**INHERITANCE**

OOP fundamentals:

* Encapsulation
* Abstraction
* Inheritance
* Polymorphism

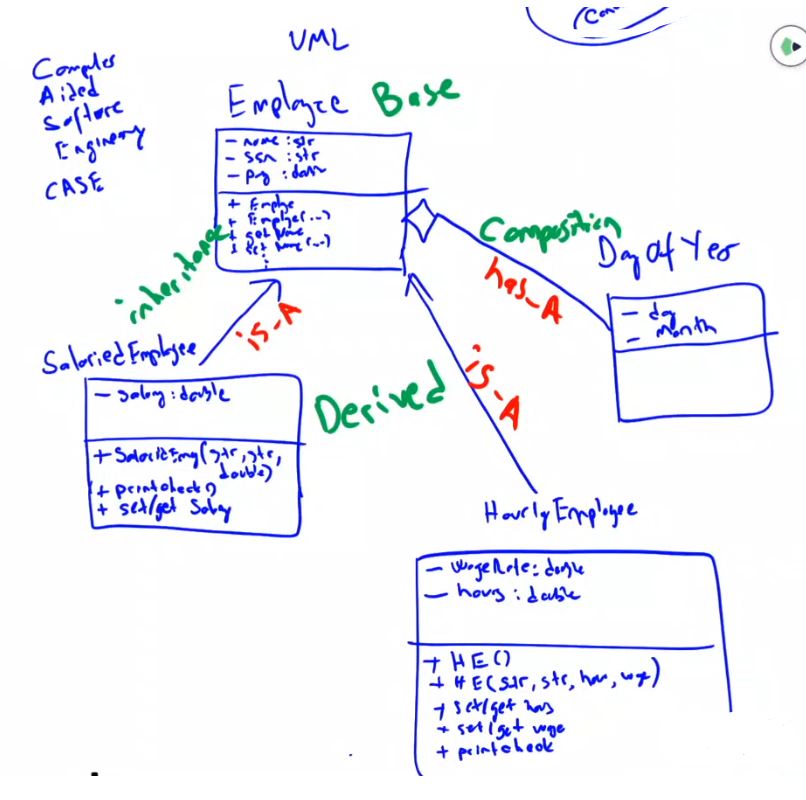
Without inheritance, there is no polymorphism.

Our main purpose is code reuse (generic code) and prevent copying-pasting.

CHECK employee.h, employee.cpp, salariedemployeeSingle.h, salariedemployeeSingle.cpp, salariedemployee.h, salariedemployee.cpp, hourlyemployee.h, hourlyemployee.cpp, 14-07 in order.

hasA relationship: a class has an object of another class.

isA relationship: relationship between SalariedEmployee and Employee classes. A class inherited from the another class.



(unified modelling language)

- : private +: public

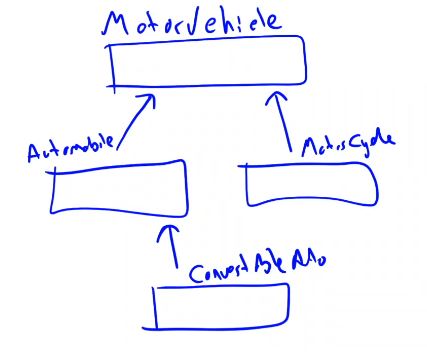
If you put DayOfYear object inside Employee class, then it is a hasA relationship.

We derive new classes (SalariedEmployee and HourlyEmployee) out of Employee class.

Compiler knows that there is a isA relationship between SalariedEmployee and Employee class. If I need to send an Employee parameter to a function, it is okey to send SalariedEmployee to that function bc every SalariedEmployee actually Employee.

* So if function definition is like this: … f(Employee \*)
* I can call the function like this: f(&SalariedEmployee);

Each SalariedEmployee can behave like an Employee bc I inherited SalariedEmployee from Employee class.



It is possible to have inherited class from another inherited class.

Derived class automatically has base class’s:

* Public and private member variables
* Public and private member functions

We don’t need Employee type object since no one’s just an employee. General concept of employee helpful:

* All have names
* All have social security numbers
* Associated functions for these “basics” are same among all employees

We won’t have “objects” of employee class, however.

We can redefine existing function members and/or add new function or data members in derived class.

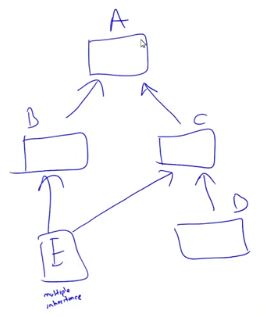
In C++, we don’t have subclasses or methods. We have derived classes and base classes.

Derived class interface only lists new or “to be redefined” members:

* Since all others inherited are already defined
* i.e.: “all” employees have ssn, name, etc.

Derived class adds:

* Constructors
* Other data and/or function members



C++ allows multiple inheritance, JAVA doesn’t.

A : Parent class - refers to base class - Ancestor of E and D (class that’s a parent of a parent)

B - C : Child of A - refers to derived class

E : Descendant of A - opposite of ancestor

**Constructors in Derived Classes**

* Base class constructors are NOT inherited in derived classes.
  + But they can be invoked within derived class constructor (First thing derived class constructor does).

**Base Class Private Data**

Derived class INHERITS private members, but still CANNOT DIRECTLY ACCESS them (not even through derived class member functions).

Private members can only be accessed “by name” in member functions of the class they’re defined in.

Private functions or private data members can only be accessed within that class only. Doesn’t matter if you are a some other class, doesn’t matter if you are a derived class from that class.

Private data members can be accessed indirectly via accessor or mutator member functions but private member functions simply not available.

Private member functions should be simply helper functions and they should be used only in class they’re defined.

**protected**

Allows access by name in derived class but nowhere else, still no access by name in other classes.

In class it’s defined 🡪 acts like private

Without inheritance “protected” is simply “private”.

**Redefinition of Member Functions**

Inherited member functions not declared, automatically inherited unchanged.

There is no redefinition of member variables.

**Redefining vs. Overloading**

Redefining in derived class:

* Same parameter list
* Essentially “re-writes” same function
* Done with same signature
* Signature as in C, just name. You cannot overload the function in base class, you redefine it
* Only happens with inheritence

Overloading:

* Different parameter list
* Defined “new” function that takes different parameters
* Done with different signature
* Overloaded functions must have different signatures (Same name - different signature)

**Accessing Redefined Base Function**

When redefined in derived class, base class’s definition not “lost”

Can specify it’s use:

Employee Jane;

HourlyEmployee Sally;

Jane.printCheck(); 🡪 calls Employee’s printCheck function

Sally.printCheck(); 🡪 calls HourlyEmployee’s printCheck function

Sally.Employee::printCheck(); 🡪 calls Employee’s printCheck function

Jane.HourlyEmployee::printCheck(); 🡪 NOT ALLOWED

**Functions NOT Inherited**

All normal functions in base class are inherited in derived class

EXCEPTIONS:

* Constructors
* Destructors
* Copy constructor
  + But if not defined, generates “default” one
  + Recall need to define one for pointers
* Assignment operator
  + If not defined 🡪 default

BIG THREE ARE NOT INHERITED.

ACTUALLY EXCEPTIONS ARE INHERITED BUT THEY DON’T BECOME YOUR CONSTRUCTOR OR BIG THREE.

If defaults are okay for big three, then you would be fine.

Assignment operator and copy constructor must be used in derived class definitions. Similar to how derived class constructor invokes base class constructor.

**Assignment Operator Example**

Given “Derived” is derived from “Base”:

Derived& Derived::operator=(const Derived& rightSide)

{

Base::operator=(rightSide);

…

}

Calls assignment operator from base class. This takes care of all inherited member variables.

Would then set new variables from derived class.

**Copy Constructor Example**

Derived::Derived(const Derived& Object) : Base(Object), …

{ … }

After : is invocation of base copy constructor, sets inherited member variables of derived class object being created.

Note that Object is the type Derived; but it’s also of type Base, so argument is valid.

**Destructors in Derived Classes**

If base class destructor functions correctly

* Easy to write derived class destructor

When derived class destructor is invoked

* Automatically calls base class destructor!
* So no need for explicit call

So derived class destructors need only be concerned with derived class variables

* And any data they “point” to
* Base class destructor handles inherited data automatically

CHECK pfarrayd.h, pfarrayd.cpp, pfarraydbak.h, pfarraydbak.cpp, 14-12.cpp in order.

class B{

public:

B(){cout << “B constructor”;}

~B(){cout << “B destructor”;}

};

class De : public B{

public:

De() : B() {cout << “Derived constructor”;}

~De(){cout << “Derived destructor”;}

};

int main(){

B b;

De d;

return 0;

}

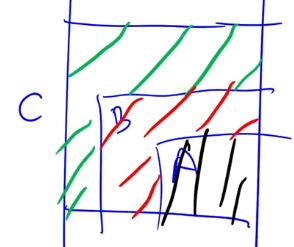
What we get:

1. B - constructor 🡪 because of the “B b;”
2. B - constructor

because of the “De d;”

1. D - constructor
2. D - destructor because of the De’s destructor De’s destructor called first bc it’s top of
3. B - destructor the stack. B’s destructor will be called automatically after that.
4. B - destructor 🡪 because of B’s destructor

Very similar to composition constructor-destructor calling order. Before the main class’s constructor works, the constructor of composed object’s class will be called.

**Destructor Calling Order**

Consider:

* class B derives from class A
* class C derives from class B
  + A 🡨 B 🡨 C
  + (C is a B object and A object, B is a A object)

When object of class C goes out of scope:

* class C destructor called 1st
* then class B destructor is called
* finally class A destructor is called

Opposite of how constructors are called (actually how constructors are finished execution).

Creating object A first, then B, then C. (Constructor of C calls the constructor of B, constructor of B calls the constructor of A.) First one that finish execution is constructor of A, then B, then C. So this is the order; not starting to construct order, but finishing construction order.

Destroying object C first, then B, then A.

**“Is a” vs. “Has a” Relationships**

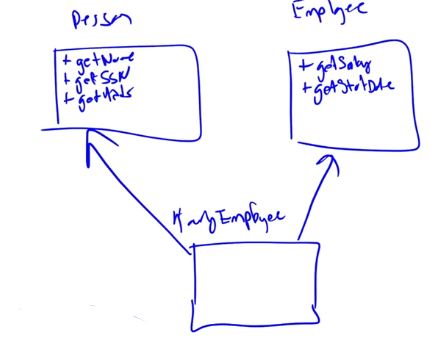
Inheritance considered an “Is a” relationship.

A class contains objects of another class as it’s member data considered a “Has a” relationship.

**Protected and Private Inheritance**

New inheritance forms 🡪 both are rarely used and is A relationship is gone with them bc customer of derived class cannot use my public functions. Derived classes cannot behave like base class.

* Protected inheritance:
  + class SalariedEmployee : protected Employee { … };
  + Public members in base class become protected in derived class
* Private inheritance:
  + class SalariedEmployee : private Employee { … };
  + All members in base class become private in derived class

**Multiple Inheritance**

Derived class can have more than one base class.

* Syntax:

class derivedMulti : public base1, base2 { … };

Possibilities for ambiguity are endless!

JAVA doesn’t allow multiple inheritance.

![Diagram, engineering drawing

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4RDaRXhpZgAATU0AKgAAAAgABAE7AAIAAAAFAAAISodpAAQAAAABAAAIUJydAAEAAAAKAAAQyOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAE1lcnQAAAAFkAMAAgAAABQAABCekAQAAgAAABQAABCykpEAAgAAAAM5NwAAkpIAAgAAAAM5NwAA6hwABwAACAwAAAiSAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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one is problem.

I am inheriting studentEmployee in 2 paths.

studentEmployee becomes 2 times my base class. I have inherited name 2 times. I will keep 2 names in my class now.

I have student part and employee part in my studentEmployee. Each has name because of person class. Waste of memory.

There is virtual inheritance to solve this problem.