Ch 14.4: Copy Constructors

CS 2308
Fall 2018

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14.4 Copy Constructors

- Special constructor used when a newly created object is **initialized** using another object of the **same class**.

```
Time t1;
Time t2 (t1);
Time t3 = t1;
```

Both of the last two use the copy constructor

- The **default copy constructor** (provided by the c++ compiler) copies values of member variables to corresponding member variables.
- Default copy constructor works fine in most cases

IntCell declaration

- Problem: what if the object contains a pointer?

```
class IntCell
{
   private:
      int *storedValue;    //ptr to int

   public:
      IntCell (int initialValue);
      ~IntCell();
      int read () const;
      void write (int x);
};
```


IntCell Implementation

```
#include "IntCell.h"

IntCell::IntCell (int initialValue) {
  storedValue = new int;
  *storedValue = initialValue;
}

IntCell::~IntCell() {
  delete storedValue;
}

int IntCell::read () const {
  return *storedValue;
}

void IntCell::write (int x) {
  *storedValue = x;
}
```

Problem with member to member copying

- What we get from member to member copying in objects containing dynamic memory (ptrs):

```
IntCell object1(5);
IntCell object2 = object1; // calls copy constructor

  //object2.storedValue=object1.storedValue

object2.write(13);
cout << object1.read() << endl;
cout << object2.read() << endl;
```

What is output?

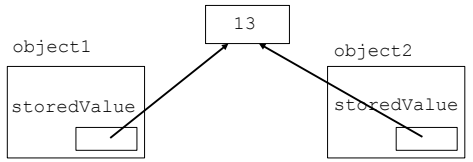
```
5
13
```

or

```
13
13
```


Problem with member to member copying

- Why are they both changed to 13?
- Member-wise copying does a shallow copy. It copies the pointer's address instead of allocating new memory and copying the value.
- As a result, both objects point to the same location in memory



Programmer-Defined Copy Constructor

- Prototype and definition of copy constructor:

```
IntCell(const IntCell &obj);
```

Add to class declaration

```
IntCell::IntCell(const IntCell &obj) {
   storedValue = new int;
   *storedValue = obj.read();
}
```

- Copy constructor takes a **reference** parameter to an object of the class
  - otherwise, pass-by-value would use the copy constructor to initialize the obj parameter, which would call the copy constructor: this is an infinite loop

Programmer-Defined Copy Constructor

Each object now points to separate dynamic memory:

```
IntCell object1(5);
IntCell object2 = object1;  //now calls MY copy constr

object2.write(13);
cout << object1.read() << endl;
cout << object2.read() << endl;
```

Output:

```
5
13
```