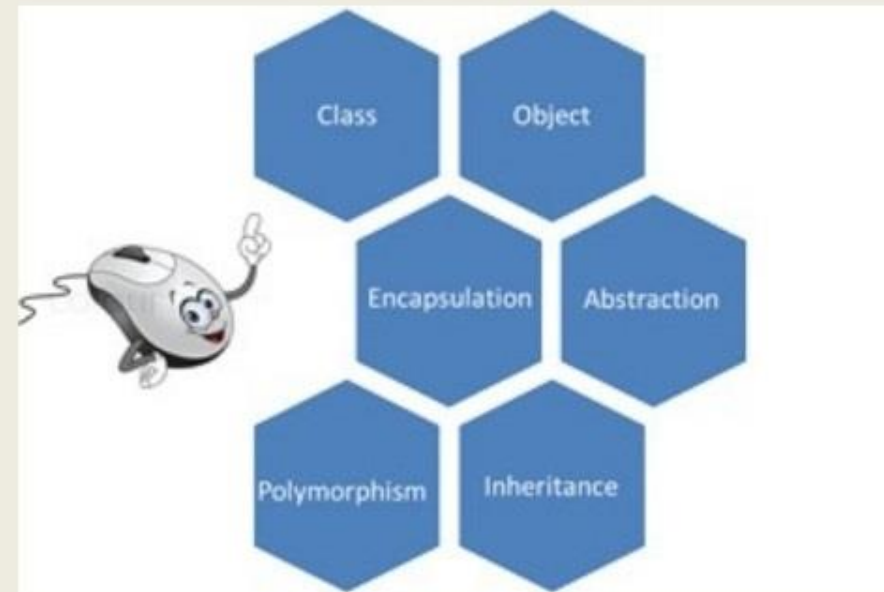


Introduction to Object-Oriented Programming



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:

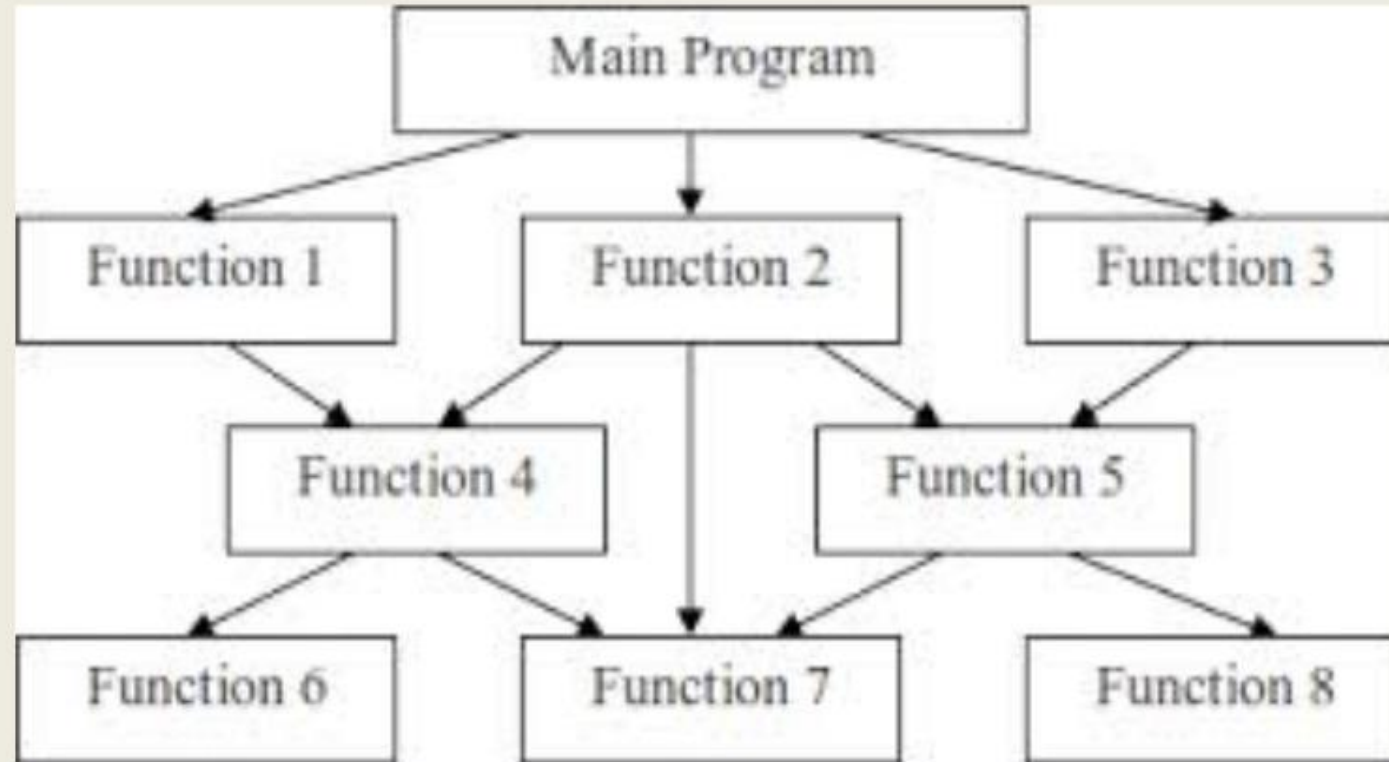


Fig 1: Structure of Procedure-Oriented Programming

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.

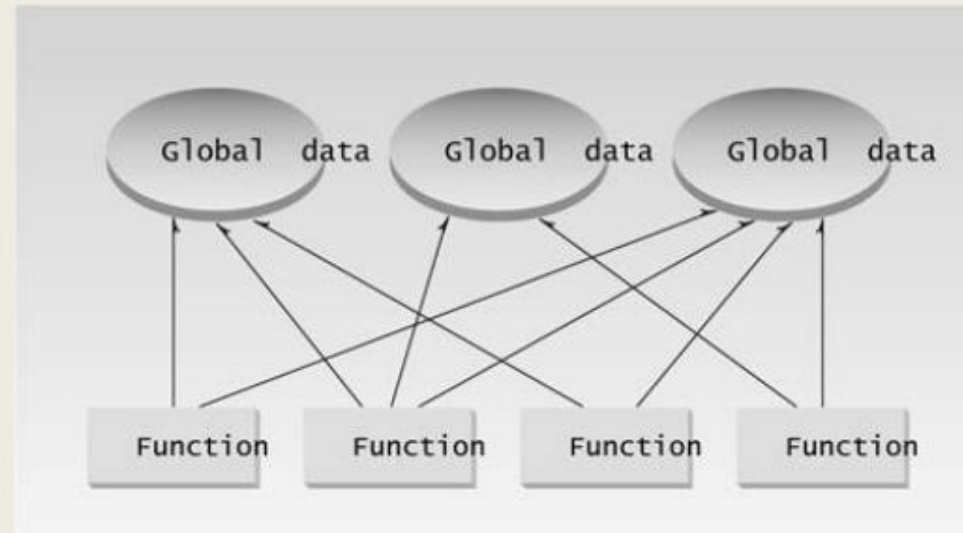


Fig 2: Procedural paradigm

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

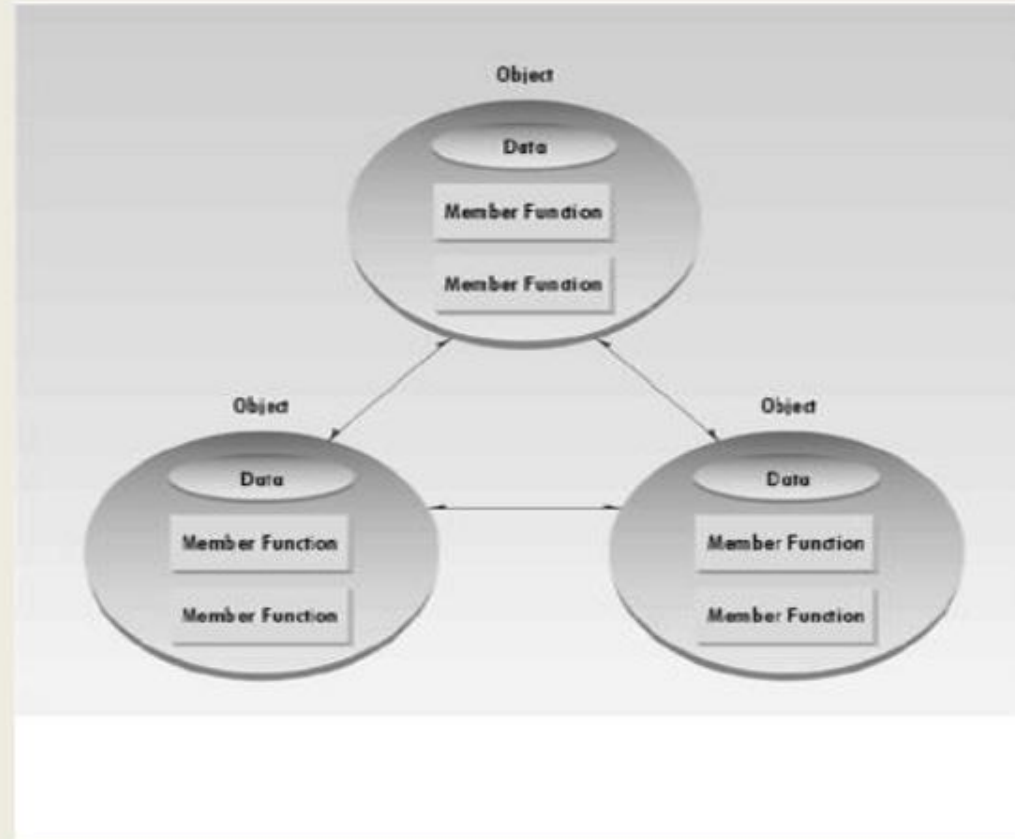


Fig 3: Object-Oriented paradigm

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

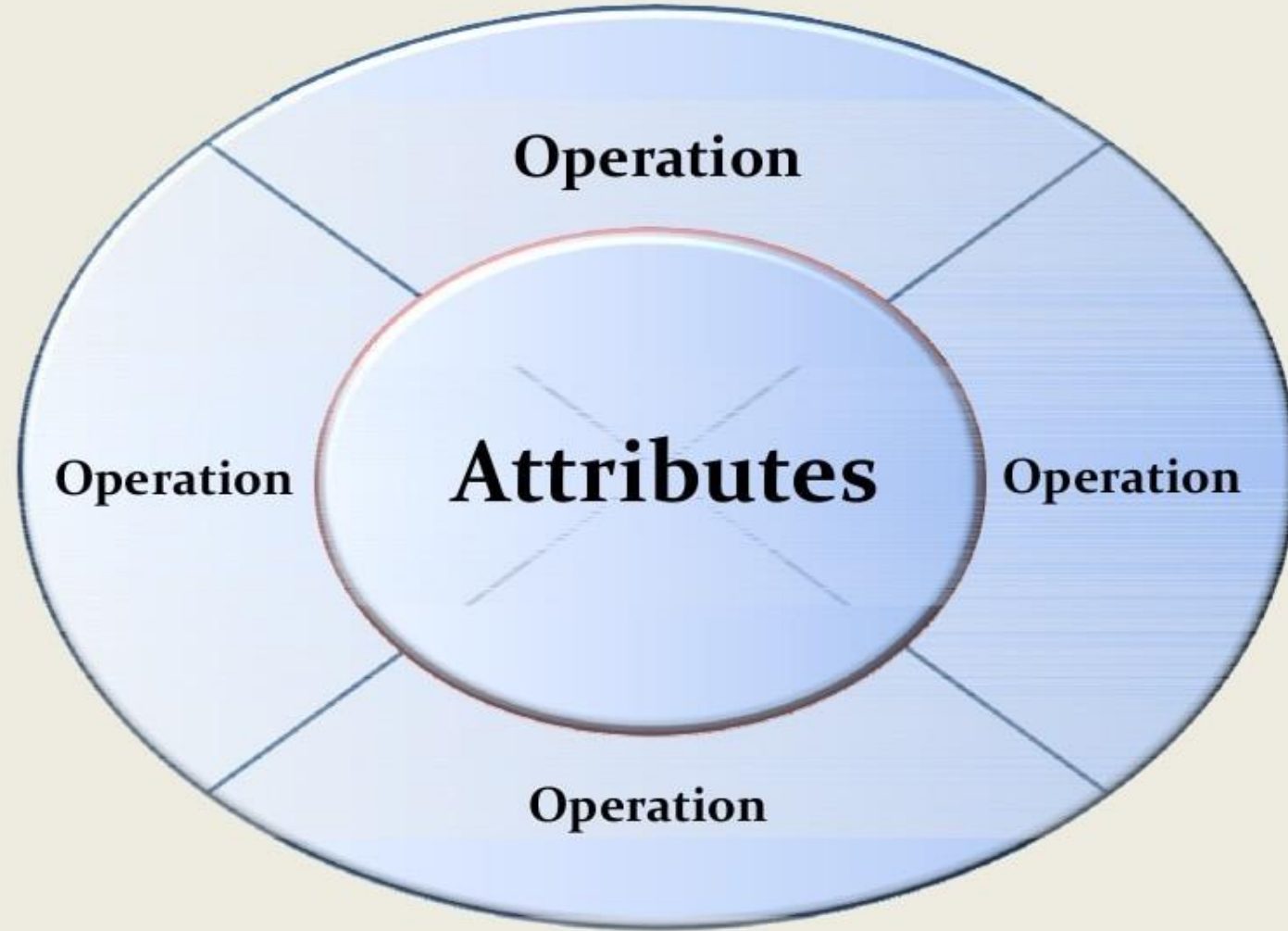
- Reverse top-down approach.
- Lower level tasks are first carried out and are then integrated to provide the solution of a single program.
- Lower level structures of the program are evolved first then higher level structures are created.
- It promotes code reuse.
- It may allow unit testing.

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:**

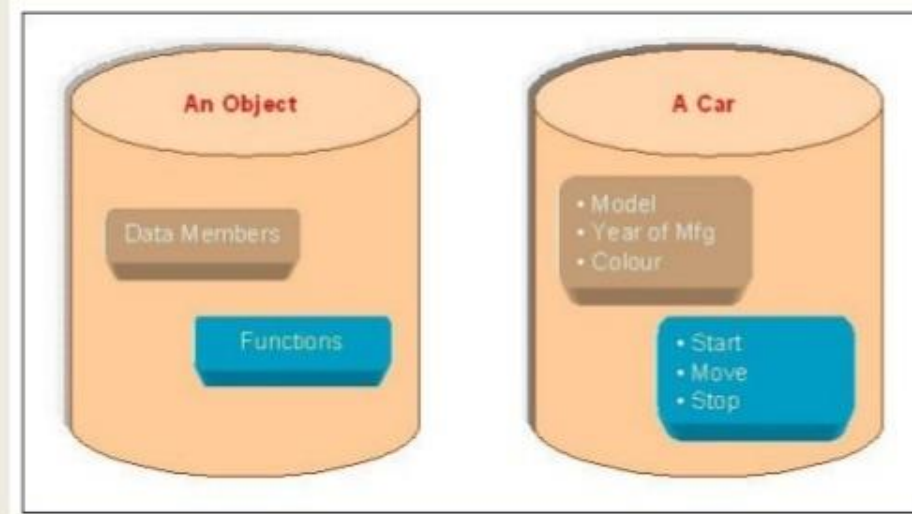
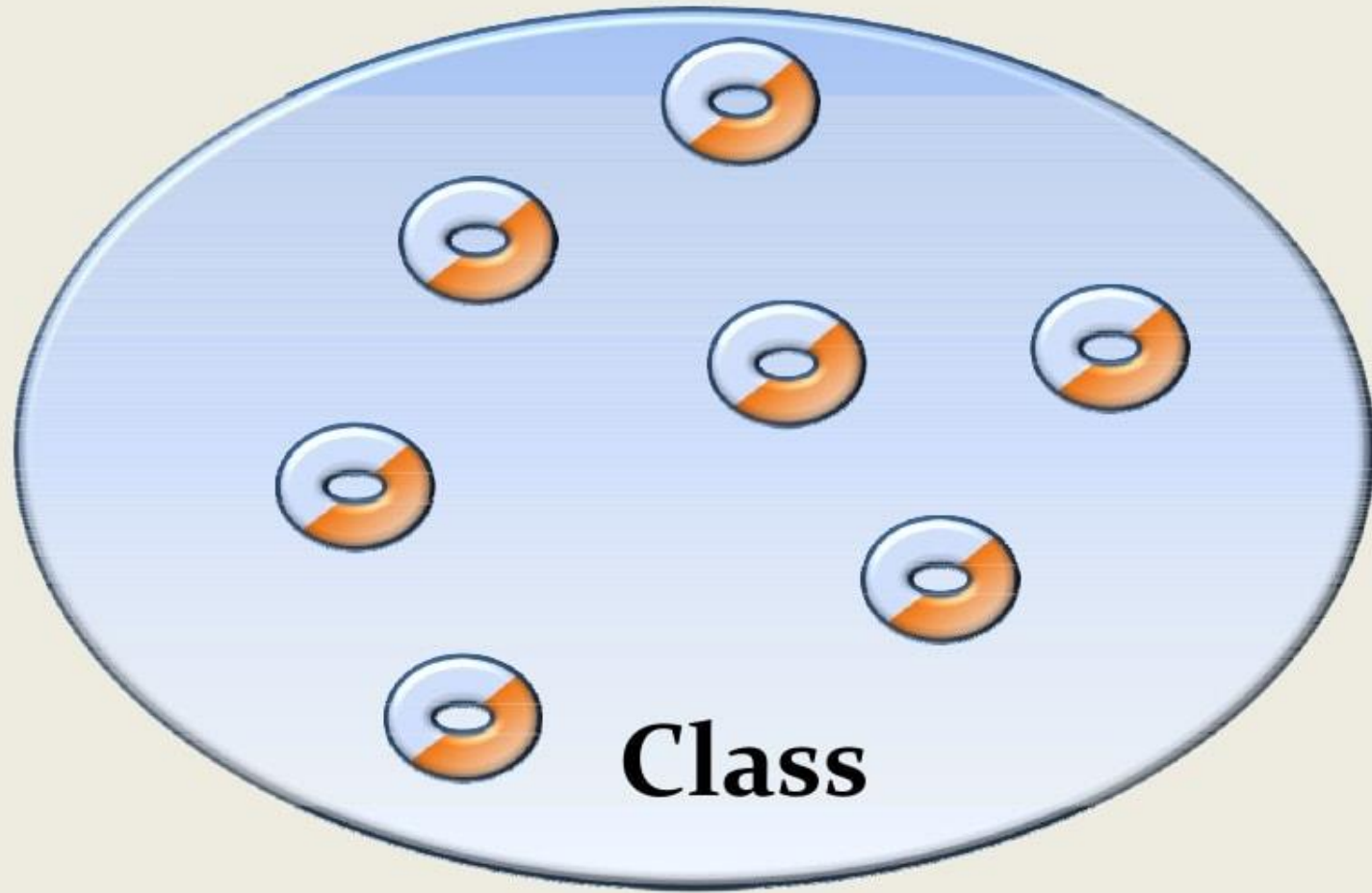


Fig 4: Representation of object.

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



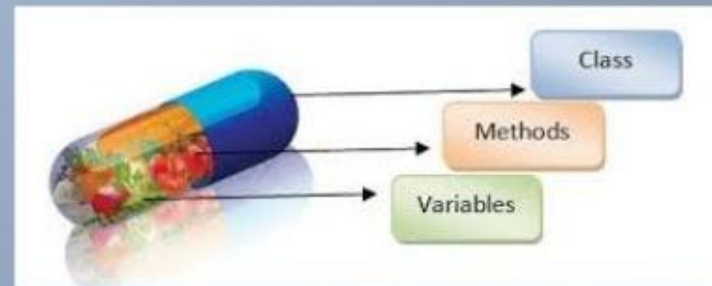
Classes

- 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


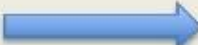
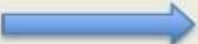
- Encapsulation is the first pillar or principle of object-oriented programming.
- In simple words, “**Encapsulation** is a process of binding **data members** (variables, properties) and **member functions** (methods) into a single unit”.
- And **Class** is the best example of encapsulation.

Encapsulation

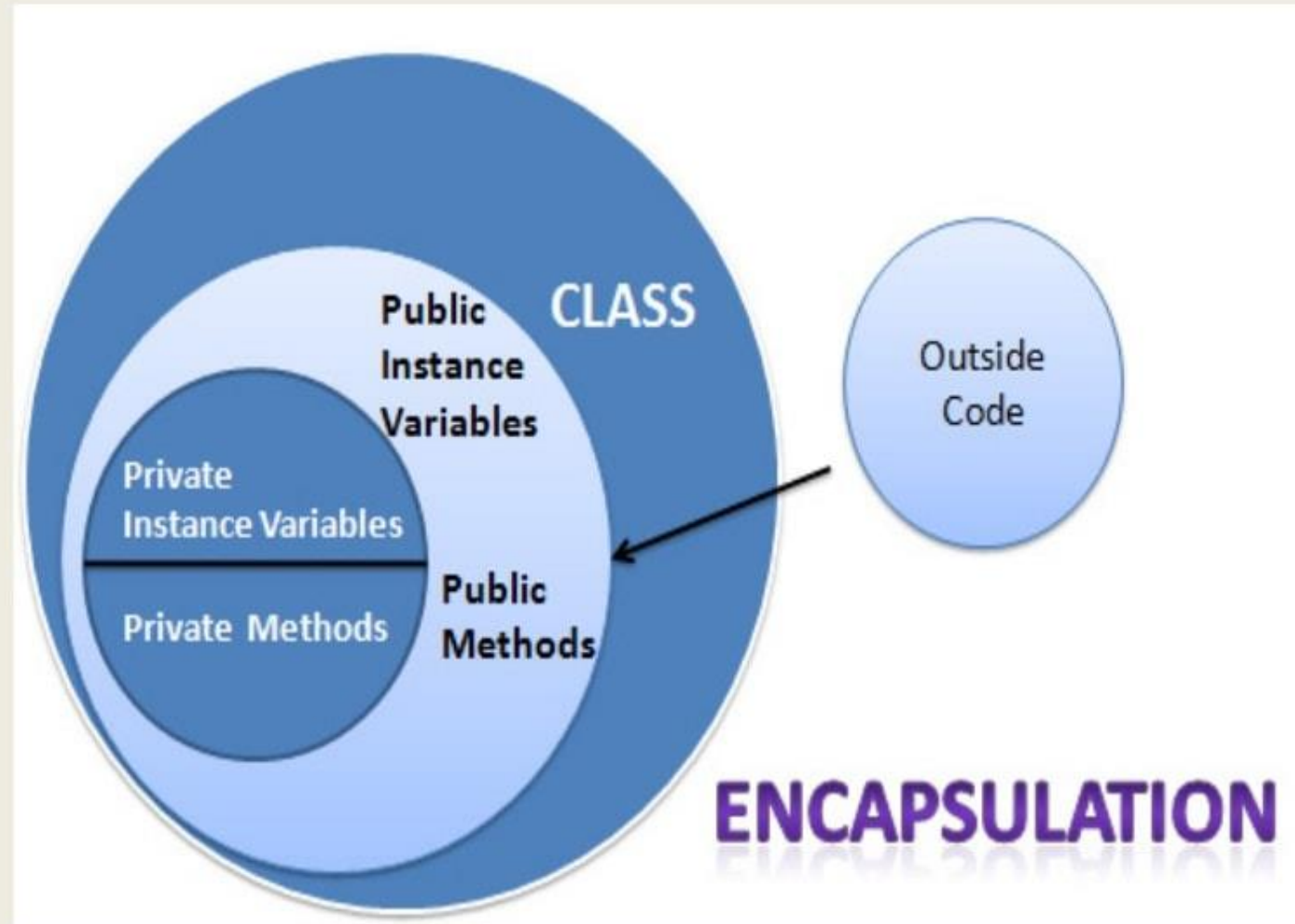
- For example: **Medical store**
- Lets say you have to buy some **medicines**. You go to the **medical store** and ask the **chemist** for the medicines.
- Only the **chemist** has access to the **medicines** in the store based on your prescription.
- The **chemist** knows what **medicines** to give 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



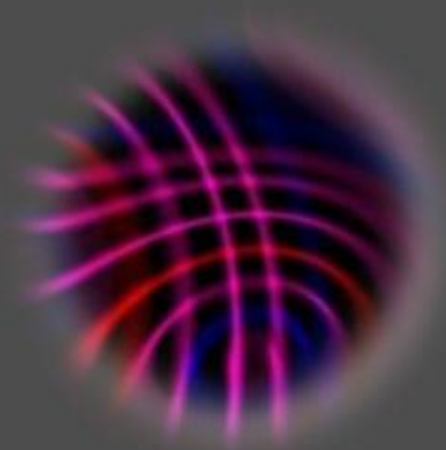
Encapsulation

- 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**.

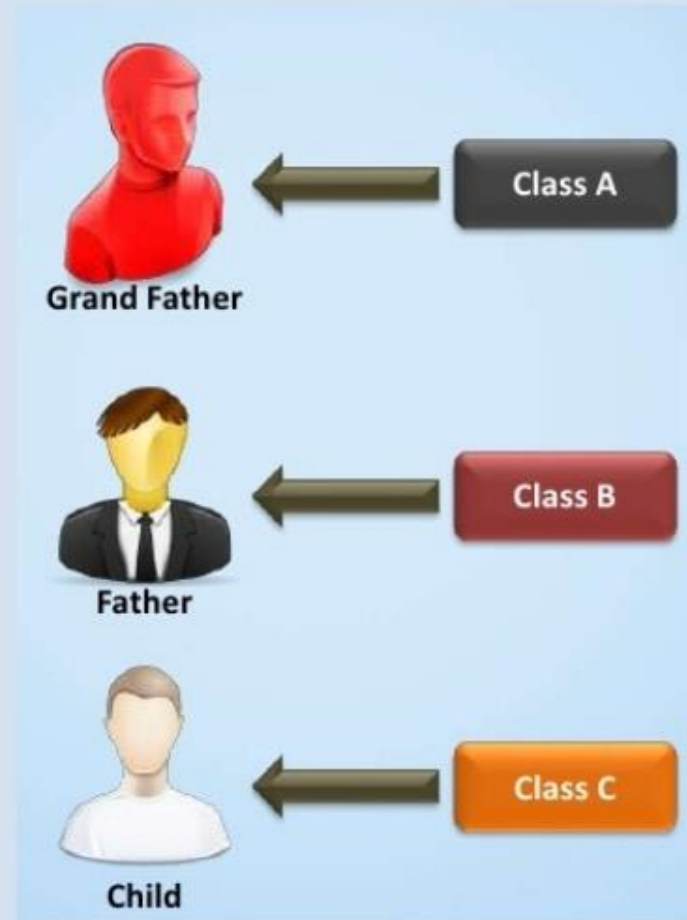
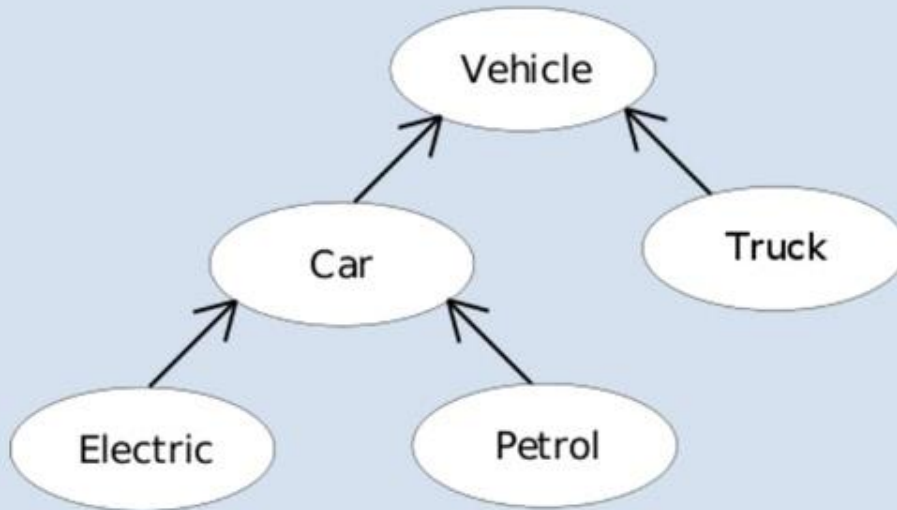


Abstraction

- 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:

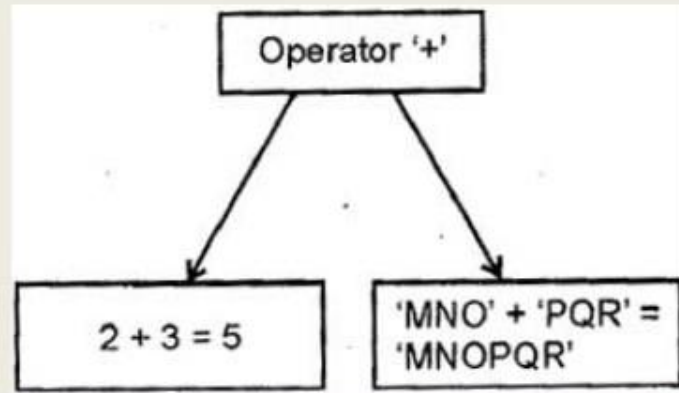
1. Single Inheritance
 2. Hierarchical Inheritance
 3. Multiple Inheritance
 4. Multi Level Inheritance
- We will explain all of the above in detail later when we cover Inheritance.



Polymorphism

Polymorphism

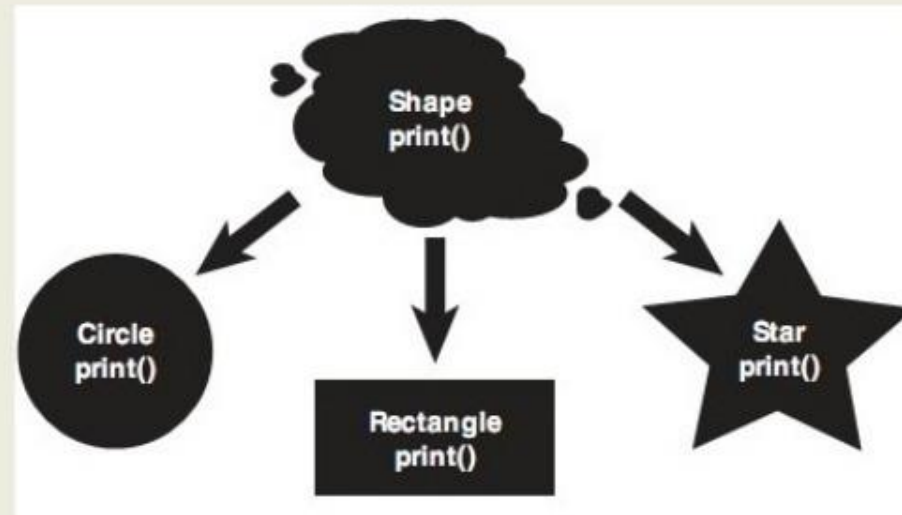
- **Polymorphism** is a **Greek** term which means ability to take more than one form.
- For example, **+** is used to make sum of two **numbers** as well as it is used to combine two **strings**.



- 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.



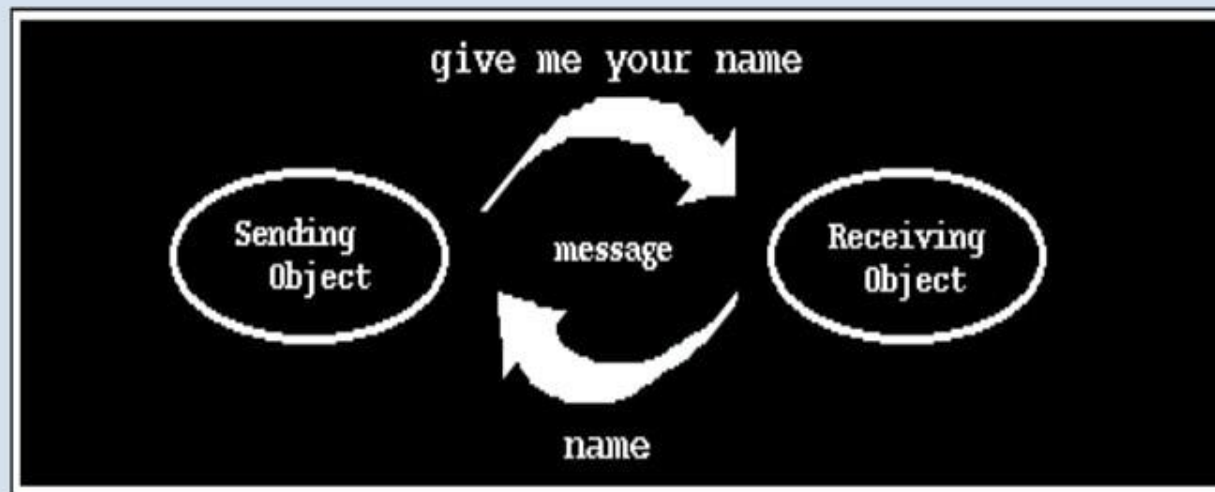
Dynamic binding

- 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**.

Dynamic binding

- For example, compiler comes to know at runtime that which function of **sum** will be call either with **two arguments** or with **three arguments**.

Message Passing

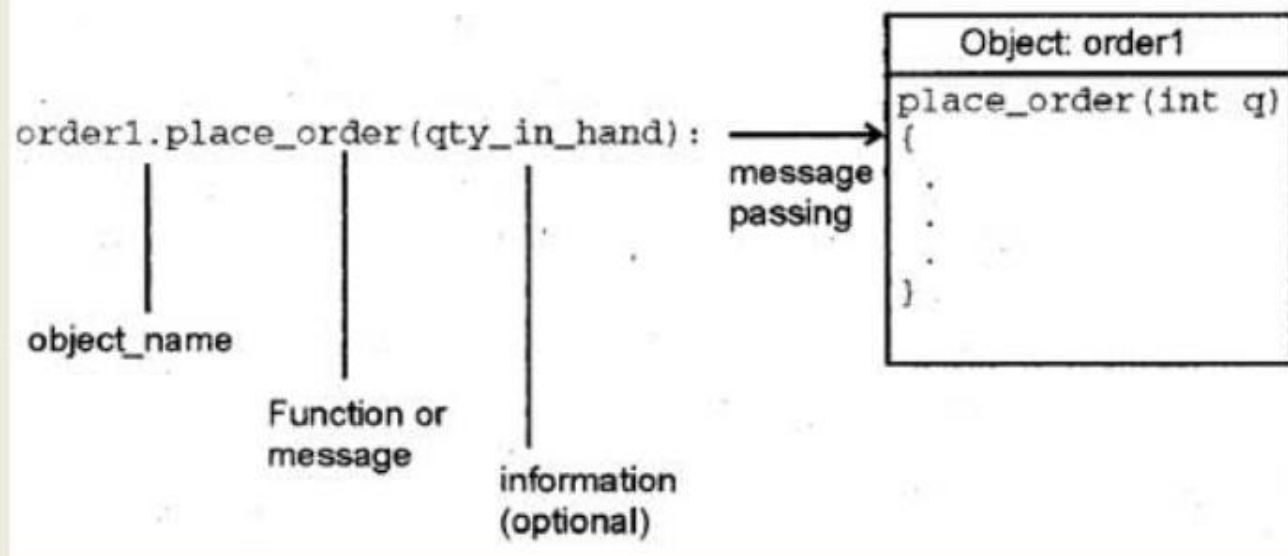


Message Passing

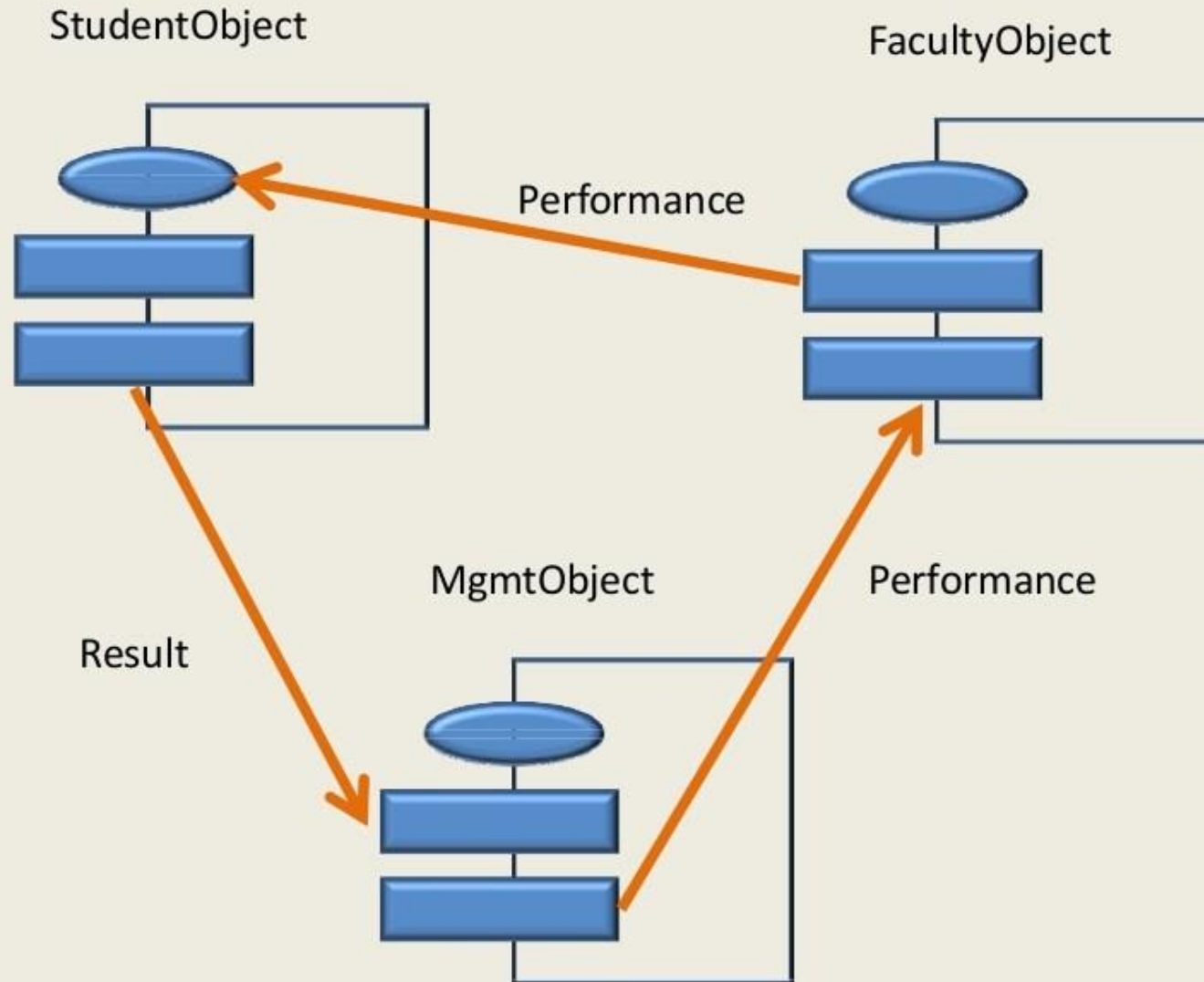
- Objects can **communicate** with each others by passing message same as people passing message with each other.
- Objects can send or receive message or information.
- Message passing involves the following basic steps:
 - Creating classes that define objects & their behavior.
 - Creating objects from 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.



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...