Introduction to C, C++, and Unix/Linux

CS 60

Lecture 10: Classes

Today

→ C++ Classes

→ Reading [KR] Chapters 1-7

→ Read [So] chapters 1, 3, 4 (Boolean), 9, 13, 14 & 18 & 10

From namespace to class

- A C++ class combines data and functions in a single namespace, creating a new data type
- Combines features of a struct with a namespace, along with some extra options
  - Data can be declared public, protected, private
  - Some functions automatically generated (e.g., constructor, destructor, copy constructor, **`=`**, **`new`**, **`delete`**)
  - **`this`**

Classes and objects

- A C++ class is an object type
  - Defining a class means defining the attributes (data) and behavior (methods/functions) of a new data type
- An object is created by declaring a variable of the class type (instantiation)

```
class Player {
 ...
};
```

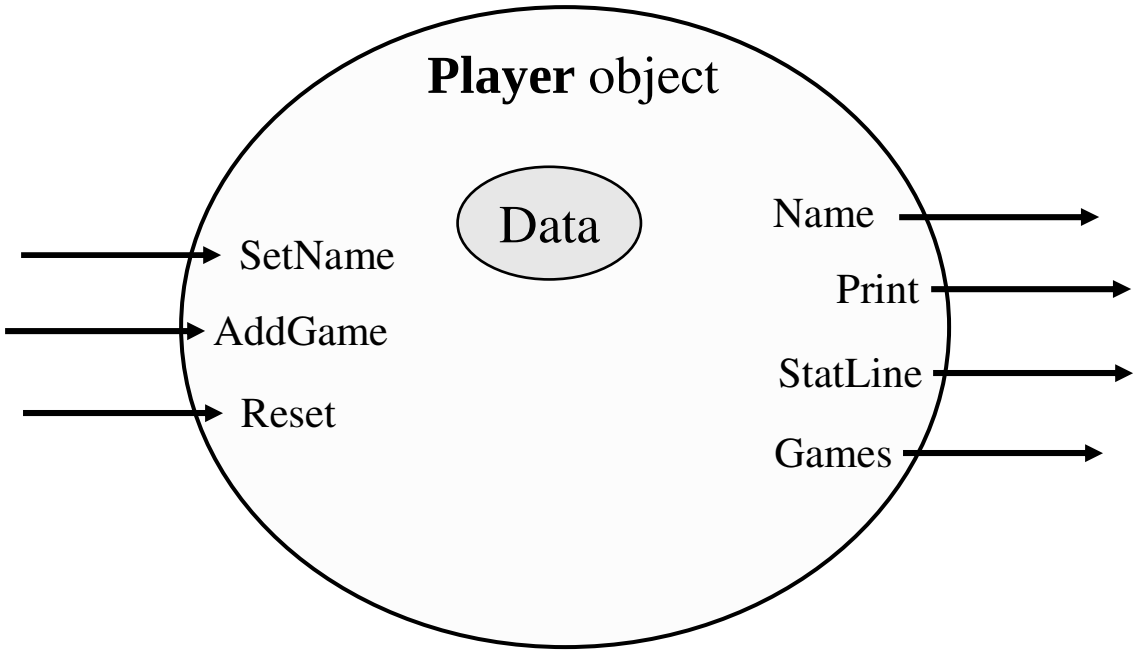
Class definition/specification
(Often in include file)

```
Player p1, p2, p3;
```

Class instantiation

Class interface

- The interface defines the behavior of the class to the *outside world* (to other classes and functions that may access variables of your class type).
- The *interface* to a class is the list of public data members and methods
- The implementation of your class doesn't matter outside the class – only the interface
  - The implementation can change dramatically, as long as the interface stays the same



The class user "sees" the interface, not the internal (private) data (directly) and functions

Object oriented programming

- In OOP, the programmer *thinks about* and *defines* the attributes and behavior of objects
  - Often the objects are modeled after real-world entities

- Very different approach than *function-based* programming (like C)
  - Most of the action happens inside classes!
  - Though we still provide **`main()`**, and many other things don't change...

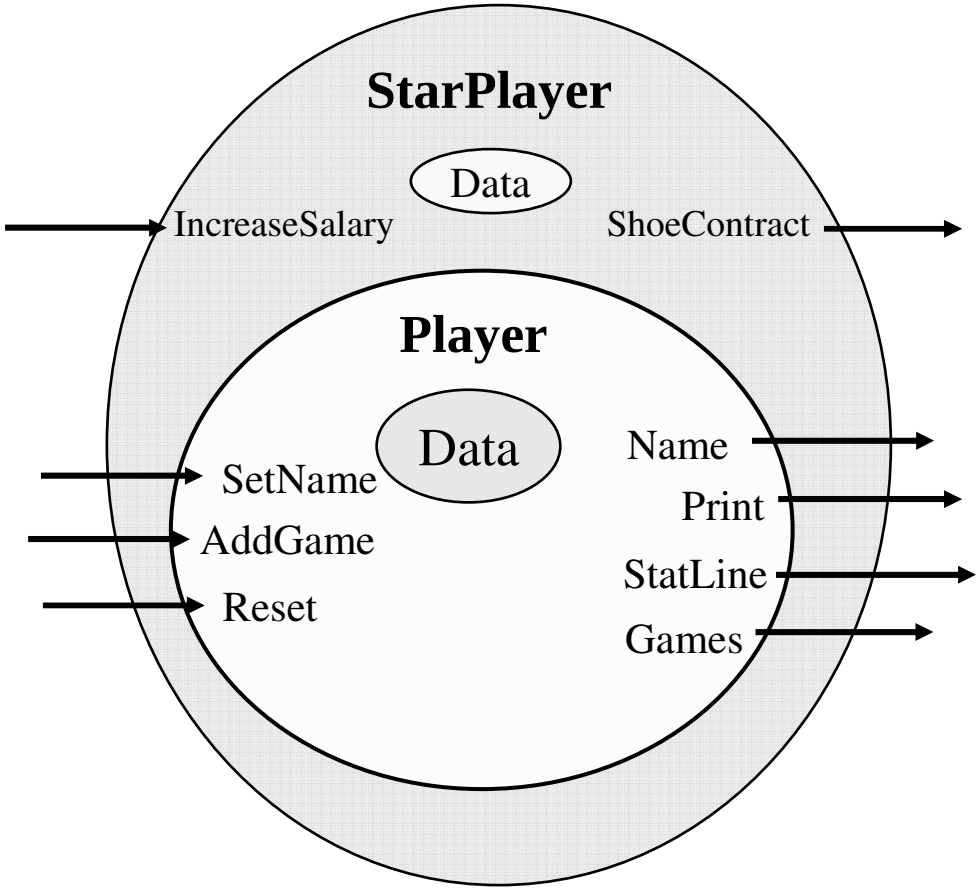
Reasons for object oriented programming

- Modularization
  - Abstraction – representing the essential features of something without including inessential detail
  - Encapsulation – grouping related things together
  - Information hiding – expose only what you want
- Inheritance
- Polymorphism

Inheritance

- It is possible to *extend* existing classes without knowing much about them
  - Add whatever new behavior you want
- Example:
  - You have a class that represents a "player"
  - Create a new class that is a "star player"
    - Most of the behavior and attributes are the same, but a few are different – specialized

Inheritance (cont.)



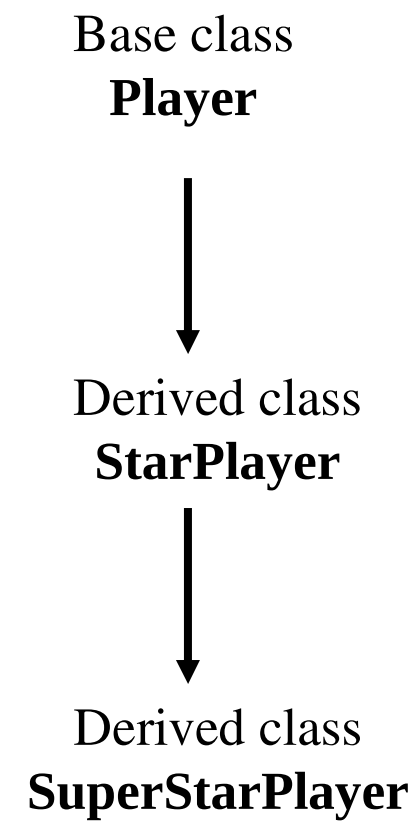
Base class
Player

Derived class
StarPlayer

Derived class
SuperStarPlayer

Inheritance (cont.)

- A **SuperStarPlayer** is a **StarPlayer** is a **Player**
- Any function that takes a **Player** can be passed a **StarPlayer** or a **SuperStarPlayer**




```
float PPG(Player p)
{
  return(p.points/p.games);
}
```

If **`points`** and **`games`** are ints, should be this:

```
return((float)p.points/p.games);
```

This assumes that the data variables **`points`** and **`games`** are public (but they will not be public – compiler error!)

Polymorphism

- The ability of different objects to respond to the same *message* in different ways.

- Tell an **`int`** to print itself: **`i.print();`**
- Now tell a **`double`**: **`x.print();`**
- Now tell a **`Player`**: **`p1.print();`**

Or:

```
cout << i;
cout << x;
cout << p1;
```

Example: Player.h

```
class Player {
private:
  std::string name;
  int games;
  int points;
  int rebounds;
  int assists;
public:
  void Print();
  bool AddGame(int, int, int);
  std::string Name();
  void SetName(std::string);
  void Reset();
};
```

Data (private)

Functions (public)

Example: Player.cpp

```
void Player::Print()
{
  cout << name << " " << rebounds << " " <<
  assists << endl;
}

void Player::AddGame(int points, int rebs,
  int assts)
{
  game++; this->points += points;
  rebounds += rebs; assists += assts;
}
```

When defining class functions, data can be accessed directly (no "**`Player::`**" required)

```
inline std::string Player::Name()
{
  return name;
}

inline void Player::SetName(std::string name)
{
  this->name = name;
}

inline void Player::Reset()
{
  games = points = rebounds = assists = 0;
}
```

Example: main.cpp

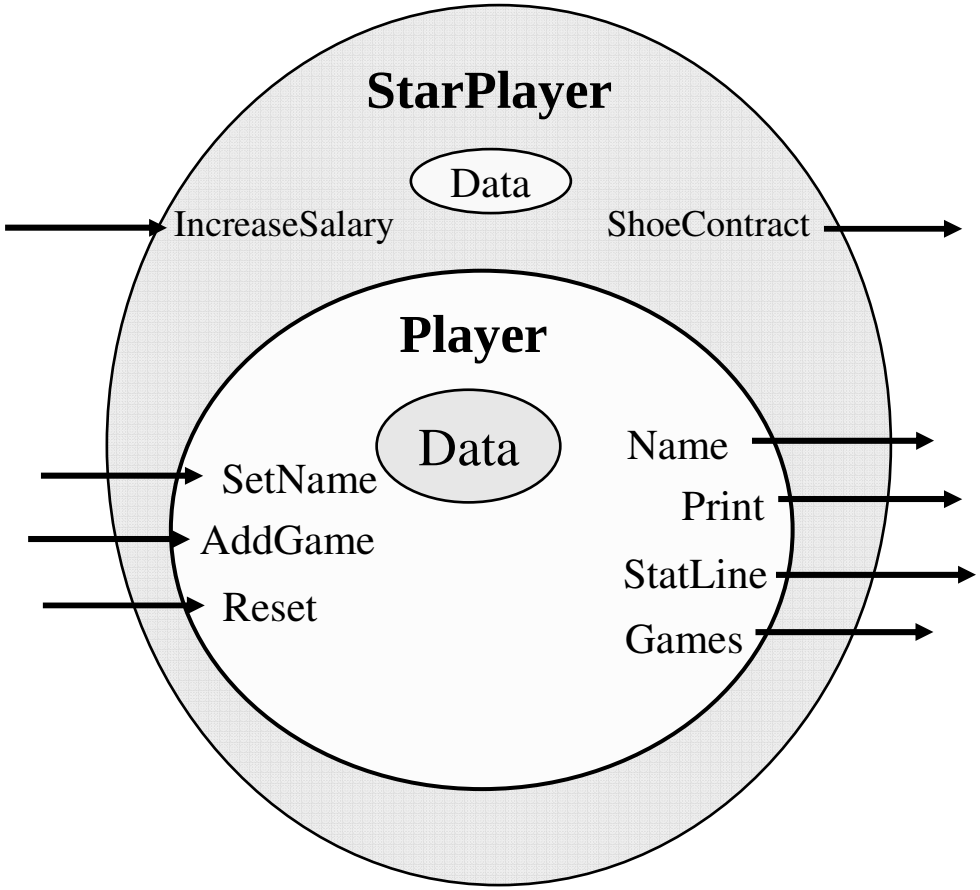
```
Player p1, p2;

p1.SetName("Steve Nash");
p1.AddGame(48, 5, 5);
p2.SetName("Dirk Nowitzki");
p2.AddGame(25, 8, 3);

std::cout << p1.Name() << "has scored " <<
  p1.points << endl;
```

Maybe do this at initialization time?

No, can't access this member variable – it's private!

What are the initial values of the data variables? Undefined

Inheritance (cont.)



Base class
Player

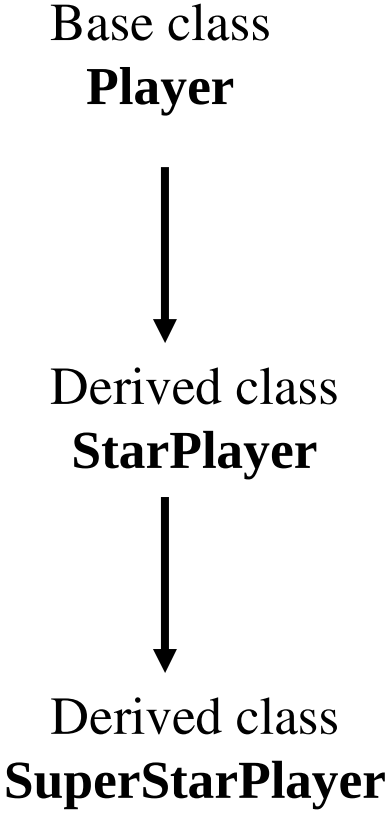
Derived class
StarPlayer

Derived class
SuperStarPlayer

Inheritance (cont.)

- A **SuperStarPlayer** is a **StarPlayer** is a **Player**
- Any function that takes a **Player** can be passed a **StarPlayer** or a **SuperStarPlayer**

BUT NOT VICE VERSA!!



Player **StarPlayer** **SuperStarPlayer**



Player
StarPlayer
SuperStarplayer **`Function1(Player p)`** 

StarPlayer
SuperStarplayer **`Function2(StarPlayer p)`** 

SuperStarplayer **`Function3(SuperStarPlayer p)`** 

```
class Player {
private:
  std::string name;
  int games;
  int points;
  int rebounds;
  int assists;
public:
  void Print();
  bool AddGame(int, int, int);
  std::string Name();
  void SetName(std::string);
  void Reset();
};
```

Data (private)

The class interface

Functions (public)

```
class StarPlayer : public Player {
private:
  int extraMillions;
  std::string sponsor;
public:
  void IncreaseSalary(int millions);
  std::string& ShoeContract();
};

class SuperStarPlayer : public StarPlayer {
public:
  void Print();
};
```

```
void StarPlayer::IncreaseSalary(int m)
{
  extraMillions += m;
}

std::string& StarPlayer::ShoeContract()
{
  return(sponsor);
}

void SuperStarPlayer::Print()
{
  std::cout << “The fabulous ”;
  Player::Print();
}
```

```
class Player {
private:
  // data
public:
  // functions
  int Points() { return points; }
  Player();
  Player(std::string name);
};
```

Functions can be defined in the class definition itself

Automatically inlined

Constructor functions

```
Player p1;
Player p2("Larry Bird");
```

Notice: No return value type for constructor (and destructor) functions!

```
Player::Player()
{
  name = “”;
  Reset();
}

Player::Player(str::string str)
{
  name = str;
  Reset();
}
```