Pointers and Dynamic Memory Allocation

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Constructors Clarifications

- Multiple constructors, only one is invoked

main()

```
#include “Animal.hpp"

int main()
{

    Animal nameless; //calls default constructor

    Animal tiger(“tiger”); //calls parameterized const. w/ default args

    Animal shark(“shark”, false, true); //calls parameterized constructor
                                        //with all arguments
    //more code here . . .

}; //end main
```

```
class Animal
{
public:
    Animal(); //default constructor

    Animal(std::string name, bool domestic = false,
                             bool predator = false);//parameterized constructor

    // more code here


};// end Animal
```

Constructors Clarifications

- Multiple constructors, only one is invoked

- Initialize ALL data members in parameterized constructor, not only those with arguments

- Explicitly call Base class constructor only if needs argument values or if there is no default to be called

```h
class Fish
{
public:
    Fish(); //default constructor

   Fish(std::string name, bool domestic = false,
                    bool predator = false);//parameterized
constructor

   // more code here



};// end Fish
```

Fish.cpp

```
#include “Fish.hpp"



//default constructor
Fish::Fish(): venomous_(0){}


//parameterized constructor
Fish::Fish(string name, bool domestic, bool predator):
        Animal(name, domestic, predator), venomous_(0){}

//more code here . . .
```

Base class (Animal) constructor always called first. It will initialize derived data members.

Base class parameterized constructor needs access to argument values and must be called explicitly.

Pointer Variables

A typed variable whose value is the address of another variable of same type

```
int x = 5;
int y = 8;
int *p, *q = nullptr;  //declares two int pointers


. . .
```

Make sure you do this if not assigning a value!

Program Stack

Type	Name	Address	Data
...	...	...	...
int	x	0x12345670	5
int	y	0x12345674	8
int pointer	p	0x12345678	`nullptr`
int pointer	q	0x1234567C	`nullptr`
...	...	...	...

```
int x = 5;
int y = 8;
int *p, *q = nullptr;  //declares two int pointers


. . .
p = &x;      // sets p to the address of x
q = &y;      // sets q address of y
```

Make sure you do this if not assigning a value!

Program Stack

Type	Name	Address	Data
...	...	...	...
int	x	0x12345670	5
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int pointer	p	0x12345678	0x12345670
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int x = 5;
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int *p, *q = nullptr;  //declares two int pointers


. . .
p = &x;       // sets p to the address of x
q = &y;       // sets q address of y
```

Make sure you do this if not assigning a value!

We won't do much of this

Program Stack

Type	Name	Address	Data
...	...	...	...
int	x	0x12345670	5
int	y	0x12345674	8
int pointer	p	0x12345678	0x12345670
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Recall Dynamic Variables

What if I cannot statically allocate data? (e.g. will be reading from input at runtime)

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What if I cannot statically allocate data? (e.g. will be reading from input at runtime)

Allocate dynamically with **`new`**

Dynamic Variables

Created at runtime in the memory **heap**
using operator **new**

Nameless typed variables accessed through pointers

```
// create a nameless variable of type dataType on the
//application heap and stores its address in p
dataType *p = new dataType;
```

Program Stack

Type	Name	Address	Data
...	...	...	...
dataType ptr	p	0x12345678	0x100436f20
...	...	...	...

Heap

Type	Address	Data
...	...	...
dataType	0x100436f20	
...	...	...

Accessing members

```
dataType some_object;
dataType *p = new dataType;
// initialize and do stuff with instantiated objects

. . .

string my_string = some_object.getName();
string another_string = p->getName();
```

To access member functions in place of . operator

Deallocating Memory

```
delete p;
p = nullptr;
```

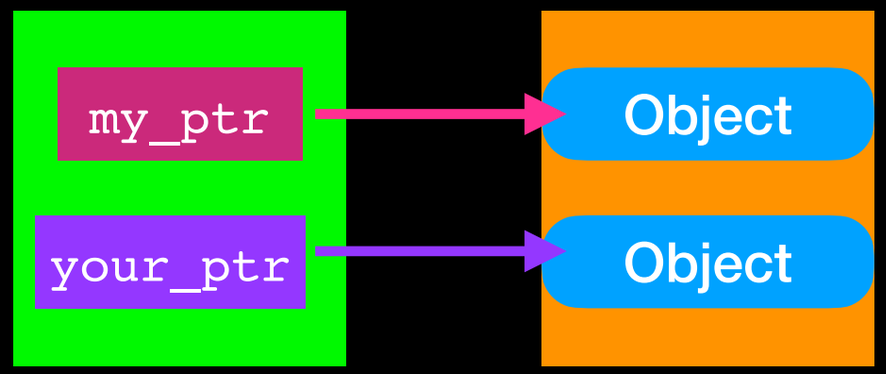
Deletes **the object** pointed to by p

Must do this!!!

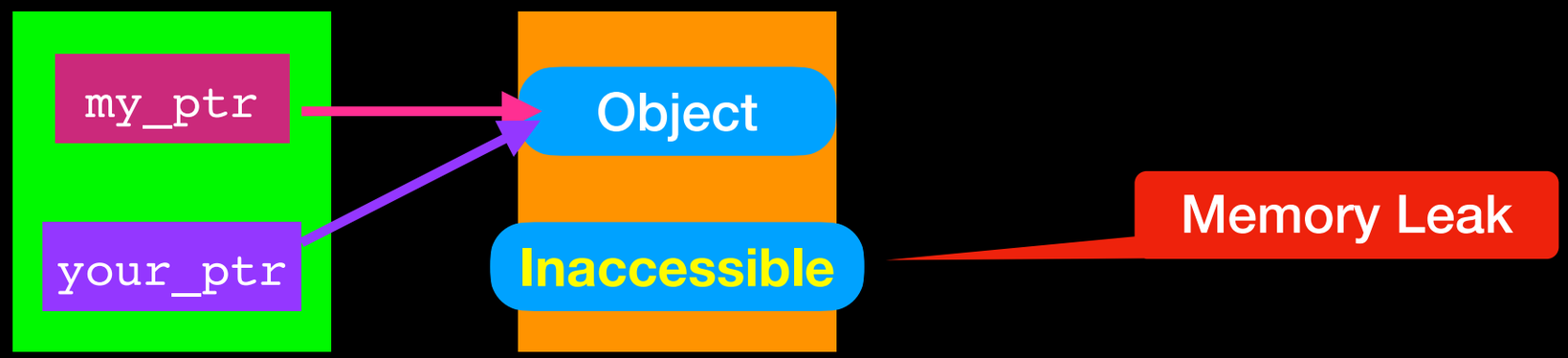
Avoid Memory Leaks (1)

Occurs when object is created in free store but program no longer has access to it

```
dataType *my_ptr = new dataType;
dataType *your_ptr = new dataType;
// do stuff with my_ptr and your_ptr
```



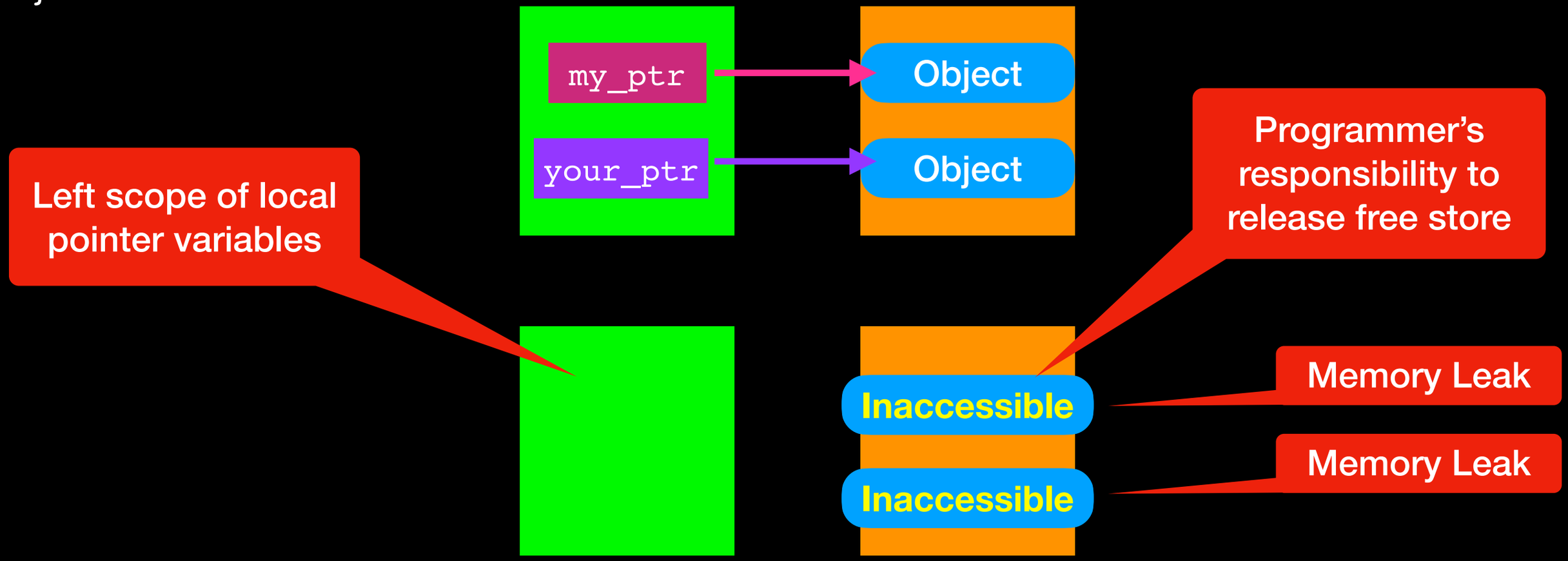

```
your_ptr = my_ptr;
```



Avoid Memory Leaks (2)

Occurs when object is created in free store but program no longer has access to it

```
void leakyFunction(){
dataType *my_ptr = new dataType;
dataType *your_ptr = new dataType;
// do stuff with my_ptr and your_ptr
}
```

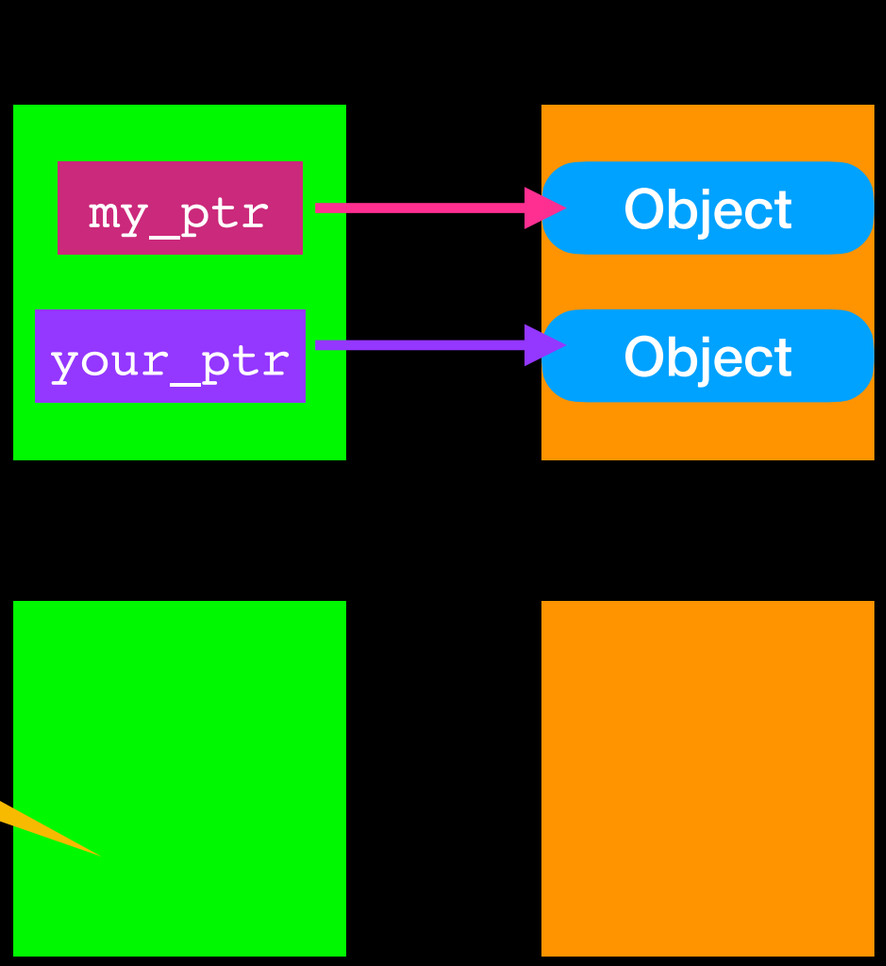


Avoid Memory Leaks (2)

Occurs when object is created in free store but program no longer has access to it

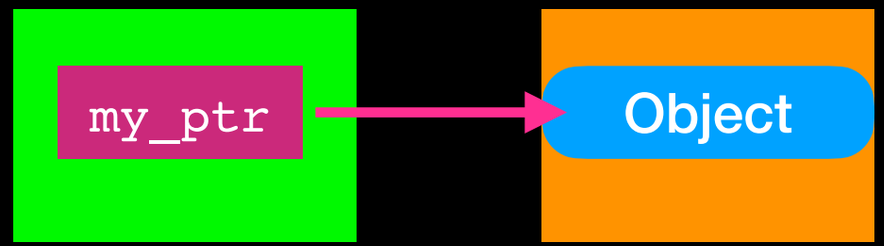
```
void leakyFunctionFixed(){
dataType *my_ptr = new dataType;
dataType *your_ptr = new dataType;
// do stuff with my_ptr and your_ptr
delete my_ptr;
my_ptr = nullptr;
delete your_ptr;
your_ptr = nullptr;
}
```

Left scope of local pointer variables but deleted dynamic objects first

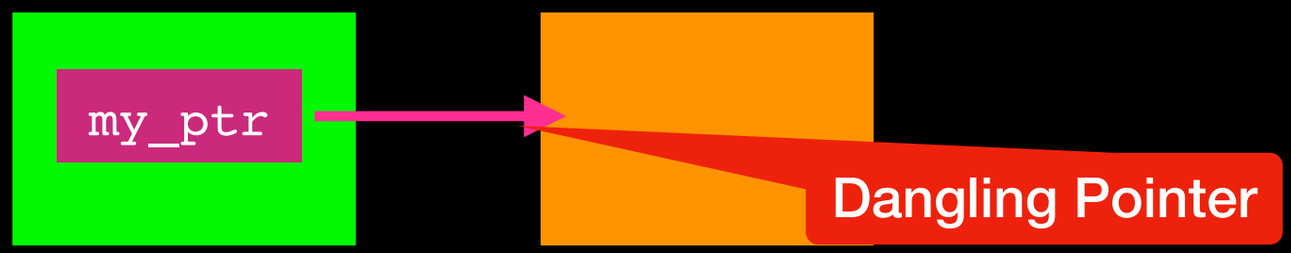


Avoid Dangling Pointers

Pointer variable that no longer references a valid object



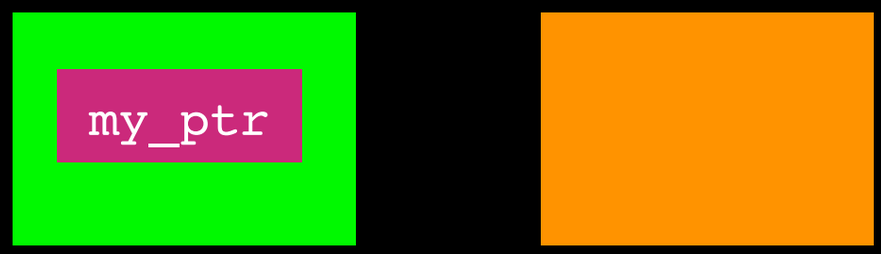

```
delete my_ptr;
```



Fix

```
delete my_ptr;
my_ptr = nullptr;
```

Must do this!!!



Avoid Dangling Pointers

Pointer variable that no longer references a valid object

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delete my_ptr;
my_ptr = nullptr;
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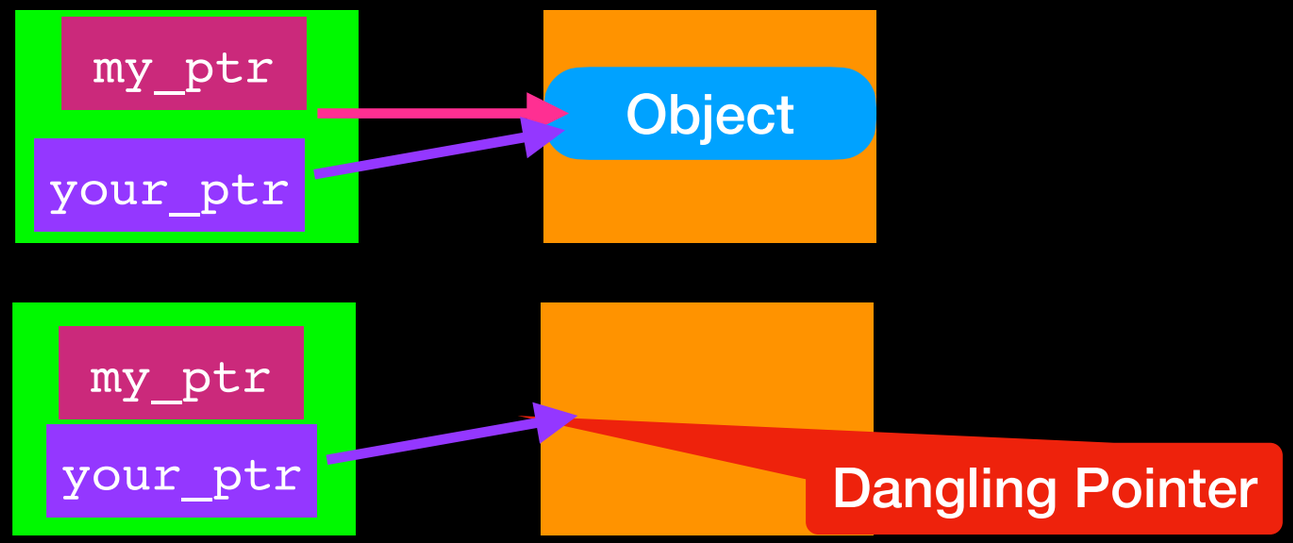
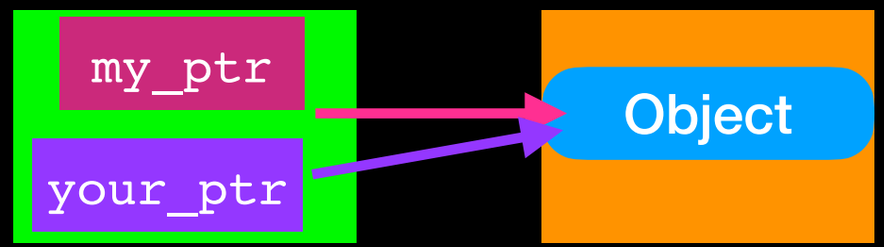
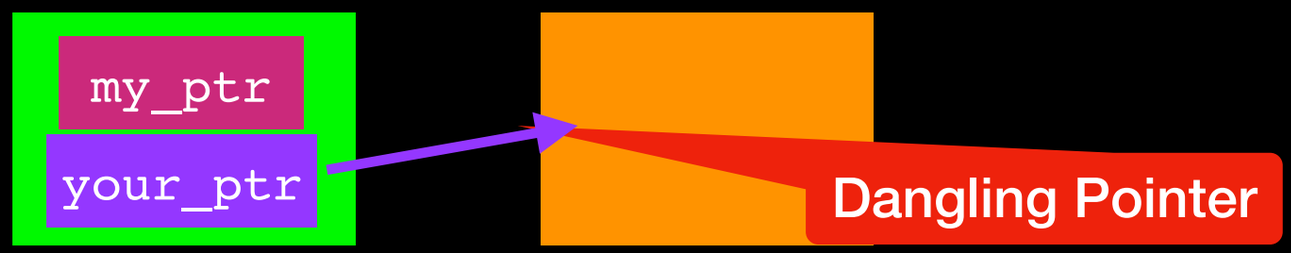


Avoid Dangling Pointers

Pointer variable that no longer references a valid object

```
delete my_ptr;
my_ptr = nullptr;
```



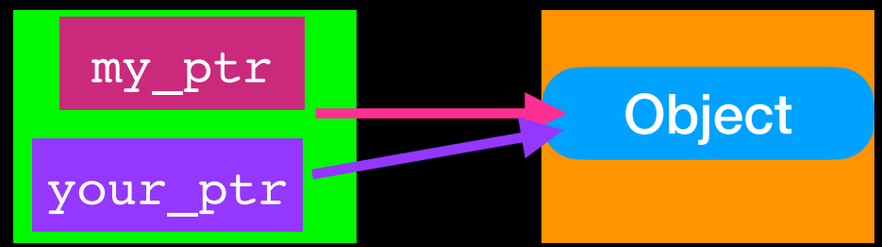


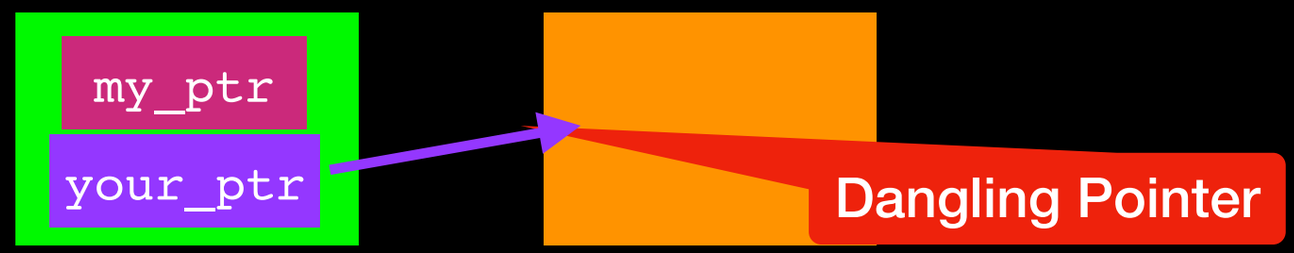
```
delete your_ptr;// ERROR!!!! No object to delete
```

Avoid Dangling Pointers

Pointer variable that no longer references a valid object

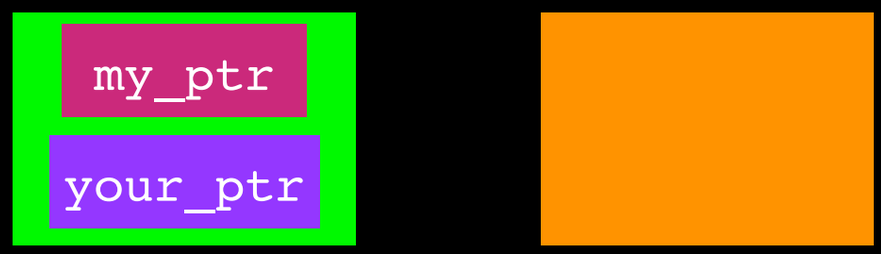
```
delete my_ptr;
my_ptr = nullptr;
```





Fix

```
delete my_ptr;
my_ptr = nullptr;
your_ptr = nullptr;
```



Must set all pointers to `nullptr`!!!

What is wrong with the following code?

```
void someFunction()
{
   int* p = new int[5];
   int* q = new int[10];

   p[2] = 9;
   q[2] = p[2]+5;
   p[0] = 8;
   q[7] = 15;

   std::cout<< p[2] << " " <<  q[2] << std::endl;
   q = p;
   std::cout<< p[0]  << " " << q[7] << std::endl;

}
```

What is wrong with the following code?

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{
   int* p = new int[5];
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   p[2] = 9;
   q[2] = p[2]+5;
   p[0] = 8;
   q[7] = 15;

   std::cout<< p[2] << " " <<  q[2] << std::endl;
   q = p;
   std::cout<< p[0]  << " " << q[7] << std::endl;

}
```

MEMORY LEAK:
`int[10]` **lost on heap**

SEGMENTATION FAULT
`int[5]` **index out of range**

MEMORY LEAK:
Did not delete `int[5]`
before exiting function

Next let's try a different implementation for Bag