Why Do We Need Object-Oriented Programming?

- Object-Oriented Programming was developed because limitations were discovered in earlier approaches to programming.
- To appreciate what OOP does, we need to understand what these limitations are and how they arose from traditional programming languages.

Procedure-Oriented Programming

- C, Pascal, FORTRAN, and similar languages are procedural languages.
- Each statement in the language tells the computer to do something:
  - get some input
  - add these numbers
  - divide by 6
  - display that output
- A program in a procedural language is a list of **instructions**.

Procedure-Oriented Programming

Division into Functions:

- Procedural program is divided into **functions**
- Each function has a clearly defined purpose and a clearly defined interface to the other functions in the program.
- The idea of breaking a program into functions can be further extended by grouping a number of functions together into a larger entity called a **module**.

Procedure-Oriented Programming

Division into Functions:

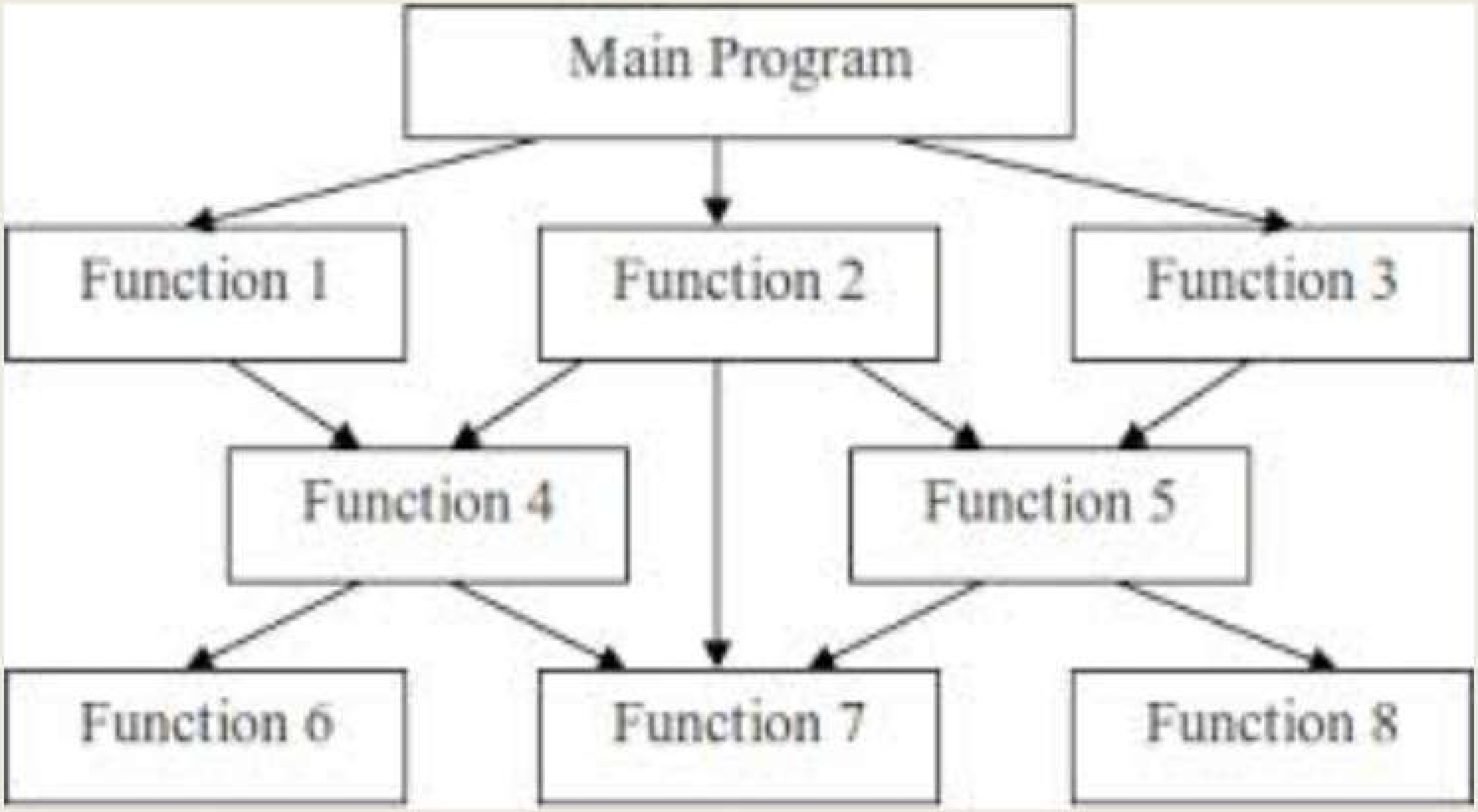


Fig 1: Structure of Procedure-Oriented Programming

Procedure-Oriented Programming

- In Multi-function program important data items are placed as **global** so that they may be accessed by all functions.
- Each function may have its own **local** data.

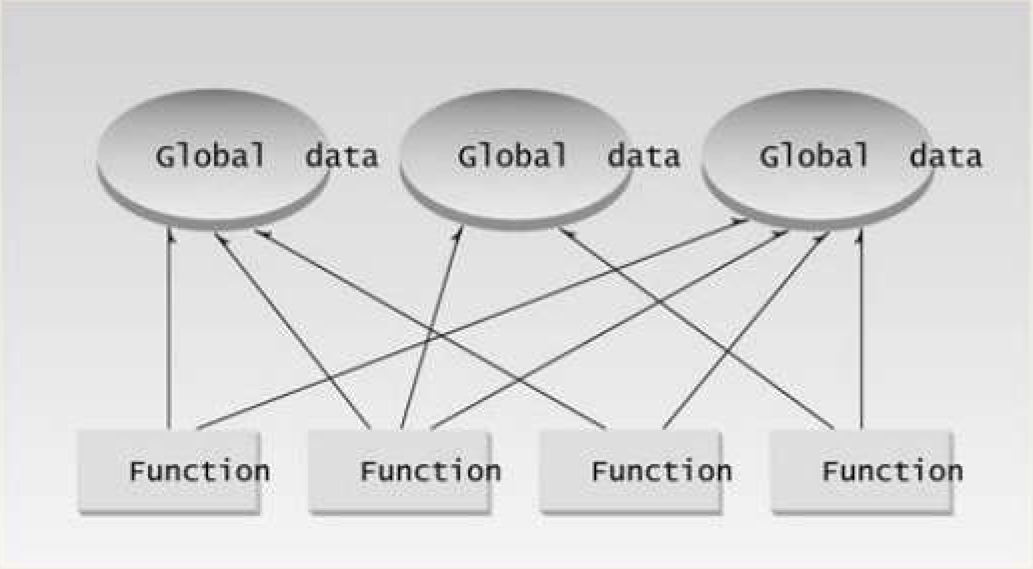


Fig 2: Procedural paradigm

Procedure-Oriented Programming

Drawbacks:

- Since every function has complete access to the global variables, the new programmer can corrupt the data accidentally by creating function.
- We can access the data of one function from other since, there is no protection.
- In large program it is very difficult to identify what data is used by which function.
- Similarly, if new data is to be added, all the function needed to be modified to access the data.
- Does not model real world problem very well.

Procedure-Oriented Programming

Characteristics:

- Emphasis is on doing things (algorithms).
- Large programs are divided into smaller programs known as **functions**.
- Most of the functions share **global** data.
- Data move openly around the system from function to function.
- Functions transform data from one form to another.
- Employs **top-down approach** in program design.

Top-Down Approach

- Top-down decomposition is the process of breaking the overall procedure or task into component parts (modules) and then subdivide each component module until the lowest level of detail has been reached.
- Example :The payroll system of a company can contain the following modules or tasks
  - Master file
  - Earnings
  - Deductions
  - Taxing
  - Net earning
  - Print reports

Object-Oriented Programming

- OOP was introduced to overcome flaws in the procedural approach to programming.
- Such as lack of reusability & maintainability.
- Fundamental idea behind object-oriented languages is to combine into a single unit both **data** and the **functions that operate on that data**.
- Such a unit is called an **object**.

Object-Oriented Programming

- In OOP, problem is divided into the number of entities called objects and then builds data and functions around these objects.
- It ties the data more closely to the functions that operate on it, and protects it from accidental modification from the outside functions.
- Data of an object can be accessed only by the functions associated with that object.
- Communication of the objects done through function.

Object-Oriented Programming

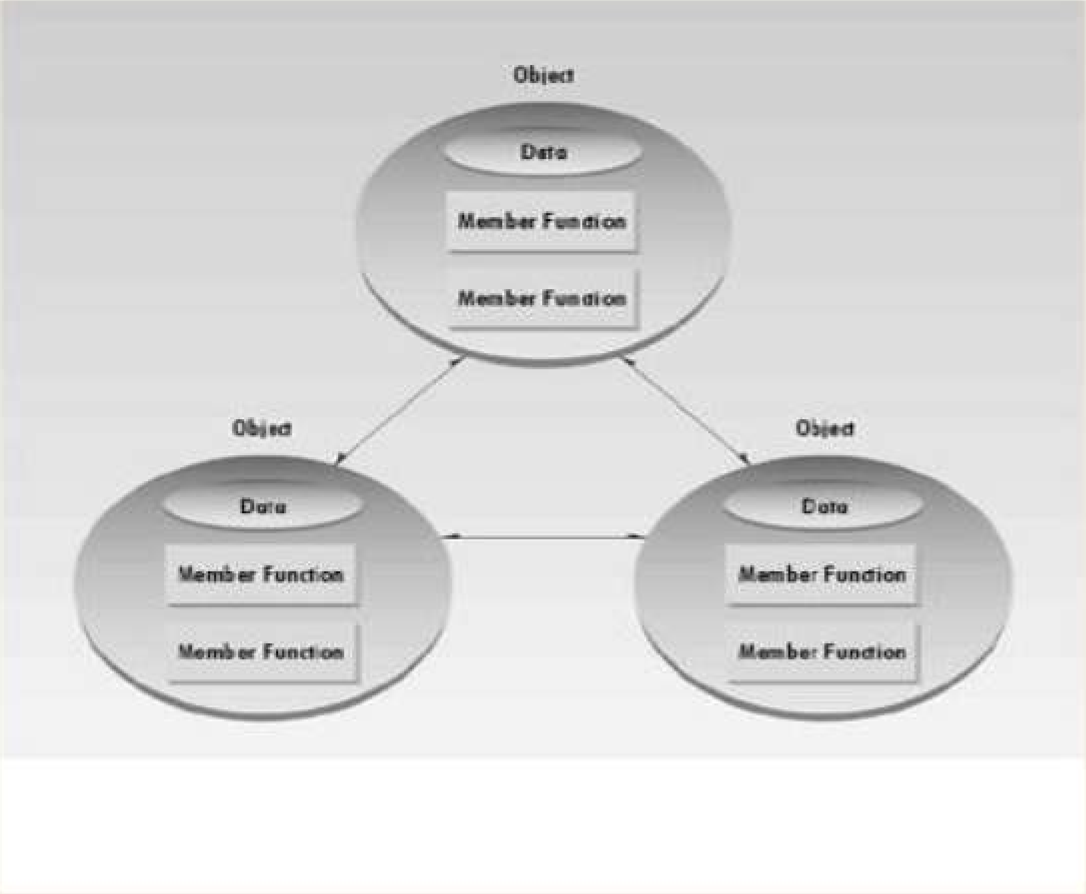


Fig 3: Object-Oriented paradigm

Object-Oriented Programming

Characteristics:

- Emphasis on data rather than procedure.
- Programs are divided into entities known as **objects**.
- Data Structures are designed such that they characterize objects.
- Functions that operate on data of an object are tied together in data structures.
- Data is hidden and cannot be accessed by external functions.
- Objects communicate with each other through functions.
- New data and functions can be easily added whenever necessary.
- Follows bottom up design in program design.

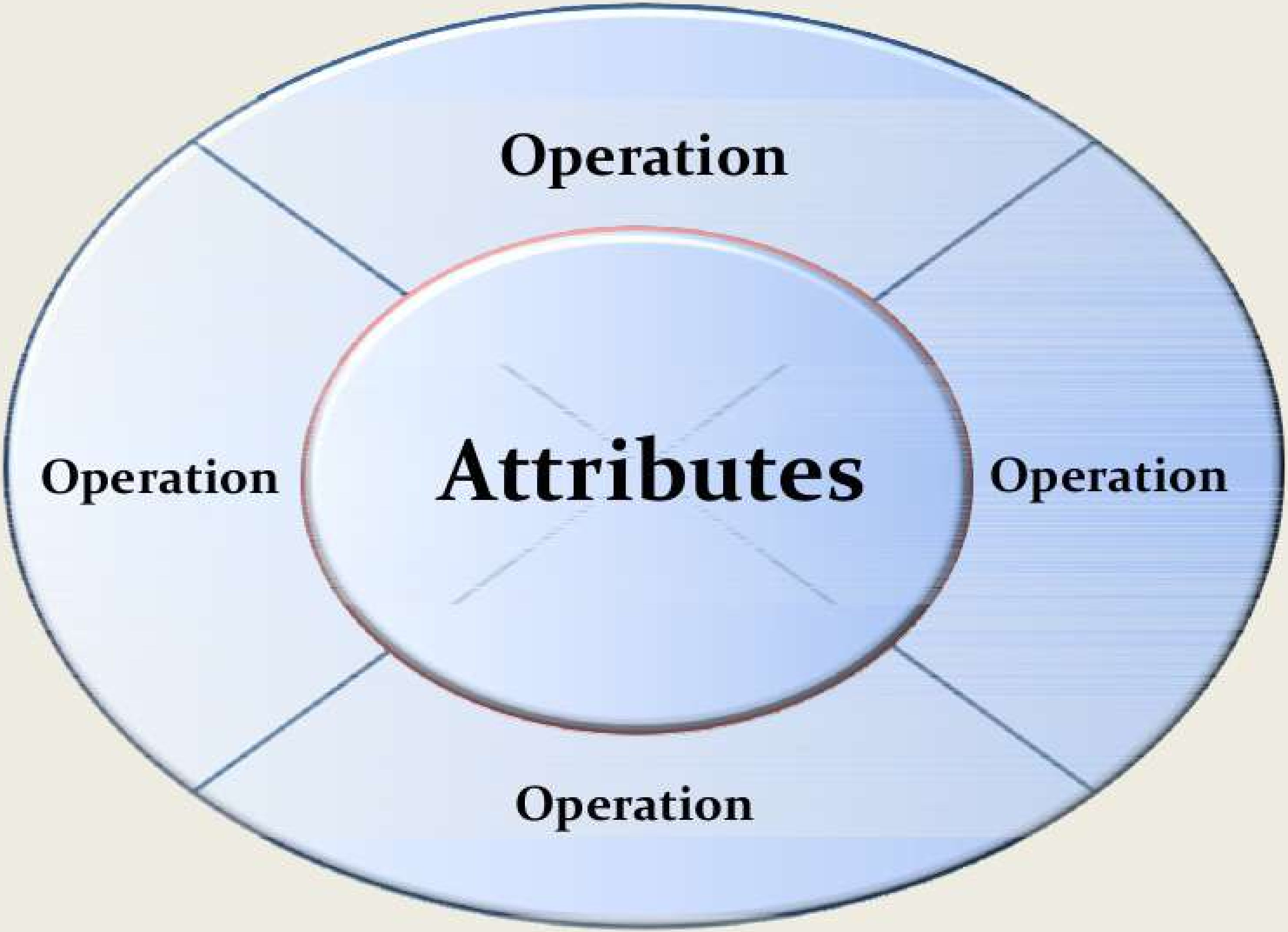
Bottom up approach

- Reverse top-down approach.
- Lower level tasks are first carried out and are then integrated to provide the solution of a single program.
- Lower level structures of the program are evolved first then higher level structures are created.
- It promotes code reuse.
- It may allow unit testing.

Basic Concepts of oops

1. Objects
2. Classes
3. Data Abstraction
4. Data Encapsulation
5. Inheritance
6. Polymorphism
7. Dynamic binding
8. Message Passing

Objects



Objects

- Objects are the basic run-time entities of an object oriented system.
- They may represent a person, a place or any item that the program must handle.
- Example:

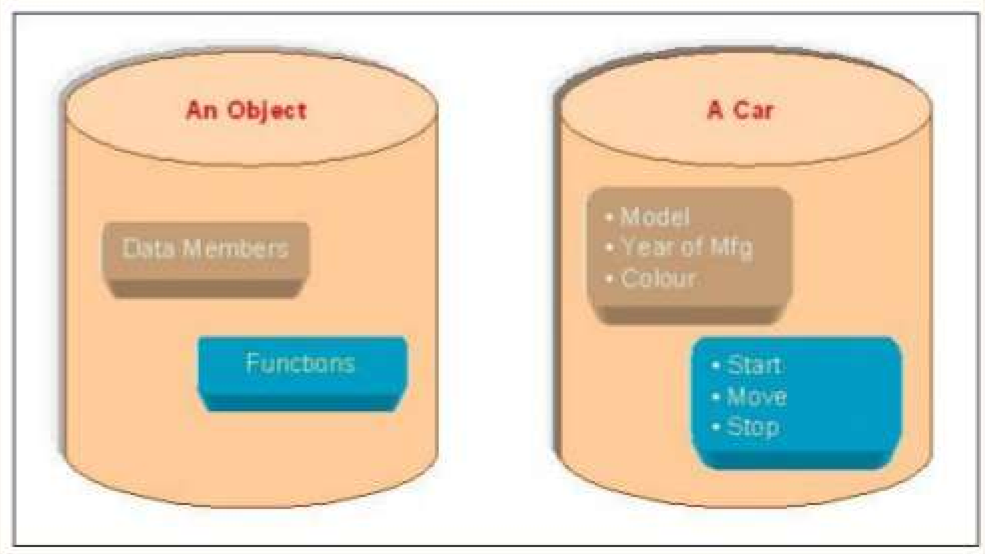
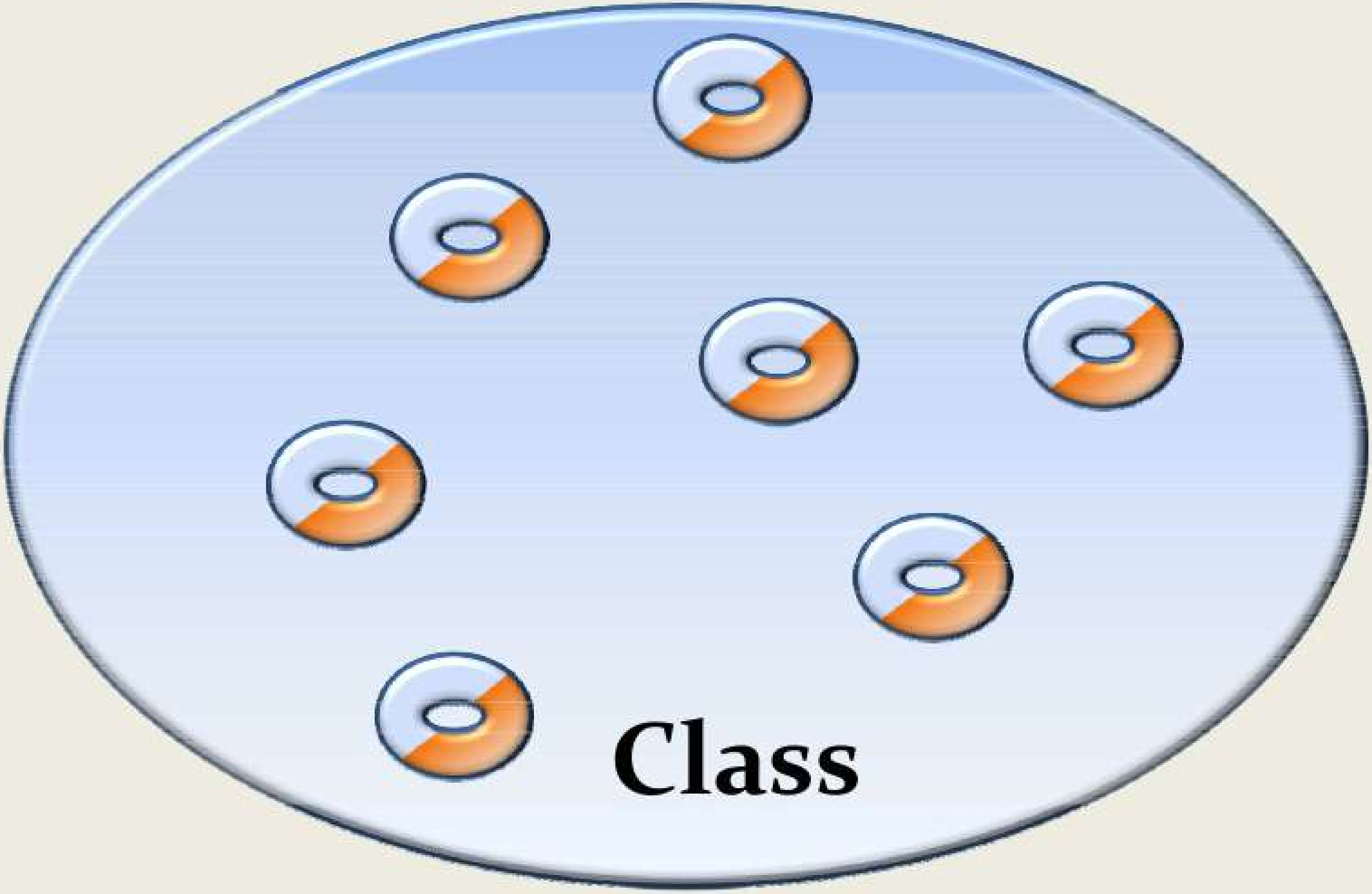


Fig 4: Representation of object.

Objects

- When a program is executed, the objects interact by sending messages to one another.
- For e.g. if “customer” and “account” are two objects in a program, then the customer object may send a message to the account object requesting for the bank balance.
- Each object contains data, and code to manipulate the data.

Classes



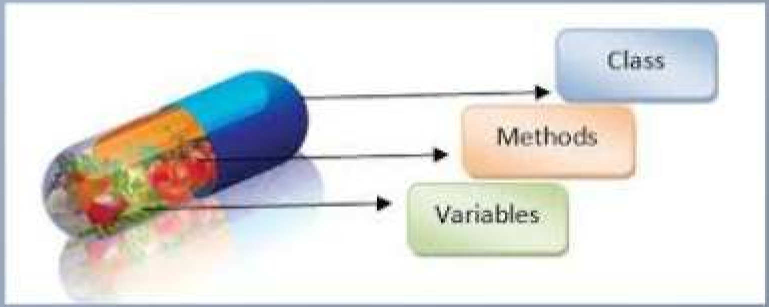
Classes

- Classes are user-defined data types and it behaves like built in types of programming language.
- Object contains code and data which can be made user define type using class.
- Objects are variables of class.
- Once a class has been defined we can create any number of objects for that class.
- A class is collections of objects of similar type.

Classes

- We can create object of class using following syntax,
- Syntax: `class-name object-name;`
- Here class name is class which is already created. Object name is any user define name. For example, if Student is class,
- Example: `Student ram, sham;`
- In example ram and sham are name of objects for class Student. We can create any number of objects for class.

Encapsulation



Encapsulation

- Encapsulation is the first pillar or principle of object-oriented programming.
- In simple words, “Encapsulation is a process of binding data members (variables, properties) and member functions (methods) into a single unit”.
- And Class is the best example of encapsulation.

Encapsulation

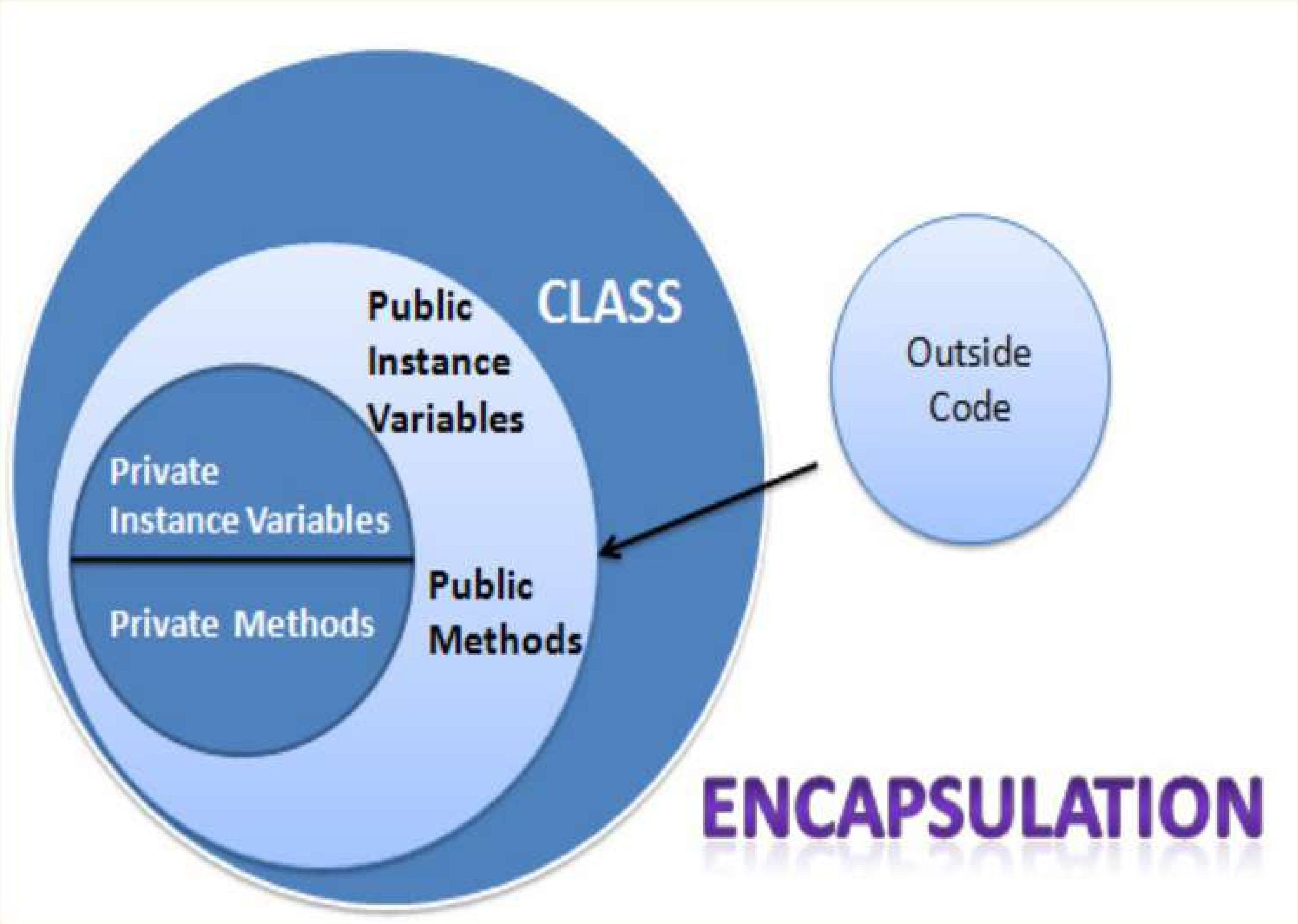
- For example: Medical store
- Lets say you have to buy some medicines. You go to the medical store and ask the chemist for the medicines.
- Only the chemist has access to the medicines in the store based on your prescription.
- The chemist knows what medicines to give to you.
- This reduces the risk of you taking any medicine that is not intended for you.

Encapsulation

In this example,

- MEDICINES → Member Variables.
- CHEMIST → Member Methods.
- You → External Application or piece of Code.

Encapsulation



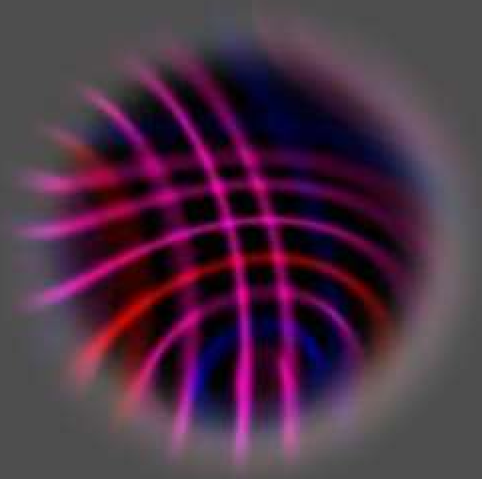
Encapsulation

- Through Encapsulation, Data is not accessible to the outside world, and only those functions which are wrapped in the class can access it.
- Encapsulation solves the problem at the implementation level.
- A class can specify how accessible each of its members (variables, properties, and methods) is to code outside of the class.

Encapsulation

- So encapsulation means hiding the important features of a class which is not been needed to be exposed outside of a class and exposing only necessary things of a class.
- Here hidden part of a class acts like Encapsulation and exposed part of a class acts like Abstraction.

Abstraction



Abstraction

- Abstraction refers representation of necessary features without including more details or explanations.
- Data abstraction is a programming (and design) technique that relies on the separation of interface and implementation.

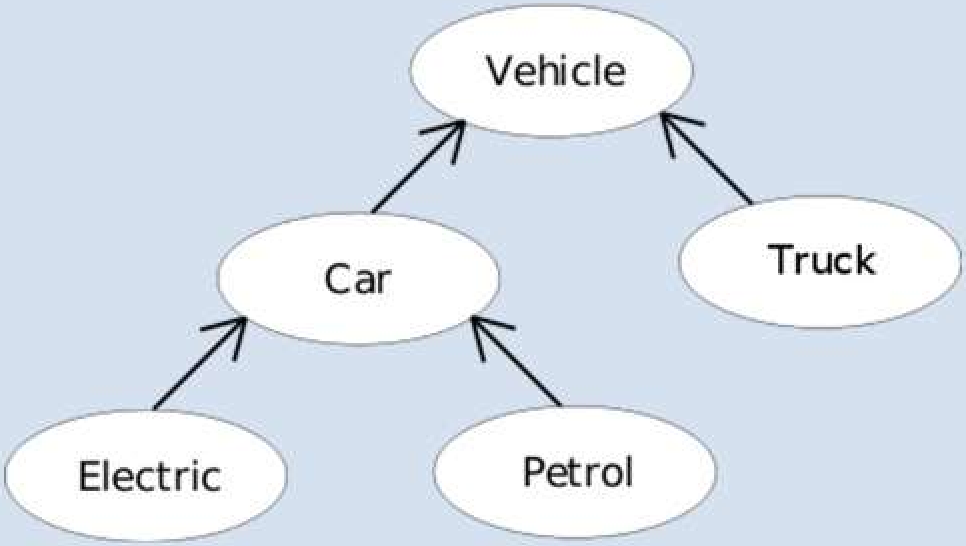
Abstraction

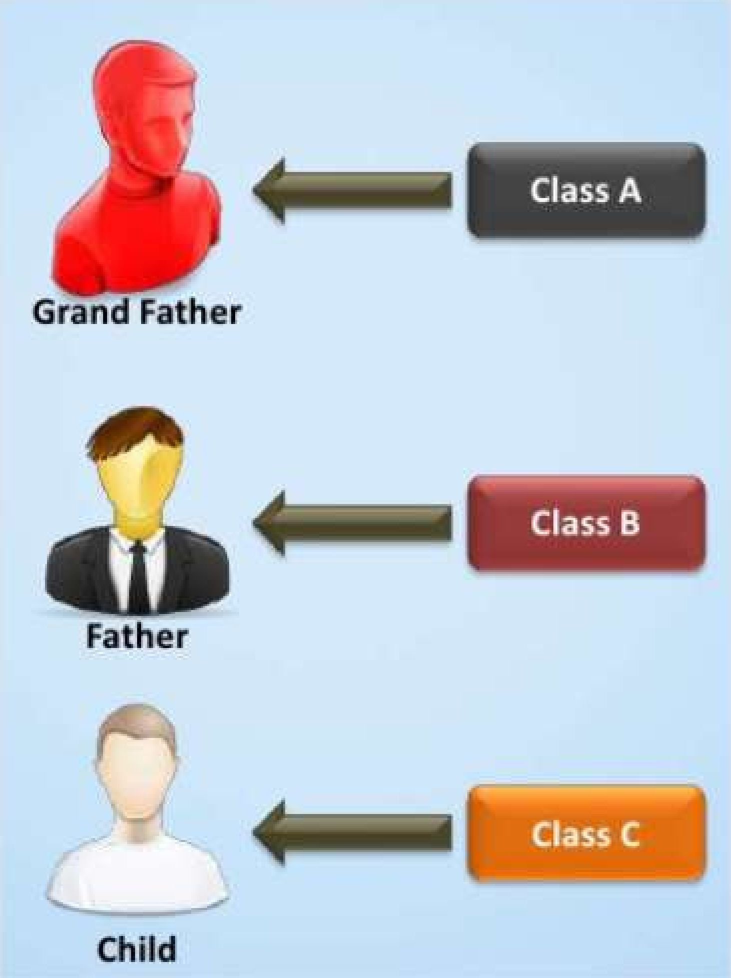
- When you **press a key on your keyboard the character appears on the screen,** you need to know only this, but How exactly it works based on the electronically is not needed.
- This is called **Abstraction**.

Abstraction

- Another Example is when you use the **remote control of your TV**, you do not bother about how pressing a key in the remote changes the channel on the TV. You just know that pressing the + volume button will increase the volume!

Inheritance





Inheritance

- The mechanism of deriving a new class from an old class is called inheritance or derivation.
- The old class is known as base class while new class is known as derived class or sub class.
- The inheritance is the most powerful features of OOP.

Inheritance

- For Example:
- Consider an example of family of three members having a mother, father & son named Jack.
- Jack father : tall and dark
- Jack Mother : Short and fair
- Jack is tall and fair, so he is said to have inherited the features of his father and mother resp.

Inheritance

- Through effective use of inheritance, you can save lot of time in your programming and also reduce errors
- Which in turn will increase the quality of work and productivity.

Inheritance

The different types of Inheritance are:

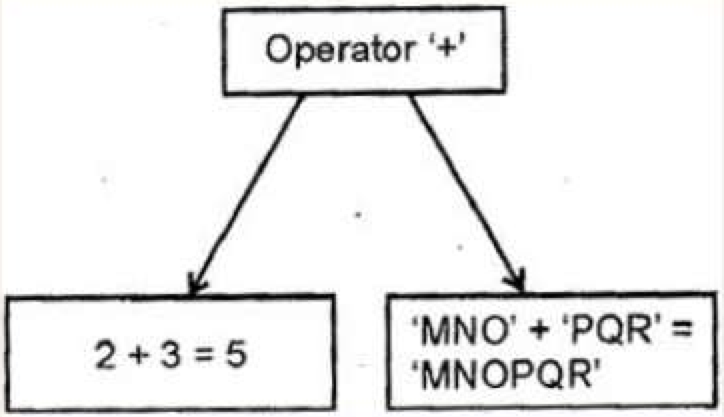
1. Single Inheritance
2. Hierarchical Inheritance
3. Multiple Inheritance
4. Multi Level Inheritance

- We will explain all of the above in detail later when we cover Inheritance.

Polymorphism

Polymorphism

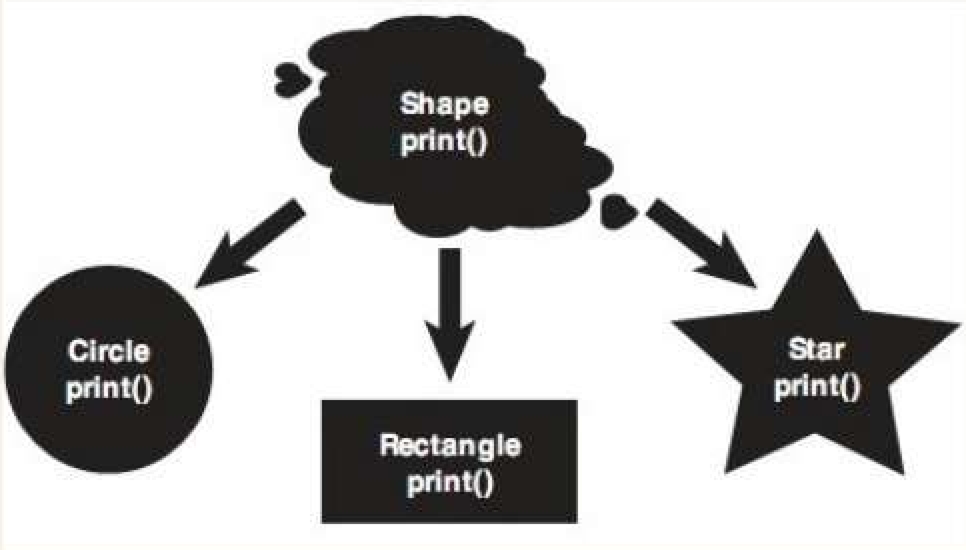
- Polymorphism is a Greek term which means ability to take more than one form.
- For example, + is used to make sum of two numbers as well as it is used to combine two strings.



- This is known as operator overloading because same operator may behave differently on different instances.

Polymorphism

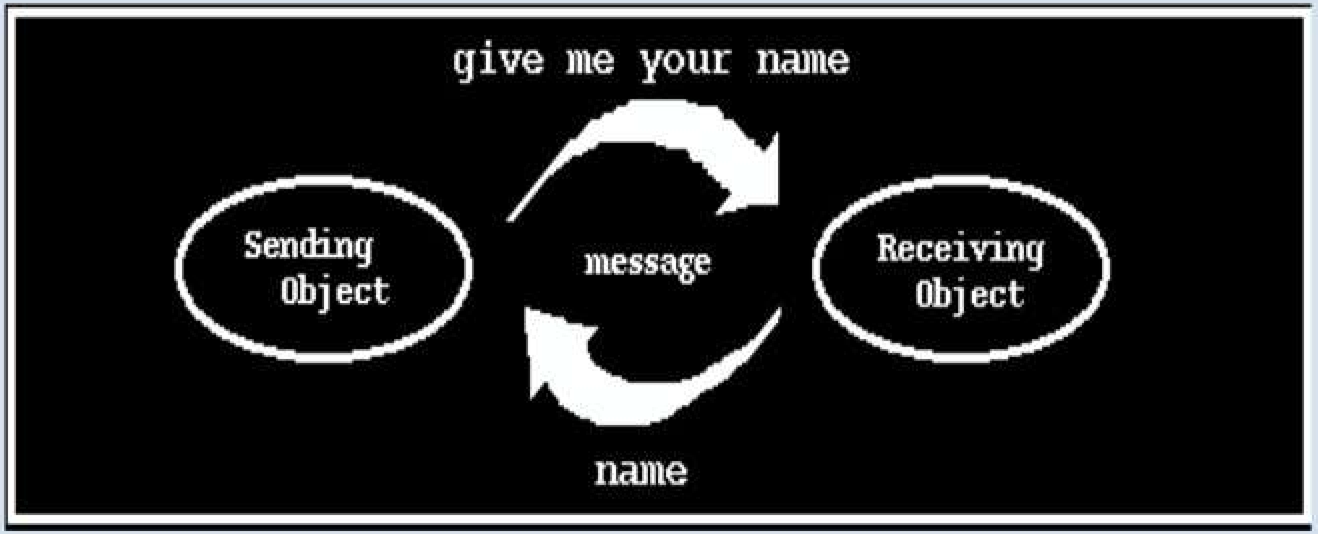
- Same way functions can be overloaded.
- For example, sum () function may takes two arguments or three arguments etc. i.e. sum (5, 7) or sum (4, 6, 8).
- Single function print() draws different objects.



Dynamic binding

- Binding means link between procedure call and code to be execute.
- It is the process of linking of a function call to the actual code of the function at run-time.
- That is, in dynamic binding, the actual code to be executed is not known to the compiler until run-time.
- It is also known late binding.

Message Passing

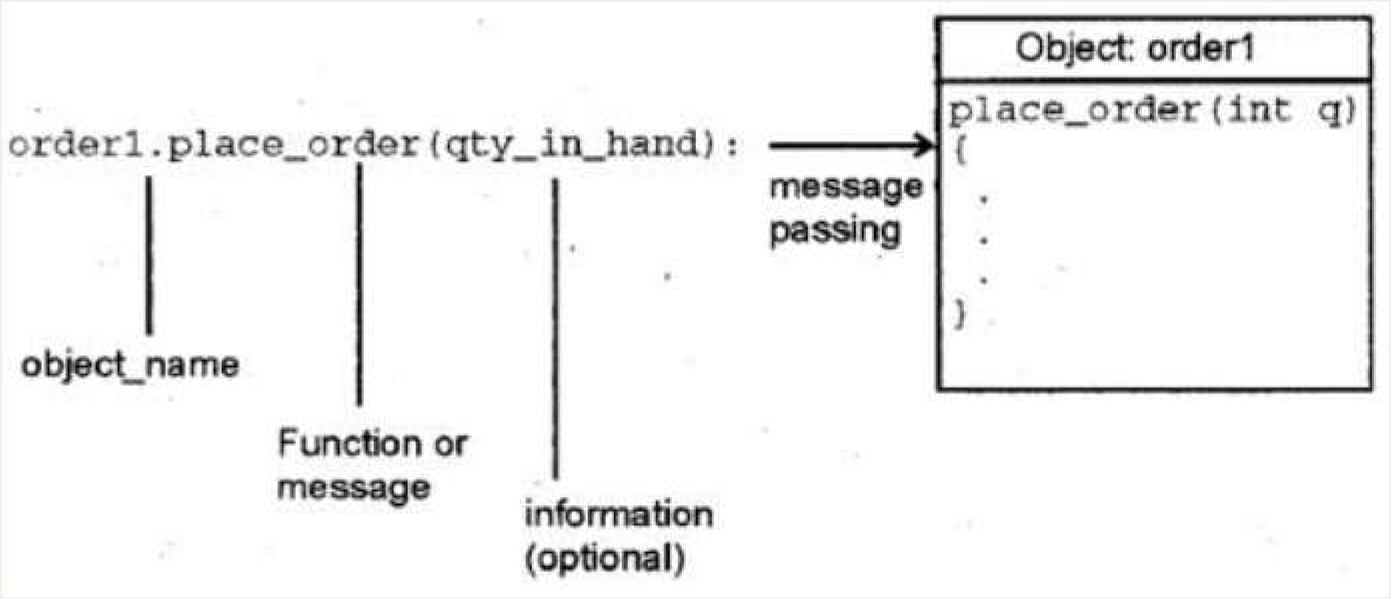


Message Passing

- Objects can communicate with each others by passing message same as people passing message with each other.
- Objects can send or receive message or information.
- Message passing involves the following basic steps:
  - Creating classes that define objects & their behavior.
  - Creating objects from class definitions.
  - Establishing communication among objects.
- Concept of message passing makes it easier to talk about building systems that directly model or simulate their real-world counterparts.

Message Passing

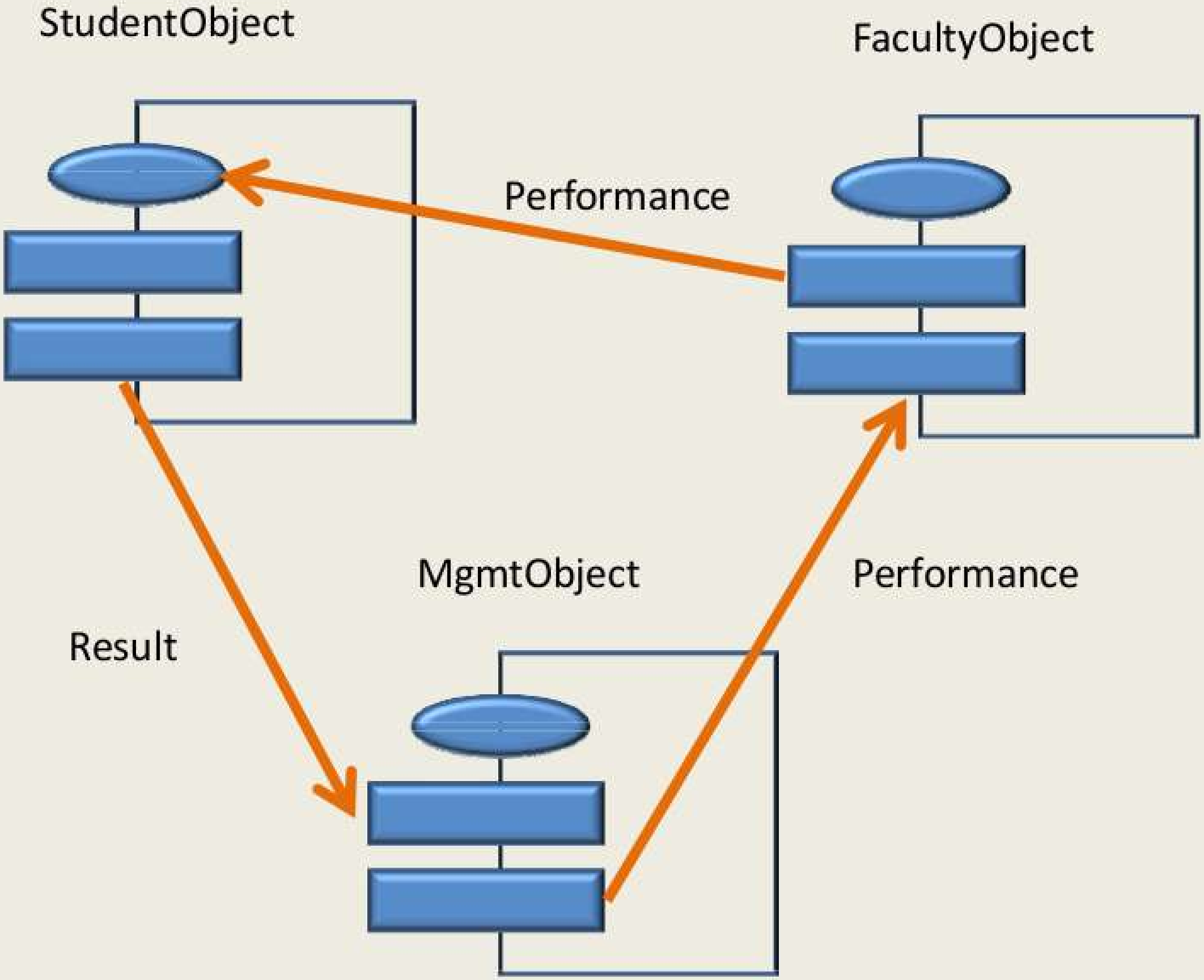
- For example, consider two classes *Product* and *Order*. The object of the *Product* class can communicate with the object of the *Order* class by sending a request for placing order.



```
order1.place_order(qty_in_hand):
```

```
place_order(int q)
{
 .
 .
 .
}
```

Message Passing



Benefits of OOP

- User can create new data type or users define data type by making class.
- Code can be reuse by using inheritance.
- Data can be hiding from outside world by using encapsulation.
- Operators or functions can be overloaded by using polymorphism, so same functions or operators can be used for multitasking.

Benefits of OOP

- Object oriented system can be easily upgrade from small system to large system.
- It is easy to partition work for same project.
- Message passing techniques make communication easier.
- Software complexity can be easily managed.
- Maintenances cost is less.
- Simple to implement.

Areas for applications of OOP

- Real time systems
- Simulation and modeling
- Object oriented database
- Hypertext, hypermedia and expertext
- AI and expert systems
- Neural network and parallel programming
- Decision support system
- Office automation system
- CIM / CAM / CAD systems

TO BE CONTINUED...