CS 225

#5: Parameters

February 3, 2021 · *G Carl Evans*

Heap Memory – Allocating Arrays

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;
```

*: **new[]** and **delete[]** are identical to **new** and **delete**, except the constructor/destructor are called on each object in the array.

Reference Variable

A reference variable is an alias to an existing variable. Modifying the reference variable modifies the variable being aliased. Internally, a reference variable maps to the same memory as the variable being aliased. Three key ideas:

1.

2.

3.

reference.cpp

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

Memory and Function Calls

Suppose we want to join two Cubes together:

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 }
```

By default, arguments are "passed by value" to a function. This means that:

-
-

Alterative #1: Pass by Pointer

joinCubes-byPointer.cpp

```
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 }
```

Alternative #2: Pass by Reference

joinCubes-byReference.cpp

```
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 }
```

Contrasting the three methods:

	By Value	By Pointer	By Reference
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			
Safety			

Using the `const` keyword

1. Using `const` in function parameters:

joinCubes-by*-const.cpp

```
15  Cube joinCubes(const Cube  s1, const Cube  s2)
15  Cube joinCubes(const Cube *s1, const Cube *s2)
15  Cube joinCubes(const Cube &s1, const Cube &s2)
```

Best Practice: *"All parameters passed by reference must be labeled const."* – *Google C++ Style Guide*

2. Using `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  }
```

Cube.cpp

```
…
11    double Cube::getVolume()                    {
12      return length_ * length_ * length_;
13    }
14
15    double Cube::getSurfaceArea()               {
16      return 6 * length_ * length_;
17    }
…
```

Returning from a function

Identical to passing into a function, we also have three choices on how memory is used when returning from a function:

Return by value:

```
15  Cube joinCubes(const Cube &s1, const Cube &s2)
```

Return by reference:

```
15  Cube &joinCubes(const Cube &s1, const Cube &s2)
```

…remember: never return a reference to stack memory!

Return by pointer:

```
15  Cube *joinCubes(const Cube &s1, const Cube &s2)
```

…remember: never return a reference to stack memory!

Copy Constructor

When a non-primitive variable is passed/returned **by value,** a copy must be made. As with a constructor, an automatic copy constructor is provided for you if you choose not to define one:

All **copy constructors** will:

The **automatic copy constructor**:

1.

2.

To define a **custom copy constructor**:

Cube.h

```
4   class Cube {
5     public:
…       // …
9       Cube(const Cube & other);   // custom copy ctor
```