C++: Inheritance II

Announcement

- Speaking of exams
  - The date for the Final has been decided:
  - Saturday, November 16th
  - 8am – 10am
  - 01-2000

Project

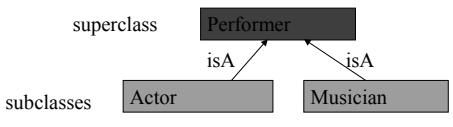
- Questions?
- Clock problem due Oct 16th

Plan for this week

- This is "abstraction week"
  - Thursday: Inheritance in C++
  - Monday: Exam
  - Tuesday: Inheritance in C++ (cont'd)

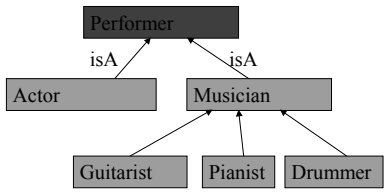
Subclassing

- 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 **inherits** 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.

Inheritance

- Behind the scenes
  - The memory allocated for an object of a derived class consists of:
    - An area for the base class's data
    - An area for the derived class's data

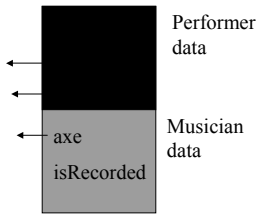
Inheritance

```
class Performer
{
private:
  float basePay;
  char *name;
  char  *talent;
    …
public:
  Performer (char *name, char
   * talent);
  virtual float
   calculatePay();
}
```

```
class Musician : public
   Performer
{
private:
     Instrument *axe;
     bool isRecorded;
     …
public:
     Musician (char *name);
     virtual float
   calculatePay();
     virtual void
   setInstrument (Intrument
   *I);
}
```

Inheritance

- What the memory for Musician looks like



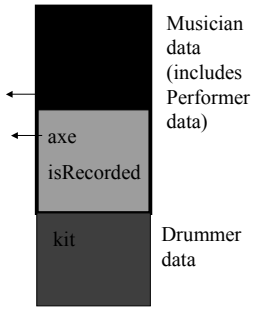
Inheritance

- Let's add a Drummer

```
class Drummer : public Musician
{
private:
      Drum kit[];
public:
      Drummer (char *name);
      virtual void setInstrument
  (Instrument *I);
}
```

Inheritance

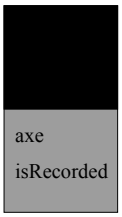
- What the memory for drummer looks like



Inheritance and Construction

- When a member of a derived class is constructed, the constructor of it's base class is called first
  - This fills in the memory area containing members of the base class.

Inheritance and Construction




```
Musician *M = new Musician("Ringo");
```

Musician's constructor is called
Performer's constructor is called
Musician's constructor continues

Inheritance and Construction


```
Drummer *D = new Drummer("Ringo");
```

Drummer's constructor is called
Musician's constructor is called
Performer's constructor is called
Musician's constructor continues
Drummer's constructor continues

Constructing Derived Class Objects

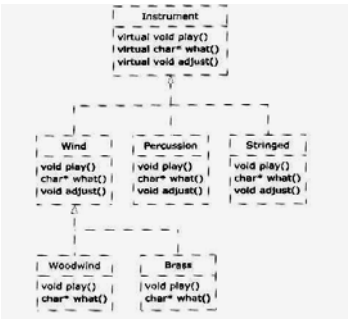
```
Musician::Musician (char *name) :
  Performer (name, "music"), axe (0),
  isRecorded(false),...
{
}
```

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

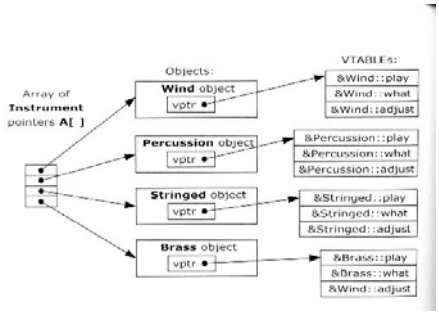
Virtual Functions

- What about virtual functions?
  - C/C++ allows one to define pointers to functions.
  - For all classes with virtual functions (defined or redefined), the compiler will create an array of pointers to virtual functions (VTABLE)
  - Objects of such classes have a hidden data member (vpt) which will point to the correct VTABLE array.

Virtual Functions



Virtual Functions



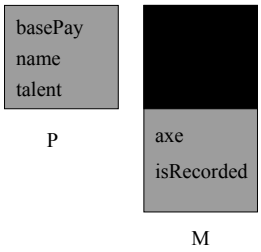
Virtual Functions

- Questions?

Slicing

- Recall that polymorphism can only be achieved using pointers rather than objects themselves.
- Attempts to copy a base class object with a derived class object will cause slicing.
  - Only the base class section of the derived object will be copied.

Slicing

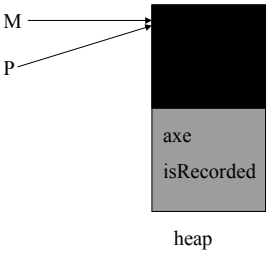



```
Musician M ("Ringo");
Performer P (M);
```

Space allocated for P

Copy constructor called

Correct Polymorphism




```
Musician *M (new
Musician ("Ringo"));
```

```
Performer *P (M);
```

M allocated on heap

Pointer copy.

Slicing

- Questions?

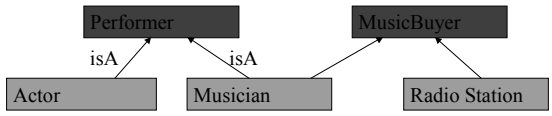
Multiple Inheritance

- In C++, a class can be derived from more than 1 base class.
- Recall that C++ has no notion of an interface.

Multiple Inheritance

```
class MusicBuyer
{
private:
    float cashOnHand;
    …
public:
   MusicBuyer (float cash);
   …
}
```

Multiple Inheritance



Multiple Inheritance

- Objects of classes that have multiple base classes will have a data section for each Base class.
  - The constructor for each base class will need to be called in the constructor for the derived class.

Multiple Inheritance

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

Musician::Musician (char *name) : Performer
  (name, "music"), MusicBuyer(100.0), ...
{
}
```

Multiple Inheritance


```
Musician *M = new Musician("Ringo");
```

Musician's constructor is called
Performer's constructor is called
MusicBuyer's constructor is called
Musician's constructor continues

Multiple Inheritance

- Why some think Multiple Inheritance is evil
  - Data member ambiguity
  - Can possibly derive from a base class twice
  - Extra work for compiler.
  - Most multiple inheritance heirarchies can be done using single inheritance
- Java chose to disallow
  - Created interfaces instead
  - I suggest you do the same!

Multiple Inheritance

- Questions

Summary

- Inheritance
  - What really goes on…
  - Virtual functions and VTABLE
  - Slicing
- Multiple Inheritance
- Questions