CS202: Programming Systems

Week 2

Constructors & Destructor

10/2022

CS202 – What will be discussed?

- Constructors
- The `this` pointer
- Destructor
- Member Initialization
- Copy constructor
- Assignment operator

Constructors

- Constructor is a physical piece of code (in fact, it is a special type of method) that is used to construct and initialize objects.
- It is automatically invoked when a new object is created.
- There is no returned value, even a `void`.
- A class can have many constructors (overload)
- Name of the constructors must be the same as the class name.

Notes on constructors

- If no constructor is implemented, the compiler will issue a default constructor
- The default construtor:
  - No argument
  - Invoke other default constructors of data members if they are objects.
  - Doesn’t initialize other data members if they are not objects.

Default constructor

- If there is at least one construtor, the default constructor will not be created by the compiler

```
class Date
{
public:
   Date(int iNewDay);
   ...
private:
   ...
};
```

```
int main()
{
    Date today; //error
    …
    return 0;
}
```

Other constructors

- They allow users different options to create a new object

```
class Date {
public:
    Date();
    Date(int, int);
    Date(int, int, int);
    …
private:
    int iDay, iMonth, iYear;
};
```

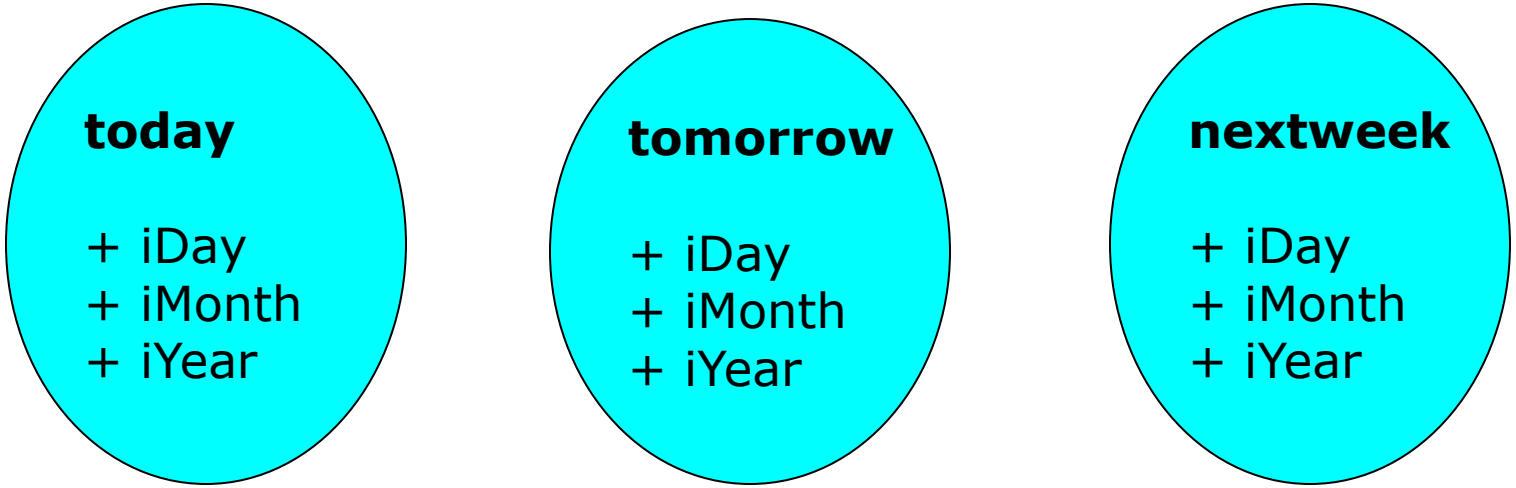
The `this` pointer

- Check the following lines of code, are they correct in terms of: syntax? semantics? useful?

```
Date::Date(int iDay, int iMonth, int iYear)
{
      iDay = iDay;
      iMonth = iMonth;
      iYear = iYear;
}
```

```
Date today(4, 10, 2021);
```

The `this` pointer



- How can we know **`day, month or year`** of which object are using?

The `this` pointer

- C++ adds an implicit function parameter - the pointer to the current object instance: `this`
- `this` is a constant pointer, you cannot modify it within a member function.

The `this` pointer

```
Date::Date(int iDay, int iMonth, int iYear)
{
      iDay = iDay;
      iMonth = iMonth;
      iYear = iYear;
}
```

- Syntax: correct
- Semantic: legal
- Useful: NO!!!

The code should be

```
Date::Date(int iDay, int iMonth, int iYear)
{
      this->iDay = iDay;
      this->iMonth = iMonth;
      this->iYear = iYear;
}
```

Destructor

- Invoked automatically, when the variable is removed from memory (e.g. goes out of scope).
- Each class can have at most one destructor
- The destructor name is a name of a class preceded by a tilde sign (~).
- Destructor, the same as constructor, has no return type (even void)
- Destructor frees the resources used by the object (allocated memory, file descriptors, semaphores etc.)

Example

```
class MyArray {
public:
    MyArray();
    ~MyArray() {
        n = 0;
        delete [] pArr;
        pArr = NULL;
    }
private:
    int n;
    int *pArr;
};
```

Notes on destructor

- You don’t need to write a destructor if your class has nothing to clean up.
- If you are using resources, for example dynamic memory allocation, and you forget to have your destructor, the program will create the **memory leaking**.

Members Initialization

- Distinguish between Assignment and Initialization

```
Date(int iNDay, int iNMonth, int iNYear)
{
      iDay = iNDay;
      iMonth = iNMonth;
      iYear = iNYear;
}
```

- This is assignment, not Initialization

Members Initialization

- This is members initialization

```
class Date {
public:
    Date();
    Date(int iNDay, int iNMonth, int iNYear)
        : iDay(iNDay), iMonth(iNMonth), iYear(iNYear)
    {}
    ~Date();
    …
private:
    int iDay, iMonth, iYear;
};
```

Mandatory Members Initialization

- Const members
- References
- Sub-objects which require arguments in constructors

```
class Test
{
private:
 Another& refA; // reference member
 const int MAX; // const member
 vector arr;
public:
 Test(Another& r) : refA(r), MAX(100), arr (MAX) {}
};
```

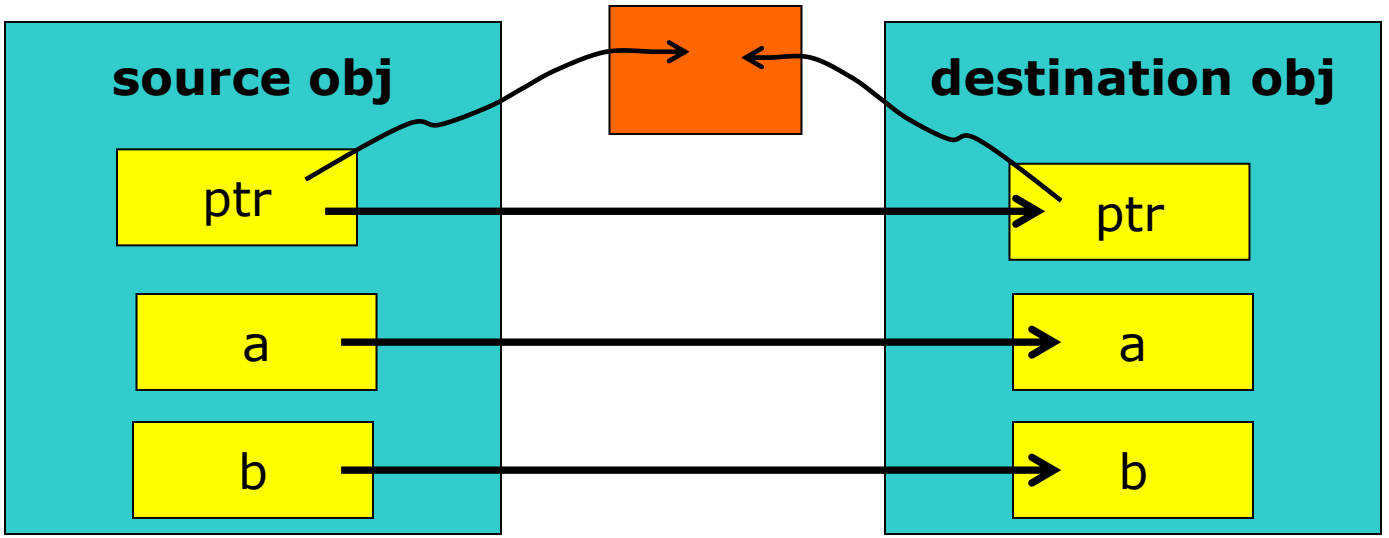
Default copy constructor

- In each class, if there is no copy constructor, a default copy constructor will be generated. It helps to create a new object of this class from another object. For example:

```
int main()
{
    Rectangle a;
    Rectangle b(a); // invoke copy constructor
    Rectangle c = a; // invoke copy constructor
}
```

Default copy constructor (cont.)

- Default copy constructor performs a bitwise copy from the source to the current object:



Copy constructor

- Due to the bitwise copy of the default constructor, it will cause a serious problem if the copying takes place when the object has a member pointer with a dynamic allocated memory.
  - Pointers of the source obj and the destination obj will refer into the same memory

Copy constructor

- Depending on the members of the class to decide whether to have a copy constructor
  - When having dynamic allocated members

```
Test::Test(const Test& src)
{
        iSize = src.iSize;
        ptr = new int [iSize];
        for (int i=0; i<iSize; ++i)
                ptr[i] = src.ptr[i];
}
```

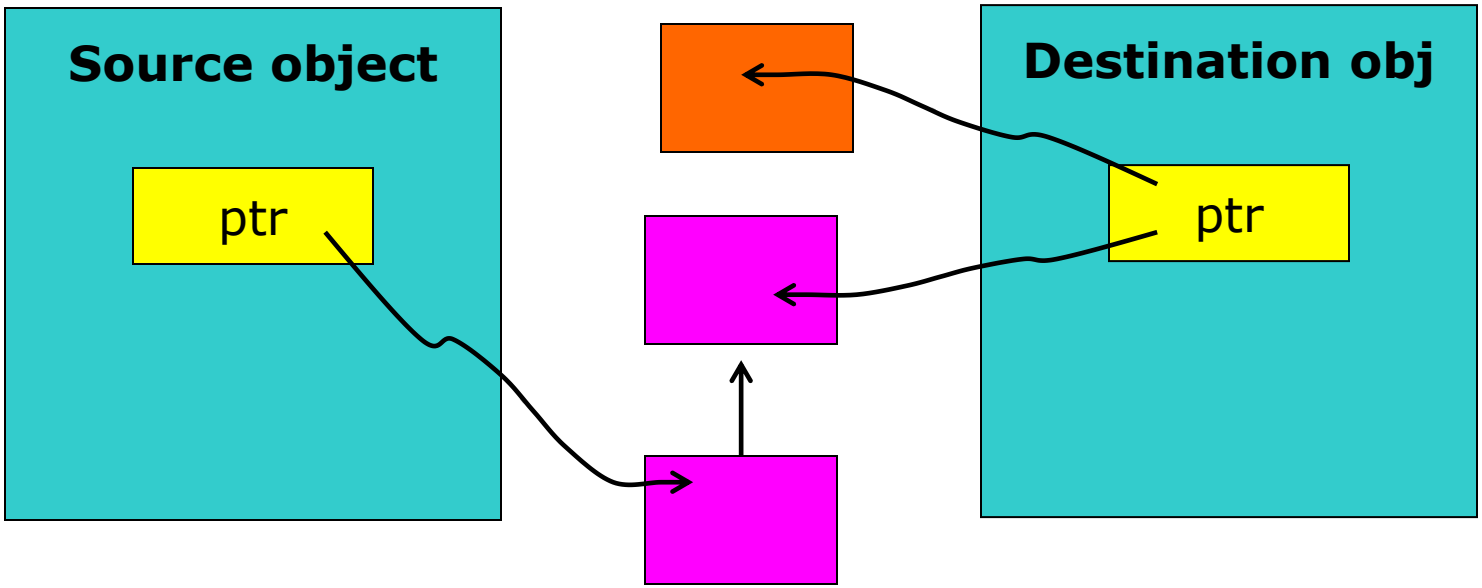
The default assignment operator

- Similar to the default copy constructor, in each class, if there is no assignment operator, a default assignment operator will be generated
- It also has a similar functionality of a default copy constructor, i.e. doing a bitwise copy from the source object to the destination object.

Assignment operator

- Thus, if there is a pointer member in the class, an assignment operator should be defined.
- Note: assignment operator is a bit different from the copy constructor:
  - Clean up the allocated memory that the pointer member is pointing to before being allocated with a new memory.
  - Remember to check for self-assignment

Assignment operator



- Clean up the memory it is pointing to
- Copy the memory to a new place

For example

```
Test& Test::operator=(const Test& src)
{
    if (this != &src)
    {
       delete [] ptr;
       iSize = src.iSize;
       ptr = new int [iSize];
       for (int i=0; i<iSize; ++i)
             ptr[i] = src.ptr[i];
    }
    return *this;
}
```

Assignment operator (using **swap**)

- The **src** is swapped from the **this** object, and will be deleted right after the function finishes

```
Test& Test::operator=(Test src)
{
    swap(iSize, src.iSize);
    swap(ptr, src.ptr);
    return *this;
}
```

Copy constructor vs Assignment Op

Copy constructor:

- Create an object from scratch
- No need to check for seft-assignment
- No need to free the resource before copying

Remember

The 3 following functions often go together:

- Copy constructor
- Assignment operator
- Destructor