



CS 225

Data Structures

September 2- Parameters

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heap-puzzle3.cpp

```
5 int *x;
6 int size = 3;
7
8 x = new int[size];
9
10 for (int i = 0; i < size; i++) {
11     x[i] = i + 3;
12 }
13
14 delete[] x;
```

Pointers and References

A variable containing an instance of an object:

```
1 Cube s1;
```

A reference variable of a Cube object:

```
1 Cube & r1 = s1;
```

A variable containing a pointer to a Cube object:

```
1 Cube * p1;
```



Reference Variable

A reference variable is an alias to an existing variable.

Key Idea: Modifying the reference variable modifies the variable being aliased.



Reference Variable

Three facts about reference variables:

1.

2.

3.

Reference Variable

A reference variable is an alias to an existing variable.

```
1 #include <iostream>
2
3 int main() {
4     int i = 7;
5     int & j = i;    // j is an alias of i
6
7     j = 4;
8     std::cout << i << " " << j << std::endl;
9
10    i = 2;
11    std::cout << i << " " << j << std::endl;
12    return 0;
13 }
```

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);
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32      Cube c3 = joinCubes(*c1, *c2);
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34      return 0;
35  }
```

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();
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18      double newLength = std::pow( totalVolume, 1.0/3.0 );
19
20      Cube result(newLength);
21      return result;
22  }
```

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

Parameter Passing Properties

| | By Value <code>void foo(Cube a) { ... }</code> | By Value (Pointer) <code>void foo(Cube *a) { ... }</code> | By Reference <code>void foo(Cube &a) { ... }</code> |
|---|--|---|---|
| Exactly what is copied when the function is invoked? | | | |
| Does modification of the passed in object modify the caller's object? | | | |
| Is there always a valid object passed in to the function? | | | |
| Speed | | | |
| Programming Safety | | | |



Using `const` in function parameters

joinCubes-byValue-const.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(const Cube c1, const 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  }
```

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24
25
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```
28  int main() {
29      Cube *c1 = new Cube(4);
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32      Cube c3 = joinCubes(*c1, *c2);
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34      return 0;
35  }
```

joinCubes-byPointer-const.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(const Cube * c1, const Cube * c2) {
16      double totalVolume = c1->getVolume() + c2->getVolume();
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18      double newLength = std::pow( totalVolume, 1.0/3.0 );
19
20      Cube result(newLength);
21      return result;
22  }
23
24
25
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```

```
28  int main() {
29      Cube *c1 = new Cube(4);
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joinCubes-byRef-const.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(const Cube & c1, const Cube & c2) {
16      double totalVolume = c1.getVolume() + c2.getVolume();
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18      double newLength = std::pow( totalVolume, 1.0/3.0 );
19
20      Cube result(newLength);
21      return result;
22  }
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28  int main() {
29      Cube *c1 = new Cube(4);
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34      return 0;
35  }
```



const as part of a member functions' declaration

Cube.h

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

Cube.cpp

```
1 #include "Cube.h"
2 namespace cs225 {
3     Cube::Cube() {
4         length_ = 1;
5     }
6
7     Cube::Cube(double length) {
8         length_ = length;
9     }
10
11     double Cube::getVolume() {
12         return length_ * length_ *
13             length_;
14     }
15
16     double
17     Cube::getSurfaceArea() {
18         return 6 * length_ *
19             length_;
20     }
21 }
```


joinCubes-byValue-const.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(const Cube c1, const Cube c2) {
16      double totalVolume = c1.getVolume() + c2.getVolume();
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18      double newLength = std::pow( totalVolume, 1.0/3.0 );
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21      return result;
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28  int main() {
29      Cube *c1 = new Cube(4);
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32      Cube c3 = joinCubes(*c1, *c2);
33
34      return 0;
35  }
```



Copy Constructor

[Purpose]:

All copy constructors will



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         Cube(const Cube & other);
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"
11            << endl;
12    }
13
14    Cube::Cube(double length) {
15        length_ = length;
16        cout << "1-arg ctor"
17            << endl;
18    }
19
20
21
22
23
24
25
... // ...
```

joinCubes-byValue-const.cpp

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```

Calls to constructors

| | By Value <code>void foo(Cube a) { ... }</code> | By Value (Pointer) <code>void foo(Cube *a) { ... }</code> | By Reference <code>void foo(Cube &a) { ... }</code> |
|---|--|---|---|
| <code>Cube::Cube()</code> | | | |
| <code>Cube::Cube(double)</code> | | | |
| <code>Cube::Cube(const Cube &)</code> | | | |

joinCubes-byPointer-const.cpp

```
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12   * Creates a new Cube that contains the exact volume
13   * of the volume of the two input Cubes.
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15  Cube joinCubes(const Cube * c1, const Cube * c2) {
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28  int main() {
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