

C++

Destructors, order of construction / destruction

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Destructors

- A **destructor** is a member function of a class which is called when the object is destroyed
- For a class X, the destructor is called $\sim X()$
 - Example: $X::\sim X()$
- A destructor takes no argument
- A destructor has no return value
- There is only one destructor per class

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Default destructor

- If the user does not provide a destructor, the compiler will automatically generate one: the default destructor
- The default destructor does not delete dynamically allocated variable
 - If your object uses dynamically allocated variables, you need to implement a destructor that will release such memory

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Example

```
class A{
private:
    int* array;
    int size;
public:
    A() : size(10) {
        array = new int[size];
    }

    ~A() {
        delete[] array;
    }
};
```

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Destructor call

- The destructor for an object is always automatically called
- An object can be destroyed in two ways:
 - It was allocated on the stack and goes out of scope
 - It was allocated dynamically (on the heap) and it is deleted by using the keyword **delete** (or `delete[]` if it is an array)

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Example

```
void f()
{
  A a(10); // local var. alloc. on the stack

  // .....

} // a destroyed, ~A() called
```

```
void f()
{
  A* a = new A(10); // alloc. on heap

  // .....

  delete a; // a destroyed, ~A() called
}
```

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Order of construction and destruction

- In the case where an object contains other objects (“Has - a” relationship), we want to know in which order the component objects are constructed / destructed
- In the case a function declares objects, we want to know the order in which they are destroyed

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Order of construction and destruction: example

```
class A {
public:
  A() { cout << "A()" << endl; }
  ~A() { cout << "~A()" << endl; }
};

class B {
private:
  A a;
public:
  B() { cout << "B()" << endl; }
  ~B() { cout << "~B()" << endl; }
};

int main() {
  cout << "beginning" << endl;
  B b;
  cout << "end" << endl;
}
```

Result:

```
Beginning
A()
B()
End
~B()
~A()
```

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Order of construction / destruction

- In B(), you do not need to call the constructor for A, it is called automatically
 - B::B() {cout << "B()" << endl;} is equivalent to:
B::B() : a() {cout << "B()" << endl;}
- Of course, you can always decide to control construction by calling the appropriate constructor using the initialization list syntax
- When an object is constructed, all its data members are constructed first
- In ~B() you do not need to call the destructor for A, it is called automatically
- Destruction appears in the opposite order to construction

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Example with pointers

```
class A {
public:
    A() { cout << "A()" << endl; }
    ~A() { cout << "~A()" << endl; }
};

class B {
private:
    A* a;
public:
    B() { a = new A(); cout << "B()" << endl; }
    ~B() { cout << "~B()" << endl; delete a; }
};

int main() {
    cout << "beginning" << endl;
    B b;
    cout << "end" << endl;
}
```

Result:

```
Beginning
A()
B()
End
~B()
~A()
```

Do not forget to **delete a**

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Order of const. / dest. with multiple members

- Class's destructor will automatically invoke the destructors for member objects.
- They are destroyed in the reverse order they appear within the declaration for the class

```
class A {
public:
    ~A();
    // ...
};

class B {
private:
    A a1;
    A a2;
    A a3;

public:
    ~B();
    // ...
};

B::~~B()
{
    // compiler invoke:
    // a3.~A()
    // a2.~A()
    // a1.~A()
}
```

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Order of destruction of local object

- For local objects, order of destruction is opposite to the order of construction
- For an array of objects, order of destruction is opposite to the order of construction

```
void f()
{
    A a1;
    A a2;
    // ...

} // a2 destroyed
// a1 destroyed
```

```
void f()
{
    A a[10];
    // ...

} // a[9] destroyed
// a[8] destroyed ...
// a[0] destroyed
```

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