CE/CZ2002
Tutorial 9
Q1: C→C++
Q2: OO in C++

```c
#include<stdio.h>

void bubble(int a[],int n)
{
       int i,j,t;
    for(i=n-2;i>=0;i--)
       {
       for(j=0;j<=i;j++)
          {
            if(a[j]>a[j+1])
                     {
               t=a[j];
               a[j]=a[j+1];
               a[j+1]=t;
            }
        }
     }
  }//end function.

 int main()
  {
      int a[100],n,i;

      printf("\n\n Enter number of Integer elements to be sorted: ");
      scanf("%d",&n);

      for( i=0;i<=n-1;i++)
      {
          printf("\n\n Enter integer value for element no.%d : ",i+1);
          scanf("%d",&a[i]);
      }

      bubble(a,n);

      printf("\n\n Finally sorted array is: ");
      for( i=0;i<=n-1;i++)
            printf("%d  ",a[i]);
  } //end program.
```

```
import java.util.Scanner;

class BubbleSort {

       public static void bubble(int a[],int n)
       {
              int i,j,t;
              for(i=n-2;i>=0;i--)
              {
                 for(j=0;j<=i;j++)
                 {
                           if(a[j]>a[j+1])
                           {
                              t=a[j];
                              a[j]=a[j+1];
                              a[j+1]=t;
                           }
                     }
                }
         }//end function.

   public static void main(String args[])
   {
         int n,i;
         int a[] = new int[100];

       System.out.print("\n\n Enter number of Integer elements to be sorted: ");
       Scanner in = new Scanner(System.in);
       n = in.nextInt();
       for( i=0;i<=n-1;i++)
       {
        System.out.print("\n\n Enter integer value for element no. " + (i+1) + " : " );
                      a[i] = in.nextInt();
       }
           bubble(a,n);

           System.out.print("\n\n Final sorted array is : ");
                for( i=0;i<=n-1;i++)
                      System.out.print(a[i] + "   " );

                System.out.println() ; // optional
         } //end program.
}
```

C vs. C++: Simple Comparison

```c
#include <stdio.h>

int getFact(int n) {
  int c, fact = 1;
  if ( n < 0 )
      printf("Number should be non-negative.");
  else
      for (c = 1; c <= n; c++)
          fact = fact * c;
   return fact;
}

int main()
{
  int n = 1;

  printf("Enter a number to calculate it's factorial\n");
  scanf("%d", &n);

  printf("Factorial of %d = %d\n", n, getFact(n));

  return 0;
}
// save as <anyname>.c
```

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

int getFact(int n) {
  int c, fact = 1;
  if ( n < 0 )
  std:: cout << "Number should be non-negative." << endl ;
  else
      for (c = 1; c <= n; c++)
          fact = fact * c;
   return fact;
}

int main()
{
  int n = 1;

  cout << "Enter a number to calculate it's factorial > ";
  cin >> n;

  cout << "Factorial of " << n << " = " << getFact(n) << endl;

  return 0;
}
// save as <anyname>.cpp
```

Q1a. Identify the line number of the code to be changed

```
1   #include<stdio.h>
2
3   void bubble(int a[],int n)
4   {
5           int i,j,t;
6       for(i=n-2;i>=0;i--)
7           {
8           for(j=0;j<=i;j++)
9              {
10               if(a[j]>a[j+1])
11                        {
12                  t=a[j];
13                  a[j]=a[j+1];
14                  a[j+1]=t;
15               }
16           }
17       }
18    }//end function.
19
20   int main()
21    {
22        int a[100],n,i;
23
24        printf("\n\n Enter number of Integer elements to be sorted: ");
25        scanf("%d",&n);
26
27        for( i=0;i<=n-1;i++)
28        {
29            printf("\n\n Enter integer value for element no.%d : ",i+1);
30            scanf("%d",&a[i]);
31        }
32
33        bubble(a,n);
34
35        printf("\n\n Finally sorted array is: ");
36        for( i=0;i<=n-1;i++)
37              printf("%d  ",a[i]);
38    } //end program.
```

Q1b. Directly replace with the C++ language syntax

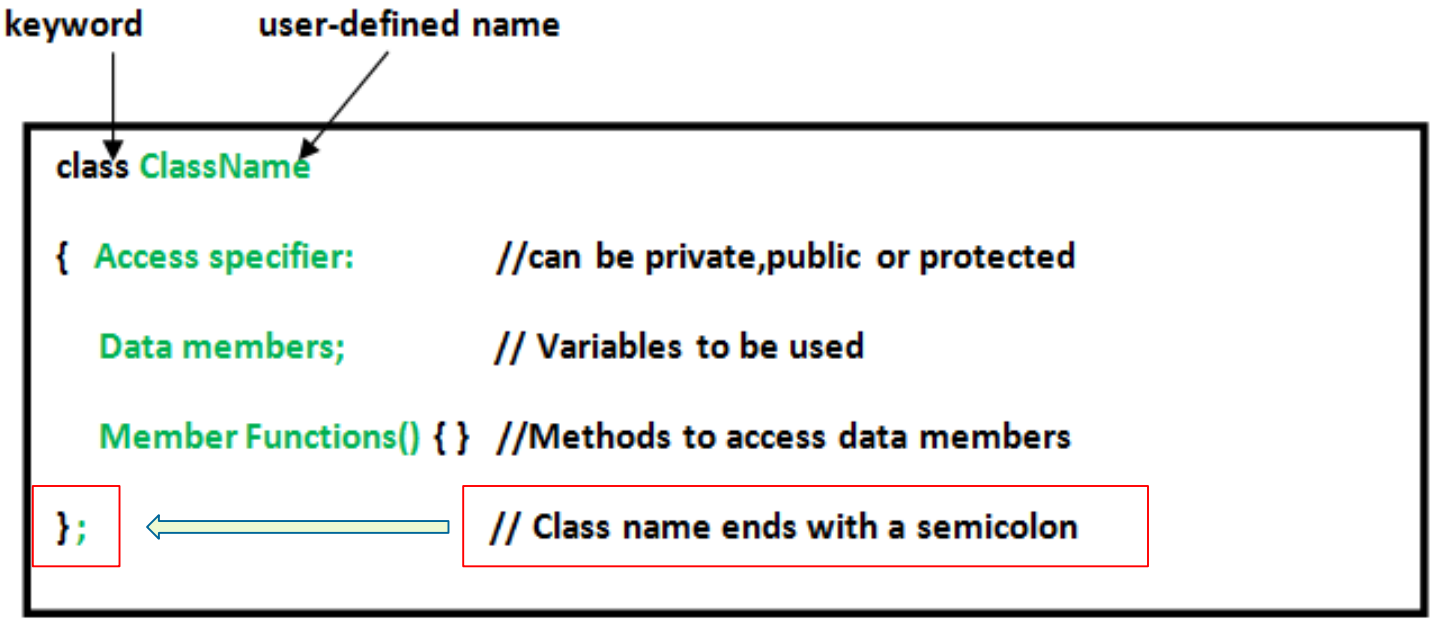
```
#include <iostream>
// using namespace std;
void bubble(int a[],int n)
{
       int i,j,t;
    for(i=n-2;i>=0;i--)
       {
       for(j=0;j<=i;j++)
          {
            if(a[j]>a[j+1])
                    {
               t=a[j];
               a[j]=a[j+1];
               a[j+1]=t;
            }
        }
     }
  }//end function.

 int main()
  {
      int a[100],n,i;

      std::cout << "\n\n Enter number of Integer elements to be sorted: ";
      std::cin >> n;

      for( i=0;i<=n-1;i++)
      {
          std::cout << "\n\n Enter integer value for element no." << i+1 << " ";
          std::cin >> a[i];
      }

      bubble(a,n);

       std::cout << "\n\n Finally sorted array is: ";
      for( i=0;i<=n-1;i++)
            std::cout << a[i] << " " ;
  } //end program.
```

```
#include <iostream>
using namespace std;
void bubble(int a[],int n)
{
int i,j,t;
for(i=n-2;i>=0;i--)
{
for(j=0;j<=i;j++)
{
if(a[j]>a[j+1])
{
t=a[j];
a[j]=a[j+1];
a[j+1]=t;
}
}
}
}//end function.
int main()
{
int a[100],n,i;
cout << "\n\n Enter number of Integer elements to be sorted: ";
cin >> n;
for( i=0;i<=n-1;i++)
{
cout << "\n\n Enter integer value for element no." << i+1 << " ";
cin >> a[i];
}
bubble(a,n);
cout << "\n\n Finally sorted array is: ";
for( i=0;i<=n-1;i++)
cout << a[i] << " " ;
} //end program.
```

Q1c

- Write the code as a C++ class.

C++ class



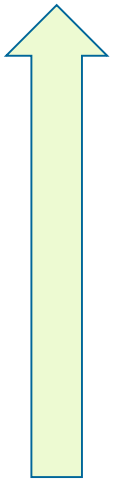
https://www.geeksforgeeks.org/c-classes-and-objects/

```
void bubble(int a[],int n)
{
int i,j,t;
for(i=n-2;i>=0;i--)
{
for(j=0;j<=i;j++)
{
if(a[j]>a[j+1])
{
t=a[j];
a[j]=a[j+1];
a[j+1]=t;
}
}
}
}//end function.
```

```
class BubbleSort {
    private :
        int _size ;
        int *_numArray ;

    public :
        BubbleSort(int nums[], int size)
```

```
class BubbleSort {
    private :
        int _size ;
        int *_numArray ;

    public :
        BubbleSort(int nums[], int size) : _size(size), _numArray(nums){}
```

Constructor



Initializer List is used to initialize data members of a class. The list of members to be initialized is indicated with constructor as a comma separated list followed by a colon.

```
public :
    BubbleSort(int nums[], int size) : _size(size), _numArray(nums){}

    void sort()
    {
        int t ;
        for(int i=_size-2;i>=0;i--)
        {
           for(int j=0;j<=i;j++)
           {
                if(_numArray[j]>_numArray[j+1])
                {
                   t=_numArray[j];
                   _numArray[j]=_numArray[j+1];
                   _numArray[j+1]=t;
                }
           }
        }
     }//end function.

    ~BubbleSort() { delete _numArray ; }  // destructor
```

Stack allocation version

```
int main()
{
int a[100],n,i;
cout << "\n\n Enter number of Integer elements to be sorted: ";
cin >> n;
for( i=0;i<=n-1;i++)
{
cout << "\n\n Enter integer value for element no." << i+1 << " ";
cin >> a[i];
}

BubbleSort b(a,n);
b.sort() ;

cout << "\n\n Finally sorted array is: ";
for( i=0;i<=n-1;i++)
cout << a[i] << " " ;

} //end program.
```

Heap allocation version

```
int main()
{
int a[100],n,i;
cout << "\n\n Enter number of Integer elements to be sorted: ";
cin >> n;
for( i=0;i<=n-1;i++)
    {
    cout << "\n\n Enter integer value for element no." << i+1 << " ";
    cin >> a[i];
    }

BubbleSort *b = new BubbleSort(a,n);
b->sort();

cout << "\n\n Finally sorted array is: ";
for( i=0;i<=n-1;i++)
cout << a[i] << " " ;

delete b ;
} //end program.
```

Q2

Referring to Tutorial 5 Question 3(v) and its solution, implement the codes for :

a. the Polygon class,

b. its subclasses Rectangle and Triangle class AND

c. a printArea function demonstrating dynamic binding of the calArea implementation.

Q2

```
public class Polygon {
    public enum KindofPolygon { POLY_PLAIN, POLY_RECT,   POLY_TRIANG};
    protected String name;
    protected float width;
    protected float height;
    protected KindofPolygon polytype;

    public Polygon(String theName, float theWidth, float theHeight) {
                    name = theName;
                    width = theWidth;
                    height = theHeight;
                    polytype = KindofPolygon.POLY_PLAIN;
    }
    public KindofPolygon getPolytype() {
                    return polytype;
    }
    public void setPolytype(KindofPolygon value) {
            polytype = value;
    }
    public String getName()  { return name; }
    public abstract float calArea();
    public void printWidthHeight( ) {
System.out.println("Width = " + width +  " Height = " +   height);
    }
}
```

Polymorphism

- **Virtual**
  - To force method evaluation to be based on object type rather than reference type. [<ref type> <name> = new <obj type>(..)]
  - Without **virtual** => non polymorphic (no dynamic binding)
  - **Example : virtual** void area() { cout << "....." << endl ; }
  - **Virtual** function magic only operates on pointers(*) and references(&).
  - If a method is declared **virtual** in a class, it is **automatically virtual** in all **derived** classes.
- **Pure method => abstract** method (pure virtual)
  - By placing **"= 0"** in its declaration
  - **Example : virtual** void area() **= 0** ; // abstract method
  - **The class becomes an abstract** class

https://www.learncpp.com/cpp-tutorial/126-pure-virtual-functions-abstract-base-classes-and-interface-classes/

Q2

```
public class Polygon {
    public enum KindofPolygon { POLY_PLAIN, POLY_RECT,  POLY_TRIANG};
    protected String name;
    protected float width;
    protected float height;
    protected KindofPolygon polytype;

    public Polygon(String theName, float theWidth, float theHeight) {
                    name = theName;
                    width = theWidth;
                    height = theHeight;
                    polytype = KindofPolygon.POLY_PLAIN;
    }
    public KindofPolygon getPolytype() {
                    return polytype;
    }
    public void setPolytype(KindofPolygon value) {
            polytype = value;
    }
    public String getName()  { return name; }
    public abstract float calArea();
    public void printWidthHeight( ) {
System.out.println("Width = " + width +  " Height = " +   height);
    }
}
```

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

using namespace std ;

enum KindofPolygon { POLY_PLAIN, POLY_RECT, POLY_TRIANG};
string StringKindofPolygon[] = { "POLY_PLAIN", "POLY_RECT", "POLY_TRIANG"};

class Polygon {

protected :
        string name;
        float width;
        float height;
        KindofPolygon polytype;

public :
        Polygon(string theName, float theWidth, float theHeight):name(theName) {
                width = theWidth;
                height = theHeight;
                polytype = POLY_PLAIN;
        }
    KindofPolygon getPolytype() {
                return polytype;
        }

        void setPolytype(KindofPolygon value) {
                polytype = value;
        }
        string getName() { return name; }
        virtual float calArea() = 0 ;
        void printWidthHeight( ) {
                cout << "Width = " << width << " Height = " << height << endl;
        }
};
```

Enumeration in C++

- Enum is a user defined data type where we specify a set of values for a variable and the variable can only take one out of a small set of possible values. We use enum keyword to define a Enumeration.

```
enum direction {East, West, North, South}dir
```

https://beginnersbook.com/2017/09/cpp-enumeration/

Simple enum Example

```
#include<iostream>
using namespace std;
enum direction {East, West, North, South}dir;
int main()
{
   dir = West;
   cout<<dir;
   return 0;
}
```

Q2b

- Implement the codes for its subclasses Rectangle and Triangle class

```
public class Rectangle extends Polygon {
    public Rectangle(String theName, float theWidth,
                     float theHeight)
    {
        super(theName, theWidth, theHeight) ;
         this.polytype =   KindofPolygon.POLY_RECT;
    }
    public float calArea() { return width * height; }
}
```

Class Inheritance

```
class Point3D : public Point {
   int _z;
public:
   Point3D( const int x, const int y, const int z) : Point(x, y)
         { _z = z; }
.....
};
```

Using Base class constructor

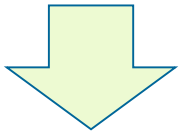
```
: Point(x, y) , _z(z)  { }
```

Specify the desired base constructors after a **single colon** just before the body of constructor.

Class Multiple Inheritance

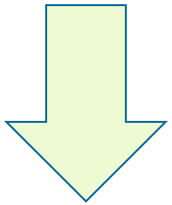
```
class DrawableString : public Point, public DrawableObject
{
.....
}
```

```
public class Rectangle extends Polygon {
    public Rectangle(String theName, float theWidth,
                     float theHeight)
    {
         super(theName, theWidth, theHeight) ;
          this.polytype =    KindofPolygon.POLY_RECT;
    }
    public float calArea() { return width * height; }
}
```



```
class Rectangle : public Polygon {
public :
        Rectangle(string theName, float theWidth,
                        float theHeight) : Polygon(theName, theWidth, theHeight)
    {
                polytype = POLY_RECT;
    }

    float calArea() { return width * height; }
};
```

```
public class Triangle extends Polygon {
    public Triangle (String theName, float theWidth,
                     float theHeight
    {
        super(theName, theWidth, theHeight) ;
        this.polytype = KindofPolygon.POLY_TRIANG;
    }
    public float calArea() { return 0.5f * width * height; }
}
```



```
class Triangle : public Polygon  {
public :
    Triangle (string theName, float theWidth,
                      float theHeight) : Polygon(theName, theWidth, theHeight)
    {
              polytype = POLY_TRIANG;
    }

    float calArea() { return 0.5f * width * height; }
};
```

Q2c

Implement the codes for a *printArea* function demonstrating dynamic binding of the *calArea* implementation.

```
public class TestPolygon {   // (ii)
    public static void printArea(Polygon poly) {
            float area = poly.calArea( );
              System.out.println("The area of the " +
    poly.getPolytype()  + " is " + area);
    }

public static void main(String[] args ) {
          Rectangle rect1 = new Rectangle("Rect1", 3.0f, 4.0f);
          printArea(rect1);
          rect1.printWidthHeight();

          Triangle triang1= new Triangle("Triang1", 3.0f, 4.0f);
          printArea(triang1);
          triang1.printWidthHeight();
    }
}
```

```
class TestPolygon {

public :
	static void printArea(Polygon& poly) {
		float area = poly.calArea( );
		cout <<"The area of the " << StringKindofPolygon[poly.getPolytype()]  <<  " is " << area << endl;
	}
};

int main() {

	Rectangle rect1("Rect1", 3.0f, 4.0f);
	rect1.printWidthHeight();
	TestPolygon::printArea(rect1);


	Triangle triang1("Triang1", 3.0f, 4.0f);
	triang1.printWidthHeight();
	TestPolygon::printArea(triang1);
}
```