CSC 211: Object Oriented Programming

Copy Constructors and Assignment Operator

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THINK BIG WE DO℠

More on constructors …

- So far …
  - default constructors, overloaded constructors
- C++ also defines **copy constructors**
  - used to create an object as a copy of an existing object
  - if you don't define your own, C++ will synthesize one copy constructor for you

```
Point2D obj1;                  // default constructor
Point2D obj2(4.5, 3.2);        // overloaded constructor
Point2D obj3(obj2);            // copy constructor
Point2D obj4 = obj3;           // copy constructor
```

When are copy constructors invoked?

```
Point2D myfunc(Point2D obj) {
    Point2D newobj;
    // ...
    return newobj;
}

int main () {
    // copy constructor is invoked when an object is initialized from
    // another object of the same type
    Point2D obj2(4.5, 3.2);     // overloaded constructor
    Point2D obj3(obj2);         // copy constructor
    Point2D obj4 = obj3;        // copy constructor

    // copy constructor is invoked when a non-reference object is
    // passed to a function
    myfunc(obj4);               // copy constructor

    // copy constructor is invoked when a non-reference object is
    // returned from a function
    Point2D obj5 = myfunc(obj2);
}
```

Shallow vs deep copies

- Synthesized copy constructors perform **shallow copies**
  - a shallow copy is a byte-to-byte copy of all data members (works fine most of the cases, except when pointers are used)

```
Point2D::Point2D(const Point2D& obj) {
    x = obj.x;
    y = obj.y;
    // ...
}
```

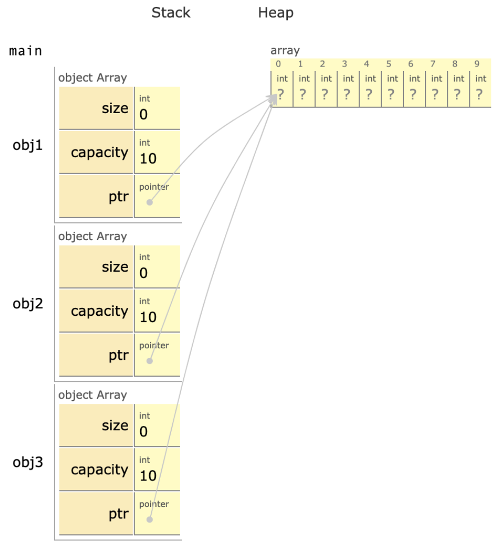
- Sometimes a **deep copy** is necessary (can handle more complex objects)
  - must define your own copy constructor

```
class Array {
    public:
        Array(int cap);
        ~Array();
    private:
        int size;
        int capacity;
        int *ptr;
};

Array::Array(int cap) {
    size = 0;
    capacity = cap;
    ptr = new int[cap];
}

Array::~Array() {
    delete [] ptr;
}

int main () {
    Array obj1(10);
    Array obj2(obj1);
    Array obj3 = obj2;
}
```



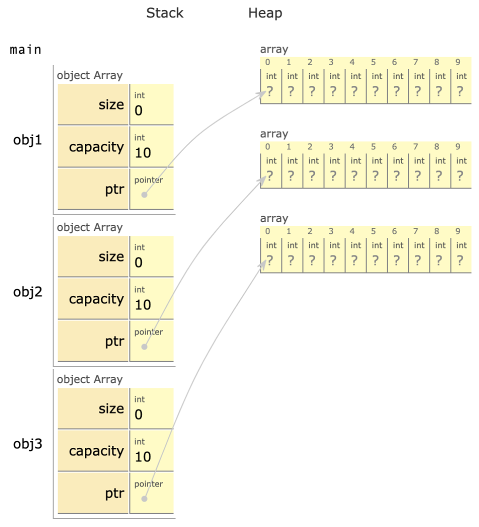
shallow copies

```
Array::Array(int cap) {
    size = 0;
    capacity = cap;
    ptr = new int[cap];
}

Array::Array(Array& obj) {
    size = obj.size;
    capacity = obj.capacity;
    ptr = new int[capacity];
    for (int i = 0 ; i < size ; i++) {
        ptr[i] = obj.ptr[i];
    }
}

Array::~Array() {
    delete [] ptr;
}

int main () {
    Array obj1(10);
    Array obj2(obj1);
    Array obj3 = obj2;
}
```



deep copies

The **assignment** operator =

- Assignment is not construction
- The assignment operator `'='` assigns an object to an existing object (already constructed)

```
Point2D obj1;                // default constructor
Point2D obj2(4.5, 3.2);      // overloaded constructor
Point2D obj3(obj2);          // copy constructor
Point2D obj4 = obj3;         // copy constructor
obj1 = obj4;                 // assignment operator
```

- If you don't define your own, C++ will synthesize one assignment operator for you (performs **shallow copy**)

How to overload the `'='` operator?

```
Point2D& Point2D::operator=(const Point2D &obj) {
    // always check against self-assignment
    // especially when performing deep copies
    if (this != &obj) {
        x = obj.x;
        y = obj.y;
    }
    // always return *this, necessary for
    // cascade assignments (a = b = c)
    return *this;
}
```

can perform either shallow or deep copies

The this pointer

- Pointer accessible only within member functions of a class
  - it points to the object for which the member function is called
  - static member functions do not have this pointer

```
void Date::set_year(int y) {
    // statements below are equivalent
    year = y;
    this->year = y;
    (*this).year = y;
}
```

How many calls?

```
Point2D myfunc(const Point2D& obj) {
    Point2D newobj;
    newobj = obj;
    // ...
    return newobj;
}

int main () {
    Point2D obj2(4.3, 1.1);
    Point2D obj3(obj2);
    Point2D obj4 = myfunc(obj3);
    Point2D obj5;
    obj5 = obj4 = obj2;
}
```