Lecture One

Basic Features of Object Oriented Programming (OOP)

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C/C++ Basic I/O

General form of C++ Console I/O

- **Input Command**: **cin >> variable;**
- **Output Command**: **cout << expression;**

C Basic I/O	C++ Basic I/O
a) Input Statements	
scanf("%s", strName);	cin >> strName;
scanf("%d", &iCount);	cin >> iCount;
scanf("%f", &fValue);	cin >> fValue;
scanf("%d %d %d", &day, &month, &year);	cin >> day >> month >> year;
b) Output Statements	
printf("%s%c%s%c", "Hello", ' ', "World", '!');	cout << "Hello" << ' ' << "World" << '!';
printf("Value of iCount is: %d", iCount);	cout << "Value of iCount is: " << iCount;
printf("Enter day, month, year");	cout << "Enter day, month, year: ";

I/O in C++ Programming

C Code

```c
#include <stdio.h>
int main() {
    int a, b, sum;
    char str[16];

    printf("Enter number 1: ");
    scanf("%d", &a);
    printf("Enter number 2: ");
    scanf("%d", &b);
    printf("Enter a string: ");
    scanf("%s", str);
    sum = a + b;
    printf("The sum is %d : %s", sum, str);

    return 0;
}
```

Output:

```
Enter number 1: 12
Enter number 2: 23
Enter a string: Love C Programming.
The sum is 35 : Love
```

Why? How to solve this?

C++ Code

```cpp
#include <iostream>
using namespace std;
int main() {
    int a, b, sum;
    char str[16];

    cout << "Enter number 1: ";
    cin >> a;
    cout << "Enter number 2: ";
    cin >> b;
    cout << "Enter a String: ";
    cin >> str;
    sum = a + b;
    cout << "The sum is "<< sum << " : " << str;

    return 0;
}
```

Output:

```
Enter number 1: 14
Enter number 2: 25
Enter a String: Love C++ Prog.
The sum is 39 : Love
```

Programming with C++

Two versions of C++:

Old version of C++:

```
#include <iostream.h>

int  main(){
      /*  program code */
      return 0;
}
```

➢ Includes **filename**

New version of C++:

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

int main(){
      /* program code */
     return 0;
}
```

➢ Includes **stream** which is mapped to file by compiler

Bjarne Stroustrup (1979)

Filename used in Old Version	File stream used in New Version
iostream.h	iostream
string.h	cstring
math.h	cmath
graphics.h	cgraphics

Comments

- Multi-line comments

  /* one or more lines of comments */

- Single line comments

  // …

Some differences between C and C++

SL#	Area	C	C++
1.	Empty parameter list	**void** is mandatory. char fl(void);	**void** is optional. char fl();
2.	Function prototype	Function prototype is optional but recommended.	All functions must be prototyped.
3.	Returning a value	➢A **non-void** function in not required to actually return a value. If it doesn't, a **garbage value** is returned. ➢ "**Default-to-int**" rule: If a function does not explicitly specify the return type, an integer return type is assumed.	➢If a function is declared as returning a value, it **must** return a value. ➢ C++ has **dropped** the "default-to-int" rule.
4.	Local variable declaration	Local variables are declared at the **start of a block**, prior to any action statement.	Local variables can be declared **anywhere**.
5.	**bool** data type	-	C++ defines the **bool** data type and also **keywords true** and **false**.

I/O in Java Programming

- ✓ **System** class of java provides facilities like standard input, standard output and standard error streams. *System class can't be instantiated*.
- ✓ Java **Scanner** is a utility class to read user input or process simple regex-based parsing of file or string source. Regex is a short form of regular expression.

JAVA Code

```
import java.util.Scanner;

public class Program7 {
    public static void main(String[] args) {
        Scanner myObj = new Scanner(System.in);

        System.out.print("Enter the first number: ");
        int a = myObj.nextInt();
        System.out.print("Enter the second number: ");
        int b = myObj.nextInt();

        int sum = a + b;
        System.out.println("The sum is "+ sum+ ".");
    }
}
```

Scanner Methods:

- `nextBoolean()`
- `nextByte()`
- `nextDouble()`
- `nextFloat()`
- `nextInt()`
- `nextLine()`
- `nextLong()`
- `nextShort()`

Output:

```
Enter the first number: 12
Enter the second number: 34
The sum is 46.
```

Notes for Java:

1. Java does **not allow** any variable or function out of a class.

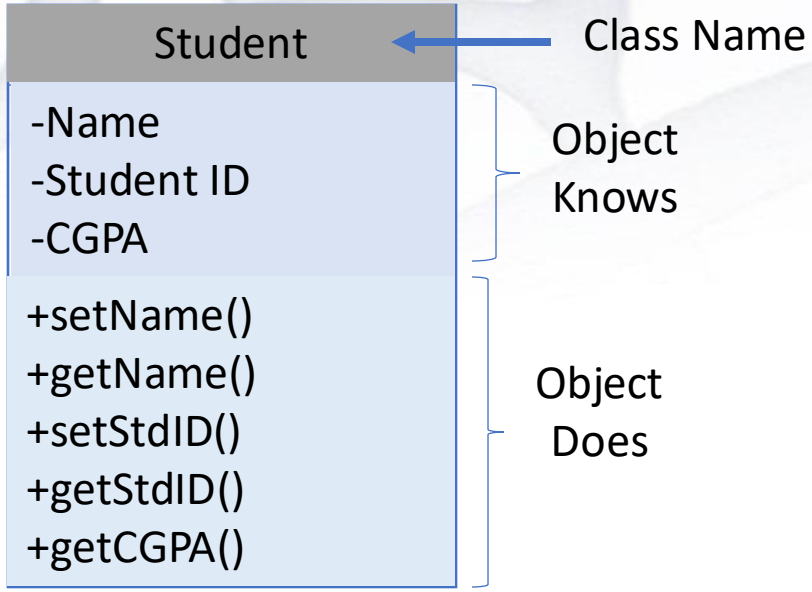
2. main() method must be within a class.

3. main() method must be **public** and **static**. **Why?**

4. A source file may contain multiple class or interface; but only one of them is public.

2.The source file name must be same with public class or interface name.

Class vs. Object



- means **private**
+ means **public**

Examples

Class: Student
Object: Lisa, Latif, Mahmud, Habiba

Class: A template or blueprint that defines the properties and behaviors of a type of objects.

Object: A specific instance of a class.

Structure vs. Class

C Code

Program8.c

```
#include <stdio.h>

typedef struct xx{
        char name[20];
        int rollno;
        double cgpa;
} Student;

int main() {
     Student karim;
     printf("Enter the name: ");
     gets(karim.name);
     printf("Enter Rollno: ");
     scanf("%d", &karim.rollno);
     printf("Enter CGPA: ");
     scanf("%lf", &karim.cgpa);

     printf("\nName: %s\n", karim.name);
     printf("Rollno: %d\n", karim.rollno);
     printf("CGPA: %.2lf\n", karim.cgpa);
}
```

Output:

```
Enter the name: Karim Ahmed
Enter Rollno: 12
Enter CGPA: 3.85

Name: Karim Ahmed
Rollno: 12
CGPA: 3.85
```

Structure vs. Class

Program8.cpp

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

typedef struct xx{
private:
        char name[20];
        int rollno;
        double cgpa;
public:                          //setter - getter
         void setName(char *N){ strcpy(name, N);}
         char *getName(){return name;}
         void setRollno(int R){ rollno = R; }
         int getRollno(){ return rollno;};
         void setCGPA(double CGPA){ cgpa = CGPA;}
         double getCGPA(){ return cgpa;}
} Student;
```

C++ Code

```
int main() {
      Student karim;
      char iname[20];
      int irollno;
      double icgpa;

      cout << "Enter the name: ";
 //   cin >> karim.name;  //Error - Why?
      cin >> iname;
      karim.setName(iname);

      cout << "Enter Rollno: ";
 //   cin >> karim.rollno; //Error - Why ?
      cin >> irollno;
      karim.setRollno(irollno);

      cout << "Enter CGPA: ";
      cin >> icgpa;
      karim.setCGPA(icgpa);

      cout << karim.getName() << " ";
      cout << karim.getRollno();
      cout << " " << karim.getCGPA();
}
```

Output:

```
Enter the name: Karim
Enter Rollno: 12
Enter CGPA: 3.85
Karim 12 3.85
```

Does it allow a name as **"Karim Ahmed"**? **Why?**

Structure vs. Class

- By default, all members of a structure are **Public**

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

typedef struct xx{
private:
        char name[20];
        int rollno;
        double cgpa;
public:                          //setter - getter
         void setName(char *N){ strcpy(name, N);}
         char *getName(){return name;}
         void setRollno(int R){ rollno = R; }
         int getRollno(){ return rollno;};
         void setCGPA(double CGPA){ cgpa = CGPA;}
         double getCGPA(){ return cgpa;}
} Student;
```

C++ Code

- By default, all members of a class are **Private**

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

class Student{
        char name[20];
        int rollno;
        double cgpa;
public:                          //setter - getter
         void setName(char *N){ strcpy(name, N);}
         char *getName(){return name;}
         void setRollno(int R){ rollno = R; }
         int getRollno(){ return rollno;};
         void setCGPA(double CGPA){ cgpa = CGPA;}
         double getCGPA(){ return cgpa;}
};
```

Use of Class in Java

- Java doesn't support **Structure, Pointer or Union.**
- **main** method – static, public, inside class

```
import java.util.Scanner;

class Student{
    private String name;
    private int rollno;
    private double cgpa;

    //setter - getter
    public void setName(String N){name = N;}
    public String getName(){return name;}
    public void setRollno(int R){ rollno = R; }
    public int getRollno(){ return rollno;};
    public void setCGPA(double CGPA){ cgpa = CGPA;}
    public double getCGPA(){ return cgpa;}
}
```

Output:

```
Enter name: Abdur Rahim
Enter Rollno: 12
Enter CGPA: 3.85
Name: Abdur Rahim Rollno: 12 CGPA: 3.85
```

StudentDemo.java

Java Code

```
public class StudentDemo{
    public static void main(String[] args){
        Student std = new Student();
        String iname = new String();
        Scanner obj = new Scanner(System.in);
        int irollno;
        double icgpa;

        System.out.print("Enter name: ");
        iname = obj.nextLine();
        std.setName(iname);

        System.out.print("Enter Rollno: ");
        irollno = obj.nextInt();
        std.setRollno(irollno);

        System.out.print("Enter CGPA: ");
        icgpa = obj.nextDouble();
        std.setCGPA(icgpa);

        System.out.print("Name: " + std.getName()+
            " Rollno: " + std.getRollno() +
            " CGPA: " + std.getCGPA());
    }
}
```

Features of OOP

Three Key Features of OOP

Encapsulation

- Wrap up data and functions/methods together
- Insulation of data from direct access by the program – data hiding

Polymorphism

One Interface, multiple methods

- Function overloading:
  - (1) Use a single name to multiple methods;
  - (2) different number and types of arguments.
- Operator overloading:
  - Use of single operator for different types of operands

Inheritance

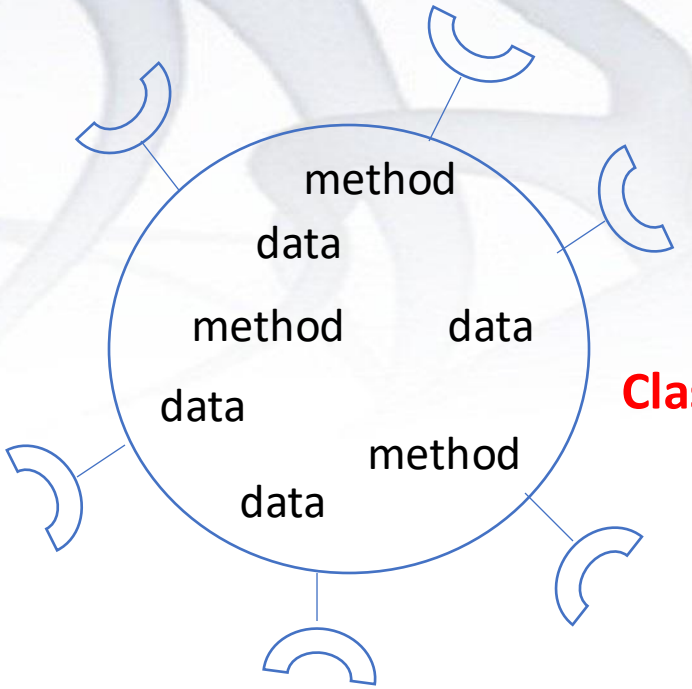
- One class inherits the properties of another class
- provide hierarchical classifications
- Permits reuse of common code and data

Abstraction

- Representing essential features without details
- Class defines a list of abstract attributes (**data members**) and methods to operate on these attributes

Encapsulation / Data Hiding

❖ **Wrap up data** and **functions/methods** together



Class

Interface
(Public method/data)

C++ Code

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

class myclass {
    int  a;
public:
    myclass();  // constructor
    int geta() { return a;}
};

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

int main(){
    myclass ob;

 //    cout << a;  // wrong -Why?
     cout << ob.geta();     // OK
     return 0;
}
```

Java Code

```
class MyClass{
   private int a;
   MyClass(){
      System.out.println("In Constructor");
      a = 10;
   }
   public int getA(){return a;}
}

public class Encapsulation{
   public static void main(String[] args){
      MyClass ob = new MyClass();
 //    System.out.println("a: "+a);  Error - Why?
      System.out.println(ob.getA());
   }
}
```

Output:

```
In Constructor
10
```

Polymorphism

One Interface, multiple methods

- **Function overloading**: (supported by both C++ & Java)
  (1) Use a **single name** to **multiple methods**;
  (2) **different** number and types of **arguments**.
- **Operator overloading**: (Java doesn't support customized operator overloading)
  Use of **single operator** for **different** types of operands

Function / Constructor Overloading

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

class date {
   int month, day, year;
public:
   date(char *str);
   date(int d, int m, int y){
      day = d;
      month = m;
      year = y;
   }
   void show(){
      cout << day << '/' << month << '/' ;
      cout << year << '\n';
   }
};
```

C++ Code

```
date::date(char *str){
      sscanf(str, "%d%*c%d%*c%d", &day, &month, &year);
}

int main() {
    date sdate("31/12/99");
    date idate(31, 12, 99);

    sdate.show();
    idate.show();
    return 0;
}
```

Output:

```
31/12/99
31/12/99
```

Polymorphism

```
import java.time.LocalDate;

class MyDate{
    private int day;
    private int month;
    private int year;

    MyDate(String str){
        LocalDate date = LocalDate.parse(str);
        day = date.getDayOfMonth();
        month = date.getMonthValue();
        year = date.getYear();
    }

    MyDate(int newDay, int newMonth, int newYear){
        day = newDay;
        month = newMonth;
        year = newYear;
    }

    public void showMyDate(){
        System.out.println(day+"/"+month+"/"+year);
    }
}
```

PolymorphismDemo.java

JAVA Code

```
public class PolymorphismDemo {
    public static void main(String[] args) {
        MyDate sDate = new MyDate("2024-05-12");
        MyDate iDate = new MyDate(23, 7, 2025);

        sDate.showMyDate();
        iDate.showMyDate();
    }
}
```

Output:

```
12/5/2024
23/7/2025
```

Operator overloading:

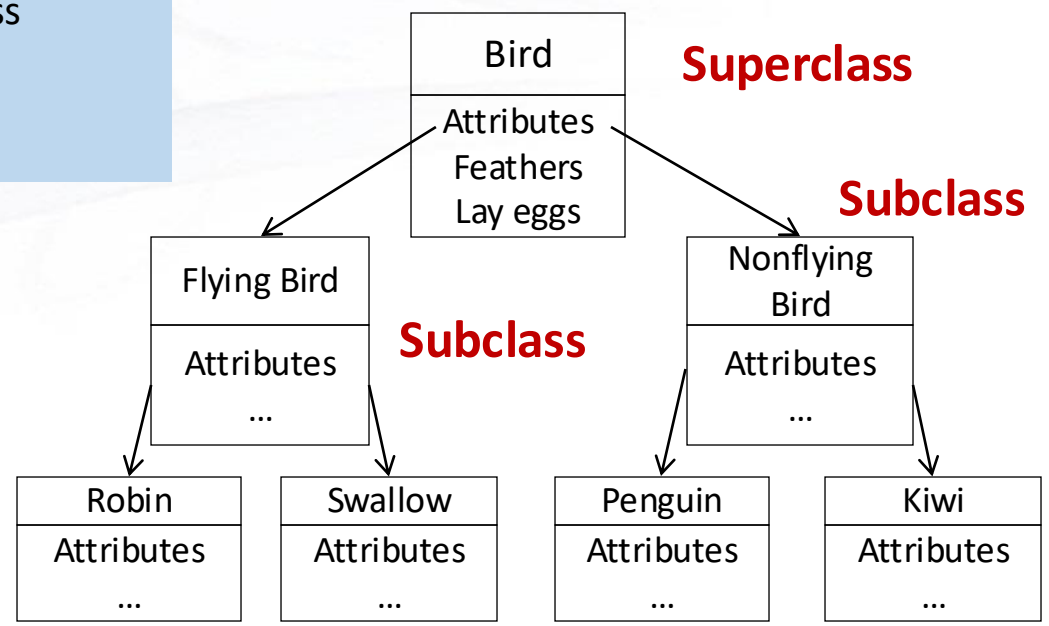
a = 4 + 6;

ob1 = ob2 + ob3; → **Not Supported in Java.**

Shall be discussed in next.

Inheritance

- One class **inherits** the **properties** of another class
- provide **hierarchical classifications**
- Permits **reuse** of common **code** and **data**




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

class base {                    Superclass
   int x;
public:
   void setx(int n) { x = n; }
   void showx() { cout << x << '\n'; }
   int getx(){ return x; }
};

class derived: public base {    Subclass
   int y;
public:
   void sety(int n) { y = n; }
   void showy() {
        cout << y << '\n';
        cout << y+getx() <<'\n';
   }
};
```

C++ Code

```
int main(){
   derived ob;

   ob.setx(10);
   ob.sety(20);
   ob.showx();
   ob.showy();
   return 0;
}
```

Output:

```
10
20
30
```

Inheritance

```
class Base{
   private int x;

   public void setX(int newX){ x = newX;}
   public int getX(){ return x;}
   public void showX(){System.out.println("X = "+x);}
}

class Derived extends Base{
   private int y;
   public void setY(int newY){ y = newY;}
   public void showY(){
      System.out.println("Y= "+y + "  X= "+ getX());
   }
}
```

Java Code

```
public class InheritanceDemo {
   public static void main(String[] args) {
      Derived obj = new Derived();

      obj.setX(10);
      obj.setY(20);
      obj.showX();
      obj.showY();
   }
}
```

Output:

```
X = 10
Y= 20   X= 10
```

Abstraction

Abstract Class and Method:

- **Abstract class** is a superclass without a complete implementation of every method.
  - There can be **no objects** of an abstract class.
  - Abstract can be used to create **object references**.
- **Abstract method** refers to **subclasser responsibility** to override it, otherwise, it will report a **warning message**.
  - **Constructor** and **static method** cannot be **Abstract.**

C++ Code

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

class Figure{
protected:
   double dim1, dim2;
public:
   Figure(double d1, double d2){
       dim1 = d1;
       dim2 = d2;
   }
   virtual double area() = 0; // Pure virtual function
};

class Rectangle: public Figure{
public:
   Rectangle(double d1, double d2): Figure(d1, d2){}
   double area(){
       return dim1 * dim2;
   }
};

class Triangle: public Figure{
public:
   Triangle(double d1, double d2): Figure(d1, d2){}
   double area(){
       return dim1 * dim2 / 2;
   }
};

int main(){
   Figure *p;
   Rectangle r(10, 7);
   Triangle t(10, 5);

   p = &r;
   cout << "Rectangle Area: " << p->area() << endl;

   p = &t;
   cout << "Triangle Area: " << p->area() << endl;

   return 0;
}
```

Abstraction

```
abstract class Figure {
    double dim1, dim2;
    Figure(double a, double b){ dim1 = a; dim2 = b;}
    abstract double area();
    void show(){System.out.println("Abstract");}
}

class Rectangle extends Figure {
    Rectangle(double a, double b) { super(a, b);}
    double area(){ return dim1*dim2;}
    void show(){
        System.out.println("Rectangle Area: "+area());
    }
}

class Triangle extends Figure {
    Triangle(double a, double b) {super(a, b);}
    double area(){ return 0.5*dim1*dim2;}
    void show(){
        System.out.println("Triangle Area: "+area());
    }
}
```

Java Code

```
public class Main {
    public static void main(String[] args) {
        Rectangle r = new Rectangle(10,7);
        Triangle t = new Triangle(10, 5);
        Figure figref;

        figref = r;
        figref.show();

        figref = t;
        figref.show();
    }
}
```

Output:

```
Rectangle Area: 70.0
Triangle Area: 25.0
```

Interface in Java

Abstract class: private /public /protected variable and method **declaration / implementation** is allowed.

Interface: only static final variable and method **declaration** is allowed. No method implementation.

Fly.java

```
public interface Fly {
      public String fly();
}

class Dog implements Fly{
      public String fly(){ return "I cannot fly."; }
      public String MakeSound(){ return "I sound berk.";}
}

class Bird implements Fly{
      public String fly() { return "I fly in the sky.";}
      public String MakeSound(){ return "I sound chi-chi.";}
}

class Biman implements Fly{
     public String fly(){
         return "I fly too high in the sky.";
     }
}
```

InterfaceDemo.java

```
public class InterfaceDemo {
   public static void main(String[] args) {
        Fly doggy = new Dog();
        Bird sweety = new Bird();
        Fly gogon = new Biman();

        System.out.println("I am a dog."+ doggy.fly()+ ((Dog) doggy).MakeSound());
        System.out.println("I am a bird."+sweety.fly() + sweety.MakeSound());
        System.out.println("I am a Biman." + gogon.fly());
   }
}
```

Output:

I am a dog.I cannot fly.I sound berk.
I am a bird.I fly in the sky.I sound chi-chi.
I am a Biman.I fly too high in the sky.

Scope Resolution Operator (::) in C++

Scope Resolution Operator is used for **two purposes** in C++:

To access a **hidden global variable**

C++ Code

Program5.cpp

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

int count = 0;

int main(void) {
     int count = 0;
     ::count = 1;
     count = 2;
     cout << "Global: " << ::count << endl;
     cout << "Local: " << count;
     return 0;
}
```

Output:

```
Global: 1
Local: 2
```

To access a **hidden member class** or **member variable** with a **class**

C++ Code

Program6.cpp

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

class X {
public:
    static int count;
};

int X::count = 10;

int main () {
     cout << "count: " << X::count;
}
```

Output:

```
count: 10
```

Namespaces in C++

- A **namespace** is a **declarative region** that **localizes** the names of identifiers to **avoid name collisions.**
- **Three ways of using namespace.**

```
#include <iostream>
#include <string>

int main(){
    std::string str;

    std::cout << "Enter a string: ";
    getline(std::cin, str);
    std::cout << str << std::endl;

    return 0;
}
```

Output:

```
Enter a string: Love C++
Love C++
```

C++ Code

```
#include <iostream>
#include <string>
using std::cin;
using std::cout;
using std::endl;
using std::string;

int main(){
    string str;

    cout << "Enter a string: ";
    getline(cin, str);
    cout << str << endl;

    return 0;
}
```

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

int main(){
    string str;

    cout << "Enter a string: ";
    getline(cin, str);
    cout << str << endl;

    return 0;
}
```

- **Java programming uses separate namespace for each package.**

Namespaces in C++

- C++ library is defined within its own namespace, std.
- The general form of defining namespace is shown as:

```
namespace name{
}
```

Unnamed namespace is declared with the scope of a single file.

```
namespace{
}
```

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

namespace {
    void displayMsg() {
        cout << "unnamed namespace." << endl;
    }

    int add(int a, int b) {
        return a + b;
    }
}
```

- There are two general form of using statement:

```
using namespace name;
using name::member;
```

- Declaration of new namespaces are required for creating library of reusable code or code that requires widest portability.

```
int main() {
    displayMsg();
    int result = add(5, 3);
    cout << "Result: " << result << endl;
    return 0;
}
```

Output:

```
unnamed namespace.
Result: 8
```

Creation of Own Namespaces in C++

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

namespace firstNS{
    class MyClass {
        int i;
    public:
        MyClass(int n) { i = n; }
        void setI(int n) { i = n; }
        int getI() { return i; }
    };

    const char* str = "Hello from firstNS!";
    int counter = 0;
}

namespace secondNS{
    int x, y;
}
```

Output:

```
I: 99
Hello from firstNS!
10 9 8 7 6 5 4 3 2 1
X: 10
Y: 20
```

```
int main() {
    firstNS::MyClass ob(10);

    ob.setI(99);
    cout << "I: " << ob.getI() << endl;
    using firstNS::str;
    cout << str << endl;

    using namespace firstNS;
    for( counter = 10; counter; counter--)
       cout << counter << " ";
    cout << endl;

    secondNS::x = 10;
    secondNS::y = 20;

    cout << "X: " << secondNS::x << endl;
    cout << "Y: " << secondNS::y << endl;

    return 0;
}
```

Creation of Own Namespaces in C++

➢There can be more than one namespace declaration of the same name in the same file or different files.

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

namespace Demo{
    int a;
}

int x;

namespace Demo{
    int b;
}
```

```
int main(){
    using namespace Demo;

    a = b = x = 100;
    cout << "a: " << a << endl;
    cout << "b: " << b << endl;
    cout << "x: " << x << endl;

    return 0;
}
```

Output:

```
a: 100
b: 100
x: 100
```

Packages in Java

```
import java.time.LocalDate;

class MyDate{
   private int day;
   private int month;
   private int year;

   MyDate(String str){
        LocalDate date = LocalDate.parse(str);
        day = date.getDayOfMonth();
        month = date.getMonthValue();
        year = date.getYear();
   }

   public void showDate(){
        System.out.println("Date: "+ day+"/"+month+"/"+year);
   }
}
```

```
public class Main {
   public static void main(String[] args) {
        MyDate date = new MyDate("2024-05-12");
        date.showDate();
   }
}
```

Output:

```
Date: 12/5/2024
```

Some more common packages in Java:

- `import java.lang.*;`
- `import java.io.*;`
- `import java.util.*;`

`import java.lang.*;` is **Automatic.**

- ✓ Hierarchical Structure of Packages
- ✓ A package contains **classes** and other **subordinate packages**
- ✓ **Leave** of a hierarchy is a **class name**.

```
import java.util.*;
class MyDate extends Date{
   ……
}

is equivalent to

class MyDate extends java.util.Date{
   ……
}
```

Packages in Java

- There are **no core Java classes** in the **unnamed default package**; all of the standard classes are stored in some named package.
- Java is useless without much of the functionality in **java.lang** and so, it is implicitly imported by the compiler for all programs.
- If a class with the same name exists in **two different imported packages**, then **compiler will remain silent** and generate a **compile-time error** if the name is not used explicitly with the class specifying its package.
- when a package is imported, only those items within the package declared as **public** will be available to **non-subclasses** in the importing code.
- Packages act as **containers** for classes and other subordinate packages. Classes act as containers for data and code.

Creation of Own Packages in Java

- To create a package, simply include **package** command as the first statement in java source file.

```
package mypack;
```

- If **package** command is omitted, the class names are put into the default package, which has no name.
- Creating hierarchy of package.

```
package mypack.prog.myprog;
```

which is stored as mypack\prog\myprog in windows environment.

- A package cannot be renamed without renaming the directory in which classes are stored.

Creation of Own Packages in Java

```
package mypack;

class Balance{
   String name;
   double bal;

   Balance(String n, double b){
      name = n;
      bal = b;
   }
   void show(){
      System.out.println(name + ": $" + bal);
   }
}

class AccountBalance {
   public static void main(String[] args) {
       Balance[] current = new Balance[3];
       current[0] = new Balance(”Jerry", 123.23);
       current[1] = new Balance("Tell", 157.02);
       current[2] = new Balance("Tom", -12.33);
       for(int i=0; i<3; i++) current[i].show();
   }
}
```

Command line:

```
java mypack.AccountBalance
```

Incorrect Command:

```
java AccountBalance
```

`AccountBalanace` must be qualified with its package name.

Output:

```
Jerry: $123.23
Tell: $157.02
Tom: $-12.33
```

Good Practices

Setter - Getter

```
class Student{
   private String name;
   private int stdID;

   public void setName(String newname){
       name = newname;
   }

   public String getName(){
       return name;
   }

   public void setStdID(int newID){
       stdID = newID;
   }

   public int getStdID(){
       return stdID;
   }
}
```

Naming Convention

1. Every name should be meaningful.

```
Box ix;          // Very bad choice
Box b;           // Bad choice
Box mybox;       // Bad choice
Box myBox;       // Good choice
```

2. Class names shall be started with Upper Case; method and variable names shall be started with Lower Case.

```
class myclass;          // Bad choice
class MyClass;          // Good choice
double Val;             // Bad choice
int ID;                 // Bad choice
int stdID;              // Good choice
double Count(){…}           // Bad choice
double countName(){…}       // Bad choice
```

Using Initializer List in C++

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

class Point{
      int x, y;
public:
      Point(int a = 0, int b = 0){
            x = a;
            y = b;
      };
     void display(){
            cout << "x: " << x;
            cout << ", y: " << y << endl;
      }
};

int main(){
      Point p1(10, 20);
      p1.display();
      return 0;
}
```

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

class Point{
      int x, y;
public:
      Point(int a = 0, int b = 0): x(a), y(b) {}
      void display(){
            cout << "x: " << x;
            cout << ", y: " << y << endl;
      }
};

int main(){
      Point p1(10, 20);
      p1.display();
      return 0;
}
```

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

class Point{
      int x, y;
public:
      Point(int a = 0, int b = 0): x(a), y(b){
            cout << "x: " << x;
            cout << ", y: " << y << endl;
      }
};

int main(){
      Point p1(10, 20);
      return 0;
}
```