Lecture 13

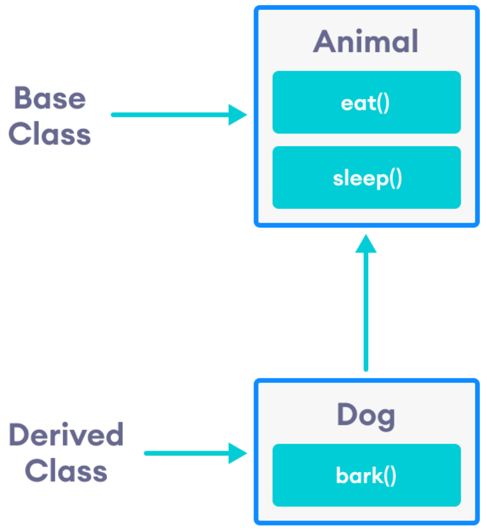
C++ Inheritance

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`.



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`.

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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;
}
```

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;
    }
```

```cpp
    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;
}
```

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";
```