C++ [OOP]

CLASSES AND OBJECTS

- The main purpose of C++ programming is to add object orientation to the C programming language.
- A class is used to specify the form of an object and it combines data representation and methods for manipulating that data into one neat package.
- The data and functions within a class are called members of the class.

CLASS ACCESS MODIFIERS

- **Data hiding** is one of the important features of **Object Oriented Programming** which allows **preventing** the functions of a program to **access directly the internal representation of a class type**.

- A class can have **multiple public, protected, or private labeled sections**. Each section remains in **effect until either** another section label or the closing right brace of the class body is seen.

  - **public**: Any class can access the features
  - **protected**: Any subclass can access the feature
  - **private**: No other class can access the feature

CLASS ACCESS MODIFIERS

```
1.  class Base {
2.      public:
3.    // public members go here
4.
5.      protected:
6.    // protected members go here
7.
8.      private:
9.    // private members go here
10. };
```

THE PUBLIC MEMBERS EXAMPLE

- A **public** member is accessible from anywhere **outside the class** but **within a program**.

```
#include <iostream>
using namespace std;
class Line
{
   public:
      double length;
      void setLength( double len );
      double getLength( void );
};
```

THE PUBLIC MEMBERS EXAMPLE CON…

```
// Member functions definitions
double Line::getLength(void)
{
    return length ;
}

void Line::setLength( double len )
{
    length = len;
}
```

THE PUBLIC MEMBERS EXAMPLE CON…

```
// Main function for the program
int main( )
{   Line line;

   // set line length
   line.setLength(6.0);
   cout << "Length of line : " << line.getLength() <<endl;

   // set line length without member function
   line.length = 10.0; // OK: because length is public
   cout << "Length of line : " << line.length <<endl;
   return 0; }
```

```
Length of line : 6
Length of line : 10
```

THE PRIVATE MEMBERS

- A **private** member variable or function cannot be accessed, or even viewed from outside the class. Only the class and friend functions can access private members.
- **By default all the members** of a class would be **private**, for example in the following class **width** is a **private** member.

```
class Box
{  double width;
   public:
      double length;
      void setWidth( double wid );
      double getWidth( void );
};
```

THE PRIVATE MEMBERS EXAMPLE

```
#include <iostream>
using namespace std;
class Box
{   public:
      double length;
      void setWidth( double wid );
      double getWidth( void );
   private:
      double width;
};
// Member functions definitions
double Box::getWidth(void)
{
    return width ;
}
```

THE PRIVATE MEMBERS EXAMPLE CON…

```
void Box::setWidth( double wid ) {
    width = wid;
}
int main( ) {
   Box box;
   // set box length without member function
   box.length = 10.0; // OK: because length is public
   cout << "Length of box : " << box.length <<endl;

   // set box width without member function
   // box.width = 10.0; // Error: because width is private
   box.setWidth(10.0);  // Use member function to set it.
   cout << "Width of box : " << box.getWidth() <<endl;
   return 0; }
```

```
Length of box : 10
Width of box : 10
```

THE PROTECTED MEMBERS EXAMPLE

- A **protected** member variable or function is very similar to a private member but it provided one additional benefit that they can be accessed in child classes which are called derived classes.

- #include <iostream>
- using namespace std;
-
- class Box
- {
- protected:
- double width;
- };

THE PROTECTED MEMBERS EXAMPLE CON…

```
class SmallBox:Box // SmallBox is the derived class.
{   public:
      void setSmallWidth( double wid );
      double getSmallWidth( void );
};

// Member functions of child class
double SmallBox::getSmallWidth(void) {
    return width ;
}
```

…THE PROTECTED MEMBERS EXAMPLE CON

```
void SmallBox::setSmallWidth( double wid ) {
    width = wid;
}

// Main function for the program
int main( ) {
   SmallBox box;

   // set box width using member function
   box.setSmallWidth(5.0);
   cout << "Width of box : "<< box.getSmallWidth() << endl;

   return 0;
}
```

```
Width of box : 5
```

CLASS DEFINITIONS

- When you define a class, you define a **blueprint for a data type**. This doesn't actually define any data, but it does define what the class name means, that is, what an object of the class will **consist of** and what **operations can be performed** on such an object.

- A class definition starts with the keyword **class** followed by the **class name;**

CLASS DEFINITIONS EXAMPLE

```
1. class Box
2. {
3.    public:
4.       double length;   // Length of a box
5.       double breadth;  // Breadth of a box
6.       double height;   // Height of a box
7. };
```

DEFINE C++ OBJECTS:

1. Box Box1; // Declare Box1 of type Box
2. Box Box2; // Declare Box2 of type Box

ACCESSING THE DATA MEMBERS

```
1. #include <iostream>
2. using namespace std;
3. class Box
4. {
5.    public:
6.       double length;   // Length of a box
7.       double breadth;  // Breadth of a box
8.       double height;   // Height of a box
9. };
```

ACCESSING THE DATA MEMBERS CON…

```
1.  int main( )
2.  {
3.     Box Box1;        // Declare Box1 of type Box
4.     Box Box2;        // Declare Box2 of type Box
5.     double volume = 0.0;     // Store the volume of a box here

1.    // box 1 specification
2.    Box1.height = 5.0;
3.     Box1.length = 6.0;
4.     Box1.breadth = 7.0;
```

…ACCESSING THE DATA MEMBERS CON

```
1.  // box 2 specification
2.     Box2.height = 10.0;
3.     Box2.length = 12.0;
4.     Box2.breadth = 13.0;

1.     // volume of box 1
2.     volume = Box1.height * Box1.length * Box1.breadth;
3.     cout << "Volume of Box1 : " << volume <<endl;
4.     // volume of box 2
5.     volume = Box2.height * Box2.length * Box2.breadth;
6.     cout << "Volume of Box2 : " << volume <<endl;
7.     return 0;
8.  }
```

```
Volume of Box1 : 210
Volume of Box2 : 1560
```

CLASS MEMBER FUNCTIONS

- A **member function** of a class is a function that has its definition or its prototype **within the class** definition like any other variable.

```
class Box
{
   public:
      double length;         // Length of a box
      double breadth;        // Breadth of a box
      double height;         // Height of a box
      double getVolume(void);// Returns box volume
};
```

CLASS MEMBER FUNCTIONS CON…

Member functions can be defined within the class definition or separately using scope resolution operator, ::.

Method 1

```
class Box
{
   public:
      double length;      // Length of a box
      double breadth;     // Breadth of a box
      double height;      // Height of a box

      double getVolume(void)
      {
         return length * breadth * height;
      }
};
```

Method 2

```
double Box::getVolume(void)
{
    return length * breadth * height;
}

Box myBox;          // Create an object
myBox.getVolume();
// Call member function for the object
```

FULL EXAMPLE

- https://ideone.com/n9IX03

INHERITANCE

- **"C++ is Multi Inheritance, unlike Java is Single inheritance".**
- Inheritance allows us to define a class in terms of another class, which makes it easier to create and maintain an application. This also provides an opportunity **to reuse the code functionality** and **fast** implementation time.

- When creating a class, instead of **writing completely new data members** and **member functions**, the programmer can designate that the new class should inherit the members of an existing class. This existing class is called the **base** class, and the new class is referred to as the **derived** class.

BASE & DERIVED CLASSES

- A class can be derived from more than one classes, which means it can inherit data and functions from **multiple base classes**.
- To define a derived class, we use a class derivation list to specify the base **class(es).** A class derivation list names **one** or **more base classes** and has the form:
  - class **derived-class**: **access-specifier base-class**
  - Where access-specifier is one of **public, protected,** or **private.**
  - "base-class" is the name of a previously defined class.

FULL EXAMPLE

- Consider a base class **Shape** and its derived class **Rectangle:**
- **https://ideone.com/dwJAOM**

ACCESS CONTROL AND INHERITANCE

- A derived class can **access all the non-private members** of its base class.
- A derived class inherits **all base class methods** with the following exceptions:
  - Constructors, destructors and copy constructors of the base class.
  - Overloaded operators of the base class.
  - The friend functions of the base class.

TYPE OF INHERITANCE [**PUBLIC**]

- **Public Inheritance:**
  - When deriving a class from a **public** base class, **public** members of the base class become **public** members of the derived class and **protected** members of the base class become **protected** members of the derived class.
  - A base class's **private**members are never accessible directly from a derived class, but can be accessed through calls to the **public** and **protected** members of the base class.

TYPE OF INHERITANCE [**PROTECTED AND PRIVATE**] CON…

- **Protected Inheritance**
  - When deriving from a **protected** base class, **public** and **protected** members of the base class become **protected** members of the derived class.
- **Private Inheritance**
  - When deriving from a **private** base class, **public** and **protected** members of the base class become **private** members of the derived class.

MULTIPLE INHERITANCES EXAMPLE

- https://ideone.com/yFSOrV

FUNCTION OVERLOADING

- An overloaded declaration is a declaration that had been **declared with the same name** as a previously declared declaration **in the same scope**, except that both declarations have different arguments and obviously different definition (implementation).
- Function Overloading Example:
  - https://ideone.com/ktn9Ln

POLYMORPHISM

- The word **polymorphism** means having many forms. Typically, polymorphism occurs when there is a hierarchy of classes and they are related by **inheritance**.
- C++ polymorphism means that a call to a member function will cause a different function to be executed depending on the type of object that invokes the function.
- Example:
  - https://ideone.com/rGNTCc OR

POLYMORPHISM [**STATIC RESOLUTION**]

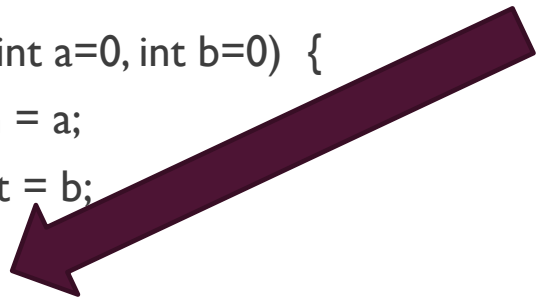
- Output of previous example:

```
Parent class area
Parent class area
```

- WHY !!!
- The reason for the **incorrect output** is that the call of the function area() is being set once by the compiler as the version defined in the base class. This is called **static resolution** of the function call, or **static linkage** - the function call is **fixed before the program is executed.** This is also sometimes called **early binding** because the area() function is set during the compilation of the program.

POLYMORPHISM CON…

```
class Shape {
   protected:
      int width, height;
   public:
      Shape( int a=0, int b=0)  {
         width = a;
         height = b;
      }
      virtual int area() {
         cout << "Parent class area :" <<endl;
         return 0;
      }
};
```



Rectangle class area
Triangle class area

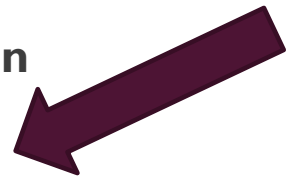
This time, the compiler looks at the **contents of the pointer instead of it's type.** Hence, since addresses of objects of tri and rec classes are stored in *shape the respective area() function is called.

VIRTUAL FUNCTION

- **A virtual function** is a function in a base class that is declared using the keyword **virtual**. Defining in a base class a virtual function, with another version in a derived class, **signals to the compiler that we don't want static linkage for this function.**

PURE VIRTUAL FUNCTIONS

```
class Shape {
   protected:
      int width, height;
   public:
      Shape( int a=0, int b=0) {
         width = a;
         height = b;
      }
      // pure virtual function
      virtual int area() = 0;
};
```



The = 0 tells the compiler that the function has no body

This virtual function will be called **pure virtual function**.

It's possible that **you'd want to include a virtual function in a base class** so that it **may be redefined in a derived class to suit the objects of that class**, but that there is no meaningful definition you could give for the function in the **base class**.

DATA ENCAPSULATION

- **Data encapsulation** led to the important OOP concept of **data hiding**.
- Encapsulation is an Object Oriented Programming concept that binds together the data and functions that manipulate the data, and that **keeps both safe from outside** interference and misuse.

- **Data encapsulation** is a mechanism of bundling the data, and the functions that use them.

DATA ENCAPSULATION CON…

- C++ **supports** the properties of encapsulation and data hiding through the **creation of user-defined types**, called **classes.**

- We already have studied that a class can contain **private, protected** and **public** members.
- By default, all items defined in a class are **private**

…DATA ENCAPSULATION CON

```
class Box {
   public:
      double getVolume(void) {
         return length * breadth * height;
      }
   private:
      double length;      // Length of a box
      double breadth;     // Breadth of a box
      double height;      // Height of a box
};
```

The variables length, breadth, and height are **private**.

This means that they can be accessed **only** by other members of the Box class, and not by any other part of your program.

This is one way encapsulation is achieved.

DATA ENCAPSULATION EXAMPLE

- https://ideone.com/jNBKrP