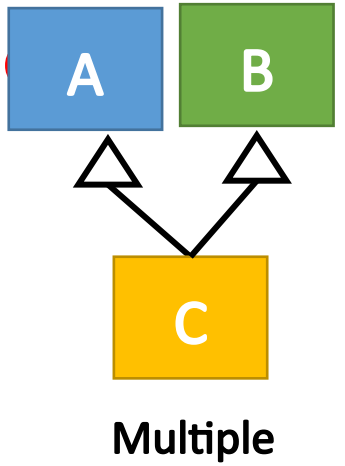
Class/Object Relationships

Multiple Inheritance

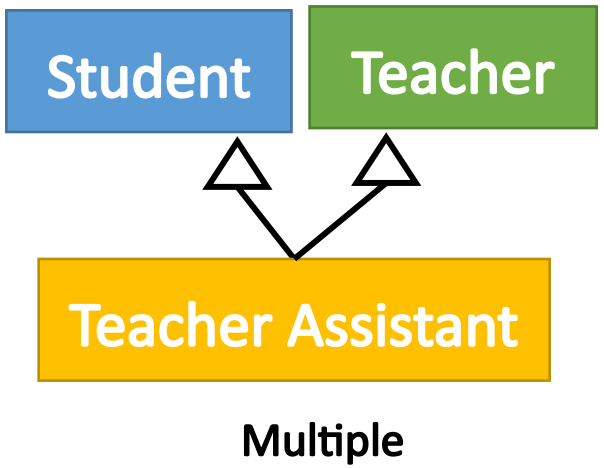
CS(217) Object Oriented Programming

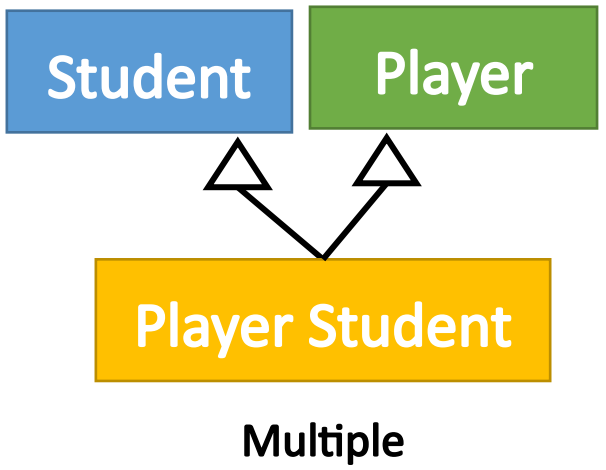
Abeeda Akram

Inheritance (is-a) Multiple Inheritan

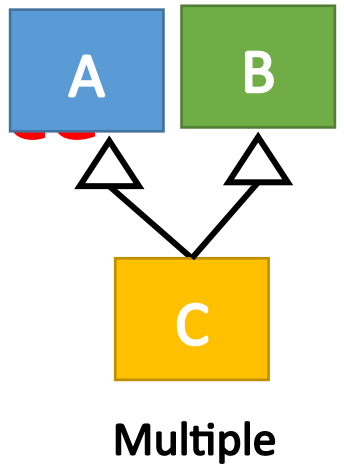


- Inherit directly from more than one base classes
- (Abstract or Concrete)
- Base classes possibly unrelated



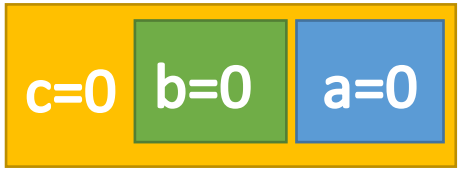


Inheritance (is-a) Multiple Inheritance

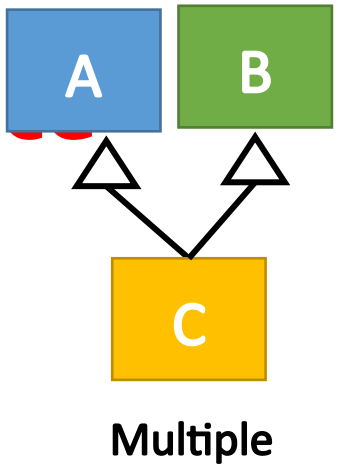



```
class A{
    int a;
public:
    A(int a=0){ this->a=a;}
};

class B{
    int b;
public:
    B(int b=0){ this->b = b;}
};
```

```
class C: public A, public B{
    int c;
public:
  //Call constructors of both base classes
    C(int a=0, int b=0, int c=0) :A(a),
    B(b)
    { this->c = c;}
};

void main(){
    C c1;
    //C inherited data from both A and B
}
```

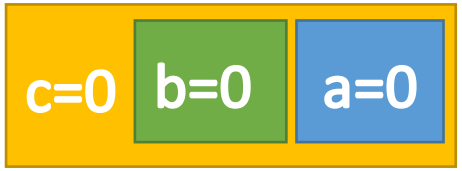


Inheritance (is-a) Multiple Inheritance




```
class A{
    int a;
public:
    A(int a=0){ this->a=a;}
    void print(){ cout<<a;}
};

class B{
    int b;
public:
    B(int b=0){ this->b = b;}
    void print(){ cout<<b;}
};
```

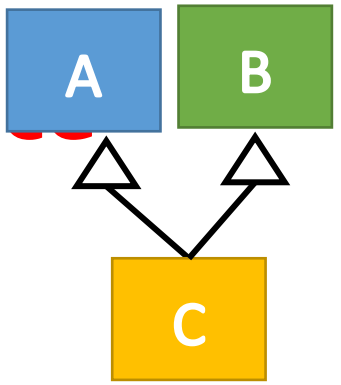
```
class C: public A, public B{
    int c;
public:
    C(int a=0, int b=0, int c=0)
    :A(a), B(b)
    { this->c = c;}
};
void main(){
    C c1;
    c1.print();
}
```



Issue 1: Base classes may have same functions.

Which print function will be called A's or B's?

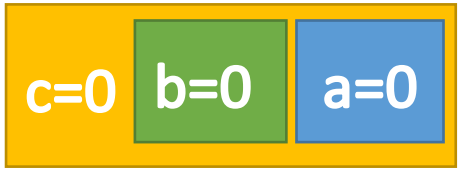
Inheritance (is-a) Multiple Inheritance



Multiple

```
class A{
    int a;
public:
    A(int a=0){ this->a=a;}
    void print(){ cout<<a;}
};

class B{
    int b;
public:
    B(int b=0){ this->b = b;}
    void print(){ cout<<b;}
};
```

```
class C: public A, public B{
    int c;
public:
    C(int a=0, int b=0, int c=0) :A(a), B(b)
    { this->c = c;}
};
void main(){
    C c1;
    c1.A::print();
    c1.B::print();
}
```

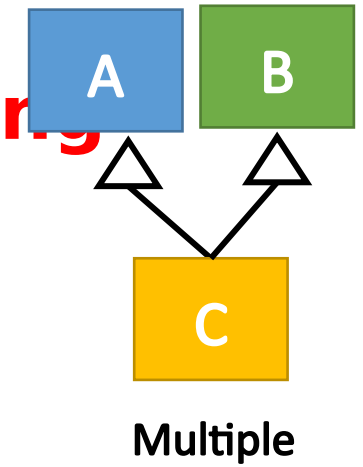


Issue 1: Base classes may have same functions.

Provide explicit name of base class to call same function and to resolve the conflict.

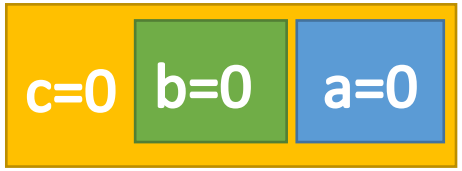
C's data will not print!

Inheritance (is-a) Function Overriding




```
class A{
    int a;
public:
    A(int a=0){ this->a=a;}
    void print(){ cout<<a;}
};

class B{
    int b;
public:
    B(int b=0){ this->b = b;}
    void print(){ cout<<b;}
};
```

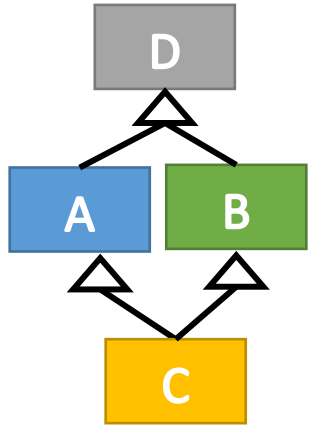
```
class C: public A, public B{
   int c;
public:
   C(int a=0, int b=0, int c=0) :A(a), B(b)
   { this->c = c;}
   void print(){
      A::print();
      B::print();
      cout<<c;
   }
};
void main(){
   C c1;
   c1.print();
}
```



Issue 1: Base classes may have same functions.

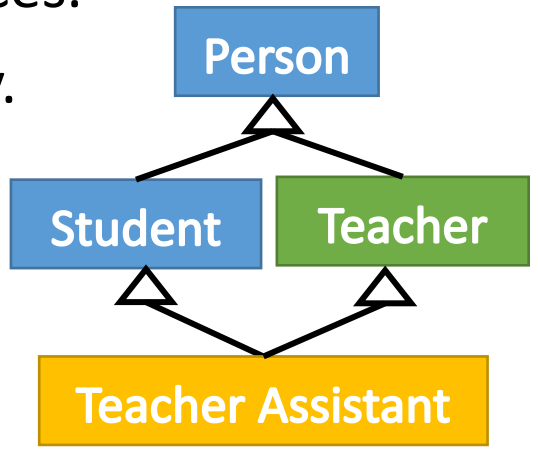
Override the inherited functions and call base class functions explicitly in overridden function.

Inheritance (is-a) Diamond Problem

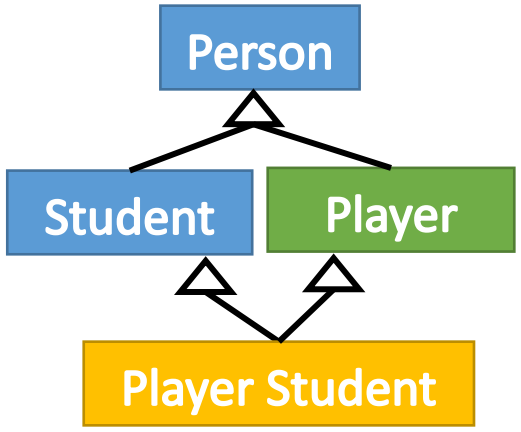


Multiple

- More than one base classes are inherited from a common base class.
  - System will inherit two Person objects in Teacher Assistant one from Student and one from Teacher?
  - Similarly system will inherit two Person objects in Player Student one from Student and other from Player class?
- Maintenance overhead to explicitly handle each class members.
- Causes more problems and ambiguous references.
- Resolve through virtual base classes in C++ only.

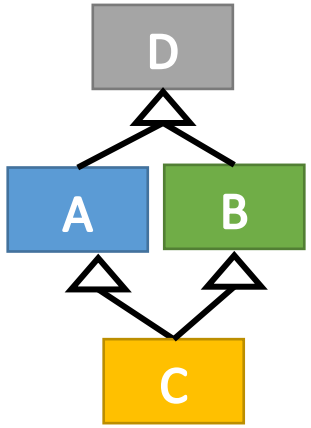


Multiple



Multiple

Inheritance (is-a) Virtual Class



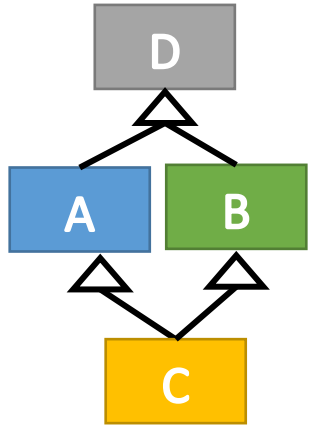
Multiple

1. Virtual base class has only one instance of base object in derived classes.
2. The objects of virtual base class are created before derived classes
3. All classes will share same object of base class.
4. Only one time constructor is called on virtual base class object.

```
class D{};
class A: virtual public D{}; //Virtual inheritance of D in A
class B: virtual public D{}; //Virtual inheritance of D in B
class C: public A, public B{};
 //Now one copy of D's object will be created in Class C
instead of two.
```

Issue: Which derived class is responsible for calling the constructor of class D?

Inheritance (is-a) Virtual Class



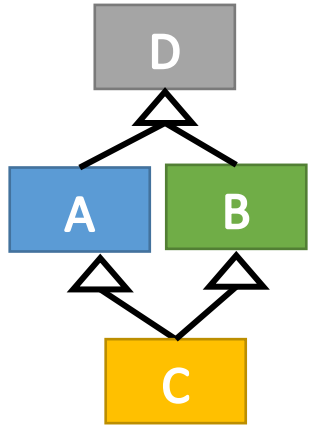
Multiple

- All derived classes should add constructer call for their base classes.
- A derived class can also call the constructor of Grand Parent base class.

```
class D{
    int d;
public:
    D(int d=0){ this->d=d;}
};
class A: virtual public D{
    int a;
public:
    A(int a=0, int d=0) :D(d)
    { this->a=a;}
};
```

```
class B: virtual public D{
    int b;
public:
    B(int b=0, int d=0) :D(d)
    { this->b=b;}
};
class C: public A, public B{
    int c;
public:
  //Call constructors of all base classes
    C(int a=0, int b=0, int c=0, int d=0)
    :D(d), A(a), B(b)
    { this->c = c;}
};
```

Inheritance (is-a) Virtual Class



Multiple

Which derived class is responsible for calling the constructor of class D?

- Only one time constructor is called on virtual base class object.
- Constructor call depends on type of the object that is created.
- The last derived class is responsible for constructor call.

```
void main(){
    A a1(3, 9); //Call constructor of D from A
    B b1(4, 5); //Call constructor of D from B

    C c1 (2, 3, 4, 1); //Call constructor of D fro

    //Now constructor call from A and B is skipped by system
    as one copy of D's object is already created in C's
    object
}
```

Inheritance (is-a) Multiple Inheritance and Interface

- Some Object oriented languages such as java and c# does not allow multiple inheritance of concrete and abstract classes.
- A derived class can inherit data from only single base class (Abstract or Concrete).
- But, they allow to inherit multiple Interfaces.
  - Interface classes has no data members, and have all pure virtual functions.
  - Therefore issue of diamond problem is avoided completely by using them.

```
class IExample{
public:
// Pure virtual functions
    virtual void Function1() = 0;
    virtual void Function2() = 0;
    virtual void Function3() = 0;
    virtual ~IExample();
};
```