# Inheritance

Comp Sci 1575 Data Structures

# Inheritance



"The great thing about Object Oriented code is that it can make small, simple problems look like large, complex ones."

# Outline




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public mode
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private mode
Inheritance
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Single
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Hybrid
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Parameterized versus default
Polymorphism and abstract classes

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# Inheritance



- When creating a class, rather than writing completely new data members and member functions, make a new class inherit members of an existing class
- Existing class whose properties are inherited by new class is called the **Parent**, **Base**, or **Super class**
- New class which inherits properties of base class is called **Child**, **Derived**, or **Sub class**
- The derived class inherits the members of the base class, on top of which it can add its own members.
- **Inheritance** is the capability of one class to acquire properties and characteristics from another class

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# Purpose of inheritance



1. **Code re-usability:** When a new class inherits an existing class, all its methods and fields become available in the new class
2. Makes it easier to create and maintain large applications
3. Allows **abstract classes as interfaces** (more coming up soon)

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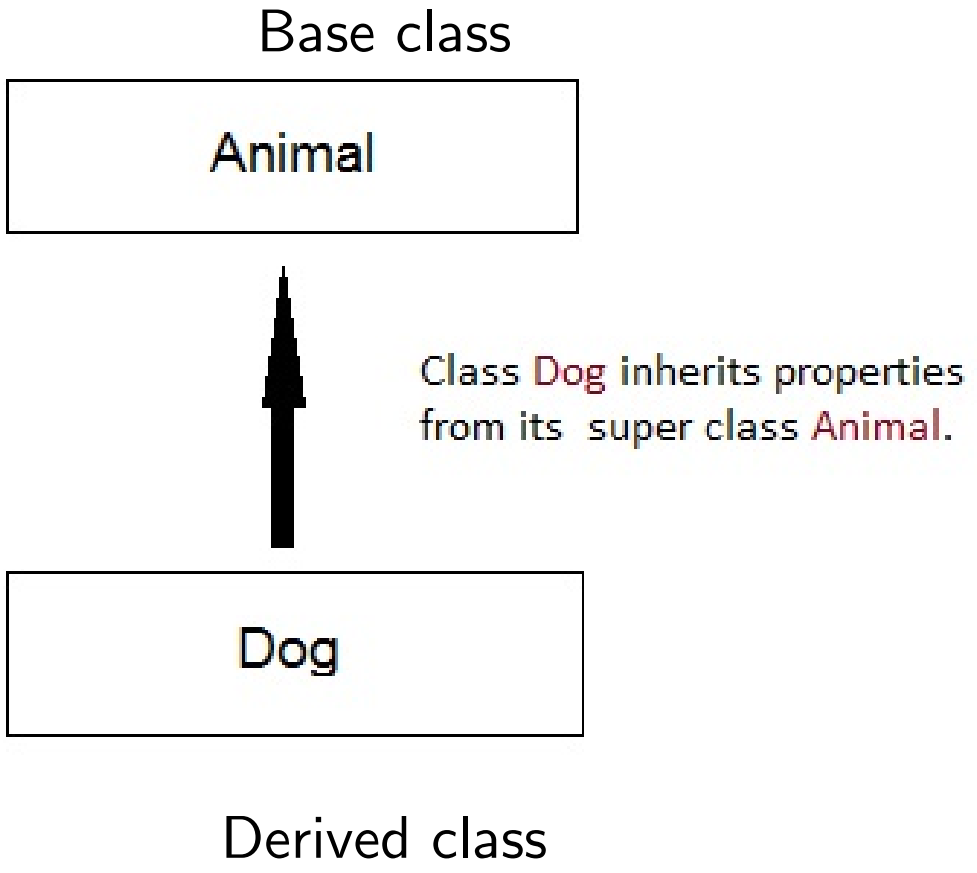
# Base and derived classes





# Class derivation list specifies the base class



```
class Animal {
  public:
    int brain = 1;
};

// Class derivation list:
class Dog: public Animal {
  public:
    int spots = 34;
};

int main() {
  Dog d;
  cout << d.brain;   // 1
  cout << d.spots;   // 34
}
```

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# Access specifiers in base class



Access levels in the original base class:

1. **Public**: Base class's public members are accessible to all
2. **Protected**: Base class's protected members are accessible only to the derived class(s)
3. **Private**: Base class's private members are never accessible directly from a derived class, but can be accessed through calls to the public and protected member functions of the base class.

# Access control modes



Modifiers of the original access specifiers:

1. **Public**: public members of the base class become public members of the derived class and protected members of the base class become protected members of the derived class. **This is most common.**
2. **Protected**: public and protected members of the base class are demoted to protected members of the derived class
3. **Private**: public and protected members of the base class are demoted to private members of the derived class

# Access control modes modify access specifiers



Original access specifier in base:

| **Who has access?** | **public** | **protected** | **private** |
|---|---|---|---|
| members of the same class | yes | yes | yes |
| members of derived class | yes | yes | no |
| non members | yes | no | no |

---

Base class has members that are public, protected, and private (left index)

| | **Derived Class** | **Derived Class** | **Derived Class** |
|---|---|---|---|
| **Base class** | **Public Mode** | **Protected Mode** | **Private Mode** |
| **Public** | Public | Protected | Private (accessible) |
| **Protected** | Protected | Protected | Private (accessible) |
| **Private** | Not accessible | Not accessible | Not accessible |

Derived class (top indices) inherits these levels (intersections)

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# public mode



```
class Animal {
  string thoughts;
  public:
    int brain = 1;
};

class Dog : public Animal {
  public:
    int spots = 34;
    void printSpots() {cout << brain;} // ??
};

int main() {
  Dog d;
  cout << d.brain; // ??
  d.printSpots(); // ??
  cout << d.spots;  // 34
  cout << d.thoughts; // ??
}
```

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# protected mode



```
class Animal {
  public:
    int brain = 1;
};

// Class derivation list:
class Dog : protected Animal {
  public:
    int spots = 34;
    void printSpots() {cout << brain;} // ??
};

int main() {
 Dog d;
 cout << d.brain; // ??
 d.printSpots(); ??
 cout << d.spots;  // 34
}
```

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# private mode



```
class Animal {
  public:
    int brain = 1;
};

// Class derivation list:
class Dog : private Animal {
  public:
    int spots = 34;
    void printSpots() {cout << brain;} // ??
};

int main() {
  Dog d;
  cout << d.brain; // ??
  d.printSpots(); ??
  cout << d.spots;  // 34
}
```

# Kahoot

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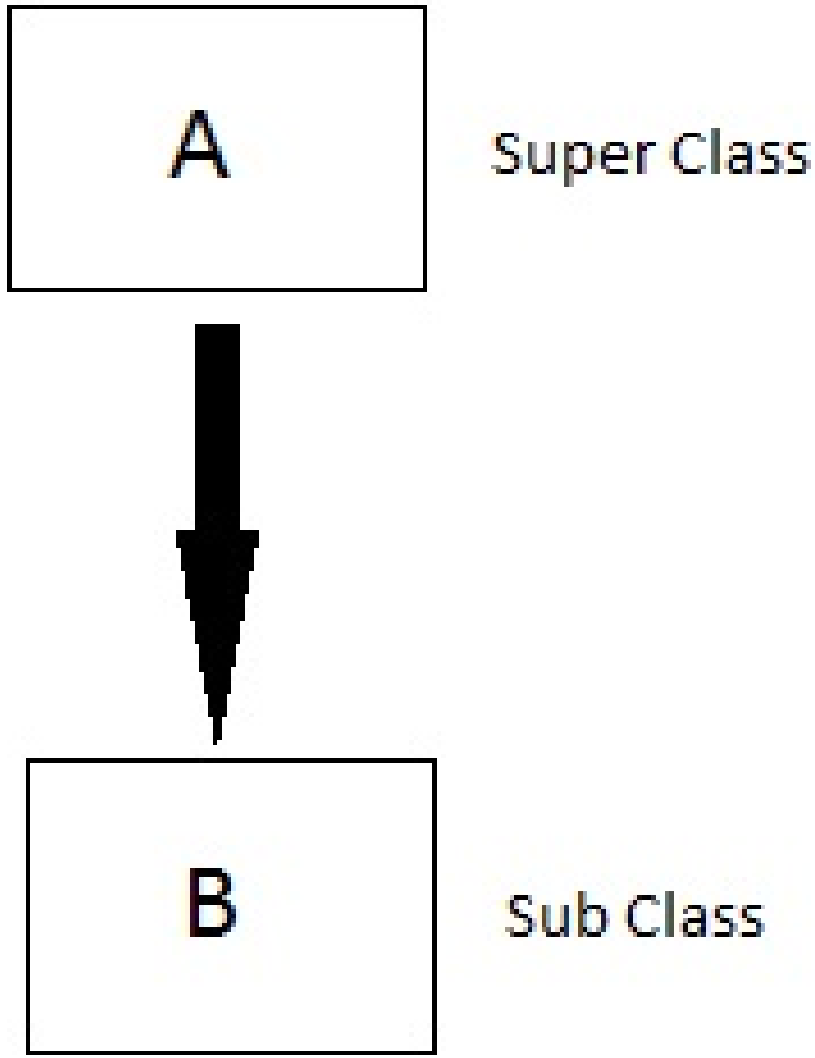
# Types of inheritance: Single



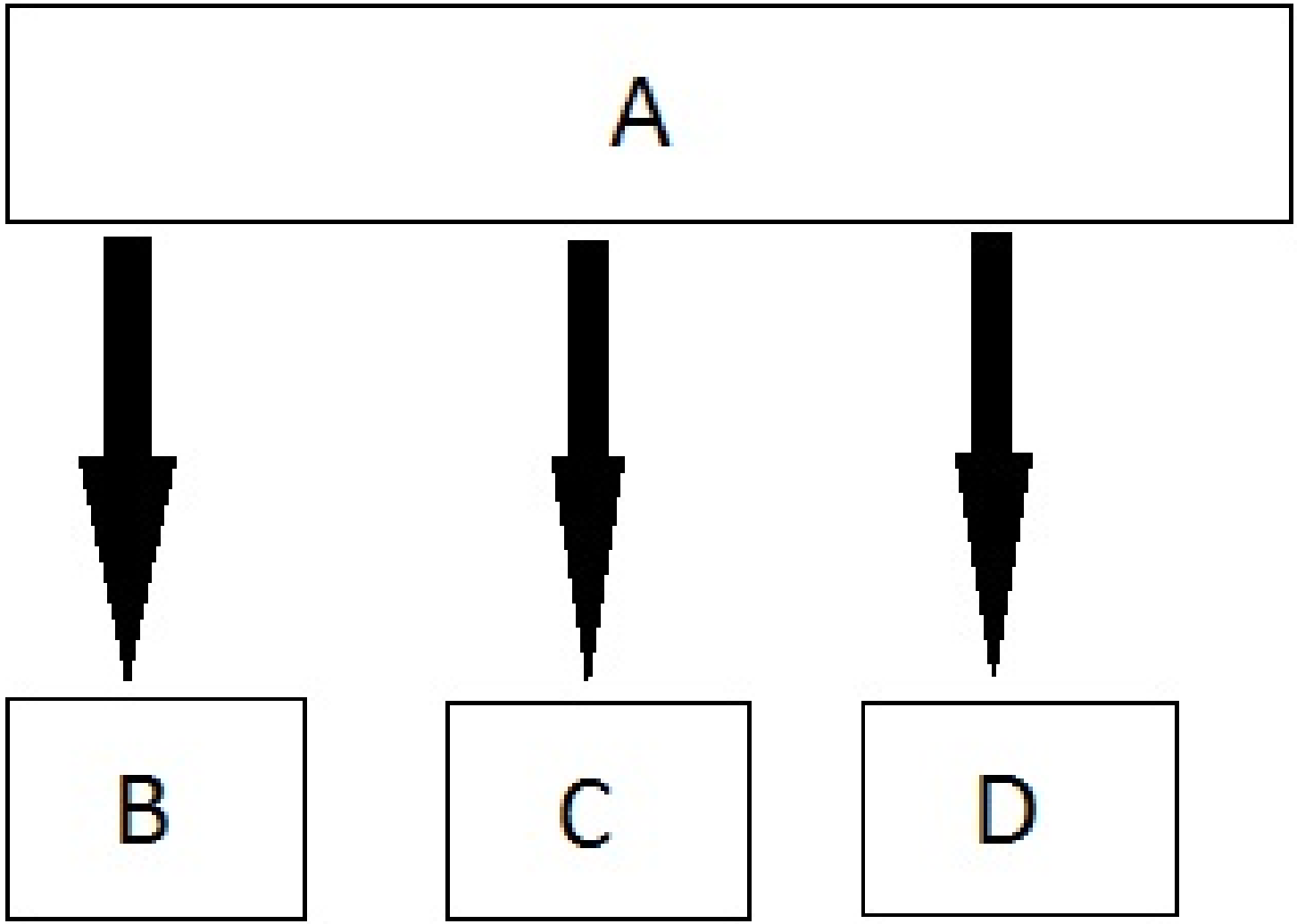
One derived class inherits from only one base class. It is the most simplest form of Inheritance.



# Types of inheritance: Hierarchical

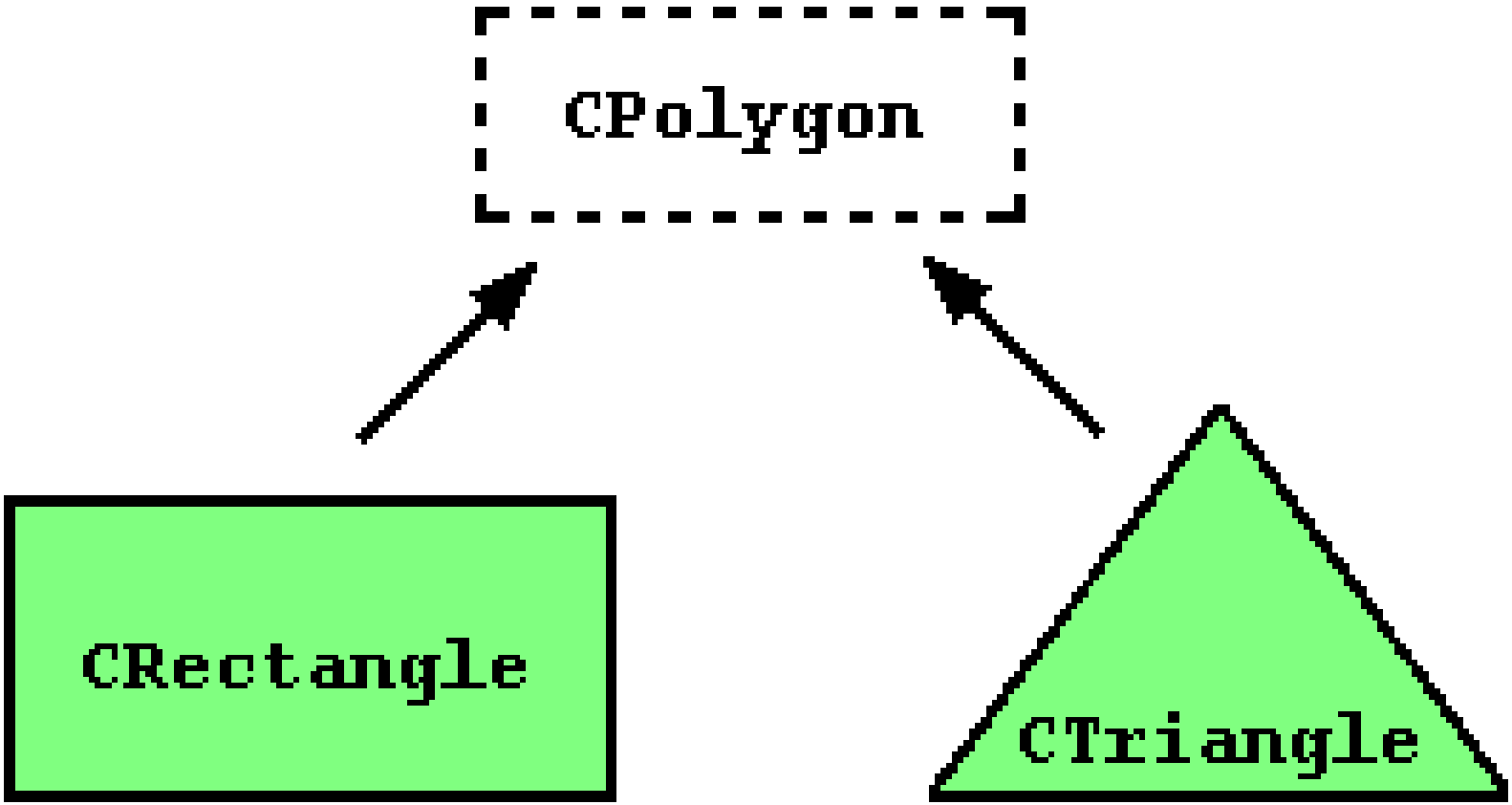


Multiple derived classes inherits from a single base class.



# Types of inheritance: Hierarchical





# Types of inheritance: Hierarchical

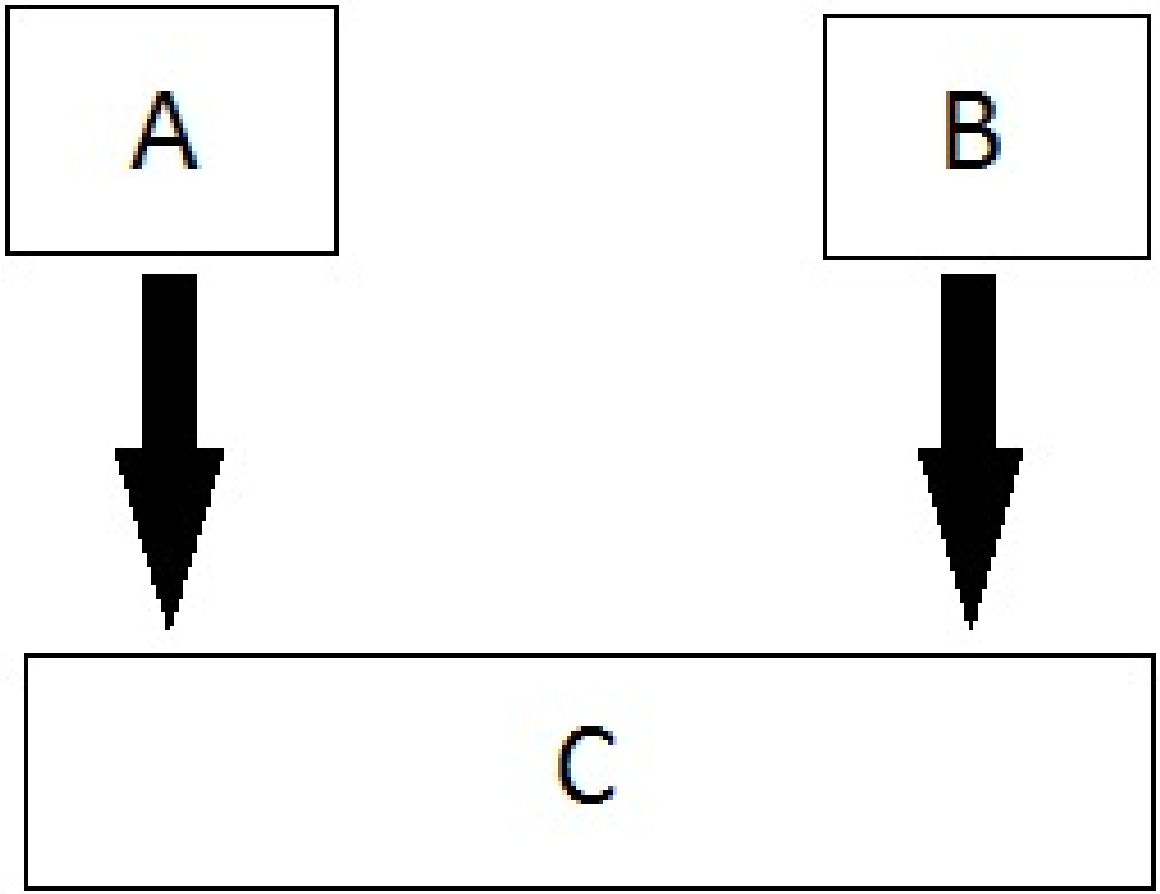


```
class Polygon {
  protected:
    int width, height;
  public:
    void set_values(int a, int b){
      width=a; height=b;
    }
};

class Rectangle: public Polygon {
  public:
    int area(){
      return width * height;
    }
};

class Triangle: public Polygon {
  public:
    int area(){
      return width * height / 2;
    }
};

int main() {
  Rectangle rect;
  Triangle trgl;
  rect.set_values(4,5);
  trgl.set_values(4,5);
  cout << rect.area() << endl; // 20
  cout << trgl.area() << endl; // 10
  return 0;
}
```

# Types of inheritance: Multiple



A single derived class may inherit from two or more than two base classes.



# Types of inheritance: Multiple

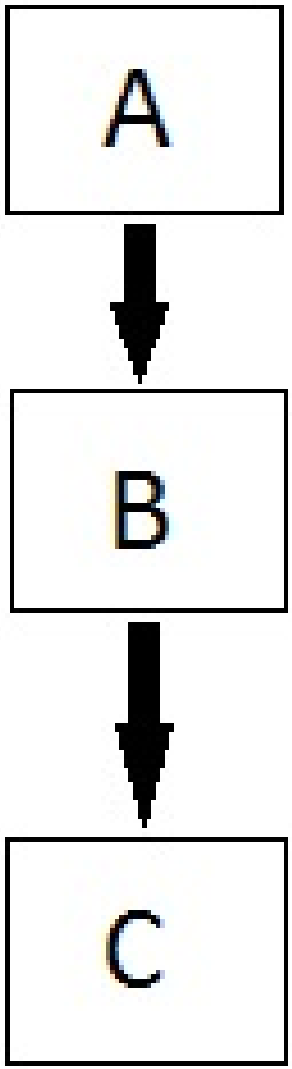


```
class Shape {
   public:
      void setWidth(int w) {width = w;}
      void setHeight(int h) {height = h;}

   protected:
      int width;
      int height;
};

class PaintCost  {
   public:
      int getCost(int area) {return area * 70;}
};

class Rectangle: public Shape, public PaintCost {
   public:
      int getArea() {return (width * height);}
};

int main(void) {
   Rectangle Rect;
   int area;
   Rect.setWidth(5);
   Rect.setHeight(7);
   area = Rect.getArea();
   cout << Rect.getArea() << endl;    // 35
   cout << Rect.getCost(area) << endl;    // 2450
   return 0;
}
```

# Types of inheritance: Multilevel



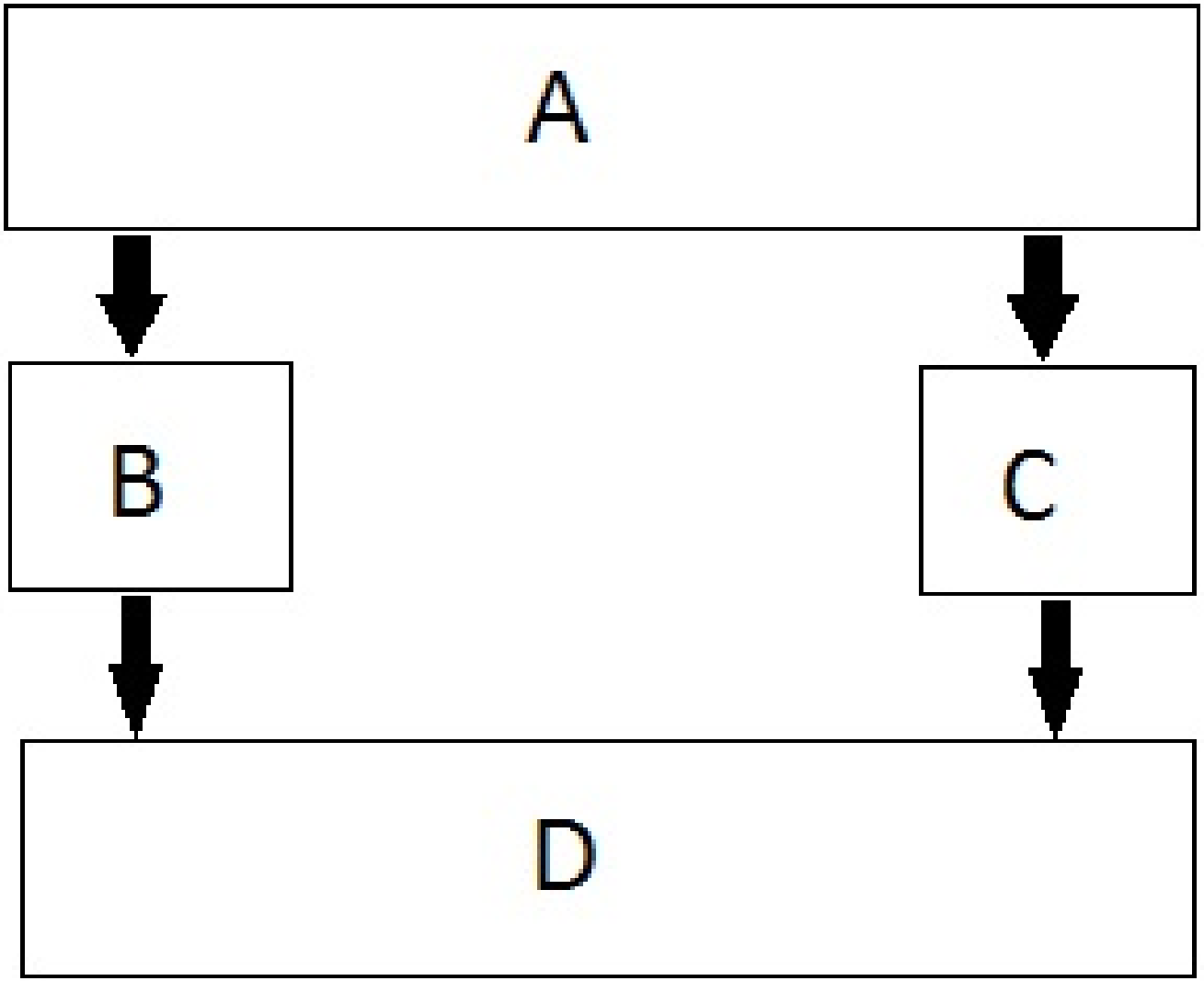
Derived class inherits from a class, which in turn inherits from some other class. The Super class for one, is sub class for the other.



# Types of inheritance: Hybrid



Hybrid Inheritance is combination of Hierarchical and Mutilevel Inheritance.



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# What is not inherited from the base class?



- Constructors, copy constructor, and destructor of the base class
- Assignment operator=()
- Friends of the base class
- Originally private members of the base class (inherited but not accessible)

# Kahoot

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# Constructors of base and derived classes



- Base class constructors are always called with the derived class constructors
- First the base class default constructor is executed, and then the derived class's constructor

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# Constructor of base class is called with the derived



```
class Base {
  int x; // Remember, classes default to private
  public:
    Base() {cout << "Base default constructor";}
};

class Derived : public Base {
  int y;
  public:
    Derived(){cout << "Derived default constr";}
    Derived(int i){
      y = i;
      cout << "Derived parameterized";
    }
};

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

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# Parameterized versus default



- Unless otherwise specified, the constructors of a derived class calls the default constructor of its base class(es)
- To call base class's parameterized constructor inside derived class's parameterized constructor, we must mention it explicitly while declaring derived class's parameterized constructor.

# Force calling of base parameterized constructor



```
class Base{
  public:
    int x;
    Base(int i){ x = i; }
};

class Derived: public Base {
  public:
    int y;

    // Specify base parameterized constructor
    Derived(int j): Base(j) { // Options here?
      y = j;
    }
};

int main(){
  Derived d(10);
  cout << d.x;     // 10
  cout << d.y;     // 10
}
```

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# Next time



Polymorphism and abstract classes