Entity Relationship Diagram

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At the end of this lesson, you will be able to:

- Analyze and model relationship based on a set of information requirements.

- Develop an ERD model based on required type of model (Chen or Crow's Foot).

- Create an ERD model using a specific data modelling tool

What is ERD?

- ERD is a data modeling technique used in software engineering to produce a conceptual data model of an information system.

- So, ERDs illustrate the logical structure of databases.

- Way to document the entities in a database, along with the attributes.

Notation uses three main constructs

- Entity → table
- Attribute → column
- Relationship → line

How to find entities?

Entity:
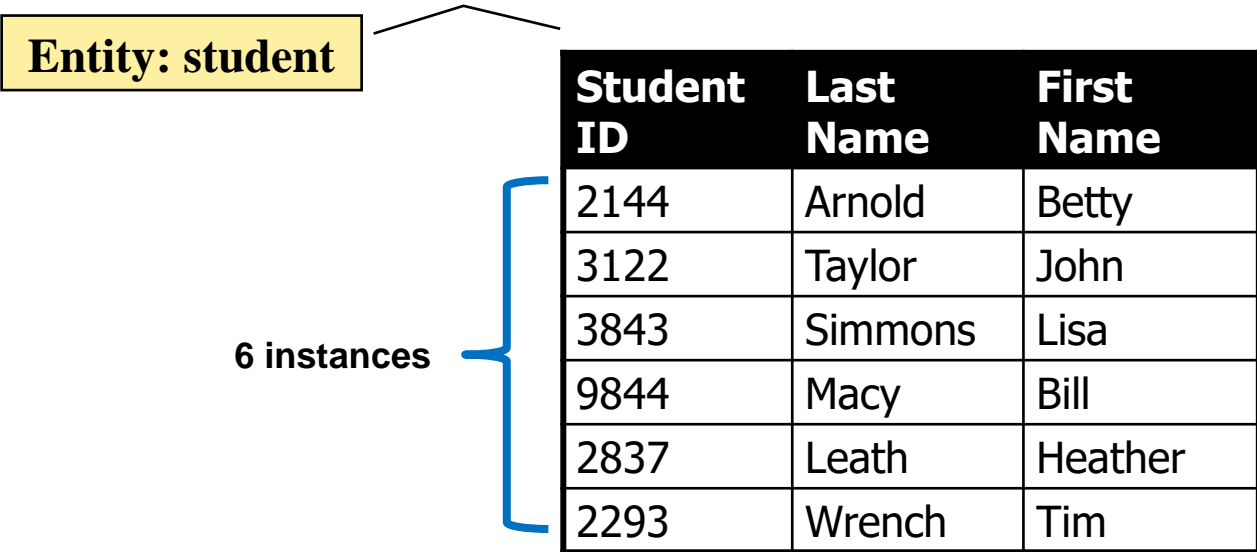
- ⊳ "...anything (people, places, objects, events, etc.) about which we store information (e.g. supplier, machine tool, employee, utility pole, airline seat, etc.)."

- ⊳ Tangible: customer, product

- ⊳ Intangible: order, accounting receivable

- ⊳ Look for singular nouns (beginner)

- ⊳ BUT a proper noun is not a good candidate….

Entity Instance: a single occurrence of an entity.

Entity: student

Student ID	Last Name	First Name
2144	Arnold	Betty
3122	Taylor	John
3843	Simmons	Lisa
9844	Macy	Bill
2837	Leath	Heather
2293	Wrench	Tim

6 instances

Attribute:

▷ Attributes are **data** objects that either **identify** or **describe entities** (property of an entity).

▷ In other words, it is a descriptor whose values are associated with individual entities of a specific entity type

▷ The process for identifying attributes is similar except now you want to look for and extract those names that appear to be descriptive noun phrases.

"Describe detail information about an entity "

■ Entity: Student

■ Attributes:

- ▷ Student_ID
- ▷ LastName
- ▷ FirstName

3 attributes / columns / fields

Entity: student

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Classes/Types of attributes:

- Simple attribute
- Composite attribute
- Derived attributes
- Single-valued attribute
- Multi-valued attribute

- A simple attribute cannot be subdivided.
  - ➤ Examples: Age, Gender, and Marital status
- A composite attribute can be further subdivided to yield additional attributes.
  - ➤ Examples:
    - ADDRESS --→ Street, City, State, Zip
    - PHONE NUMBER --→ Area code, Exchange number

Derived Attribute

◼ is not physically stored within the database

◼ instead, it is derived by using an algorithm.

➢ Example 1: Late Charge of 2%

MS Access: InvoiceAmt * 0.02

➢ Example 2: AGE can be derived from the date of birth and the current date.

MS Access: int(Date() – Emp_Dob)/365)

Single-valued Attribute

■ can have only a single value.

▷ Examples:

- A person can have only one social security number.

- A manufactured part can have only one serial number.

Multi-value Attribute

■ can have many values.

➤ Examples:

　A person may have several college degrees.

　A household may have several phones with different numbers

　A car color

- **Entity**:
  - ▷ Student
- **Attributes**:
  - ▷ ID#: "123-45-6789" (single-valued)
  - ▷ Cell Phone: "(063)917-456-7227, (063)915-567-8255" (multi-valued)
  - ▷ Name: "Peter dela Paz" (composite)
  - ▷ Address: "14 JP Rizal St., Masipit, Calapan City" (composite)
  - ▷ Gender: "Female" (simple)
  - ▷ Age: 24 (derived)

Null Values

■Some attribute values could be optional or maybe they are not crucial to have.

■For example, if you have an attribute Hobbies. It is OK for the value of this attribute to be missing. In this case, we call it "NULL" value.

■Key Attributes cannot be NULL because they uniquely identify an entity, so they have to have a value.

Key Attribute

■Keys should be Minimal. A key is minimal if it cannot be broken into smaller parts that work as a key.

➤ For example: – SectionID, courseID, Semester, Year – Is it Minimal? – Yes, because none of its smaller parts can work by itself as a key.

➤ "studentID + studentAge", is it minimal key of Student? – No, because "studentID" by itself works as a key.

Primary Key (PK)

■ Is an attribute (or field) that uniquely identifies every record in a certain table.

Primary key Rules

1. Unique
2. Never Changing
3. Never Null

Foreign Key (FK)

■ Is the same as a primary key, but just located in a foreign place (other table). But FKs don't have to be unique.

Write the corresponding key of the following given entities.

Entity	Key
a. Author	
b. Publisher	
c. Faculty	
d. Course	
e. Section	

Relationship:

- Relationships are associations between entities.
- Typically, a relationship is indicated by a verb connecting two or more entities.
- **Employee** is assigned to **Project**
- Relationships should be classified in terms of cardinality.
  - One-to-one, one-to-many, many-to-many

Degree of Relationship:

■ The number of participating entities in a relationship defines the degree of the relationship.

➢ Binary = degree 2

➢ Ternary = degree 3

➢ n-ary = degree n

Binary Relationship includes two entity types.

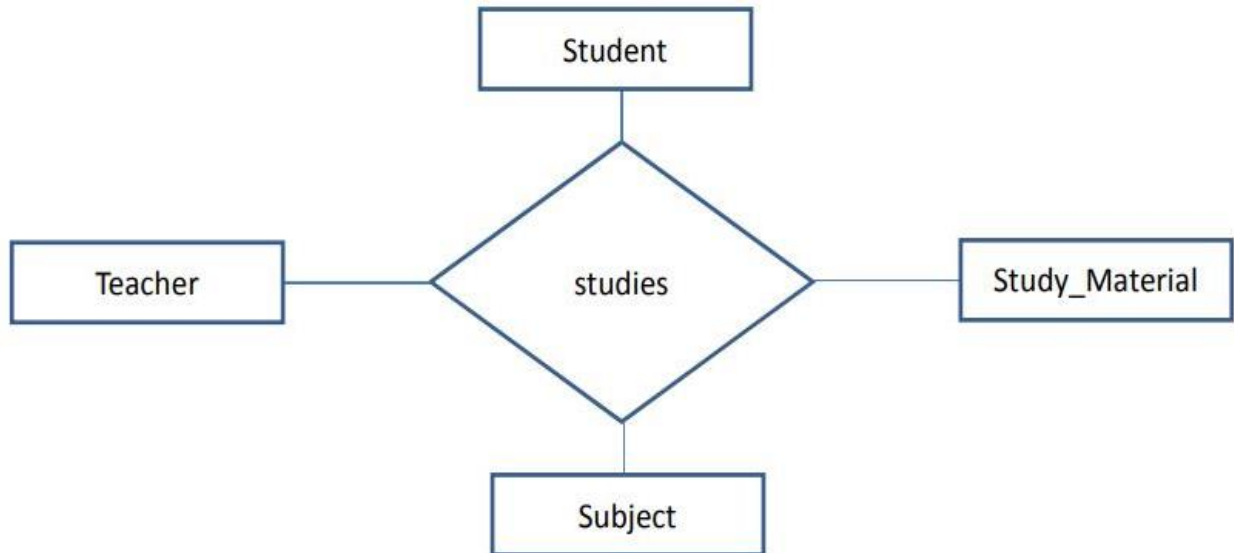Example: Student "takes" Class. Its notation in ER Diagram is as follows.

Ternary relationship includes 3 entity types. Example: Works_in: is a relationship that shows, each employee (Employee), Who worked in which department(Department) and where the department is located (Location)
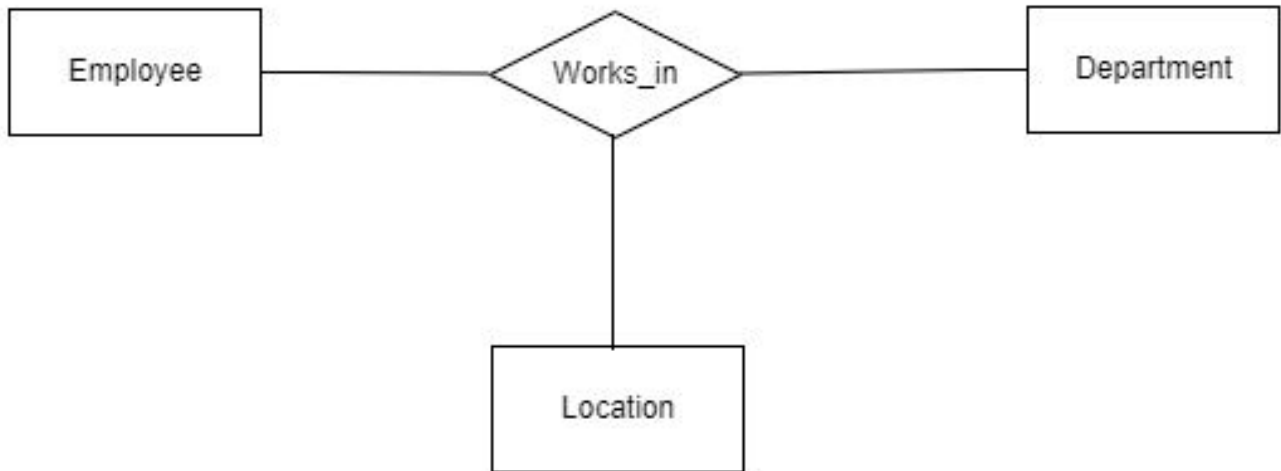
N-ary Relationship includes N entity types.

Example: studies: is a 4-ary relationship that shows that a "student" studies a "subject" with a "teacher" and the help of "study_material"
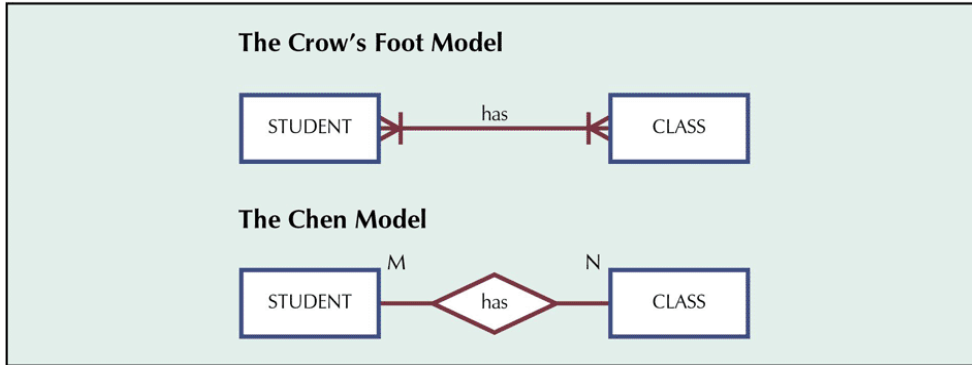
The 1:1 Relationship Between PROFESSOR and DEPARTMENT

The M:N Relationship Between STUDENT and CLASS
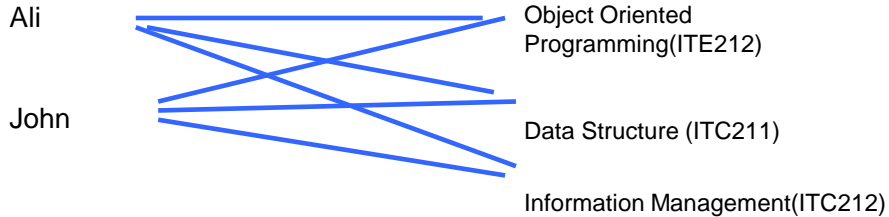
The tables have **many redundancies!!**

Table name: STUDENT
Primary key: STU_NUM   + CLASS_CODE   **Database name: Ch03_CollegeTry**
Foreign key: none   CLASS_CODE

STU_NUM	STU_LNAME	CLASS_CODE
321452	Bowser	10014
321452	Bowser	10018
321452	Bowser	10021
324257	Smithson	10014
324257	Smithson	10018
324257	Smithson	10021

+ STU_NUM

Table name: CLASS
Primary key: CLASS_CODE
Foreign key: STU_NUM

CLASS_CODE	STU_NUM	CRS_CODE	CLASS_SECTION	CLASS_TIME	CLASS_ROOM	PROF_NUM
10014	321452	ACCT-211	3	TTh 2:30-3:45 p.m.	BUS252	342
10014	324257	ACCT-211	3	TTh 2:30-3:45 p.m.	BUS252	342
10018	321452	CIS-220	2	MWF 9:00-9:50 a.m.	KLR211	114
10018	324257	CIS-220	2	MWF 9:00-9:50 a.m.	KLR211	114
10021	321452	QM-261	1	MWF 8:00-8:50 a.m.	KLR200	114
10021	324257	QM-261	1	MWF 8:00-8:50 a.m.	KLR200	114

The Crow's Foot Model
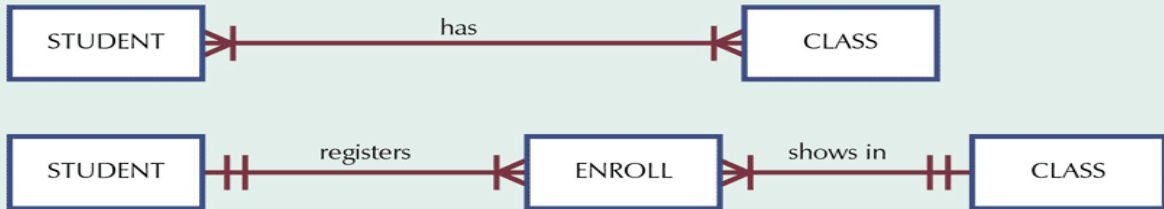
The Chen Model
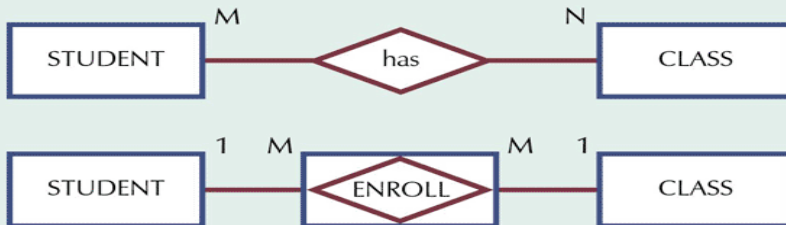
Changing the M:N relationship to TWO 1:M relationships

Converting the M:N relationship into TWO 1:M relationships

Table name: STUDENT
Primary key: STU_NUM
Foreign key: none

		STU_NUM	STU_LNAME
▶	+	321452	Bowser
	+	324257	Smithson

The database designer has 2 main options to define a composite table's primary key: either

use the combination of those foreign keys or create a new primary key.

Table name: ENROLL
Primary key: CLASS_CODE + STU_NUM
Foreign key: CLASS_CODE, STU_NUM

	CLASS_CODE	STU_NUM	ENROLL_GRADE
▶	10014	321452	C
	10014	324257	B
	10018	321452	A
	10018	324257	B
	10021	321452	C
	10021	324257	C

Foreign keys reference the primary keys in the other tables of which it has a relationship with

Table name: CLASS
Primary key: CLASS_CODE
Foreign key: CRS_CODE

		CLASS_CODE	CRS_CODE	CLASS_SECTION	CLASS_TIME	CLASS_ROOM	PROF_NUM
▶	+	10014	ACCT-211	3	TTh 2:30-3:45 p.m.	BUS252	342
	+	10018	CIS-220	2	MWF 9:00-9:50 a.m.	KLR211	114
	+	10021	QM-261	1	MWF 8:00-8:50 a.m.	KLR200	114

Cardinality:

- ▻ The cardinality is the number of occurrences in one entity which are associated to the number of occurrences in another.

- ▻ There are three basic cardinalities (degrees of relationship).

- ▻ one-to-one (1:1), one-to-many (1:M), and many-to-many (M:N)

One-to-one (1:1). One entity from entity set X can be associated with at most one entity of entity set Y and vice versa.

For example, One department is managed by only One employee. One employee can manage only One department.

■ **One-to-many (1:N).** One entity from entity set X can be associated with more than one entities of entity set Y but from entity set Y one entity can be associated with at most one entity. For example, One teacher can teach Many classes. One class is only taught by only One teacher.

Table name: PAINTER
Primary key: PAINTER_NUM
Foreign key: none

Database name: Ch03_Museum

		PAINTER_NUM	PAINTER_LNAME	PAINTER_FNAME	PAINTER_INITIAL
		123 Ross		Georgette	P
	+	126	Itero	Julio	G

Table name: PAINTING
Primary key: PAINTING_NUM
Foreign key: PAINTER_NUM

	PAINTING_NUM	PAINTING_TITLE	PAINTER_NUM
►	1338 Dawn Thunder		123
	1339	Vanilla Roses To Nowhere	123
	1340	Tired Flounders	126
	1341	Hasty Exit	123
	1342	Plastic Paradise	126

The Implemented 1:M relationship between PAINTER and PAINTING

Many-to-many. One entity from X can be associated with more than one entity from Y and vice versa.

For example, One teacher can teach Many classes. One class can be taught by Many teachers

Crow's Foot Notation

- Known as IE notation (most popular)
- Entity:
  - ▷ Represented by a rectangle, with its name on the top. The name is singular (entity) rather than plural (entities).

entity
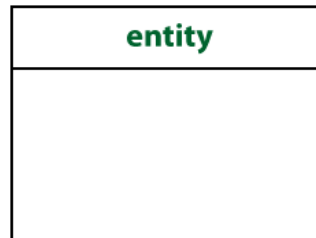
■Identifiers are represented by underlying the name of the attribute(s)
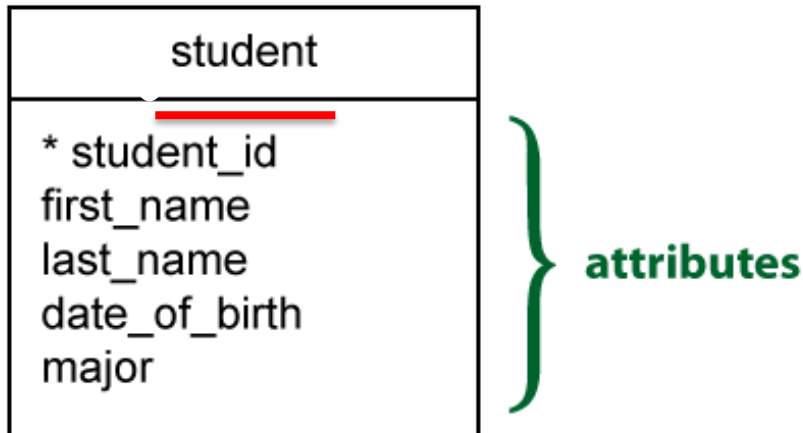
Basic Cardinality Type

- 1-to-1 relationship
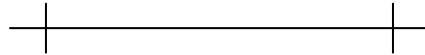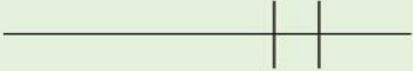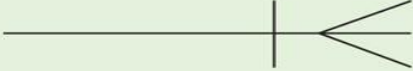
- 1-to-M relationship
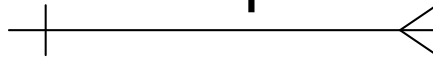
- M-to-N relationship
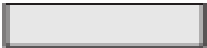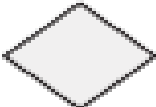
Symbol	Meaning
	Mandatory—One
	Mandatory—Many
	Optional—One
	Optional—Many

Example Model
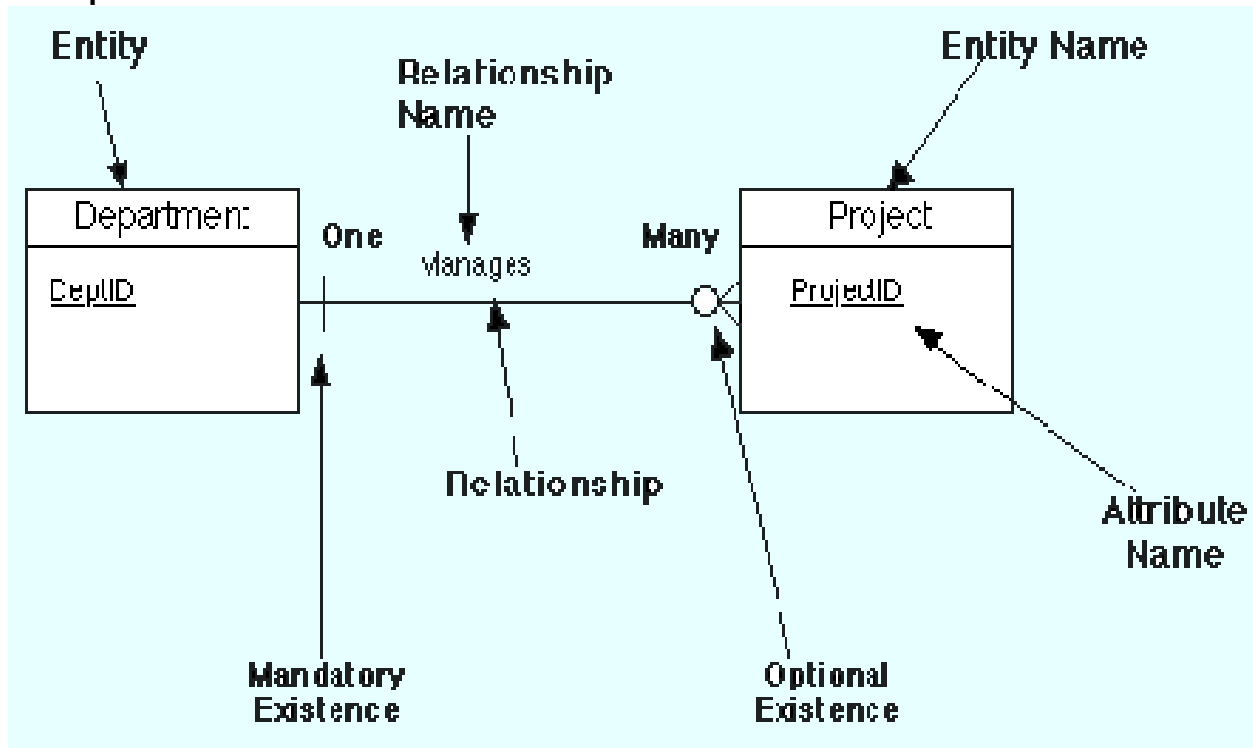
Chen Model

Symbol	Meaning
▭	Entity
▣	Weak Entity
◇	Relationship
◈	Indentifying Relationship
⬭	Attribute
⬭	Key Attribute

Chen Model

Multivalued Attribute

Composite Attribute

Derived Attribute

Total Participation of E_2 in R

Cardinality Ratio 1 : N for E_1 : E_2 in R

Structural Constraint (min, max) on Participation of E in R
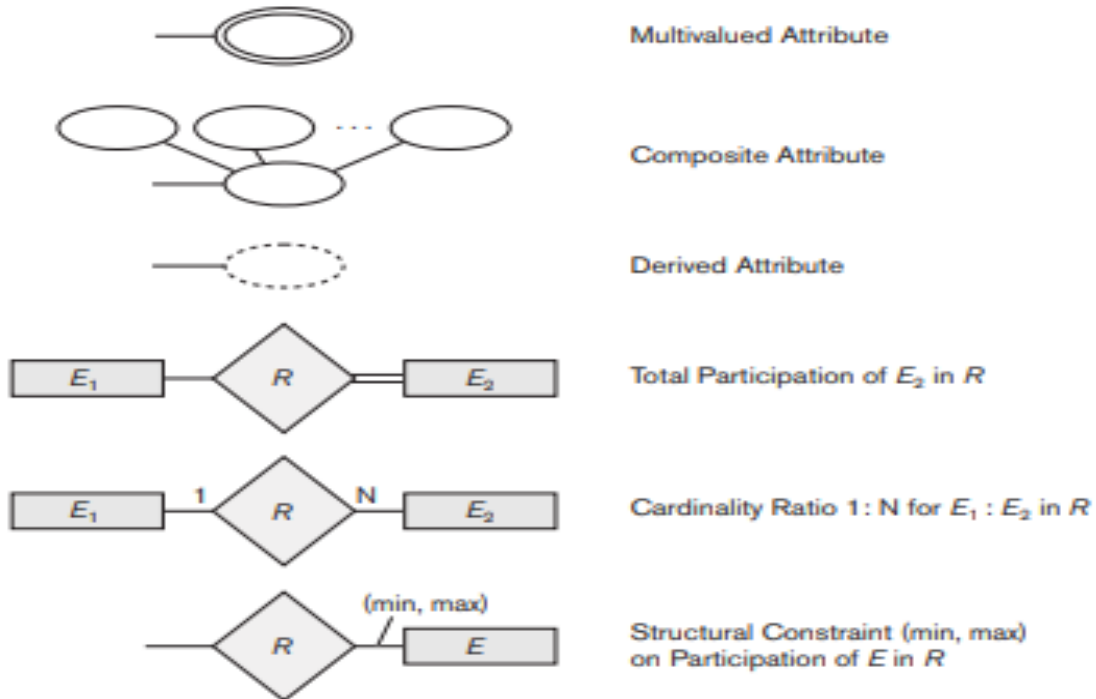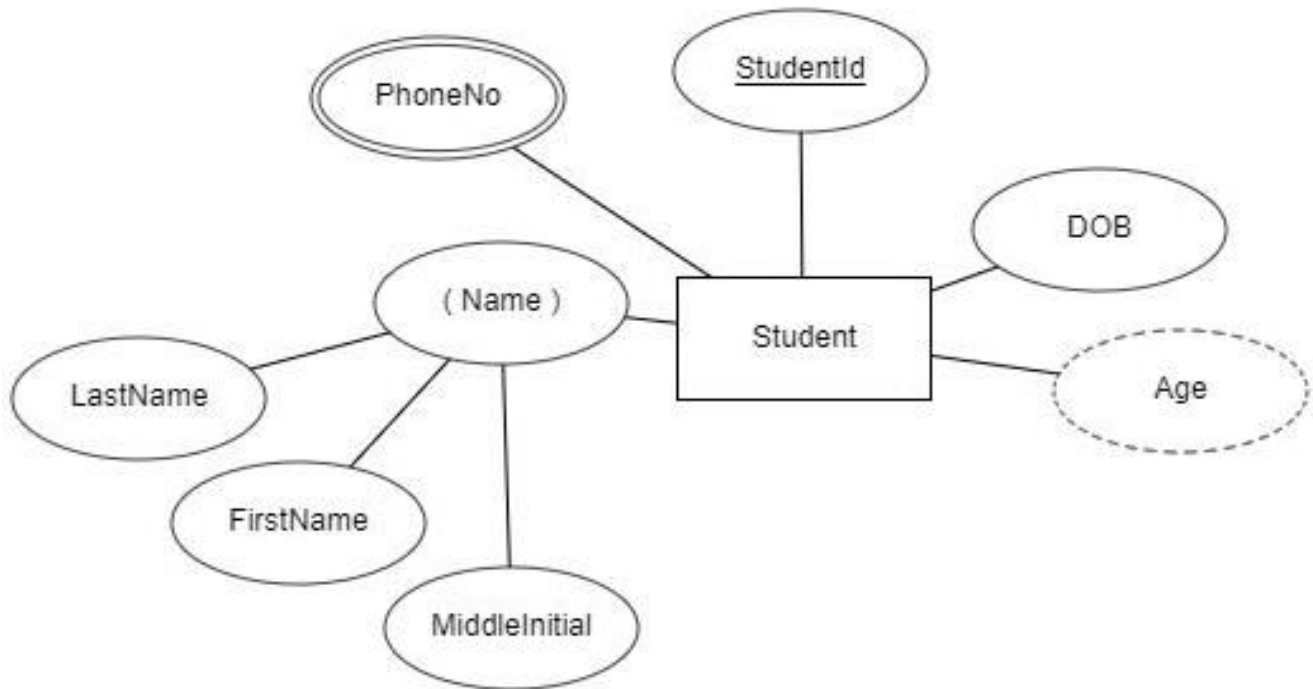
Chen Model

Chen Model
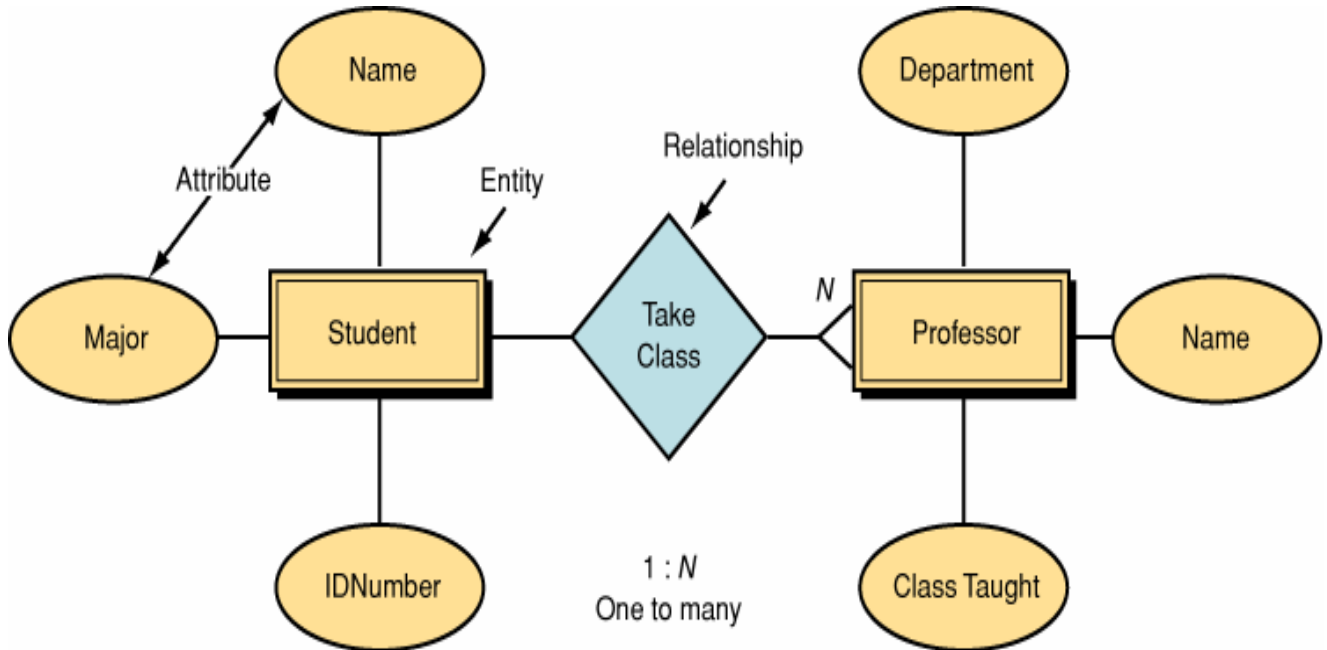
An ER diagram for a University database schema using min-max notation