Programming Technique II
SCSJ1023

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Lecturer
Dr. Arafat Mohammed

School of Computing,
Faculty of Engineering
Universiti Teknologi Malaysia

Course Overview

- The course covers another concept of programming: **Object-Oriented Programming (OOP)**

- Language used: **C++**

Course Topics

- Introduction to OOP
- Introduction to Classes and Objects
- Constructors and Destructors
- Class and Object Manipulations
- String Manipulations
- Advanced File Operations
- Associations, Aggregations and Compositions
- Inheritance
- Polymorphisms
- Exceptions and Templates

01: Introduction to Object-oriented Programming

Programming Technique II

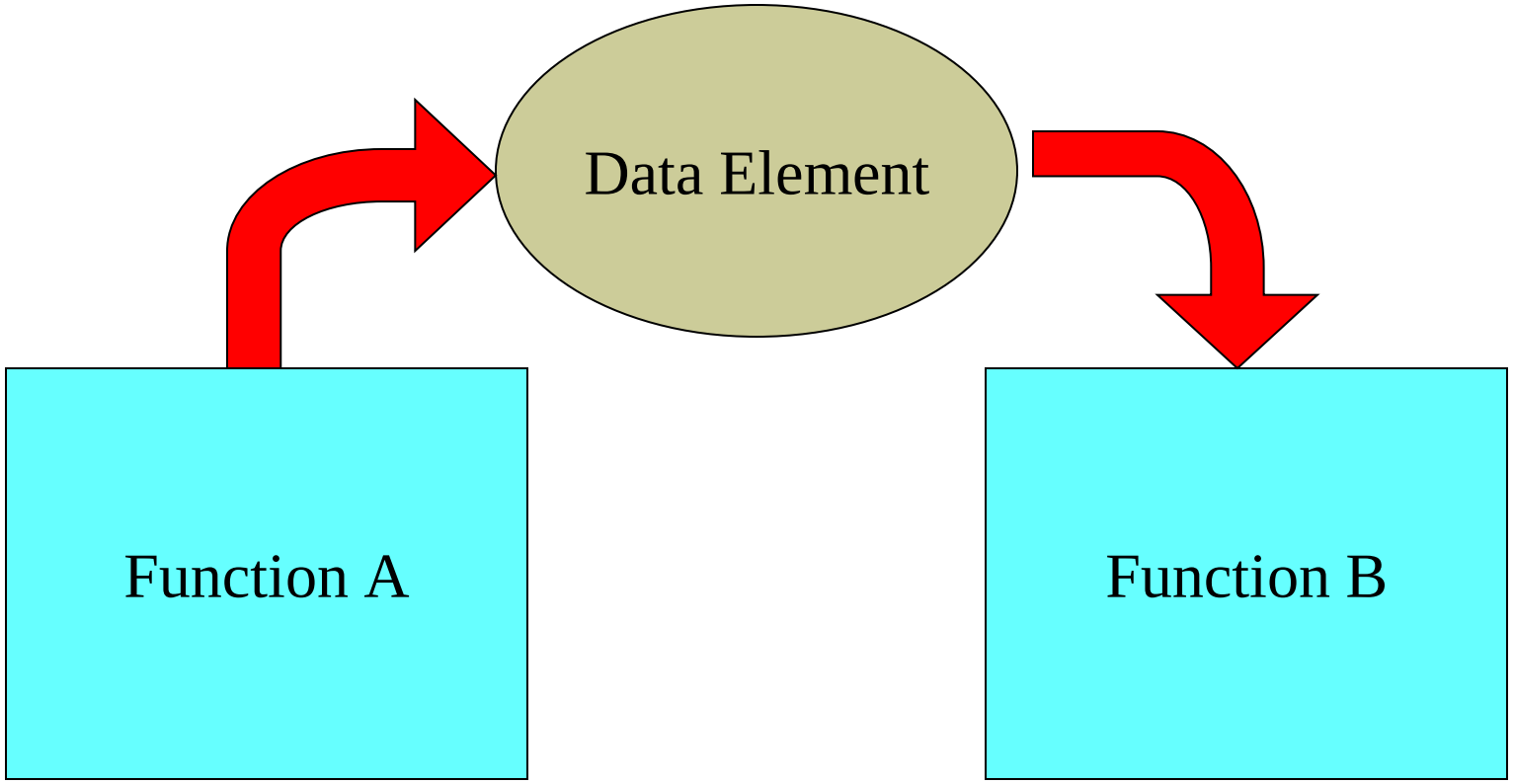
(SCSJ1023)

Adapted from Tony Gaddis and Barret Krupnow (2016), Starting out with C++: From Control Structures through Objects

Procedural Programming

- Traditional programming languages were procedural.
  - C, Pascal, BASIC, Ada and COBOL
- Programming in procedural languages involves choosing data structures (appropriate ways to store data), designing algorithms, and translating algorithm into code.
- In procedural programming, data and operations on the data are separated.
- This methodology requires sending data to procedure/functions

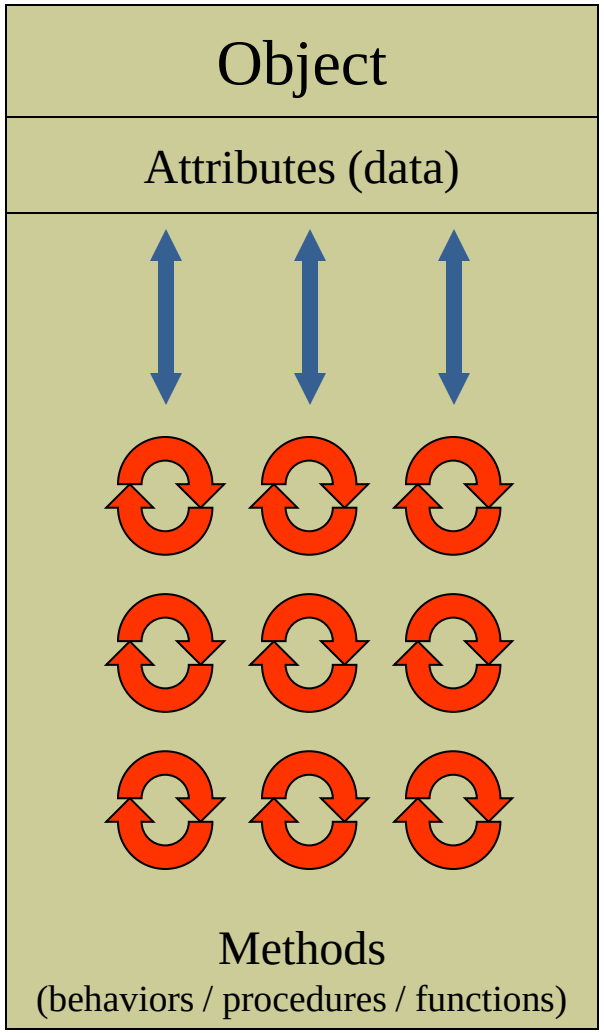
Procedural Programming



Object-Oriented Programming

- Object-oriented programming (OOP) is centered on **objects** rather than procedures / functions.
- Objects are a melding of **data and procedures** that manipulate that data.
- Data in an object are known as **properties** or **attributes** .
- Procedures/functions in an object are known as **methods**.

Object-Oriented Programming



Object Orientation Principle

- Divide-and-conquer
- Encapsulation and Modularity
- Public Interface
- Information Hiding
- Generality
- Extensibility
- Abstraction

Principles of Object Orientation

- Divide-and-Conquer Principle
  - The first step in designing a program is to divide the overall program into a number of objects that will interact with each other to solve the problem.
  - Problem solving: Break problems (programs) into small, manageable tasks.

Principles of Object Orientation

- Encapsulation Principle
  - The next step in designing a program is to decide for each object, what attribute it has and what actions it will take.
  - The goal is that each object is a self-contained module with a clear responsibility and the attributes and actions necessary to carry out its role.
  - Problem solving: Each object knows how to solve its task and has the information it needs.
  - For object to work cooperatively and efficiently, we have to clarify exactly how they are to interact, or interface, with one another.
  - Each object should present a clear public interface that determines how other objects will be used.

Principles of Object Orientation

- Information Hiding Principle
  - To enable objects to work together cooperatively, certain details of their individual design and performance should be hidden from other objects.
  - Each object should shield its users from unnecessary details of how it performs its role.

Principles of Object Orientation

- Generality Principle
  - To make an object as generally useful as possible, we design them not for a particular task but rather for a particular kind of task. This principle underlies the use of software libraries.
  - Objects should be designed to be as general as possible.
  - Objects are designed to solve a kind of task rather than a singular task.

Principles of Object Orientation

- Extensibility Principle
  - One of the strength of the object-oriented approach is the ability to extend an object's behavior to handle new tasks.
  - An object should be designed so that their functionality can be extended to carry out more specialized tasks.

Principles of Object Orientation

- Abstraction is the ability to focus on the important features of an object when trying to work with large amounts of information.

Benefits of Object-oriented programming

- Save development time (and cost) by reusing code
  - once an object class is created it can be used in other applications

- Easier debugging
  - classes can be tested independently
  - reused objects have already been tested

Self-test: Introduction to Object Oriented Programming

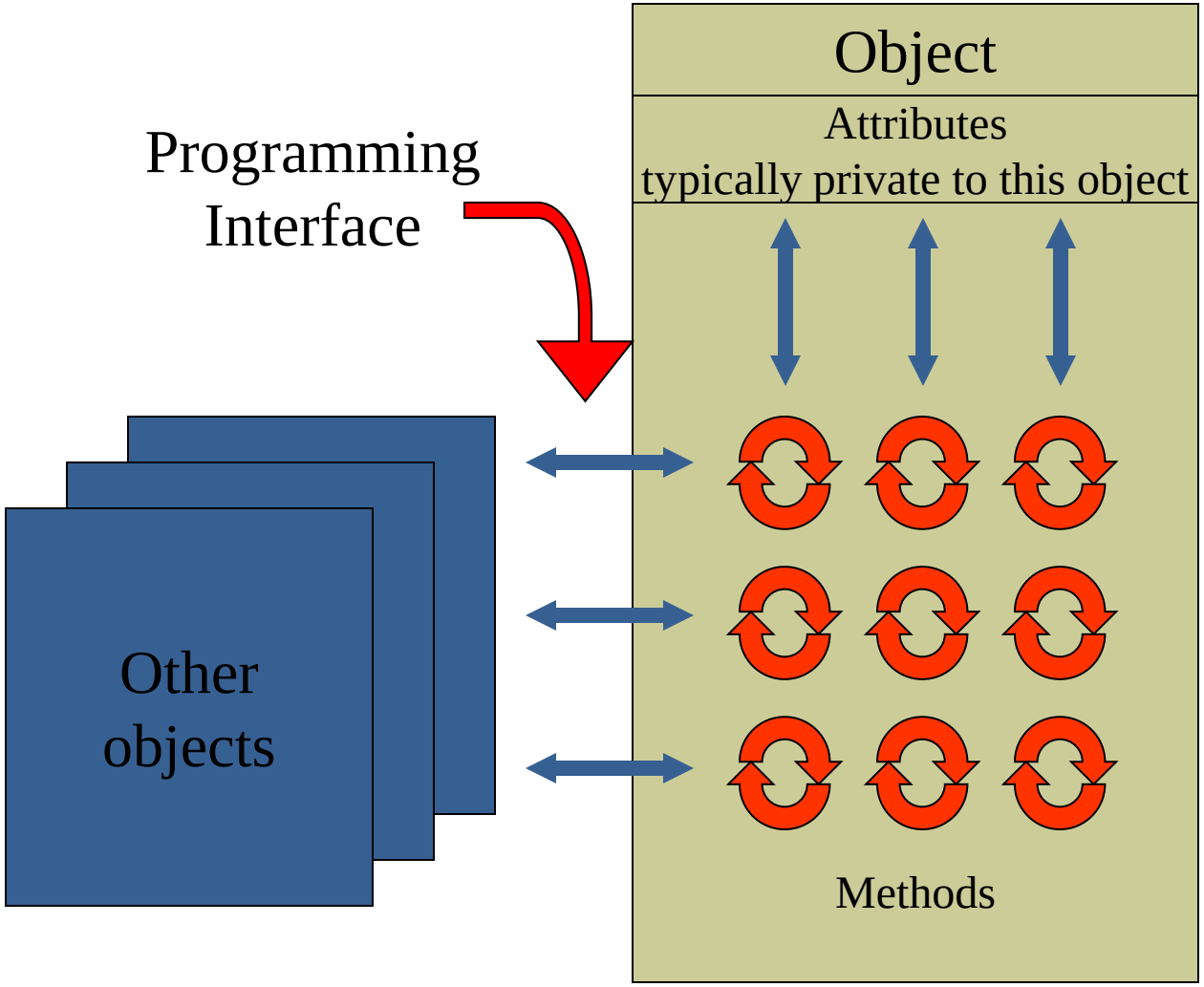
- What are the seven basic principles of object orientation? Provide a brief description of each.

- State the benefits of object oriented programming.

Object-Oriented Programming

- Object-oriented programming combines data and methods via **encapsulation**.
- **Data hiding** is the ability of an object to hide data from other objects in the program
- Only object's methods should be able to directly manipulate its attributes
- Other objects are allowed to manipulate object's attributes via the object's methods.
- This indirect access is known as a **programming interface**

Object-Oriented Programming



Object-Oriented Programming Languages

- Pure OO Languages
  - Smalltalk, Eiffel, Actor, Java
- Hybrid OO Languages
  - C++, Objective-C, Object-Pascal

OOP Principles: Classes

- A class is the **template** or mould or blueprint from which objects are actually made.

- A class **encapsulates** the attributes and actions that characterizes a certain type of object.

OOP Principles: Objects

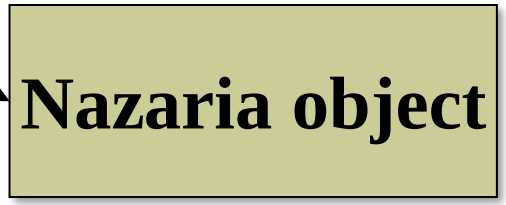
- Classes can be used to **instantiate** as many objects as are needed.
- Each object that is created from a class is called an **instance** of the class.
- A program is simply a collection of objects that interact with each other to accomplish a goal.

Classes and Objects

The *Car* class defines the attributes and methods that will exist in all objects that are instances of the class.

The Kancil object is an instance of the Car class.

The Nazaria object is an instance of the Car class.



OOP Principles: Encapsulation

- **Encapsulation** is a key concept in working with objects: **Combining attributes and methods** in one package and hiding the implementation of the data from the user of the object.

Encapsulation:

Attributes/data
+
Methods/functions = Class

Example:
a car has attributes and methods below.

Car
Attributes: model, cylinder capacity
Methods: move, accelerate

OOP Principles: Data Hiding

- **Data hiding** ensures methods **should not directly access** instance attributes in a class other than their own.

- Programs should interact with object attributes only through the object's methods.

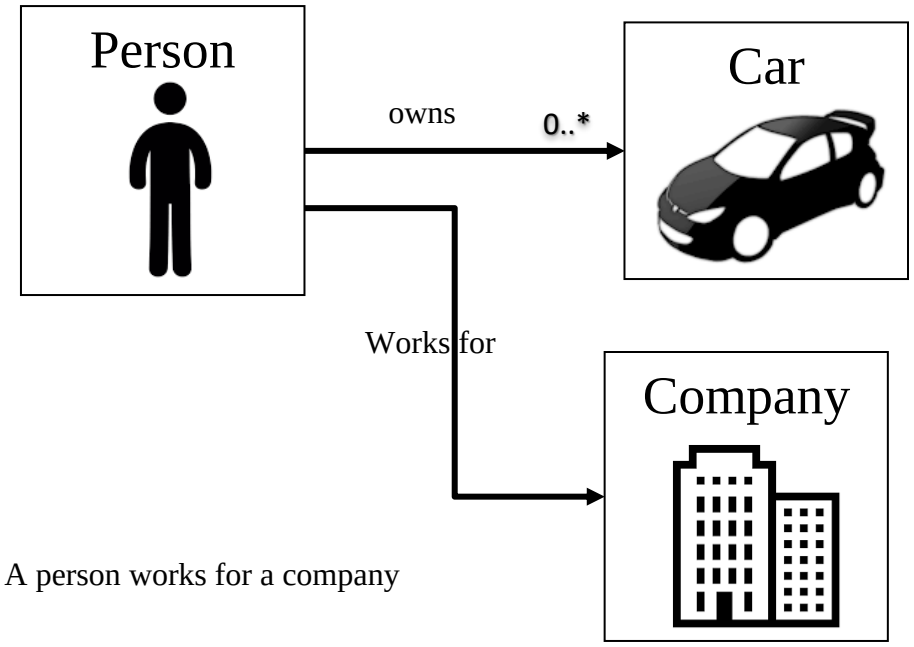
- Data hiding is important for several reasons.
  - It protects of attributes from accidental corruption by outside objects.
  - It hides the details of how an object works, so the programmer can concentrate on using it.
  - It allows the maintainer of the object to have the ability to modify the internal functioning of the object without “breaking” someone else's code.

OOP Principles: Associations

- **Association**: relates classes to each other through their objects.
- Association can be, one to one, one to many, many to one, or many to many relationships.

Example:

A person can own several cars



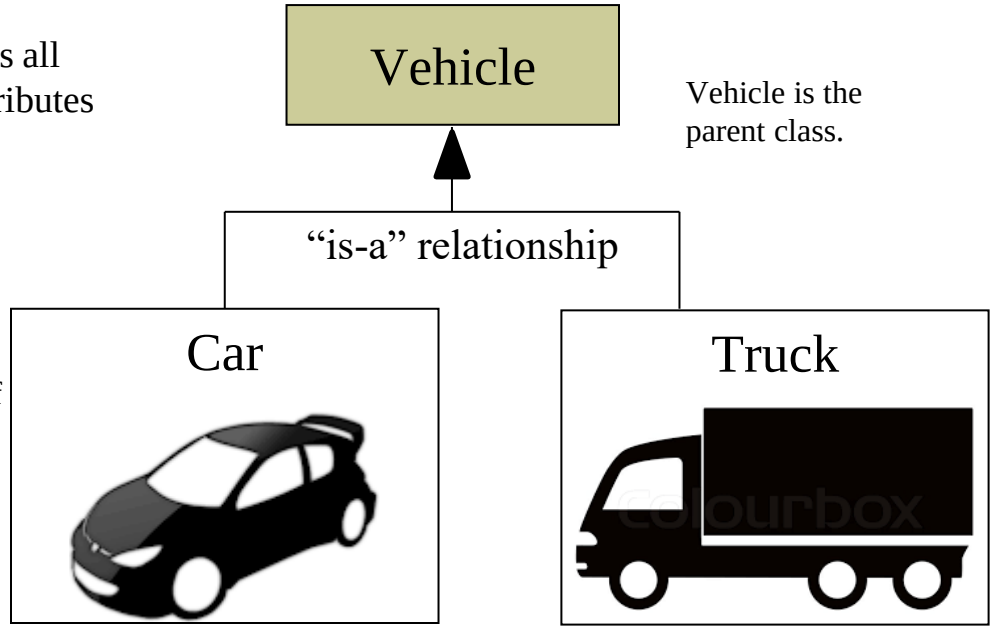
A person works for a company

OOP Principles: Inheritance

- Inheritance is the ability of one class to **extend** the capabilities of another.
  - it allows code defined in one class to be reused in other classes

Example:

Vehicle represents all of the generic attributes and methods of a vehicle.



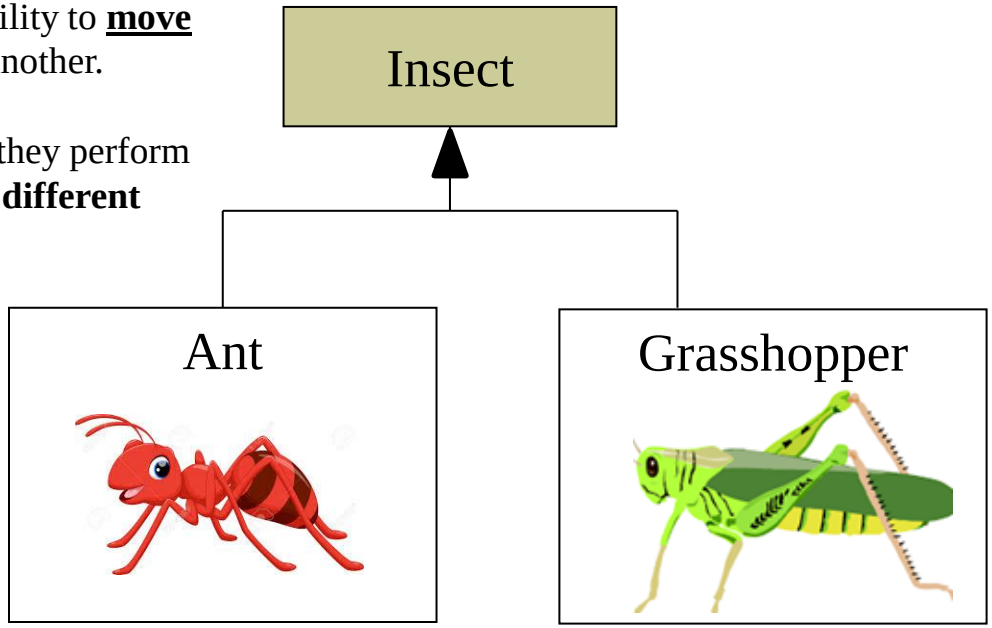
OOP Principles: Polymorphism

- Polymorphism is the ability of objects **performing the same actions differently**.

Example:

Insects have the ability to **move** from one point to another.

However, the way they perform their **movement is different**



Ants **move** by **crawling**

Grasshoppers **move** by **jumping**

Self-test: Introduction to Object Oriented Programming

- State the differences between procedural programming and Object Oriented Programming.
- What is an Object and what is a Class? What is the difference between them?
- What is an Attribute?
- What is a Method?
- What is encapsulation? How it relates to data hiding?
- What is association?
- What is inheritance? How it relates to polymorphism?

The Unified Modeling Language

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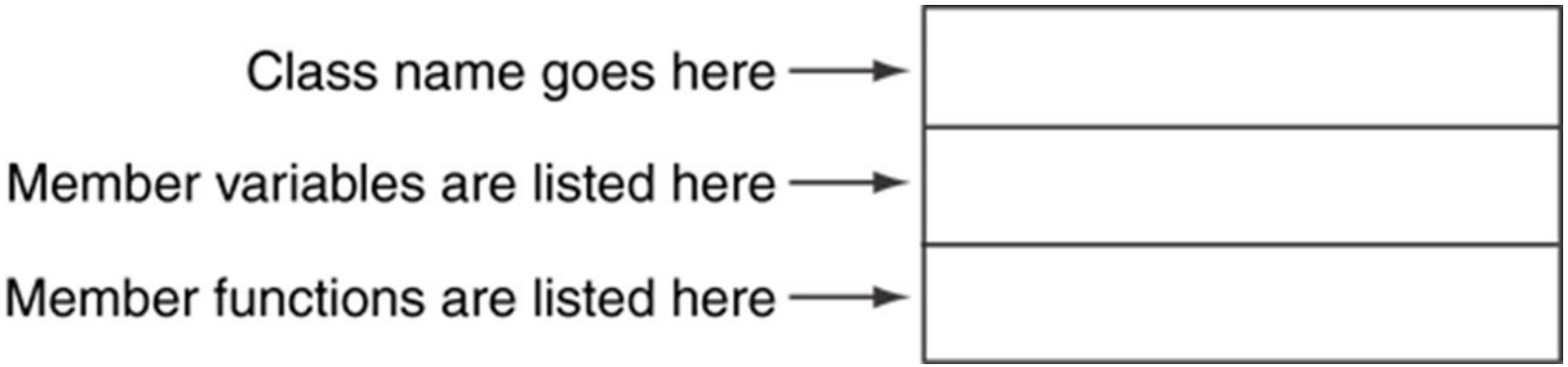
The Unified Modelling Language

- UML stands for Unified Modelling Language.

- The UML provides a set of standard diagrams for graphically depicting object-oriented systems

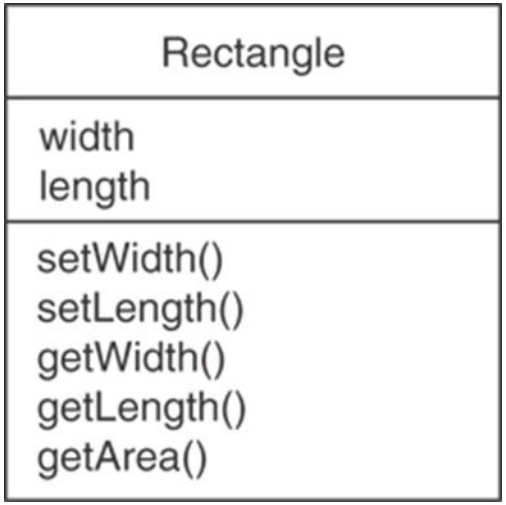
UML Class Diagram

- A UML diagram for a class has three main sections.



Example: A Rectangle Class

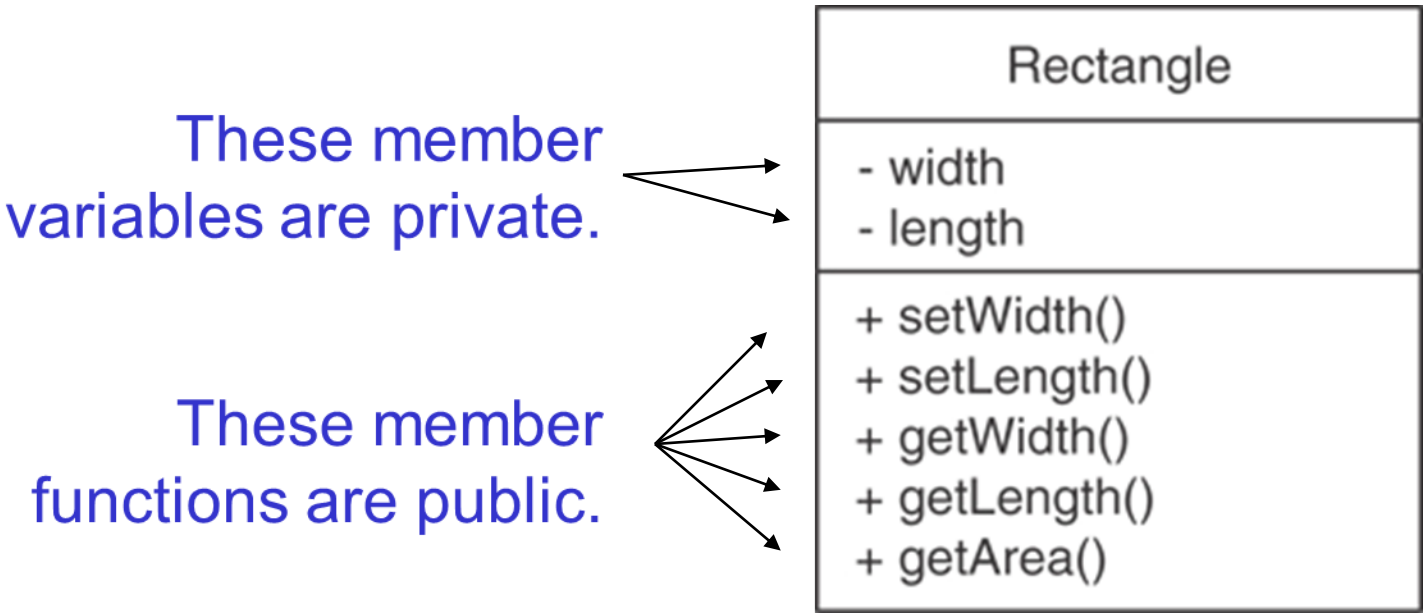
- A UML diagram for a class has three main sections.




```
class Rectangle
{
   private:
      double width;
      double length;
   public:
      bool setWidth(double);
      bool setLength(double);
      double getWidth() const;
      double getLength() const;
      double getArea() const;
};
```

UML Access Specification Notation

- In UML you indicate a private member with a minus (-) and a public member with a plus(+).



UML Data Type Notation

- To indicate the data type of a member variable, place a colon followed by the name of the data type after the name of the variable.

```
- width : double
- length : double
```

UML Parameter Type Notation

- To indicate the data type of a function's parameter variable, place a colon followed by the name of the data type after the name of the variable.

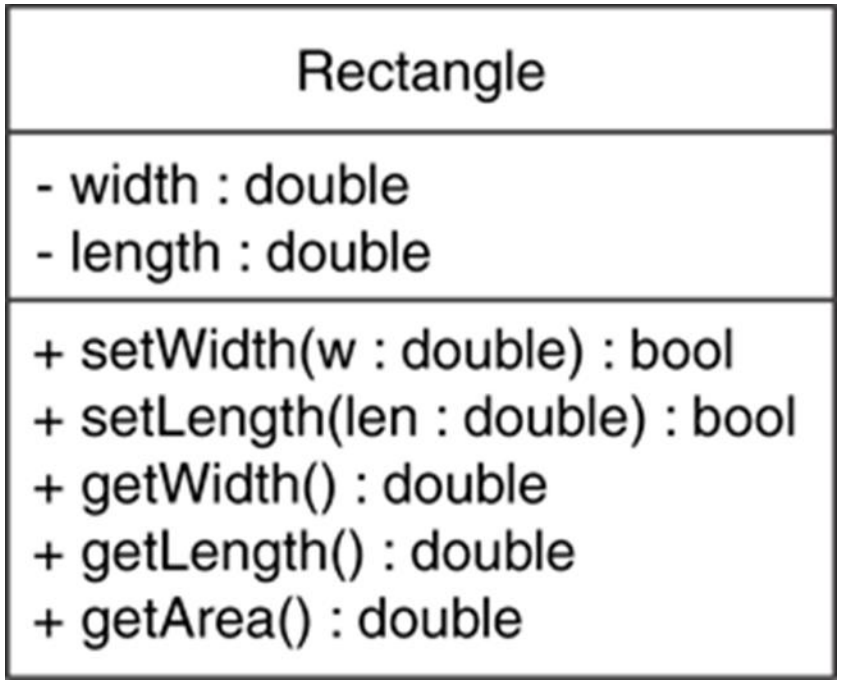
```
+ setWidth(w : double)
```

UML Function Return Type Notation

- To indicate the data type of a function's return value, place a colon followed by the name of the data type after the function's parameter list.

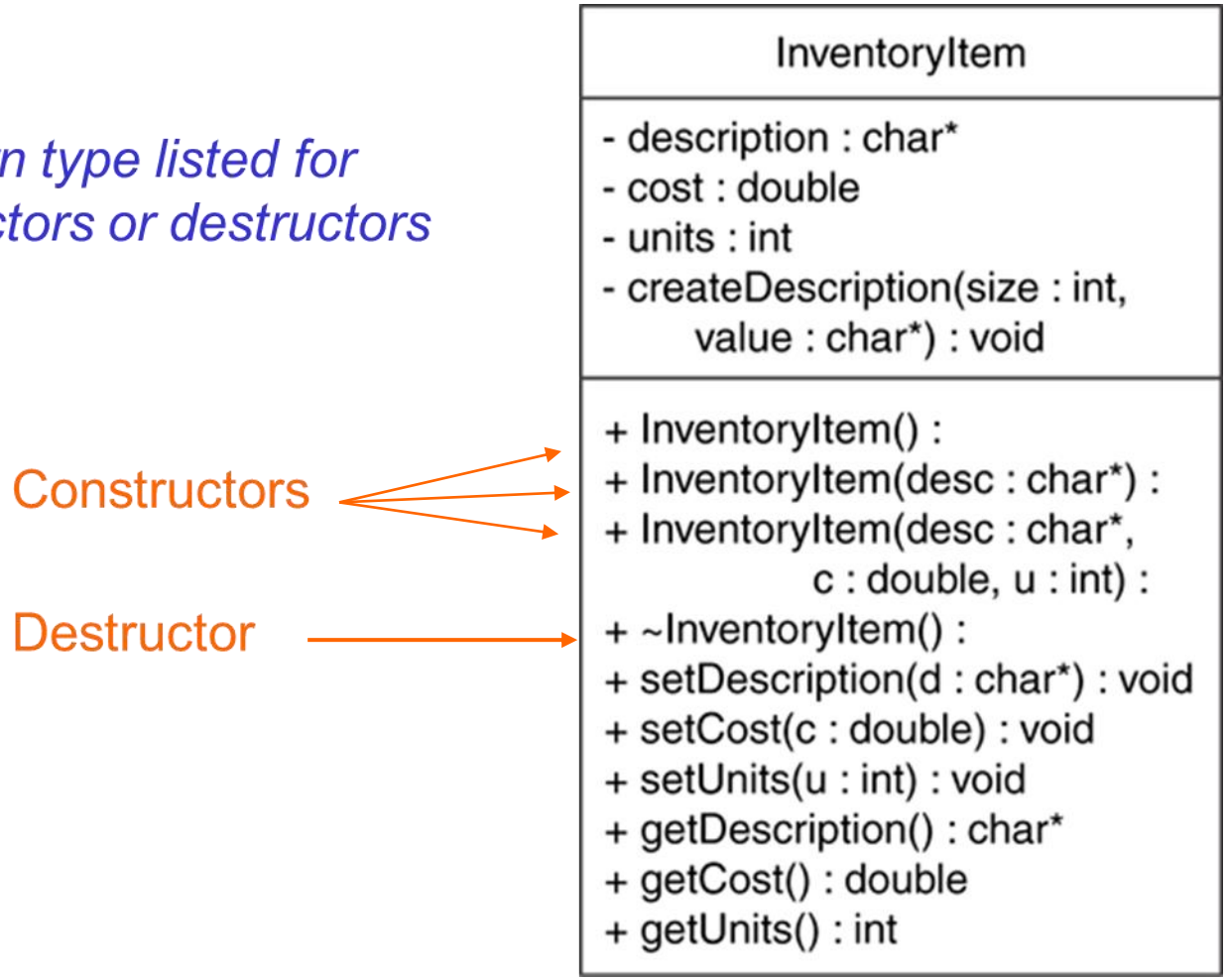
```
+ setWidth(w : double) : void
```

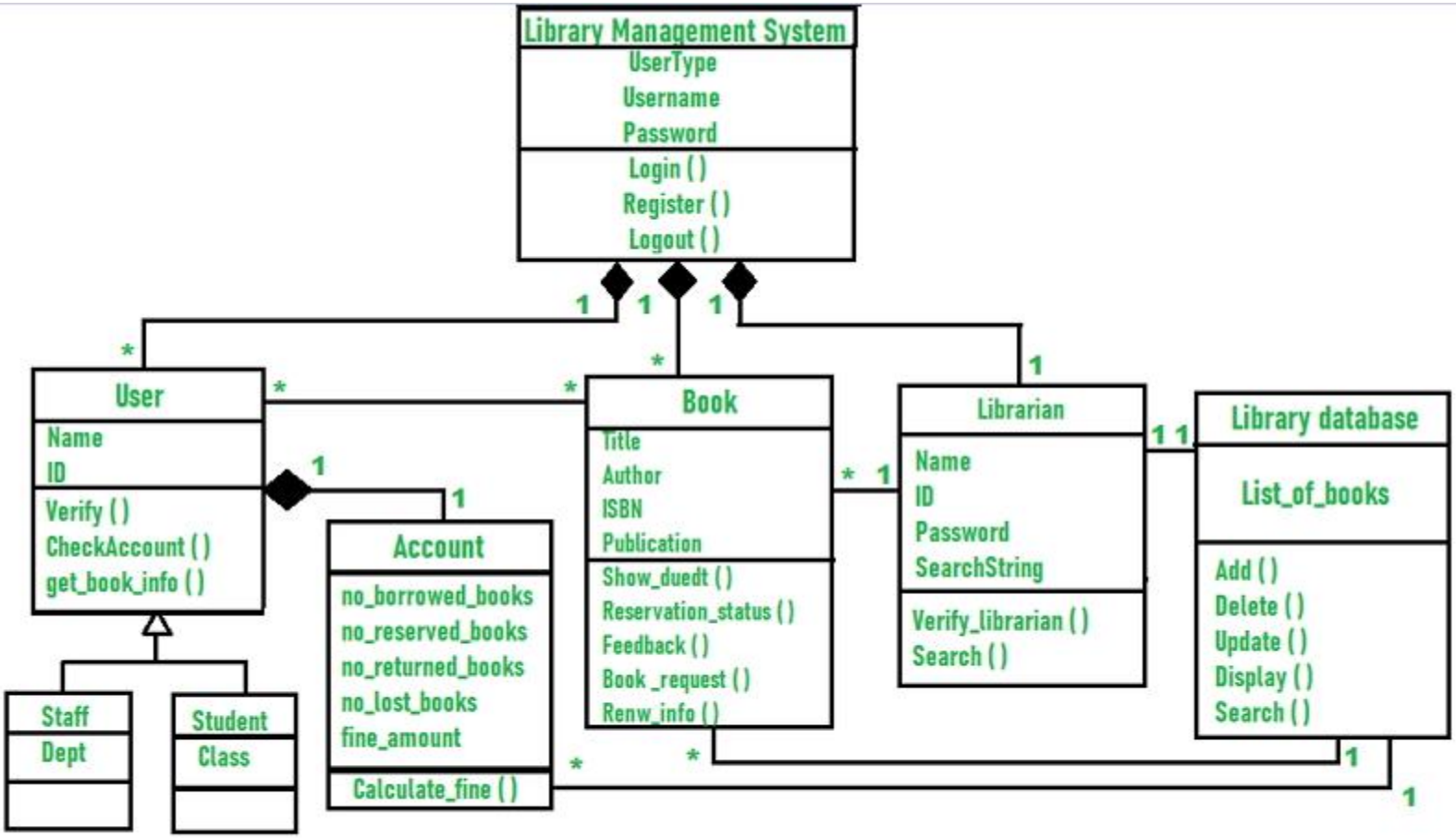
The Rectangle Class



Showing Constructors and Destructors

No return type listed for constructors or destructors





CLASS DIAGRAM FOR LIBRARY MANAGEMENT SYSTEM