

Constructing and Destructing

- Version 1: Dr. Ofir Pele
- Version 2: Dr. Miri Ben-Nissan
- Version 3: Dr. Erel Segal-Halevi

C**C++****Java**

Objects on the stack:

Construct**No****Yes*****Impossible*****Destruct****No****Yes**

Objects on the heap:

Construct**No****(malloc)****Yes****(new)****Yes****(new)****Destruct****No****(free)****Yes****(delete)****No****(done
automatically
by garbage
collector)**

C++ Laws of Construction and Destruction

1. Every object must be **constructed** before it is used.

- Stack object: when it is defined.
- Heap object: when it is created.

2. Every object must be **destroyed** after it stops being of use.

- Stack object: when gets out of scope.
- Heap object: when it is deleted.

Constructors *(folder 4)*

```
class MyClass
```

```
{
```

```
public:
```

```
① MyClass();
```

```
② MyClass( int i );
```

```
③ MyClass( double x, double y );
```

```
...
```

```
};
```

```
int main() {
```

```
    MyClass a; // Calls 1
```

```
    MyClass b {5}; // Calls 2
```

```
    MyClass c {1.0, 0.0}; // Calls 3
```

```
}
```

Constructors and Arrays *(folder 4)*

```
class MyClass
```

```
{
```

```
public:
```

```
① MyClass();
```

```
② MyClass( int i );
```

```
③ MyClass( double x, double y );
```

```
...
```

```
};
```

```
int main() {
```

```
    MyClass a[5]; // Calls 1 five times
```

```
    MyClass b[5] {11, 22}; // Calls 2 two times
```

```
    MyClass c[5] { {11,22}, 33}; // Calls 3 then 2
```

```
}
```

Constructors – parameterless ctor

```
class MyClass {  
public:  
    MyClass(); // parameterless ctor.  
    //...  
};  
//...  
int main() {  
    MyClass a; // parameterless ctor called  
    // ...  
}
```

Constructors – default parameterless ctor

```
class MyClass {  
public:  
    // No ctors  
};
```

```
int main() {  
    MyClass a; // default parameterless ctor:  
}
```

Constructors – no default parameterless ctor

```
class MyClass {  
public:  
    MyClass(int x); // no parameterless ctor.  
  
};  
  
int main() {  
    MyClass a;      // compiler error -  
    MyClass b[5];   // no parameterless ctor.  
}
```


Constructors – explicit default parameterless ctor

```
class MyClass {  
public:  
    MyClass(int x);  
    MyClass() = default;  
};
```

```
int main() {  
    MyClass a; // default parameterless ctor  
}
```

Constructors – deleted default parameterless ctor

```
class MyClass {  
public:  
    MyClass() = delete;  
};
```

```
int main() {  
    MyClass a; // compiler error -  
               // no parameterless ctor.  
               // (why would someone do this??)  
}
```

Destructors

Goal: Ensure proper “cleanup”:

- Free allocated memory;
- Close opened files or db connections;
- Notify related objects, etc.

Use: Called for:

- A stack object – when it goes out of scope.
- A heap object – when it is explicitly deleted.

Destructors *(folder 5)*

```
#include <cstdlib>
class MyClass
{
public:
    MyClass();    // constructor
    ~MyClass();   // destructor
private:
    char* _mem;
};
MyClass::MyClass()
{
    _mem = new char[1000];
}
MyClass::~~MyClass()
{
    delete[] _mem;
}
```

```
int main()
{
    → MyClass a;
    if( ... )
    {
        → MyClass b;

        → }
    → }
```

Destructors – common errors *(folder 5)*

1. Forgetting to write a destructor.
Might cause a memory leak.
2. Calling a destructor twice.
Possible reason - shallow copy.

Memory allocation in C

```
IntList* L =  
(IntList*)malloc(sizeof(IntList));
```

Does not call constructor!

Internal data members are not initialized

```
free(L);
```

Does not call destructor!

Internal data members are not freed

Memory allocation in C++

Special operators:

```
IntList *L = new IntList;
```

1. Allocate memory
2. Call constructor

```
delete L;
```

3. Call destructor
4. Free memory

new

Can be used with any type:

```
int *i = new int;
```

```
char **p = new (char *);
```


New & Constructors

```
class MyClass
```

```
{
```

```
public:
```

```
① MyClass();
```

```
② MyClass( int i );
```

```
③ MyClass( double x, double y );
```

```
};
```

```
MyClass* a;
```

```
a = new MyClass; // Calls ①
```

```
a = new MyClass {5}; // Calls ②
```

```
a = new MyClass { 1.0, 0.0 }; // Calls ③
```

New & arrays

To allocate arrays, use

```
int *a = new int[10]; //array of 10 ints
```

```
size_t n = 4;
```

```
IntList *array = new IntList[n];
```

```
// array of n IntLists.
```

```
// - must have a parameterless ctor!
```

```
array[0].func();
```

```
IntList* b0 = new IntList;
```

```
b0->func();
```

Delete & arrays

Special operation to delete arrays

```
int *a = new int[10];
```

```
int *b = new int[10];
```

```
delete [] a; // proper delete command
```

```
delete b;    // apparently works,
```

```
// but may cause segmentation fault
```

```
// or memory leak (folder 6)
```

Allocate array of objects w/o def. cons.

```
size_t n = 4;
MyClass **arr = new MyClass *[n];
// array of n pointers to MyClass (no
// cons. is invoked)

for (size_t i=0; i<n; ++i)
{
    arr[i] = new MyClass (i);
    // each pointer points to a MyClass
    // object allocated on the heap, and
    // the cons. is invoked.
}
```

Free an allocated array of pointers to objects

```
size_t n = 4;  
for (size_t i=0; i<n; ++i)  
{  
    delete (arr[i]);  
    // invoked the dest. of each MyClass  
    // object allocated on the heap, and  
    // free the memory.  
}  
delete [] arr;  
// free the memory allocated for the  
// array of pointers. No dest. is invoked
```

RAII – Resource Acquisition Is Initialization

A class that uses resources (file, memory, database, locks ...) should:

- Acquire them in the constructor.
- Release them in the destructor.