C++ Classes

The big picture before the details

- Provide a constructor (or the compiler will, and it will be wrong!)
- When your object holds dynamic data (pointers and new memory) you want to ensure deep copies so….
- YOU MUST IMPLEMENT
  - Destructor
  - Copy constructor
  - Assignment operator (one of many operators)

- If you are lazy make the copy and assignment operator private, then they cannot be copied or assigned
- Use the destructor to deallocate your dynamic memory

Outline

- Friend functions verses getters and setters
- Objects in Libraries
- Constructors
- Destructors
- What compiler creates for you
- Dynamic memory and objects
- RAII

Friends

- Break encapsulation (but not as bad as getters and setters)
- .h file
  - Friend function declared in class with prefix word ‘friend’
- .cpp file
  - Friend func definition
- See project 9_getter_setter_friends_are_all_bad

Objects in Libraries

- See 9_Library_class_demo and 9_Library_class
- Link just like a library full of functions

Constructors (review)

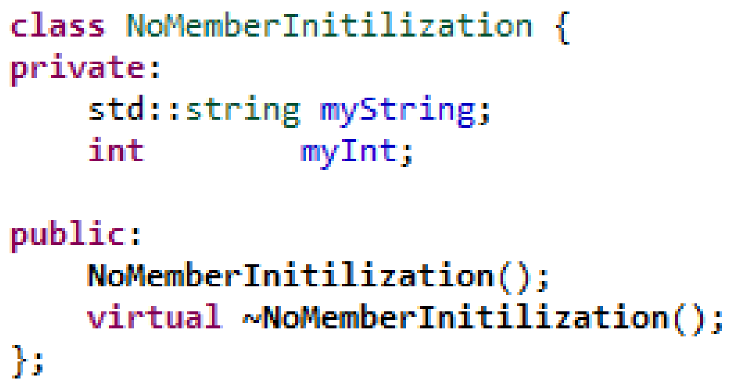
- Default constructor (no arguments)
  - Classname::classname()
- Overloaded constructors (with arguments)
  - Classname::classname(type varName,…)
- Copy constructor
- Assignment operator

Get to these in a bit

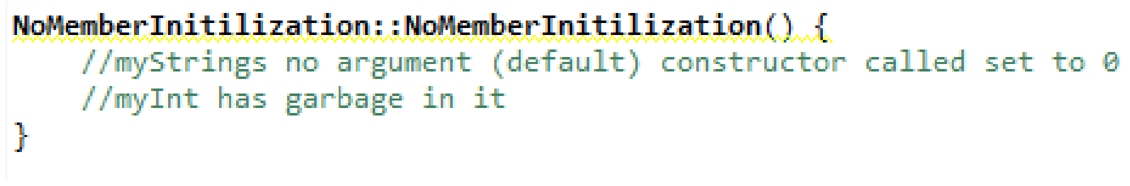
- Constructors set up the object for use

Constructors- Member Initialization (review)

- If you do NO initialization
  - For Objects – their default constructor is called
  - Primitives (ints, bools, doubles, longs, char etc) – NO INITIALIZATION AT ALL ….Best to initialize…



```
class NoMemberInitilization {
private:
    std::string myString;
    int         myInt;

public:
    NoMemberInitilization();
    virtual ~NoMemberInitilization();
};
```



```
NoMemberInitilization::NoMemberInitilization() {
    //myStrings no argument (default) constructor called set to 0
    //myInt has garbage in it
}
```

Constructors- Member Initialization (review)

- 2 ways
  - Initialize in constructor body
  - Initializer list (uses copy constructor)
- Which is better?
- Construction of objects proceeds in 2 phases
  - 1. Initialization of Data members
  - 2. Execution of the body of the constructor that was called
- So if you initialize in constructor body, you initialize an object with default constructor then assign in constructor body. 2 calls
- Also what if 1 of data members is const? Must use initilizer list!
- TLDR always use Initializer list, faster and handles const data members.

- See **library_classdemo -** class_initializeinconstructor and classs_initlist

Destructor (review)

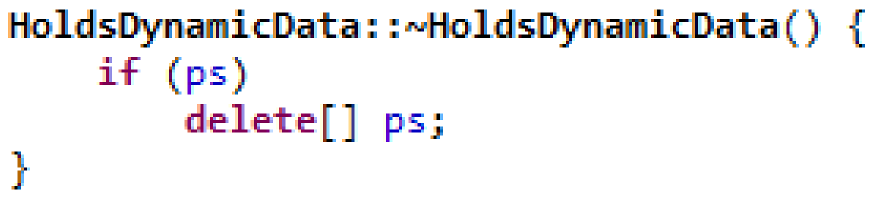
- A function that gets called when an object is destroyed.
- Called when object goes out of scope (whether statically or dynamically allocated)
- Its purpose is to clean up after object
  - dynamically allocated memory that the object has pointers to
  - Close open filestreams
  - Close database connections
  - Close network connections
- Syntax:

```
classname::~classname();
```

See **library_classdemo –** class_destructor

Destructor
Objects with dynamic memory (review)

- If dynamic memory allocated deallocate it.



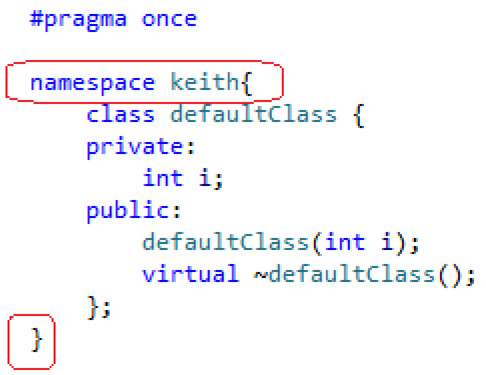
```
HoldsDynamicData::~HoldsDynamicData() {
    if (ps)
        delete[] ps;
}
```

- **<u>Must</u>** write yourself if object has dynamically allocated members, or object members that cannot make a copy of themselves.
- Otherwise let compiler handle it

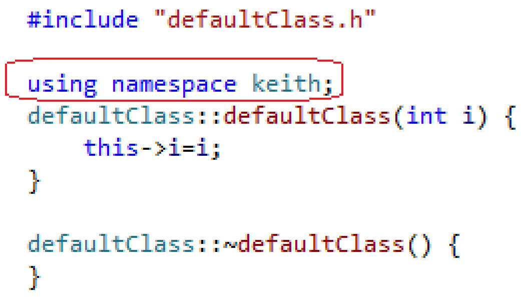
Default IDE Class Creation

- Creates .h and .cpp file (header and implementation)
- With same name as class
- With a no argument constructor and a destructor

- Optional: Can define namespace to protect against collisions (keith::string will not conflict with std::string)
- Do namespaces after class is working



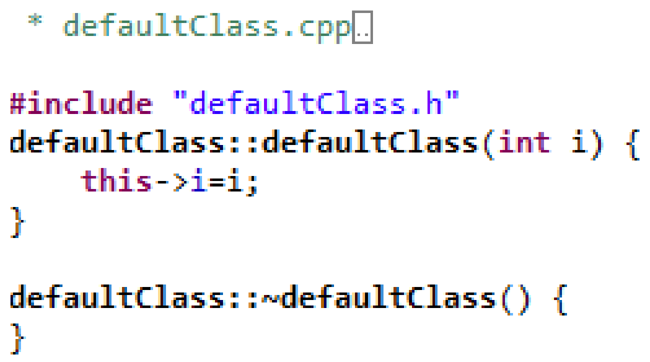
```
#pragma once

namespace keith{
    class defaultClass {
    private:
        int i;
    public:
        defaultClass(int i);
        virtual ~defaultClass();
    };
}
```



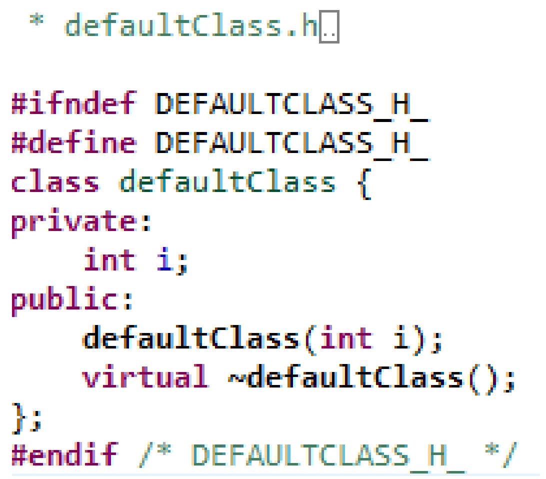
```
#include "defaultClass.h"

using namespace keith;
defaultClass::defaultClass(int i) {
    this->i=i;
}

defaultClass::~defaultClass() {
}
```

Compiler created Functions

- Given this class

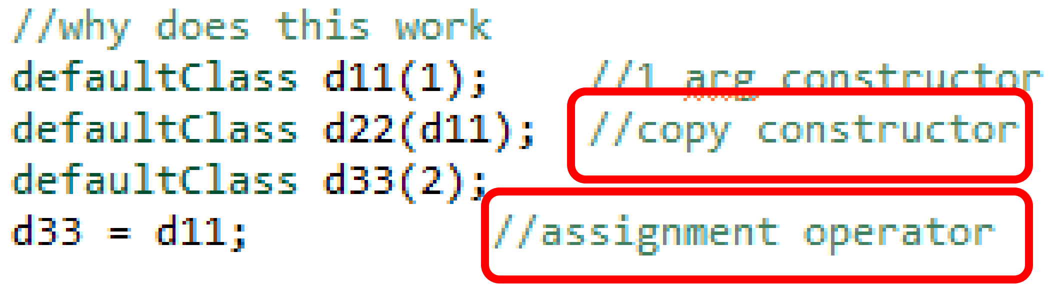


```
 * defaultClass.cpp

#include "defaultClass.h"
defaultClass::defaultClass(int i) {
    this->i=i;
}

defaultClass::~defaultClass() {
}
```



```
 * defaultClass.h

#ifndef DEFAULTCLASS_H_
#define DEFAULTCLASS_H_
class defaultClass {
private:
    int i;
public:
    defaultClass(int i);
    virtual ~defaultClass();
};
#endif /* DEFAULTCLASS_H_ */
```

- Why does this work?



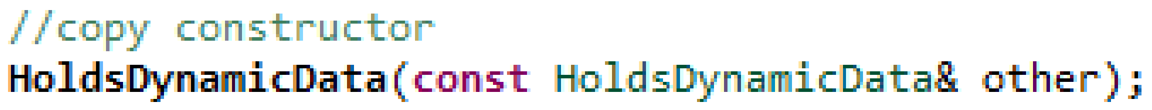
```
//why does this work
defaultClass d11(1);     //1 arg constructor
defaultClass d22(d11);  //copy constructor
defaultClass d33(2);
d33 = d11;             //assignment operator
```

Where is the copy constructor and assignment operator? I did not write it.

- Compiler did.
- It will invisibly write copy constructor, assignment operator destructor for you and others if needed
- Does ‘shallow’ copy (variable to variable)
    1. Fine if class has no dynamically allocated memory
    2. all member variables know how to make copy of themselves
- What if you have dynamic data, or ignorant variables?
    - Show demo (9_classes project - class.cpp)
- Need a ‘deep’ copy (dynamic mem to new dynamic mem)
- Must write these 3 functions if have dynamic member vars
    - Copy constructor
    - Assignment operator
    - Destructor

Copy Constructor
Objects with dynamic memory

- A special constructor that is used to make a copy of an existing instance



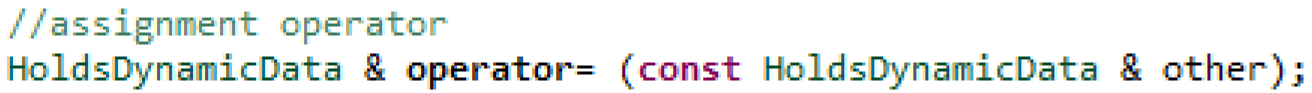
```
//copy constructor
HoldsDynamicData(const HoldsDynamicData& other);
```

- Where is it used?
    - Initializer lists (Constructing a new instance from another)
    - Pass by value to a function
    - Show demo (9_classes holdsdynamicdata.cpp)

- **Must** write yourself if object has dynamically allocated members, or object members that cannot make a copy of themselves.
- Otherwise let compiler handle it

Assignment Operator
Objects with dynamic memory

- One of many operators



```
//assignment operator
HoldsDynamicData & operator= (const HoldsDynamicData & other);
```

- Used with =
- Show demo (9_classes holdsdynamicdata.cpp)

- **Must** write yourself if object has dynamically allocated members, or object members that cannot make a copy of themselves.
- Otherwise let compiler handle it

Yikes! How can I remember all this

- Follow the template in
- 9_copy_and_assign_template

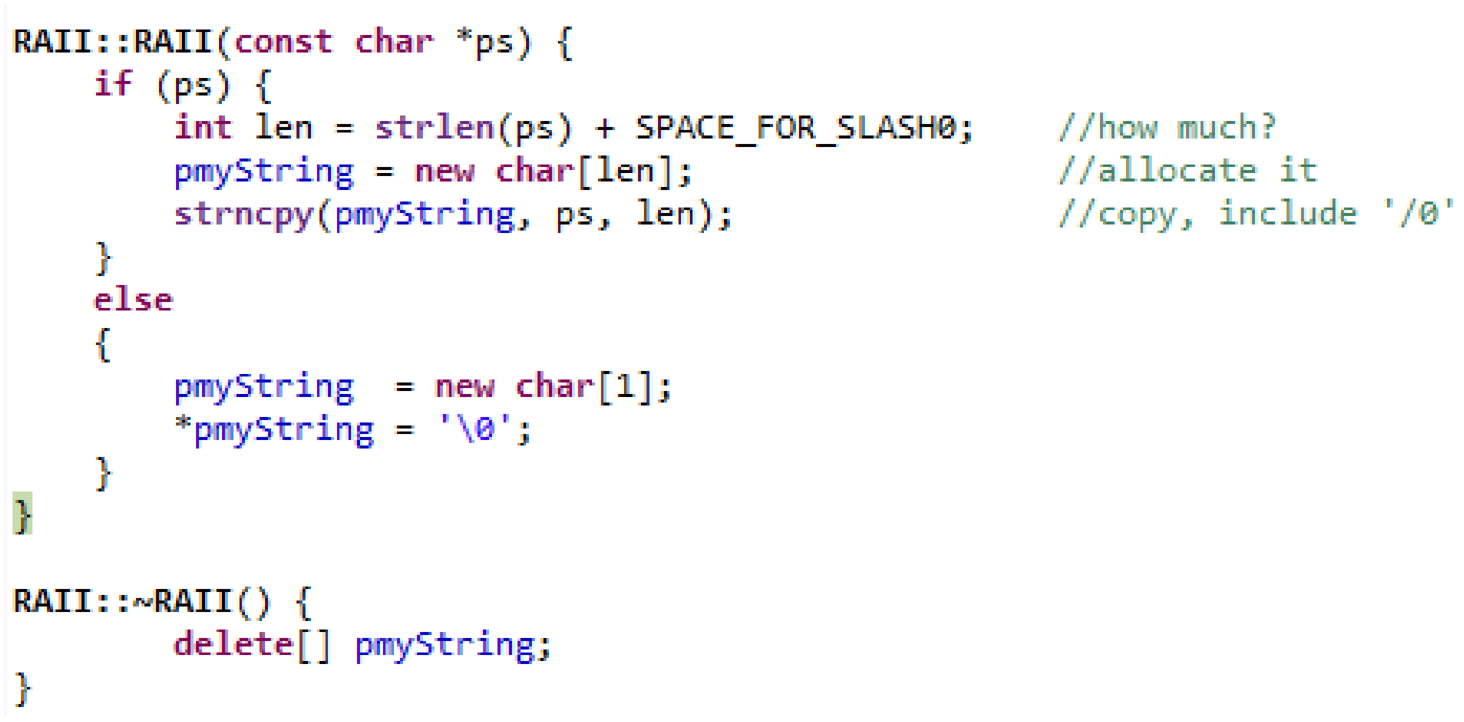
Don’t want to implement?

- If you don’t want to implement copy constructor or assignment operator (or others as well)
- Why not just not write them?
  - Because compiler will if you dont

- Solution: Mark them as private
- But friend functions, and class methods can still access
- Solution: Do not define them, then they are declared so compiler will not generate them, but if you try to call them anywhere, You get a linker error.

Automatic memory Management

- RAII (Resource Acquisition Is Initialization)
- Object manages dynamic memory allocation
- As well as deletion, (you cant lose)

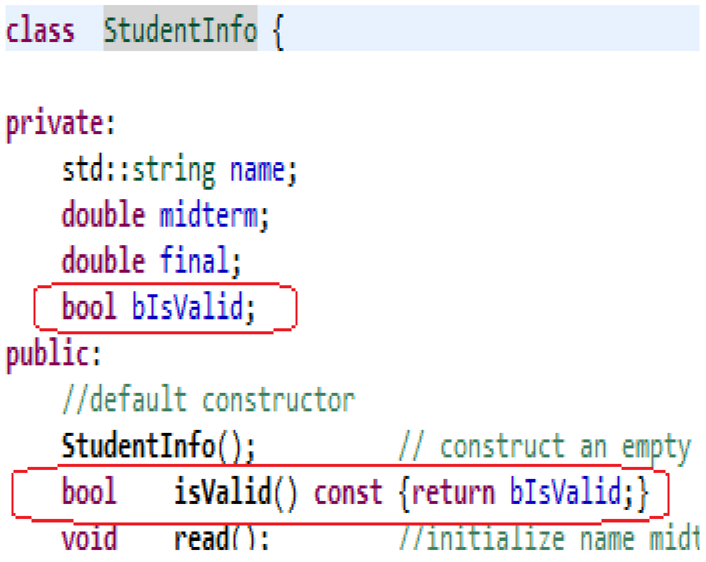


```
RAII::RAII(const char *ps) {
    if (ps) {
        int len = strlen(ps) + SPACE_FOR_SLASH0;    //how much?
        pmyString = new char[len];                  //allocate it
        strncpy(pmyString, ps, len);                //copy, include '/0'
    }
    else
    {
        pmyString  = new char[1];
        *pmyString = '\0';
    }
}

RAII::~RAII() {
        delete[] pmyString;
}
```

Classes – what happens before read()?

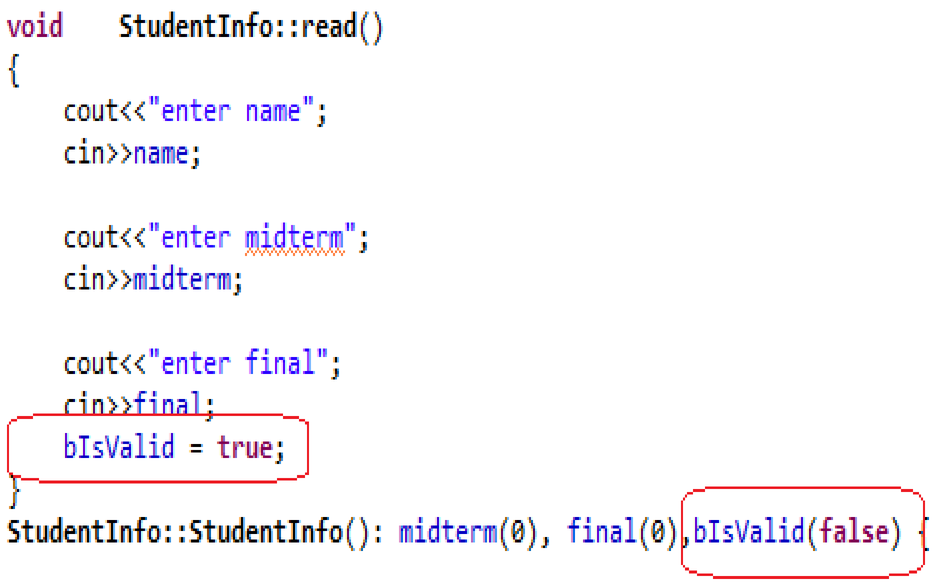
- Object members are initialized to default state.
- How to verify that they have valid data?
- Add isValid() function

.h file



```
class  StudentInfo {

private:
    std::string name;
    double midterm;
    double final;
    bool bIsValid;
public:
    //default constructor
    StudentInfo();              // construct an empty
    bool    isValid() const {return bIsValid;}
    void    read();             //initialize name midt
```

.cpp file



```
void    StudentInfo::read()
{
    cout<<"enter name";
    cin>>name;

    cout<<"enter midterm";
    cin>>midterm;

    cout<<"enter final";
    cin>>final;
    bIsValid = true;
}
StudentInfo::StudentInfo(): midterm(0), final(0),bIsValid(false) {
```

Summary

- When your object holds dynamic data – YOU MUST IMPLEMENT
  - Destructor
  - Copy constructor
  - Assignment operator (one of many operators)