Dr. Vishwanath Karad
MIT WORLD PEACE UNIVERSITY | PUNE
TECHNOLOGY, RESEARCH, SOCIAL INNOVATION & PARTNERSHIPS

CET1042B: Object Oriented Programming with C++ and Java

SCHOOL OF COMPUTER ENGINEERING AND TECHNOLOGY

S. Y. B. TECH. COMPUTER SCIENCE AND ENGINEERING
(CYBERSECURITY AND FORENSICS)

CET1042B: Object Oriented Programming with C++ and Java

Teaching Scheme
Theory: 2 Hrs. / Week

Credits: 02 + 02 = 04
Practical: 4 Hrs./Week

Course Objectives

1) **Knowledge:** (i) Learn object oriented paradigm and its fundamentals.
2) **Skills:** (i) Understand Inheritance, Polymorphism and dynamic binding using OOP.
   (ii) Study the concepts of Exception Handling and file handling using C++ and Java.
3) **Attitude:** (i) Learn to apply advanced concepts to solve real world problems.

Course Outcomes

1) Apply the basic concepts of Object Oriented Programming to design an application.
2) Make use of Inheritance and Polymorphism to develop real world applications.
3) Apply the concepts of exceptions and file handling to store and retrieve the data.
4) Develop efficient application solutions using advanced concepts.

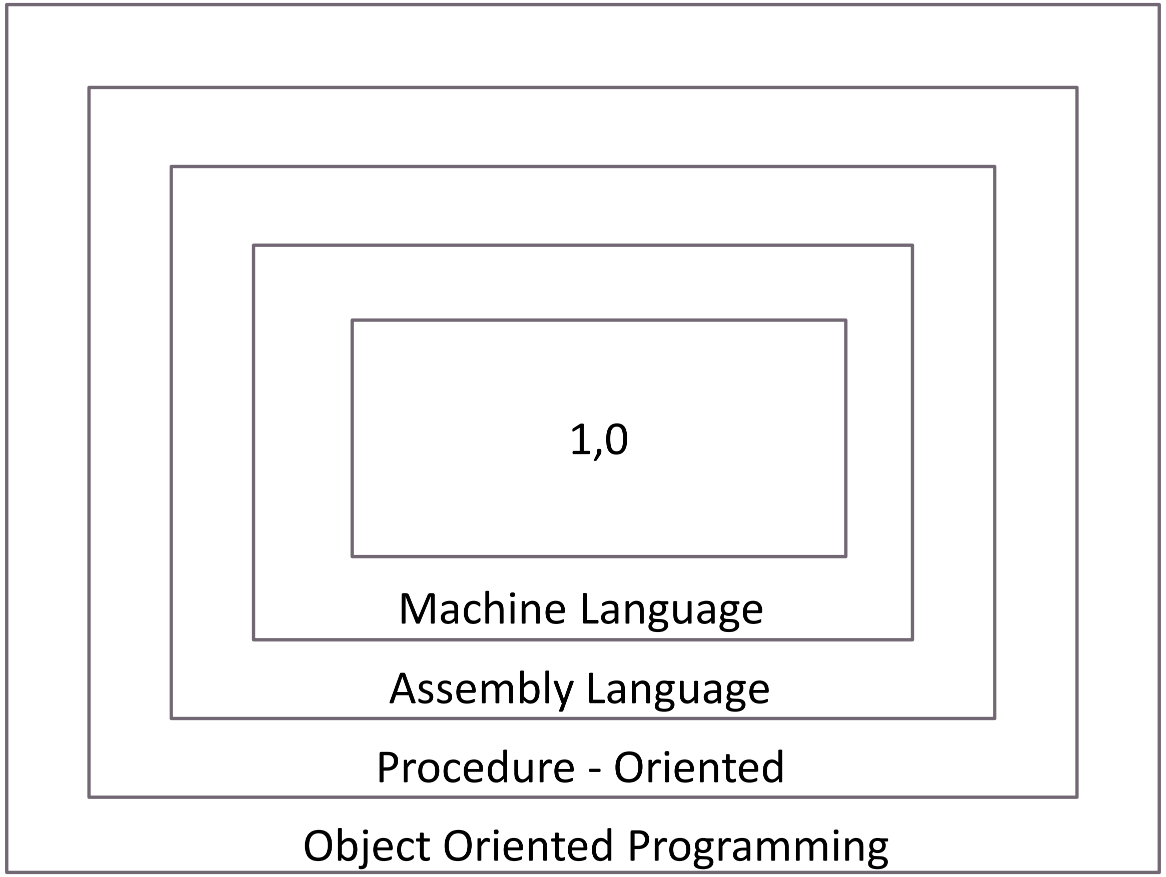
Module 1

Introduction to Object Oriented Programming (OOP)

Introduction to Object Oriented Programming (OOP)

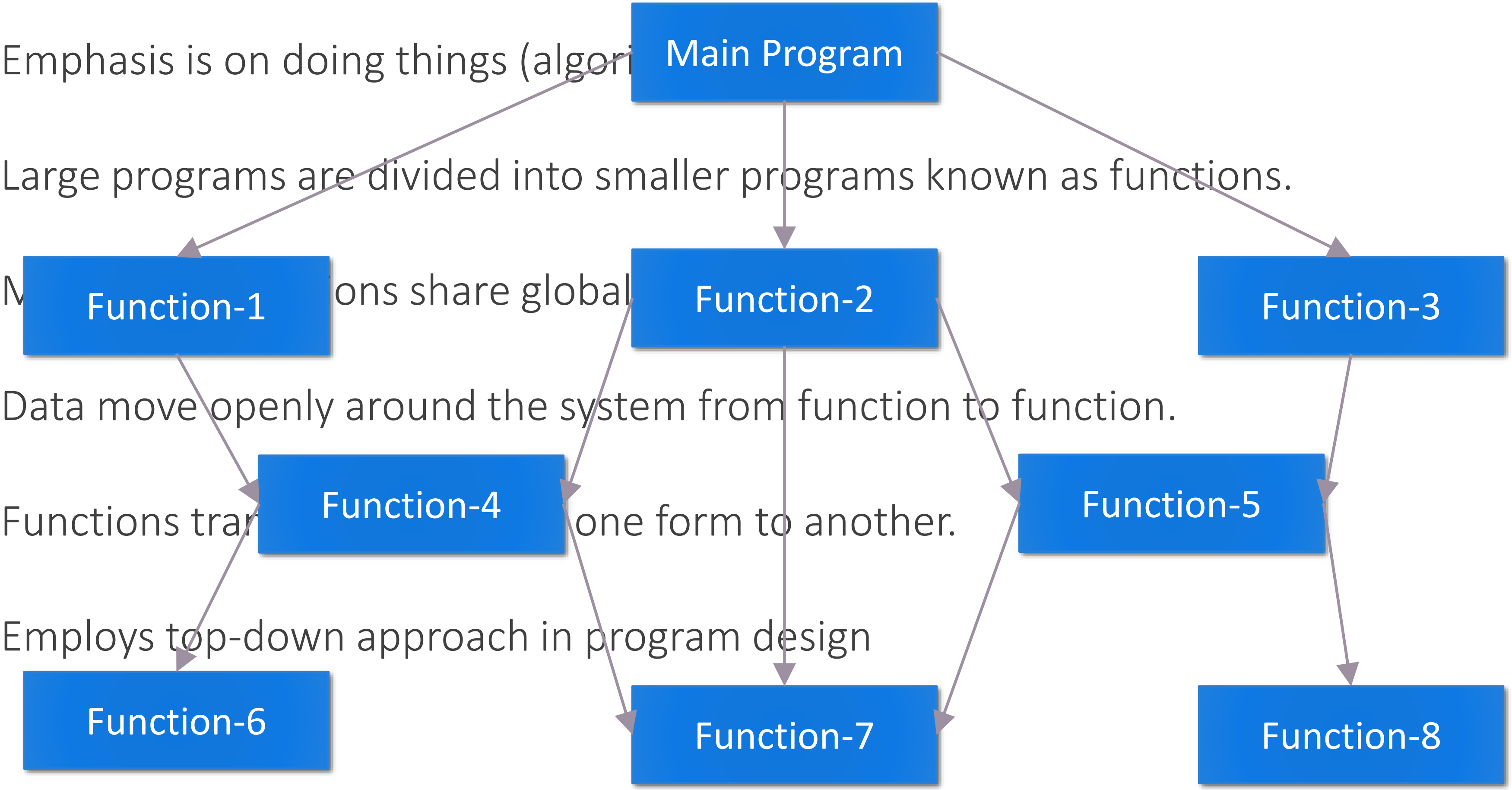
- Introduction to OOP
- Fundamentals of object-oriented programming
  - ✓ Classes
  - ✓ Objects
  - ✓ Methods
  - ✓ Data Abstraction
  - ✓ Data Encapsulation
  - ✓ Information hiding
  - ✓ Inheritance
  - ✓ Polymorphism
- Benefits of OOP
- Case study/examples with respect to C++, JAVA Programming languages

Software Evolution



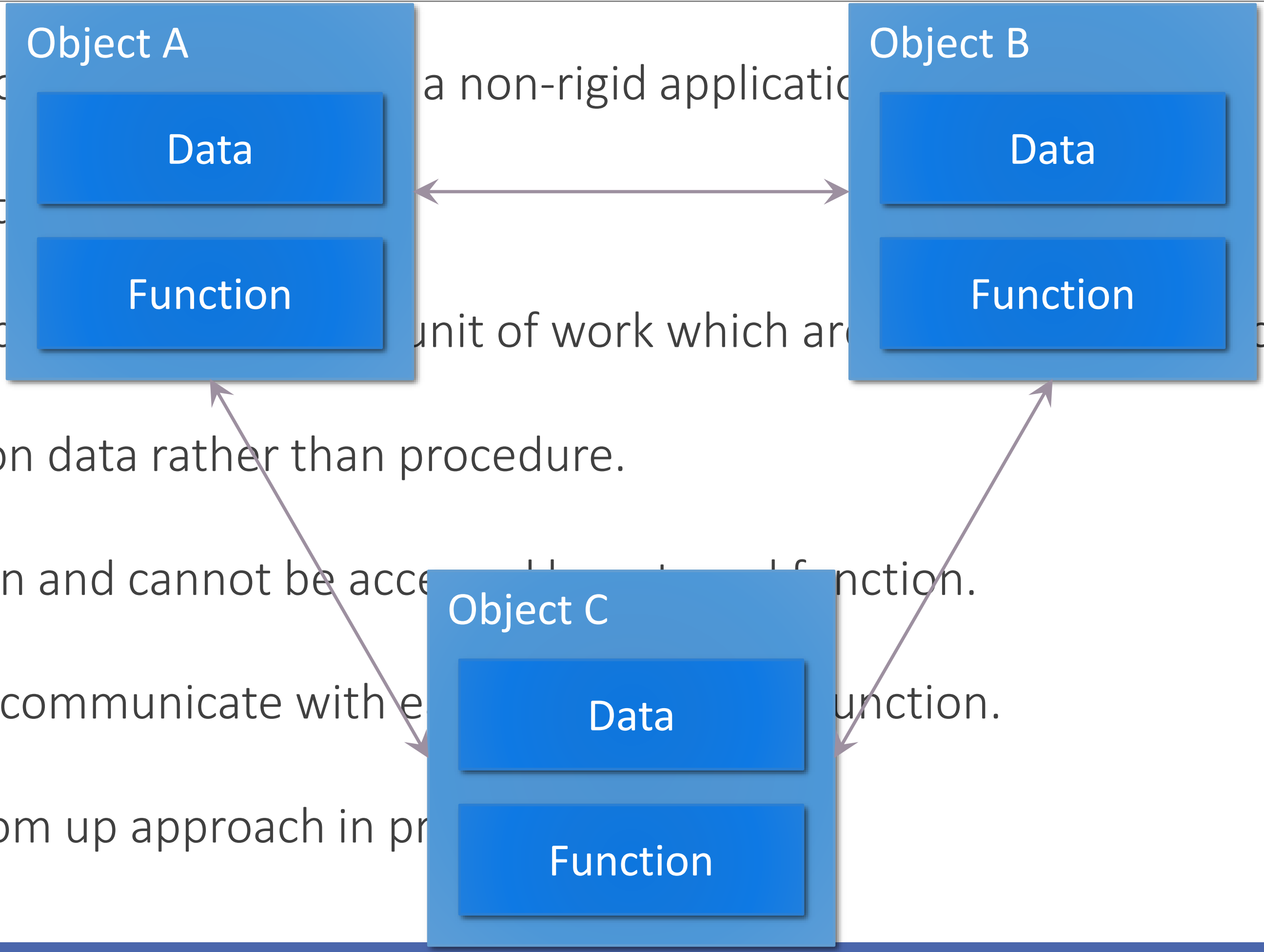
Procedural Programming

- Emphasis is on doing things (algori
- Large programs are divided into smaller programs known as functions.
- M ons share global
- Data move openly around the system from function to function.
- Functions tra one form to another.
- Employs top-down approach in program design



Object Oriented Programming

- Design metho a non-rigid applicati
- Works on ent
- Decompose p unit of work which ar cts.
- Emphasis is on data rather than procedure.
- Data is hidden and cannot be acce nction.
- Objects may communicate with e unction.
- Follows bottom up approach in pr



Features of OOP

Programming language with OOP support has to fulfill the features like

- Object
- Class
- Data Abstraction
- Data Encapsulation
- Inheritance
- Polymorphism

Objects

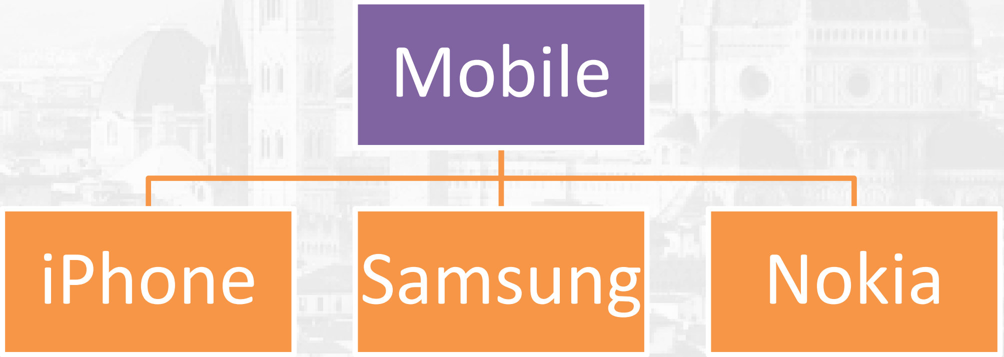
- Any real world entity which can have some characteristics or which can perform some work is called as Object.
- The object is also called as an instance i.e. a copy of an entity in programming language.
- A mobile manufacturing company, at a time manufactures lacs of pieces of each model which are actually an ***instance***.
- These objects are differentiated from each other via some identity (e.g. IMEI number) or its characteristics.

```
Mobile mbl1;
Mobile mbl2;
```

```
Mobile mbl1 = new Mobile ();
Mobile mbl2 = new Mobile ();
```

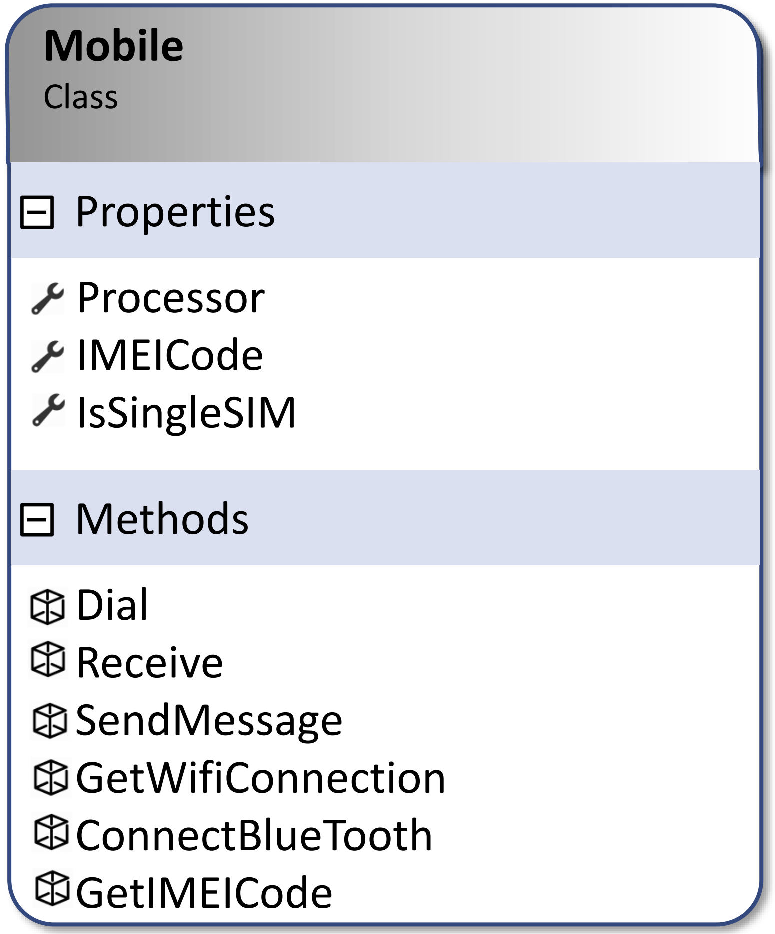
Real life Example

- Mobile as an object was designed to provide basic functionality as
  - Calling and Receiving calls
  - Messaging
- Thousands of new features and models are getting added



Class

- A Class is a plan which describes the object.
- We call it as a blue print of how the object should be represented.
- Mainly a class would consist of a name, attributes & operations.
- A **Mobile** can be a class which has some attributes like Profile Type, IMEI Number, Processor, and some more.) and operations like Dial, Receive & Send Message etc.



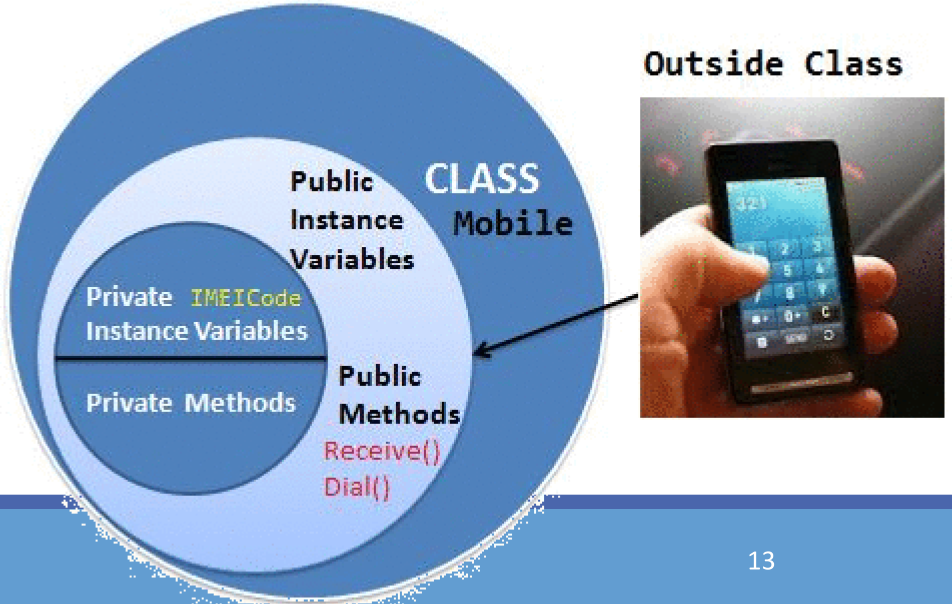
Abstraction

- Only show relevant details and rest all hide it
  - its most important pillar in OOPS as it is providing us the technique to hide irrelevant details from User
- Dialing a number calls some method internally which concatenate the numbers and displays it on screen but what is it doing we don't know.
- Clicking on green button actual send signals to calling person's mobile but we are unaware of how it is doing.

```
void Dial()
{
   //Write the logic
   cout << "Dial a number";
}
```

Encapsulation

- It is defined as the process of enclosing one or more details from outside world through access right.
- It says how much access should be given to particular details.
- Both Abstraction and Encapsulation works hand in hand because Abstraction says what details to be made visible and Encapsulation provides the level of access right to that visible details.
- i.e. It implements the desired level of abstraction.

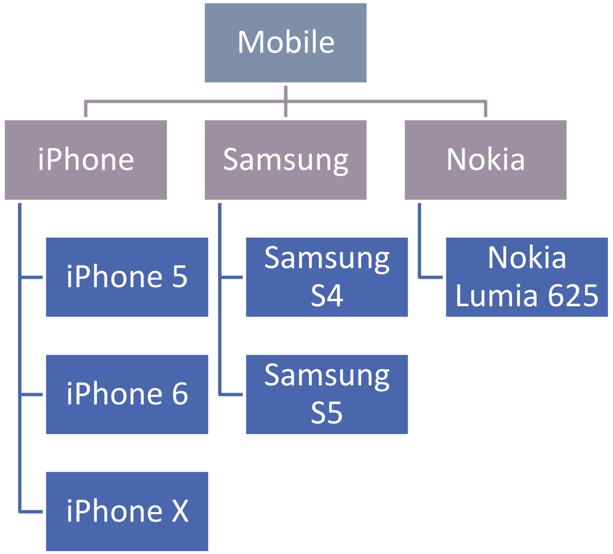


private:
    string IMEICode = "76567556757656";

Inheritance

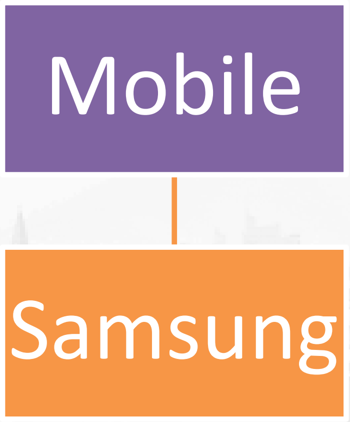
- Ability to extend the functionality from base entity to new entity belonging to same group.
- This will help us to reuse the functionality which is defined before.
- There are mainly 5 types of inheritance as

  1. Single level inheritance
  2. Multiple inheritance
  3. Multi-level inheritance
  4. Hierarchical inheritance
  5. Hybrid inheritance

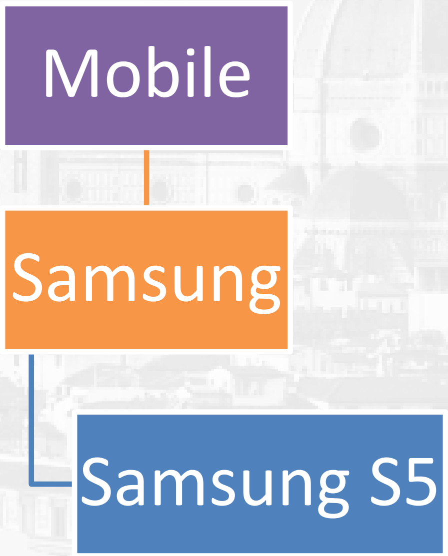


Inheritance

- Single level inheritance
  - Single base class & a single derived class i.e. - A base mobile features are extended by Samsung brand.

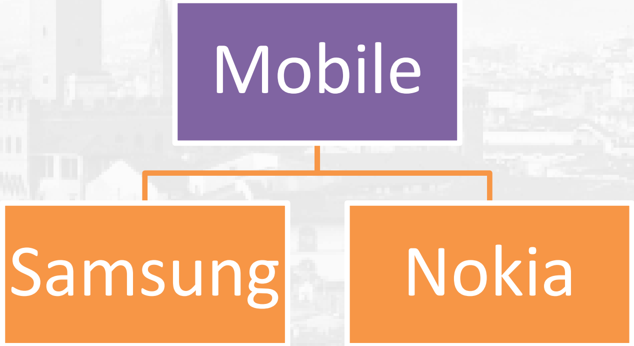


- Multilevel inheritance
  - In Multilevel inheritance, there is more than one single level of derivation.
  - E.g. After base features are extended by Samsung brand, a new model is launched with latest Android OS

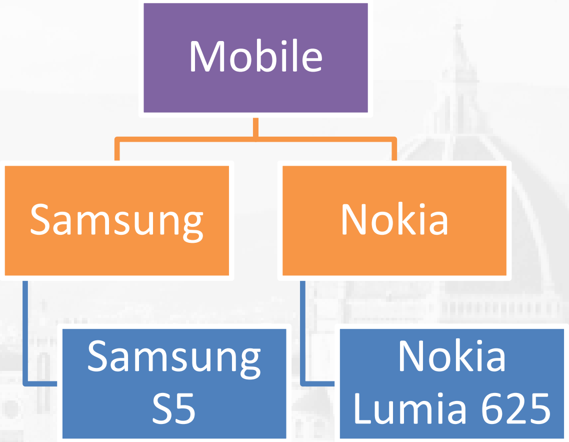


Inheritance

- Hierarchical inheritance
  - Multiple derived class would be extended from base class
  - It’s similar to single level inheritance but this time along with Samsung, Nokia is also taking part in inheritance.



- Hybrid inheritance
  - Single, Multilevel, & hierarchal inheritance all together construct a hybrid inheritance.



Polymorphism

- Polymorphism can be defined as the ability of doing the same operation but with different type of input.
- More precisely we say it as ‘many forms of single entity’
- Static or Compile time polymorphism
  - ✓ The compiler knows which overloaded method it is going to call.
- Dynamic polymorphism or Runtime polymorphism
  - ✓ Method Overriding is used to implement dynamic polymorphism
- By runtime polymorphism, we can point to any derived class from the object of the base class at runtime that shows the ability of runtime binding.

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Object based Vs Oriented Language

- **Objects-based** programming are languages that support programming with objects
- Feature that are required for object based programming are:
  - Data encapsulation
  - Data hiding and access mechanisms
  - Automatic initialization and clear-up of objects
  - Operator overloading

e.g. Visual Basic

- **Object-oriented** programming language incorporates two additional features, namely, inheritance and dynamic binding
- Feature that are required for object based programming are:
  - Data encapsulation
  - Data hiding and access mechanisms
  - Automatic initialization and clear-up of objects
  - Operator overloading
  - Inheritance
  - dynamic binding

e.g. C++, Java

Applications of OOP

- Real-business system are often complex and contain many objects with complicated attributes and methods.
- Some of the areas of application of OOPs are:
  - Real-time system
  - Simulation and modeling
  - Object-oriented data bases
  - Hypertext, Hypermedia, and expert text
  - AI and expert systems
  - Neural networks and parallel programming
  - Decision support and office automation systems
  - CIM/CAM/CAD systems

Basics of C++

Simple C++ Program

```
// Simple C++ program to display "Hello World"
// Header file for input output functions
#include<iostream>
```

instructs the compiler to include the contents of the file enclosed within angular brackets into the source file.

```
using namespace std;
```

defines a scope for the identifiers that are used in a program

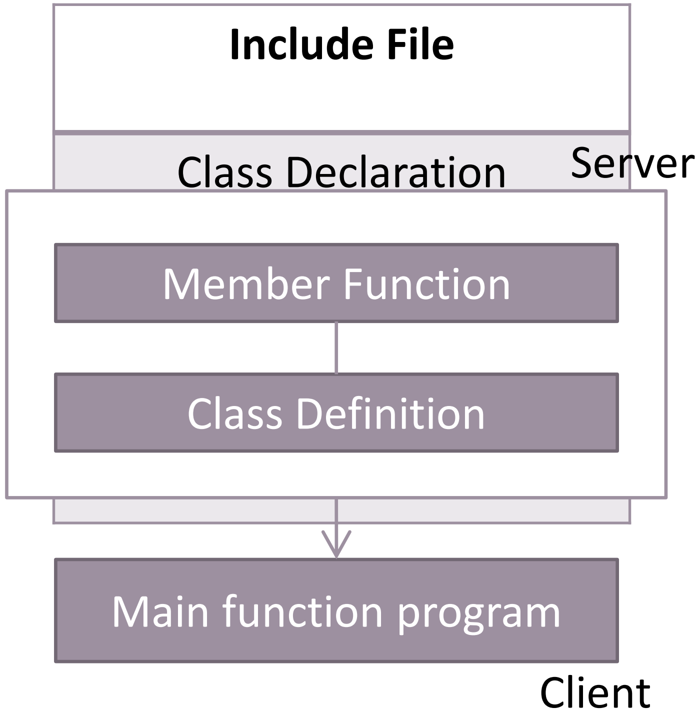
```
// main function - where the execution of program begins
int main()
{
   // prints message as hello world
   cout<<"Hello World";

   return 0;
}
```

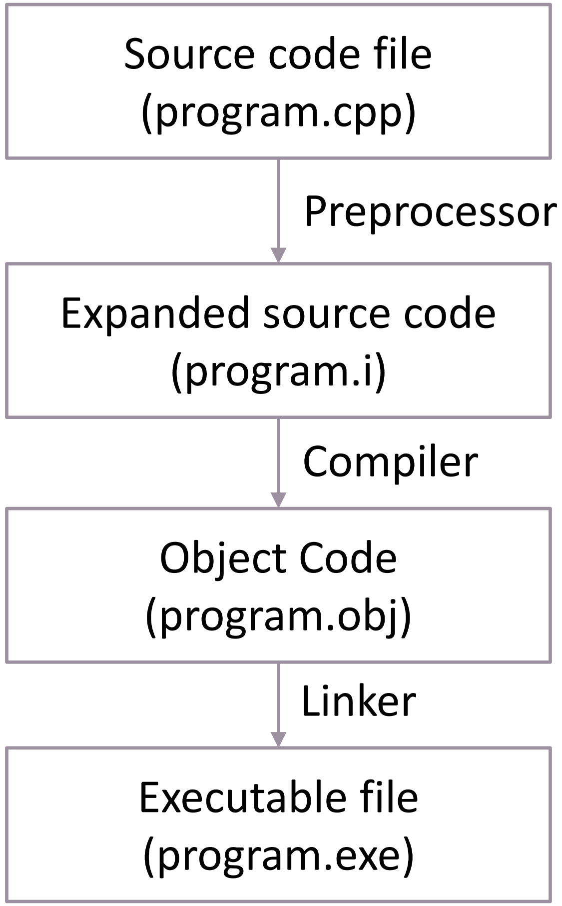
every main() returns an integer value to operating system and therefore it should end with return (0) statement

Structure of C++ Program

- Typical C++ program contains four sections
- It is a common practice to organize a program into three separate files
- The class declarations are placed in a header file and the definitions of member functions go into another file.
- The main program that uses the class is placed in a third file which “**includes**” the previous two files as well as any other file required



C++ Compilation and Linking



FUNCTION in C++

- Function is a collection of declarations and statements
- A function must be defined prior to it’s use in the program

```
type    name_of_the_function (argument list)
        {
                //body of the function
        }
```

C++ Function Definition

- C++ function is defined in two steps (preferably but not mandatory)
  - Step #1 – declare the *function signature* in either a header file (.h file) or before the main function of the program
  - Step #2 – Implement the function in either an implementation file (.cpp) or after the main function

The Syntactic Structure of a C++ Function

- A C++ function consists of two parts
  - The function header, and
  - The function body

- The function header has the following syntax

```
<return value> <name> (<parameter list>)
```

- The function body is simply a C++ code enclosed between { }

Example of User-defined C++ Function

Function header

Function body

```
double computeTax(double income)
{
    if (income < 5000.0)
        return 0.0;
   else
        double taxes = 0.07 * (income-5000.0);
    return taxes;
}
```

Function Signature

- The function signature is actually similar to the function header except in two aspects:
  - The parameters’ names may not be specified in the function signature
  - The function signature must be ended by a semicolon
- Example

Unnamed Parameter

Semicolon ;

```
double computeTaxes(double) ;
```

Why Do We Need Function Signature?

- For Information Hiding
  - If you want to create your own library and share it with your customers without letting them know the implementation details, you should declare all the function signatures in a header (.h) file and distribute the binary code of the implementation file
- For Function Abstraction
  - By only sharing the function signatures, we have the liberty to change the implementation details from time to time to
    - Improve function performance
    - make the customers focus on the purpose of the function, not its implementation

Example

```
#include <iostream>
#include <string>
using namespace std;
// Function Signature
   double getIncome(string);
   double computeTaxes(double);
   void printTaxes(double);
void main()
{
  // Get the income;
  double income = getIncome("Please enter the employee income: ");
  // Compute Taxes
  double taxes = computeTaxes(income);
  // Print employee taxes
  printTaxes(taxes);
}
```

```
double computeTaxes(double income){
  if (income<5000) return 0.0;
  return 0.07*(income-5000.0);
}
double getIncome(string prompt){
  cout << prompt;
  double income;
  cin >> income;
      return income;
}
void printTaxes(double taxes){
  cout << "The taxes : $" << taxes << endl;
}
```

Default Arguments in Function

Case 1: No argument passed

```
void temp (int = 10, float = 8.8);
int main() {
     temp();
}
void temp(int i, float f) {
     … … …
}
```

Case 2: First argument passed

```
void temp (int = 10, float = 8.8);
int main() {
     temp(6);
}
void temp(int i, float f) {
     … … …
}
```

Case 3: All arguments passed

```
void temp (int = 10, float = 8.8);
int main() {
     temp(6, -2.3);
}
void temp(int i, float f) {
     … … …
}
```

Case 4: Second argument passed

```
void temp (int = 10, float = 8.8);
int main() {
     temp(3.4);
}
void temp(int i, float f) {
     … … …
}
```

i = 3, f=8.8
Because, only the second argument cannot be passed. The parameter will be passed as the first argument.

```
// C++ Program to demonstrate working of default argument
 #include <iostream>
 using namespace std;
void display(char = '*', int = 1);
int main()
 {
          cout << "No argument passed:\n";
           display();
          cout << "\nFirst argument passed:\n";
           display('#');
           cout << "\nBoth argument passed:\n";
          display('$', 5);
          return 0;
 }
void display(char c, int n) {
           for(int i = 1; i <= n; i++) {
           cout << c;
           }
 cout << endl;
 }
```

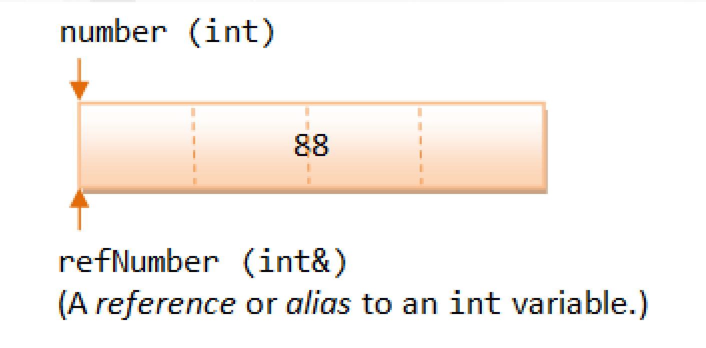
Common Mistakes in DEFAULT ARGUMENTS

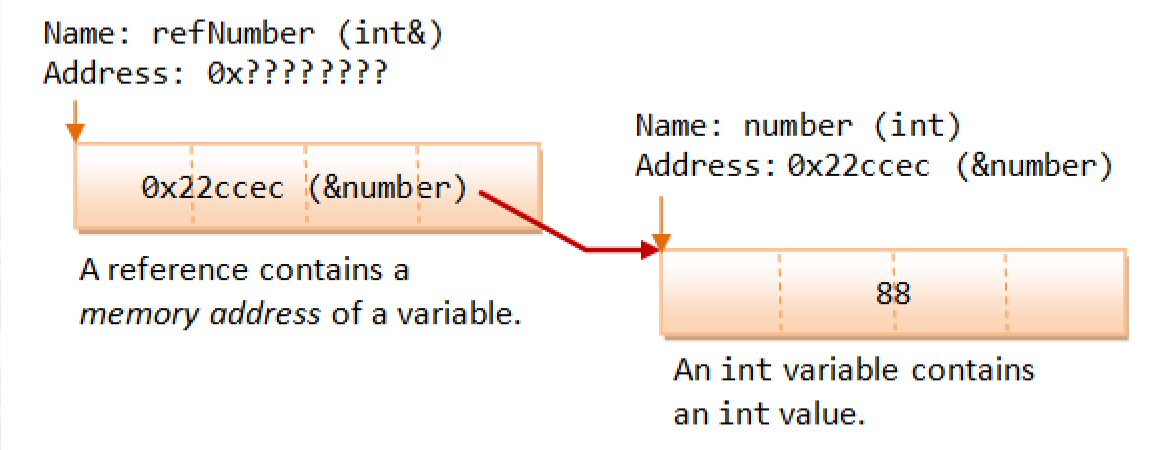
- void add(int a, int b = 3, int c, int d = 4);

- void add(int a=3, int b , int c, int d);

How References Work?

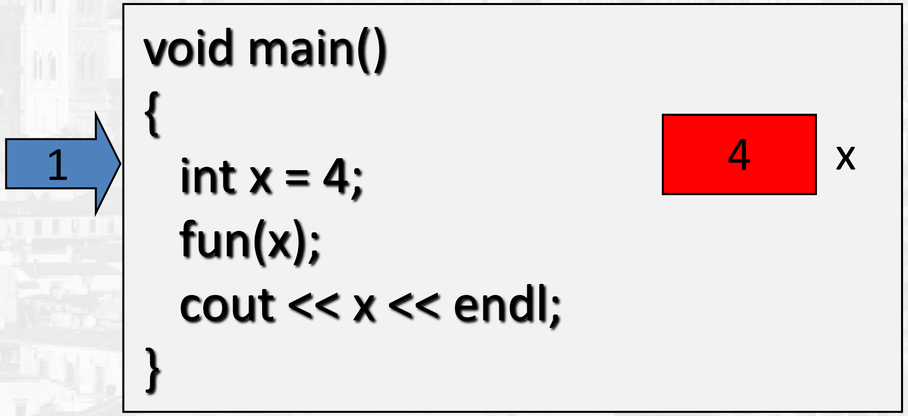
```
type &newName = existingName;
int number = 88; // Declare an int variable called number
int & refNumber = number; // Declare a reference (alias)
```





Example of Reference Parameters

```
#include <iostream.h>
void fun(int &y)
{
    cout << y << endl;
    y=y+5;
}
void main()
{
    int x = 4; // Local variable
    fun(x);
    cout << x << endl;
}
```



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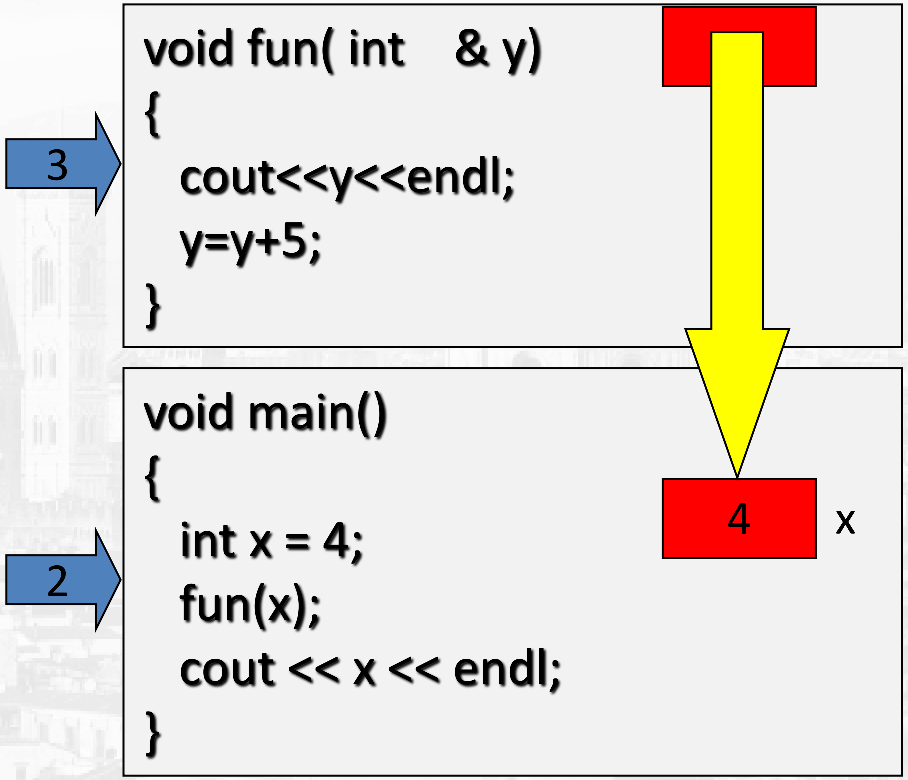
```



Example of Reference Parameters

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{
    cout << y << endl;
     y=y+5;
}
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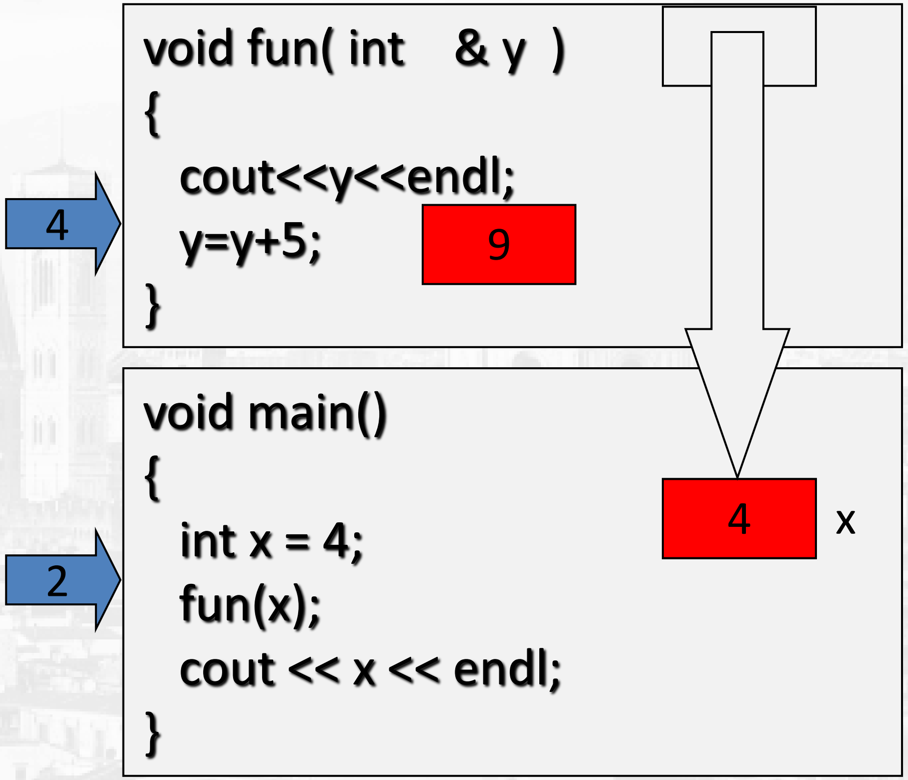
{
    int x = 4; // Local variable
    fun(x);
    cout << x << endl;
}
```



Example of Reference Parameters

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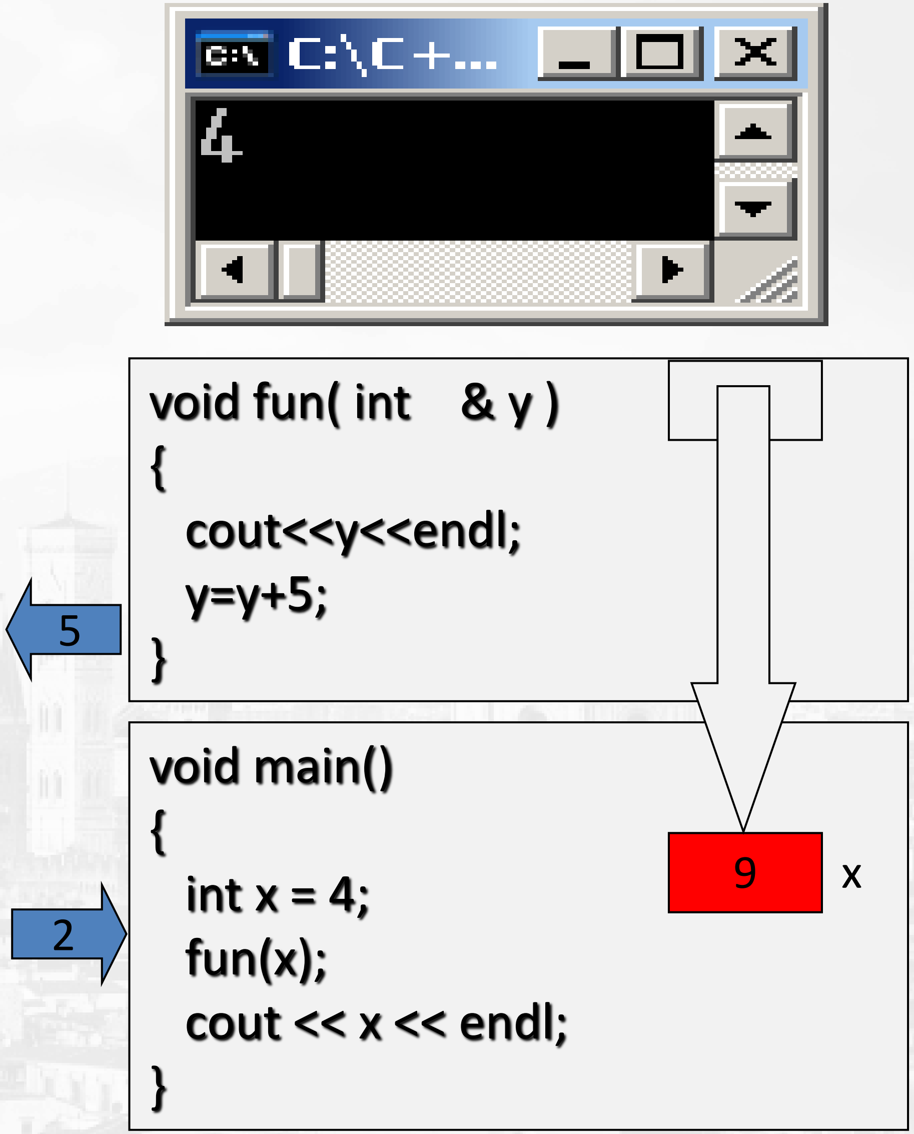
```



Classes and Objects

Class

- A way to bind data and associated function together
- An expanded concept of a data structure, instead of holding only data, it can hold both data and function.
- The data is to be hidden from external use.

Syntax of Class

keyword

```
class class_name
{
        private:
        variable declaration;
        public:
        function declaration;
        ….
} ;
```

body

data member

member function

Access specifiers

Access Specifiers

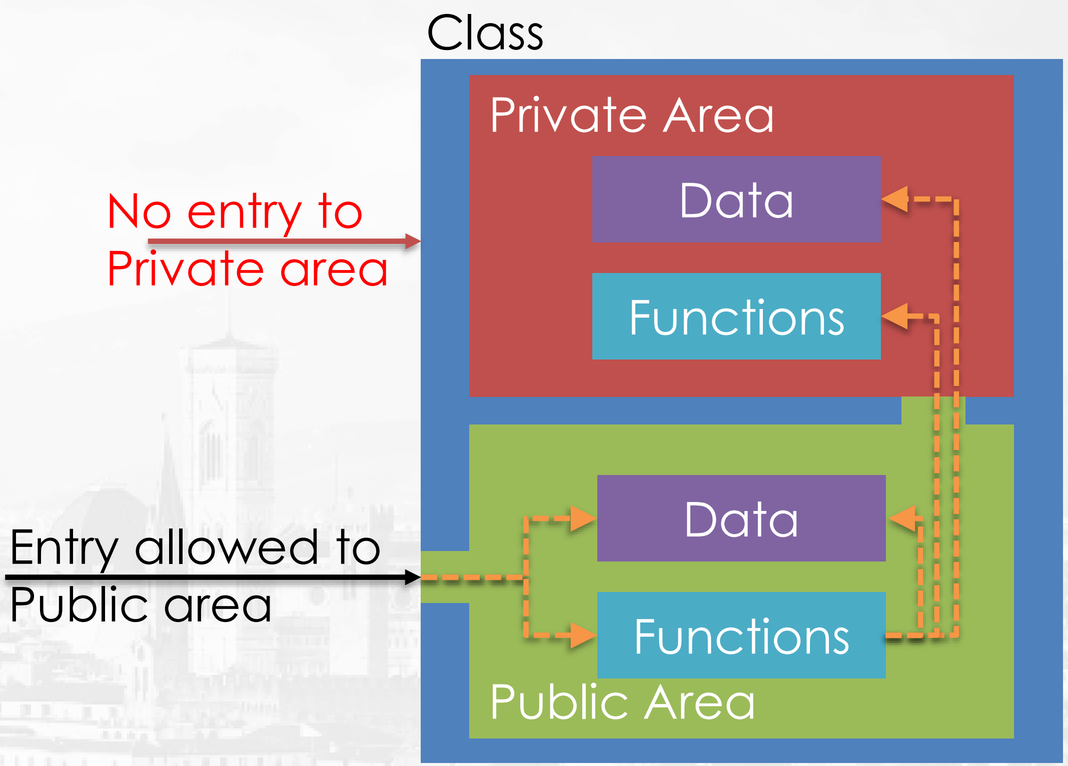
Less Restrictive

public
- Accessible from own class
- Accessible from derived class
- Accessible from class objects

protected
- Accessible from own class
- Accessible from derived class

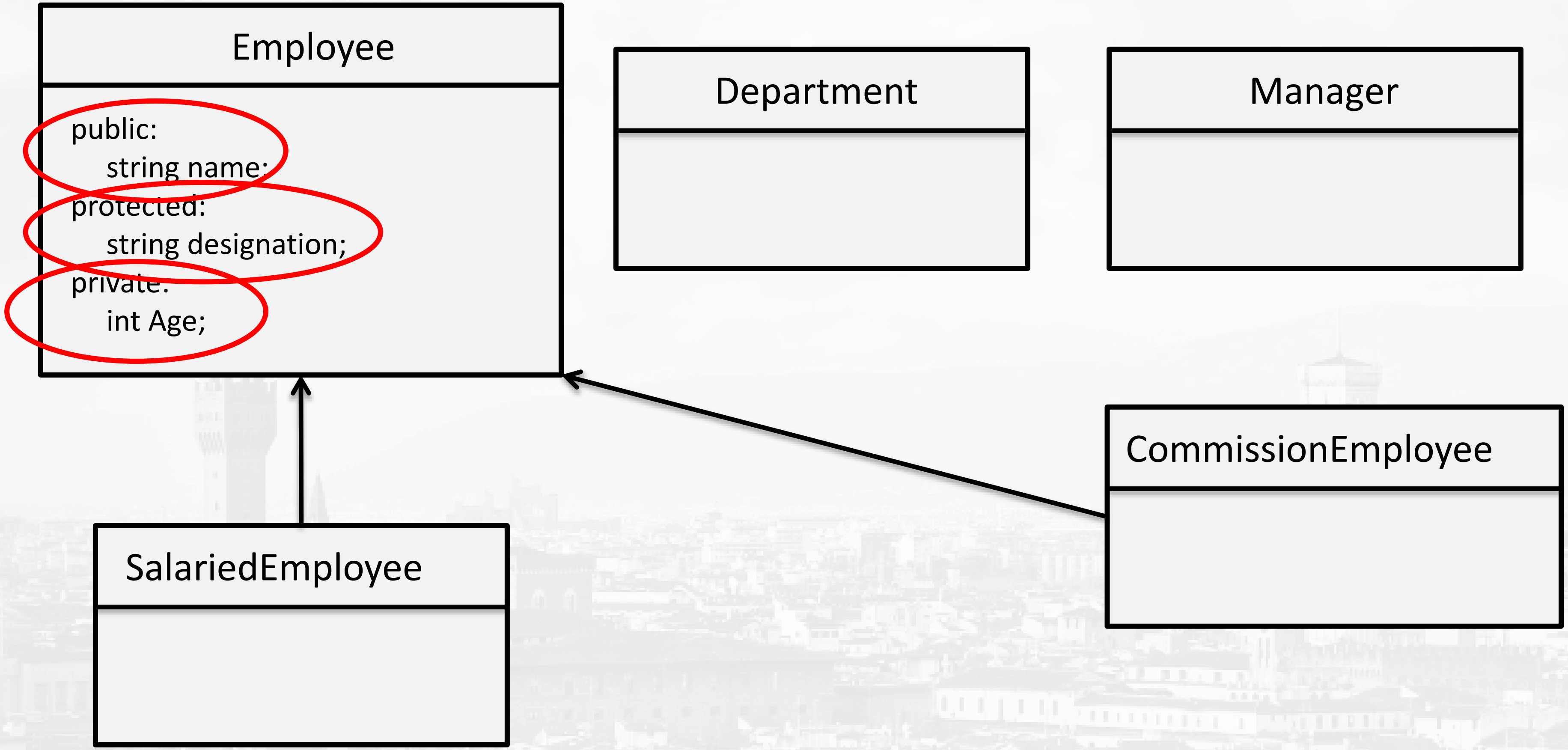
private
- Accessible from own class

More Restrictive



* In C++ By default all items defined in the class are private

Access Specifiers



Access Specifiers

```
class Person {
    public:                          //access control
        string firstName;     //these data members
        string lastName;      //can be accessed
        tm dateofBirth;       //from anywhere
    private:
        string address;   // can be accessed inside the class
        long int insuranceNumber;   //and by friend classes/functions
    protected:
        string phoneNumber; // can be accessed inside this class,
        int salary;     // by friend functions/classes and derived classes

};
```

Objects

- A class provides the blueprints for objects, so basically an object is created from a class.
- Objects of a class are declared with exactly the same sort of declar

```
#include <iostream>
using namespace std;
class Box {
        public:
        double length; // Length of a box
        double breadth; // Breadth of a box
        double height; // Height of a box
};

int main() {
       Box Box1; // Declare Box1 of type Box
       Box Box2; // Declare Box2 of type Box
       double volume = 0.0; // Store the volume of a box here
}
```

Class

Public data members

Objects of Box class

Objects

- The objects of class will have their own copy of data members.
- The public data members of objects of a class can be accessed using the direct member access operator (.)

```
int main() {
    Box Box1; // Declare Box1 of type Box
    Box Box2; // Declare Box2 of type Box
    double volume = 0.0; // Store the volume of a box here

    // box 1 specification
    Box1.height = 5.0;
    Box1.length = 6.0;
    Box1.breadth = 7.0;

    // box 2 specification
    Box2.height = 10.0;
    Box2.length = 12.0;
    Box2.breadth = 13.0;

    // volume of box 1
    volume = Box1.height * Box1.length * Box1.breadth;
    cout << "Volume of Box1 : " << volume <<endl;

    // volume of box 2
    volume = Box2.height * Box2.length * Box2.breadth;
    cout << "Volume of Box2 : " << volume <<endl;
    return 0;
}
```

Access data members of **Box1** object

Access data members of **Box2** object

Member Functions

- Can be defined inside class

```
return_type  function_name  (parameters)
{
        // function body
}
```

- Or outside the class

```
return_type  class_name::function_name (forma
{
        // function body
}
```

- Functions defined inside class are treated as inline functions by compiler

```
class Box {
  public:
    double length, breadth, height;
    double getVolume(void) {    //  Returns box volume
        return length * breadth * height;
    }
    double getSurfaceArea(void);    // returns surface area
};
// member function definition
double Box::getSurfaceArea(void) {
      ....
}
int main() {
      Box Box1;
      Box1.length = 10;
      Box1.height = 20;
      Box1.breadth=30;
      cout << "Volume of box: " << Box1.getVolume() << endl;
      cout << "Surface Area of box: " << Box1.getSurfaceArea() << endl;
}
```

Inline function

member function declaration

member function definition outside class

accessing member functions

Arrays of Objects

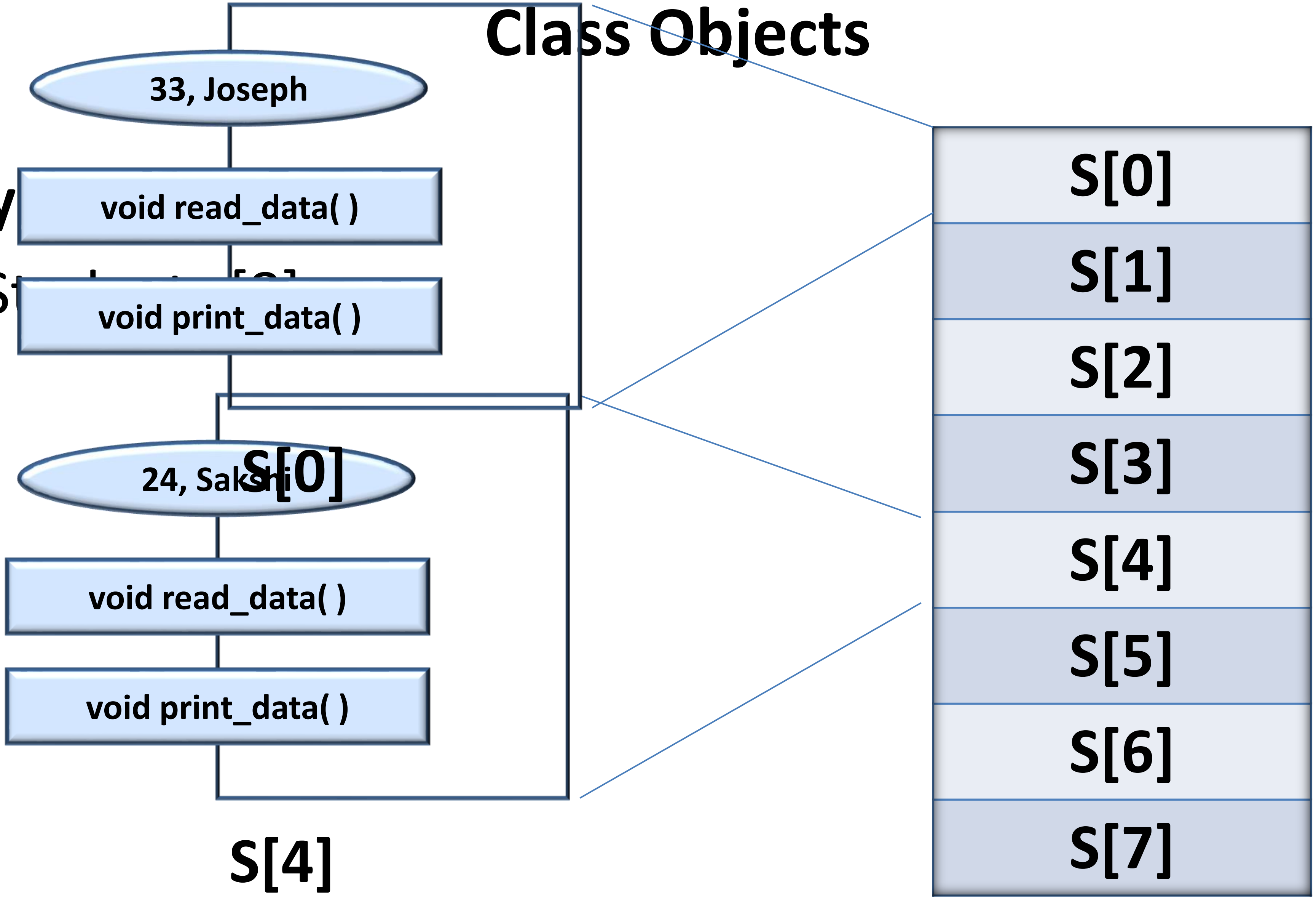
- **Several** objects of the **same class** can be declared as an array and used just like an array of any other data type.

- The **syntax** for declaring and using an object array is **exactly** the **same** as it is for any other type of array.

Class Objects

- **Array**

ex: St



Array of Objects

```
#include <iostream>
#include <string>
using namespace std;
class Student
{
        string name;
        int marks;
        public:
                void  setName()
                {
                        cin>>name;
                }
                void setMarks()
                {
                        cin >> marks;
                }
                void displayInfo()
                {
                        cout << "Name : " << name << endl;
                        cout << "Marks : " << marks << endl;
                }
};
```

```
int main()
{
        Student st[5];
        for( int i=0; i<5; i++ )
        {
                cout << "Student " << i + 1 << endl;
                cout << "Enter name" << endl;
                st[i].getName();
                cout << "Enter marks" << endl;
                st[i].getMarks();
        }

        for( int i=0; i<5; i++ )
        {
                cout << "Student " << i + 1 << endl;
                st[i].displayInfo();
        }
        return 0;
}
```

Static Members of a C++ Class

- We can define class members static using **static** keyword.
- When we declare a member of a class as static it means no matter how many objects of the class are created, there is only one copy of the static member.
- A static member is shared by all objects of the class. All static data is initialized to zero when the first object is created, if no other initialization is present.
- We can't put it in the class definition but it can be initialized outside the class as done in the following example by redeclaring the static variable, using the scope resolution operator :: to identify which class it belongs to.

Static Data Members of a C++ Class

```
#include <iostream>
 using namespace std;
class Box {
   public:
      static int objectCount;

      // Constructor definition
      Box(double l = 2.0, double b = 2.0, double h = 2.0)
{
         cout <<"Constructor called." << endl;
         length = l;
         breadth = b;
         height = h;

         // Increase every time object is created
         objectCount++;
      }
      double Volume() {
         return length * breadth * height;
      }
 private:
      double length;     // Length of a box
      double breadth;    // Breadth of a box
      double height;     // Height of a box
};
// Initialize static member of class Box
int Box::objectCount = 0;

int main(void) {
   Box Box1(3.3, 1.2, 1.5);    // Declare box1
   Box Box2(8.5, 6.0, 2.0);    // Declare box2

   // Print total number of objects.
   cout << "Total objects: " << Box::objectCount << endl;

   return 0;
}
```

Output:

Constructor called.
Constructor called.
Total objects: 2

Static Member Functions

- By declaring a function member as static, you make it independent of any particular object of the class.
- A static member function can be called even if no objects of the class exist and the **static** functions are accessed using only the class name and the scope resolution operator **::**.
- A static member function can only access static data member, other static member functions and any other functions from outside the class.
- Static member functions have a class scope and they do not have access to the **this** pointer of the class. You could use a static member function to determine whether some objects of the class have been created or not.

Static Member Functions

```
#include <iostream>
 using namespace std;
class Box {
  public:
    static int objectCount;
        // Constructor definition
    Box(double l = 2.0, double b = 2.0, double h = 2.0) {
      cout <<"Constructor called." << endl;
      length = l;
      breadth = b;
      height = h;
      // Increase every time object is created
      objectCount++;
    }
    double Volume() {
      return length * breadth * height;
    }
    static int getCount() {
      return objectCount;
    }
 private:
      double length;     // Length of a box
      double breadth;    // Breadth of a box
      double height;     // Height of a box
};

// Initialize static member of class Box
int Box::objectCount = 0;

int main(void) {
   // Print total number of objects before creating object.
   cout << "Initial Stage Count: " << Box::getCount() << endl;

   Box Box1(3.3, 1.2, 1.5);    // Declare box1
   Box Box2(8.5, 6.0, 2.0);    // Declare box2

   // Print total number of objects after creating object.
   cout << "Final Stage Count: " << Box::getCount() << endl;

   return 0;
}
```

Output:

Initial Stage Count: 0
Constructor called.
Constructor called.
Final Stage Count: 2

Static and non-static variable

```
#include <iostream>
Using namespace std;
 void foo()
 {
for( int i=0; i<5; ++i )
{
 static int staticVariable = 0;
 int local = 0;
 ++local;
 ++staticVariable;
 cout << local << "\t" << staticVariable << "\n";
 }
 } int main()
 {
 foo();
return 0;
 }
```

Results:

1 1

1 2

1 3

1 4

1 5

Dynamic Memory Allocation

- Dynamic memory allocation in C/C++ refers to performing memory allocation manually by programmer.
- Dynamically allocated memory is allocated on **Heap** and non-static and local variables get memory allocated on **Stack**
- Memory in C++ program is divided into two parts −
  - **The stack** − All variables declared inside the function will take up memory from the stack.
  - **The heap** − This is unused memory of the program and can be used to allocate the memory dynamically when program runs.

Applications of Dynamic Memory Allocation

- To allocate memory of variable size which is not possible with compiler allocated memory except variable length arrays.
- The most important use is flexibility provided to programmers. We are free to allocate and deallocate memory whenever we need and whenever we don't need anymore. There are many cases where this flexibility helps.
- Examples of such cases are Linked List, Tree, etc.

new and delete Operators

- The new operator denotes a request for memory allocation on the Heap

```
pointer-variable = new data-type;
// Pointer initialized with NULL
// Then request memory for the variable
int *p = NULL;
p = new int;
                                   OR
// Combine declaration of pointer
// and their assignment
int *p = new int;
```

Initialize memory:

pointer-variable = **new** data-type(value);

Example:

```
int *p = new int(25);
float *q = new float(75.25);
```

Pointers and Dynamic Memory

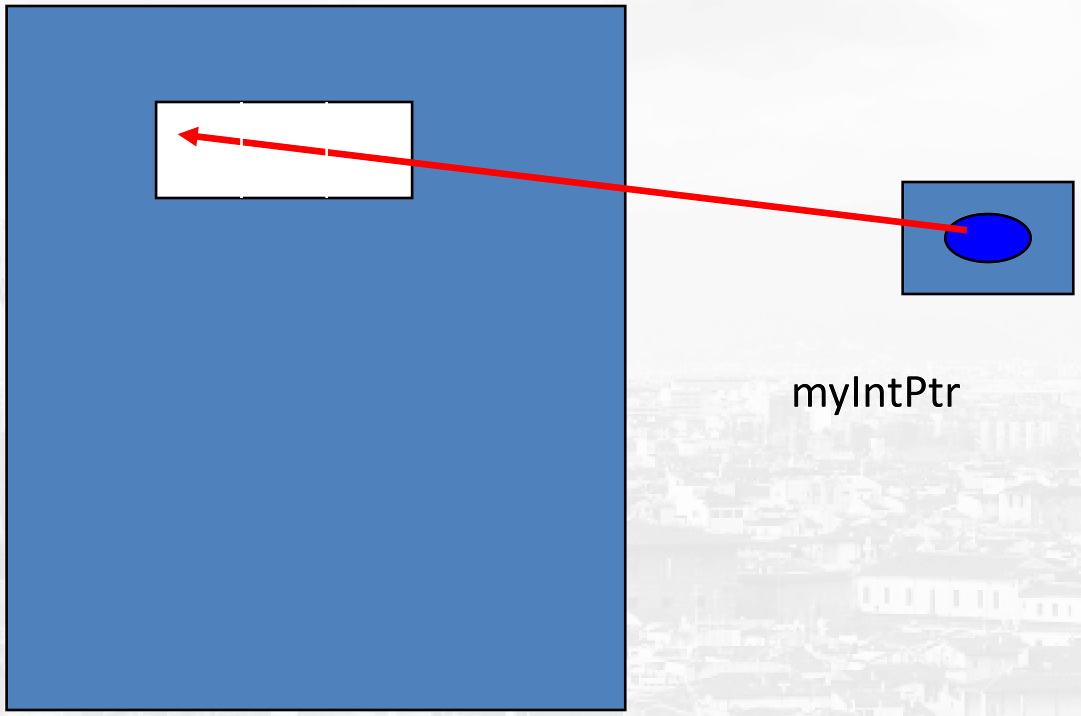
Here are the steps:

```
int * myIntPtr;        // create an integer pointer variable
myIntPtr = new int;    // create a dynamic variable  of the size integer
```

new returns a pointer (or memory address) to the location where the data is to be stored.

Pointers and Dynamic Memory

Free Store (heap)

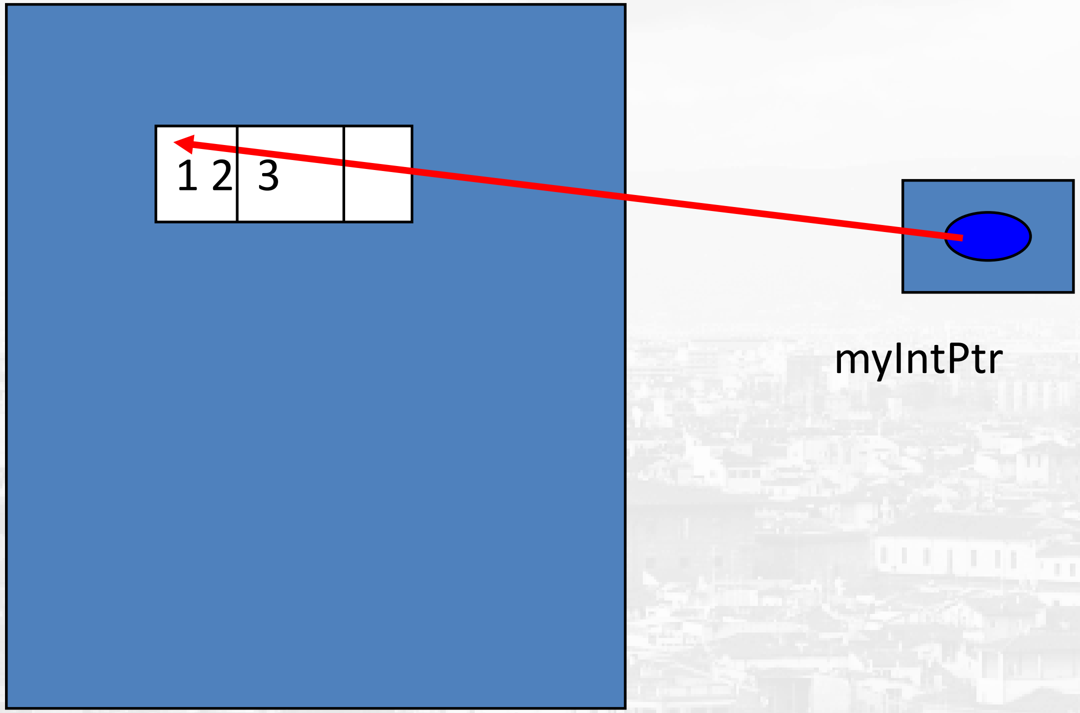



```
int * myIntPtr;
myIntPtr = new int;
```

Pointers and Dynamic Memory

Use pointer variable

Free Store (heap)




```
int * myIntPtr;
myIntPtr = new int;
```

```
*myIntPtr = 123;
```

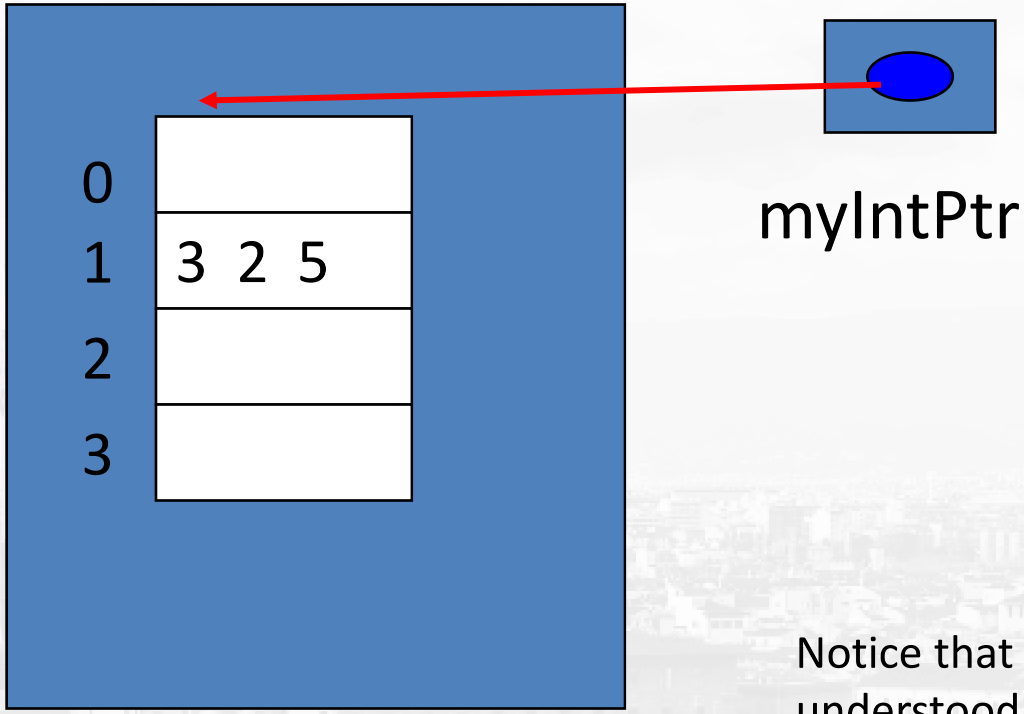
Pointers and Dynamic Memory

- We can also allocate entire arrays with the new operator. These are called dynamic arrays.

- This allows a program to ask for just the amount of memory space it needs at run time.

Pointers and Dynamic Memory

Free Store (heap)



int * myIntPtr;

myIntPtr = new int[4];

myIntPtr[1] = 325;

Notice that the pointer symbol is understood, no * is used to reference the array element.

Pointers and Dynamic Memory

- The *new* operator gets memory from the free store (heap).

- When you are done using a memory location, it is your responsibility to return the space to the free store. This is done with the *delete* operator.

```
delete myIntPtr;     // Deletes the memory pointed
delete [ ] arrayPtr; // to but not the pointer variable
```

Pointers and Dynamic Memory

- Dynamic memory allocation provides a more flexible solution when memory requirements vary greatly.

- The memory pool for dynamic memory allocation is larger than that set aside for static memory allocation.

- Dynamic memory can be returned to the free store and allocated for storing other data at later points in a program. (reused)

Inline functions

- On function call instruction, CPU stores the memory address of instruction following the function call
- CPU then transfers the control to callee function
- CPU executes callee function, stores function return value at predefined memory location/register and returns control back to caller
- It becomes an overhead if execution time of function is less than switching time for caller function

Inline functions

main.cpp

```
int main() {
      int x = 20;
      int y = 10;
      cout << "Sum of Numbers: " << AddNumbers(x, y) << endl;
      cout << "Difference between Numbers: " << SubtractNumbers(x, y);
      cout << "Multiplication of numbers: "  << MultiplyNumbers(x,
}
```

save regs
pass args

call AddNumbers

z = x – y;

restore regs

Mymaths.cpp

```
class ArithmaticOperations {
      int AddNumbers(int x, int y){
            int z;
            z = x + y;
            return z;
      }
      inline int SubtractNumbers (int x, int y) {
            int z;
            z = x – y;
            return z;
      }
      int MultiplyNumbers (int x, int y) {
            int z;
            z = x * y;
            return z;
      }
};
```

PROLOG

EPILOG

Inline Functions

- Inline functions reduce the call overhead.
- Inline functions gets expanded when called
  - i.e. when inline function is called, entire code of inline function is inserted/substituted at point of inline function call
  - The substitution is performed by compiler at compile time

```
inline return-type function-name(parameters)
{
   // function code
}
```

- By default compiler treats class methods defined under class as inline functions

```
class Employee {
  static int EmployeeId;
  public:
    int getEmpId (void) {
        return ++EmployeeId;
    }
    void addEmployee(str);
};
void Employee::addEmployee(str name) {
    newId = getEmpId();
    cout << "Added New Empl " <<name  <<" with Id: "<<
newId <<endl;
    ….
}
int Employee::EmployeeId
int main() {
     Employee Emp_A, Emp_B;
     Emp_A.addEmployee("Amit");
     Emp_B.addEmployee("Bijoy");
}
```

…ata Members

…ch are shared by all objects are known as …

…ble is maintained by th… …d it is …

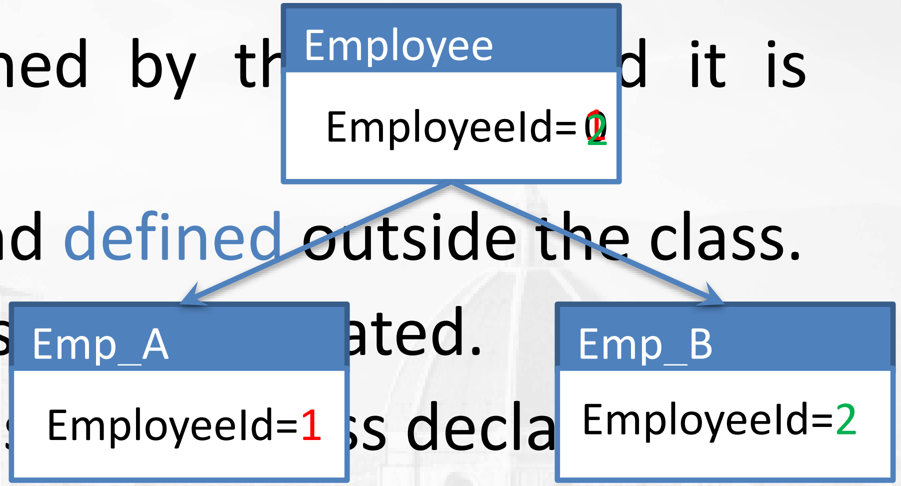
…ide the class and defined outside the class.

…irst object of its … …ated.

…nber variable in… …ss decla…

…out its lifetime is the entire program.

…used to maintain values common to the entire class.




```
# a.out
Added New Empl Amit with Id: 1
Added New Empl Bijoy with Id: 2
```

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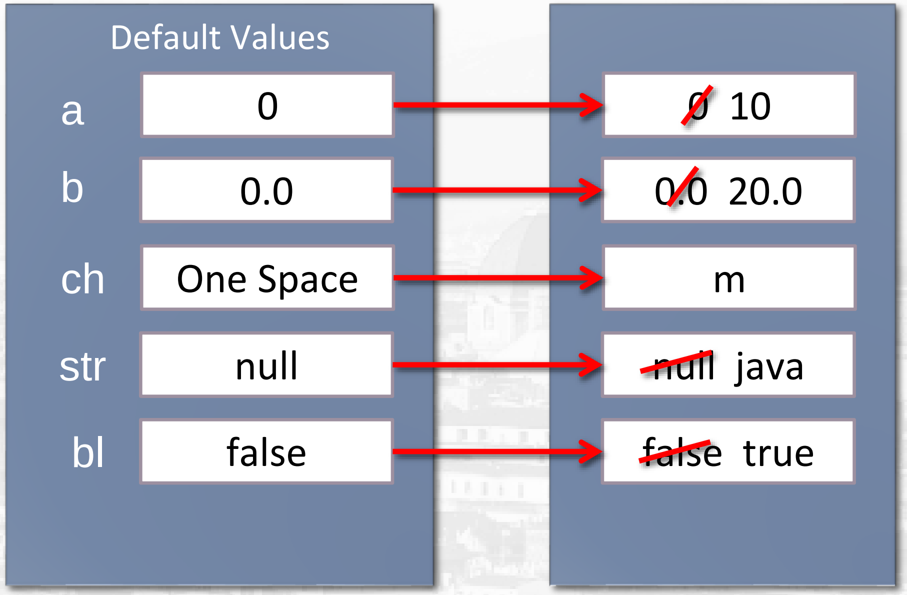
Constructors

- A constructor is a special member function that is a member of a class and has **same** name as that of class.
- It is used to initialize the object of the class type with a legal initial value.
- It is called constructor because it constructs the values of data members of the class.

```
Class A
{
        int a;
        float b;
        char ch;
        String str;
        boolean bl;

A()
{
        a=10;
        b=20.0;
        ch='m';
        str="java"
        bl=true
}
}
```



Constructor - Declaration

- For the T class:

  T(args); // inside class definition

  or T::T(args); // outside class definition

```
class X {
    int i ;
    public:
            int j,k ;
            X() {
                i = j = k =0;
            }
};
 X::X()
{
i = j = k =0;
}
```

Inside class

Outside class (a.k.a. inline definition)

Constructor - Properties

Name same as Class name

```
class X {
    int i ;
    public:
        int j,k ;
        X() {
            i = j = k =0;
        }
};
```

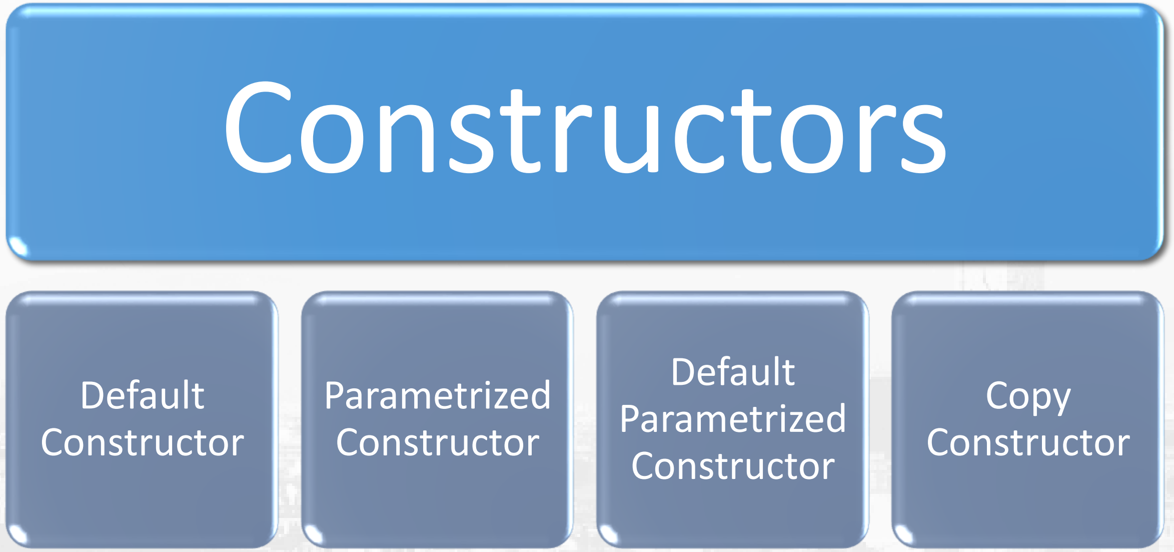
Under public section

Does not return anything. Not even void

- Automatically called when an object is created
- We can define our own constructors
- They can not be inherited.
- Constructors cannot be static.
- Overloading of constructors is possible
- Constructors can have default argument as other C++ functions.
- If you do not specify a constructor, the compiler generates a default constructor for you (expects no parameters and has an empty body).
- Default and copy constructor are generated by the compiler whenever required.

Types of Constructors

- There are several forms in which a constructor can take its shape, namely



Default Constructor

- This constructor has no argument in it
  - Compiler creates one, if not explicitly defined
- Default Constructor is also called as *no argument constructor*

```
class rectangle{
		private:
				float height;
				float width;
		public:
rectangle(){
		cout <<“creating rectangle object”;
}
};
```

```
int main()
{
		rectangle rect;
}
```

```
# a.out
creating rectangle object
```

Parameterized Constructors

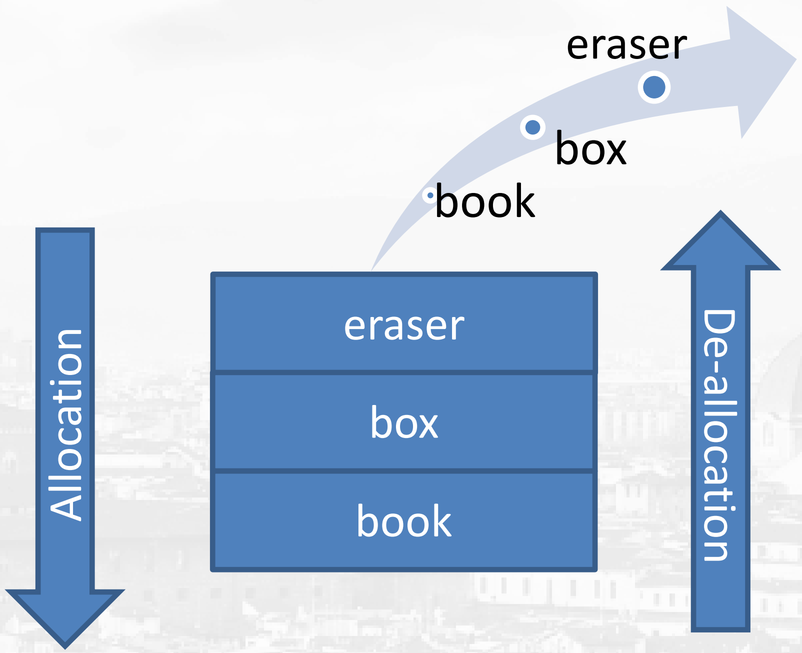
- A parameterized constructor is just one that has parameters specified in it.
- We can pass the arguments to constructor function when object is created.
- A constructor that can take arguments are called *parameterized constructors*

```
class rectangle{
    private:
        float height;
        float width;
     public:
        rectangle(float h, float w){
            height=h;
            width=w;
        }
};
```

```
int main()
{
        rectangle book(10.0, 20.0); //implicit call
        rectangle box = rectangle(20.0,30.0) //explicit call
        rectangle eraser= rectangle(25.0, 35.0)
}
```

Memory Allocation

- It is important to understand that compiler allocates memory to objects sequentially and destroys in reverse order. This is because C++ compiler uses the concept of stack in memory allocation and de-allocation



Default Parametrized Constructors

- Default argument is an argument to a function that a programmer is not required to specify.
- C++ allow the programmer to specify default arguments that always have a value, even if one is not specified when calling the funtion

    e.g. int power(int a, int b=2);

- The programmer may call this function in two ways

    result = power(10,3); // result = 10^3 = 1000

    result = power(10); // result = 10^2 = 100

- On similar lines, it is possible to define constructors with default parameters

    rectangle(float h=1.0, float w=2.0)

    and hence these are valid call statements

        rectangle book(10.0, 20.0); // results into book object with height=10.0, width=20.0

        rectangle box(10.0); // results into box object with height=10.0, width=2.0

Constructor Overloading

- You can have more than one constructor in a class, as long as each has a different list of arguments

```
class rectangle{
        private:
                float height;
                float width;
        public:
          rectangle(){
            height=width=10.0;
          }
           rectangle(float h, float w){
                height=h;
                width=w;
           }
        };
```

Overloaded Constructors

```
class Addition
{
    int num1,num2,res;
    float num3, num4, f_res;
    public:
    Addition(int a, int b); // int constructor
    Addition(float m, float n); //float constructor
    void add_int( );
    void add_float();
    void print();
};
```

Overloaded Constructor with parameters B'Coz they are also functions!

Example of default and default parameterized constructor

```
class rectangle{
        private:
                float height;
                float width;
        public:
                rectangle(float h, float w);
rectangle(){
        height=width=1.0;
}
rectangle(float h, float w=5.0){
        height = h;
        width = w;
}
};
```

```
void main()
{
   rectangle book(); //implicit call of default constructor
   rectangle box(20.0); //implicit call of default
                              parametrized constructor
   rectangle eraser(10.0, 20.0); // explicit call of default
                              parametrized constructor
   rectangle sharpener = rectangle(10);
   rectangle geometry_box = rectangle(50.0,70.0);
   paper = rectangle (3.0, 6.0);
   calculator = rectangle (15.0, 25.0) //explicit call
                                      for existing object
}
```

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Copy Constructor

clare and initialize an object

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```
class rectangle{
        private:
                float height;
                float width;
        public:
                rectangle(float h, float w);

rectangle(float h, float w){
        height=h;
        width=w;
}
rectangle(rectangle &p){
        height = p.height;
        width = p.width;
}
};
```

```
int main()
{
        rectangle book_1(10.0, 20.0);
        rectangle book_2(book_1);
}
```

This would define the book_2 object and at the same time initialize it to the value of book_1. i.e. height and width of book_2 object would be 10 and 20 respectively

Destructors

- A destructor is used to destroy the objects that have been created by a constructor.
- Like constructor, the destructor is a member function whose name is the same as the class name but is preceded by a tilde.

  ~T();

- It is a good practice to declare destructors in a program since it releases memory space for further use.
- Whenever ***new*** is used to allocate memory in the constructor, we should use ***delete*** to free that memory.

NOTE:
A class can have **ONLY ONE** destructor

Destructors

Syntax:

```
class class_name
{
public:
~class_name();
};
```

Example:

```
class student
{
        public:
      ~student()
        {
          cout<<“Destructor”;
        }
};
```

Destructors

- It is a special member function of a class, which is used to destroy the memory of object
- Its name is same as class name but tilde sign preceding destructor
- It must be declared in public section
- It does not return any value; not even void
- It can be defined inline/offline
- Does not need to call because it gets call automatically whenever object is destroyed from its scope
- It can be called explicitly also using <u>delete</u> operator
- Destructor do **not** have **arguments** & **return type**.
- Destructor cannot be overloaded nor inherited.

Destructors

```
int count=0;
class rectangle
{
  public:
   rectangle(){
          count++;
          cout<<"\n Created ObjectId:"<<count;
    }
 ~rectangle() {
           count<<"\n Destroyed ObjectId:"<<count;
          count--;
          }
};
```

```
int main()
{
        cout<<"\n enter main";
        rectangle a1,a2,a3,a4
        {
                cout<<"\nEnter block1";
                alpha a5;
        }
        {
        cout<<"\nEnter block2";
        rectangle A6;
        }
        cout<<"\nRe-enter main";
        return 0;
}
```

```
#a.out
enter main
Created ObjectId:1
Created ObjectId:2
Created ObjectId:3
Created ObjectId:4
Enter block1
Created ObjectId:5
Destroyed ObjectId:5
Enter block2
Created ObjectId:5
Destroyed ObjectId:5
Re-enter main
Destroyed ObjectId:4
Destroyed ObjectId:3
Destroyed ObjectId:2
Destroyed ObjectId:1
```

Example of Dynamic Arrays

```
#include <iostream>
using namespace std;
class Box {
   public:
      Box() {
         cout << "Constructor called!" <<endl;
      }
      ~Box() {
         cout << "Destructor called!" <<endl;
      }
};
int main() {
   Box* myBoxArray = new Box[4];
   delete [] myBoxArray; // Delete array
   return 0;
}
```

Output

```
Constructor called!
Constructor called!
Constructor called!
Constructor called!
Destructor called!
Destructor called!
Destructor called!
Destructor called!
```

Friend Functions/Classes

- friends allow functions/classes access to private data of other classes.
- **Friend functions**
  - A 'friend' function has access to all private and protected members (variables and functions) of the class for which it is a 'friend'.
  - friend function is not the actual member of the class.
  - To declare a 'friend' function, include its prototype within the class, preceding it with the C++ keyword '**friend**'.

Program to illustrate the use of a friend function

```
include <iostream>
using namespace std;
class sample
{
        int a;
        int b;
  public:
void setvalue()
    {
        a=25;
        b=40;
    }

friend float mean(sample s);
};

float mean(sample s)
  {
     return float(s.a + s.b)/2.0;
  }
```

```
int main()

{
sample X;       // object X
X.setvalue();
cout « "Mean value = " « mean(X)<<"\n”;
return 0;
}
```

Output:

Mean value=32.5

Example

```
class Employee
{
private:
            string name;
            double salary;
             friend void raiseSalary(double a, Employee &e);
public:
            Employee();
            Employee(string n, double s);
            string getName();
            double getSalary();
};
Employee::Employee() : name(""), salary(0) {}
Employee::Employee(string n, double s): name(n), salary(s) {}
string Employee::getName() { return name; }
double Employee::getSalary() { return salary; }
void raiseSalary(double a, Employee &e)
{
e.salary += a;// Normally not allowed to access e.salary
}
```

```
class Boss
{
public:
     Boss();
      void giveRaise(double amount);
private:
    Employee e;
};
Boss::Boss() {}
void Boss::giveRaise(double amount)
{
raiseSalary(amount,e);
cout << e.getSalary() << endl;
}
```

Friend Function

```
#include <iostream>
using namespace std;
class XYZ
{
private:
int num=100;
       char ch='Z';
public:
friend void disp(XYZ obj);
 };
```

```
void disp(XYZ obj)
{
cout<<obj.num<<endl;
cout<<obj.ch<<endl;
}
int main()
{ XYZ obj;
  disp(obj);
  return 0;
}
```

Output:

```
100
Z
```

Friend Class Example

```cpp
#include <iostream>
using namespace std;
class XYZ
{
private:
		char ch='A';
		int num = 11;
 public:
	friend class ABC;
};
class ABC
{
public:
		void disp(XYZ obj)
		{
		 cout<<obj.ch<<endl;
		 cout<<obj.num<<endl;
		}
};
```

```cpp
int main()
{
 ABC obj;
 XYZ obj2;
 obj.disp(obj2);
 return 0;
}
```

Output:

```
	A
	11
```

References