CET1046B Object Oriented Concepts with C++ and Java

School of Computer Engineering and Technology

CET1046B Object Oriented Concepts with C++ and Java

Teaching Scheme
Theory: 2 Hrs / Week

Credits: 01 + 01
Practical: 2Hrs/Week

Course Objectives:

1. Knowledge
- Learn object oriented paradigm and its fundamentals.

2. Skills
- Understand Inheritance, Polymorphism and dynamic binding using C++ and Java
- Study the concepts of Exception Handling and file handling using C++ and Java

3. Attitude
- Learn to apply advanced concepts to solve real world problems.

Course Outcomes:

After completion of this course, students will be able to:

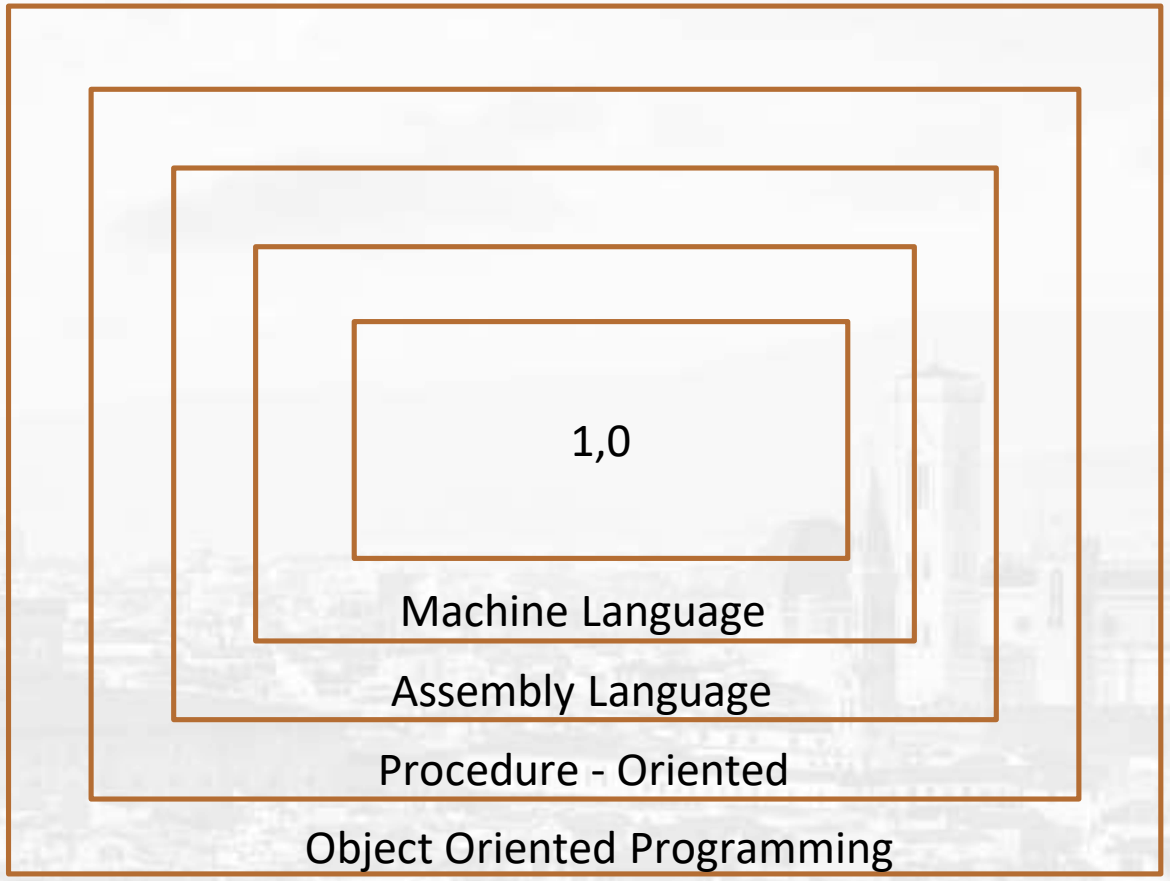
1. Apply the basic concepts of Object Oriented Programming to design an application.
2. Make use of Inheritance and Polymorphism to develop real world applications.
3. Apply the concepts of exceptions and file handling to store and retrieve the data.
4. Develop an application using advance concepts.

Syllabus

Module No	Content
1	**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.
2	**Inheritance and Polymorphism** **Inheritance:** Types of inheritance, Virtual Base Class **Polymorphism:** Introduction to Polymorphism, Types of Polymorphism: Static polymorphism, Dynamic polymorphism. Virtual Function, Abstract base Class, Interfaces. Case study/examples with respect to C++, JAVA Programming languages.
3	**Exception Handling and File and IO Streams**: Introduction, Exception Handling Mechanism - try, catch and throw, Multiple Exceptions **File and IO Streams:** Stream and Files, Stream Classes, File Pointers, File I/O with Member Functions. Case study/examples with respect to C++, JAVA Programming languages.
4	**Advance concepts:** Introduction to STL, Collection framework Case study/examples with respect to C++, JAVA Programming languages.

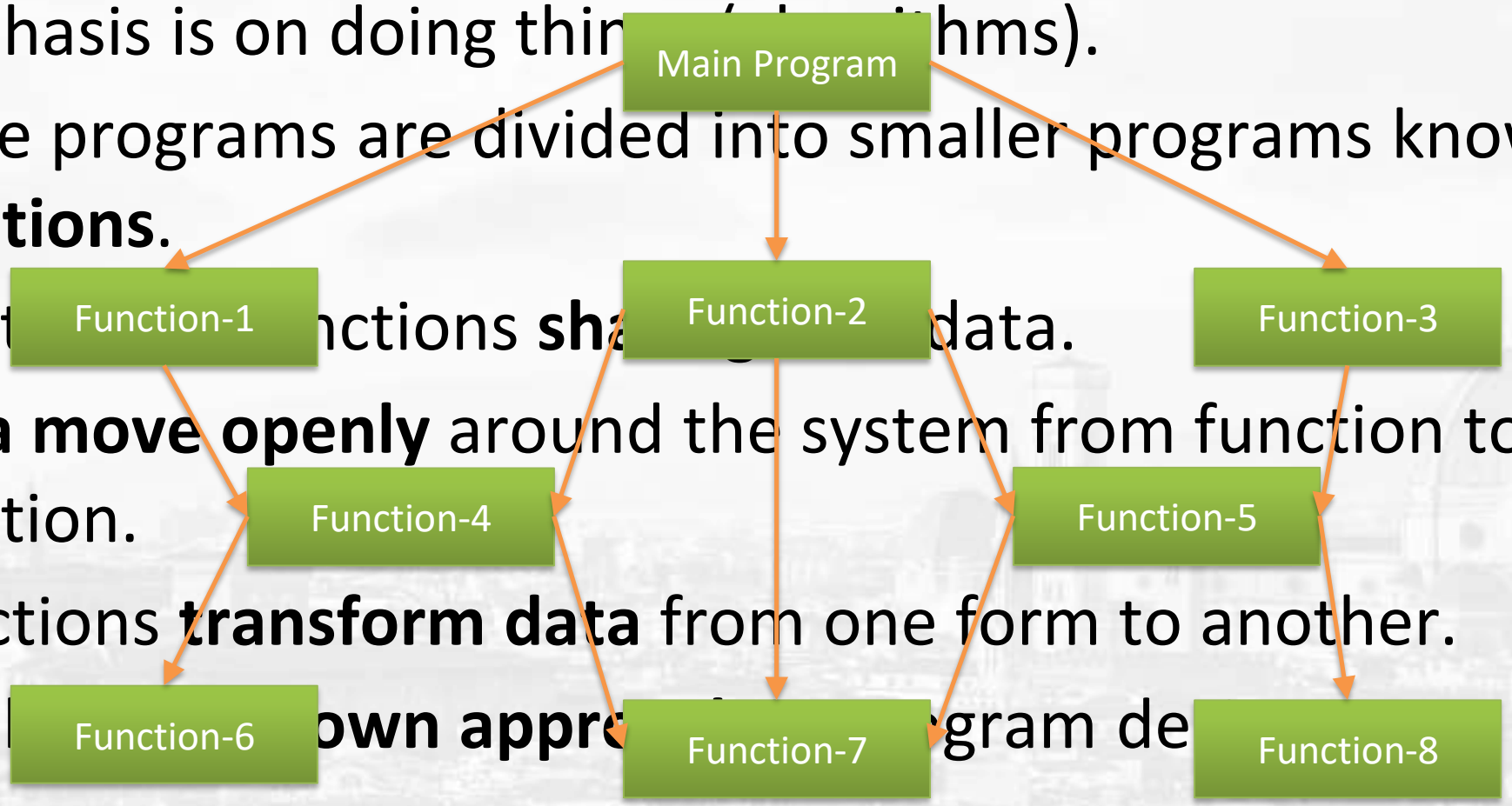
Fundamentals of OOP

Software Evolution



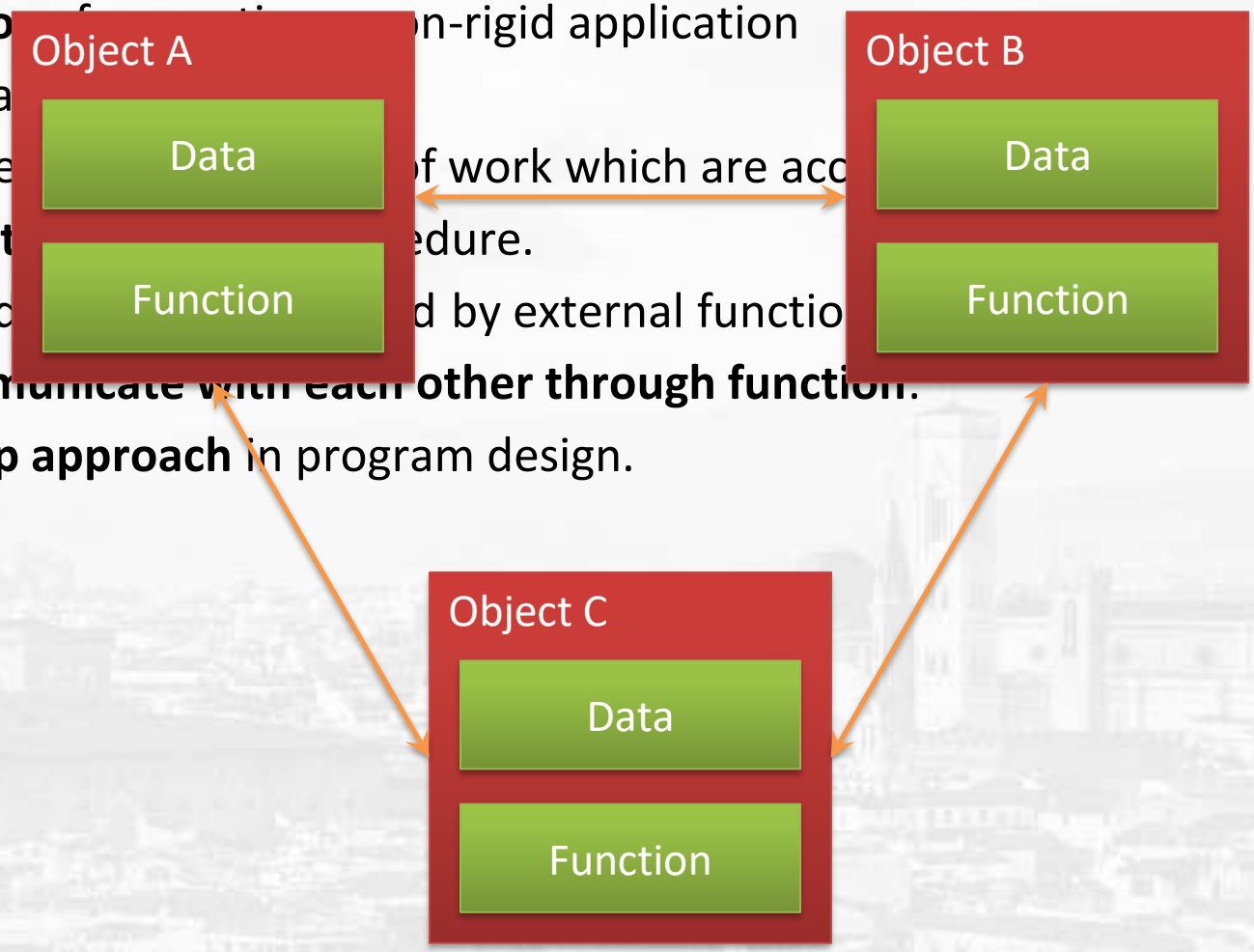
Procedural Programming

- Emphasis is on doing thin hms).
- Large programs are divided into smaller programs known as **functions**.
- Most nctions **sha** data.
- **Data move openly** around the system from function to function.
- Functions **transform data** from one form to another.
- Empl **own appro** gram de



Object Oriented Programming

- **Design methodolo** n-rigid application
- Works on entity ca
- Decompose proble f work which are acc
- **Emphasis is on dat** edure.
- **Data is hidden** and d by external functio
- Objects may **communicate with each other through function**.
- Follows **bottom up approach** in program design.

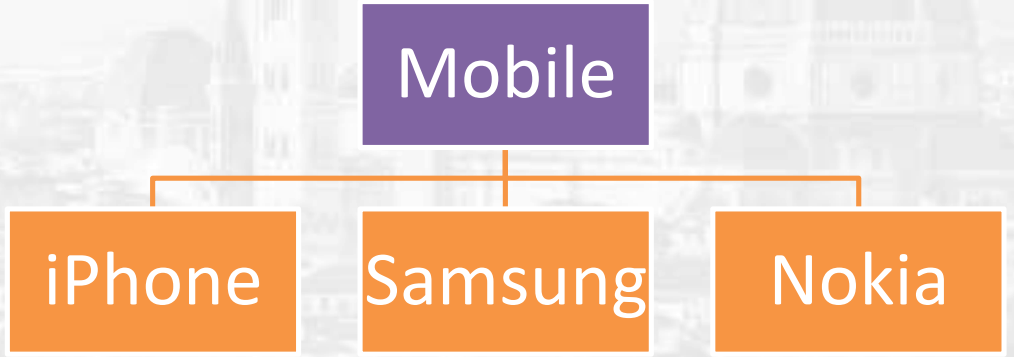


Features of OOP

- Programming language with OOP support has to fulfill these features
  - Abstraction
  - Encapsulation
  - Inheritance
  - Polymorphism

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



Objects

- Any **real world entity** which can have some characteristics or which can perform some work.
  - 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***.
  - objects are differentiated from each other via some identity (e.g. IMEI number) or its characteristics.

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

Mobile
Class

- Properties
  - Processor
  - IMEICode
  - IsSingleSIM
- Methods
  - Dial
  - Receive
  - SendMessage
  - GetWifiConnection
  - ConnectBlueTooth
  - GetIMEICode

```
class Mobile
{
    private:
        string IMEICode, SIMCard, Processor;
        int InternalMemory;
        bool IsSingleSIM;
    public:
        void GetIMEICode()  {
            cout << "IMEI Code - IEDF34343435235";
        }
        void Dial() {
            cout << "Dial a number";
        }
        void Receive() {
            cout << "Receive a call";
        }
        void SendMessage(){
            cout << "Message Sent";
        }
}
```

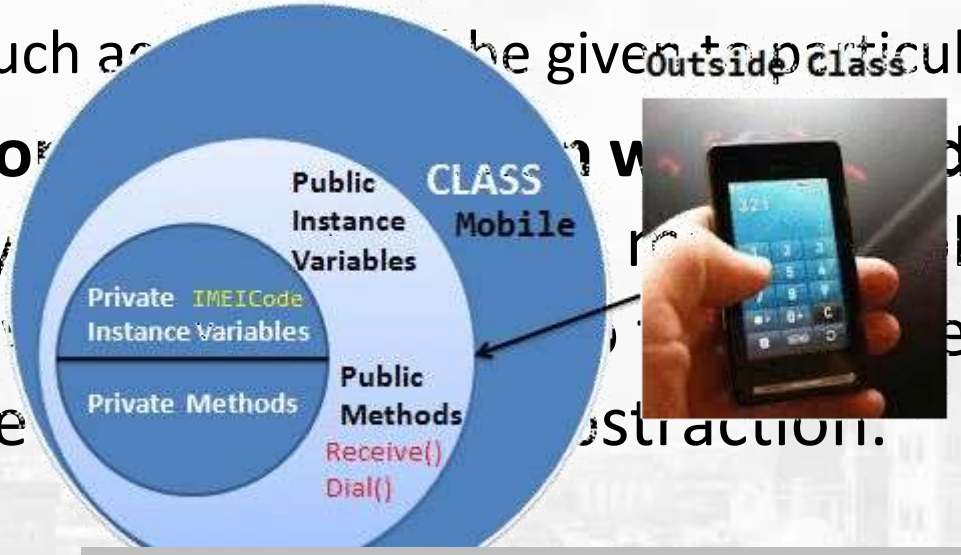
Abstraction

- 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

- Encapsulation is defined as the process of **enclosing one or more details** from outside world through access right.
  - It says how much ac… be given to particular details.
- Both **Abstractio… w… d in hand** because Abstraction say… r… le & Encapsulation provides the le… … e details. i.e. – It implements the … …straction.




```
private:
    string IMEICode = "76567556757656";
```

Polymorphism

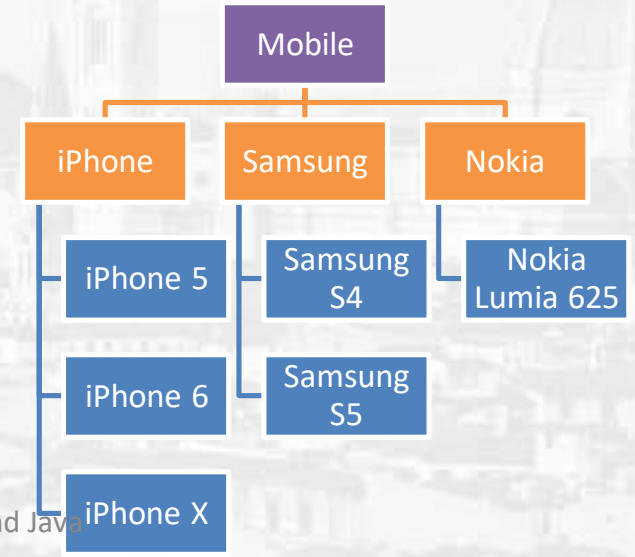
```
class Samsumg :public  Mobile
{
   public:
      void GetWIFIConnection()  {
           cout<<"WIFI connected";
      }
        //This is one method which shows camera functionality
       void CameraClick()  {
            cout<<“Camera clicked";
       }
         //overloaded method which shows camera functionality as well but with panaroma mode
       void CameraClick(string CameraMode) {
            cout<<"Camera clicked in " + CameraMode + " Mode";
       }
}
```

Polymorphism

- **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.

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 4 types of inheritance:
  - Single level inheritance
  - Multi-level inheritance
  - Hierarchical inheritance
  - Hybrid inheritance
  - Multiple inheritance



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

Application 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 expertext
  - AI and expert systems
  - Neural networks and parallel programming
  - Decision support and office automation systems
  - CIM/CAM/CAD systems

Why C++ ?

- C++ is a versatile language for handling very large programs including editors, compilers, databases, communication systems and any complex real life applications systems
  - C++ allows create **hierarchy related objects** to build special object-oriented libraries which can be used later by many programmers.
  - the C part of C++ gives the language the **ability to get close to the machine-level** details.
  - C++ programs are **easily maintainable and expandable** - it is very easy to add to the existing structure of an object.
  - It is expected that C++ will replace C as a general-purpose language in the near future.

BASICS OF C++

Simple C++ Program

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

using namespace std;

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

   return 0;
}
```

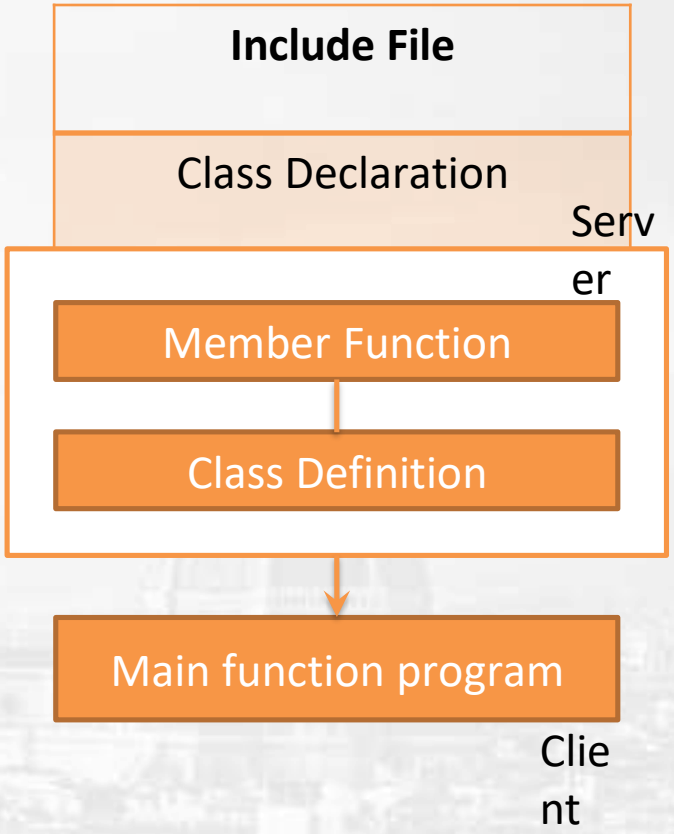
instructs the compiler to include the contents of the file enclosed within angular brackets into the source file.

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

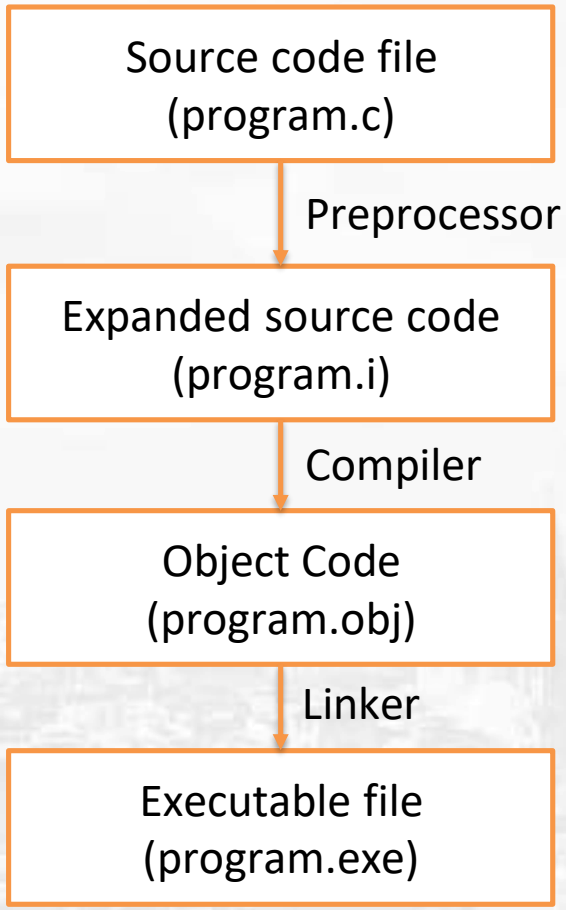
every main() returns an integer value to operating system and therefore it should end with return (0) statement

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/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 Defination

- 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

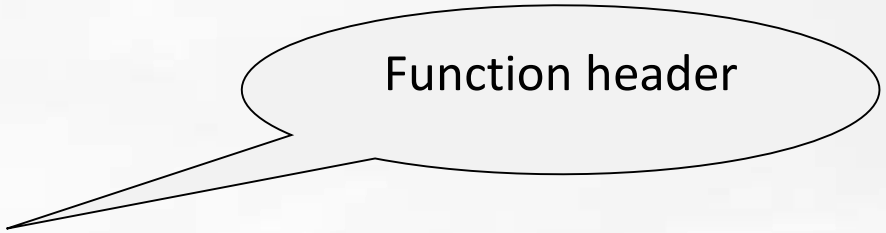
```
<return value> <name> (<parameter list>)
```

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

Example of User-defined C++ Function

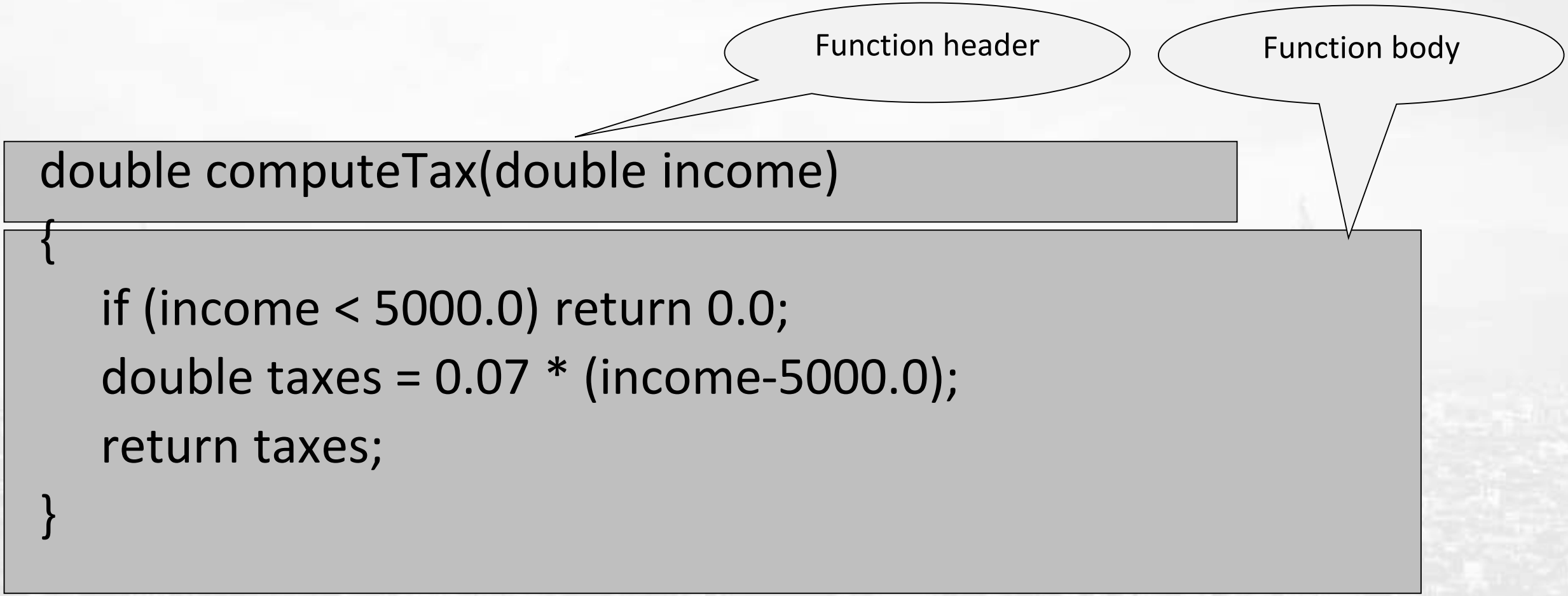
```
double computeTax(double income)
{
    if (income < 5000.0) return 0.0;
    double taxes = 0.07 * (income-5000.0);
    return taxes;
}
```

Example of User-defined C++ Function



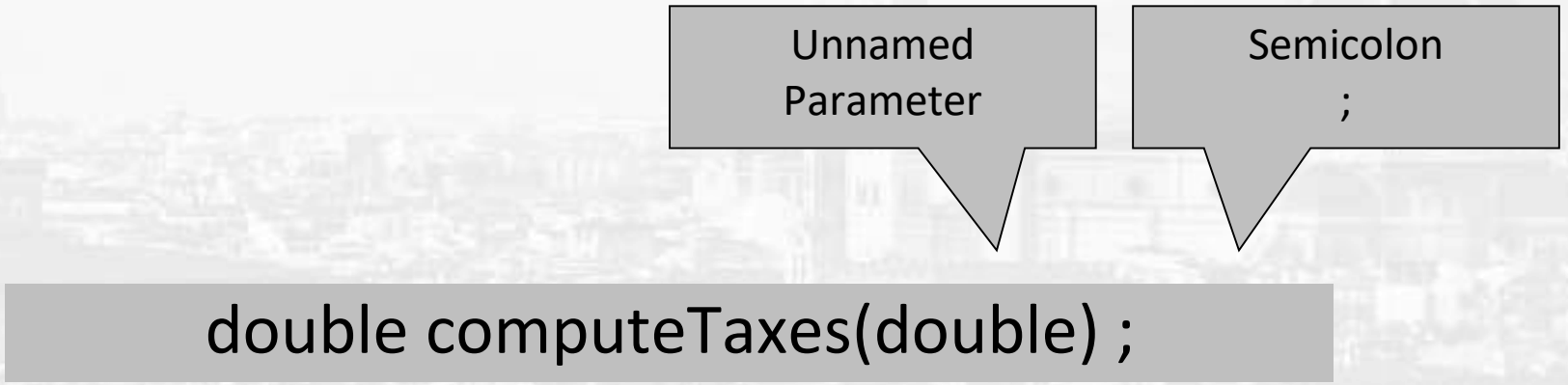

```
double computeTax(double income)
{
    if (income < 5000.0) return 0.0;
    double taxes = 0.07 * (income-5000.0);
    return taxes;
}
```

Example of User-defined C++ Function



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



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 is $" << 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);

Reference Variables

- A reference is an *alias*, or an *alternate name* to an existing
  - Contains the address of a variable (like a pointer)

```
int x = 5;
int &z = x;          // z is another
name for x
```

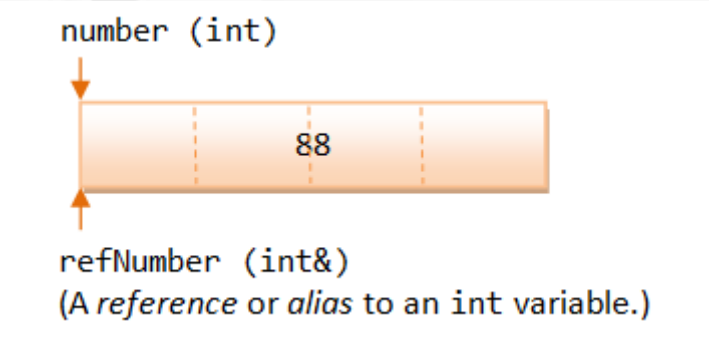
  - No need to perform any dereferencing (unlike a pointer)
  - Must be initialized when it is declared

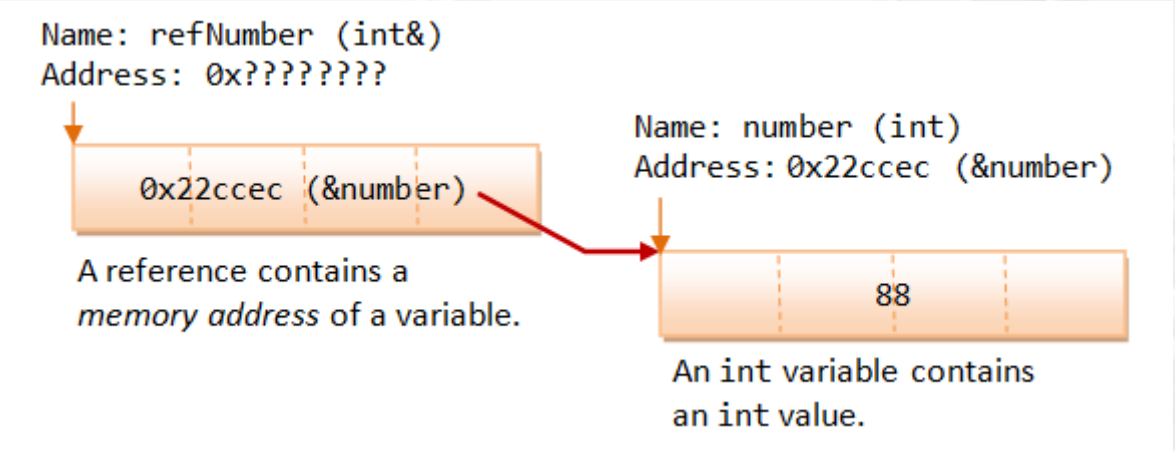
```
int &y ;          //Error: reference must be initialized
```

- References acts as function formal parameters to support pass-by-reference
- Any changes to reference variable inside the function are reflected outside the function

How References Work?

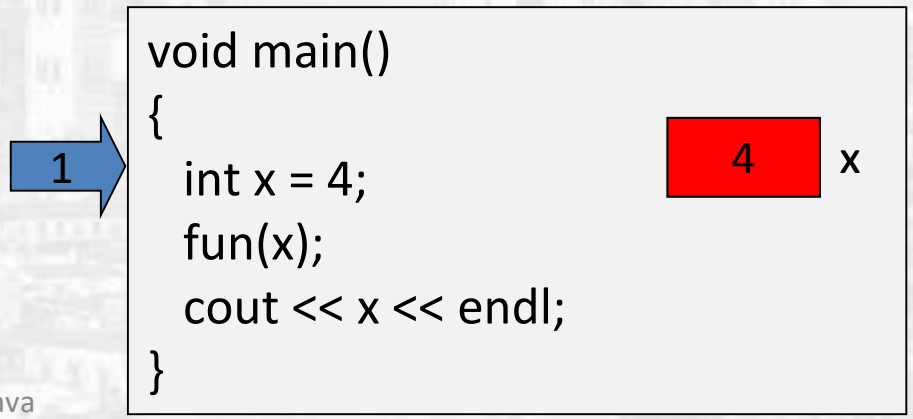
```
type &newName = existingName;
int number = 88; // Declare an int variable called number
int & refNumber = number; // Declare a reference (alias)
```





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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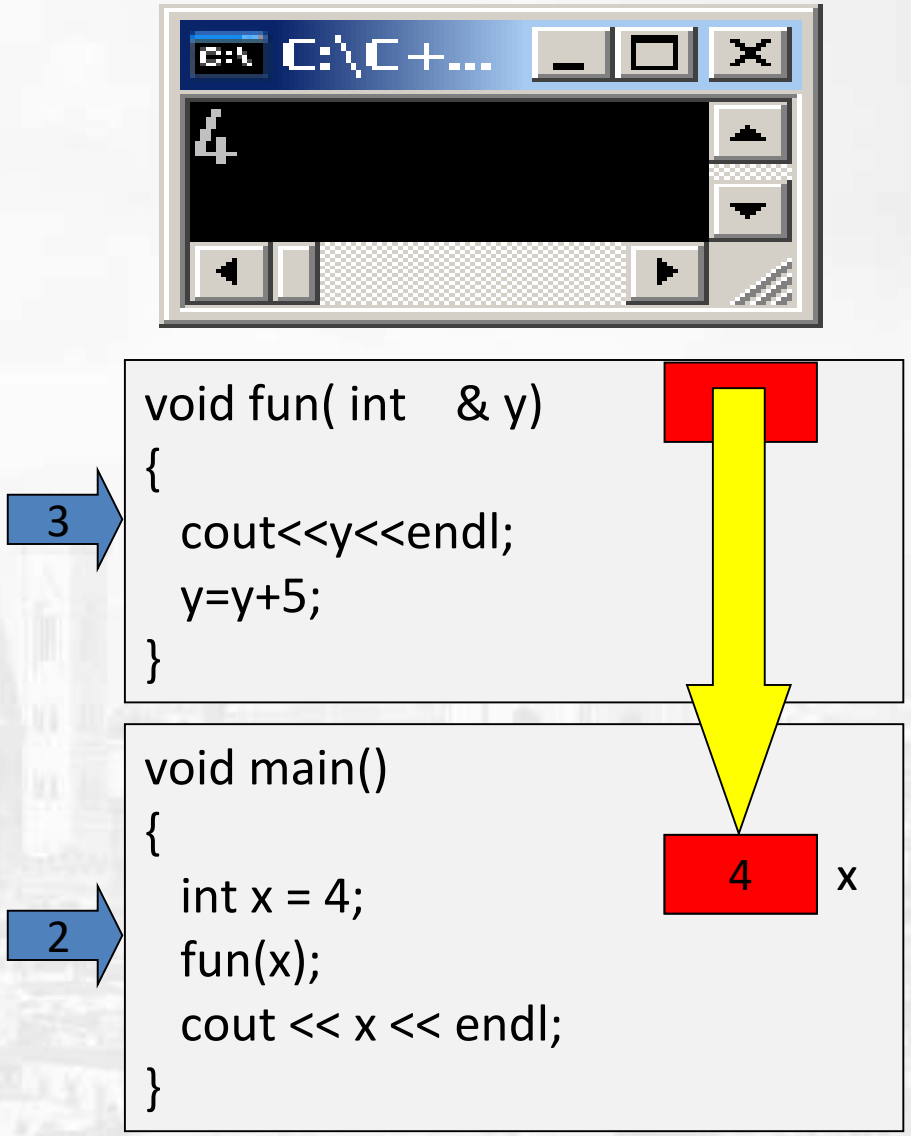
    cout << x << endl;
}
```



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;
}
```
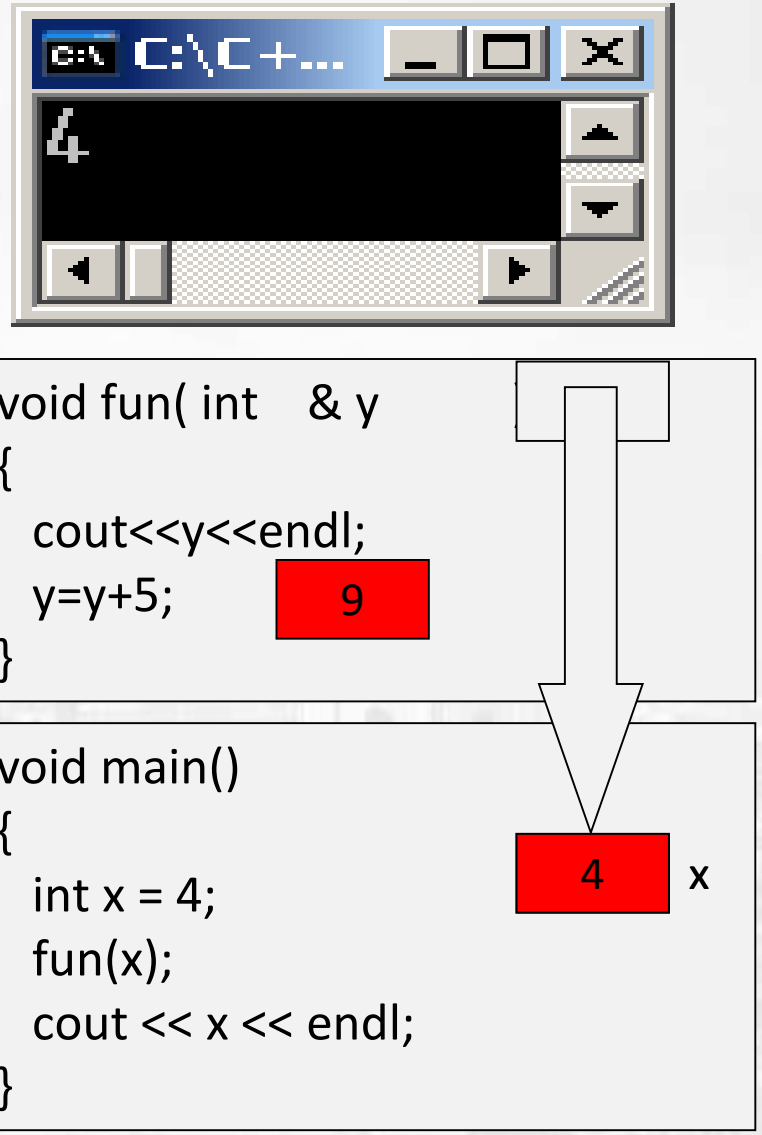
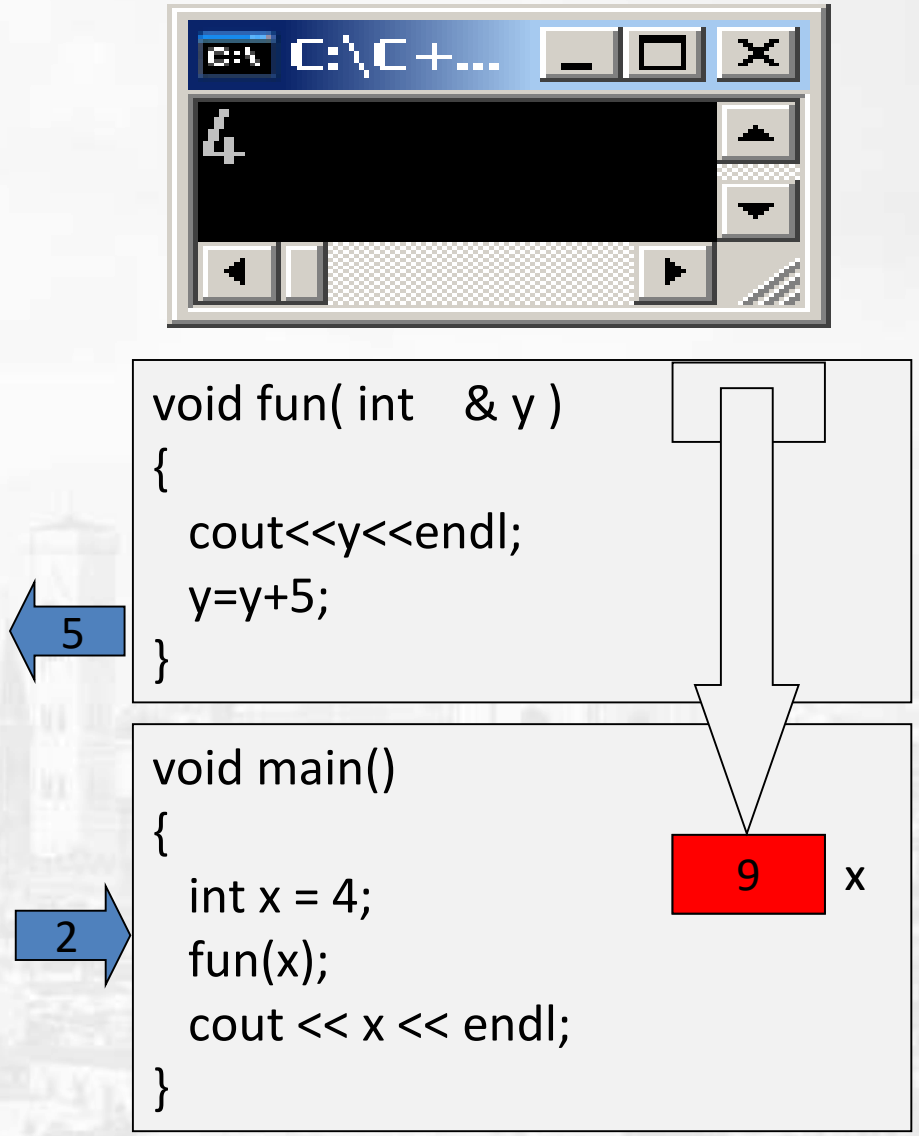



Example of Reference Parameters

```
#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;
}
```

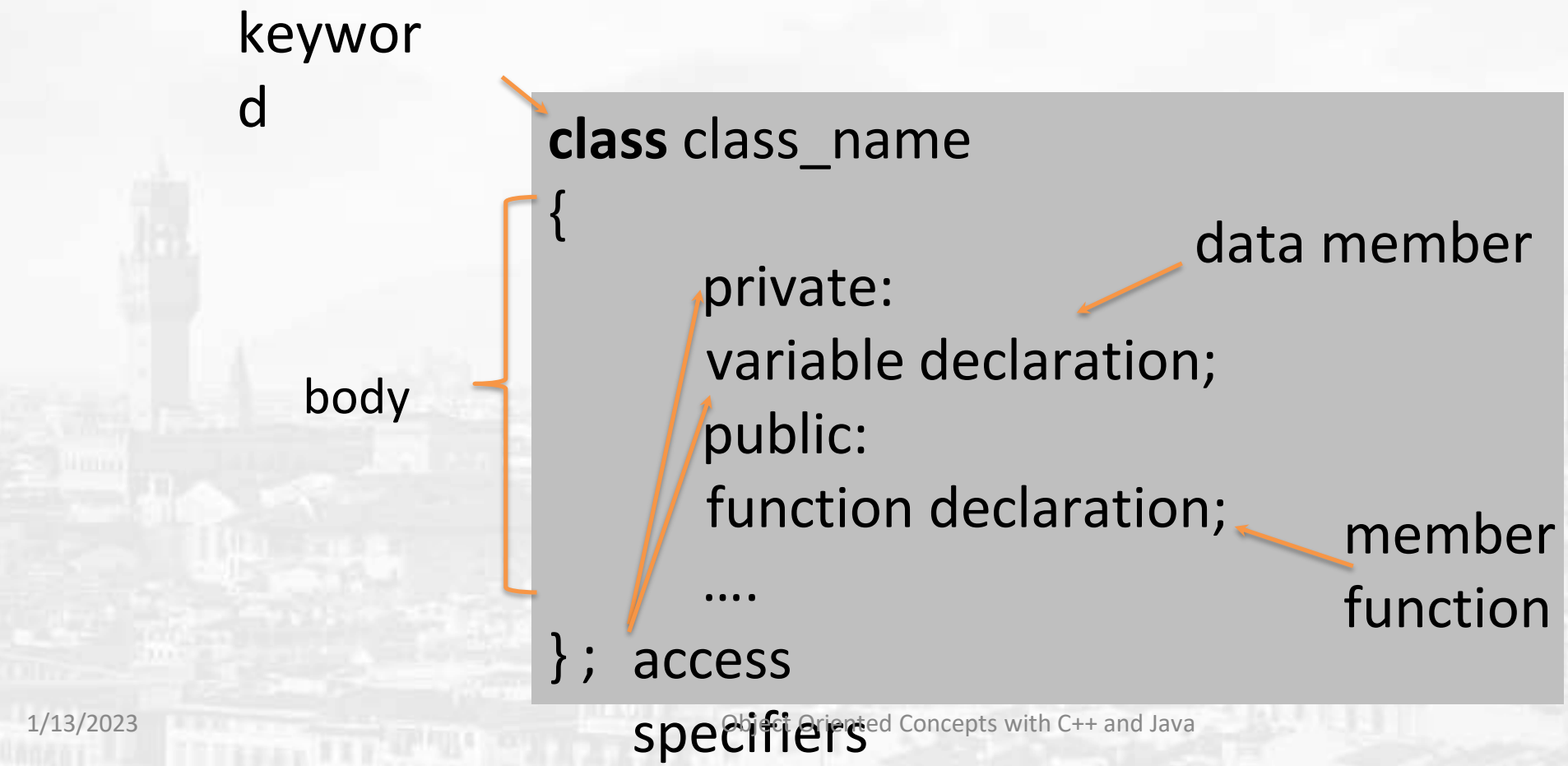


Classes and Objects

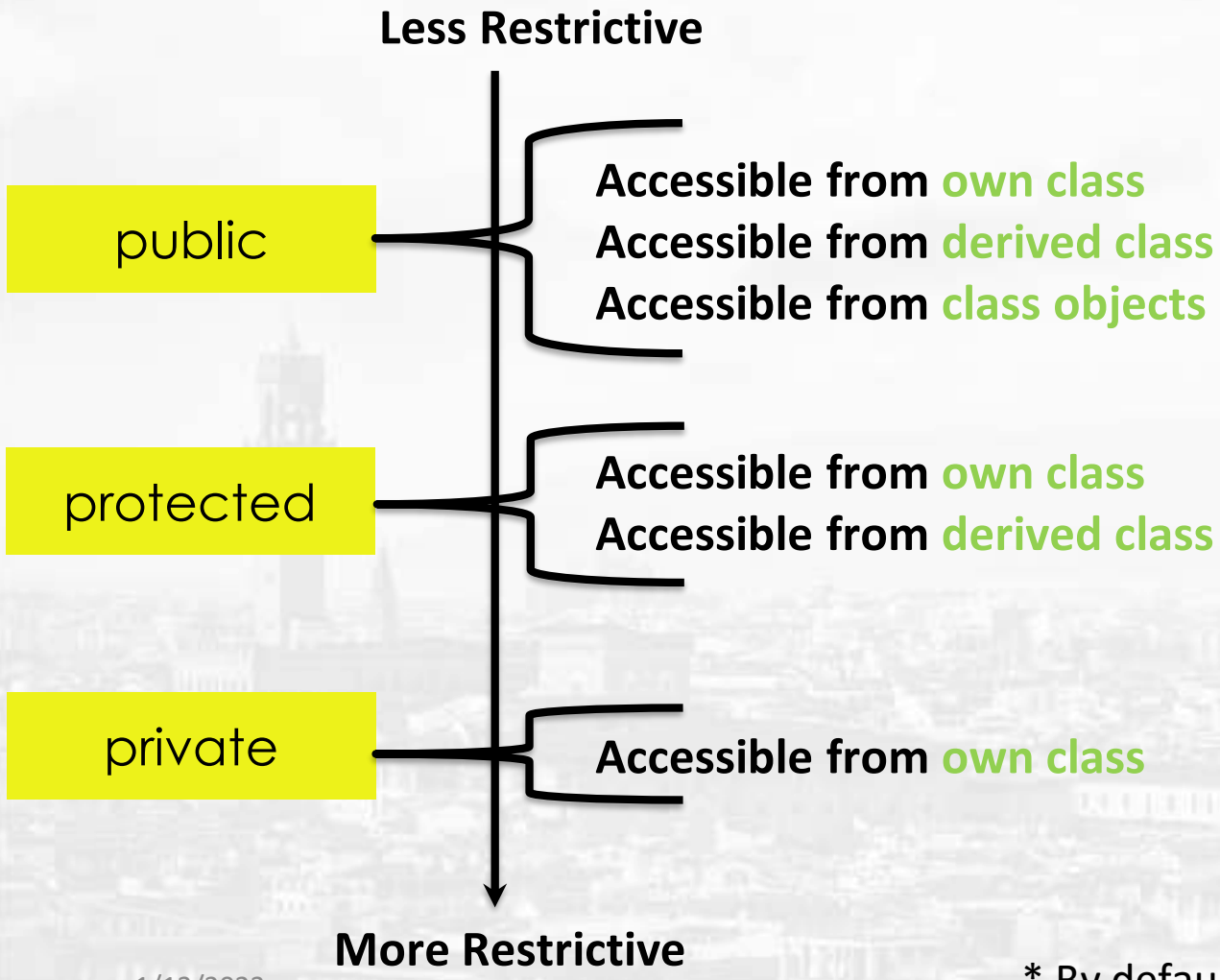
Class

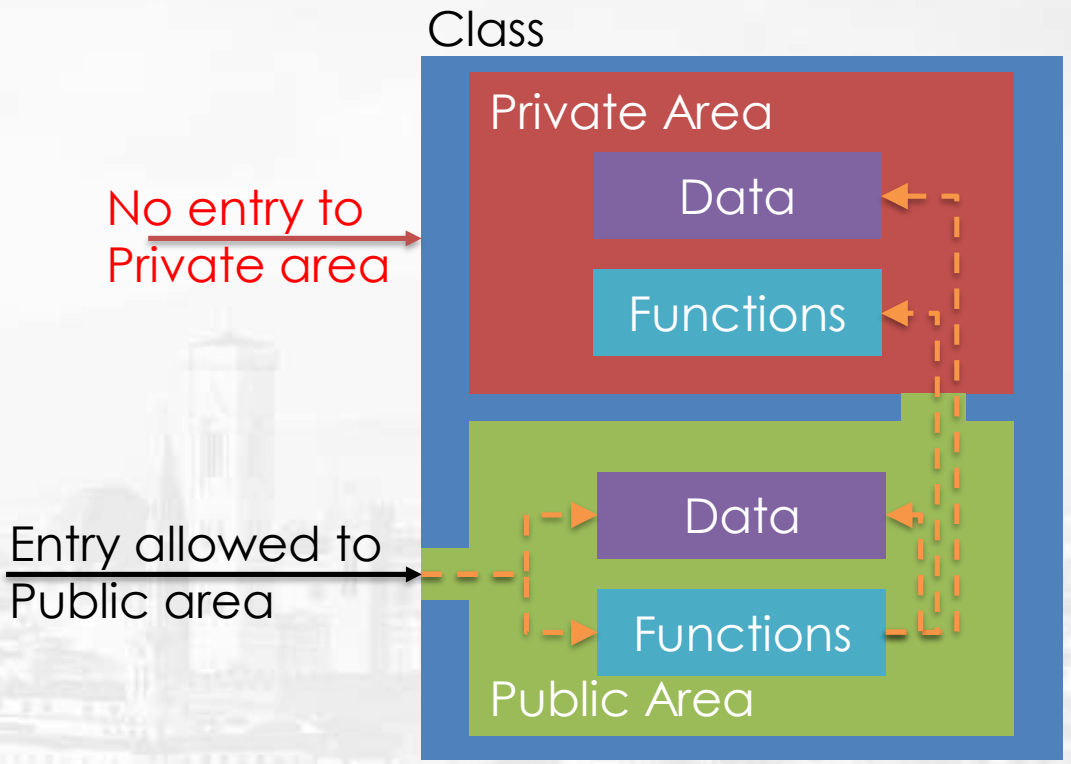
- A way to bind data and associated function together
- An expanded concept of a data structure, instead of holding only data, it can hold both data and function.
- The data is to be hidden from external use.

Class


keywor
d
class class_name
{
private:
variable declaration;
public:
function declaration;
….
} ; access
specifiers
data member
member
function
body

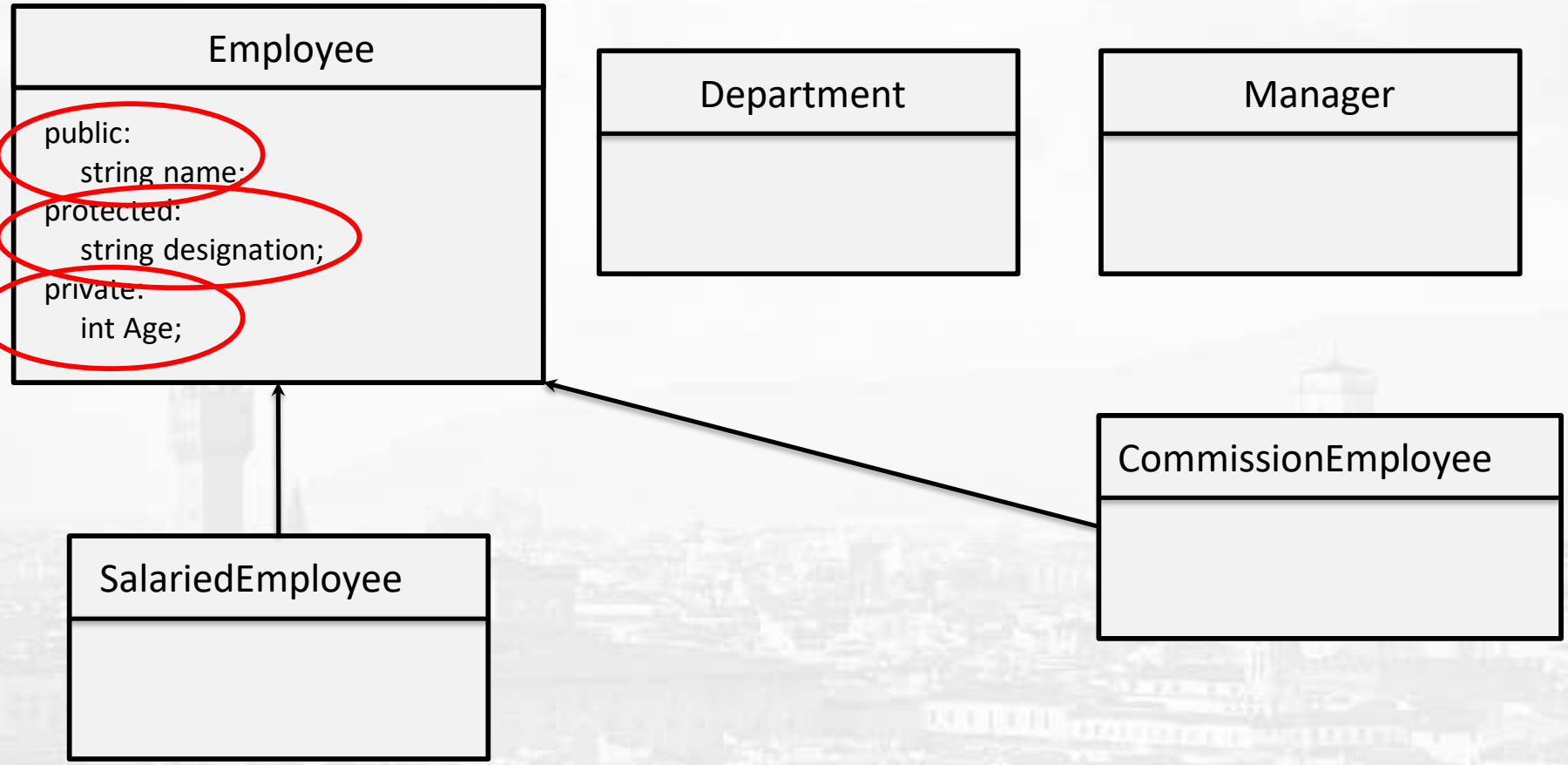
Access Specifiers





* 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 declaration

```
#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

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;
}
```

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

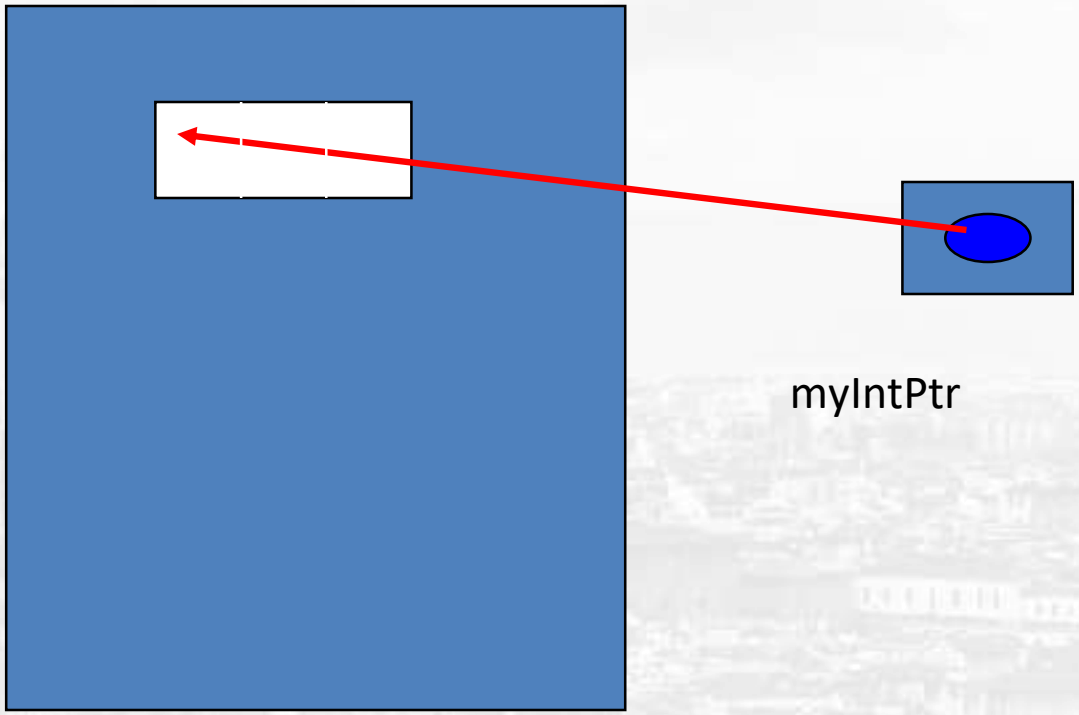
Here are the steps:

```
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)



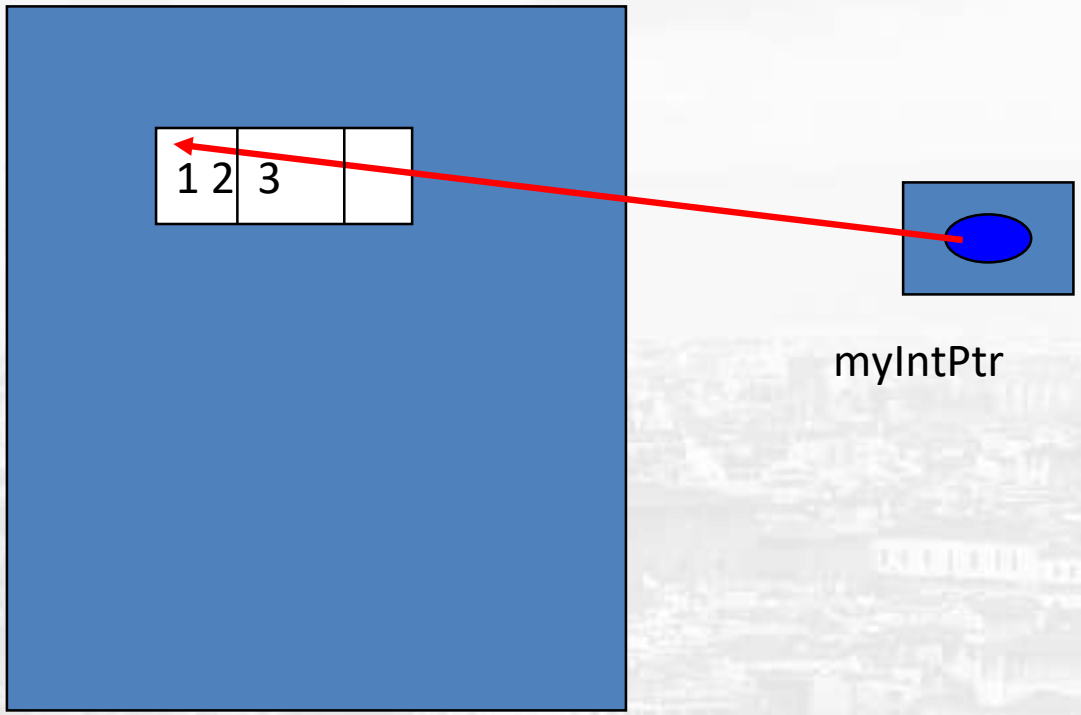
myIntPtr

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

Pointers and Dynamic Memory

Use pointer variable

Free Store (heap)




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

```
*myIntPtr = 123;
```

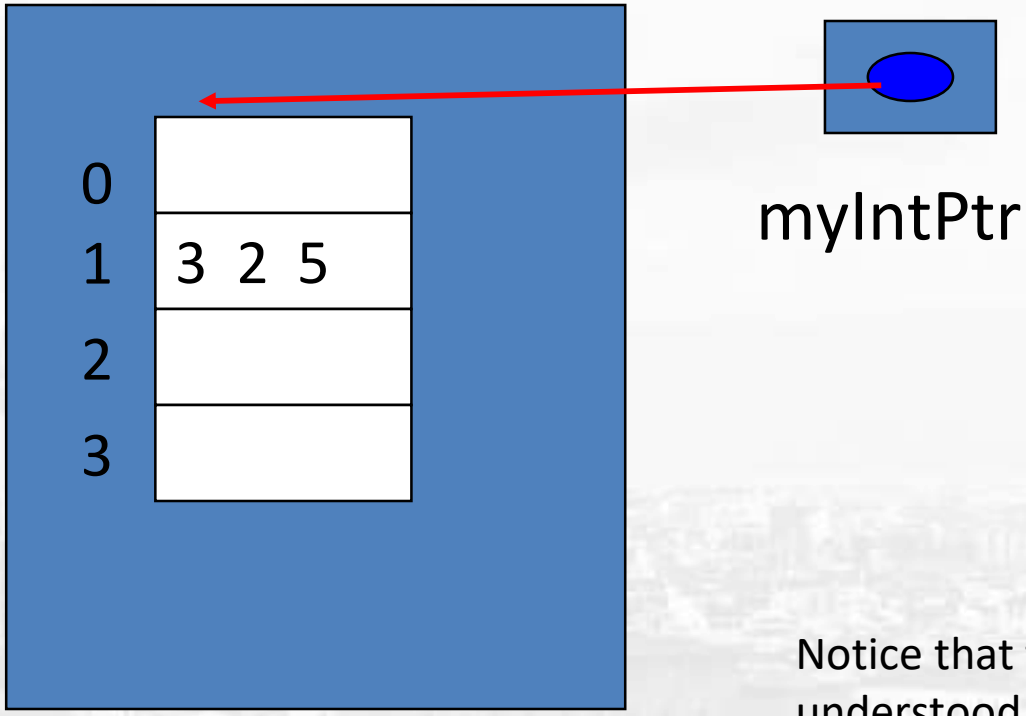
Pointers and Dynamic Memory

- 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)

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!
```

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: “ << SubtractNumbe
        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

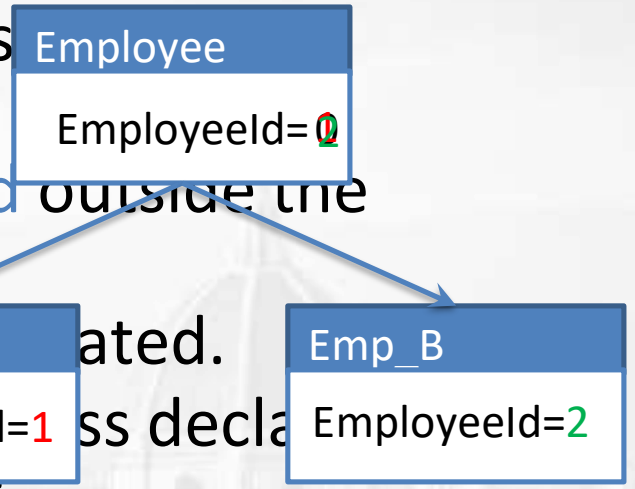
- Inline functions reduce the call overhead.
- Inline functions gets expanded when called
  - i.e. when inline function is called, entire code of inline function is inserted/substituted at point of inline function call
  - The substitution is performed by compiler at compile time

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

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

Members

- ared by all objects are known as
- tained by the clas
- class and defined outside the
- ect of its ated.
- riable in ss decla
- fetime is the entire program.
- aintain values common to the



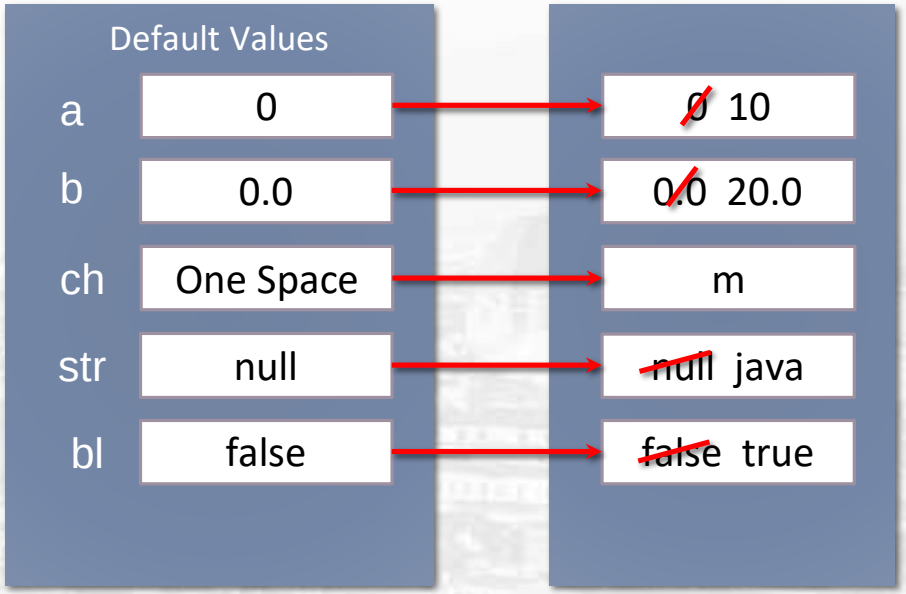

```
class Employee {
  static int EmployeeId;
  public:
    int getEmpId (void) {
        return ++EmployeeId;
    }
    void addEmployee(str);
};
void Employee::addEmployee(str name) {
    newId = getEmpId();
    cout << "Added New Empl " <<name  <<" with Id: "<<
newId <<endl;
    ....
}
int Employee::EmployeeId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

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

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

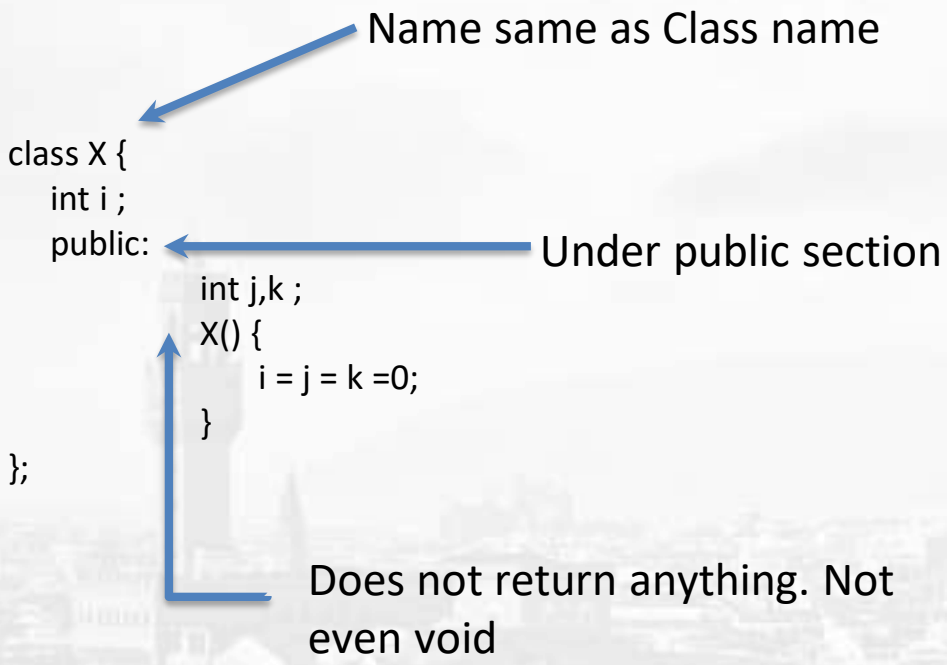
  or T::T(args); // outside class definition

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

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

Outside class

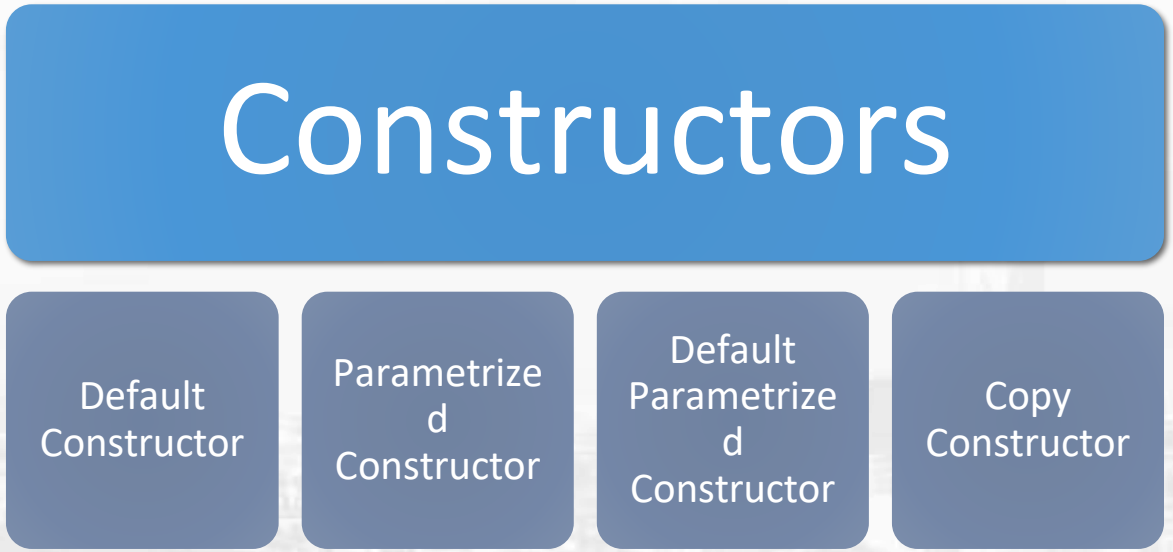
Constructor - Properties



- Automatically called when an object is created
- We can define our own constructors
- They can not be inherited.
- These 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

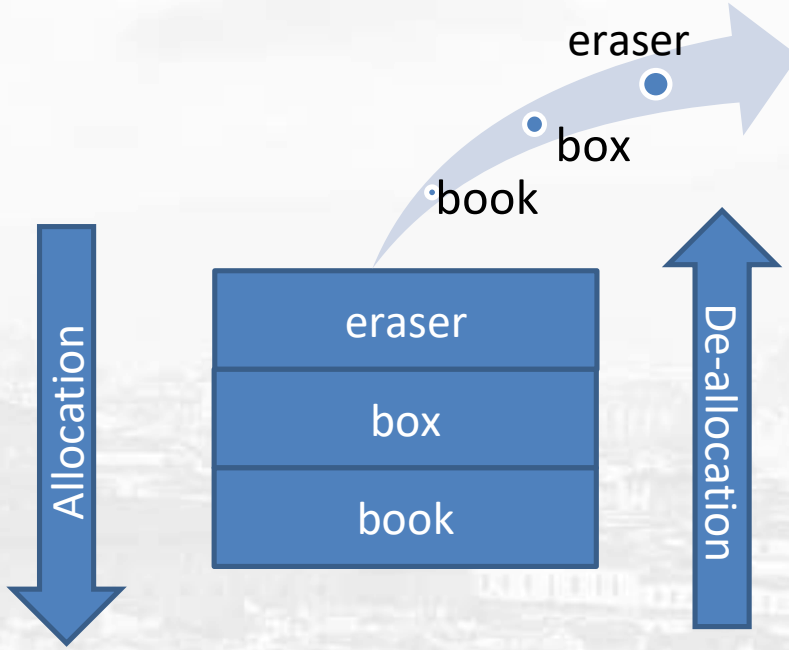
- A parameterized constructor is just one that has parameters specified in it.
- We can pass the arguments to constructor function when object is created.
- A constructor that can take arguments are called *parameterized constructors*

```
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, width=20

  rectangle box(10.0); // results into box object with height=10, width=1

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;
            }
        };
```

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); // implicit 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

}
```

Copy Constructor

clare and initialize an object

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r&);

```
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.

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
```

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 delete operator
- It does not take parameters
- Destructor cannot be overloaded nor inherited.

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'.

Example

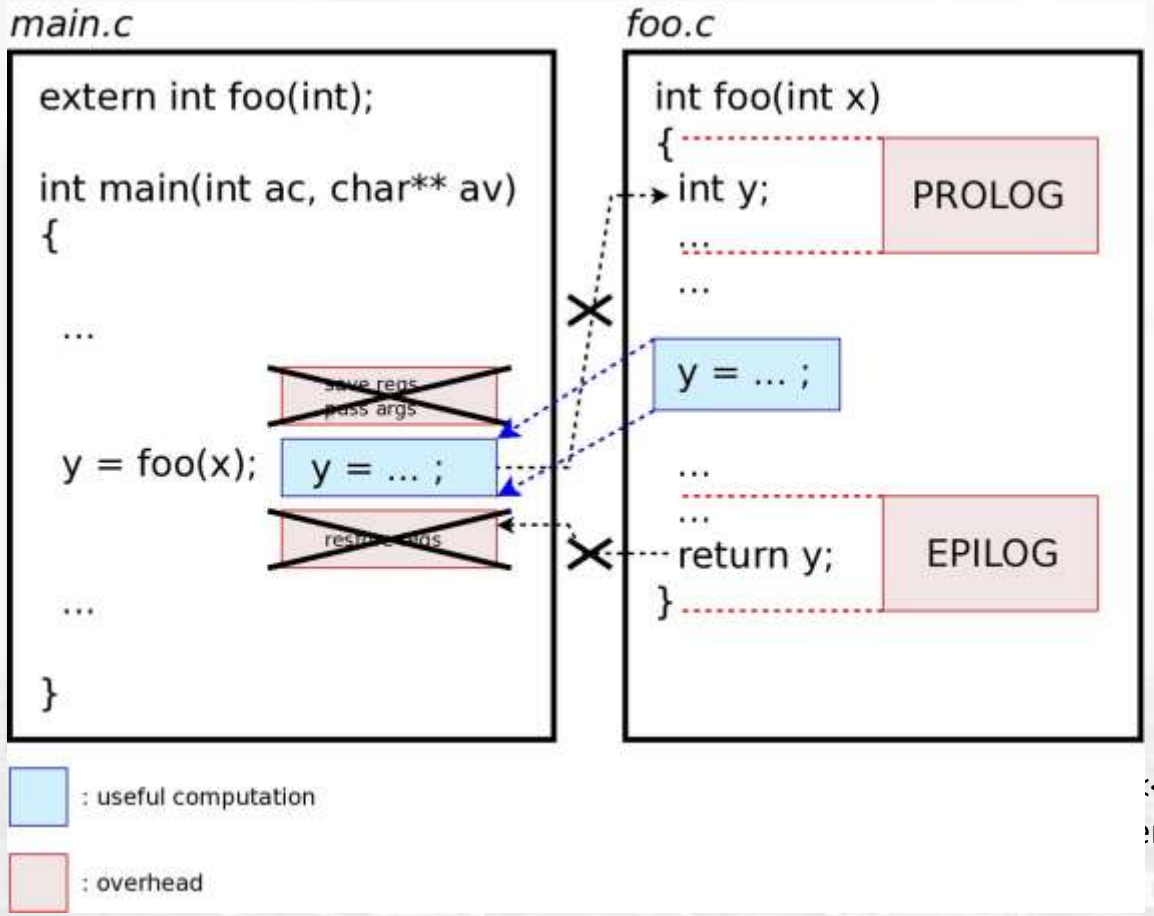
```
class Employee
{
private:
        string name;
        double salary;
         friend void raiseSalary(double a, Employee &e);
public:
        Employee();
        Employee(string n, double s);
        string getName();
        double getSalary();
};
Employee::Employee() : name(""), salary(0) {}
Employee::Employee(string 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
}
```

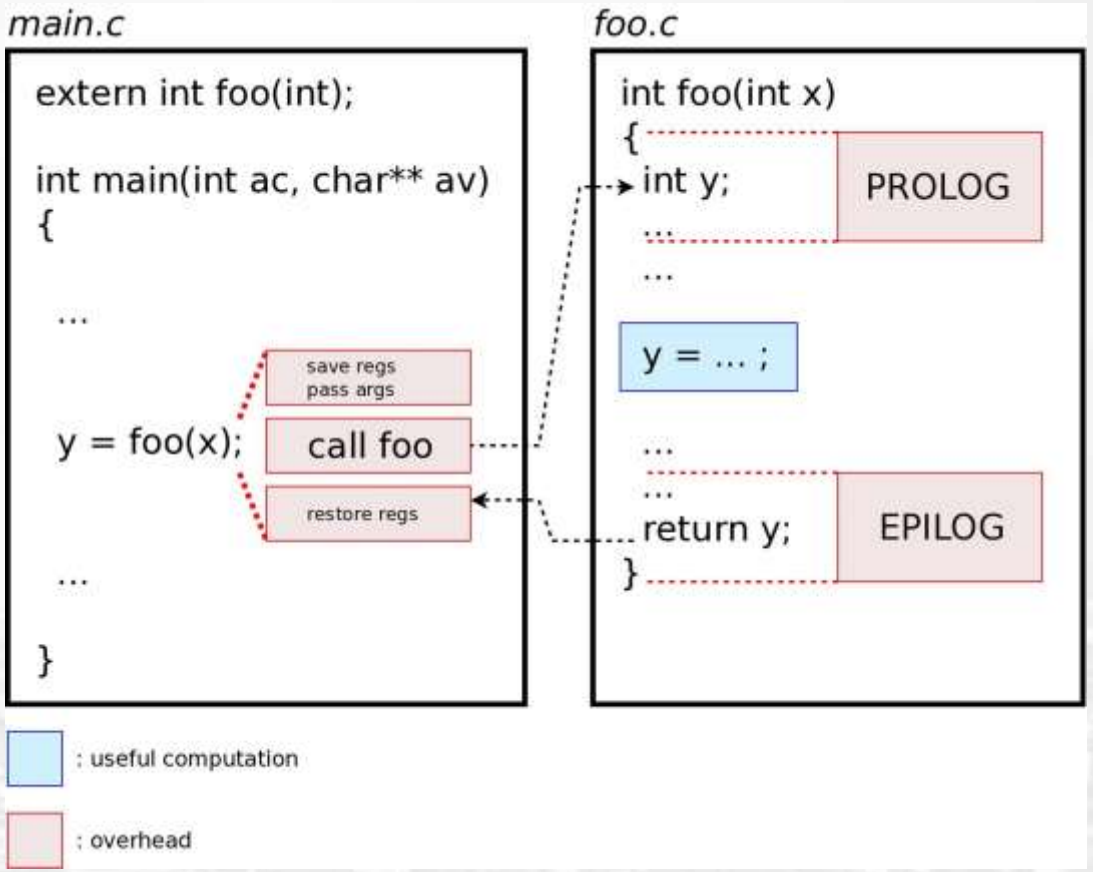
```
class Boss
{
public:
     Boss();
      void giveRaise(double amount);
private:
    Employee e;
};
Boss::Boss() {}
void Boss::giveRaise(double amount)
{
raiseSalary(amount,e);
cout << e.getSalary() << endl;
}
```

References

BACKUP SLIDES

Function Calls





Inline functions

- Compiler may not perform inlining in such circumstances like:
  1) If a function contains a loop. (for, while, do-while)
  2) If a function contains static variables.
  3) If a function is recursive.
  4) If a function return type is other than void, and the return statement doesn’t exist in function body.
  5) If a function contains switch or goto statement.

Function Calls

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

int main() {
      int x = 20;
      int y = 10;
      cout << “Sum of Num
      cout << “Difference b
      cout << “Multiplicatio
}
```