Module 2:
Class and object concepts and declaration

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Acknowledgement

- This presentation reuses materials from:
  - Course CS202: Programming Systems
    Instructor: MSc. Karla Fant,
    Portland State University
  - Course CS202: Programming Systems
    Instructor: Dr. Dinh Ba Tien,
    University of Science, VNU-HCMC
  - Course DEV275: Essentials of Visual Modeling with UML 2.0
    IBM Software Group

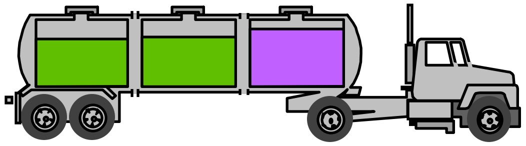
Outline

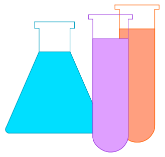
- What is an object?
- What is a class?
- OO Design
- Class identifying
- Class declaration

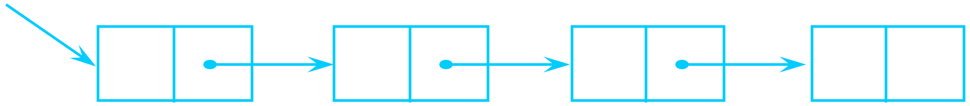
What is an object?

What Is an Object?

- Informally, an object represents an entity, either physical, conceptual, or software.
  - Physical entity
  - Conceptual entity
  - Software entity

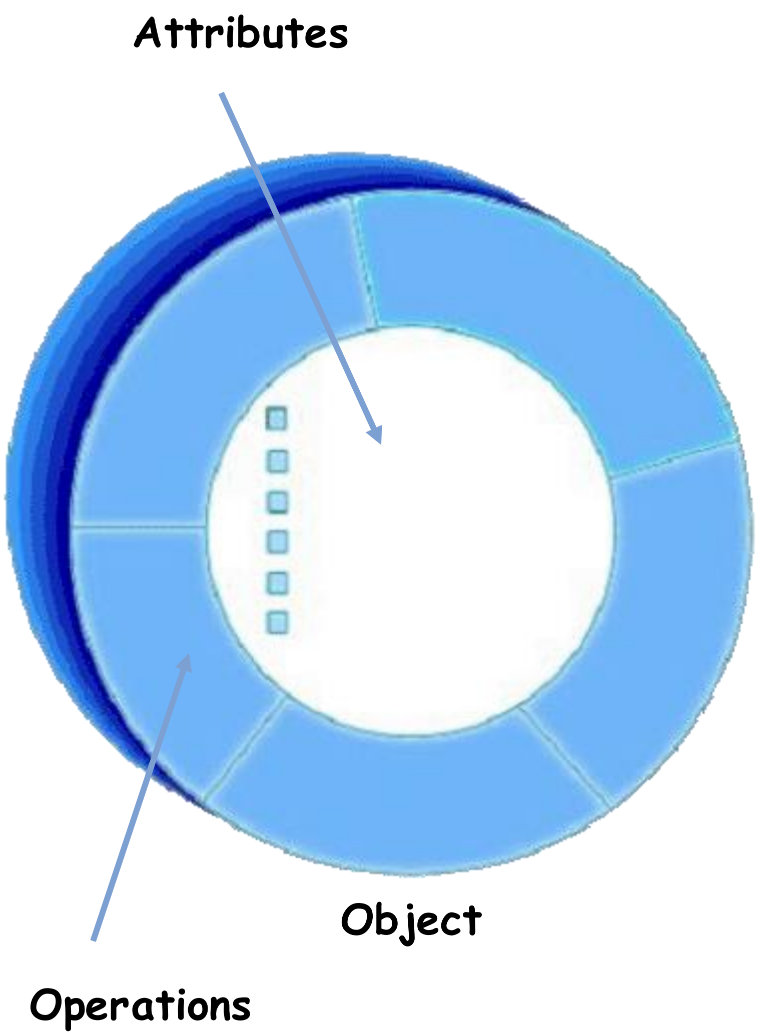

Truck


Chemical Process


Linked List

A More Formal Definition

- An object is an entity with a well-defined boundary and *identity* that encapsulates *state* and *behavior*.
  - State is represented by attributes and relationships.
  - Behavior is represented by operations, methods, and state machines.

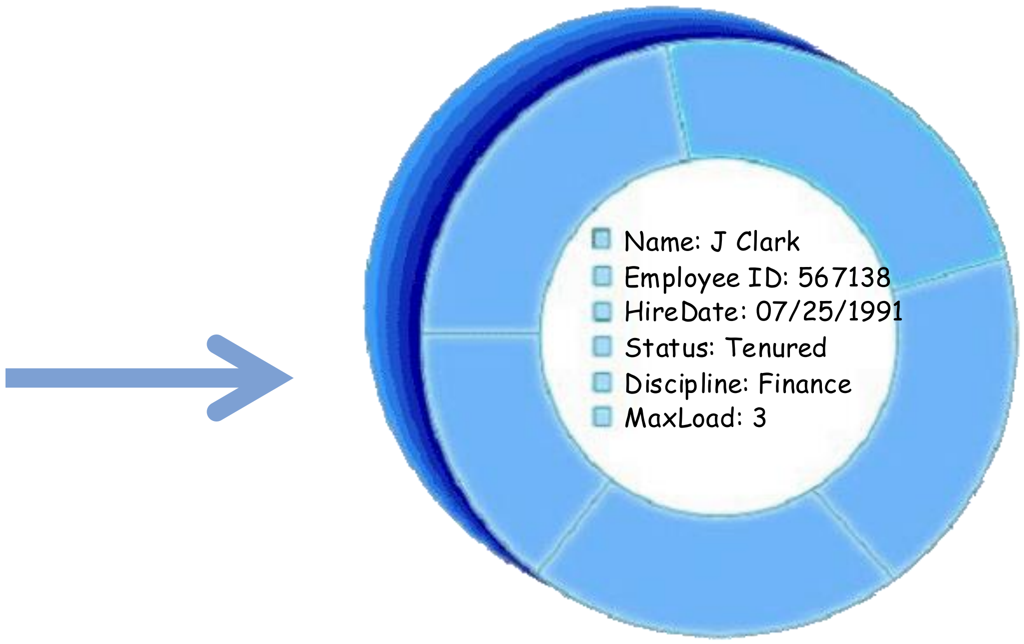


An Object Has State

- State is a condition or situation during the life of an object, which satisfies some condition, performs some activity, or waits for some event.
- The state of an object normally changes over time.

An Object Has State

Name: J Clark
Employee ID: 567138
Date Hired: July 25, 1991
Status: Tenured
Discipline: Finance
Maximum Course Load: 3 classes



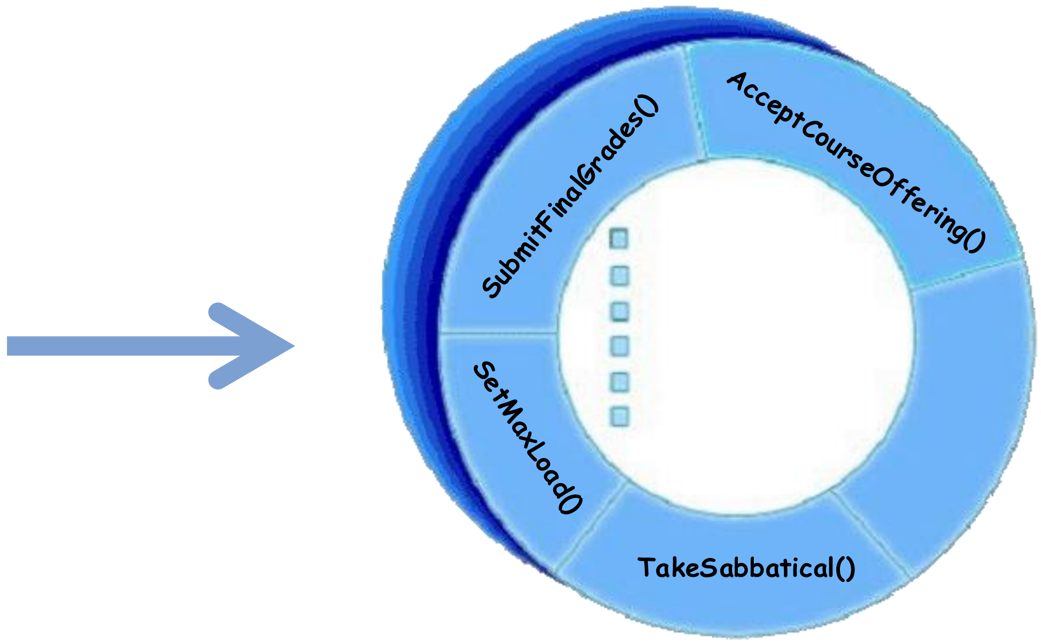
Professor Clark

An Object Has Behavior

- Behavior determines how an object acts and reacts.
- The visible behavior of an object is modeled by a set of messages it can respond to (operations that the object can perform).

An Object Has Behavior

Professor Clark's behavior
- Submit Final Grades
- Accept Course Offering
- Take Sabbatical
- Set Max Load



Professor Clark

An Object Has Identity

- Each object has a unique identity, even if the state is identical to that of another object.

Professor "J Clark" teaches Biology

Professor "J Clark" teaches Biology

What is a class?

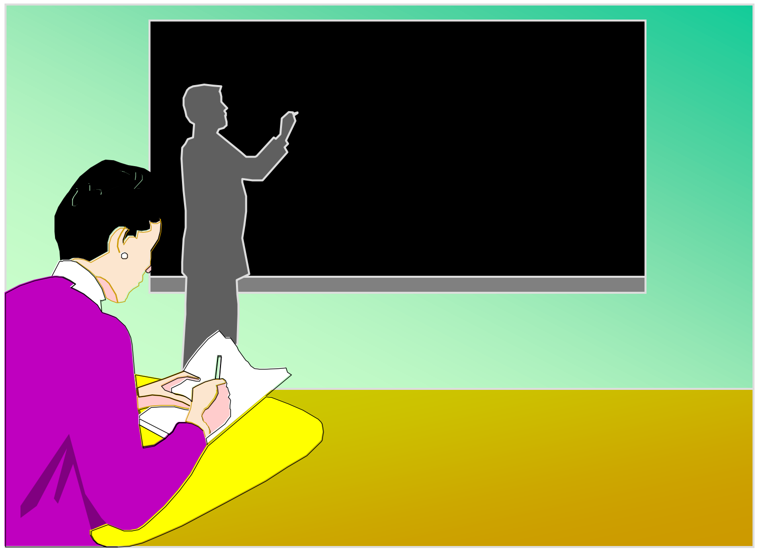
What Is a Class?

- A class is a description of a set of objects that share the same *attributes*, *operations*, *relationships*, and *semantics*.
  - An object is an instance of a class.
- A class is an abstraction in that it
  - Emphasizes relevant characteristics.
  - Suppresses other characteristics.

A Sample Class

<u>Class</u>
Course

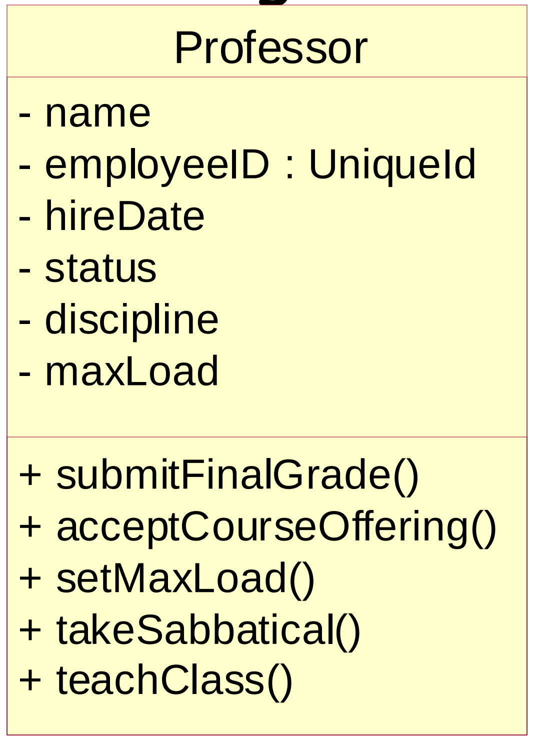
<u>Properties</u>
Name
Location
Days offered
Credit hours
Start time
End time



<u>Behavior</u>
Add a student
Delete a student
Get course roster
Determine if it is full

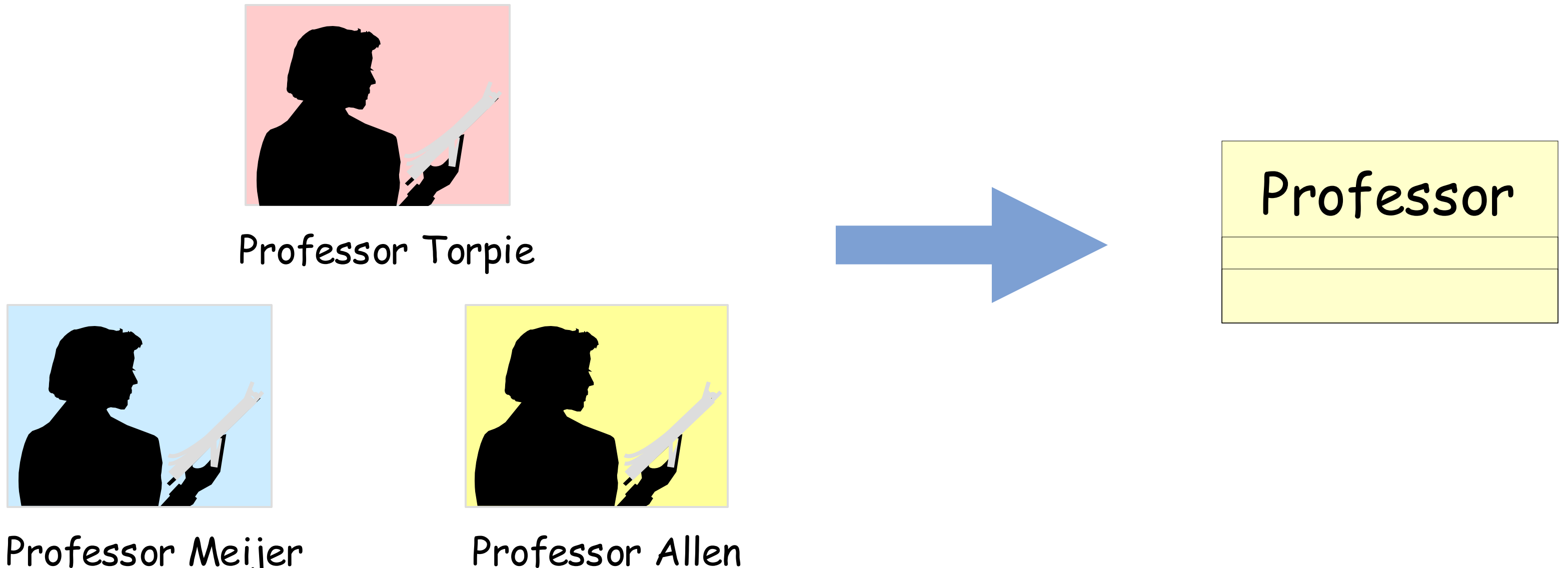
Representing Classes in the UML

- A class is represented using a rectangle with three compartments:
  - The class name
  - The structure (attributes)
  - The behavior (operations)



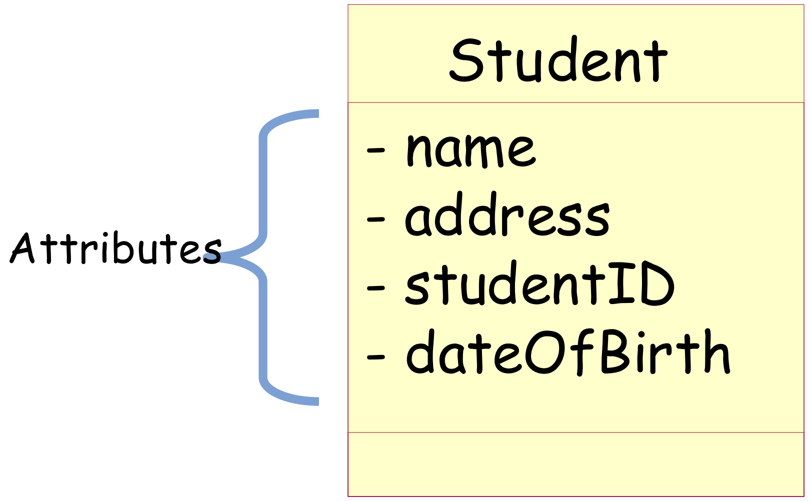
The Relationship between Classes and Objects

- A class is an abstract definition of an object.
  - It defines the structure and behavior of each object in the class.
  - It serves as a template for creating objects.
- Classes are not collections of objects.

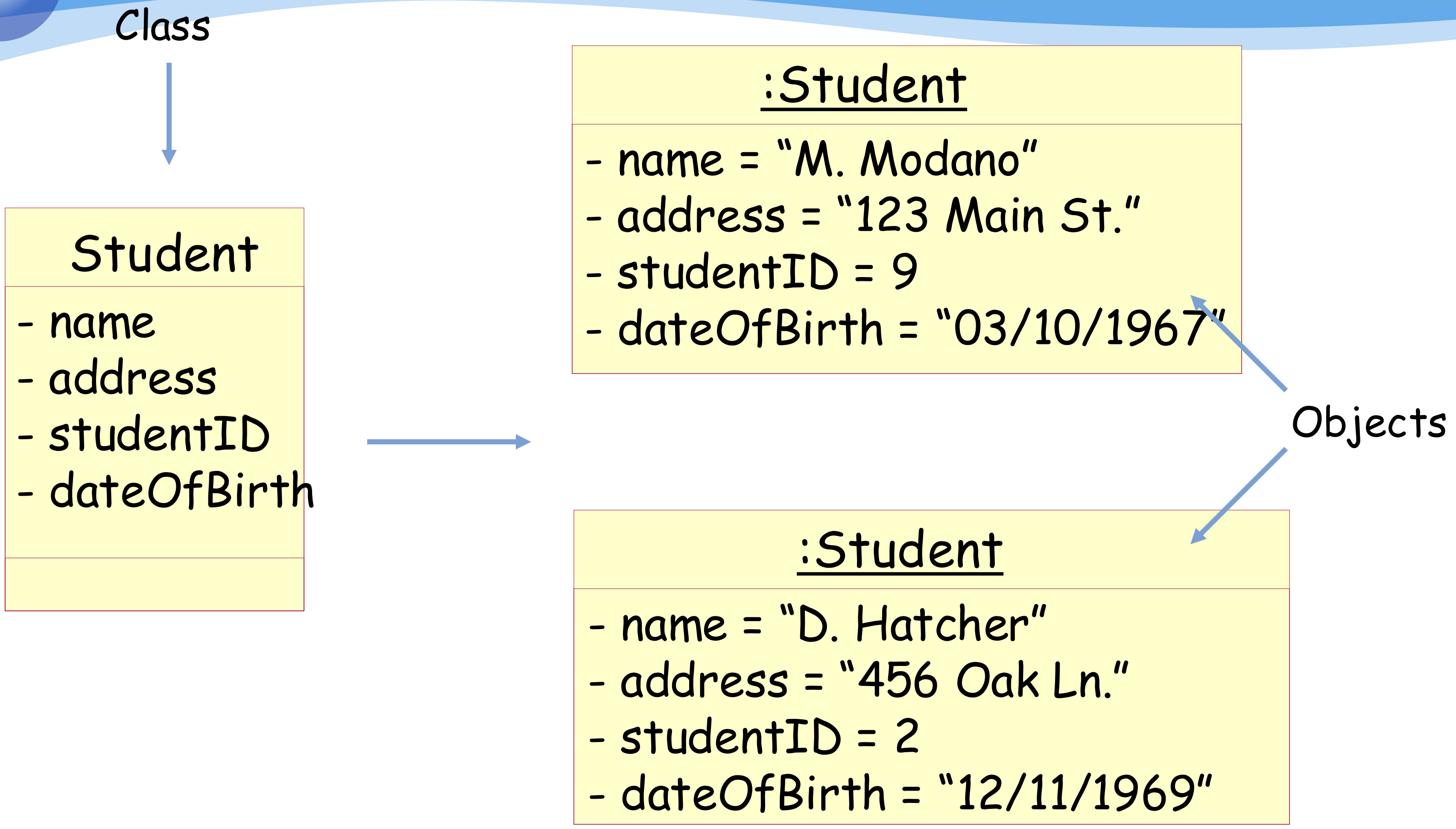


What Is an Attribute?

- An attribute is a named property of a class that describes the range of values that instances of the property may hold.
  - A class may have any number of attributes or no attributes at all.

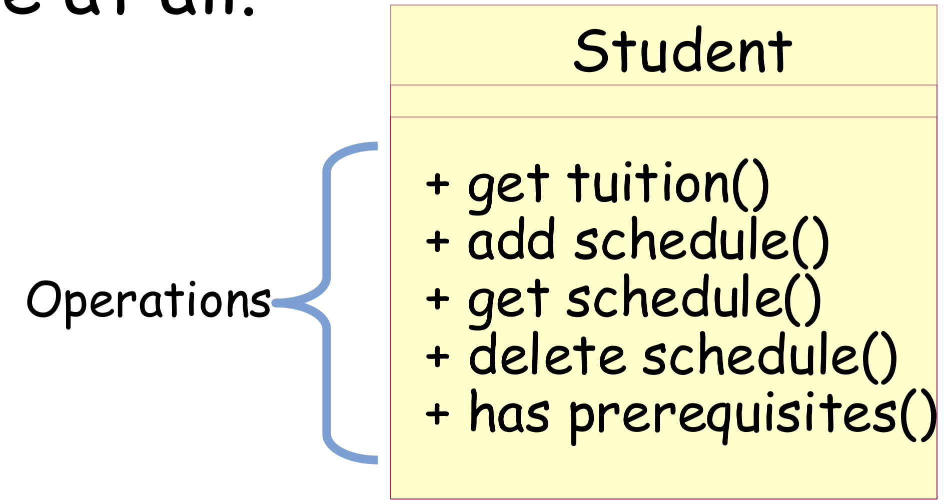


Attributes in Classes and Objects



What Is an Operation?

- A service that can be requested from an object to effect behavior. An operation has a signature, which may restrict the actual parameters that are possible.
- A class may have any number of operations or none at all.

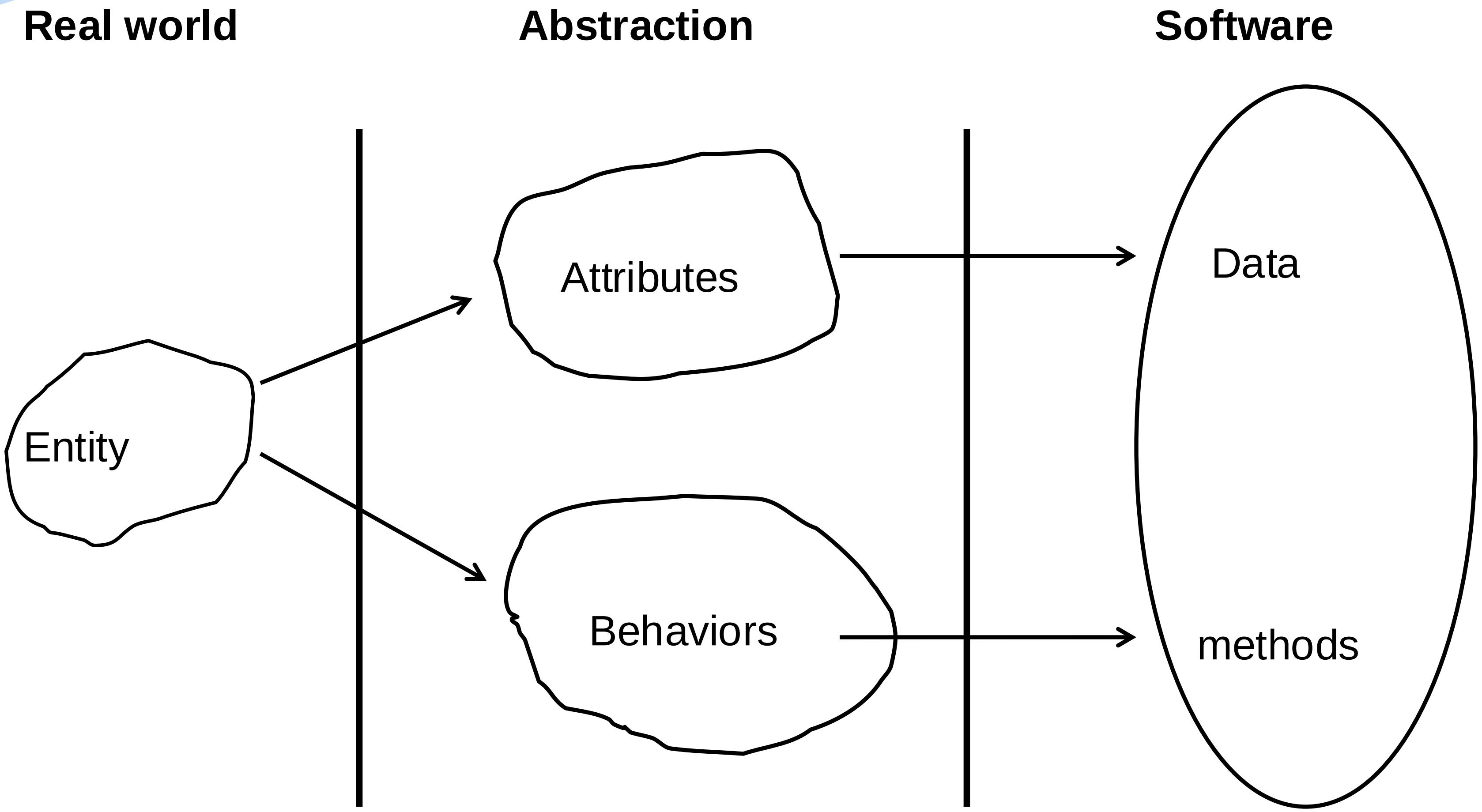


OO Design

Object-oriented design

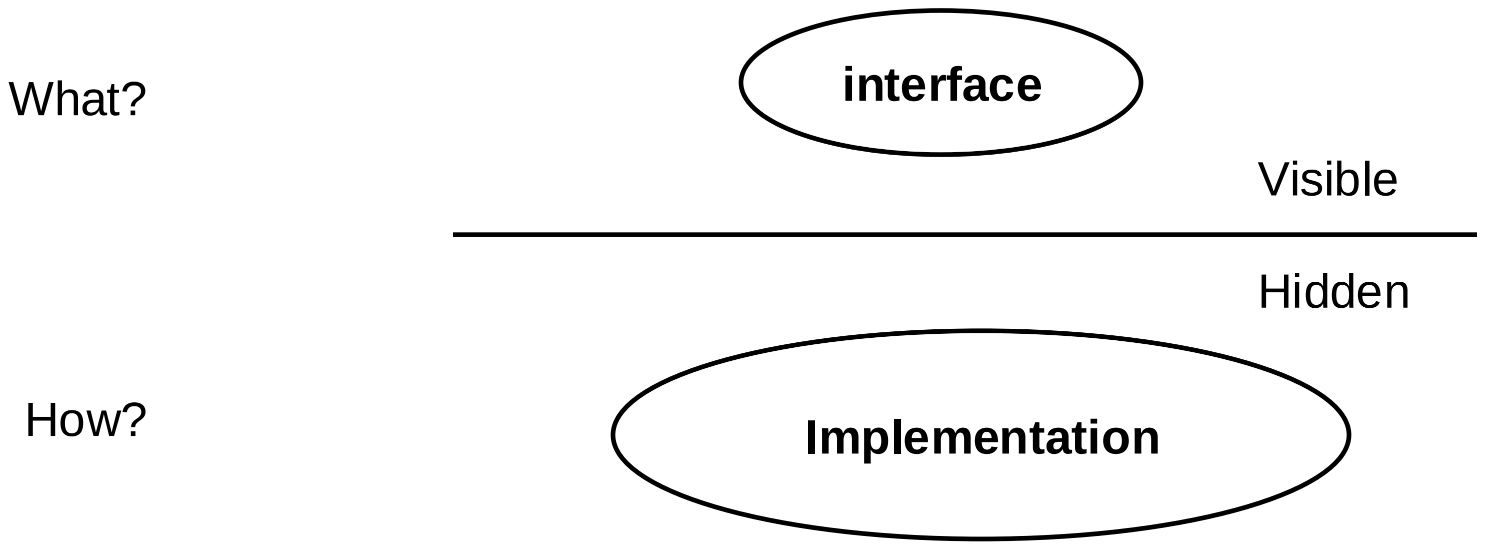
- Abstract Data Types (ADT)
- Divide project into a set of cooperating classes
- Each class has a very specific functionality
- Think of a class as similar to a data type
- Class can be used to create instances of objects

Mapping the real world to software



Classes in OO Programming

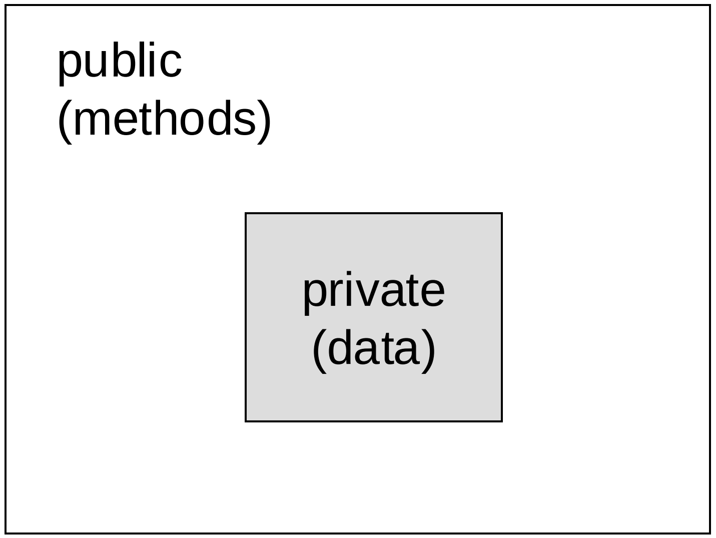
- Separation interface from implementation



Structure of a class

- A class models an entity in real world
- A class represents all members of a group of objects
- A class provides a public interface and a private implementation
- Hiding the data and "algorithm" from the user

Structure of a class



class

Class Identifying

Designing process

- Identifying classes
- Identifying behaviors
  - Decide whether behavior is accomplised by a single class or through the collaboration of a number of "related" classes
  - Static behavior: behavior always exists
  - Dynamic behavior: depending of when/how a behavior is invoked, it might or might not be legal

Example:

- Game “Tetris”:
  - possible classes:
    - Board,
    - Block (square block),
    - Piece (composed of several blocks),
    - Player (is it necessary?),
    - Line of Blocks

Example:

- e-Shopping Website
  - possible classes:
    - Product
      - Attributes: Name, ID, price, status, manufacturer's name, images, technical description.
    - Product Category:
      - Attributes: Name
    - Manufacturer
      - Attributes: Name, Country, Website

Example

- Website “National Foolball Competition”
  - People: Player, Referee, Coach, Team Manager…
  - Places: Stadium, City…
  - Things: Ball (is it necessary?)
  - Organizations: Team, National Football Association
  - Concepts: Half, Round, Season…
  - Events: Match (is this a concept or an event?), Goal

Class

- A class should:
  - be a real-world entity
  - be important to the discussion of the requirements
  - have a crisply defined boundary
  - make sense; (i.e. can identify the attributes and behaviors)
  - closely related

Object

- An "object" is an instance of a class
  - Just like a "variable" is an instance of a specific data type
- We can zero or more variables (or objects) in our programs

```
/* DataType       Variable*/
   int            x;
   Fraction       f;
```

Class and object

- A class is a blueprint for an object.
- When you instantiate an object, you use a class as the basis for how the object is built.
- A class can be thought of as a sort of higher-level data type. For example:

```
myClass myObject;
```

Class and object

- Each object has its own attributes and behaviours .
- A class defines the attributes and behaviours that all objects created with this class will possess.

- Classes are pieces of code.
- Objects are created from classes,

Class declaration

Class declaration in C++

```
class  <Name of the class>
{
        public:
                <public attributes and methods>
        private:
                <private attributes and methods>
};
```

Scope

- `private`: only visible to methods of the class itself.
- `public`: can be use from inside of the class or any client outside

An example

```
class  CDate
{
    public:
        CDate();
        CDate(int iNewDay, int iNewMonth, int iNewYear);
        int     getDay();       // return day
        int     getMonth();     // return month
        int     getYear();      // return year
        ...
    private:
        int     m_iDay, m_iMonth, m_iYear;
};
```

Scope resolution operator ::

- Tell the compiler the method or attribute belongs to a certain object

  For example:

```
        CDate::getDay()
        CDate::getMonth()
```

Separation declaration from definition

```
//keep in 1 file
class  CDate
{
    public:
            int   getDay();

   private:
            ...
};

int   CDate::getDay()
{
            return m_iDay;
}
```

```
// header file .h
class  CDate
{
    public:
            int   getDay();
   private:
            ...
};

// implementation file .cpp
int   CDate::getDay()
{
            return m_iDay;
}
```

How to use the Date class

```
int main()
{
    CDate today(20, 10, 2008);
    CDate tomorrow, someDay;

    //can I do this?
    cout << today.m_iMonth; //!!!
    //how about
    cout << today.getMonth();
    ...
}
```

Encapsulation and data hiding

- Encapsulation:
  - A C++ class provides a mechanism for packaging data and the operations that may be performed on that data into a single entity
- Information Hiding
  - A C++ class provides a mechanism for specifying access

Taxonomy of member functions

- The types of member functions may be classified in a number of ways. A common taxonomy:
    - **Constructor/Initalization**: an operation that creates a new instance of a class
    - **Observer**: an operation that reports the state of the data members (aka Accessors, Getters)
    - **Mutator**: an operation that changes the state of the data members of an object
    - **Iterator**: an operation that allows processing of all the components of a data structure sequentially

Taxonomy of member functions

- **Constructor/Initalization**: an operation that creates/initalize a new instance of a class
  - Constraint Checking methods?

Taxonomy of member functions

- **Observer**: an operation that reports the state of the data members
  - Provides value of an internal attribute
  - Provides some value calculated from internal attributes only
  - Provides some value calculated from internal attributes AND some external parameter(s)

Taxonomy of member functions

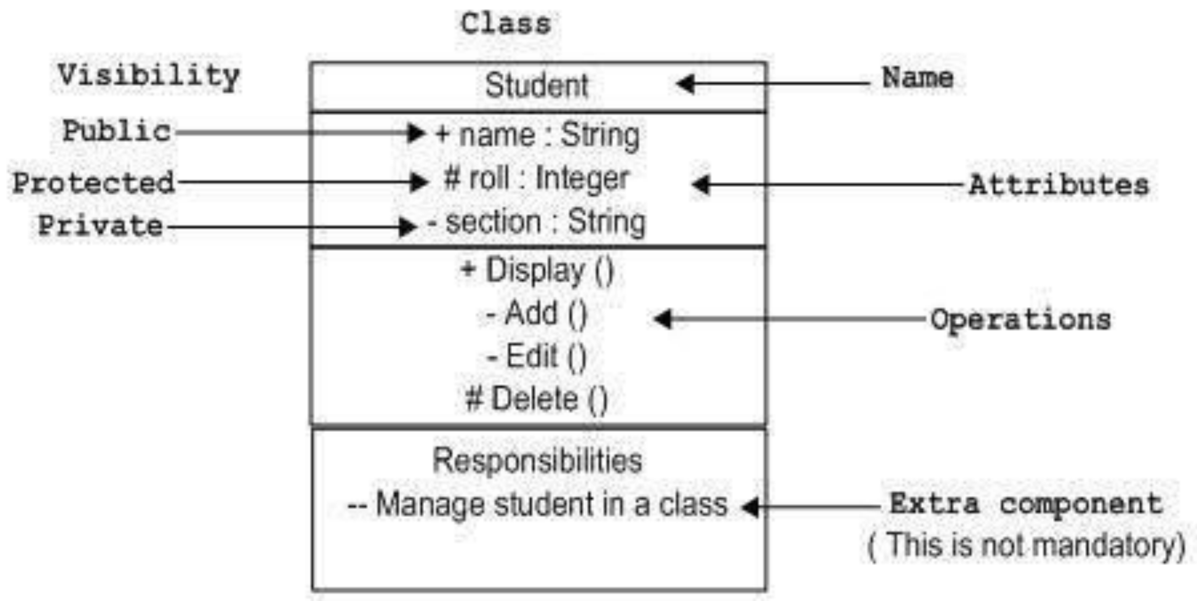
- **Mutator**: an operation that changes the state of the data members of an object
  - Updates value of an internal attribute
  - Transforms values of internal attributes
  - Constraint Checking methods?

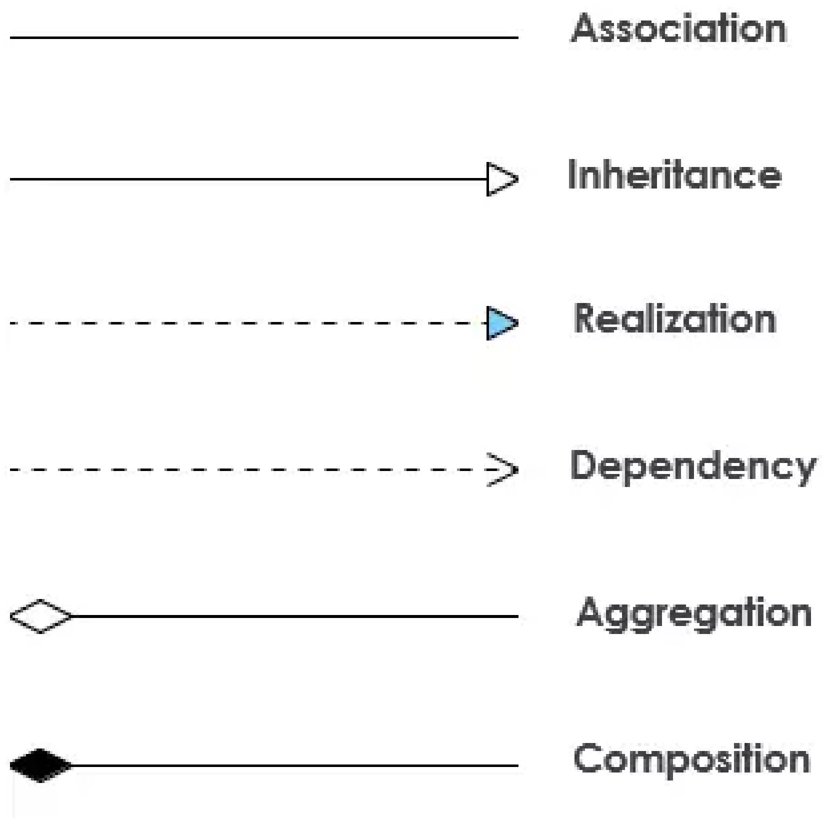
Taxonomy of member functions

- **Iterator**: an operation that allows processing of all the components of a data structure sequentially

Exercises

- List member functions of the following classes:
  - Date
  - Fraction with numerator and denominator
  - Employee


Class
Visibility
Student
Name
Public
+ name : String
Protected
# roll : Integer
Attributes
Private
- section : String
+ Display ()
- Add ()
Operations
- Edit ()
# Delete ()
Responsibilities
-- Manage student in a class
Extra component
(This is not mandatory)


Association
Inheritance
Realization
Dependency
Aggregation
Composition