C++: Inheritance

Questions from last time

- long long?
  - long is a size specifier
    - There is no long long.
    - There is however a `long int`
    - There is however a `long double`

Questions from last time

- new
  - new[-5] will throw a bad_alloc exception
    - May also return a null pointer
  - What about `new[]`
    - You can override the `new` operator
    - new[] is the operator that gets called when allocating memory for an array of objects.
      - `MyClass fred[] = new MyClass[20];`

Project

- Design due April 4th
- Shapewin
  - Distribution can be found in
    - Source, include, libs
      - ~cs4/pub/util/src/Shapewin
      - ~cs4/pub/util/include/Shapewin
      - ~cs4/pub/util/lib/libShapewin.a
    - Docs
      - http://www.cs.rit.edu/~cs4/pub/doc/shapewin
  - Shapewin overview tomorrow in lecture
- Questions?

Questions

- Any other questions before we start?

Plan for the week

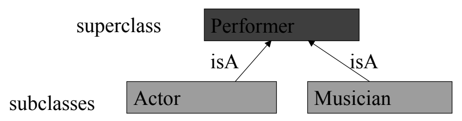
- Today: Inheritance I (Basics)
- Tomorrow: Inheritance II (Behind the scenes)
- Thursday: Templates and the STL

Subclassing

- Defining a class as a <u>specialization</u> or <u>extension</u> of another class.
- The more general class is called the <u>superclass</u>.
- The more specific class is called the <u>subclass</u>.
- Implies an <u>IS-A</u> relationship.

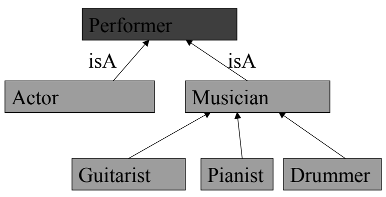
Subclassing

- Define a more general class "Performer".
- Both Actors and Musicians are specializations of Performer



Class Heirarchies

- Class heirarchies can be as deep as needed:



Subclassing and Inheritance

- When you define a class as a subclass:
  - The subclass <u>**inherits**</u> all of the data members and methods of the superclass.
  - In addition, a subclass can have data/methods that are it's own.
  - Inheritance is transitive:
    - I.e. If B is a subclass of A and C is a subclass of B, then C inherits the data/methods from both B and A.

Polymorphism (in Java)

- A variable of a superclass can reference an object of any one of it's subclasses.
- The variable remembers what subclass of object is referenced so that the correct methods of the subclass are called.

Polymorphism in Action (Java)

- Example

```
Performer A = new Actor("foo");
Performer M = new Musician ("bar");
Performer P = new Performer ("fred");

// calls Actor's calculatePay
float Apay = A.calculatePay();

// calls Musician's calculatePay
float Mpay = M.calculatePay();

// calls Performer's calculatePay
Float Ppay = P.calculatePay();
```

How this is done in C++

- First, C++ terminology
  - Superclass is called the <u>base class</u>
  - Subclass is called the <u>derived class</u>.

How this is done in C++

- Syntax

```
class Performer
{
…
}
class Musician : public Performer
{
…
}
```

How this is done in C++

- Access specifier
  - public – Public members can be used by all
  - Private – Members can be used only by base class.
  - Protected – Public and protected members seen only be base and dervived class.
- For all work done in CS4, the access will be specified as `public`

C++ and Polymorphism

- Funny thing about C++ Inheritance
  - You can only gain polymorphic behavior on pointers (or references) to objects an not on objects themselves.

```
Actor A;
Performer P(A) // allowed but loose Actor
                       // specific behaviour --
  slicing
Performer *PP = new Actor (); // okay

P.calculatePay(); // Performer's calculatePay called
PP->calculatePay(); // Actor's calculatePay called.
```

Virtual functions

- In Java, by default, the subclass could override the definition of any method in the superclass.
- In C++, this only allowed if the method in the superclass (base class) is declared as `virtual`.

Virtual functions

```
class Performer
{
public:
   // it's okay to redefine this method
   virtual void calculatePay();

   // it's not okay for this one
   void myFunct();
}
```

Virtual functions

```
class Musician : public Performer
{
public:
 // this method redefines superclass
   void calculatePay();

   // this method belongs only to this class
   void myFunct();

}
```

Virtual functions

```
Performer *P = new Musician();
Musician *M = new Musician();

// Will call Musician's calculatePay
P->calculatePay();
M->calculatePay();

// Will call Performer's myFunct
P->myFunct();

// Will call Musician's myFunct
M->myFunct();
```

Virtual functions

- Questions?

Abstract Methods

- To declare an abstract method, declare as virtual and set to 0.
- No `abstract` keyword like in Java

```
class Performer
{
public:
   // subclass must redefine this method
   virtual void calculatePay()=0;

   // it's not okay for this one
   void myFunct();
}
```

Abstract Methods

- Like in Java, any class with abstract methods is an abstract class and cannot be directly instantiated.
- Unlike Java, this is implied and not specifically labeled as `abstract`.

Interfaces

- There are no explicit interfaces in C++.
- Instead, an interface can be implemented as:
  - A class with
    - No data member (except for static)
    - All methods declared as abstract.
  - Subclasses must give definition for all method…just like in Java interfaces.

Interfaces (Java)

```
public interface Configuration
{
     void applyAction();
     boolean isGoal();
     …
}
```

Interfaces

```
class Configuration
{
public:
     virtual void applyAction() =
  0;
     virtual boolean isGoal() = 0;
     …
}
```

Interfaces

- Questions?

Constructing Derived Class Objects

- When an object of a derived class is constructed:
  - The constructor of the base class is called first.
  - Base class constructor arguments pased in on initializer list.

Constructing Derived Class Objects

```
class Performer
{
public:
   Performer (char *name, char *talent);
}
class Musician : public Performer
{
public:
   Musician (char *name);

private:
   int otherData;
}
```

Constructing Derived Class Objects

```
Musician::Musician (char *name) :
  Performer (name, "music"), otherData
  (0), ...
{
}
```

- There is no `super` function in C++
- Call to base class constructor required unless base class has a default constructor.

- Questions?

Constructing Derived Class Objects

- Base class constructors should not call virtual functions

```
class Performer
{
public:
   Performer (char *name, char *talent);
   virtual void calculatePay();
}
class Musician : public Performer
{
public:
   Musician (char *name);
   void calculatePay();
```

Constructing Derived Class Objects

```
Performer::Performer (char *name, char
  *talent)
{
 ...
   calculatePay();  // not a good idea
 ...
}
```

More on `super`

- In Java, you can call methods from your superclass by using `super`.

```
class Musician
{
…
public void calculatePay()
{ …
    super.calculatePay();  // calls Performer's
    …
}
```

More on `super`

- In C++ you must specify the name of the base class by name (there is no super reference)

```
void Musician::calculatePay()
{…
      Performer::calculatePay();
      …
}
```

Summary

- Inheritance & Polymorphism
- C++ Syntax
- Virtual Functions
- Abstract Classes
  - No interfaces
- Construction