Class/Object Relationships

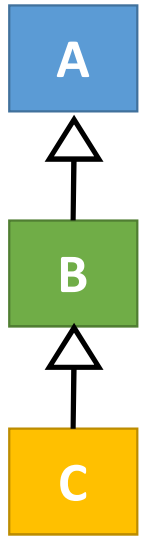
CS(217) Object Oriented Programming

- Compile Time Binding
- Slicing Problem

Inheritance (is-a)

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

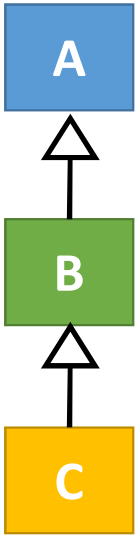
```
class B: public A{
    int b;
public:
    B(int a=0, int b=0):A(a) { this->b = b;}
//override print function inherited from A
    void print() {
        A::print();
        cout<<b;
    }
//overload print function inherited from A
    void print(int x){ cout<<x+b; }
    void funb() { cout<<“funb”<<endl};
};
```



Inheritance (is-a)

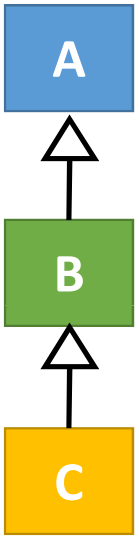
```
class C: public B{
    int c;
public:
    C(int a=0, int b=0, int c=0) :B(a,b)
    { this->c = c;}
//override print function inherited from B
    void print() {
        B::print();
        cout<<c;
    }
//overload print function inherited from B
    void print(int x, int y){
        cout<<x+y+c;
    }

    void func(){ cout<< "func" <<endl; }
};
```



Inheritance (is-a) **Compile Time Binding**

- Call the functions on object according to the type of object.
- Cannot change compile time binding of static objects.
- Can be changed for pointers or reference to objects.




```
void main(){
    A a1(2);
    a1.print(); //Base print called print a's data

    B b1 (3,4);
    b1.print(); //Derived print called print a's and b's data
    b1.print(3); //overloaded print called
    b1.funb(); //new function defined in b called

    C c1 (5,6,7);
    c1.print(); //Derived print called print a's and b's and c's data
    c1.print(3); //inherited print called
    c1.funb(); //inherited funb called
    c1.print(3, 5); //overloaded print called
    c1.func(); //new function defined in c called
}
```

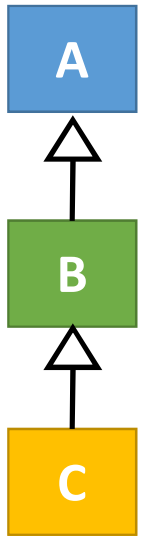
a=2

b=4 a=3

c=7 b=6 a=5

Inheritance (is-a) **Object Slicing Problem**

- We can assign derived class object to base class object.
- Only copy data of base class, derived portion is discarded.
- Compile time binding system will call base class functions only.




```
void main(){
    A a1 (2);
    B b1 (3, 4);
    C c1 (5,6,7);

    a1 = b1; //slice b1 and copy in a1 the A's portion only.
    a1.print(); //Base print called print A's data only.
    a1.funb(); a1.print(3); //Compile time Error

    a1 = c1; //slice c1 and copy in a1 the A's portion only.
    a1.print(); //Base print called print A's data only.
    a1.funb(); a1.func();   //Compile time Error
    a1.print(3); a1.print(3, 4); //Compile time Error

}
```

a=2

b=4 a=3

c=7 b=6 a=5

a=3

a=5

Inheritance (is-a) **Object Slicing Problem**

- We can assign derived class object to base class object.
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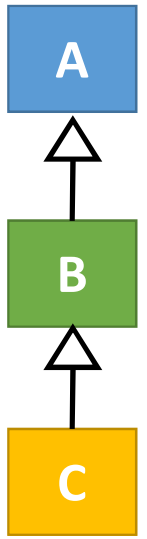
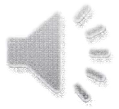
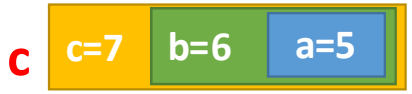


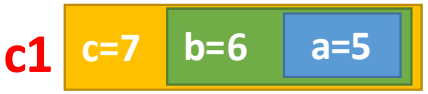

```
void main(){
    A a1 (2);
    B b1 (3, 4);
    C c1 (5,6,7);

    b1 = c1; //slice c1 and copy in b1 the B's portion only.
    b1.print(); //Base print called print B's and A's only.
    b1.print(3); //overloaded print called.
   b1.func(); b1.print(3, 4); //Compile time Error

    c1 = b1; or c1 = a1; //Compile time Error: We cannot assign base class object
    to derived class.
    b1 = a1; //Every derived is a base but every base is not a derived.
}
```

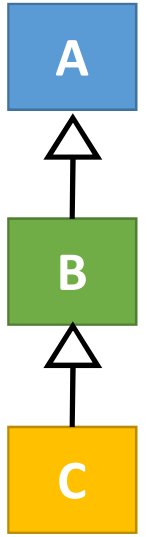


Inheritance (is-a) Object Slicing Problem

```
void fun(A a){
        a.print(); //Base print called print A's data only.
}
void fun2(B b){
        b.print(); //Base print called print B's data.
        b.print(5);
}
void fun3(C c){
        c.print(); //C's print called.
        c.print(5,9);
}
void main(){
    C c1 (5,6,7);
    fun(c1);  //slice c1 to A's object
    fun2(c1); //slice c1 to B's object
    fun3(c1);
}
```

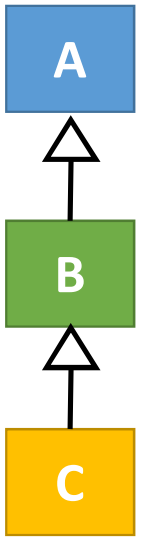






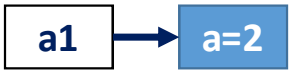
Inheritance (is-a) **Base and Derived Pointers**

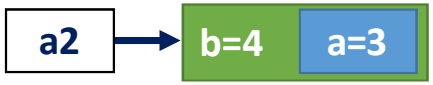
- Base class pointer can point to base or derived class objects.
- Base class pointer can only see base class members, derived part still exist.



- Compile time binding, system will call base class functions only according to type of pointer, not call overridden ones.

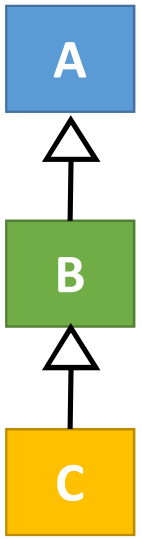
```
void main(){
    A * a1 = new A(2); //A's pointer to A's object
    a1->print(); //A's print called.

    A * a2 = new B(3, 4); //A's pointer to B's object
    a2->print(); //A's print called.
    a2->funb(); a2->print(3); //Compile time Error

    A * a3 = new C(5, 6, 7); //A's pointer to C's object
    a3->print(); //A's print called.
    a3->funb(); a3->print(3); //Compile time Error
    a3->func(); a3->print(3,8); //Compile time Error
}
```



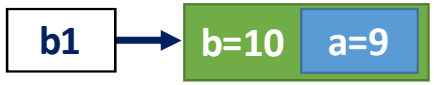


Inheritance (is-a) **Base and Derived Pointers**

- Derived class pointer can only point to its own or further derived class objects.
- Compile time binding, system will call derived class functions only according to type of pointer.

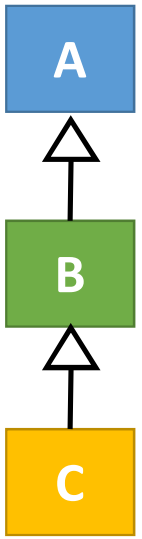



```
void main(){
    B * b1 = new B(9, 10); //B's pointer to B's object
    b1->print(); //B's print called.
    b1->funb(); b1->print(3);

    B * b2 = new C (5, 60, 70); //B's pointer to C's object
    b2->print(); //B's print called.
    b2->funb(); b2->print(3);
    b2->func(); b2->print(3,8); //Compile time Error

    B * b3 = new A(2); //Error: B's pointer to A's object
    //Every derived is a base but every base is not a derived.
    //Allowed if explicit cast made
}
```



Inheritance (is-a) **Base and Derived Pointers**

- Derived class pointer can only point to its own or further derived class objects.
- Compile time binding, system will call derived class functions only according to type of pointer.



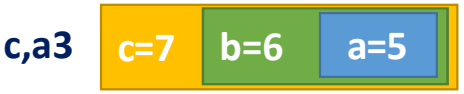

```
void main(){
    C * c1 = new C(5, 60, 70); //C's pointer to C's object
    c1-> print(); //C's print called.
    c1-> funb();
    c1-> print(3);
    c1-> func();
    c1-> print(3,8);

    C * c2 = new B(5,6); //Error: C's pointer to B's object
    C * c3 = new A(2);  //Error: C's pointer to A's object
    //Every derived is a base but every base is not a derived.
    //Allowed if explicit cast made
}
```

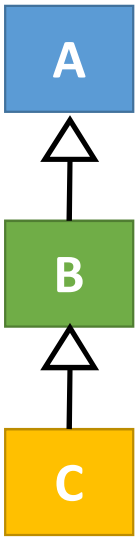
Inheritance (is-a) **Base and Derived references**

- Base class reference can be created for base or derived class objects.
- Base class reference can only see base class members, derived part still exist.

- Compile time binding, system will call base class functions only according to type of **reference** , not call overridden ones.

```
void main(){
     A a(2);   B b(3, 4);   C c(5,6,7);
     A & a1 = a;
     a1.print(); //A's print called.

     A & a2 = b; //A's reference to B's object
     a2.print(); //A's print called.
     b.print(3); //B's print called
     b.funb(); //new function defined in B called
     a2.funb(); a2.print(3); //Compile time Error

     A & a3 = c; //A's reference to C's object
     a3.print(); //A's print called.
     a3.funb(); a3.print(3); //Compile time Error
     a3.func(); a3.print(3,8); //Compile time Error
}
```

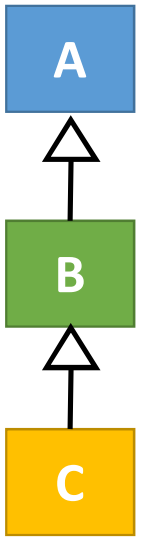




Inheritance (is-a) **Base and Derived references**

- Base class reference can be created for base or derived class objects.
- Base class reference can only see base class members, derived part still exist.
- Compile time binding, system will call derived class functions only according to type of **reference** .

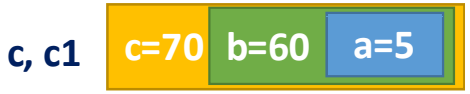
```
void main(){
    A a(2);  B b(3, 4);  C c(5,6,7);

    B & b1 = b; //B's reference to B's object
    b1.print(); //B's print called.
    b1.funb(); b1.print(3);

    B & b2 = c; //B's reference to C's object
    b2.print(); //B's print called.
    b2.funb(); b2.print(3);
    b2.func(); b2.print(3,8); //Compile time Error

    B & b3 = a; //Error: B's pointer to A's object
    //Every derived is a base but every base is not a derived.
    //Allowed if explicit cast made
}
```

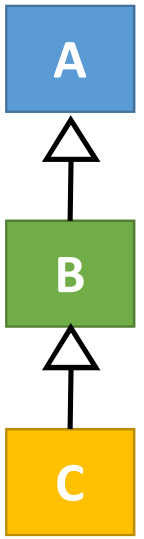


Inheritance (is-a) **Base and Derived references**

- Derived class reference can be created for derived class objects.
- Compile time binding, system will call derived class functions only according to type of **reference** .

```
void main(){
    A a(2);  B b(3, 4);  C c(5,6,7);

    C & c1 = c; //C's reference to C's object
    c1.print(); //C's print called.
    c1.funb();
    c1.print(3);
    c1.func();
    c1.print(3,8);

    C & c2 = b; //Error: C's reference to B's object
    C & c3 = a;  //Error: C's reference to A's object
    //Every derived is a base but every base is not a derived.
    //Allowed if explicit cast made
}
```

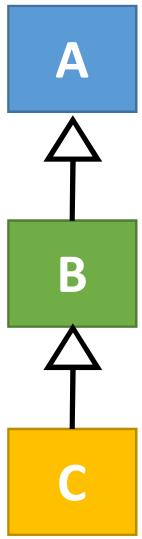




Inheritance (is-a) **Base and Derived references**

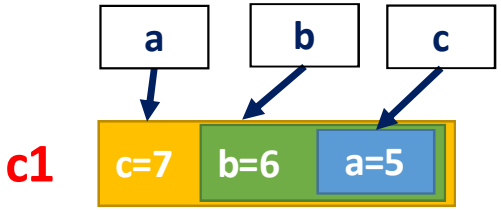
```
void fun(A & a){
        a.print(); //A's print called print A's data only.
}
void fun2(B & b){
        b.print(); //B's print called.
        b.print(5);
}
void fun3(C & c){
        c.print(); //C's print called.
        c.print(5,9);
}
void main(){
    C c1 (5,6,7);
    fun(c1);
    fun2(c1);
    fun3(c1);
}
```

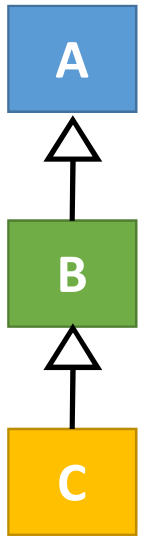
a, b, c, c1



Inheritance (is-a) Base and Derived Pointers

```
void fun(A * a){
        a->print(); //A's print called print A's data only.
}
void fun2(B * b){
        b->print(); //B's print called.
        b->print(5);
}
void fun3(C * c){
        c->print(); //C's print called
        c->print(5,9);
}
void main(){
    C c1 (5,6,7);
    fun(&c1);
    fun2(&c1);
    fun3(&c1);
}
```





Inheritance (is-a) **Compile Time Binding**

Base class static object		Call base class functions only
Derived class static object		Call derived class functions & inherited functions. Overridden and overloaded functions.
Base class static object	**Derived class static object**	Call base class functions **Slicing Issue** only copies base data in base object
Derived class static object	**Base class static object**	Error: Explicit cast required
Base class pointer or reference	**Base class object**	Call base class functions
Base class pointer or reference	**Derived class object**	Call base class functions only
Derived class pointer or reference	**Base class object**	Error: Explicit cast required
Derived class pointer or reference	**Derived class object**	Call derived class functions & inherited functions. Overridden and overloaded functions.