Intro to Classes in C++

Classes

Programmer-defined types

Made up of members

- Variables
- Functions – called methods when part of a class
- Constructors: Initialize the class
- Destructors: Clean up as the class is being removed/ deleted

Concept is the same as C#, Java, etc.

Where C-structs have only variables, C++ classes are complete objects with methods plus data

Still use .h files for ‘defining’; Use .cpp or .cc files for implementation

Syntax, semantics and concepts

While ‘C’ syntax can be used, C++ class and object syntax can be quite different

Similarities:

- include files

- Basic if/ then/ else/ while control structures

- Must still manage your own memory (but now for objects as well as data)

- Can actually write typical C code (and not use C++ enhancements)

Differences:

- include (.h) files define the class structure only

- .cpp files implement the classes (sometimes .cc files)

- new and delete (vs. malloc and free)

- Abstract classes as ‘templates’

- public/ private/ protected variables and methods

- constructors and destructors

- override and virtual methods

- inheritance and polymorphism

- ‘streams’ for I/O (e.g. ‘cout’ vs. ‘printf’)

- namespaces for scope

- iterators

[And g++ compiler in Linux]

Class Declaration – Point.h

Generally declared in a header file
- Separate declaration and definition
- Allows multiple files to #include declaration

Starts with class keyword
- Capitalized by convention

```
class Point
{

}; // Notice the semicolon!
```

Class Access Specifiers

By default, all class members are private

Change with access specifiers

- public [visible to everyone]
- private [visible only to the original class]
- protected [visible to the original class and derived classes]

Usage is different from C# / Java

- Define sections with specified access

Access Specifier Example

```
class Point
{
public:
        // All public members here
        // As many as you want

private:
        // All private members here
        // As many as you want
        int x;
        int y;
};
```

Constructors

Code to be run when object is created

- Ideally gives all variables useful values
- “Constructs” the object

Called automatically when object is created

Can have zero parameters

- Default constructor

Can require parameters

Constructor Declaration

```
class Point
{
public:
      Point();      // Default Constructor
      Point(int x, int y); // Constructor

private:
      int x;         // Member variable
      int y;               // Member variable
};
```

Methods

Functions declared as class members

- “Member functions”

Methods have access to other class members

- Other methods
- Variables

Methods can use “this” keyword

- A *pointer* to this object
- More on pointers & objects soon

Method Example

```
class Point
{
public:
        Point();     // Default Constructor
        Point(int x, int y);        // Constructor
        int GetX();                 // Method
        int GetY();                 // Method

private:
        int x;                      // Member variable
        int y;                      // Member variable
};
```

Class Implementation – Point.cpp

Generally defined in a .cpp file

- #include associated header file

Should define code of all members

- Methods
- Constructors
- Destructors

No “class” keyword in .cpp file!

- Must use scope operator

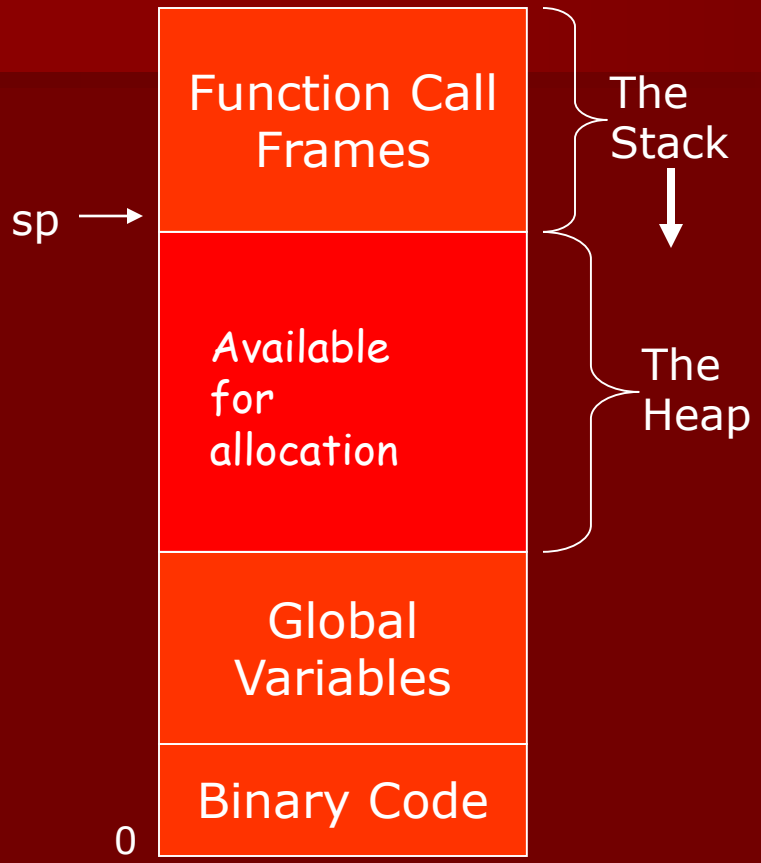
Point.cpp - Example Part 1

```
#include “Point.h"
// Constructors – Notice class name before ::
Point::Point()
{
        x = 0;
        y = 0;
}

Point::Point(int x, int y)
{
        // More on the “->” soon
        this->x = x;
        this->y = y;
}
```

Point.cpp - Example Part 2

```
// The rest of the file


// Methods – Again, class name before ::
int Point::GetX() { return x; }
int Point::GetY() { return y; }
```

Remember this? - Memory Organization



- The call stack grows from the top of memory down.
- Code is at the bottom of memory.
- Global data follows the code.
- What's left – the "heap" - is available for allocation.

Similar in C++
The stack now holds local objects as well as data
Dynamic alloation for objects (and data) is from the heap

When you declare a pointer

*int *pInt;*

It is pointing to NOTHING

You need to create a valid 'chunk' of memory, and assign the pointer to that valid memory

RAII

Resource **A**cquisition **I**s **I**nitialization

- Objects Own Resources

- Constructor is automatically called for initialization

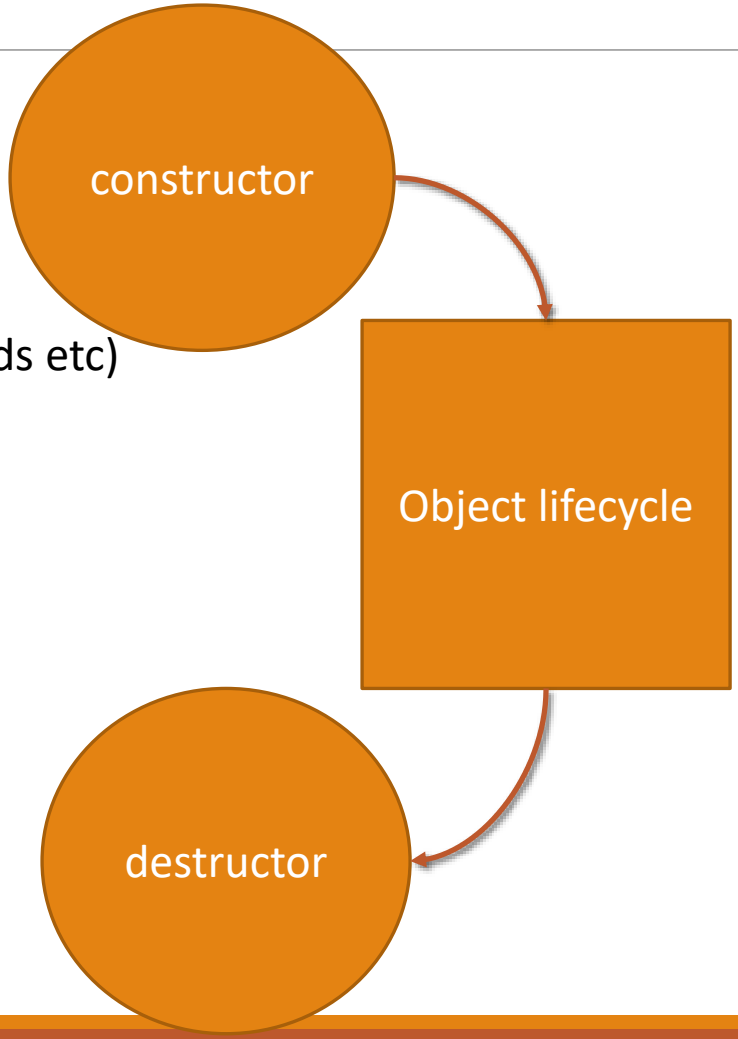
- Where an object goes out-of-scope (e.g. end of a method), it's destructor is automatically called
  - Also called when you delete an object

- The object is then responsible for releasing its own resources

This is C++'s way of a more memory safe object management framework (without garbage collection)

Lifecycle

```
//create the object
MyClass *pObject = new MyClass();
….
…
//Do stuff with the object (call methods etc)
…
…
delete pObject; //destroy the object
```



Instantiating Objects of a Class

Objects are instances of a class

Can be on the stack or the heap

- Just like arrays & other variables

Many syntax options for creating objects

For example …

```
class widget
{
private:
    int* data;
public:
    widget(const int size) { data = new int[size]; } // acquire
    ~widget() { delete[] data; } // release
    void do_something() {}
};

void functionUsingWidget() {
    widget w(1000000);
   //lifetime automatically tied to enclosing scope
   //constructs w, including the w.data member
    w.do_something();

} // automatic destruction and deallocation for w and w.data
```

Objects on the Stack

```
int main()
{
   // Call constructors, but not saved in variables
   Point();                                  // Default constructor
   Point(5,5);                         // Parameterized

   // Variables
   Point p1;                           // Default
   Point p2();                         // NEITHER!
   Point p3(5, 5);                     // Parameterized
   Point p4 = Point();                 // Default
   Point p5 = Point(5, 5);             // Parameterized
}
```

What's Wrong With This?

What's wrong with this line:

```
Point p2();
```

Looks like it should call default constructor

Technically a function declaration

- A function named p2, which returns a Point
- Yes, even though it's in the main!

Objects on the Heap

```
// Remember: new returns a pointer!
int main()
{
	// Call default constructor
	Point* p6 = new Point;
	Point* p7 = new Point();

	// Call parameterized constructor
	Point* p8 = new Point(5,5);
}
```

Destructors – time to clean up

```
// Called when the object is destroyed (stack or delete)!
class Point
{
public:
        Point();     // Default Constructor
        ~Point(); // Destructor
private:
        MyObject* pObject;
};
```

```
Point::~Point()
{
 if (pObject)
 {
    delete pObject;
    pObject = nullptr;
  }
};
```

Calling Methods – Local Variables

Can call methods once you have an object

Local variable method syntax is simple:

```
// Create a point
Point p = Point(5, 5);

// Get the x value
int x = p.GetX( );
```

Calling Methods - Pointers

Not as straight-forward

Can’t call a method on a memory address

Must dereference first, then call method

- Or use the arrow operator: ->

Calling Methods - Pointers

```
// Create a new Point, get a pointer to it
Point* p = new Point(5, 5);

// Dereference and call
int x = (*p).GetX( );

// Or use “->” syntax
// Essentially “dereference and call”
int y = p->GetY( );
```

Creating Classes/ Building

Basically, you need two files

- .h file: Sets up basic class declaration & definition
- .cpp (or .cc) implementation/ code

Compiling
- Same as “C” i.e. gcc or g++ and Makefile