CSC 211: Computer Programming
Class Inheritance and Polymorphism
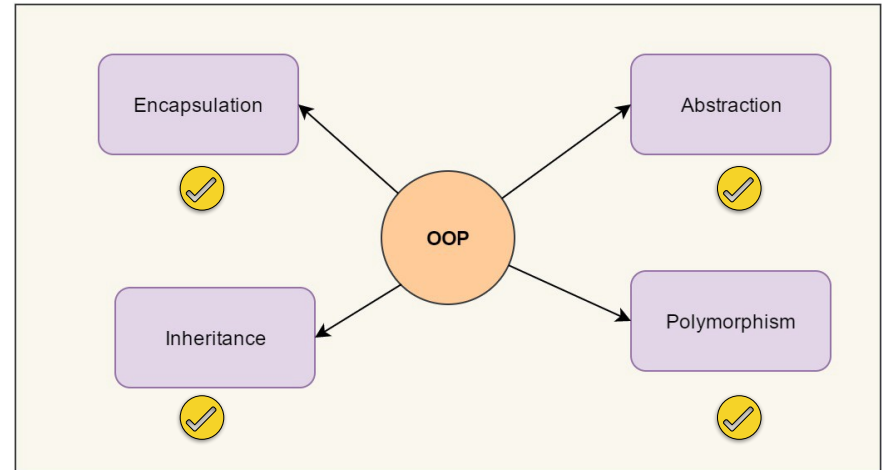
Michael Conti

Department of Computer Science and Statistics
University of Rhode Island

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THINK BIG WE DO

Four Pillars of Object Oriented Programming

Inheritance in C++

· The capability of a class to derive properties and characteristics from another class is called **Inheritance**. Inheritance is one of the most important feature of Object Oriented Programming.

· **Derived Class:** The class that inherits properties from another class is called Sub class / Derived Class / Child Class.

· **Base Class:** The class whose properties are inherited by sub class is called Base Class / Super class / Parent Class.

· Derived class is a *superset* of the base class.

Inheritance in C++

· What if we create a stand alone function that accepts an object from the base class as an argument. Could we pass in a derived class object instead?

· Yes! The derived class object has everything a base class object would have (and maybe more)!

Why and When to use Inheritance?

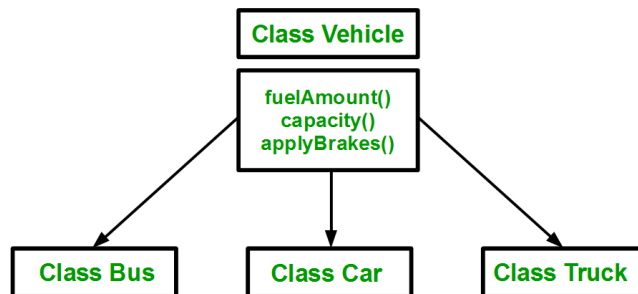**Class Bus**
fuelAmount()
capacity()
applyBrakes()

Class Car
fuelAmount()
capacity()
applyBrakes()
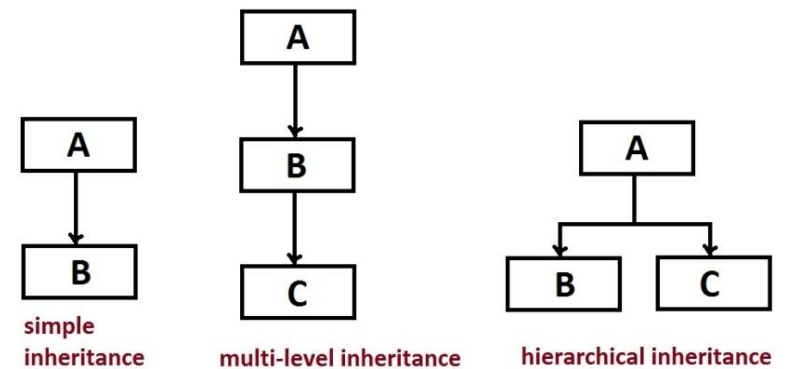
Class Truck
fuelAmount()
capacity()
applyBrakes()

Note: duplication of same code 3 times

Class Vehicle
fuelAmount()
capacity()
applyBrakes()

Class Bus   **Class Car**   **Class Truck**

Note: by using inheritance, we can avoid the duplication of data and increase re-usability of code

A
A → B
simple inheritance

A → B → C
multi-level inheritance

A → B, A → C
hierarchical inheritance

Implementing Inheritance

Syntax

```
class subclass_name : access_mode base_class_name
{
   //body of subclass
};
```

Modes of inheritance

Modes of inheritance

· **Public mode**: If we derive a sub class from a public base class then the public member of the base class will become public in the derived class and protected members of the base class will become protected in derived class.

· **Protected mode**: If we derive a sub class from a Protected base class then both public member and protected members of the base class will become protected in derived class.

· **Private mode**: If we derive a sub class from a Private base class then both public member and protected members of the base class will become Private in derived class.

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Base class member access specifier	Type of Inheritence		
	Public	Protected	Private
Public	Public	Protected	Private
Protected	Protected	Protected	Private
Private	Not accessible (Hidden)	Not accessible (Hidden)	Not accessible (Hidden)

Slide 14 — Example

```cpp
// C++ Implementation to show that a derived class
// doesn't inherit access to private data members.
// However, it does inherit a full parent object
class A {

public:
    int x;

protected:
    int y;

private:
    int z;

};

class B : public A {

    // x is public
    // y is protected
    // z is not accessible from B
};

class C : protected A {

    // x is protected
    // y is protected
    // z is not accessible from C
};

class D : private A {    // 'private' is default for classes

    // x is private
    // y is private
    // z is not accessible from D
};
```

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Order of Constructor Call with Inheritance

Slide 16 — Order of Constructor Call

‣ Base class constructors are **always called** in the derived class constructors.

‣ Whenever you create a derived class object, **first** the base class default constructor is executed and **then** the derived class's constructor finishes execution.

Order of Constructor Call

```cpp
class Base
{
    public:

    int x;
    // default constructor
    Base()
    {
        std::cout << "Base default constructor\n";
    }
};


class Derived : public Base
{

    public:

    int y;
    // default constructor
    Derived()
    {
        std::cout << "Derived default constructor\n";
    }
    // parameterized constructor
    Derived(int i)
    {
        std::cout << "Derived parameterized constructor\n";
    }
};
```

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Order of Constructor Call

```cpp
int main()
{
    Base b;
    Derived d1;
    Derived d2(10);
}
```

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Inheritance Example

Example

```cpp
class Entity{
    public:
        float x, y;

        void move(float xa, float ya){
            x += xa;
            y += ya;
        }

        void printLoc(){
            std::cout << "x = " << x << std::endl;
            std::cout << "y = " << y << std::endl;
        }
};
```

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Example

```cpp
class Player{

    public:
        const char* name;
        float x, y;

    void move(float xa, float ya){
            x += xa;
            y += ya;
    }

    void printLoc(){
            std::cout << "x = " << x << std::endl;
            std::cout << "y = " << y << std::endl;
    }

    void printName(){

        std::cout << name << std::endl;
    }

};
```

Example

```cpp
class Player : public Entity{

    public:
        const char* name;

    void printName(){

        std::cout << name << std::endl;
    }
};
```

Polymorphism

Polymorphism

· Polymorphism in C++ means, the same entity (function or object) behaves differently in different scenarios.

· Consider this example:

· The " +" operator in c++ can perform two specific functions at two different scenarios

Example

```
int a = 6;
int b = 6;
int sum = a + b;   // sum =12



              v.s



string firstName = "John";
string lastName = "Doe";

// name = "John Doe "
string name = firstName + lastName;
```

Types of Polymorphism in C++

· Polymorphism in C++ is categorized into two types

· **Compile Time Polymorphism**

  ✓ Function Overloading

  ✓ Operator Overloading

· **Runtime Polymorphism**

  ✓ Function overriding

Compile Time Polymorphism

· **Compile Time Polymorphism**

· Function overloading

  ✓ One function can perform many tasks.

  ✓ A single function is used to perform many tasks with the same name and different types of arguments.

  ✓ Correct overloaded function will be called at compile time based on argument type

Function overloading

```cpp
class Addition {
public:
    int ADD(int X,int Y)   // Function with parameter
    {
        return X+Y;      // this function is performing addition of  two int values
    }

    int ADD() {              // Function with same name but without parameter
        string a= "HELLO";
        string b="SAM";    // in this function concatenation is performed
        string c= a+b;
        cout<<c<<endl;

    }
};

int main() {
    Addition obj;    // Object is created
    cout<<obj.ADD(128, 15)<<endl; //first method is called
    obj.ADD();   // second method is called
    return 0;
}
```

Compile Time Polymorphism

· Compile Time Polymorphism

· Operator Overloading

  ✓ Defining additional semantic behavior to operators

  ✓ We do this by using operator reserved keyword.

  ✓ The purpose of operator overloading is to provide a special meaning to the user-defined data types.

  ✓ The advantage of operator overloading is to perform different operations on the same operand.

Function overloading

```cpp
#include <iostream>
using namespace std;
class A
{
  public:
    string x;

    A(){}
    A(string i)
    {
        x=i;
    }
    void operator+(A);
    void display();
};

void A::operator+(A a)
{
    string m = x+a.x;
    cout<<"The result of the addition
            of two objects is : "<<m;
}
int main()
{
    A a1("Welcome");
    A a2("back");
    a1+a2;
    return 0;
}
```

Run Time Polymorphism

· **Run Time Polymorphism**

· Function overriding

  ✓ In function overriding, we give the new definition to base class function in the derived class. At that time, we can say the base function has been overridden. It can be only possible to override a function from the 'derived class'.

  ✓ In function overriding, we have two definitions of the same function, one in the superclass and one in the derived class. The decision about which function definition requires calling happens at runtime.

  ✓ That is the reason we call it 'Runtime polymorphism'.

Function overriding

```cpp
class Animal {
    public:
    void function()
        {cout<<"Eating..."<<endl;}
};


class Man: public Animal
{
 public:
    void function()
        { cout<<"Walking ..."<<endl; }
};

int main() {

        Animal A;
        A.function();//parent class object

        Man m;
        m.function();// child class object

        return 0;
}
```

PROBLEMS   OUTPUT   DEBUG CONSOLE   TERMINAL

● michaelconti@Michaels-MacBook-Pro-2 Desktop % ./temp
Eating...
Walking ...
○ michaelconti@Michaels-MacBook-Pro-2 Desktop % ▮