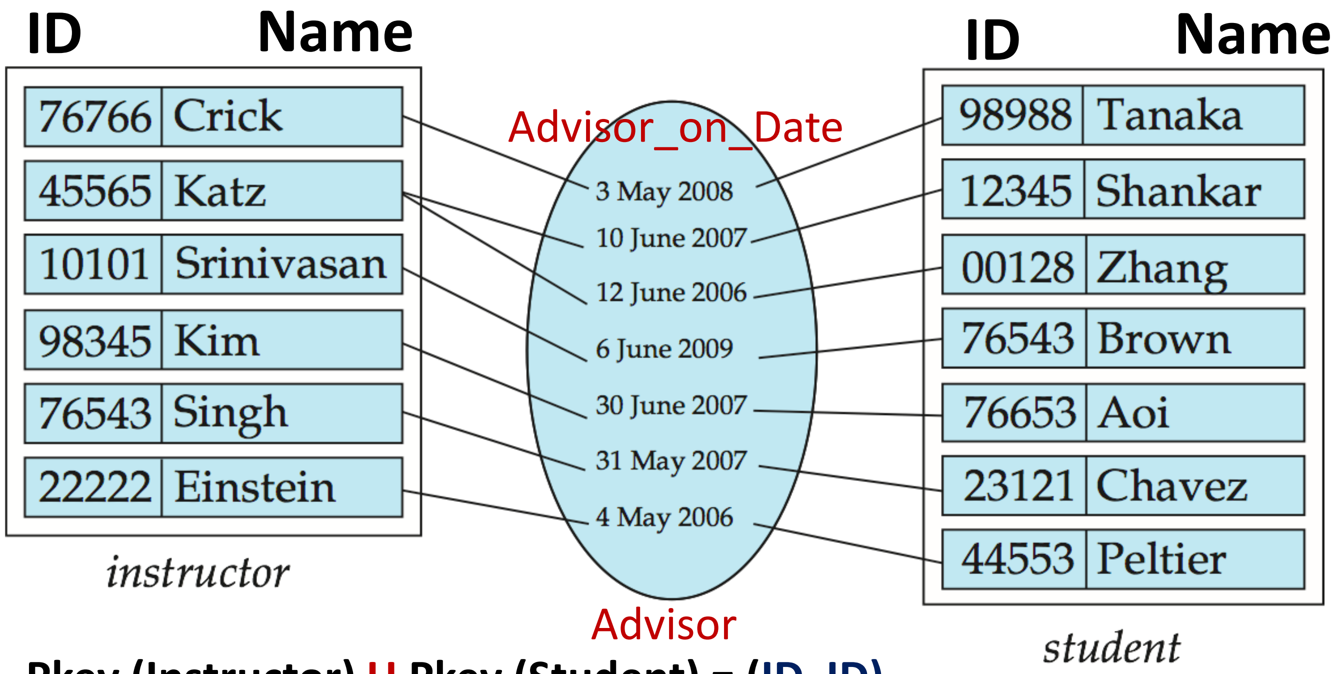
- Example:
  - Primary Key for Advisor relationship set is
    - – **Primary Key(Instructor) U Primary Key(Student)**
- i.e (ID,ID)   , i.e. ID of Instructor & ID of Student is Pkey of Advisor

Keys for Relationship Sets having Attributes

- If the relationship set R has descriptive attributes $a_1, a_2, \ldots\ldots, a_m$ associated with it, then the set of attributes-

primary-key(E_1) **U** primary-key(E_2) **U**… primary-key(E_n) **U** $\{a_1, a_2, \ldots a_m\}$ describes the individual relationship in set R

Example



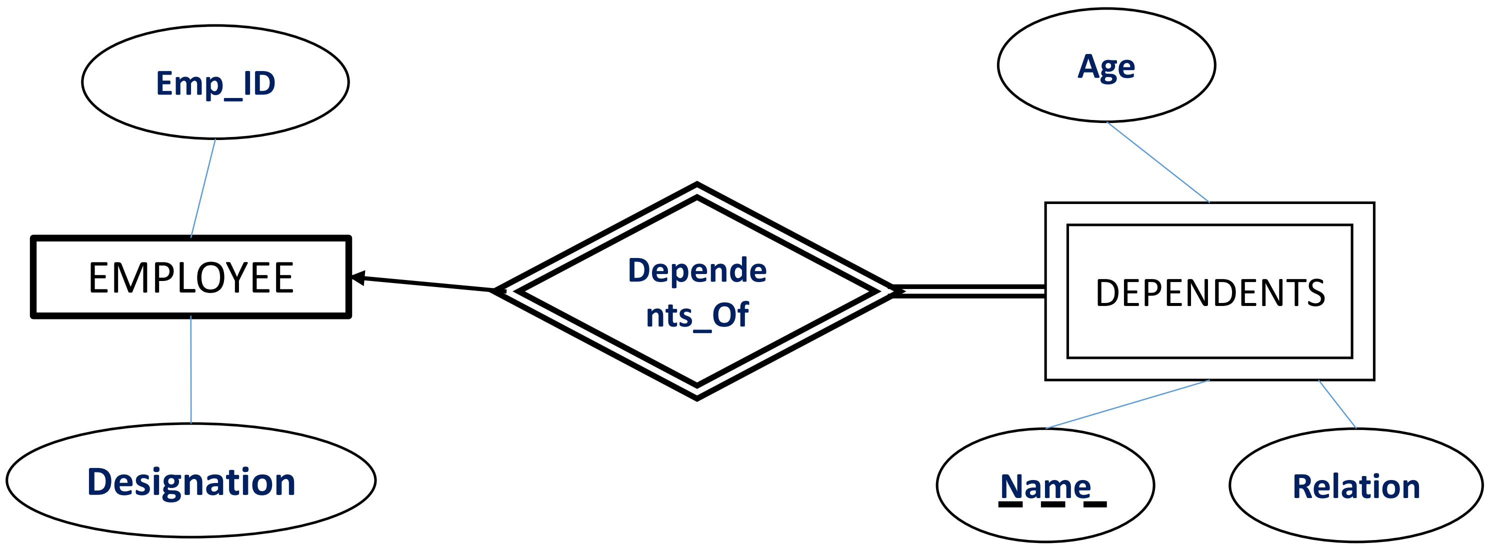
Primary key of Advisor relationship set is – **Pkey (Instructor) U Pkey (Student) = (ID, ID)**

Individual Relationship in Advisor– **Pkey (Instructor) U Pkey (Student) U {Advisor_On_Date}**

Weak Entity Sets

- An entity set that does not have sufficient attributes to form a primary key is referred to as a **weak entity set**
- An entity set that has a primary key is called strong entity set
- The existence of a weak entity set depends on the existence of a **identifying entity set**
  - It must relate to the identifying entity set **via a total partition, one-to-many relationship set** from the identifying to the weak entity set
  - **Identifying relationship** depicted using a double diamond
- The **discriminator** (*or partial key)* of a weak entity set is the set of attributes that distinguishes among all the entities of a weak entity set.
- The primary key of a weak entity set is formed by the primary key of the strong entity set on which the weak entity set is existence dependent, plus the weak entity set's discriminator.

Weak Entity Sets (Cont.)

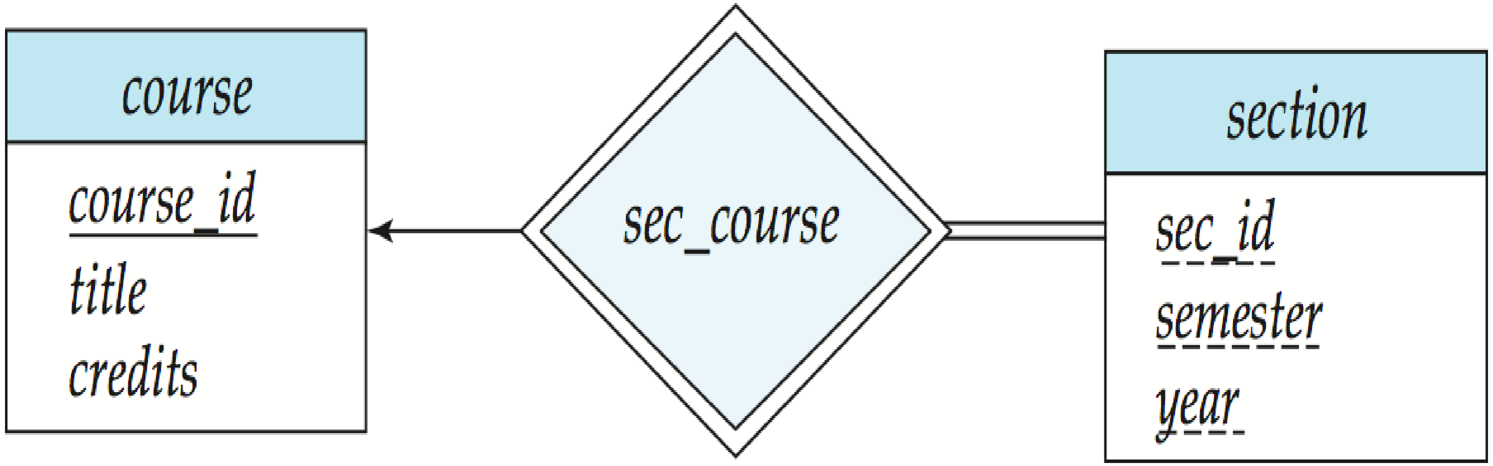


Empno	Designation
100	
101	
102	

Name	Relation	Age
X	Son	12
Y	Daughter	5
Y	Wife	25
P	Son	7

Weak Entity Sets (Cont.)

- We underline the discriminator of a weak entity set with a dashed line.
- We put the identifying relationship of a weak entity in a double diamond.
- Primary key for *section* – (***course_id, sec_id, semester, year***)



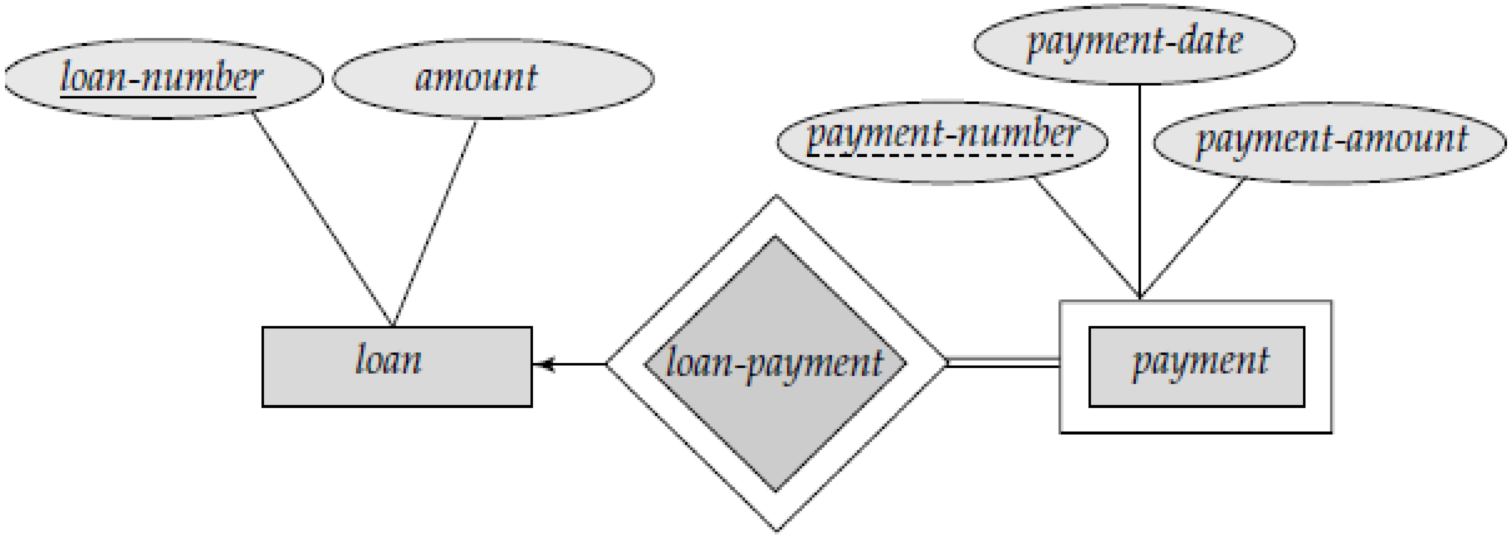
Partial key/ Discriminator: Uniquely identifies a section among the set of sections of a particular course

Course_Id	Title	Credits
MCA	Master of..	36
MTech	Info. Security	38
MTech	S/W Engg	36
M.Sc.	Buisness Analytics	38

Sec_Id	Semester	Year
A	I	2016
B	I	2016
A	III	2016
B	III	2016
A	II	2017
B	II	2017
A	IV	2017
B	IV	2017
A	I	2016
A	III	2016
…	..	..

Weak Entity Sets (Cont.)

- Note: the primary key of the strong entity set is not explicitly stored with the weak entity set, since it is implicit in the identifying relationship.
- If *course_id* were explicitly stored, *section* could be made a strong entity, but then the relationship between *section* and *course* would be duplicated by an implicit relationship defined by the attribute *course_id* common to *course* and *section*



loan-number	*amount*
L-11	900
L-14	1500
L-15	1500
L-16	1300
L-17	1000
L-23	2000
L-93	500

Loan Entity Type

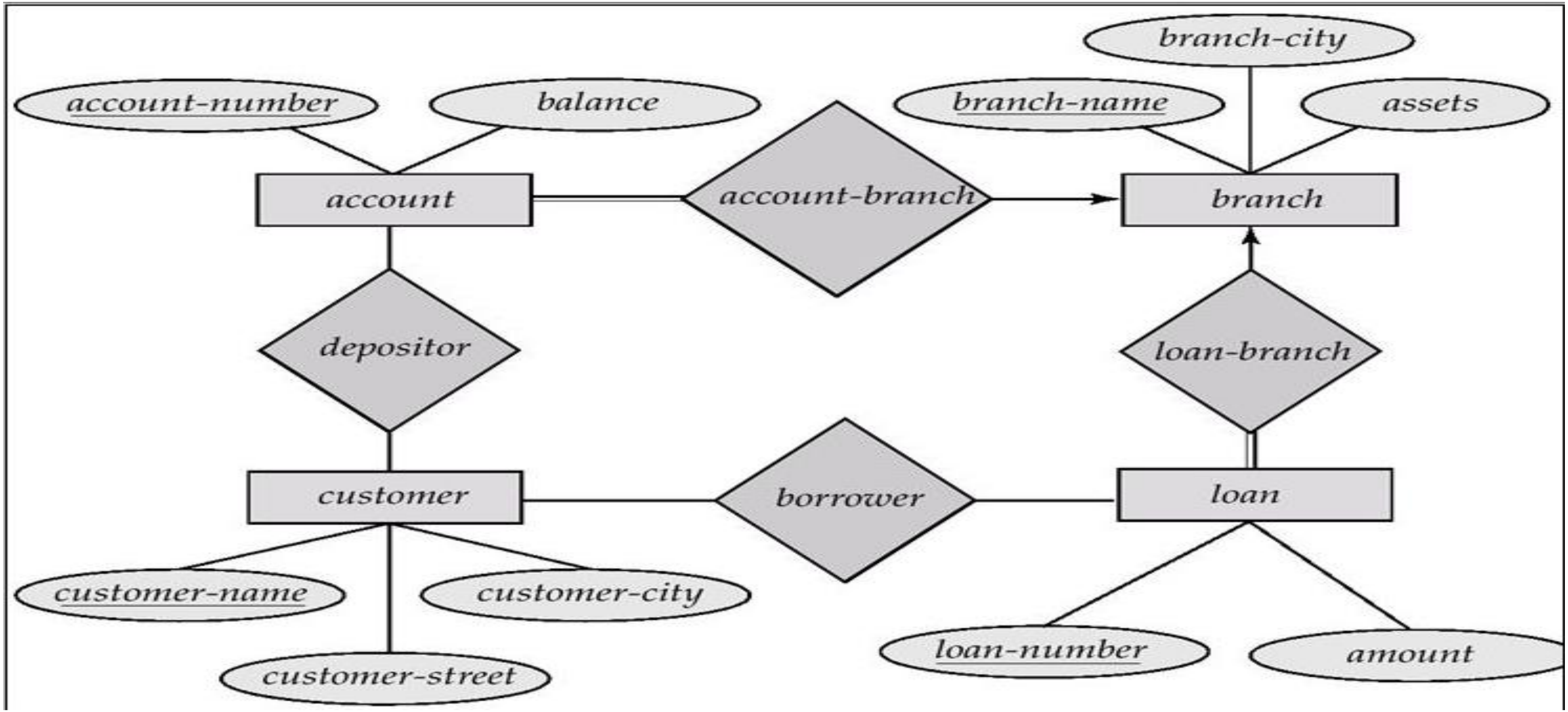
payment-number	*payment-date*	*payment-amount*
53	7 June 2001	125
69	28 May 2001	500
22	23 May 2001	300
58	18 June 2001	135
5	10 May 2001	50
6	7 June 2001	50
7	17 June 2001	100
11	17 May 2001	75
103	3 June 2001	900
104	13 June 2001	200

Payment Entity Type – Weak Entity

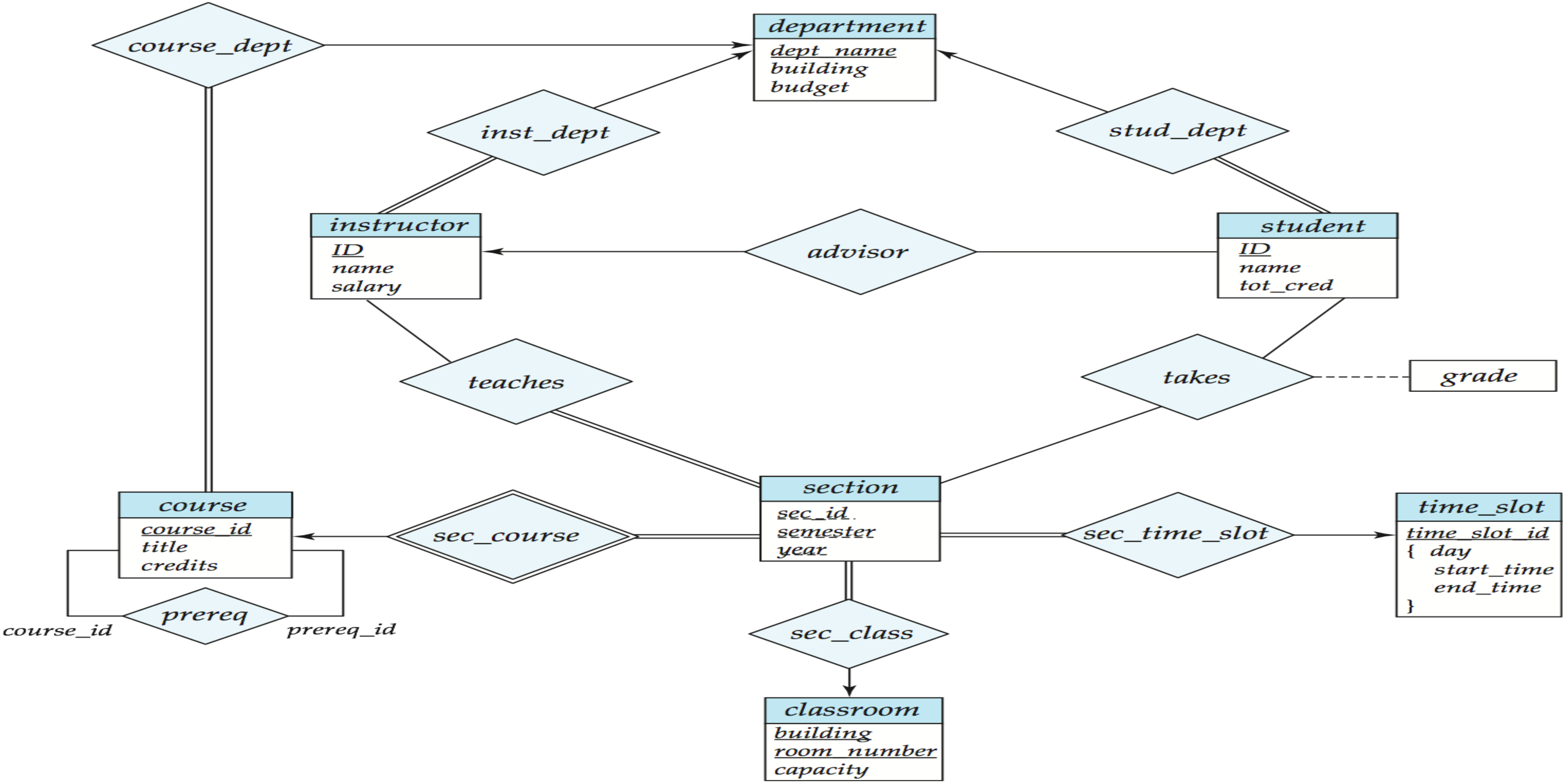
loan-number	*payment-number*	*payment-date*	*payment-amount*
L-11	53	7 June 2001	125
L-14	69	28 May 2001	500
L-15	22	23 May 2001	300
L-16	58	18 June 2001	135
L-17	5	10 May 2001	50
L-17	6	7 June 2001	50
L-17	7	17 June 2001	100
L-23	11	17 May 2001	75
L-93	103	3 June 2001	900
L-93	104	13 June 2001	200

Payment Entity Type can be Identified with respect Loan using PK of Loan

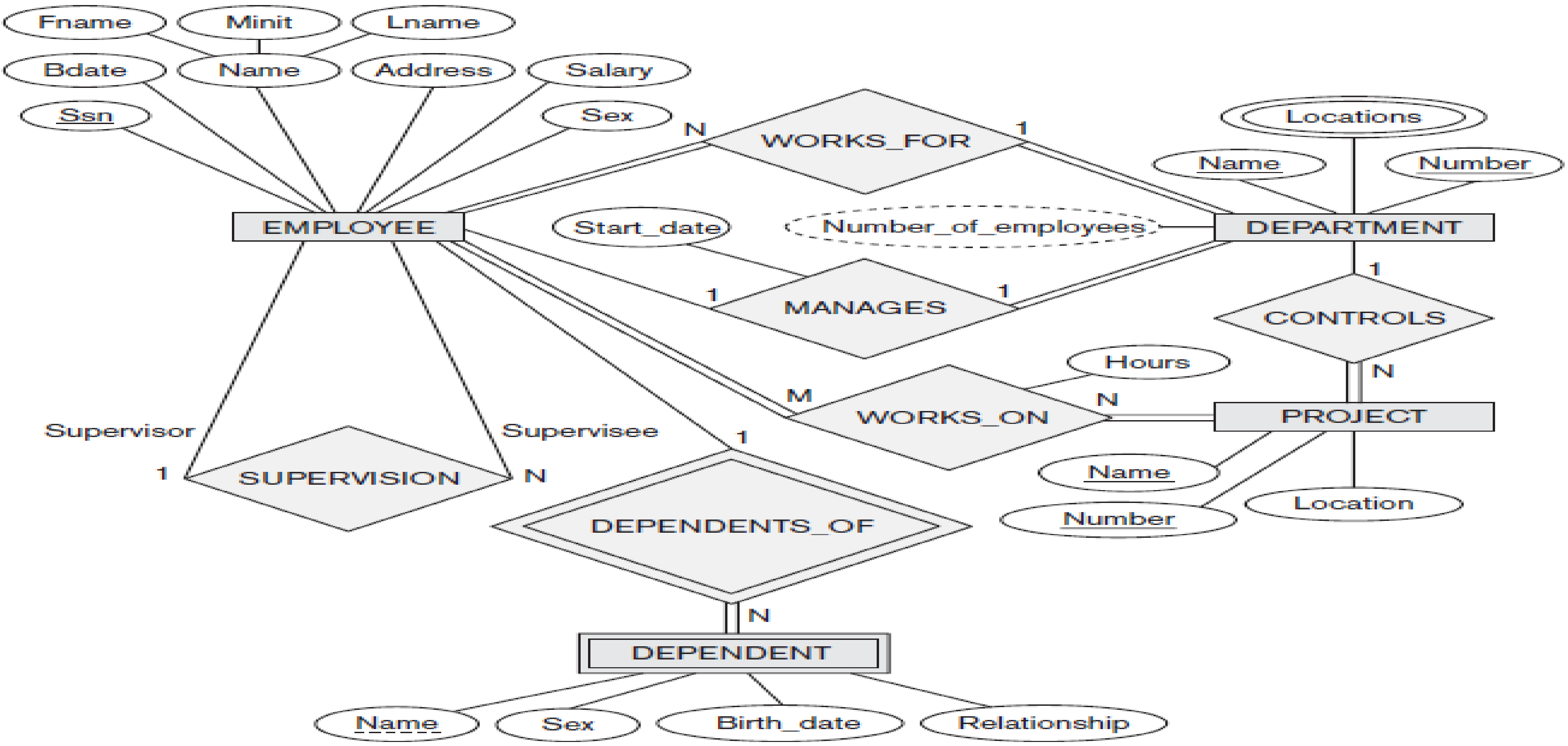
Exercise(Cont'd)-ER Model for Banking Database



Exercise(Cont'd)-ER Model for University Database



Exercise(Cont’d)-ER Model for Company Database



Information to be fetched from Requirements

- Entities
    - Strong
        - Attributes-Primary key, Composite/ Simple, Multivalued/Single valued, Derived.
    - Weak
        - Partial key
- Relationship Between Entities
    - Relationship Attributes
    - Name of relationship
    - Cardinality Constraint
        - 1-1, 1-M, M-M
        - Cardinality Limits
    - Participation
        - Total/Partial

Example

An Institute want to keep track of information about Funded Projects, Agencies which are Funding them and Faculties who work in those Projects.

The college is comprised of several departments such as – MCA,CS,IT ,MECH, EEE etc.. and each department has a Department Number such as D1,D2,.. used to identify each department. Many faculties work in every department . Each faculty is identified by a unique Employee Number. Information about each faculty we need is employee name, Qualification, Research-Domain. Each Departments may have many funded research projects. Information about these projects such as an unique Project-ID, Title, Fund-Received, Duration. Each of these projects are funded by one or more funding agencies such as – MHRD,DSR, DST,BARC etc.. We also need to record information about Funded Funding agencies funding the projects such as- Grant_ord_No, Agency-Name, Contact-Person, Email, Phone, Total_Grant,Year-of-Grant. An agency may fund multiple project and a project may also receive grant from multiple agencies.

Model above data requirements using ER modeling.

What are Entities here ?

What are attributes & sample entities here.

Department

Deptno,	Dname
D1	CS
D2	IT

Faculty

Empno,	Ename,	Qualification,	Research-Domain
101	Raj	MTech	Data-Mining
102	Vinay	Mtech,PhD	Network Eng
106	Manu	MCA, PhD	AI

Projects

Project-ID,	Title,	Fund-Received,	Duration
P1	XYXX	200K	2
P2	GHKL	500K	3
P3	FGHK		

Agency

Grant_order_No,	Agency-Name,	Contact-Person,	Email,	Phone,	Total_Grant,	Year-of-Grant
MH17-1	MHRD	RamRao	ram@gmail.com	78998667	2000K	2017
MH18-5	MHRD	Vijay	Vij@ymail.com	89532689	5000K	2018
DST17-3	DST	Ravi	Ravi@gmail.com	99644775	3500K	2017

Entities

DEPARTMENT
DeptNo
DName

PROJECT
Proj-ID
Prj-Name
Duration
Fund_Received

FACULTY
Empno
Ename
{Qualification}
Research-Domain

AGENCY
Grant_Ord_No
Agency_Name
Contact-Person
Email
Phone
Total_Grant
Grant_Year

Deptno,	Dname
D1	CS
D2	IT
D3	EEE

Empno	Ename	Qualification	Research-Domain
101	Raj	MTech	Data-Mining
102	Vinay	MTech,PhD	Network Eng
106	Manu	MCA, PhD	AI
108	Rakesh	MCA,MTech	SDN

1-Many

1-Many

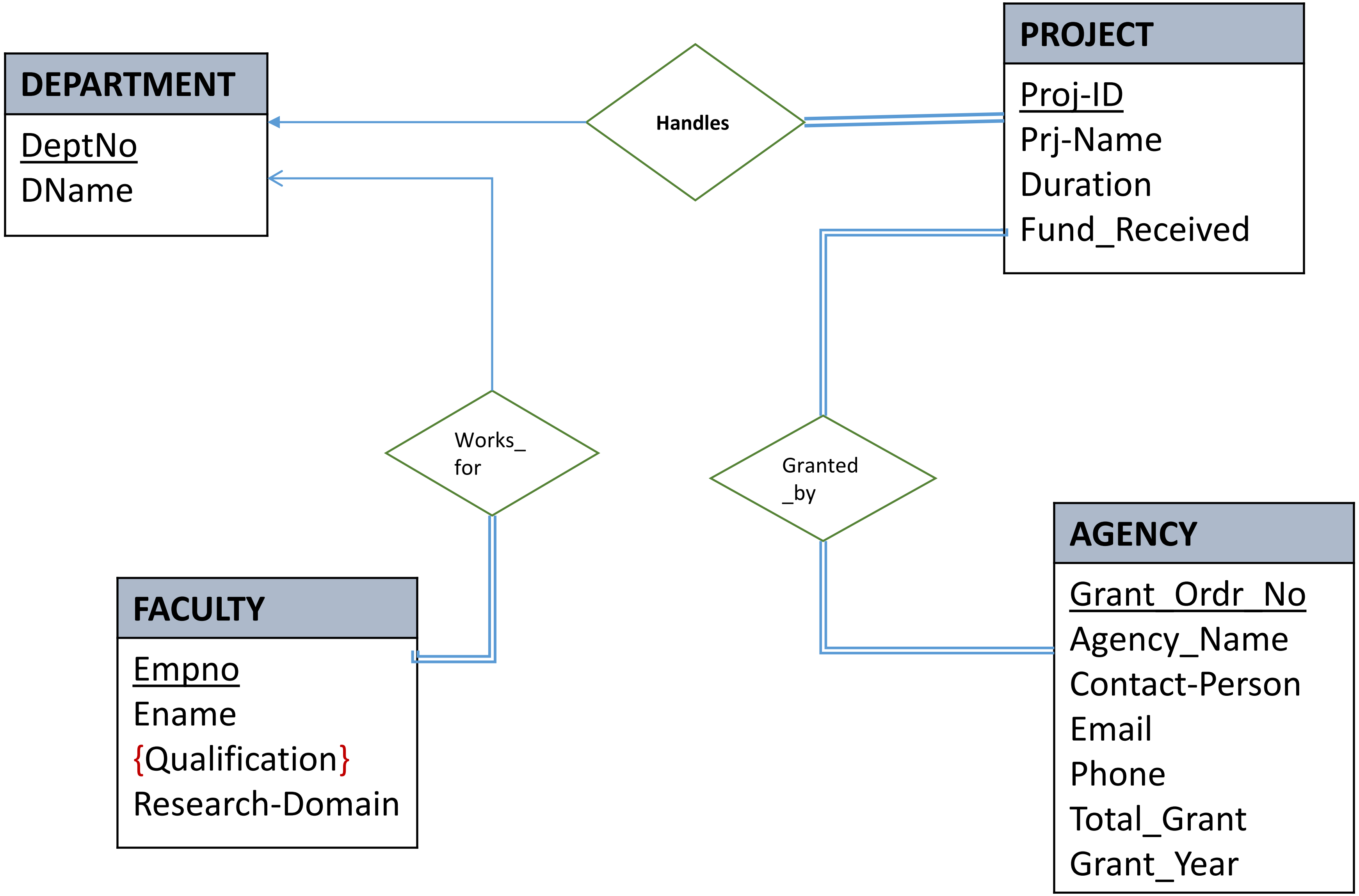
Project-ID	Title	Fund-Received	Duration
P1	XYXX	200K	2
P2	GHKL	500K	3
P3	FGHK	180K	1.5

Many-Many

Grant_order_No,Agency-Name, Contact-Person, Email,Phone,Total_Grant,Year-of-Grant

MH17-1	MHRD	RamRao	ram@gmail.com	78998667	2000K	2017
MH18-5	MHRD	Vijay	Vij@ymail.com	89532689	5000K	2018
DST17-3	DST	Ravi	Ravi@gmail.com	99644775	3500K	2017

Entities & Relationship



Example – Online Book Database

Construct a ER Diagram for a online book database where the information of the book like ISBN, title, year of publishing, number of pages, category, price is maintained. The details of authors and publishers are also included. The author details include name, address, email id and phone number. The publisher details include the publisher name, address, email id and phone number. Each book has an author and publisher associated. The database also maintains the details of the ratings and feedbacks of other authors. Book edition information is also included.

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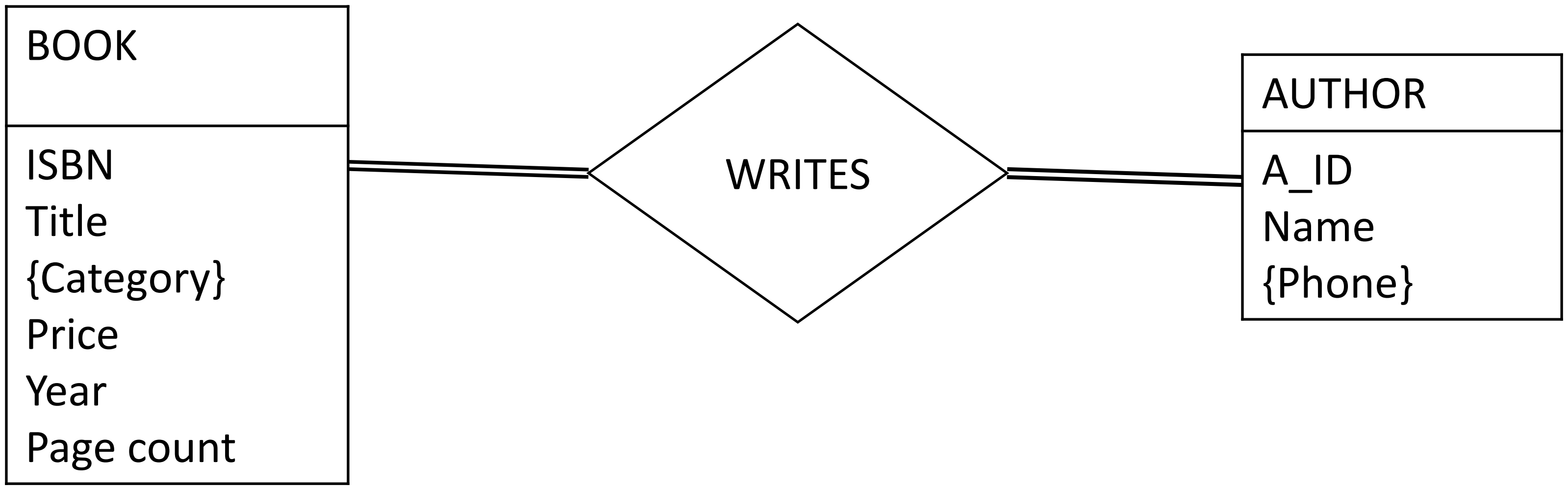
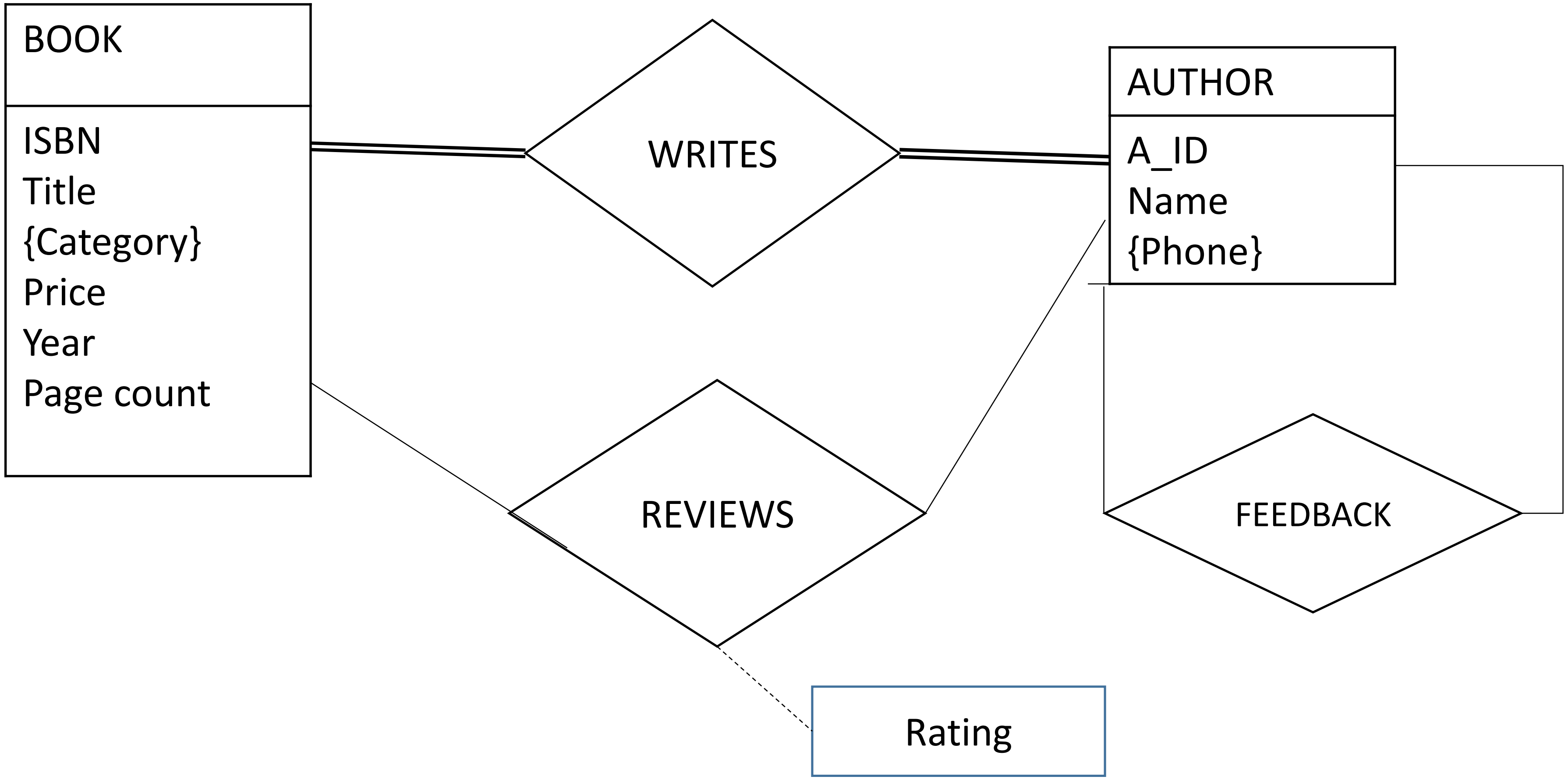
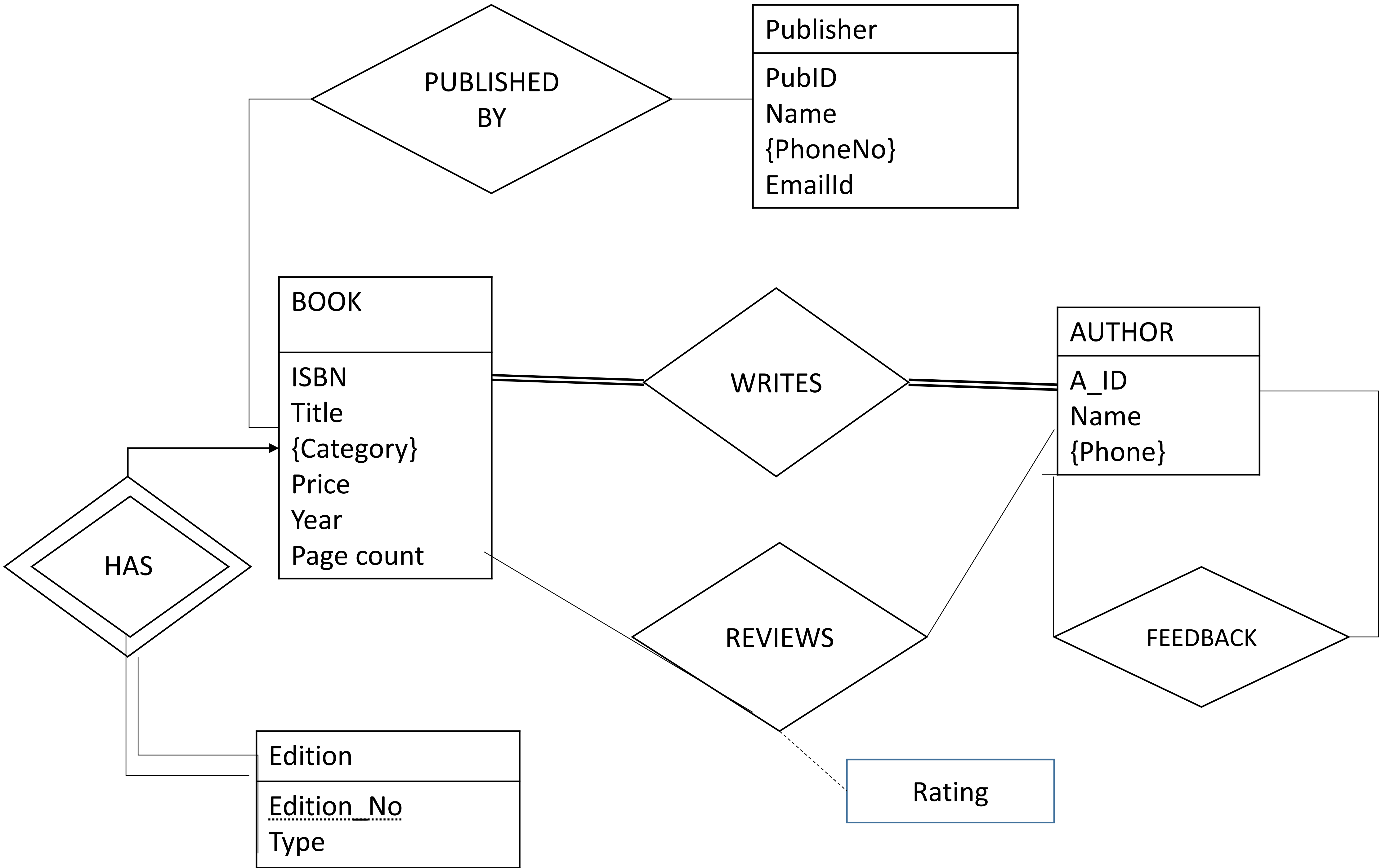
BOOK
ISBN Title

Construct a ER Diagram for a online book database where the information of the book like ISBN, title, year of publishing, number of pages, category, price is maintained. The details of authors and publishers are also included. The author details include name, address, email id and phone number. The publisher details include the publisher name, address, email id and phone number. Each book has an author and publisher associated. The database also maintains the details of the ratings and feedbacks of other authors.



Construct a ER Diagram for a online book database where the information of the book like ISBN, title, year of publishing, number of pages, category, price is maintained. The details of authors and publishers are also included. The author details include name, address, email id and phone number. The publisher details include the publisher name, address, email id and phone number. Each book has an author and publisher associated. The database also maintains the details of the ratings and feedbacks of other authors.




PUBLISHED BY
Publisher
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Reduction to Relational Schemas

Reduction to Relation Schemas

- **Entity sets** and **relationship sets** can be expressed uniformly as ***relation schemas*** that represent the contents of the database.

- A database which conforms to an E-R diagram can be represented by a **collection of schemas**.

- For each entity set and relationship set there is a **unique schema that is assigned** the name of the corresponding entity set or relationship set.

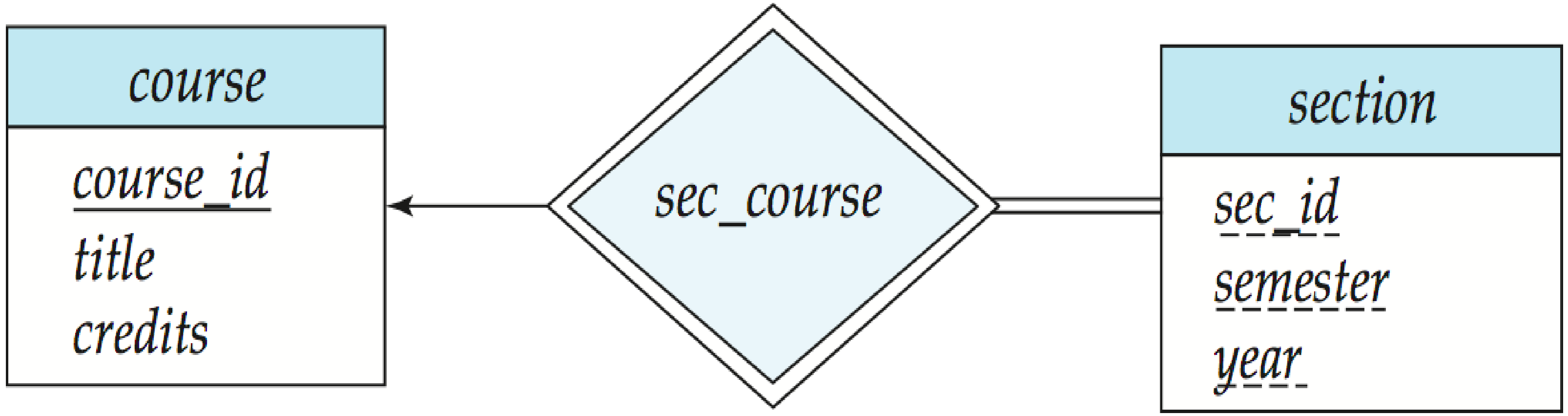
- **Each schema has a number of columns** (generally corresponding to attributes), which have **unique names**.

Representing Entity Sets With Simple Attributes

– A strong entity set reduces to a schema with the same attributes

Course(Course_ID, title, tot_cred)

– A weak entity set becomes a table that includes a column for the **primary key of the identifying strong entity** set. *section (course_id, sec_id, sem, year)*



Note: schemas **sec_course(***course_id, sec_id, sem, year)* is not represented because ***sec_course*** **schema is redundant in Section** *(course_id, sec_id, sem, year)* **schema**

Redundancy in Schema Representation

The schema corresponding to a relationship set linking a weak entity set to its identifying strong entity set is redundant.

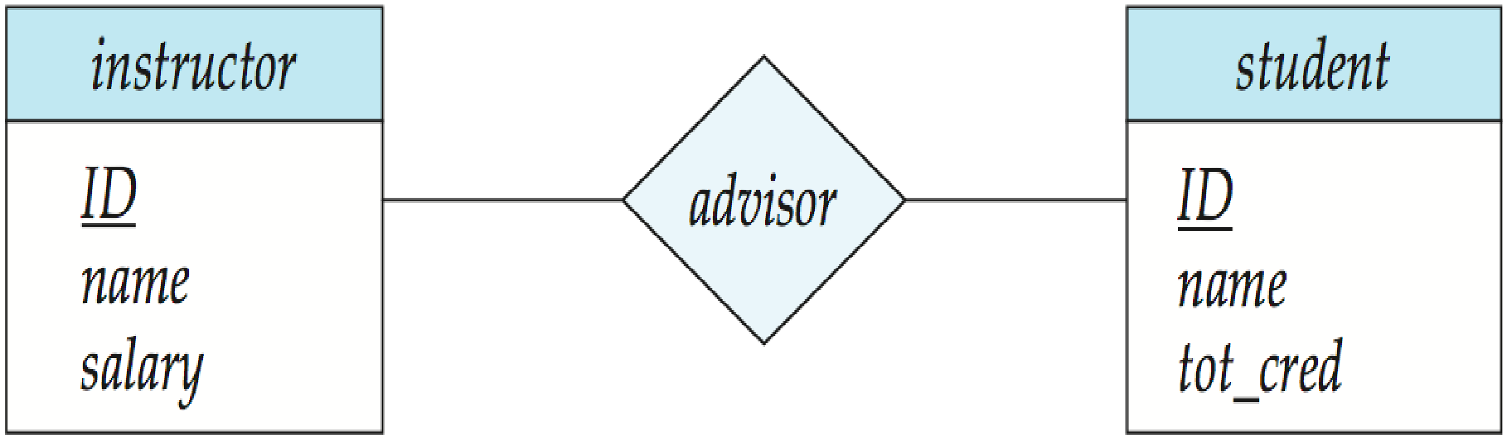
> Example: The *section* schema already contains the attributes that would appear in the *sec_course* schema

Representing Relationship Sets

- A **many-to-many** relationship set is represented as a schema with attributes for the primary keys of the two participating entity sets, and any descriptive attributes of the relationship set.
- Example: schema for relationship set *advisor*

advisor (S_ID, I_ID)

Instructor(<u>ID</u>, Name, Salary) & Student(<u>ID,</u> Name, tot_cred)

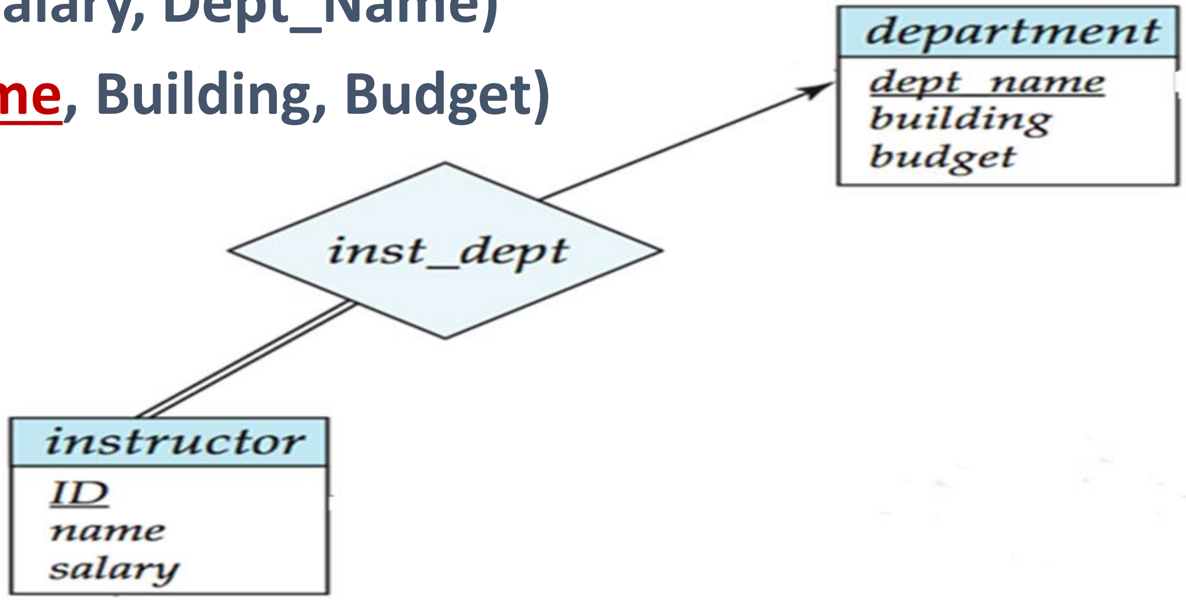


Representing Relationship sets- Many-1/1-Many

- Many-to-one and one-to-many relationship sets that are total/partial on the many-side can be represented by adding an extra attribute to the "many" side, containing the primary key of the "one" side
- Example: Instead of creating a schema for relationship set *inst_dept*, add an attribute *dept_name* to the schema arising from entity set *instructor*

Instructor(<u>ID</u>, Name, Salary, Dept_Name)

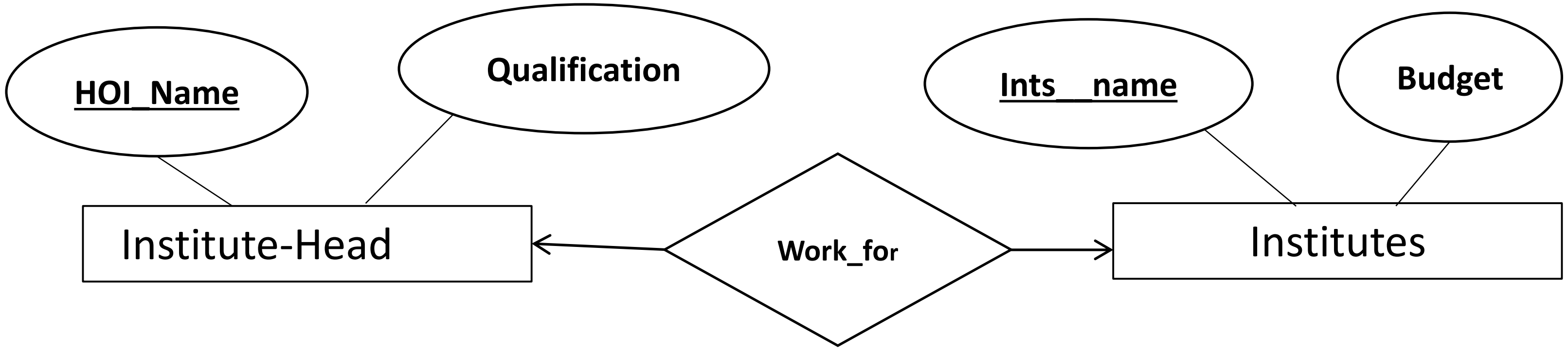
Department(<u>Dept_Name</u>, Building, Budget)



Dept_Name in Instructor is taken as **Foreign key** referencing Department.

Representing Relationship sets- 1 to 1

- For one-to-one relationship sets, either side can be chosen to act as the "many" side
  - That is, extra attribute can be added to either of the tables corresponding to the two entity sets

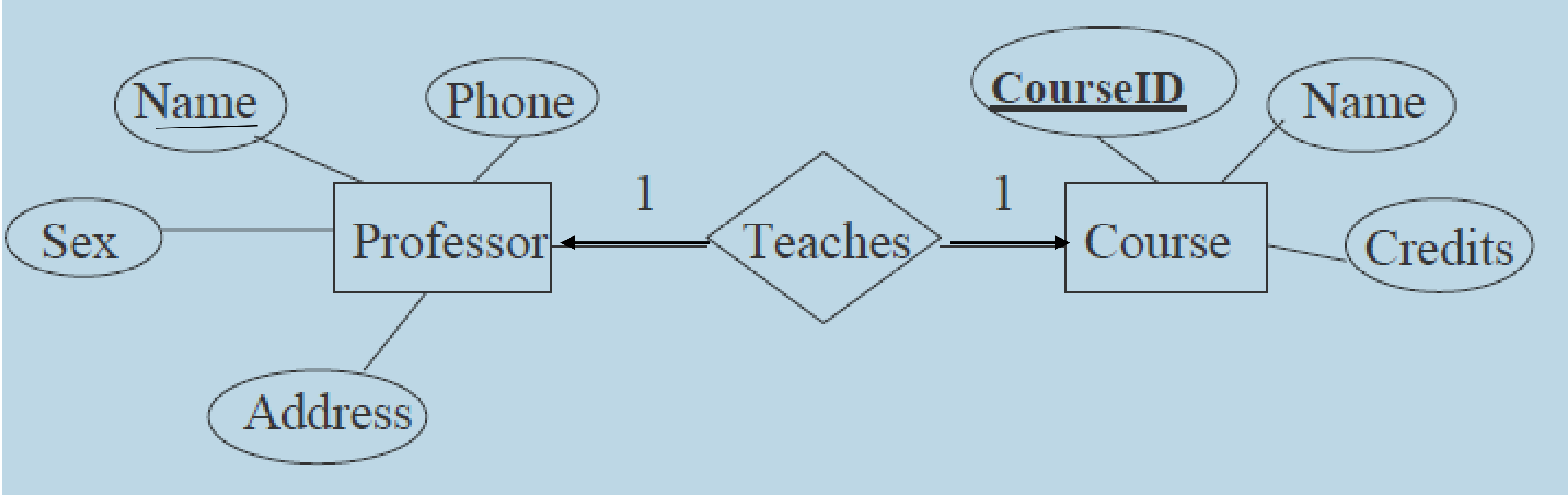


Institute_Head(**HOI_Name**, Qualification)

Institute(**Inst_Name**,Budget, HOI_Name)

HOI_Name in Institute is taken as **Foreign key** referencing Institute.

Reduce the Following ER Diagrams into Relational Schema.

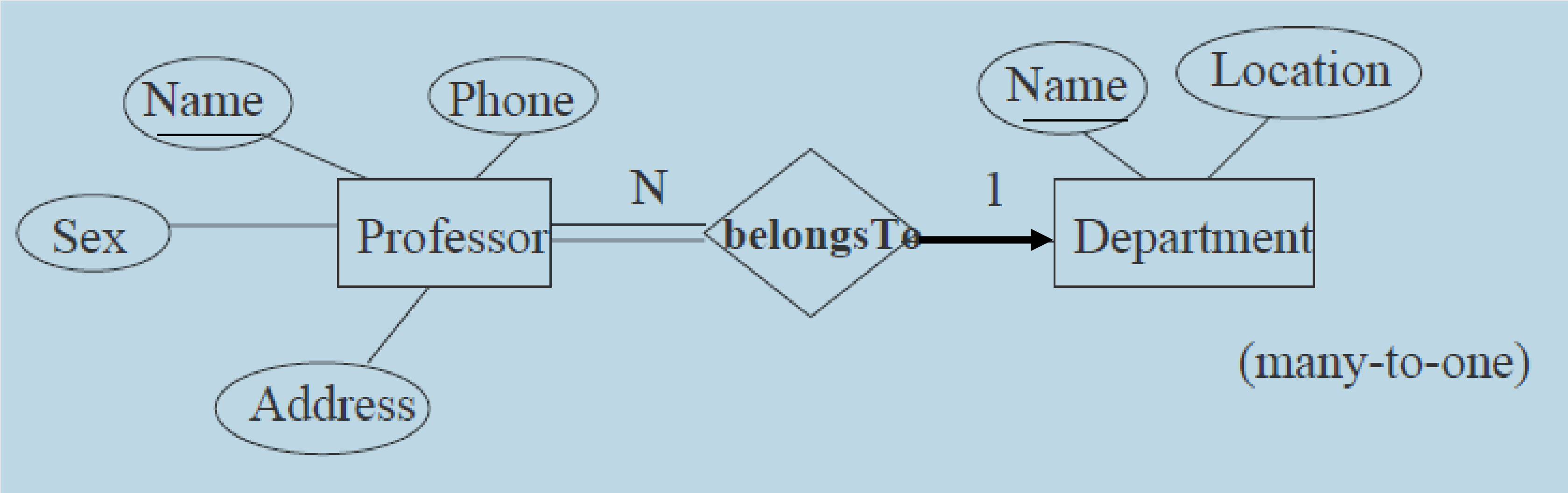


Professor(<u>Name</u>, Phone, Address, Sex, CourseID)

Course(<u>CourseId</u>,Name,Credits)

Professor.CourseID is foreign key referenceing Course.CourseID

Reduce the Following ER Diagrams into Relational Schema.

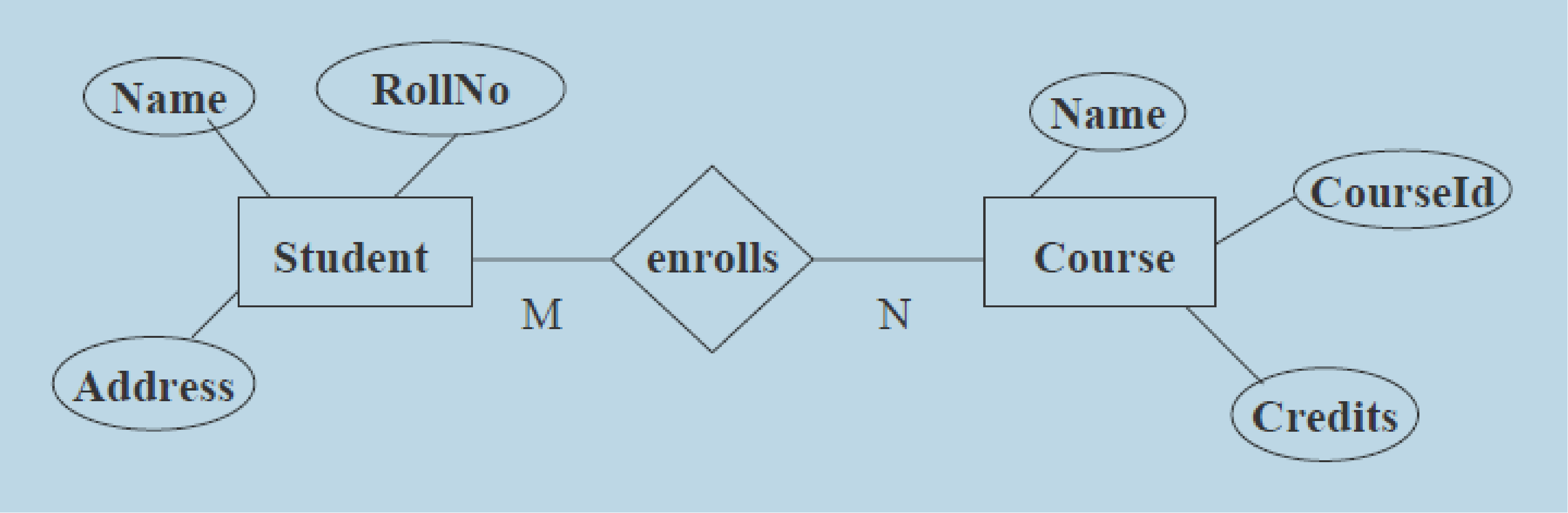


Professor(<u>Name</u>, Phone, Address, Sex, Dep_Name)

Department(<u>Name</u>, Location)

Dep_Name is foreign key referencing Department.Dep_Name

Reduce the Following ER Diagrams into Relational Schema.



Assume **Student.Rollno** and **Course. CourseId** is Primary Key in Student and Course entity types respectively.

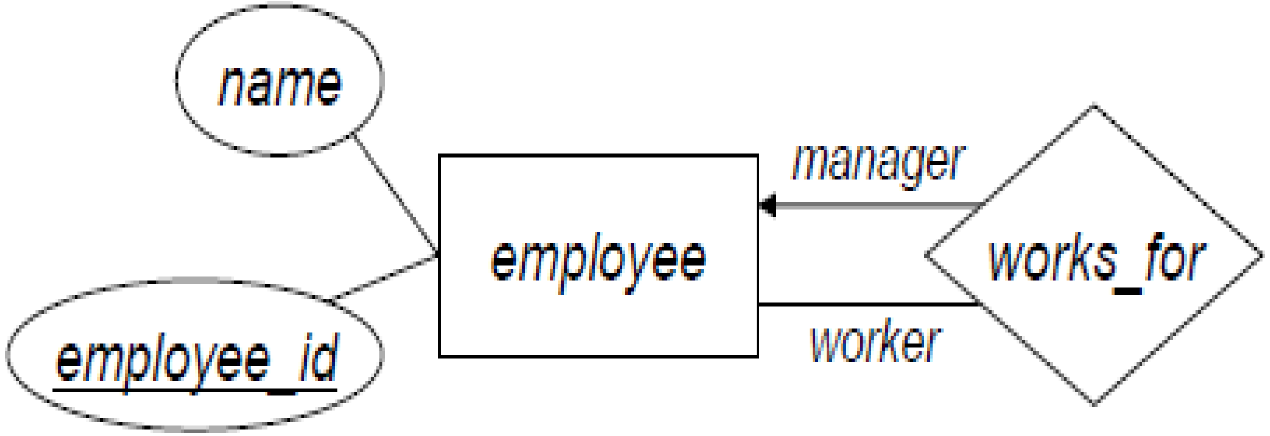
Student(Name, <u>RollNo</u>, Address)

Course(Name, <u>CourseId</u>, Credits)

Enrolls(<u>RollN,CourseId</u>)

Reduce the Following ER Diagrams into Relational Schema.

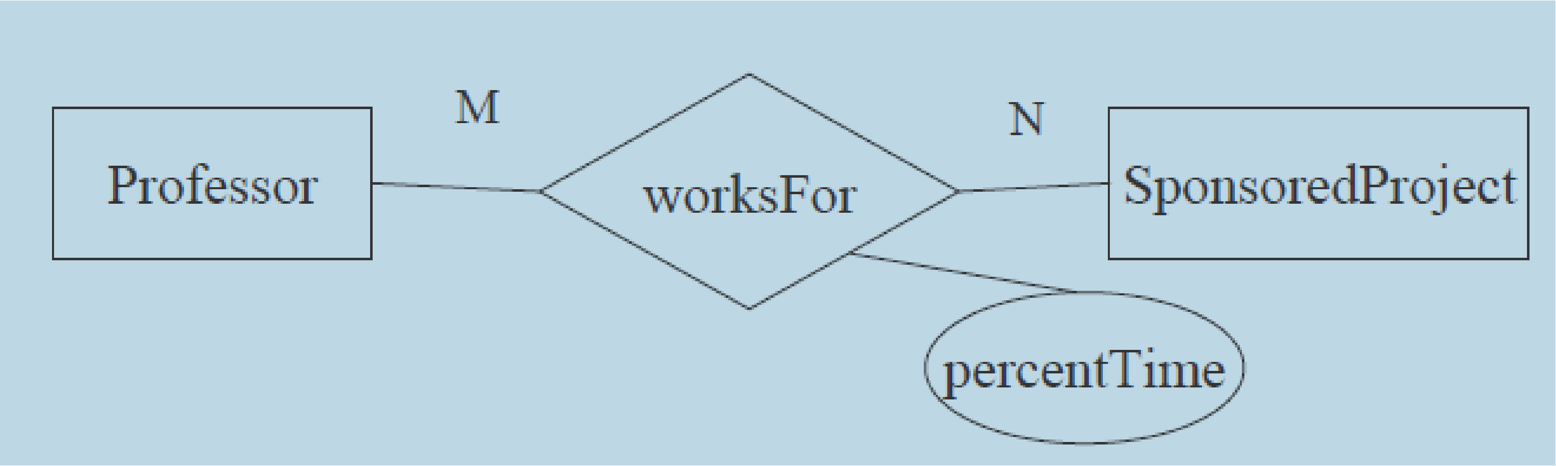
Recursive Relationship



Employee(<u>employee_id</u>, Name,manager_id)

managerId Referencing employee_id

Reduce the Following ER Diagrams into Relational Schema.

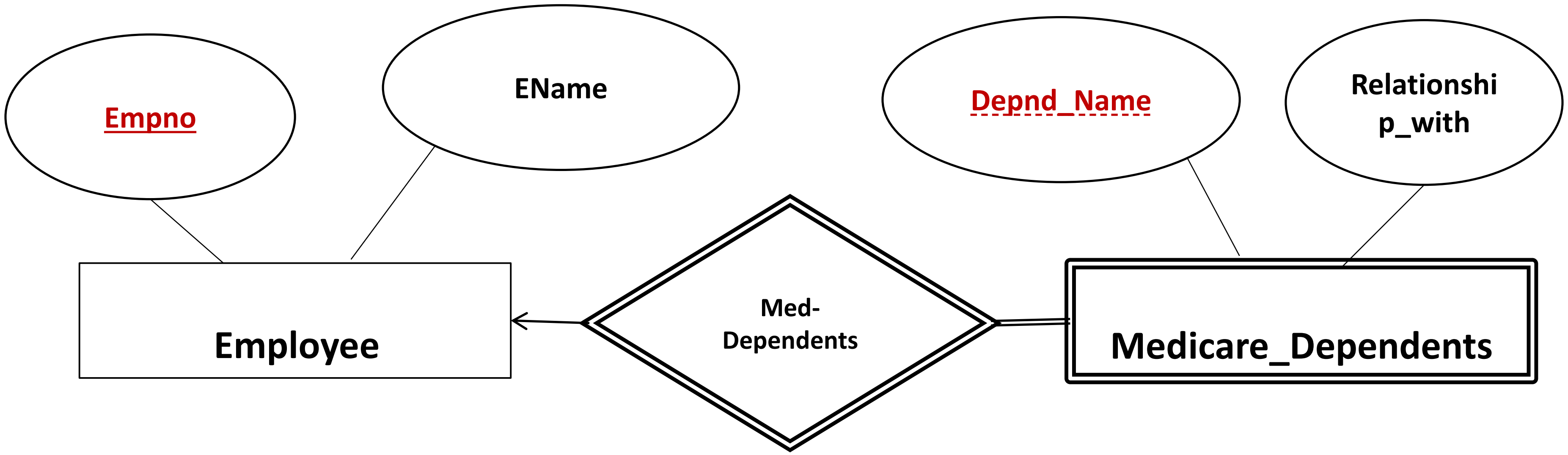


Professor(<u>Empno</u>, Name ,Address)

SponseredProject(<u>Prj_Id</u>, Name, Duration)

worksFor(<u>Empno, Prj_Id</u>, PercentTime)

Reduce the Following ER Diagrams into Relational Schema.



Employee(Empno,Ename)

Medicare_Dependents(Empno,Depnd_Name, Relationship_with)

Empno in Medicare_Dependets is Foreign key Referencing Empno in Employee.

Representing Composite Attributes in Schema

instructor

<u>ID</u>
name
  first_name
  middle_initial
  last_name
address
  street
    street_number
    street_name
    apt_number
  city
  state
  zip
{ phone_number }
date_of_birth
age ( )

- Composite attributes are **flattened out by creating a separate attribute** for each component attribute
  - Example: given entity set *instructor* with composite attribute *name* with component attributes *first_name* and *last_name* the schema corresponding to the entity set has two attributes *name_first_name* and *name_last_name*
    - *Prefix omitted if there is no ambiguity.*
- instructor schema is
  - ***Instructor (ID,***
    first_name, middle_initial, last_name,
    street_number, street_name,
    apt_number, city, state, zip_code,
    date_of_birth)

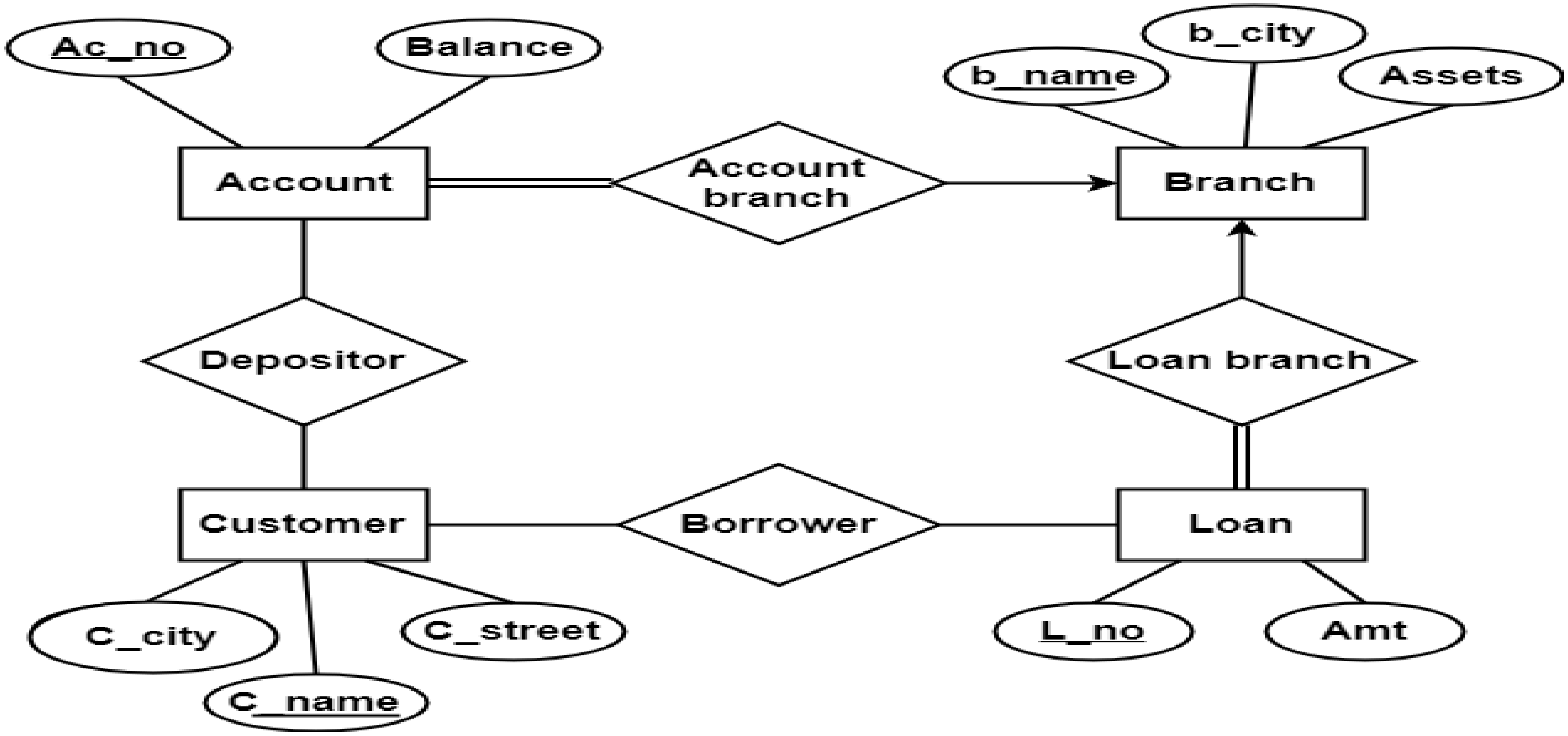
Representing Multivalued Attributes in Schema

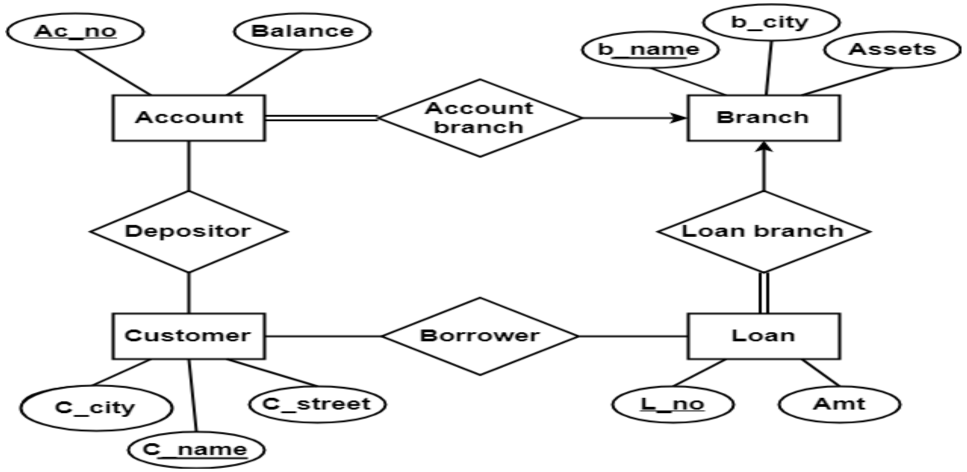
- A multivalued attribute *M* of an entity *E* is represented by a separate schema *EM*
  - Schema ***EM* has attributes** corresponding to the **primary key of *E*** and an **attribute corresponding to multivalued attribute *M***
  - **Example**: Multivalued attribute *phone_number* of *instructor* is represented by a schema:

    ***inst_phone* (*ID*, *phone_number*)**
  - Each value of the multivalued attribute maps to a separate tuple of the relation on schema *EM*
    - For example, an *instructor* entity with primary key 22222 and phone numbers 456-7890 and 123-4567 maps to two tuples:

      (22222, 456-7890) and (22222, 123-4567)

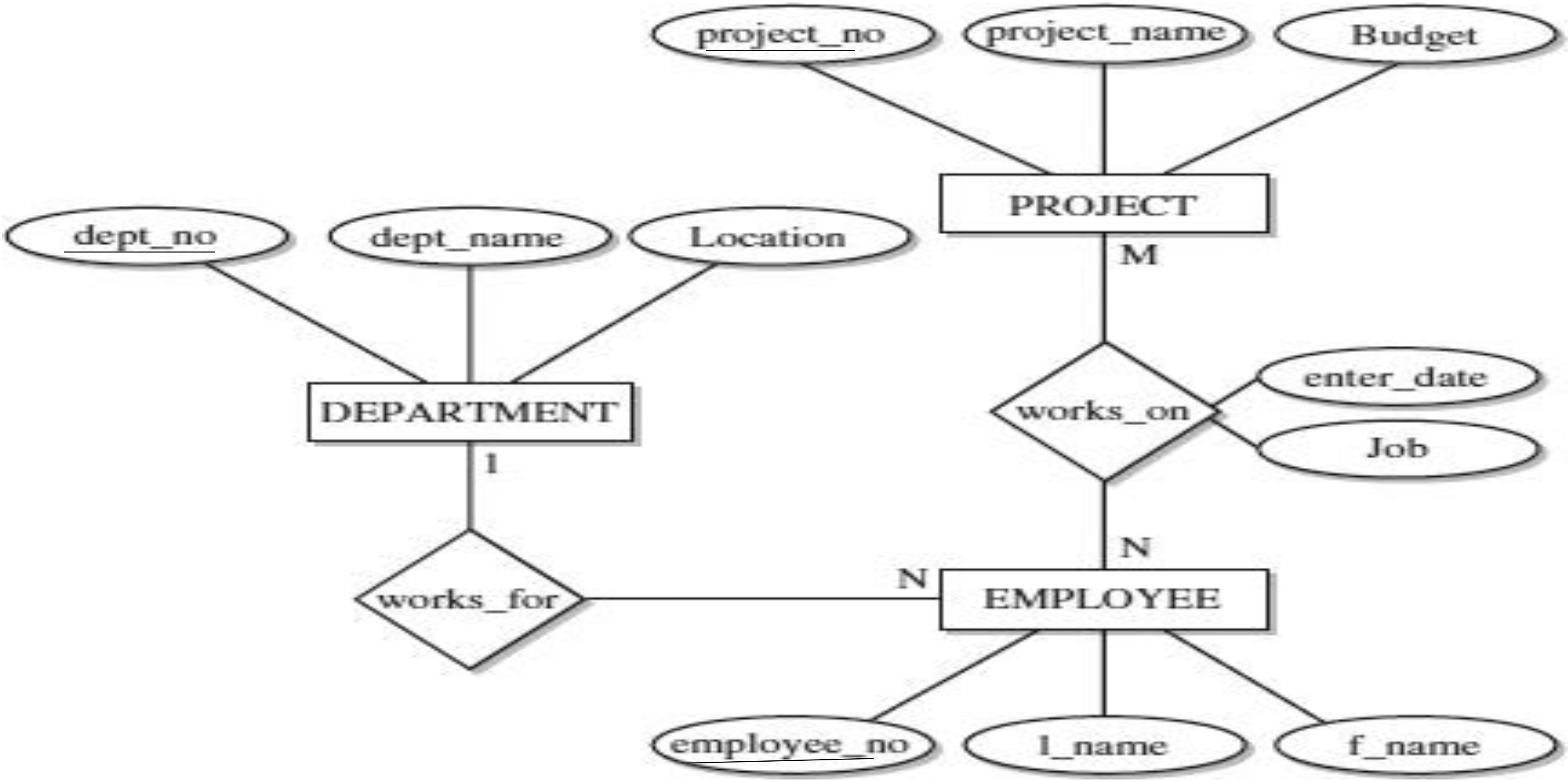
Convert the ER Diagram to relation schema

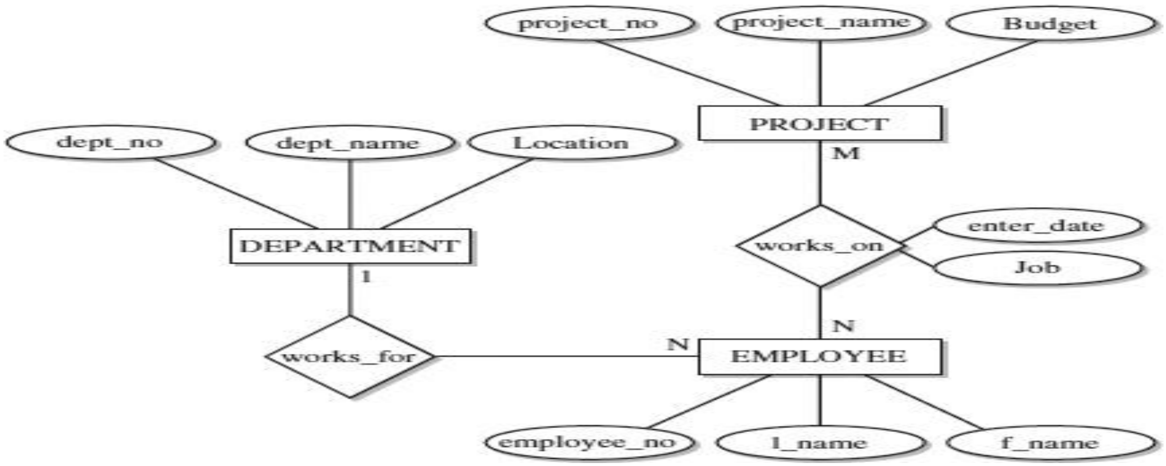




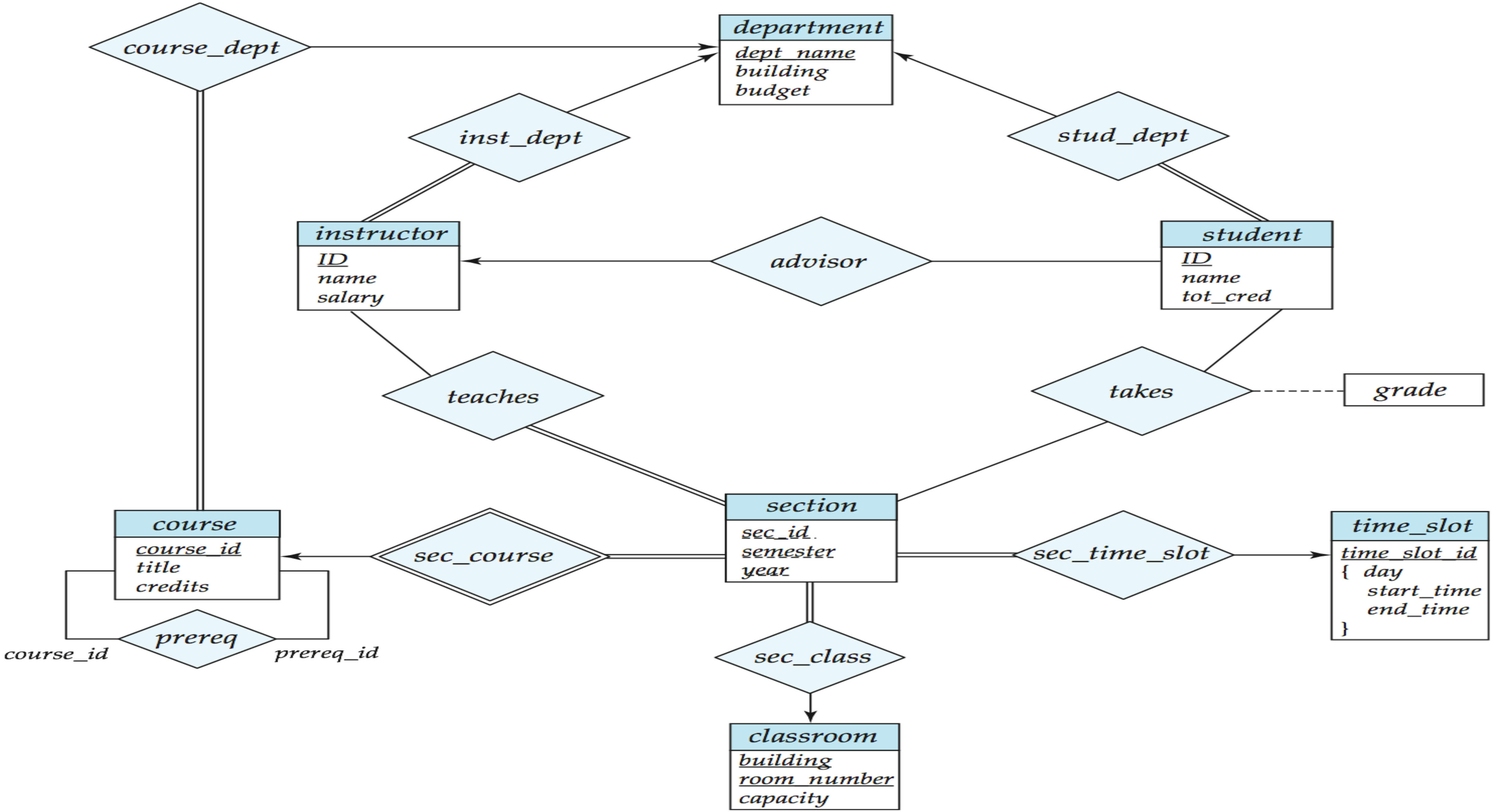
Account(Ac_no,Balance,b_name)
Branch(b_name,b_city,assets)
Customer(c_name,c_city,c_street) Loan(L-no,amt,b_name)
Depositor(ac_no,c_name) Borrower(c_name,L_no)

Convert the ER Diagram to relation schema

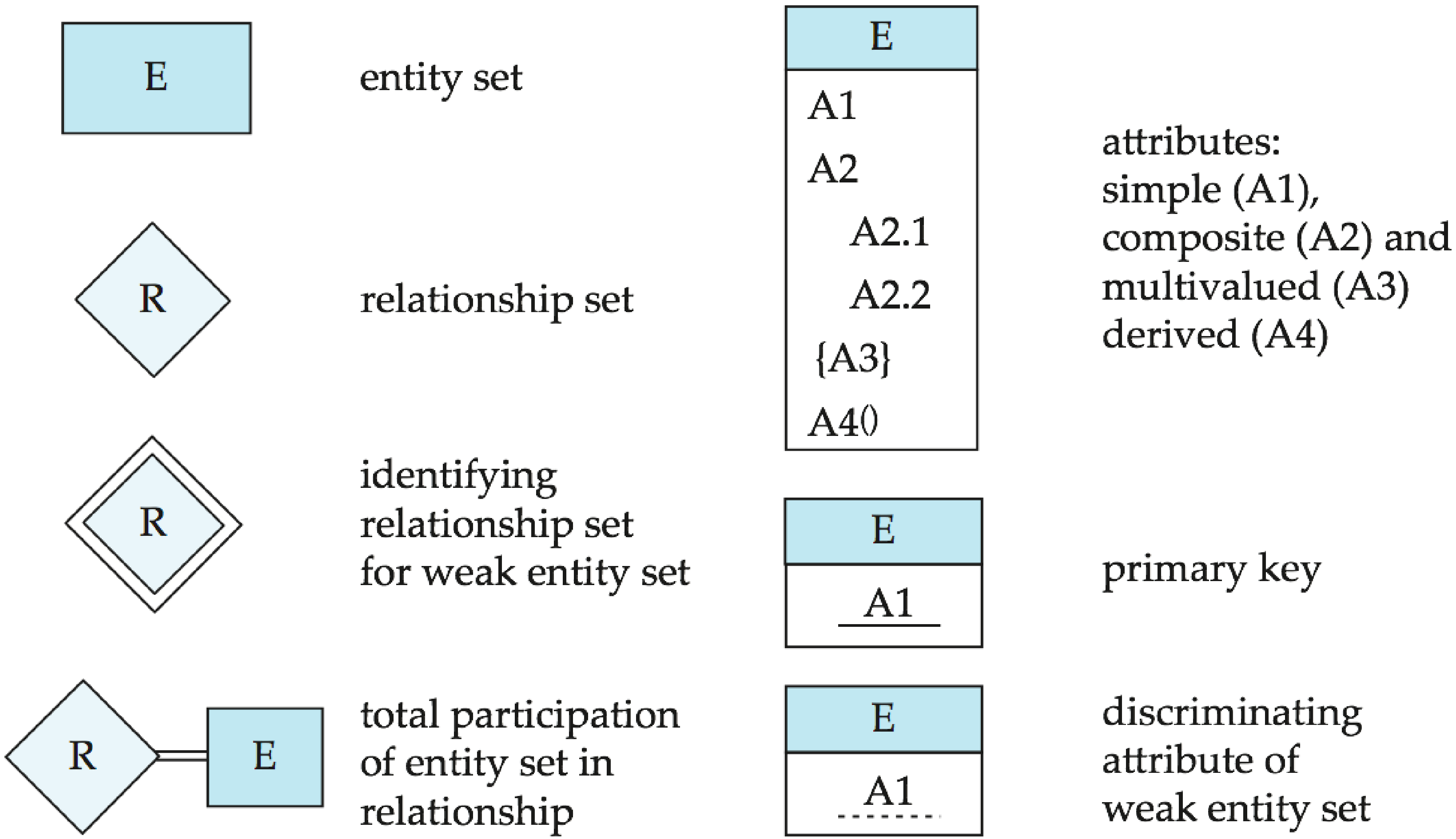




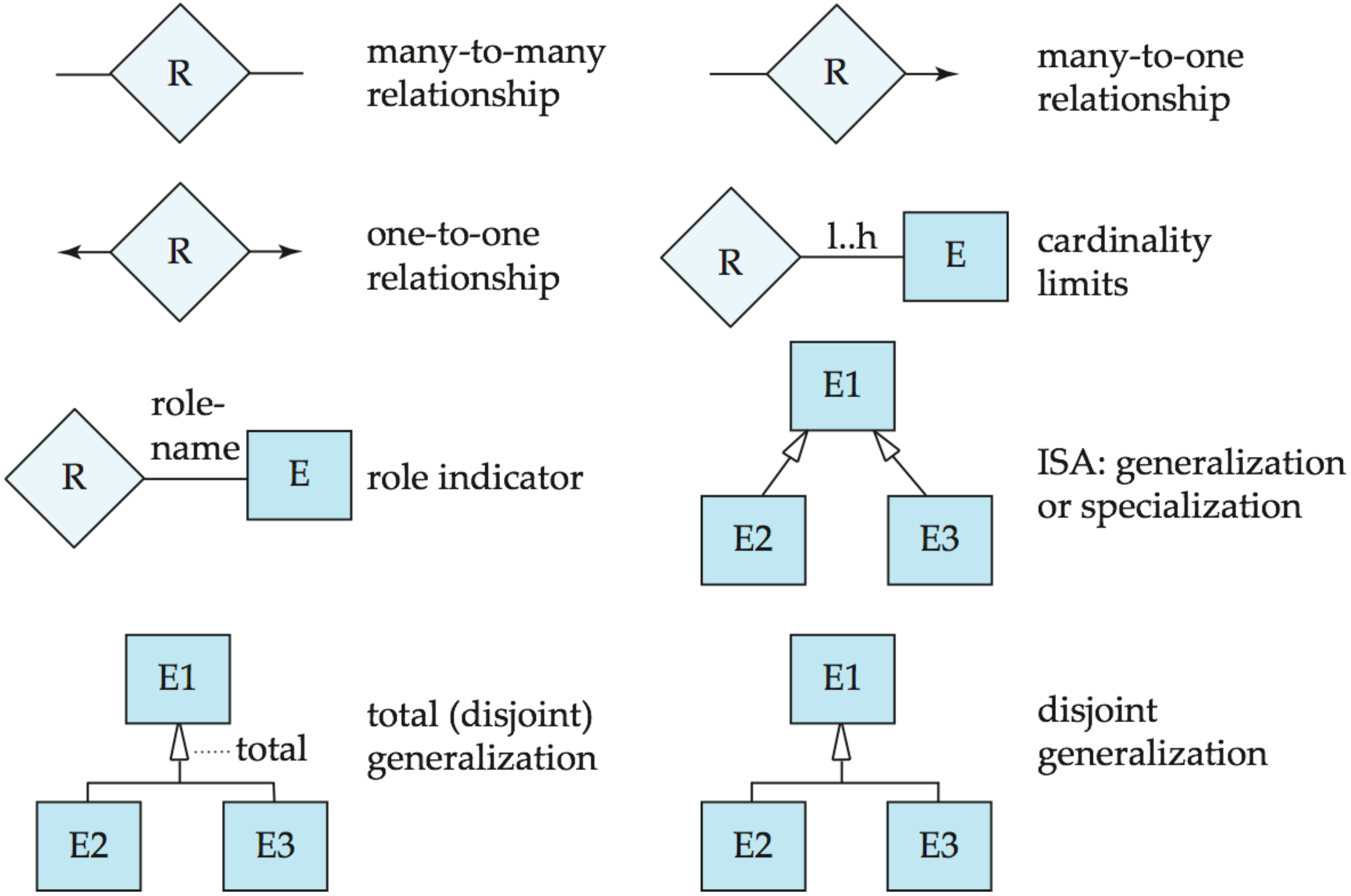
Department(dept_no,dept_name,location)
Project(project_no,p_name,budget) Employee(employee-no,l_name,f_name,dept_no)
works_on(project_no,employee_no,enter_date,job)


department
dept_name
building
budget
course_dept
inst_dept
stud_dept
instructor
ID
name
salary
advisor
student
ID
name
tot_cred
teaches
takes
grade
section
sec_id
semester
year
course
course_id
title
credits
sec_course
sec_time_slot
time_slot
time_slot_id
{ day
start_time
end_time
}
prereq
course_id
prereq_id
sec_class
classroom
building
room_number
capacity

Summary of Symbols Used in E-R Notation

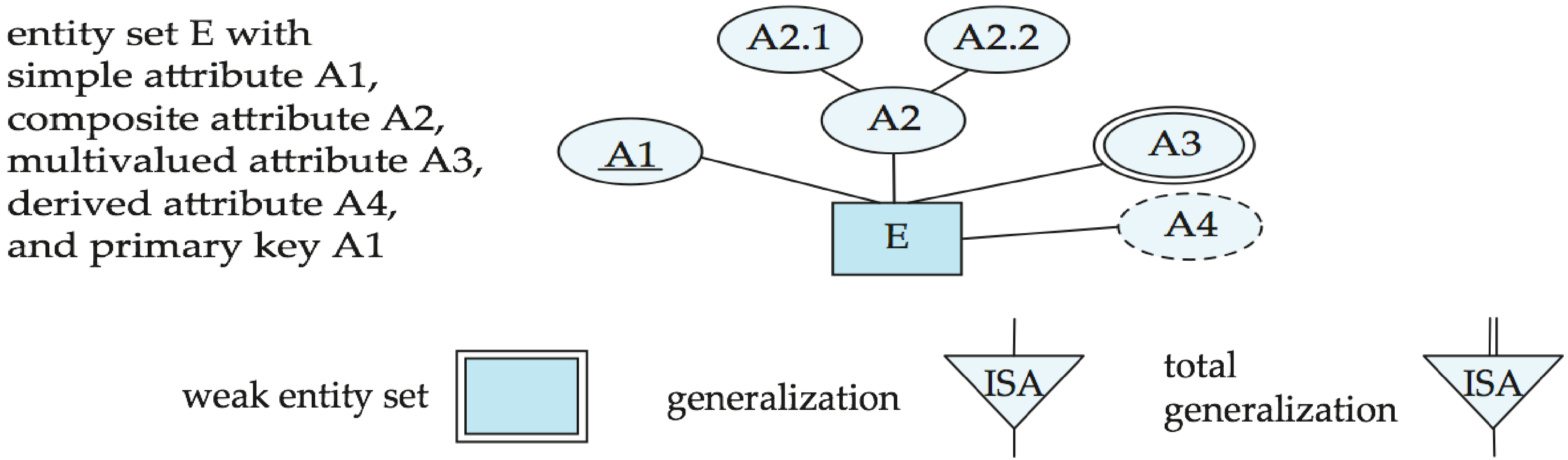


Symbols Used in E-R Notation (Cont.)



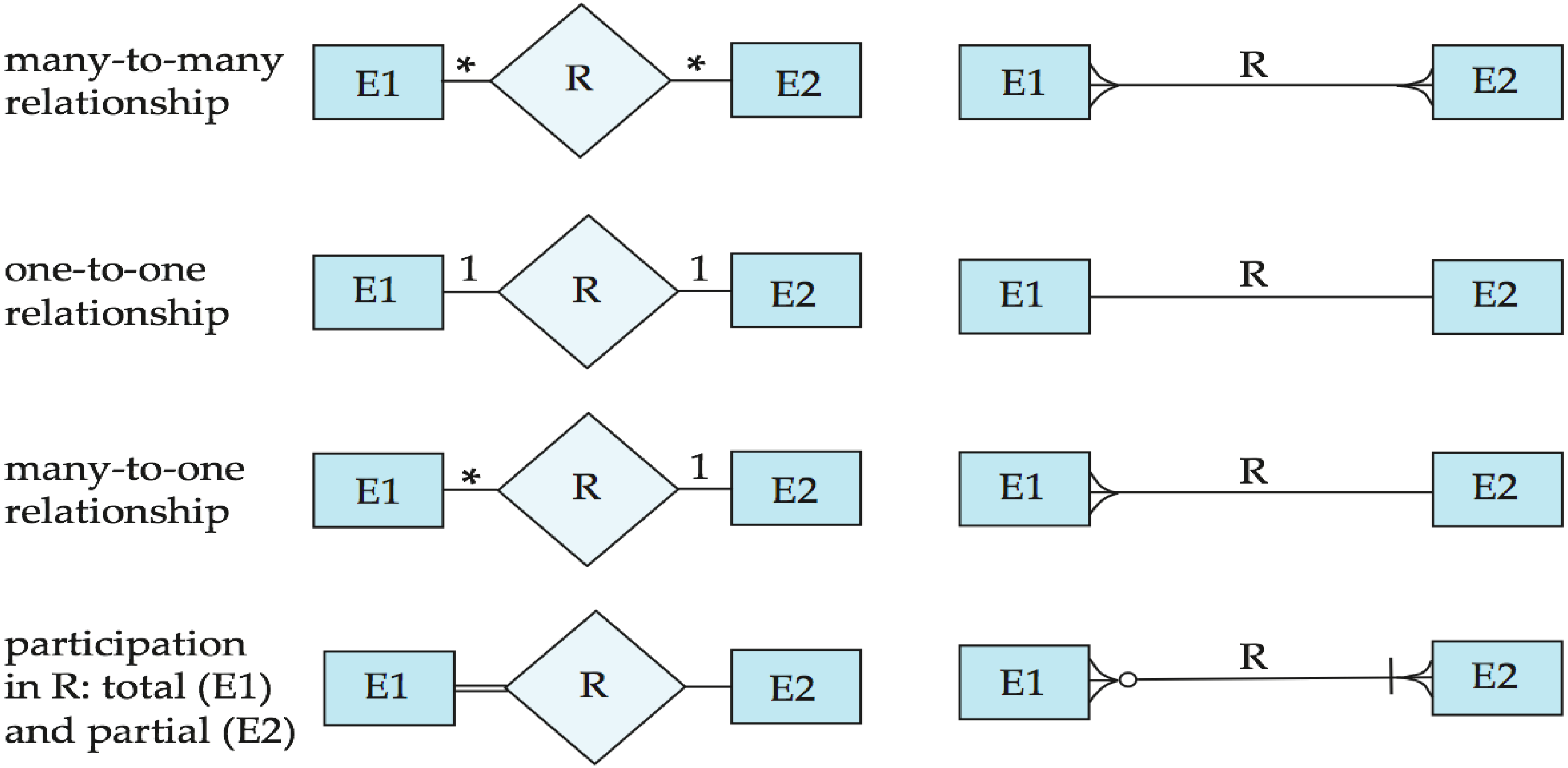
Alternative ER Notations

- Chen, IDE1FX, …



Alternative ER Notations

Chen **IDE1FX (Crows feet notation)**



Summary

- A **database-management system** (DBMS) consists of a collection of interrelated data.
- Database design mainly involves the design of the database schema. The **entity-relationship (E-R)** data model is a widely used data model for database design.
- An **entity** is an object that exists in the real world and is distinguishable from other objects.
- A **relationship** is an association among several entities. A **relationship set** is a collection of relationships of the same type, and an **entity set** is a collection of entities of the same type.
- The terms **super key**, **candidate key**, and **primary key** apply to entity and relationship sets as they do for relation schemas.
- **Mapping cardinalities** express the number of entities to which another entity can be associated via a relationship set.
- An entity set that does not have sufficient attributes to form a primary key is termed a **weak entity set**. An entity set that has a primary key is termed a **strong entity set**.

1. Explain the difference between a weak and a strong entity set.
2. Explain the distinctions among the terms primary key, candidate key, and super key with an example.
3. A weak entity set can always be made into a strong entity set by adding to its attributes the primary-key attributes of its identifying entity set. Outline what sort of redundancy will result if we do so.
4. In order to have Total Participation , should an entity be a weak entity ? If not give an strong entity participating in Total participation.
5. Construct an E-R diagram for a car-insurance company whose customers own one or more cars each. Each car has associated with it zero to any number of recorded accidents.