Constructors in C++

Difficulty Level : Easy • Last Updated : 27 Mar, 2023

Constructor in C++ is a special method that is invoked automatically at the time of object creation. It is used to initialize the data members of new objects generally. The constructor in C++ has the same name as the class or structure. Constructor is invoked at the time of object creation. It constructs the values i.e. provides data for the object which is why it is known as constructors.

• Constructor is a member function of a class, whose name is same as the class name.
• Constructor is a special type of member function that is used to initialize the data members for an object of a class automatically, when an object of the same class is created.
• Constructor is invoked at the time of object creation. It constructs the values i.e. provides data for the object that is why it is known as constructor.
• Constructor do not return value, hence they do not have a return type.

```
The prototype of the constructor looks like
    <class-name> (list-of-parameters);
```

```
Constructor can be defined inside the class declaration or outside the class
declaration

a.    Syntax for defining the constructor within the class

        <class-name>(list-of-parameters)
        {
                  //constructor definition
```

```
}
```

b. Syntax for defining the constructor outside the class

```
<class-name>: :<class-name>(list-of-parameters)
{
        //constructor definition
}
```

C++

```
// Example: defining the constructor within the class

#include<iostream>
using namespace std;
class student
{
    int rno;
    char name[50];
    double fee;
    public:
    student()
    {
        cout<<"Enter the RollNo:";
        cin>>rno;
        cout<<"Enter the Name:";
        cin>>name;
        cout<<"Enter the Fee:";
        cin>>fee;
    }



    void display()
    {
        cout<<endl<<rno<<"\t"<<name<<"\t"<<fee;
    }
};
```

```
int main()
{
    student s;  //constructor gets called automatically when we create the object of t
    s.display();
    return 0;

}
```

C++

```
// Example: defining the constructor outside the class

#include<iostream>
using namespace std;
class student
{
    int rno;
    char name[50];
    double fee;
    public:
    student();
    void display();

};

    student::student()
    {
        cout<<"Enter the RollNo:";
        cin>>rno;
        cout<<"Enter the Name:";
        cin>>name;
        cout<<"Enter the Fee:";
        cin>>fee;
    }

   void student::display()
    {
        cout<<endl<<rno<<"\t"<<name<<"\t"<<fee;
    }

int main()
{
    student s;
    s.display();
    return 0;
}
```

Characteristics of constructor

- The name of the constructor is same as its class name.
- Constructors are mostly declared in the public section of the class though it can be declared in the private section of the class.
- Constructors do not return values; hence they do not have a return type.
- A constructor gets called automatically when we create the object of the class.
- Constructors can be overloaded.
- Constructor can not be declared virtual.

Types of constructor

- Default constructor
- Parameterized constructor
- Overloaded constructor
- Constructor with default value
- Copy constructor
- Inline constructor

Constructor does not have a return value, hence they do not have a return type.

The prototype of Constructors is as follows:

```
<class-name> (list-of-parameters);
```

Constructors can be defined inside or outside the class declaration:-

The syntax for defining the constructor within the class:

```
<class-name> (list-of-parameters) { // constructor definition }
```

The syntax for defining the constructor outside the class:

```
<class-name>: :<class-name> (list-of-parameters){ // constructor definition}
```

Example

C++

```
// defining the constructor within the class

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

```
class student {
    int rno;
    char name[10];
    double fee;

public:
    student()
    {
        cout << "Enter the RollNo:";
        cin >> rno;
        cout << "Enter the Name:";
        cin >> name;
        cout << "Enter the Fee:";
        cin >> fee;
    }

    void display()
    {
        cout << endl << rno << "\t" << name << "\t" << fee;
    }
};

int main()
{
    student s; // constructor gets called automatically when
               // we create the object of the class
    s.display();

    return 0;
}
```

Output

```
 Enter the RollNo:Enter the Name:Enter the Fee:
 0        6.95303e-310
```

Example

C++

```
// defining the constructor outside the class

#include <iostream>
using namespace std;
class student {
    int rno;
    char name[50];
    double fee;

public:
    student();
    void display();
```

```
};

student::student()
{
    cout << "Enter the RollNo:";
    cin >> rno;

    cout << "Enter the Name:";
    cin >> name;

    cout << "Enter the Fee:";
    cin >> fee;
}

void student::display()
{
    cout << endl << rno << "\t" << name << "\t" << fee;
}

int main()
{
    student s;
    s.display();

    return 0;
}
```

Output:

```
Enter the RollNo: 30
Enter the Name: ram
Enter the Fee: 20000
30 ram 20000
```

How constructors are different from a normal member function?

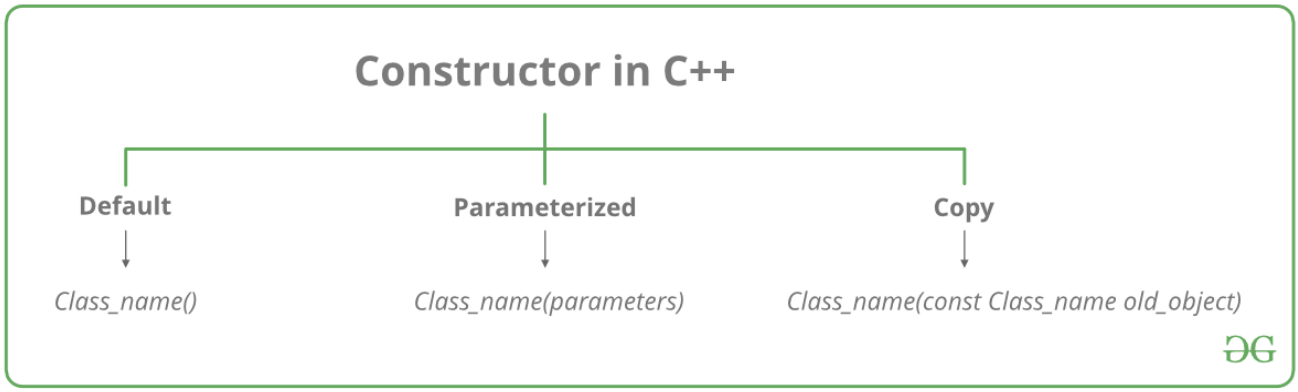
C++

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

class Line {
  public:
     void setLength( double len );
     double getLength( void );
     Line( double len ); //This is the constructor
  private:
     double length;
};
//Member function definition including constructor
Line::Line( double len ) {
```

```
  cout<<"Object is being created , length ="<< len <<endl;
  length = len;
}
void Line::setLength( double len ) {
  length = len;
}
double Line::getLength( void ) {
  return length;
}
//Main function for the program
int main() {
  Line line(10.0);
  //get initially set length
  cout<<"Length of line :" << line.getLength() << endl;
  //set line length again
  line.setLength(6.0);
  cout<<"Length of line :" << line.getLength() << endl;

  return 0;
}
```

A constructor is different from normal functions in following ways:

- Constructor has same name as the class itself
- Default Constructors don't have input argument however, Copy and Parameterized Constructors have input arguments
- Constructors don't have return type
- A constructor is automatically called when an object is created.
- It must be placed in public section of class.
- If we do not specify a constructor, C++ compiler generates a default constructor for object (expects no parameters and has an empty body).



Let us understand the types of constructors in C++ by taking a real-world example. Suppose you went to a shop to buy a marker. When you want to buy a marker, what are the options. The first one you go to a shop and say give me a marker. So just saying give me a marker mean that you did not set which brand name and which color, you didn't mention anything just say you want a marker. So when we said just I want a marker so whatever the frequently sold marker is there in the market or in his shop he will simply hand over that. And this is what a default constructor is! The second method is you go to a shop and say I want a marker a red in color and XYZ brand. So you are mentioning this and he will give you that marker. So in this case you have given the parameters. And this is what a parameterized constructor is! Then the third one you go to a shop and say I want a marker like this(a physical marker on your hand). So the shopkeeper will see that marker. Okay, and he will give a new marker for you. So copy of that marker. And that's what a copy constructor is!

Characteristics of the constructor:

- The name of the constructor is the same as its class name.
- Constructors are mostly declared in the public section of the class though it can be declared in the private section of the class.
- Constructors do not return values; hence they do not have a return type.
- A constructor gets called automatically when we create the object of the class.
- Constructors can be overloaded.
- Constructor can not be declared virtual.
- Constructor cannot be inherited.
- Addresses of Constructor cannot be referred.
- Constructor make implicit calls to **new** and **delete** operators during memory allocation.

Types of Constructors

1. Default Constructors: Default constructor is the constructor which doesn't take any argument. It has no parameters. It is also called a zero-argument constructor.

CPP

```cpp
// Cpp program to illustrate the
// concept of Constructors
#include <iostream>
using namespace std;

class construct {
public:
    int a, b;

    // Default Constructor
    construct()
    {
        a = 10;
        b = 20;
    }
};

int main()
{
    // Default constructor called automatically
    // when the object is created
    construct c;
    cout << "a: " << c.a << endl << "b: " << c.b;
    return 1;
}
```

Output

```
a: 10
b: 20
```

> ***Note:*** *Even if we do not define any constructor explicitly, the compiler will automatically provide a default constructor implicitly.*

C++

```cpp
// Example
#include<iostream>
using namespace std;
class student
```

```
{
    int rno;
    char name[50];
    double fee;
    public:
    student()                    //  Explicit Default constructor
    {
        cout<<"Enter the RollNo:";
        cin>>rno;
        cout<<"Enter the Name:";
        cin>>name;
        cout<<"Enter the Fee:";
        cin>>fee;
    }

    void display()
    {
        cout<<endl<<rno<<"\t"<<name<<"\t"<<fee;
    }
};

int main()
{
    student s;
    s.display();
    return 0;
}
```

2. Parameterized Constructors: It is possible to pass arguments to constructors. Typically, these arguments help initialize an object when it is created. To create a parameterized constructor, simply add parameters to it the way you would to any other function. When you define the constructor's body, use the parameters to initialize the object.

> ***Note:*** *when the parameterized constructor is defined and no default constructor is defined explicitly, the compiler will not implicitly call the default constructor and hence creating a simple object as*
>
> *Student s;*
> *Will flash an error*

CPP

```
// CPP program to illustrate
// parameterized constructors
#include <iostream>
using namespace std;
```

```
class Point {
private:
    int x, y;

public:
    // Parameterized Constructor
    Point(int x1, int y1)
    {
        x = x1;
        y = y1;
    }

    int getX() { return x; }
    int getY() { return y; }
};

int main()
{
    // Constructor called
    Point p1(10, 15);

    // Access values assigned by constructor
    cout << "p1.x = " << p1.getX()
         << ", p1.y = " << p1.getY();

    return 0;
}
```

Output

```
p1.x = 10, p1.y = 15
```

C++

```
// Example

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

class student
{
    int rno;
    char name[50];
    double fee;

      public:
    student(int,char[],double);
    void display();

};
```

```
student::student(int no,char n[],double f)
{
    rno=no;
    strcpy(name,n);
    fee=f;
}

void student::display()
{
    cout<<endl<<rno<<"\t"<<name<<"\t"<<fee;
}

int main()
{
    student s(1001,"Ram",10000);
    s.display();
    return 0;
}
```

When an object is declared in a parameterized constructor, the initial values have to be passed as arguments to the constructor function. The normal way of object declaration may not work. The constructors can be called explicitly or implicitly.

```
Example e = Example(0, 50); // Explicit call

Example e(0, 50);           // Implicit call
```

- **Uses of Parameterized constructor:**
  1. It is used to initialize the various data elements of different objects with different values when they are created.
  2. It is used to overload constructors.

- **Can we have more than one constructor in a class?**
  Yes, It is called Constructor Overloading.

3. Copy Constructor:

A copy constructor is a member function that initializes an object using another object of the same class. A detailed article on Copy Constructor.

Whenever we define one or more non-default constructors(with parameters) for a class, a default constructor(without parameters) should also be explicitly defined as the compiler will not provide a default constructor in this case. However, it is not necessary but it's considered to be the best practice to always define a default constructor.

Copy constructor takes a reference to an object of the same class as an argument.

```
Sample(Sample &t)
          {
                    id=t.id;
          }
```

CPP

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

class point {
private:
    double x, y;

public:
    // Non-default Constructor &
    // default Constructor
    point(double px, double py) { x = px, y = py; }
};

int main(void)
{

    // Define an array of size
    // 10 & of type point
    // This line will cause error
    point a[10];

    // Remove above line and program
    // will compile without error
    point b = point(5, 6);
}
```

Output:

```
Error: point (double px, double py): expects 2 arguments, 0 provided
```

C++

```cpp
// Implicit copy constructor

#include<iostream>
using namespace std;

class Sample
{          int id;
    public:
    void init(int x)
```

```
    {
        id=x;
    }
    void display()
    {
        cout<<endl<<"ID="<<id;
    }
};

int main()
{
    Sample obj1;
    obj1.init(10);
    obj1.display();

    Sample obj2(obj1); //or obj2=obj1;
    obj2.display();
    return 0;
}
```

Output

```
ID=10
ID=10
```

C++

```
// Example: Explicit copy constructor

#include <iostream>
using namespace std;

class Sample
{
    int id;
    public:
    void init(int x)
    {
        id=x;
    }
    Sample(){}  //default constructor with empty body

    Sample(Sample &t)   //copy constructor
    {
        id=t.id;
    }
    void display()
    {
        cout<<endl<<"ID="<<id;
    }
};
int main()
{
```

```
    Sample obj1;
    obj1.init(10);
    obj1.display();

    Sample obj2(obj1); //or obj2=obj1;    copy constructor called
    obj2.display();
    return 0;
}
```

Output

```
ID=10
ID=10
```

C++

```
#include<iostream>
#include<string.h>
using namespace std;
class student
{
    int rno;
    char name[50];
    double fee;
    public:
    student(int,char[],double);
    student(student &t)       //copy constructor
    {
        rno=t.rno;
        strcpy(name,t.name);
        fee=t.fee;
    }
    void display();

};




    student::student(int no,char n[],double f)
    {
        rno=no;
        strcpy(name,n);
        fee=f;
    }

   void student::display()
    {
        cout<<endl<<rno<<"\t"<<name<<"\t"<<fee;
    }

int main()
{
```

```
    student s(1001,"Manjeet",10000);
    s.display();

    student manjeet(s);   //copy constructor called
    manjeet.display();

    return 0;
}
```

C++

```
#include<iostream>
#include<string.h>
using namespace std;
class student
{
    int rno;
    char name[50];
    double fee;
    public:
    student(int,char[],double);
    student(student &t)       //copy constructor (member wise initialization)
    {
        rno=t.rno;
        strcpy(name,t.name);

    }
    void display();
    void disp()
    {
        cout<<endl<<rno<<"\t"<<name;
    }

};
    student::student(int no, char n[],double f)
    {
        rno=no;
        strcpy(name,n);
        fee=f;
    }

   void student::display()
    {
        cout<<endl<<rno<<"\t"<<name<<"\t"<<fee;
    }



int main()
{
    student s(1001,"Manjeet",10000);
    s.display();

    student manjeet(s);   //copy constructor called
```

```
    manjeet.disp();

    return 0;
}
```

Destructor:

A destructor is also a special member function as a constructor. Destructor destroys the class objects created by the constructor. Destructor has the same name as their class name preceded by a tilde (~) symbol. It is not possible to define more than one destructor. The destructor is only one way to destroy the object created by the constructor. Hence destructor can-not be overloaded. Destructor neither requires any argument nor returns any value. It is automatically called when the object goes out of scope. Destructors release memory space occupied by the objects created by the constructor. In destructor, objects are destroyed in the reverse of object creation.

The syntax for defining the destructor within the class

```
~ <class-name>()
{
  }
```

The syntax for defining the destructor outside the class

```
<class-name>: : ~ <class-name>(){}
```

C++

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

class Test {
public:
    Test() { cout << "\n Constructor executed"; }

    ~Test() { cout << "\n Destructor executed"; }
};
main()
{
    Test t;

    return 0;
}
```

Output

```
Constructor executed
Destructor executed
```

C++

```
#include <iostream>
using namespace std;
class Test {
public:
    Test() { cout << "\n Constructor executed"; }

    ~Test() { cout << "\n Destructor executed"; }
};

main()
{
    Test t, t1, t2, t3;
    return 0;
}
```

Output

```
Constructor executed
Constructor executed
Constructor executed
Constructor executed
Destructor executed
Destructor executed
Destructor executed
Destructor executed
```

C++

```
#include <iostream>
using namespace std;
int count = 0;
class Test {
public:
    Test()
    {
        count++;
        cout << "\n No. of Object created:\t" << count;
    }

    ~Test()
    {
```

```
        cout << "\n No. of Object destroyed:\t" << count;
        --count;
    }
};

main()
{
    Test t, t1, t2, t3;
    return 0;
}
```

Output

```
No. of Object created:    1
No. of Object created:    2
No. of Object created:    3
No. of Object created:    4
No. of Object destroyed:    4
No. of Object destroyed:    3
No. of Object destroyed:    2
No. of Object destroyed:    1
```

Characteristics of a destructor:-

1. Destructor is invoked automatically by the compiler when its corresponding constructor goes out of scope and releases the memory space that is no longer required by the program.
2. Destructor neither requires any argument nor returns any value therefore it cannot be overloaded.
3. Destructor cannot be declared as static and const;
4. Destructor should be declared in the public section of the program.
5. Destructor is called in the reverse order of its constructor invocation.

Q: What are the functions that are generated by the compiler by default, if we do not provide them explicitly?
Ans: The functions that are generated by the compiler by default if we do not provide them explicitly are:
I. Default constructor
II. Copy constructor
III. Assignment operator
IV. Destructor