CS 225

Data Structures

September 10 - Lifecycle

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Copy Constructor

Copy Constructor

Automatic Copy Constructor

Custom Copy Constructor

Cube.h

```
 1  #pragma once
 2
 3  namespace cs225 {
 4    class Cube {
 5      public:
 6        Cube();
 7        Cube(double length);
 8
 9
10        double getVolume() const;
11        double getSurfaceArea() const;
12
13      private:
14        double length_;
15    };
16  }
17
18
19
20
```

Cube.cpp

```
 7  namespace cs225 {
 8    Cube::Cube() {
 9      length_ = 1;
10      cout << "Default ctor"
             << endl;
11    }
12
13    Cube::Cube(double length) {
14      length_ = length;
15      cout << "1-arg ctor"
             << endl;
16    }
17
18
19
20
21
22
23
24
25
…     // ...
```

joinCubes-byValue.cpp

```
11 /*
12  * Creates a new Cube that contains the exact volume
13  * of the volume of the two input Cubes.
14  */
15 Cube joinCubes(Cube c1, Cube c2) {
16   double totalVolume = c1.getVolume() + c2.getVolume();
17
18   double newLength = std::pow( totalVolume, 1.0/3.0 );
19
20   Cube result(newLength);
21   return result;
22 }
23
24
25
26
```

```
28 int main() {
29   Cube *c1 = new Cube(4);
30   Cube *c2 = new Cube(5);
31
32   Cube c3 = joinCubes(*c1, *c2);
33
34   return 0;
35 }
```

Calls to constructors

	By Value `void foo(Cube a) { … }`	By Pointer `void foo(Cube *a) { … }`	By Reference `void foo(Cube &a) { … }`
`Cube::Cube()`			
`Cube::Cube(double)`			
`Cube::Cube(const Cube&)`			

joinCubes-byPointer.cpp

```
11 /*
12  * Creates a new Cube that contains the exact volume
13  * of the volume of the two input Cubes.
14  */
15 Cube joinCubes(Cube * c1, Cube * c2) {
16   double totalVolume = c1->getVolume() + c2->getVolume();
17
18   double newLength = std::pow( totalVolume, 1.0/3.0 );
19
20   Cube result(newLength);
21   return result;
22 }
23
24
25
26
```

```
28 int main() {
29   Cube *c1 = new Cube(4);
30   Cube *c2 = new Cube(5);
31
32   Cube c3 = joinCubes(c1, c2);
33
34   return 0;
35 }
```

joinCubes-byRef.cpp

```
11 /*
12  * Creates a new Cube that contains the exact volume
13  * of the volume of the two input Cubes.
14  */
15 Cube joinCubes(Cube & c1, Cube & c2) {
16   double totalVolume = c1.getVolume() + c2.getVolume();
17
18   double newLength = std::pow( totalVolume, 1.0/3.0 );
19
20   Cube result(newLength);
21   return result;
22 }
23
24
25
26
```

```
28 int main() {
29   Cube *c1 = new Cube(4);
30   Cube *c2 = new Cube(5);
31
32   Cube c3 = joinCubes(*c1, *c2);
33
34   return 0;
35 }
```

Mattox Monday

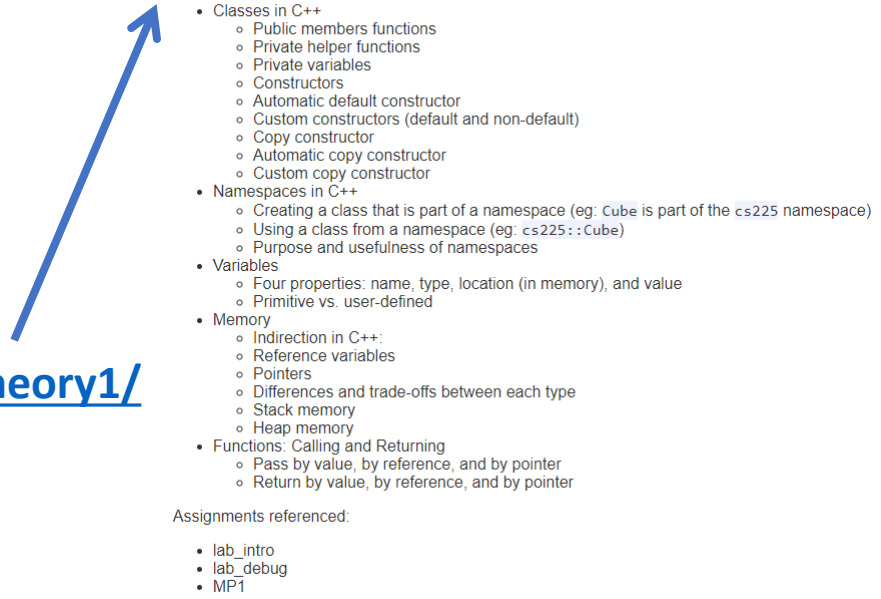
Upcoming: Theory Exam #1

Theory Exam #1

- Starts this Thursday

- **Topic List:**

  https://courses.engr.illinois.edu/cs225/fa2018/exams/exam-theory1/



Topics Covered

Topics from lecture:

- Classes in C++
  - Public members functions
  - Private helper functions
  - Private variables
  - Constructors
  - Automatic default constructor
  - Custom constructors (default and non-default)
  - Copy constructor
  - Automatic copy constructor
  - Custom copy constructor
- Namespaces in C++
  - Creating a class that is part of a namespace (eg: `Cube` is part of the `cs225` namespace)
  - Using a class from a namespace (eg: `cs225::Cube`)
  - Purpose and usefulness of namespaces
- Variables
  - Four properties: name, type, location (in memory), and value
  - Primitive vs. user-defined
- Memory
  - Indirection in C++:
  - Reference variables
  - Pointers
  - Differences and trade-offs between each type
  - Stack memory
  - Heap memory
- Functions: Calling and Returning
  - Pass by value, by reference, and by pointer
  - Return by value, by reference, and by pointer

Assignments referenced:

- lab_intro
- lab_debug
- MP1

MP1 Deadline

Programming is hard!

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Every MP in CS 225 will have an automatic 24-hour grace period after the due date.

Due: Monday, 11:59pm

Grade Period until: Tuesday, 11:59pm

MP1 Deadline

Programming is hard!

Every MP in CS 225 will have an automatic 24-hour grace period after the due date.

Due: Monday, 11:59pm

Grade Period until: Tuesday, 11:59pm

Since the MP will past-due, **there are absolutely no office/lab hours on Tuesdays**.

Registration

The last chance to register for CS 225 is today.
We will not being doing any late adds.

If you've registered late, everything so far is due this **Tuesday, Sept. 11 @ 11:59pm**.

- lab_intro
- lab_debug
- mp1

Tower.h

```
 1 #pragma once
 2
 3 #include "cs225/Cube.h"
 4 using cs225::Cube;
 5
 6 class Tower {
 7   public:
 8     Tower(Cube c, Cube *ptr, const Cube &ref);
 9     Tower(const Tower & other);
10
11   private:
12     Cube cube_;
13     Cube *ptr_;
14     const Cube &ref;
15 };
16
17
```

Tower.cpp

```
10  Tower::Tower(const Tower & other) {
11    cube_ = other.cube_;
12    ptr_ = other.ptr_;
13    ref_ = other.ref_;
14  }
```

Tower.cpp

```
10  Tower::Tower(const Tower & other) {
11    cube_ = other.cube_;
12    ptr_ = other.ptr_;
13    ref_ = other.ref_;
14  }
```

```
waf@siebl-2215-02:/mnt/c/Users/waf/Desktop/cs225/_lecture/06-lifecycle$ make
clang++ -std=c++1y -stdlib=libc++ -O0 -Wall -Wextra -pedantic -lpthread -lm main.cpp cs225/Cube.cpp Tower.cpp -o main
Tower.cpp:10:8: error: constructor for 'Tower' must explicitly initialize the reference member 'ref_'
Tower::Tower(const Tower & other) {
       ^
./Tower.h:14:17: note: declared here
    const Cube &ref_;
                ^
Tower.cpp:20:8: error: no viable overloaded '='
  ref_ = other.ref_;
  ~~~~ ^ ~~~~~~~~~~
```

Tower.cpp

```
10 Tower::Tower(const Tower & other) {
11   cube_ = other.cube_;
12   ptr_ = other.ptr_;
13   ref_ = other.ref_;
14 }
```

Tower.cpp

```
10 Tower::Tower(const Tower & other) : cube_(other.cube_),
11    ptr_(other.ptr_), ref_(other.ref_) { }
12
13
14
```

Constructor Initializer List

Tower.cpp

```
Tower::Tower(const Tower & other) {
  // Deep copy cube_:




  // Deep copy ptr_:




  // Deep copy ref_:




}
```

Destructor

Cube.h

```
 1  #pragma once
 2
 3  namespace cs225 {
 4    class Cube {
 5      public:
 6        Cube();
 7        Cube(double length);
 8        Cube(const Cube & other);
 9        ~Cube();
10
11        double getVolume() const;
12        double getSurfaceArea() const;
13
14      private:
15        double length_;
16    };
17  }
18
19
20
```

Cube.cpp

```
 7  namespace cs225 {
 8    Cube::Cube() {
 9      length_ = 1;
10      cout << "Default ctor"
             << endl;
11    }
12
13    Cube::Cube(double length) {
14      length_ = length;
15      cout << "1-arg ctor"
             << endl;
16    }
17
18
19
20
21
22
23
24
25
 …    // ...
```

Operators that can be overloaded in C++	
Arithmetic	+ - * / % ++ --
Bitwise	& | ^ ~ << >>
Assignment	=
Comparison	== != > < >= <=
Logical	! && ||
Other	[] () ->

Cube.h

```
1  #pragma once
2
3  namespace cs225 {
4    class Cube {
5      public:
6        Cube();
7        Cube(double length);
8        Cube(const Cube & other);
9        ~Cube();
10
11
12
13
14
15       double getVolume() const;
16       double getSurfaceArea() const;
17
18     private:
19       double length_;
20   };
   }
```

Cube.cpp

```
7  namespace cs225 {
8    Cube::~Cube() {
9      cout << "dtor called";
           << endl;
10   }
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
…    // ...
```