CS 162
Intro to Computer Science II

Lecture 14

Shallow vs. deep copy

Big 3

2/19/24

Oregon State University

Odds and Ends

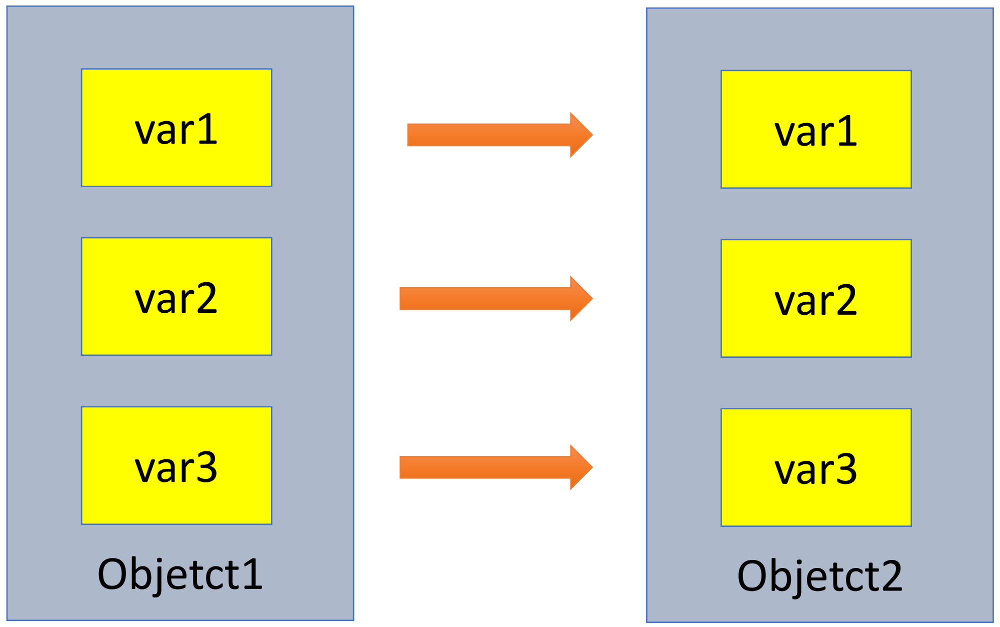
- Sign up for assignment 2 demo ASAP!
- Lab 7 posted
- Assignment 3 rubrics posted
- Design 3 (ex. + doc) + Quiz 3 past due

Today’s topics

- Midterm Report
- Shallow vs. Deep Copy
- Big 3 Implementation

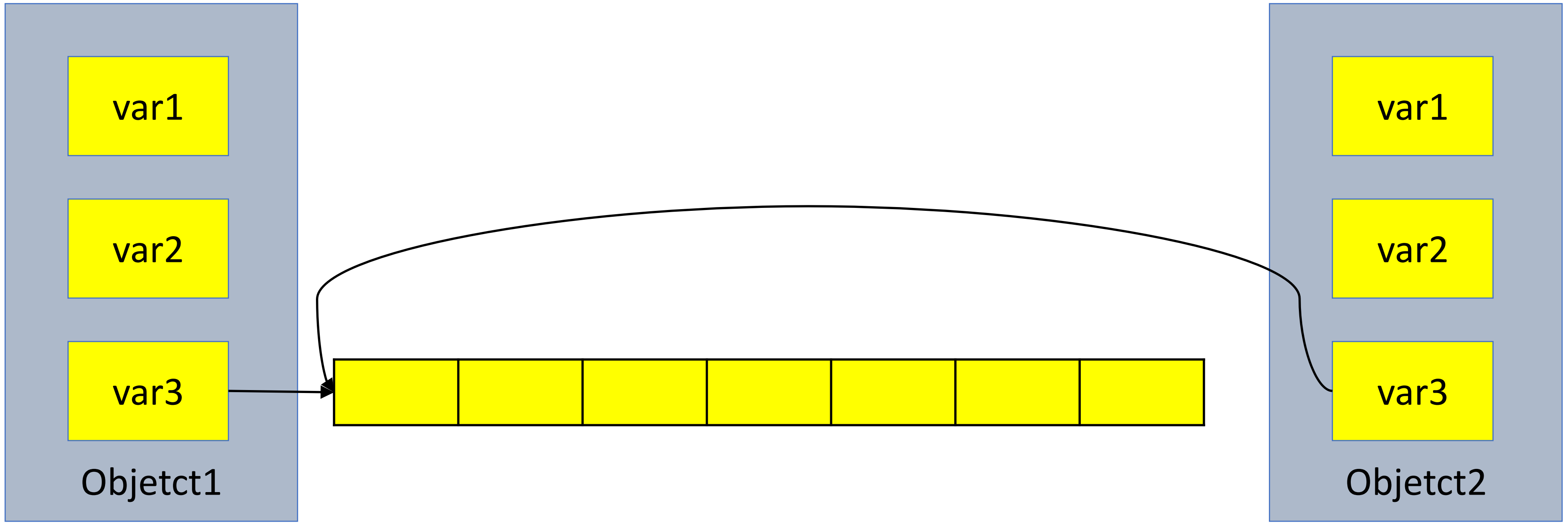
Shallow Copy vs. Deep Copy

- Shallow:
  - A.k.a.: member-wise copy
  - Copy the contents of member variables from one object to another
  - **Default behavior** when objects are copied or assigned



Shallow Copy vs. Deep Copy

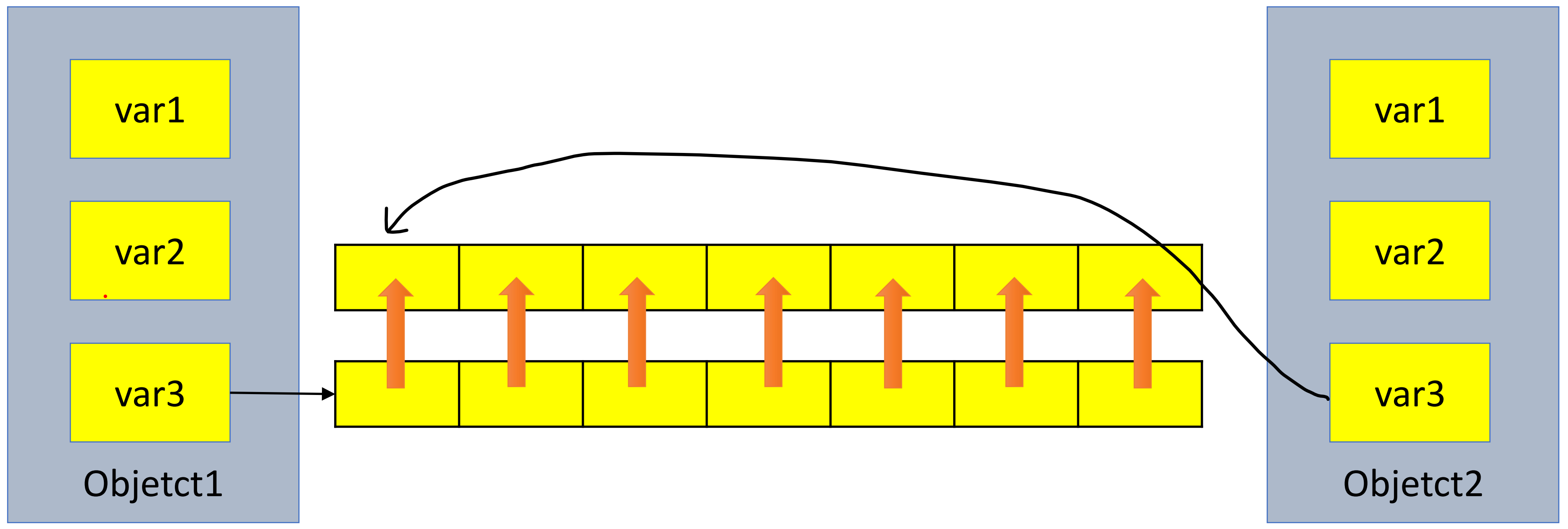
- Shallow:
  - What if the object has dynamic memory allocated?



  - This could be problematic as if we make any changes to the array in object 1, object 2 will be affected as well…

Shallow Copy vs. Deep Copy

- Deep:
  - Copy what each member variable is pointing to so that you get a separate but identical copy
  - Has to be programmer-specified



Assignment Operator (=) Overload

- Predefined assignment operator returns a reference
  - Allows us to chain assignments together: `a = b = c`
    - First set “`b = c`” and return a reference to `b`. Then set “`a = b`”
    - Need to make sure the assignment operator returns something of the same type as its left hand side
- Overloading assignment operator
  - Must be a member of the class

Assignment Operator (=) Overload

- Ex.:

```
Course& Course::operator=(const Course& obj) {//pay attention to the return type
      this->title = obj.title;                   //for non-dyn. Memory, shallow copy
      this->enroll = obj.enroll;
      this->instructor = obj.instructor;
      if (this->roster != nullptr)               //if the ptr has memory allocated
            delete [] this->roster;                    //free it
      this->roster = new  string [this->enroll];       //deep copy
      for (int i = 0; i < this->enroll; i++)
            this->roster[i] = obj.roster[i];
      return *this;                                    //return the calling obj
}
```

Copy Constructor

- Constructor that has one parameter that is of the same type as the class
  - Has to accept reference as parameter (normally `const`)
  - Allows for distinct copies, changes to one does not impact the other
  - Called automatically in three cases:
    - When a class object is being declared and initialized by another object of same type
    - Whenever an argument of the class type is “plugged in” for a call by value parameter
    - When a function returns a value of the class type

Copy Constructor

- Ex.:

```
Course::Course(const Course& obj) {                 //pay attention to the parameter
        this->title = obj.title;                    //for non-dyn. Memory, shallow copy
        this->enroll = obj.enroll;
        this->instructor = obj.instructor;
        this->roster = new  string [this->enroll];    //deep copy
        for (int i = 0; i < this->enroll; i++)
                this->roster[i] = obj.roster[i];
                                                      //no return
}
```

Destructor

- Delete the object
- Will be automatically created if one is not supplied
  - Will not handle dynamic memory
- `~Class_name();//no return type, no parameters, only one allowed`
- Called when the object goes out of scope
  - When the function ends
  - When the program ends
  - A block containing local variables ends
  - A `delete` operator is called

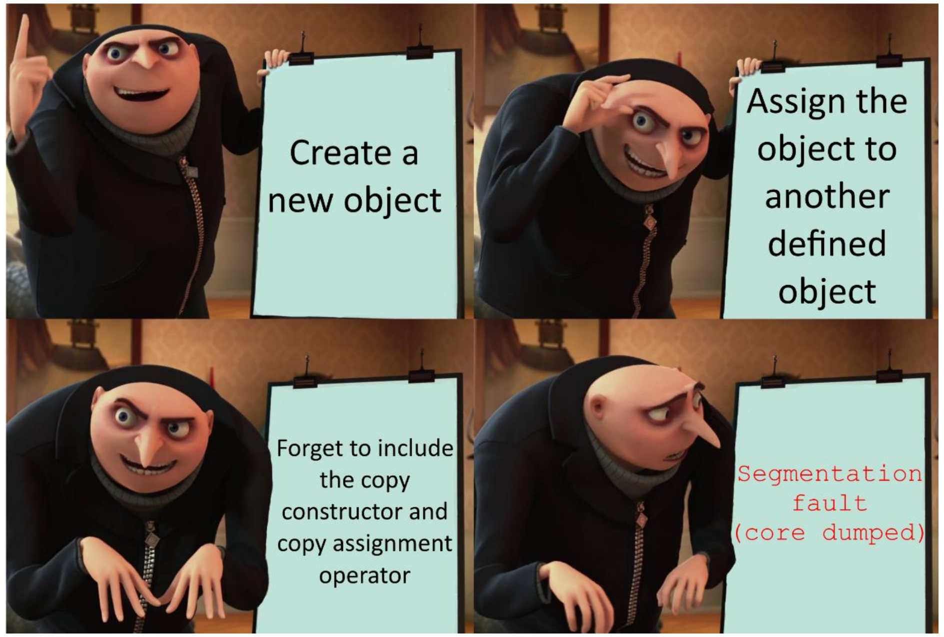
Destructor

- Ex.:

```
Course::~Course() {
        if (this->roster != nullptr){            //if the ptr has memory allocated
                delete [] this->roster;          //free it
                this->roster = nullptr;
        }
}
```

The Big Three

- If you implement either a **Destructor**, a **Copy Constructor**, or an **Overloaded Assignment Operator**, you should ensure that all 3 are defined
- If you needed one, you probably need all of them
- This rule of thumb goes by several names:
  - The Big Three
  - The Rule of Three
  - The Law of The Big Three
- *C++11 has an expanded version: The Big 5
  - We won't cover this yet


Create a new object
Assign the object to another defined object
Forget to include the copy constructor and copy assignment operator
Segmentation fault (core dumped)

Big Three Activity

Function	Prototype	Job	When is it called	Default Behavior if not defined?
Constructor	ClassName(); ClassName(w/ params)	Build the object	Default is called when object is declared with no parameters and no “=“ sign. Nondefault is called if parameters are given	The compiler will provide a default one. It will initialize all variables with garbage values, will not set up pointers
Copy Constructor				
Assignment Operator Overload				
Destructor				

Asm3 Hints:

- Which class needs Big 3?
- Where to implement the “add a flight” functionality?
- Where to implement the “remove a flight” functionality?

- Is it a good practice to access Flight internals from the Manager class?
  - i.e., get_airports()[0].get_flight()[0].get_flight_number()?
  - NO!!! THIS VIOLATES THE RULE OF ENCAPSULATION!!!!

- Game flow?
- What’s inside your main()? driver.cpp?
- Frequently check memory leaks!!!