Remaining Assignments

- HW #5 due tomorrow (Thurs)
- Project #2 due Sunday night
- Final exam on Monday

More Inheritance Details…

- C++ has **protected** visibility
- Friendship is **not** inherited
- There is no “root” class (like Java’s Object)
- Unlike Java, you may **reduce** visibility of inherited member (violating “Is-A”)

Example: ReducedVisibility

- Visibility of inherited member **can** be reduced
- No problem for static binding
- What happens for virtual method???

Private Inheritance

```
class Foo : private Bar
```

`Foo` inherits all members from `Bar`, but they become **private**.

- Used to restrict API
- Violates “Is-A” relationship

```
Foo f;
Bar &b = f;     // No longer works
Bar *p = &f;    // No longer works
```

Example: PrivateInheritance

- Used to “restrict” API for base class
- Internally, private members from base class are still available.

Multiple Inheritance

Java:

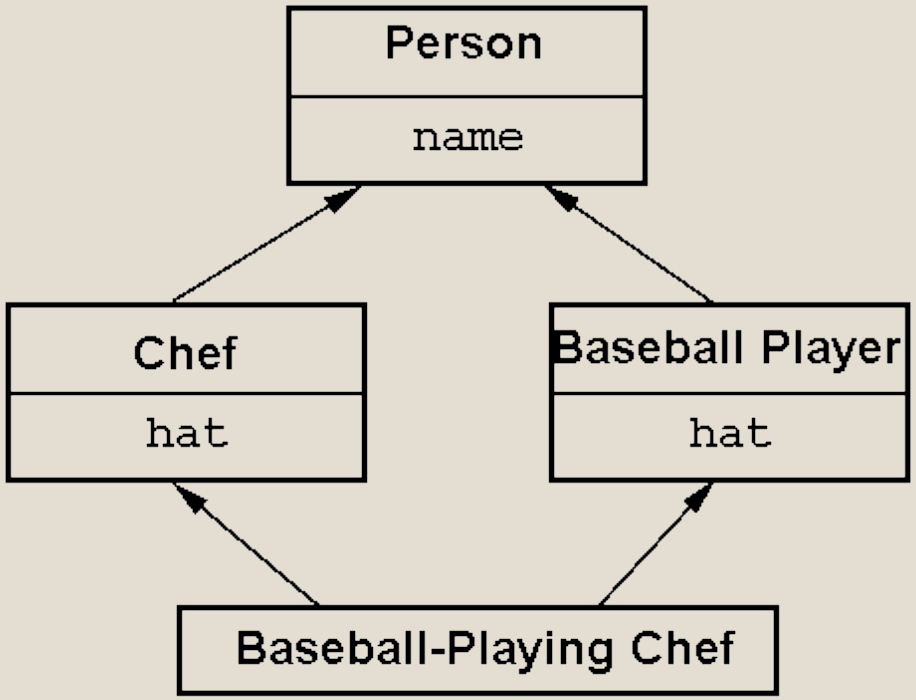
- Java has “interfaces”
- A class may implement multiple interfaces
- No multiple inheritance

C++:

- No Java-style interfaces
- Abstract classes are used instead
- Multiple Inheritance allowed and used frequently to mimic Java interfaces

Why is Multiple Inheritance Scary?

"The Diamond of Death!"



(Next slide please…)

Baseball-Playing Chef

It’s the same guy!!

The Diamond of Death!

Chef has:

- name
- hat

Baseball Player has:

- name
- hat

By default, Baseball-Chef will inherit:

- Two names (He should only have one)
- Two hats (He needs them both)

There is a messy mechanism that allows you to change the default setup so that a Baseball-Chef has only one name (but still gets both hats).

- Constructors become complicated
- Issues remain with conflicting contracts
- **Better idea: Avoid the Diamond of Death**

Template Overview

Basic idea: Code that works the same way for many different data types. (The type is a parameter.)

Templates in C++ are similar to Java generics, but are quite different:

- In C++, the compiler will generate many different versions of the same code – one for each type that is encountered.
- Works with a class or a non-class function
- Parameterized type can be object or primitive

Function Templates

Syntax:

```
template<typename T>
void foo(T)
{
   …
}
```

What will compiler do with this?

```
string s;
foo(s);
```

1. If this is the first time type `string` has been used to call `foo`, it creates a version of `foo` using `string` in place of "`T`", and calls it here.
2. If string has been used previously, it calls the function previously generated.

Example: FunctionTemplates

findMin revisited:

- Template used so we can find the minimum value of any vector.
- Works for objects or primitives
- How many versions of findMin will the compiler generate?
- What kinds of objects will cause a compilation error?

Class Templates

- A bit tricky to separate interface from implementation
- Like function templates, compiler generates as many different copies of the class as it needs.

Example: ClassTemplate

- More than one parameterized type can be used
- “friend” can be used