



Lecture Two

# Encapsulation / Data Hiding

Implemented through **Class**

© **Dr. Mohammad Mahfuzul Islam, PEng**  
Professor, Dept. of CSE, BUET



# Constructor

- Object Creation may require some sort of *initialization*. **Constructor Method** performs the tasks of initialization.
- A class's constructor is **called automatically** when an object of that class is created.
- A constructor function has the **same name as the class** of which it is a part and has **no return type**.
- Constructor may have or may not have **arguments**.

```
#include <iostream>
using namespace std;

class MyClass {
    int a = 0;
public:
    MyClass(){cout << "No Argument Constructor" << endl;}
    MyClass(int newA); // constructor
    void show();
};

MyClass::MyClass(int newA){
    cout << "Constructor with Argument" << endl;
    a = newA;
}
```

C++ Code

```
void MyClass::show(){
    cout << a << '\n';
}

int main(){
    MyClass ob1, ob2(10);

    ob1.show();
    ob2.show();
    return 0;
}
```

**Output:**

```
No Argument Constructor
Constructor with Argument
0
10
```



# Constructor

```
class MyClass {  
    private int a = 0;  
    MyClass() {System.out.println("No Argument Constructor");}  
    MyClass(int newA) {  
        System.out.println("Constructor with Argument");  
        a = newA;  
    }  
    public void show() {  
        System.out.println(a);  
    }  
}  
  
public class Main {  
    public static void main(String[] args) {  
        MyClass ob1 = new MyClass();  
        MyClass ob2 = new MyClass(10);  
  
        ob1.show();  
        ob2.show();  
    }  
}
```

Java Code

**Output:**

```
No Argument Constructor  
Constructor with Argument  
0  
10
```



# Constructor – Object Cloning

```
#include <iostream>
using namespace std;

class Box{
    double length;
    double width;
    double height;
public:
    Box(double l, double w, double h){
        length = l;
        width = w;
        height = h;
    }
    Box(const Box& ob){
        length = ob.length;
        width = ob.width;
        height = ob.height;
    }
    double volume(){
        return length * width * height;
    }
};
```

```
int main() {
    Box myBox(5, 3, 2);
    Box myClone(myBox);

    cout << "Box Volume: " << myBox.volume() << endl;
    cout << "Clone Volume: " << myClone.volume() << endl;
}
```

C++ Code

## Output:

```
Box Volume: 30
Clone Volume: 30
```



# Constructor – Object Cloning

```
class Box{
    private double length;
    private double width;
    private double height;

    public Box(double l, double w, double h){
        length = l;
        width = w;
        height = h;
    }

    public Box(Box ob){
        length = ob.length;
        width = ob.width;
        height = ob.height;
    }

    public double volume(){
        return length * width * height;
    }
};
```

Java Code

```
public class Main {
    public static void main(String[] args) {
        Box myBox = new Box(5, 3, 2);
        Box myClone = new Box(myBox);

        System.out.println("Box Volume: " + myBox.volume());
        System.out.println("Clone Volume: " + myClone.volume());
    }
}
```

**Output:**

Box Volume: 30

Clone Volume: 30



# Destructor

- While working with object, some actions may be performed when an object is destroyed, e.g., freeing the memory allocated by the object. This destructor method is called when an **object is destroyed**.
- Local objects** are destroyed when they go out of scope. **Global objects** are destroyed when the program ends.

```
#include <iostream>
using namespace std;

class myclass {
    int a;
public:
    myclass();
    ~myclass(){cout << "Destructing.....\n";};
    void show(){cout << a << endl;};
};
```

```
myclass::myclass() {
    cout << "In constructor\n";
    a = 10;
}

int main(){
    myclass ob;
    ob.show();
    return 0;
}
```

**Output:**  
In constructor  
10  
Destructing.....

- ✓ Java doesn't have any **Destructor** method.
- ✓ The garbage collector inherently handles memory allocation and release.



# Object Pointer

- Object pointer stores **address** of the object.
- When a pointer to the object is used, the **arrow operator** ( $\rightarrow$ ) is employed rather than dot (.) operator.
- Like pointers to other types, an object pointer, when **incremented**, will point to the next object of its type.

```
#include <iostream>
using namespace std;

class MyClass {
    int a;
public:
    MyClass(){ a = 10;}
    MyClass(int x){ a = x;};
    int getA() {return a;};
};
```

```
int main(){
    MyClass ob(120);
    MyClass *p;

    p = &ob;
    cout << "Object Value:" << ob.getA() << endl;
    cout << "Value using pointer:" << p->getA() << endl;

    return 0;
}
```

**Output:**

Object Value:120

Value using pointer:120

There is no **pointer operator** in Java.





# The **this** Pointer / Reference

- A special pointer (C++) or reference (Java) called **this** represents the working object and is automatically passed to any member function when it is called.
- **No programmer** uses the this pointer / reference to access a class member because the shorthand form is much easier.

```
#include <iostream>
#include <string>
using namespace std;

class Message {
    string msg;
public:
    Message(string msg) {
        this->msg = msg;
    }
    Message updateMessage(string msg);
    void displayMessage();
};
```

C++ Code

**Output:**

```
Message: Hello, World!
Message: New Message.
```

```
Message Message::updateMessage(string msg) {
    this->msg = msg;
    return *this;
}

void Message::displayMessage() {
    cout << "Message: " << this->msg << endl;
}

int main() {
    Message msg("Hello, World!");

    msg.displayMessage();
    msg = msg.updateMessage("New Message.");
    msg.displayMessage();
}
```





# The **this** Pointer / Reference

The **this** keyword in Java is a reference variable that refers to the current object.

`a = newA; => this.a = newA;`

```
class Message {  
    private String msg;  
  
    public Message(String msg) {  
        this.msg = msg;  
    }  
  
    public Message updateMessage(String msg) {  
        this.msg = msg;  
        return this;  
    }  
  
    public void displayMessage() {  
        System.out.println("Message: " + this.msg);  
    }  
}
```

Java Code

```
public class Main {  
    public static void main(String[] args) {  
        Message msg = new Message("Hello, World!");  
  
        msg.displayMessage();  
        msg = msg.updateMessage("New Message.");  
        msg.displayMessage();  
    }  
}
```

**Output:**

Message: Hello, World!

Message: New Message.

**“this” means “current object”.**



# Using **new** and **delete** in C++ Pointer

- C++ uses **new** operator for dynamically allocating memory (C uses **malloc()**).

General form: **p-var = new type;**

**p-var = new type (initial value);**

**p-var = new type [size];**

- C++ uses **delete** operator for releasing dynamically allocating memory (C uses **free()**).

General form: **delete p-var;**

**delete [] p-var;**

```
#include <iostream>
using namespace std;

class Samp{
    int a, b;
public:
    Samp(){ a = 0; b = 0;}
    Samp(int x, int y){ a = x; b = y;}
    int getProduct(){ return a * b;}
};
```

```
int main(){
    Samp *p = new Samp;
    Samp *q = new Samp(3, 4);
    Samp *r = new Samp[2];
    cout << "Product: " << p->getProduct() << endl;
    cout << "Product: " << q->getProduct() << endl;
    for(int i = 0; i < 2; i++){
        r[i] = Samp(i+1, i+2);
        cout << r[i].getProduct() << endl;
    }
    delete p;
    delete q;
    delete[] r;
    return 0;
}
```

**Output:**

**Product: 0**

**Product: 12**

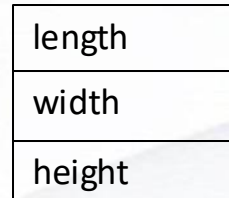
**2**

**6**

# Object Declaration

**C++**

**Box myBox;**



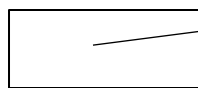
myBox

**Box \*pBox;**

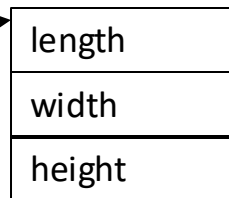


pBox

**Box \*pBox = new Box;**



pBox



**Java**

**Box myBox;**

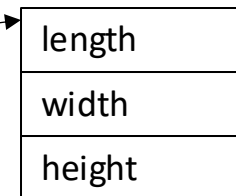


myBox

**Box myBox = new Box();**



myBox





# Reference in C++

➤ A **reference** is an **implicit pointer** that acts like another name of a variable. A reference can be used in Three ways:

- ✓ A reference can be **passed to a function**
- ✓ A reference can be **returned by a function**
- ✓ An **independent reference** can be created.

```
#include <iostream>
using namespace std;

void f(int *p) {
    *p = 100;
}

int main(){
    int a = 10;
    f(&a);
    cout << "a: " << a << endl;
    return 0;
}
```

Use of Pointer

Passing **Reference** to a function

```
#include <iostream>
using namespace std;

void f(int &p) {
    p = 100;
}

int main(){
    int a = 10;
    f(a);
    cout << "a: " << a << endl;
    return 0;
}
```

Use of Reference

C++ Code

**Output:**  
a: 100



# Reference in C++

## Passing Reference to a function

- When a **reference parameter** is used, the compiler automatically passes the **address of the variable** as the argument. There is no need to manually generate the address of the argument by preceding it with an **&** (**in fact, it is not allowed**).
- Within the function, the compiler automatically uses the variable pointed to by the reference parameter, no need to employ **\***.
- A reference parameter **fully automates** the **call-by-reference** parameter passing mechanism.

```
void f(int &n) {  
    n = 100;  
    n++;  
}
```

C++ Code

- In the above example, instead of incrementing **n**, this statement increments the value of the variable being referenced (in this case, **a**).

# Reference in C++

## A Reference returned by a function

- Very useful for **overloading** certain types of operator.

```
#include <iostream>
using namespace std;

class Coord{
    int x, y;
public:
    Coord(int a, int b){x = a; y = b;}
    Coord& operator++(){
        x++;
        y++;
        return *this;
    }
    void show() {
        cout << "(" << x << ", " << y << ")" << endl;
    }
};
```

```
int main(){
    Coord P(10, 20);
    P.show();
    ++P;
    P.show();
    return 0;
}
```

**Output:**  
(10,20)  
(11,21)

- Allow a function to be used on **the left side** of an assignment statement.

```
#include <iostream>
using namespace std;
```

```
int x;
```

```
int &f(){
    return x;
}
```

```
int main(){
    f() = 100;
    cout << x << endl;
    return 0;
}
```

**Output:**  
100

**BUT**

```
int &f(){
    int x;
    return x;
}
```

C++ Code



# Reference in C++

## Independent Reference

- An independent reference is a reference variable that in all effects is simply **another name for variable**.
- Because reference cannot be assigned new values, an **independent reference** must be **initialized** when it is declared.

C++ Code

```
#include <iostream>
using namespace std;

int main(){
    int x;
    int &ref = x;

    x = 10;
    ref = 100;
    cout << x << ", " << ref << endl;

    return 0;
}
```

**Output:**  
100, 100

The independent reference ref serves as a different name for x.

Independent reference cannot be a constant like  
`const int &ref = 10;`





# In-line Function

**In-line Function:** Like macros in C, In-line functions are not actually called, rather are expanded in line, at the point of each call.

## 🌐 Advantage:

- In-line function has **no overhead** associated with the function call and return mechanism, so much **faster** than the normal function calls.
- In parameterized macros, it is easy to forget extra parentheses are needed. In-line function is a **structure way to expand** short function in line and prevent the problems of parameterized macros.

🌐 **Disadvantage:** If in-line functions are too large and called too often, **program grows larger**. Therefore, only short functions are declared in-line.

## Inline specifier is a request, not a command to the compiler:

Some compiler will not inline a function if it contains a static variable, loop, switch or goto. If any inline restriction is violated, the compiler is free to generate a normal function.

```
#include <iostream>
using namespace std;

inline int even(int x){
    return (x % 2 == 0);
}

int main(){
    if (even(10))
        cout << "Even" << endl;
    return 0;
}
```

C++ Code

**Output:**  
Even



# Automatic In-line Function

**Automatic In-line Function:** If a member's function definition in a class is short enough, then the function automatically becomes an in-line function. The **inline** keyword is no longer necessary.

- ✓ The same restriction that apply to a normal in-line functions apply to automatic in-line functions within a class declaration.

```
#include <iostream>
using namespace std;

class Samp{
    int a, b;
public:
    Samp(int n, int m){a = n; b = m;}
    int divisible(){ return !(a%b);}
};
```

```
int main(){
    Samp s1(10, 2), s2(10,3);

    if (s1.divisible())
        cout << "10 is divisible by 2" << endl;
    if (s2.divisible())
        cout << "10 is divisible by 3" << endl;

    return 0;
}
```

**Output:**

10 is divisible by 2



# In-line function in Java

- Java doesn't support inline command. But in Java, the compiler can perform in-lining when the small final method is called.
- Because final methods can't be overridden by subclasses, and the call to a final method is resolved at compile time.

```
class Figure{  
    final private double pi = 3.14159;  
    private double radius;  
  
    // public void setPI(double newPI){ pi = newPI;}  
    public double getPI(){ return pi;}  
    public void setRadius(double newRadius){ radius = newRadius;}  
    public double getRadius(){ return radius;}  
  
    final public double circleArea(){return pi*radius*radius;}  
}
```

## JAVA Code

```
class Cylinder extends Figure{  
    private double height;  
  
    Cylinder(double newRadius, double newHeight){  
        setRadius(newRadius);  
        // setPI(3.14159);  
        height = newHeight;  
    }  
  
    /* public double circleArea(){  
        return pi*radius*radius;  
    } */  
  
    public double cylinderVolume(){  
        return circleArea()*height;  
    }  
}
```



# Object Assignment

- One object can be **assigned** to another provided that both objects are of the **same type**.
- By default, when one object is assigned to another, a **bitwise copy** of all the data members is made.

```
#include <iostream>
using namespace std;

class MyClass{
    int a, b;
public:
    void setValue(int n, int m){a = n; b = m;}
    void show(){
        cout << a << ", " << b << endl;
    }
};

class YourClass{
    int a, b;
public:
    void setValue(int n, int m){a = n; b = m;}
    void show(){
        cout << a << ", " << b << endl;
    }
};
```

```
int main(){
    MyClass ob1, ob2;
    YourClass ob3;

    ob1.setValue(10, 20);
    ob2 = ob1; //Ok
    // ob3 = ob1; //Compilation Error
    ob1.show();
    ob2.show();

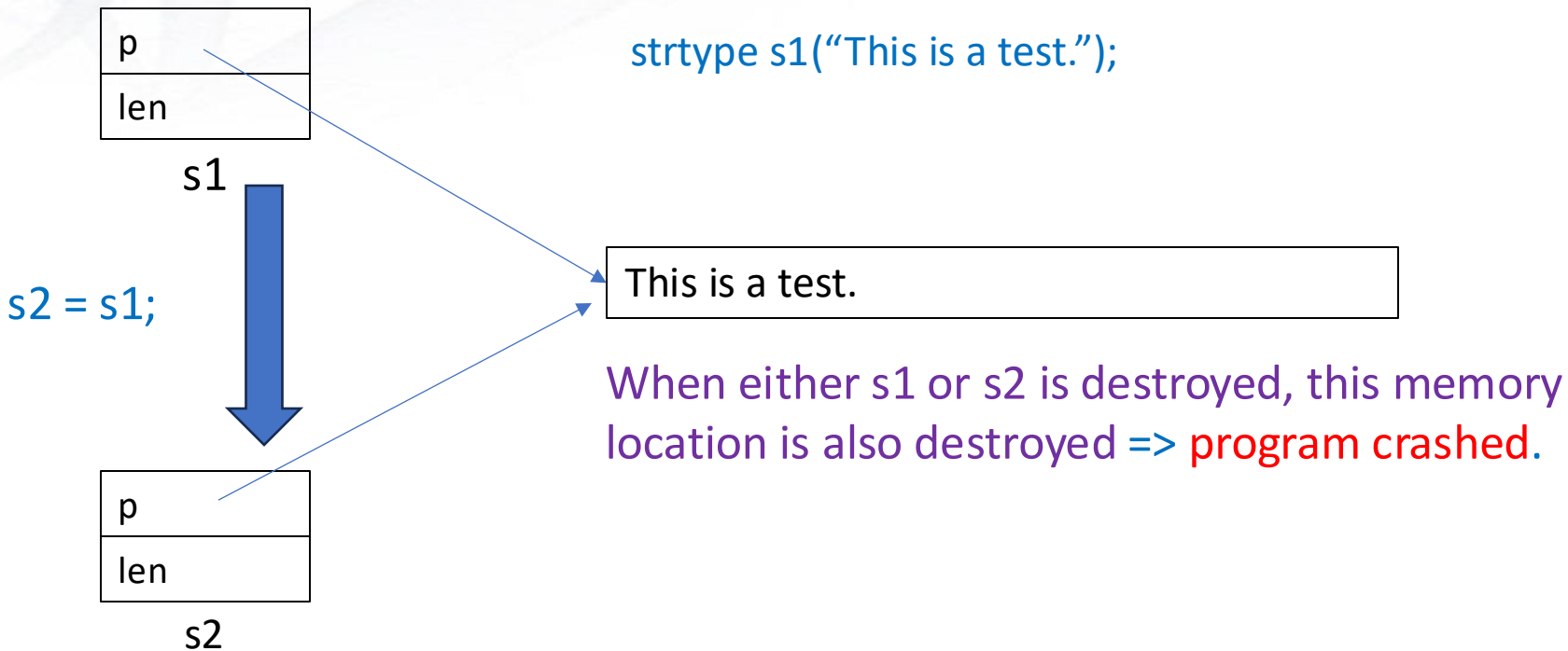
    return 0;
}
```

## Output:

```
10, 20
10, 20
```

# Problem with Object Assignment in C++

- When an object **pointing to dynamic memory allocation** is assigned to another object
  - both object **share** the **same memory**.
  - Destroying** one object **release the common memory** and possibly cause **program crash**.





# Problem with Object Assignment in C++

```
#include <iostream>
#include <cstring>
#include <cstdlib>
using namespace std;

class ObAssign{
    char *str;
    int len;
public:
    ObAssign(char *s){
        len = strlen(s);
        str = (char *)malloc(len + 1);
        strcpy(str, s);
    }
    ~ObAssign(){
        cout << "Freeing memory" << endl;
        free(str);
    }
    void show(){
        cout << str << ":" << len << endl;
    }
};
```

```
int main(){
    ObAssign ob1("Hello World"), ob2("like C++");

    ob1.show();
    ob2.show();
    ob2 = ob1; // This will cause a problem
    ob2.show();

    return 0;
}
```

**Program name:**

ObAssignProblem.cpp

## Output:

Hello World:11

Like C++:8

Hello World:11

Freeing memory

Freeing memory

ObAssignProblem(1217,0x109ed5600) malloc: \*\*\* error for object 0x7f9842f059d0: pointer being freed was not allocated

ObAssignProblem(1217,0x109ed5600) malloc: \*\*\* set a breakpoint in malloc\_error\_break to debug

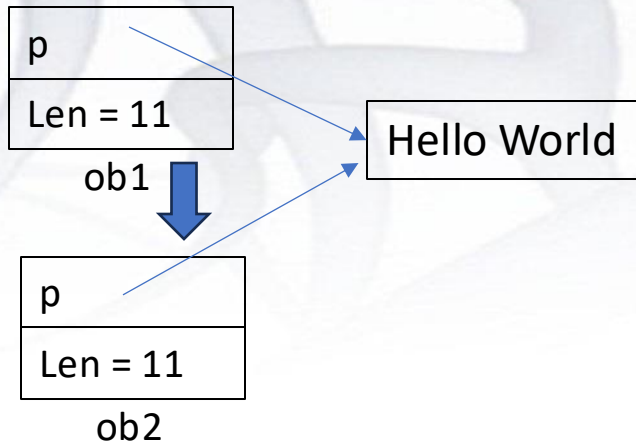
zsh: abort ./"ObAssignProblem"



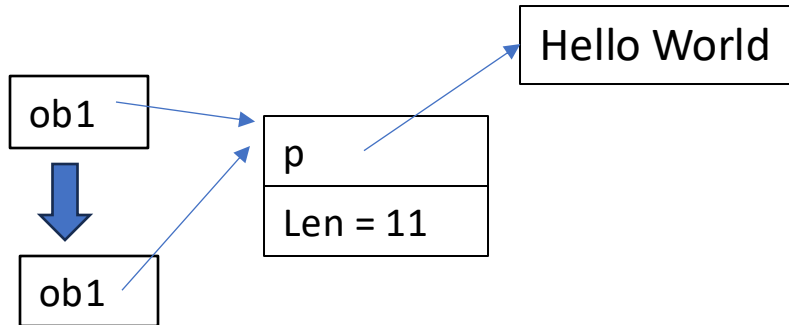
# Solution to the Object Assignment Problem in C++

## Solution 1: Use of Pointer

Without Pointer:



With Pointer:



```

int main(){
    ObAssign *ob1 = new ObAssign("Hello World");
    ObAssign *ob2 = new ObAssign("Like C++");

    ob1->show();
    ob2->show();
    ob2 = ob1;
    ob2->show();

    return 0;
}

#include <iostream>
#include <cstring>
#include <cstdlib>
using namespace std;

class ObAssign{
    char *str;
    int len;
public:
    ObAssign(char *s){
        len = strlen(s);
        str = (char *)malloc(len + 1);
        strcpy(str, s);
    }
    ~ObAssign(){
        cout << "Freeing memory" << endl;
        free(str);
    }
    void show(){
        cout << str << ":" << len << endl;
    }
};
  
```

**Output:**

```

Hello World:11
Like C++:8
Hello World:11
  
```

**No Execution of  
Destructor.  
Acceptable??**





# Solution to the Object Assignment Problem in C++

## Solution 2: Copy Assignment Operator

```
#include <iostream>
#include <cstring>
#include <cstdlib>
using namespace std;

class ObAssign {
    char *str;
    int len;
public:
    ObAssign(char *s) {
        len = strlen(s);
        str = (char *)malloc(len + 1);
        strcpy(str, s);
    }
    ObAssign& operator=(const ObAssign &obj) {
        if (this == &obj) {
            return *this; // self-assignment
        } // e.g., ob1 = ob1
        free(str);
        len = obj.len;
        str = (char *)malloc(len + 1);
        strcpy(str, obj.str);
        return *this;
    }
}
```

```
~ObAssign() {
    cout << "Freeing memory" << endl;
    free(str);
}

void show() {
    cout << str << ":" << len << endl;
}

};

int main() {
    ObAssign ob1("Hello Word"), ob2("like C++");

    ob1.show();
    ob2.show();

    ob2 = ob1; // Assignment operator is invoked
    ob2.show();

    return 0;
}
```

### Output:

```
Hello World:11
like C++:8
Hello World:11
Freeing memory
Freeing memory
```



# Passing Object as an Argument in C++

- **Parameter passing**, by default, is **called by value**. That is a bitwise copy is made.
- New object created in the function **does not call constructor**, but **destructor is called**.

```
#include <iostream>
using namespace std;

class ObArg{
    int a;
public:
    ObArg(int n){
        a = n;
        cout << "Constructing..." << endl;
    }

    ~ObArg() {
        cout << "Destructing..." << endl;
    }

    void setA(int n){ a = n; }
    int getA(){ return a; }
};
```

```
void sqrOb(ObArg ob){
    ob.setA(ob.getA() * ob.getA());
    cout << "Inside sqrOb: " << ob.getA() << endl;
}

int main(){
    ObArg ob1(10);
    cout << "Before sqrOb: " << ob1.getA() << endl;
    sqrOb(ob1);
    cout << "After sqrOb: " << ob1.getA() << endl;
    return 0;
}
```

## Output:

```
Constructing...
Before sqrOb: 10
Inside sqrOb: 100
Destructing...
After sqrOb: 10
Destructing...
```



# Problem with Passing Object as an Argument in C++

- If the **object** used as the arguments **allocates dynamic memory** and **free** the memory then the destructor function is called and the **original object** is **damaged**.

```
#include <iostream>
using namespace std;

class ObArgProb{
    int *p;
public:
    ObArgProb(int n){
        p = (int *)malloc(sizeof(int));
        *p = n;
        cout << "Constructing..." << endl;
    }
    ~ObArgProb(){
        cout << "Destructing..." << endl;
        free(p);
    }
    int getP(){ return *p; }
};

int negateP(ObArgProb ob){
    return -ob.getP();
}
```

```
int main(){
    ObArgProb ob1(10);

    cout << "Before: " << ob1.getP() << endl;
    cout << "Result: " << negateP(ob1) << endl;
    cout << "After: " << ob1.getP() << endl;
    return 0;
}
```

## Output:

Constructing...

Before: 10

Result: -10

Destructing...

After: 10

Destructing...

ObArgProb(3214,0x11af7d600) malloc: \*\*\* error for object 0x7f933b004a50: pointer being freed was not allocated

ObArgProb(3214,0x11af7d600) malloc: \*\*\* set a breakpoint in malloc\_error\_break to debug

zsh: abort ./"ObArgProb"

## Program name:

ObArgProb.cpp

# Solution to Object Passing Problem in C++

## Solution 1: Using Call by Reference

### Solution 1(a): Using Pointer

```
int negateP(ObArgProb *ob){
    return -ob->getP();
}

int main(){
    ObArgProb ob1(10);

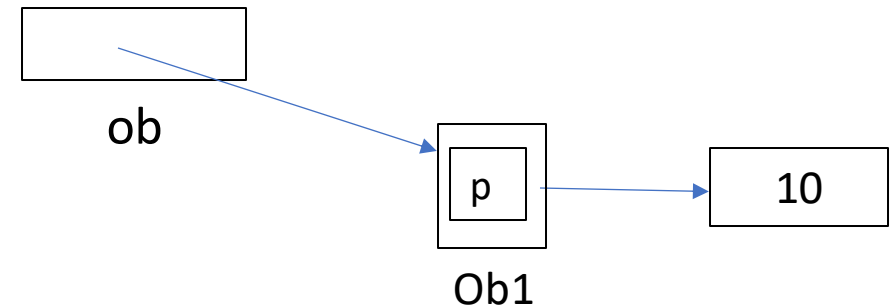
    cout << "Before: " << ob1.getP() << endl;
    cout << "Result: " << negateP(&ob1) << endl;
    cout << "After: " << ob1.getP() << endl;

    return 0;
}
```

**Output:**  
Constructing...  
Before: 10  
Result: -10  
After: 10  
Destructing...

### Solution 1(b): Using Reference

```
int negateP(ObArgProb &ob) {
    return -ob.getP();
}
```



Copy address of the Object, rather than copying the object itself.



# Solution to Object Passing Problem in C++

## Solution 2: Using Copy Constructor

```
#include <iostream>
using namespace std;

class ObArgProb{
    int *p;
public:
    ObArgProb(int n){
        p = (int *)malloc(sizeof(int));
        *p = n;
        cout << "Constructing..." << endl;
    }

    // Copy constructor
    ObArgProb(const ObArgProb &ob){
        p = (int *)malloc(sizeof(int));
        *p = *(ob.p);
        cout << "Copying..." << endl;
    }
}
```

**Output:**  
Constructing...  
Before: 10  
Result: Copying...  
-10  
Destructing...  
After: 10  
Destructing...

```
~ObArgProb() {
    cout << "Destructing..." << endl;
    free(p);
}

int getP(){ return *p; }

int negateP(ObArgProb ob){
    return -ob.getP();
}

int main(){
    ObArgProb ob1(10);

    cout << "Before: " << ob1.getP() << endl;
    cout << "Result: " << negateP(ob1) << endl;
    cout << "After: " << ob1.getP() << endl;

    return 0;
}
```



# Object Returning Problem in C++

- When an object is **returned** by a function, a **temporary object** is **created** which holds the return value. This object is return by the function.
- After the **value** has been **returned**, this object is **destroyed**.
- The **destruction** of this **temporary object** may cause **unexpected side effects**.

```
#include <iostream>
#include <cstring>
using namespace std;

class Samp {
    char *s;
public:
    Samp() { s = '\0'; }
    ~Samp() {free(s); cout << "Freeing S\n";}
    void show() {cout << s << endl;}
    void set (char *str){
        s = (char *) malloc(strlen(str)+1);
        strcpy(s, str);
    }
};
```

```
Samp input() {
    Samp s;
    s.set("Hello, world!");
    return s;
}

int main() {
    Samp ob;

    ob = input();
    ob.show();

    return 0;
}
```

## Output:

Freeing S

Hello, world!

ObReturnProb(1337,0x106d8c600) malloc: \*\*\* error for object 0x7f790e7059f0: pointer being freed was not allocated

ObReturnProb(1337,0x106d8c600) malloc: \*\*\* set a breakpoint in malloc\_error\_break to debug

zsh: abort ./"ObReturnProb"





# Solution to Object Returning Problem in C++

```
#include <iostream>
#include <cstring>
using namespace std;

class Samp {
    char *s;
public:
    Samp() {s = '\0';}

    // Copy Assignment Operator
    Samp& operator=(const Samp &ob) {
        if (this == &ob) { return *this;}
        s = (char *)malloc(strlen(ob.s) + 1);
        strcpy(s, ob.s);
        return *this;
    }

    ~Samp() {free(s); cout << "Freeing S\n";}

    void show() {cout << s << endl;}
```

## Output:

```
Freeing S
Hello, world!
Freeing S
```

```
void set(char *str) {
    s = (char *)malloc(strlen(str) + 1);
    strcpy(s, str);
}

};

Samp input() {
    Samp s;
    s.set("Hello, world!");
    return s;
}

int main() {
    Samp ob;

    ob = input();
    ob.show();

    return 0;
}
```





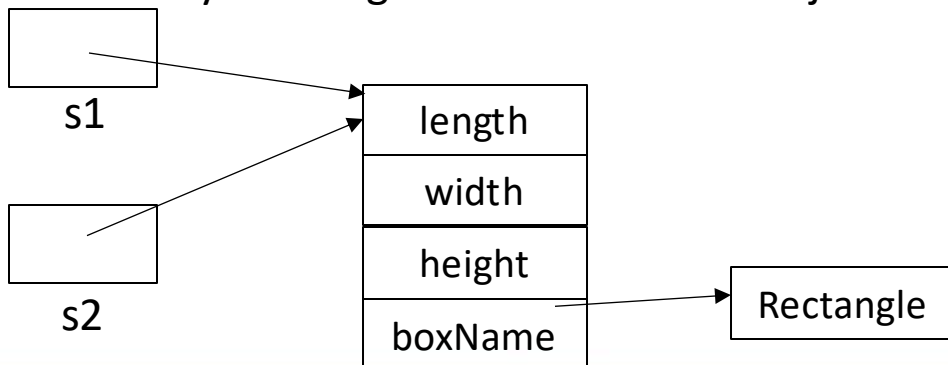
# Use Java, Be Relaxed

## Java does not have -

- ✓ Object assignment problem
- ✓ Problem with passing object as argument
- ✓ Object returning problem

## Automatic Argument Type Selection:

- When a primitive type argument is passed, then it is “**call by value**”. Bitwise copy is made.
- When an object is passed to a method, it is “**Call by Reference**”. Only creating a reference to the object.



**Garbage Collection of Java:** Java automatically manages memory allocation and deallocation for objects.

**No Destructor in Java:** Java does not have any destructors. Garbage collector inherently handle memory allocation and release.

- **All three C++ problems are arisen due to object destruction.**
- **As Java does not support object destruction, none of the problem exists in java.**



# Friend Function in C++

● A friend function is **not a member** of a class but still has **access** to its **private elements**.

● **Three uses** of friend functions

(1) to do **operator overloading**;

(2) **creation** of certain types of **I/O functions**; and

(3) one function to **have access** to the **private members** of **two or more different classes**.

● A friend function is a **regular non-member** function

```
#include <iostream>
using namespace std;

class Truck;    // Forward Declaration

class Car{
    int passenger, speed;
public:
    Car(int p, int s){ passenger = p; speed = s;}
    friend int speedGreater(Car c, Truck t);
};
```

```
class Truck{
    int weight, speed;
public:
    Truck(int w, int s){ weight = w; speed = s;}
    friend int speedGreater(Car c, Truck t);
};

int speedGreater(Car c, Truck t){
    return c.speed - t.speed;
}

int main(){
    Car c(5, 70);
    Truck t(500, 60);

    cout << "Speed Gap: " << speedGreater(c,t) << endl;

    return 0;
}
```

**Output:**

Speed Gap: 10



# Friend Function in C++

- A **member of one class** can be a **friend of another class**.

```
#include <iostream>
using namespace std;

class Truck;    //Forward Declaration

class Car{
    int passenger, speed;
public:
    Car(int p, int s){ passenger = p; speed = s;}
    int speedGreater(Truck t);
};

class Truck{
    int weight, speed;
public:
    Truck(int w, int s){ weight = w; speed = s;}
    friend int Car::speedGreater(Truck t);
};
```

```
int Car::speedGreater(Truck t){
    return speed - t.speed;
}

int main(){
    Car c(5, 70);
    Truck t(500, 60);

    cout << "Speed Gap: " << c.speedGreater(t) << endl;

    return 0;
}
```

Java does not have a "friend" keyword or concept.

**Output:**

Speed Gap: 10



# Use of static

● **static: Independent of object.** Static member can be accessed before creation of any object and without reference to any object.

- ✓ Only **one copy of static variable** and all the objects of its class share it.
- ✓ A static member cannot access non-static members of a class. **WHY?**

● Uses:

**static variable:** like global variable. When object is declared, no copy of static variable is made.

**static method:** Restrictions of static method-

- ✓ Can access static variables only and call only other static methods of their class.
- ✓ Can't refer to **this** or **super** anyway.
- ✓ **Static function** in **C** implies function can be used in multiple files.

**static block:** Executed exactly once, when first the class is loaded. Used for initialization.

- ✓ Supported only in Java. C & C++ does not support.



# Use of static

## Use of static in C

```
#include <stdio.h>
int a = 2;
static int b = 5;

static int mult(){
    a++; b++;
    return a * b;
}

void fun(){
    static int count = 0;
    count++;
    printf("Count: %d\n", count);
}

int main(){
    for(int i = 0; i < 5; i++){
        fun();
    }
    printf("Product: %d\n", mult());
    return 0;
}
```

### Output:

```
Count: 1
Count: 2
Count: 3
Count: 4
Count: 5
Product: 18
```

## Use of static (variable & method) in C++

```
#include <iostream>
using namespace std;

class StaticDemo {
    static int a;
    // static int b = 5;
    static const int b = 5;
    int n = 4, m = 5;

public:
    //static void increment() {a++; b++;}
    static void increment() {a++;}
    // static int getProduct(){ return n * m;}
    int getProduct() { return n * m;}

    static void display() {
        cout << "A: " << a << " B: " << b << endl;
    }
};

int StaticDemo::a = 0;
```

```
int main() {
    StaticDemo sd;

    sd.display();
    sd.increment();
    StaticDemo::display();
    Cout << sd.getProduct() << endl;
    return 0;
}
```

### Output:

```
A: 0 B: 5
A: 1 B: 5
20
```



# Use of static

## Use of static in Java

```
class StaticDemo {
    static int a = 3;
    static int b;
    static int c;

    static void show(int x) {
        a++; b--;
        System.out.print("A: " + a + " ");
        System.out.print("B: " + b + " ");
        System.out.print("C: " + c + " ");
        System.out.println("X: " + x);
    }

    static {
        System.out.println("Static is Initialized.");
        b = a * 4;
    }
}
```

```
public class Main {
    public static void main(String[] args) {
        StaticDemo sd = new StaticDemo();
        StaticDemo.c = 5;

        for (int i = 0; i < 2; ++i) {
            sd.show(40 + i);
        }
        // show(10);
        StaticDemo.show(10);
        System.out.println("B:" + StaticDemo.b);
    }
}
```

### Output:

```
Static is Initialized.
A: 4 B: 11 C: 5 X: 40
A: 5 B: 10 C: 5 X: 41
A: 6 B: 9 C: 5 X: 10
B:9
```





# Use of **import static** in Java

➤ Use of **import static** allows static members of a class or interface can be called **without reference**.

```
import java.lang.Math.*;
import java.lang.System.*;

public class Main {
    public static void main(String[] args) {
        double s1 = 3.0, s2 = 4.0;
        int x1 = 5, y1 = 8, x2 = 6, y2 = 10;

        double h = Math.hypot(s1, s2);
        double dist = Math.sqrt(Math.pow(x1-x2, 2)+ Math.pow(y1-y2, 2));

        System.out.println("Hypotenuse: "+ h + " Dist: " + dist);
    }
}
```

```
import static java.lang.Math.*;
import static java.lang.System.out;

public class Main {
    public static void main(String[] args) {
        double s1 = 3.0, s2 = 4.0;
        int x1 = 5, y1 = 8, x2 = 6, y2 = 10;

        double h = hypot(s1, s2);
        double dist = sqrt(pow(x1-x2, 2)+ pow(y1-y2, 2));

        out.println("Hypotenuse: "+ h + " Dist: " + dist);
    }
}
```

## OUTPUT:

Hypotenuse: 5.0 Dist: 2.23606797749979





# Use of **const** and **mutable** in C++

- When a **member function** is **declared** as **const**, it **cannot modify** the object that invokes it.
- **mutable overrides** const-ness. A **mutable member** can be modified by a **const member function**.
- **Non-Member function** cannot be **const**.

```
#include <iostream>
#include <mutex>
using namespace std;

class Demo {
    mutable int a;
    int b;

public:
    Demo() {a = 0; b = 0;}
    int getA() const {return a;}
    int getB() const {return b;}
    void setAB(int x, int y) const {
        a = x;
        // b = y;
    }
};
```

```
int main() {
    const Demo d;

    d.setAB(10, 20);
    cout << "A: " << d.getA() << endl;
    cout << "B: " << d.getB() << endl;

    return 0;
}
```

## Output:

```
A: 10
B: 0
```



# Use of **final** in Java

Three uses of **final** keyword:

**final variable**: constant, i.e., can't be modified.

Can be initialized two ways:

✓ When declared.

```
final double PI = 3.14159;
```

✓ Assign a value within constructor.

**final method**: can't be overridden.

**final class**: can't be inherited.

```
public class Main {  
    public static void main(String[] args) {  
        Cylinder cylinder = new Cylinder(3.0, 4.0);  
        System.out.print(cylinder.cylinderVolume());  
    }  
}
```

```
class Figure {  
    final private double pi = 3.14159;  
    private double radius;  
  
    // public void setPI(double newPI){ pi = newPI;}  
    public void setRadius(double newRadius) { radius = newRadius; }  
    final public double circleArea() { return pi * radius * radius; }  
}
```

```
final class Cylinder extends Figure {  
    final private double height;  
  
    Cylinder(double newRadius, double newHeight) {  
        setRadius(newRadius);  
        height = newHeight;  
    }  
  
    // public double circleArea(){ return 3.14159*radius*radius; }  
    public double cylinderVolume() { return circleArea() * height; }  
}
```

C++ does not have "final" keyword.



# Array of Objects in C++

```
#include <iostream>
#include <string>
using namespace std;
```

```
class Sa{
    int a;
public:
    Sa(int n){ a = n;}
    int getA(){ return a;}
};
```

```
class Da{
    string name;
    int b;
public:
    Da(string nam, int n){ name = nam; b = n;}
    void show(){
        cout << "(" << name << ", " << b << ")" << endl;
    }
};
```

## Output:

```
s1[0] = 10 s2[0] = 50
(A, 10)
s1[1] = 20 s2[1] = 60
(B, 20)
s1[2] = 30 s2[2] = 70
(C, 30)
s1[3] = 40 s2[3] = 80
(D, 40)
s3[0][0] = 11 s4[0][0] = 41
s3[0][1] = 12 s4[0][1] = 42
s3[1][0] = 21 s4[1][0] = 51
s3[1][1] = 22 s4[1][1] = 52
s3[2][0] = 31 s4[2][0] = 61
s3[2][1] = 32 s4[2][1] = 62
```

```
int main(){
    Sa s1[4] = {10, 20, 30, 40};
    Sa s2[4] = {Sa(50), Sa(60), Sa(70), Sa(80)};
    Sa s3[3][2] = { {11, 12}, {21, 22}, {31, 32} };
    Sa s4[3][2] = { {Sa(41), Sa(42)}, {Sa(51), Sa(52)}, {Sa(61), Sa(62)} };
    Da ob[4] = { Da("A", 10), Da("B", 20), Da("C", 30), Da("D", 40) };

    for (int i = 0; i < 4; i++){
        cout << "s1[" << i << "] = " << s1[i].getA() << " ";
        cout << "s2[" << i << "] = " << s2[i].getA() << endl;
        ob[i].show();
    }

    for (int i = 0; i < 3; i++){
        for (int j = 0; j < 2; j++){
            cout << "s3[" << i << "][" << j << "] = " << s3[i][j].getA() << " ";
            cout << "s4[" << i << "][" << j << "] = " << s4[i][j].getA() << endl;
        }
    }
}
```



# Array of Objects in Java

```
class Samp {  
    private int a;  
    Samp(int n) { a = n;}  
    public int getA(){ return a;}  
}  
  
class Std{  
    String name;  
    int id;  
    Std(String n, int i){ name = n; id = i;}  
    public void show(){  
        System.out.println(name + ":" + id);  
    }  
}
```

## Output:

```
40 41 42 43  
J:101  
L:102  
H:103
```

```
public class Main {  
    public static void main(String[] args) {  
        int[] A = new int[4];  
        int[] B = {11, 12, 13, 14};  
        int[][] C = {{21, 22}, {23, 24}, {25, 26}};  
        Samp[] S = new Samp[4];  
        Std[] std = {new Std("J", 101), new Std("L", 102), new Std("H", 103)};  
  
        for(int i =0; i < 4; ++i){  
            A[i] = 30 + i;  
            S[i] = new Samp(40+i);  
        }  
  
        for(int i =0; i< S.length; ++i){  
            System.out.print(S[i].getA()+" ");  
        }  
        System.out.println();  
        for(Std s: std){  
            System.out.println(s.name + ":" + s.id);  
        }  
    }  
}
```



# Nested Class

- The scope of **Nested Class** is limited by the scope of the enclosing class.
- A Nested class is a **static** or **non-static** member of the enclosing class. The non-static nested class is known as **Inner Class**.
- A **Inner Class** class has access to the members of enclosing class (including private members); but the enclosing class does not have access to the members of the nested class.

```
int main() {  
    Outer outer(10);  
    outer.show();  
    outer.showInner(20);  
  
    Outer::Inner inner(30);  
    inner.show();  
    inner.showOuter(outer);  
    outer.inner2.show("Hello from Inner2!");  
    return 0;  
}
```

## Output:

```
Outer: 10  
Inner: 20  
Inner: 30  
Outer: 10  
Hello from Inner2!
```

## C++ Code

```
#include <iostream>  
#include <string>  
using namespace std;  
  
class Outer {  
    int a;  
public:  
    Outer(int x) { a = x; }  
    void show() { cout << "Outer: " << a << endl; }  
  
    void showInner(int x) {  
        Inner inner(x);  
        inner.show();  
    }  
  
    class Inner {  
        int b;  
    public:  
        Inner(int y) { b = y; }  
        void show() { cout << "Inner: " << b << endl; }  
        void showOuter(Outer &ob) { ob.show(); }  
    };  
  
    class Inner2 {  
    public:  
        void show(string str) {  
            cout << str << endl;  
        }  
    };  
    Inner2 inner2;  
};
```



# Nested Class

```
class Outer {  
    private int a;  
    Outer(int x) { a = x; }  
    public void show() { System.out.println("Outer: " + a);}  
    public void showInner(int x) {  
        Inner inner = new Inner(x);  
        inner.show();  
    }  
  
    public class Inner {  
        private int b;  
        Inner(int y) { b = y; }  
        public void show() { System.out.println("Inner: " + b); }  
        public void showOuter(Outer ob) { ob.show(); }  
    };  
  
    public class Inner2 {  
        public void show(String str) { System.out.println(str); }  
    };  
    Inner2 inner2 = new Inner2();  
};
```

Java Code

```
public class Main {  
    public static void main(String[] args) {  
        Outer outer = new Outer(10);  
        outer.show();  
        outer.showInner(20);  
  
        Outer.Inner inner = outer.new Inner(30);  
        inner.show();  
        inner.showOuter(outer);  
  
        outer.inner2.show("Hello from Inner2!");  
    }  
}
```

## Output:

```
Outer: 10  
Inner: 20  
Inner: 30  
Outer: 10  
Hello from Inner2!
```





# String Class in Java

- **String** type object is immutable. Once a **String** object is created, its contents will not be altered.

```
String myStr = new String("This is a test.");
```

```
String myStr = "This is a test.";
```

- Three methods of String

- ✓ `boolean equals(secondStr)`

- ✓ `int length()`

- ✓ `char charAt(index)`

- **StringBuffer** and **StringBuilder** are peer classes of **String**, which allows string to be altered.





# Command Line Arguments in Java

## A Sample Program:

```
public class CommandLine {  
    public static void main(String[] args) {  
        for (int i = 0; i < args.length; i++) {  
            System.out.println("args[" + i + "]: " + args[i]);  
        }  
    }  
}
```

## Command Line:

```
.....> javac CommandLine  
.....> java CommandLine this is a test 100 -1
```

## Output:

```
args[0]: this  
args[1]: is  
args[2]: a  
args[3]: test  
args[4]: 100  
args[5]: -1
```



# Local Variable Type Inference in Java

```
public class Main {  
    public static void main(String[] args) {  
  
        String [] str1 = {"one", "two", "three"};  
        var str2 = "This is a test.";   
  
        for (var i = 0; i < str1.length; i++) {  
            System.out.println("str[" + i + "]: " + str1[i]);  
        }  
  
        for(var a: str1) System.out.println(a);  
        System.out.println(str2);  
    }  
}
```

Annotations and arrows:

- String
- int
- ?
- ?
- ?
- Ambiguity? Why?