Data Modeling

- A technique for defining business requirements for a database
- Also known as database modeling
- There are several notations
- Actual model is called an ERD – Entity Relationship Diagram
  - **Shows data in terms of the entities and relationships described by the data.**
  - **There exist several notations for an ERD**
  - **Martin notation is widely used.**

Data Modeling…

Entity Relationship Diagrams

Shows data in terms of the entities and relationships described by data.

Entities

An entity is something about which the business needs to store data.

Synonyms – entity type and entity class

Data Modeling…

Entity Relationship Diagrams…

Entity: is a class of

Persons
(Customer, Employee)

Places
(Building, Room)

Objects
(Book, Product)

Events
(Flight, Invoice)

Concepts
(Account, Fund)

about which we need to capture and store data.

Data Modeling…

Entity Relationship Diagrams…

Entity Instance

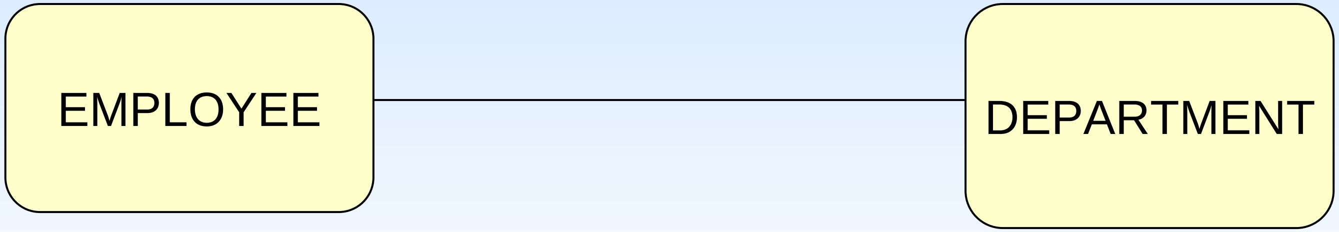
An entity instance is a single occurrence of an entity. Every entity must have an identifier or key to uniquely identify each instance.

Data Modeling…

Entity Relationship Diagrams…

Symbol:

Consider Martin notations.



The named rounded rectangle represent the entity. – ▢

A line represent the relationship. – ———

Data Modeling…

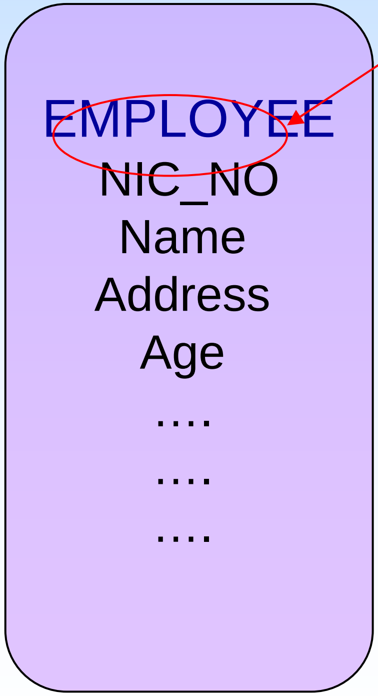
Entity Relationship Diagrams…

Attribute:

is a descriptive property or characteristics of an entity. Sometimes called as element, property, or field.

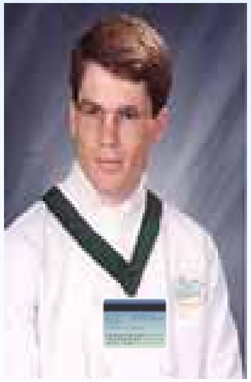
Data Modeling…

Entity Relationship Diagrams…

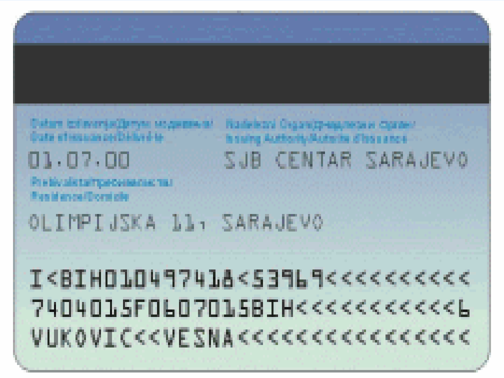


EMPLOYEE
NIC_NO
Name
Address
Age
….
….
….

A key is an attribute, or group of attributes that assumes a unique value for each entity instance. It is sometimes called an *identifier*.



This person can be identified using his ID number.



01.07.00 SJB CENTAR SARAJEVO
OLIMPIJSKA 11, SARAJEVO

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I<BIH010497418<53969<<<<<<<<<<
7404015F0607015BIH<<<<<<<<<<<6
VUKOVIC<<VESNA<<<<<<<<<<<<<<<<
```

Data Modeling…

The Odd House
Bosworth Road
Snarestone
Swadlincote
Leicestershire
DE12 7DQ

Entity Relationship Diagrams…

Compound Attribute is one that actually consist of other attributes.

Synonyms- composite attribute, concatenated attribute

Example :

Student name

Last Name
First Name
Middle Name

Address

Street Address
Postal Code
Country
City

Data Modeling…

Entity Relationship Diagrams…

The values for each **attribute** are defined in terms of three properties:

1. Data type – What type of data can be stored in that attribute (Number, Date, Text etc).
2. Domain – What values an attribute can legitimately take on.

   Refer to table 8-2 in pg 273 Ref1

3. Default – Is the value that will be recorded if not specified by the user.

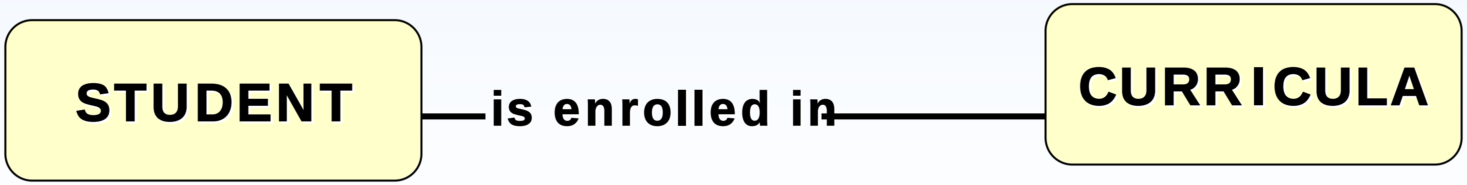
Data Modeling…

Entity Relationship Diagrams…

Relationships

Natural business association that exists between one or more entities

E.g.. A Current Student <u>is enrolled in</u> one or more curricula



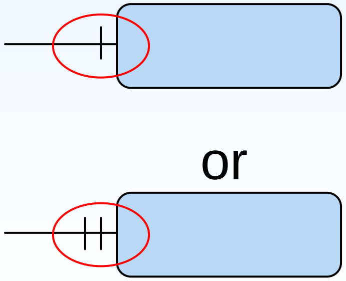
Data Modeling…

Entity Relationship Diagrams…

Cardinality

Defines the minimum and maximum number of occurrences of one entity that may be related to a single occurrences of the other entity.

Exactly one

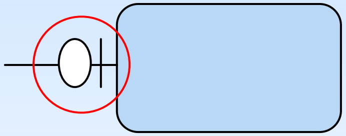


Data Modeling…

Entity Relationship Diagrams…

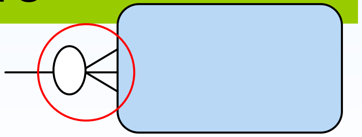
Cardinality

Zero or one



I might be married or not…

Zero, one or more



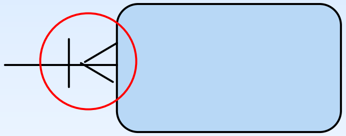
I may have one, some friends or none…

Data Modeling…

Entity Relationship Diagrams…

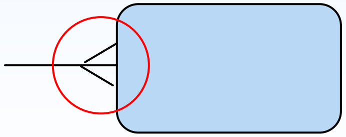
Cardinality…

One or more

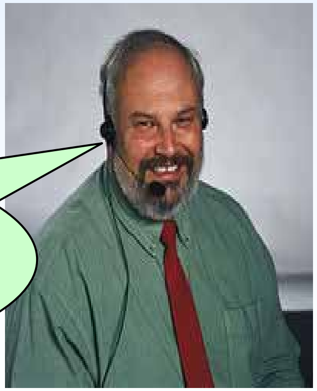


I have to work at least in one, or more projects.

More than one



I am working on many projects.



Data Modeling…

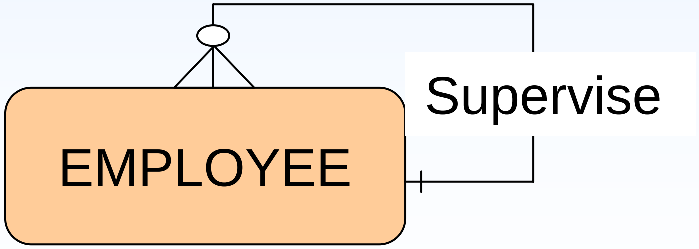
Entity Relationship Diagrams…

Degree

Number of entities that participate in the relationship

Degree =1

Recursive Relationship – Relationship that exists between different instances of the same entity.



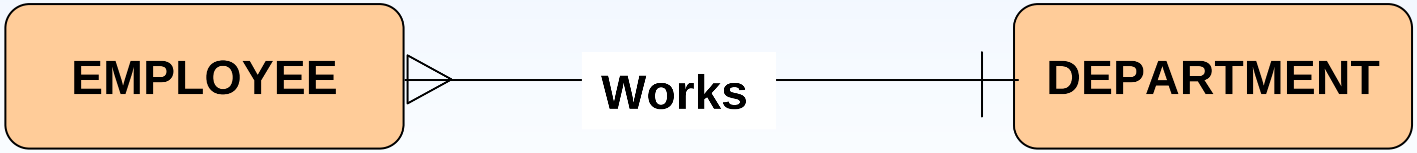
Data Modeling…

Entity Relationship Diagrams…

Degree…

Degree =2

Binary Relationship - When two different entities participates in a relationship



EMPLOYEE

Works

DEPARTMENT

Data Modeling…

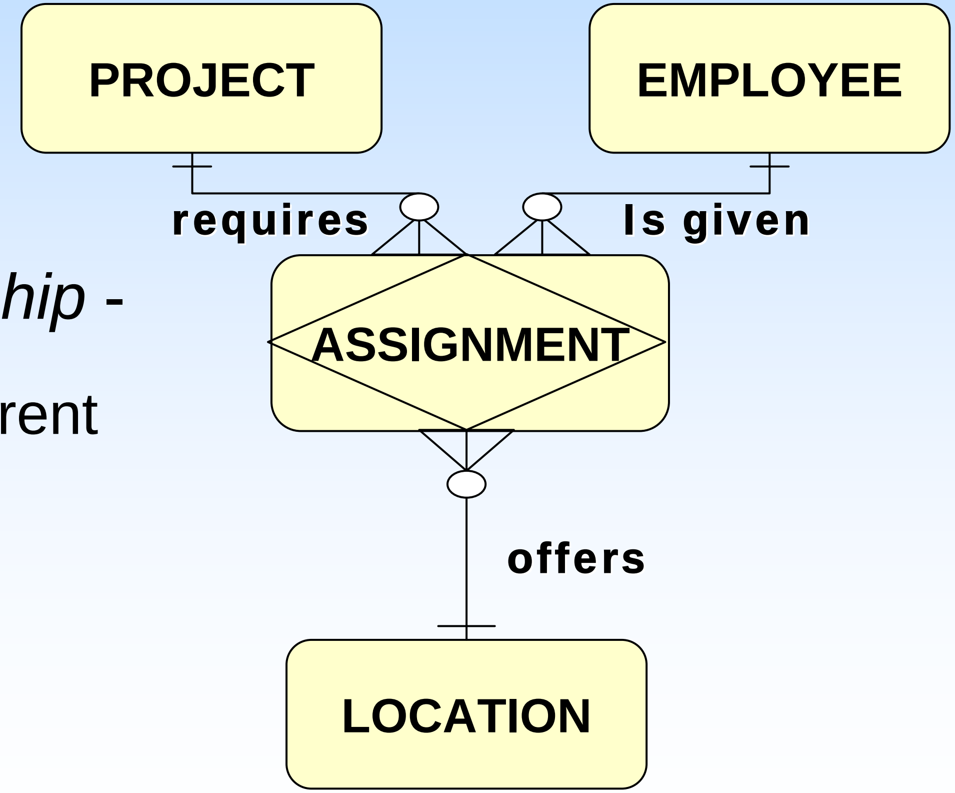
Entity Relationship Diagrams…

Degree…

Degree =3

Ternary or 3-ary Relationship -

When more than two different entities participates in a relationship.



Synchronization of System Models

- Data and process models represent different views of the same system
- These views are interrelated
- Thus, modelers need to synchronize the different views to ensure consistency and the completeness of the total system specification.

Synchronization is the process of maintaining consistency between the different types of models

Object Modeling

- A technique for identifying objects within the systems environment and identifying the relationships between those objects.

- Object Modeling techniques prescribe the use of methodologies and diagramming notations that are completely different from the ones used for data modeling and process modeling.

Object Modeling Methods

- In the late 80s and early 90s
  - Booch Method – Grady Booch
  - Object Modeling Technique (OMT) – James Rumbaugh
  - Object-Oriented Software Engineering – Ivar Jacobson
- To avoid problems of having many different methods, In 1997,
  - Unified Modeling Language (UML) - Grady Booch, James Rumbaugh, Ivar Jacobson

System Concepts for Object Modeling

- Objects
  - **Something that is or is capable of being seen, touched, or otherwise sensed and about which users store data and associate behavior**
  - **Types of objects**
    - **Person – e.g. employee, customer, instructor, student**
    - **Place – e.g. warehouse, building, room, office**
    - **Thing – e.g. product, vehicle, computer, videotape**
    - **Event – e.g. an order, payment, invoice, application**
    - **Sensual – e.g. phone call, meeting**

System Concepts for Object Modeling…

- Attributes
  - The data that represents characteristics of interest about an object

    e.g. Object : Customer

    Attributes : Customer no, first name, last name, home address, work address, contact no,…etc.

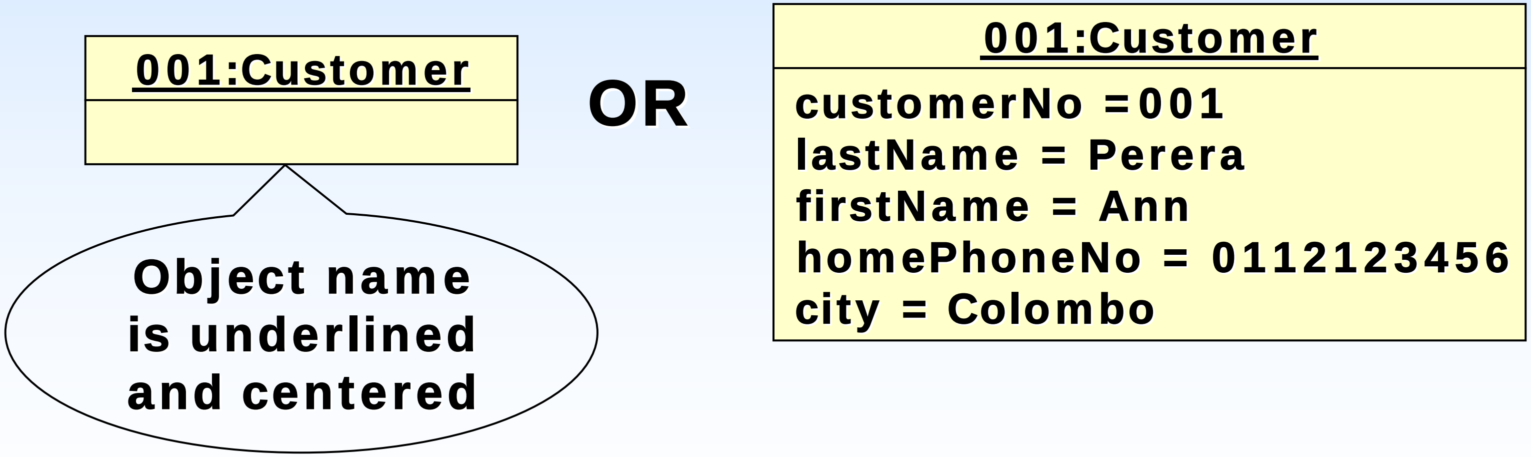
System Concepts for Object Modeling…

- Object instance
  - Each specific person, place, thing, or event, as well as the values for the attributes of that object.
  - Sometimes referred to as an Object.
  - Drawn using a rectangle with the name of the object instance
  - The name consists of the attribute that uniquely identifies it, followed by a colon and then the name of the class in which the object has been categorized.

System Concepts for Object Modeling…

- Object instance

e.g. A “CUSTOMER” Object Instance



customerNo =001
lastName = Perera
firstName = Ann
homePhoneNo = 0112123456
city = Colombo

Object name is underlined and centered

System Concepts for Object Modeling…

- Behavior
  - The set of things that an object can do and that correspond to functions that act on the object’s data or attributes.
  - Also known as a method, operation or service

e.g. Object : Door

behavior : open, shut, lock or unlock

System Concepts for Object Modeling…

- Encapsulation
  - **Packaging of several items together into one unit (both attributes and behavior of the object)**
  - **The only way to access or change an object’s attribute is through that object’s specific behavior.**
  - **Objects *encapsulates* what they do.**
    - **That is, they hide the inner workings of their operations**
      - **from the outside world**
      - **and from other objects**

System Concepts for Object Modeling…

Encapsulation

When an object carries out its operations, those operations are hidden.

E.g. When most people watch a television show,

- they usually don’t know or care about the complex electronics that sit in back of the TV screen

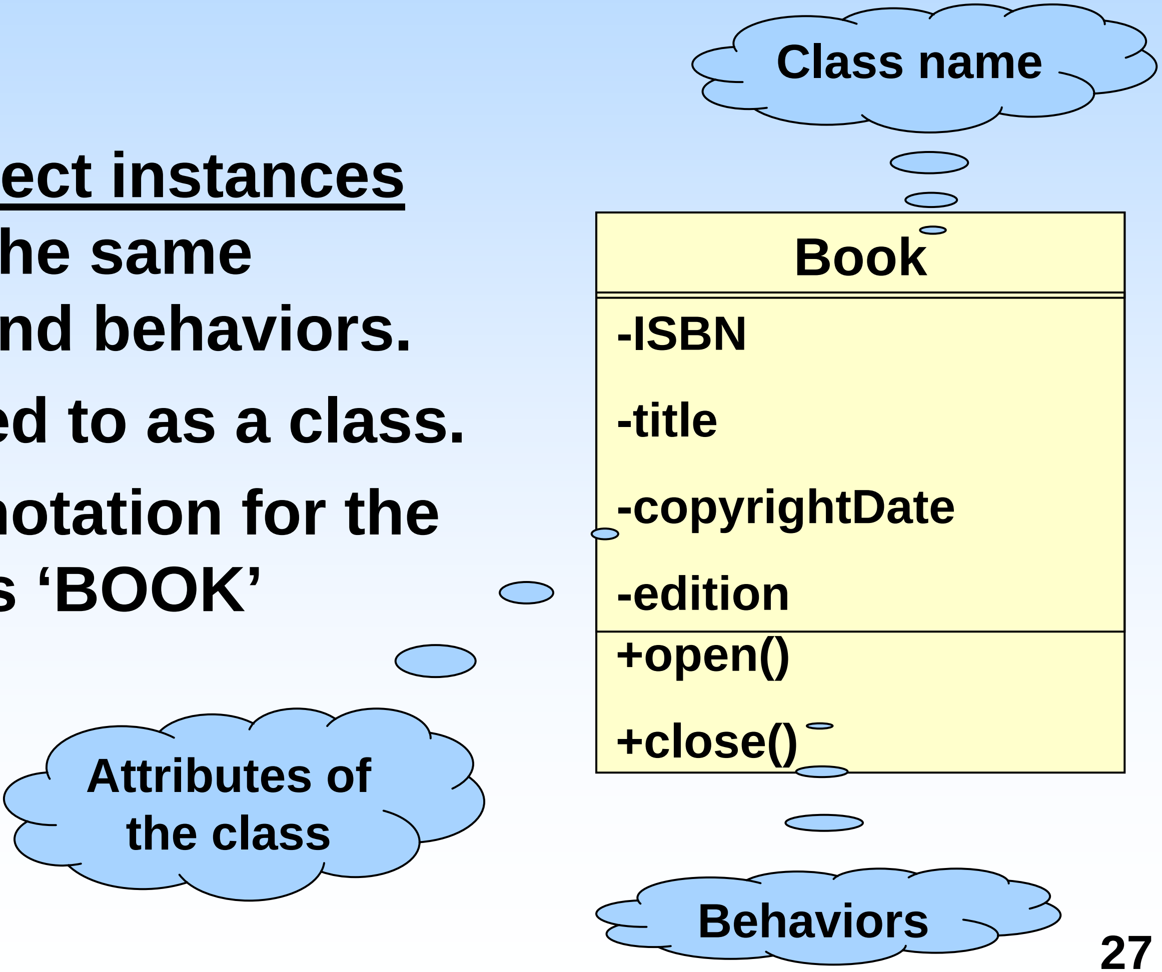
- or the operations that are happening.

The TV hides its operations from the person watching it.

System Concepts for Object Modeling…

- Object class
  - **A set of <u>object instances</u> that share the same attributes and behaviors.**
  - **Also referred to as a class.**

    e.g. UML notation for the object class ‘BOOK’



System Concepts for Object Modeling…

An Object instance

e.g.

0-07-231539-3 : Book

ISBN = 0-07-231539-3
title = Systems Analysis
copyrightDate = 2001
edition = 5th

0-09-341234-5 : Book

ISBN = 0-09-341234-5
title = Programming in C++
copyrightDate = 2006
edition = 7th

System Concepts for Object Modeling…

- Inheritance
  - The concept wherein methods and/or attributes defined in an object class can be inherited or reused by another object class.

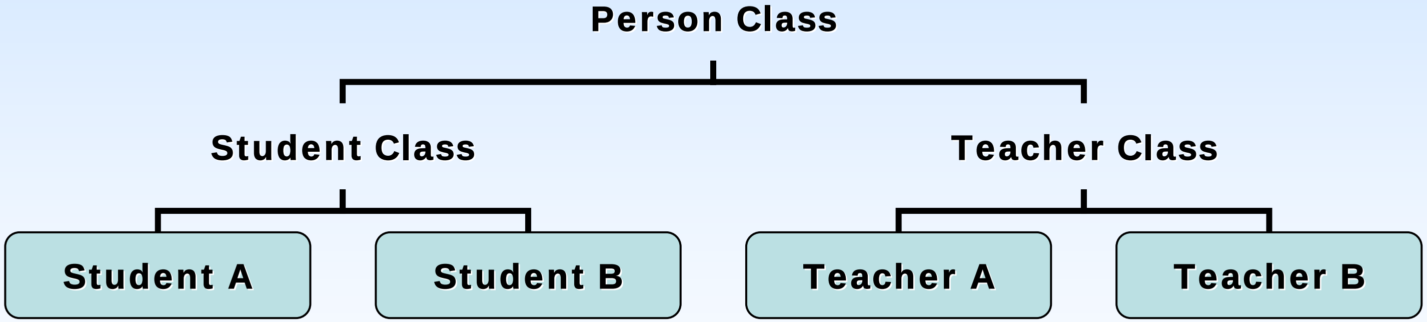
e.g. some individuals in the room might be classified as STUDENTS and TEACHERS.

Thus, STUDENT and TEACHER object classes are members of the object class PERSON

System Concepts for Object Modeling…

- Inheritance

  e.g. Cont…



Person Class

Student Class

Teacher Class

Student A

Student B

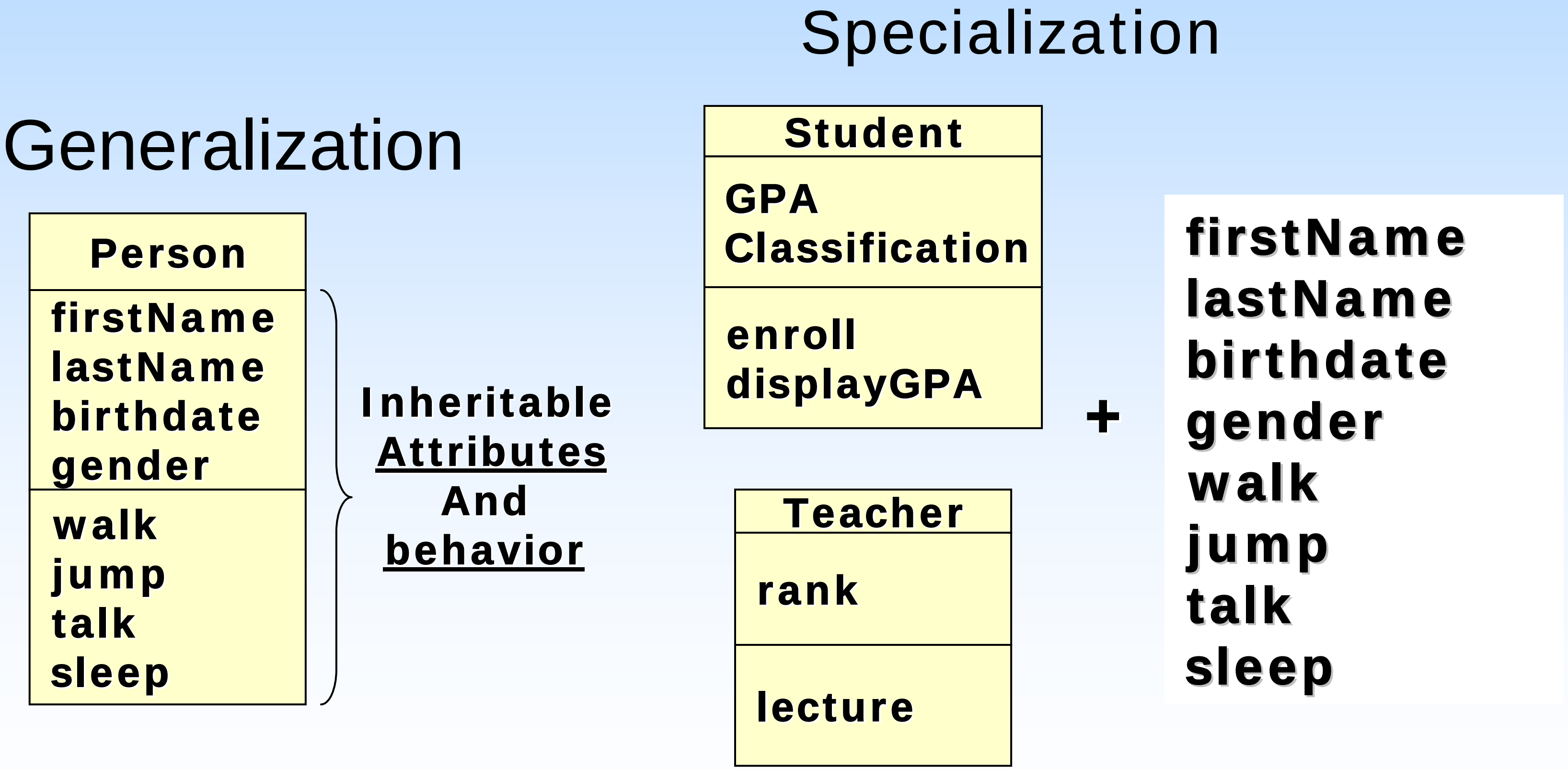
Teacher A

Teacher B

System Concepts for Object Modeling…

- Generalization / Specialization
  - A technique wherein the attributes and behaviors that are common to several types of object classes are grouped / abstracted into their own class called a super type.
  - The attributes and methods of the supertype object class are then inherited by those object classes (subtype)
  - Sometimes abbreviated as gen/spec.

System Concepts for Object Modeling…



Specialization

Generalization

Person

- firstName
- lastName
- birthdate
- gender

- walk
- jump
- talk
- sleep

Inheritable Attributes And behavior

Student

- GPA
- Classification

- enroll
- displayGPA

Teacher

- rank

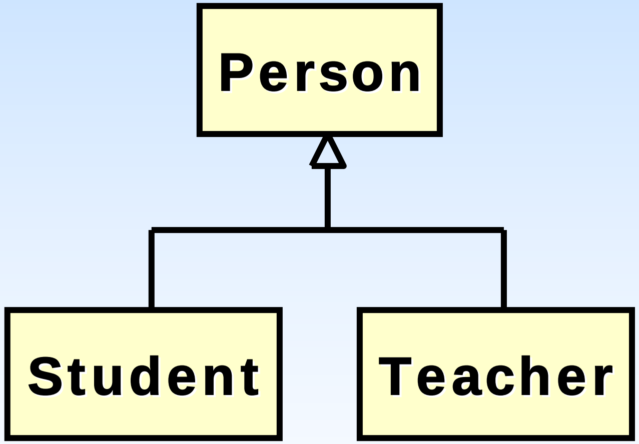
- lecture

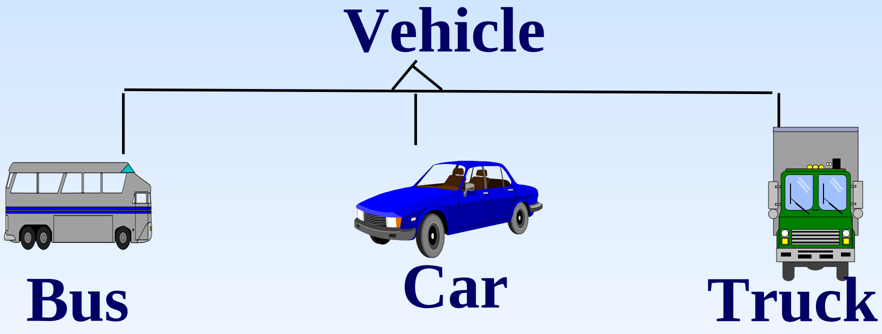
+

- firstName
- lastName
- birthdate
- gender
- walk
- jump
- talk
- sleep

System Concepts for Object Modeling…

- Generalization / Specialization





*** Specialized classes inherits from the parent class**

System Concepts for Object Modeling…

- Object Class Relationships
  - A natural business association that exists between one or more objects and classes

e.g. You interact with a text book by reading it,

with a telephone by using it,

People interact with each other by communicating with them.

System Concepts for Object Modeling…

- Object / Class Association
  - When you turn on your TV, in object oriented terms, you are in an *association* with your TV.
  - An association is unidirectional (one way) or bi-directional (two way).

    eg. *is married to*
  - Some times an object might be associated with another in more than one way.

    Gihan *is a co-worker of* Damith

    Gihan *is a friend of* Damith

UCSC

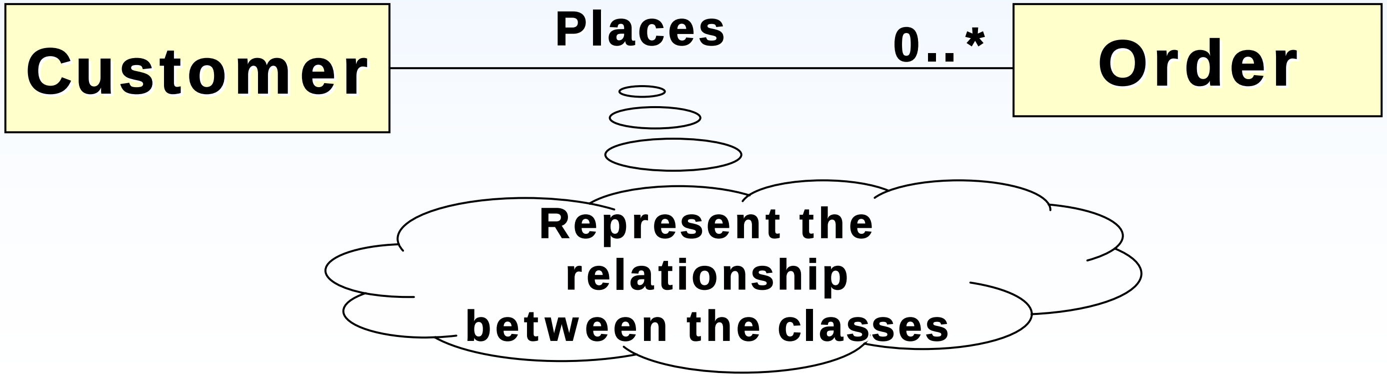
System Concepts for Object Modeling…

- Object / Class Association

  e.g.

  A CUSTOMER PLACES zero or more ORDERS

  An ORDER IS PLACED BY one and only one CUSTOMER



Customer

Places

0..*

Order

Represent the relationship between the classes

System Concepts for Object Modeling…

- Multiplicity
  - The minimum and maximum number of occurrences of one object class for a single occurrence of the related object class.

e.g. Exactly one -> **1** or *leave blank*

Zero or 1 -> **0..1**

Zero or more -> **0..*** or *****

1 or more -> **1..***

Specific range -> **7..9**

Refer Figure 10-5 pg 377 Ref1 for more details

System Concepts for Object Modeling…

- ***Aggregation***
  - A relationship in which one larger “whole” class contains one or more smaller “parts” classes. Conversely, a smaller “part” class is part of a “whole” larger class.

    e.g.

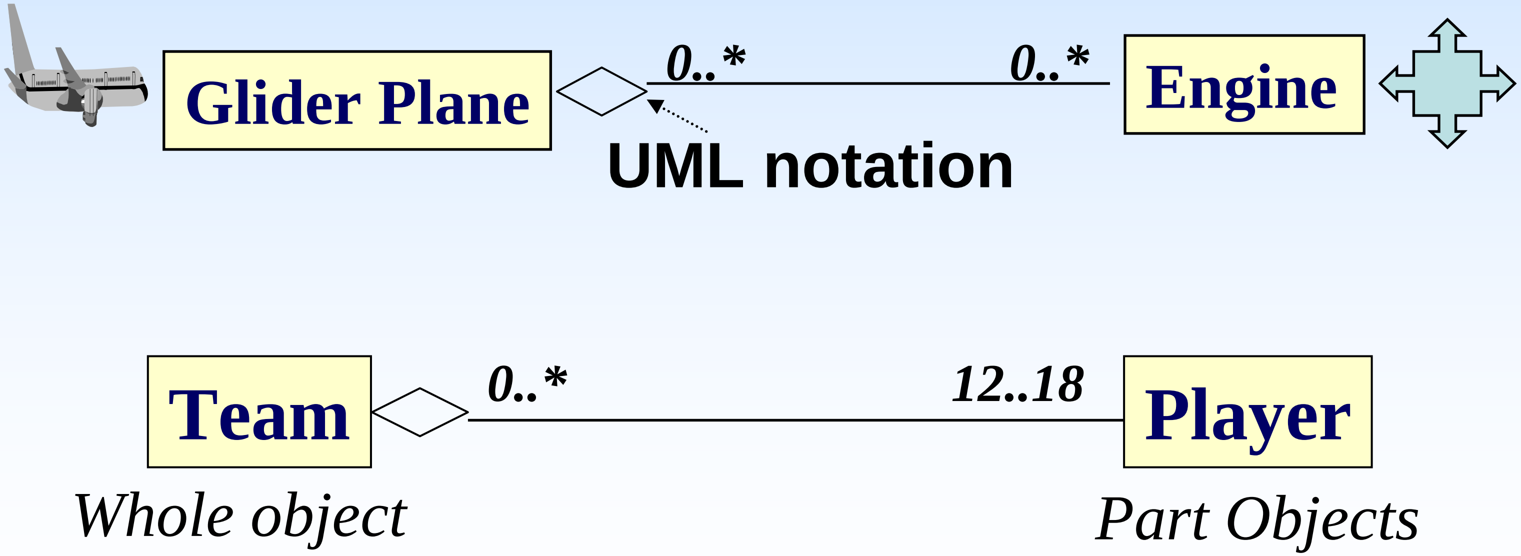
    A club – a club is made up of several club members

    A computer – a computer contains a case, CPU, motherboard, power supply …etc.

System Concepts for Object Modeling…

- ***Aggregation***

  some more examples…



Glider Plane

*0..**

*0..**

Engine

UML notation

Team

*0..**

12..18

Player

Whole object

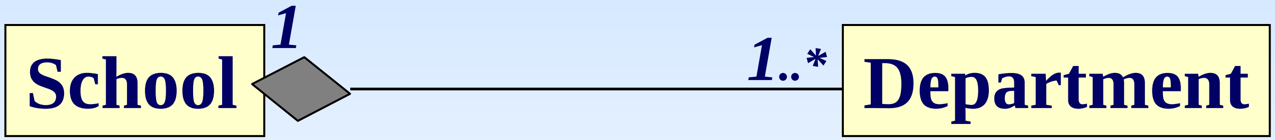
Part Objects

System Concepts for Object Modeling…

- ***Composition***
  - An aggregation relationship in which the “whole” is responsible for the creation and destruction of its “parts”.
  - If the “whole” were to die, the “part” would die with it.
  - A stronger form of aggregation.
    - The relationship between club and club member would not be composition, because members have a life out-side the club and can, belong to multiple clubs.

System Concepts for Object Modeling…

- ***Composition***
  - Drawn with a filled diamond.



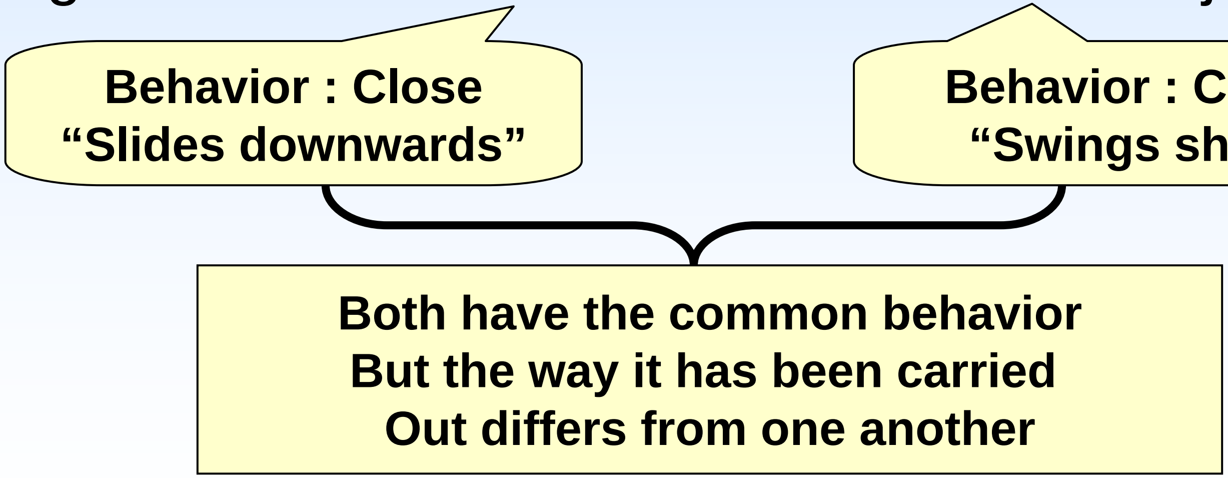
Each “part” can belong to only one “whole”, therefore, multiplicity needs to be specified only one for the “part”

Components will live and die with the whole object

System Concepts for Object Modeling…

- Polymorphism
  - Literally meaning “many forms”, the concept that different objects can respond to the same message in different ways.

e.g. Consider the WINDOW and DOOR objects



Behavior : Close
“Slides downwards”

Behavior : Close
“Swings shut”

Both have the common behavior
But the way it has been carried
Out differs from one another