INHERITANCE

Introduction of C++ Inheritance

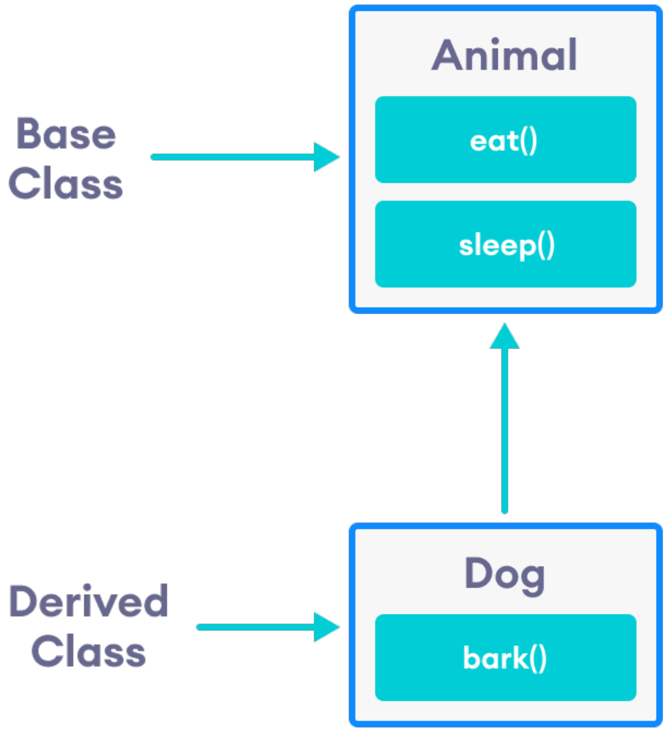
Inheritance is one of the key features of Object-oriented programming in C++. It allows us to create a new class (derived class) from an existing class (base class).

The derived class inherits the features from the base class and can have additional features of its own. **For example**,

```
class Animal {
   // eat() function
   // sleep() function
};


class Dog : public Animal {
   // bark() function
};
```

Here, the Dog class is derived from the Animal class. Since Dog is derived from Animal, members of Animal are accessible to Dog.



Inheritance in C++

Notice the use of the keyword public while inheriting Dog from Animal.

class Dog : public Animal {...};

We can also use the keywords private and protected instead of public.

is-a relationship

Inheritance is an is-a relationship. We use inheritance only if an is-a relationship is present between the two classes.

Here are some examples:

- A car is a vehicle.
- Orange is a fruit.
- A surgeon is a doctor.
- A dog is an animal.

Example 1: **Simple Example of C++ Inheritance**

// C++ program to demonstrate inheritance

```
#include <iostream>

using namespace std;


// base class

class Animal {


   public:

    void eat() {

        cout << "I can eat!" << endl;

    }


    void sleep() {

        cout << "I can sleep!" << endl;

    }

};


// derived class

class Dog : public Animal {


   public:

    void bark() {

        cout << "I can bark! Woof woof!!" << endl;

    }

};
```

```
int main() {
   // Create object of the Dog class
   Dog dog1;

   // Calling members of the base class
   dog1.eat();
   dog1.sleep();

   // Calling member of the derived class
   dog1.bark();

   return 0;
}
```

Run Code

Output

```
I can eat!
I can sleep!
I can bark! Woof woof!!
```

Here, dog1 (the object of derived class Dog) can access members of the base class Animal. It's because Dog is inherited from Animal.

```
// Calling members of the Animal class
dog1.eat();
dog1.sleep();
```

C++ protected Members

The access modifier protected is especially relevant when it comes to C++ inheritance.

Like private members, protected members are inaccessible outside of the class. However, they can be accessed by derived classes and friend classes/functions.

We need protected members if we want to hide the data of a class, but still want that data to be inherited by its derived classes.

Example 2: **C++ protected Members**

```
// C++ program to demonstrate protected members


#include <iostream>

#include <string>

using namespace std;


// base class

class Animal {


  private:

   string color;


  protected:

   string type;


  public:

   void eat() {

       cout << "I can eat!" << endl;

   }
```

```
    void sleep() {
        cout << "I can sleep!" << endl;
    }

    void setColor(string clr) {
        color = clr;
    }

    string getColor() {
        return color;
    }
};

// derived class
class Dog : public Animal {

   public:
    void setType(string tp) {
        type = tp;
    }

    void displayInfo(string c) {
        cout << "I am a " << type << endl;
        cout << "My color is " << c << endl;
    }
    void bark() {
        cout << "I can bark! Woof woof!!" << endl;
    }
};

int main() {
    // Create object of the Dog class
    Dog dog1;

    // Calling members of the base class
    dog1.eat();
    dog1.sleep();
    dog1.setColor("black");

    // Calling member of the derived class
    dog1.bark();
    dog1.setType("mammal");

    // Using getColor() of dog1 as argument
    // getColor() returns string data
    dog1.displayInfo(dog1.getColor());

    return 0;
}
```

Run Code

Output

```
I can eat!

I can sleep!

I can bark! Woof woof!!

I am a mammal

My color is black
```

Here, the variable type is protected and is thus accessible from the derived class Dog. We can see this as we have initialized type in the Dog class using the function setType().

On the other hand, the private variable color cannot be initialized in Dog.

```
class Dog : public Animal {


  public:

    void setColor(string clr) {

      // Error: member "Animal::color" is inaccessible

      color = clr;

    }

};
```

Also, since the protected keyword hides data, we cannot access type directly from an object of Dog or Animal class.

```
// Error: member "Animal::type" is inaccessible

dog1.type = "mammal";
```

Access Modes in C++ Inheritance

We have used the public keyword in order to inherit a class from a previously-existing base class. However, we can also use the private and protected keywords to inherit classes. For example,

```
class Animal {

   // code

};


class Dog : private Animal {

   // code

};

class Cat : protected Animal {

   // code

};
```

The various ways we can derive classes are known as access modes. These access modes have the following effect:

Public: If a derived class is declared in public mode, then the members of the base class are inherited by the derived class just as they are.

Private: In this case, all the members of the base class become private members in the derived class.

Protected: The public members of the base class become protected members in the derived class.

The private members of the base class are always private in the derived class.