- Examples

The key question of the std::unique_ptr is when to delete the underlying resource. This occurs when the std::unique_ptr goes out of scope or receives a new resource. Let's look at two use cases to better understand this concept.

WE'LL COVER THE FOLLOWING

Example 1

```cpp
// uniquePtr.cpp

#include <iostream>
#include <memory>
#include <utility>

struct MyInt{

  MyInt(int i):i_(i){}

  ~MyInt(){
    std::cout << "Good bye from " << i_ << std::endl;
  }

  int i_;

};


int main(){

  std::cout << std::endl;

  std::unique_ptr<MyInt> uniquePtr1{ new MyInt(1998) };

  std::cout << "uniquePtr1.get(): " << uniquePtr1.get() << std::endl;

  std::unique_ptr<MyInt> uniquePtr2;
  uniquePtr2= std::move(uniquePtr1);
  uniquePtr2= std::move(uniquePtr1);
  std::cout << "uniquePtr1.get(): " << uniquePtr1.get() << std::endl;
  std::cout << "uniquePtr2.get(): " << uniquePtr2.get() << std::endl;

  std::cout << std::endl;


  {
    std::unique_ptr<MyInt> localPtr{ new MyInt(2003) };
  }

  std::cout << std::endl;

  uniquePtr2.reset(new MyInt(2011));
  MyInt* myInt= uniquePtr2.release();
  delete myInt;

  std::cout << std::endl;

  std::unique_ptr<MyInt> uniquePtr3{ new MyInt(2017) };
  std::unique_ptr<MyInt> uniquePtr4{ new MyInt(2022) };

  std::cout << "uniquePtr3.get(): " << uniquePtr3.get() << std::endl;
  std::cout << "uniquePtr4.get(): " << uniquePtr4.get() << std::endl;

  std::swap(uniquePtr3, uniquePtr4);

  std::cout << "uniquePtr3.get(): " << uniquePtr3.get() << std::endl;
  std::cout << "uniquePtr4.get(): " << uniquePtr4.get() << std::endl;

  std::cout << std::endl;

}
```

Explanation

- The class `MyInt` (line 7 -17) is a simple wrapper for a number. We have adjusted the destructor in line 11 - 13 for observing the life cycle of `MyInt`.

- We create, in line 24, a `std::unique_ptr` and return, in line 26, the address of its resource `new MyInt(1998)`. Afterward, we move the `uniquePtr1` to `uniquePtr2` (line 29). Therefore, `uniquePtr2` is the owner of the resource. That is shown in the output of the program in lines 30 and 31.

- In line 37, the local `std::unique_ptr` reaches its valid range at the end of the scope. Therefore, the destructor of the `localPtr` – meaning the destructor of the resource new `MyInt(2003)` – will be executed.

- The most interesting lines are lines 42 to 44. At first, we assign a new resource to we assign the `uniquePtr1`. Therefore, the destructor of `MyInt(1998)` will be executed. After the resource in line 43 is released, we can explicitly invoke the destructor.

- The rest of the program is quite easy to understand. In lines 48 - 58, we create two `std::unique_ptr` and swap their resources. `std::swap` uses move semantic since `std::unique_ptr` supports no copy semantic. With the end of the main function, `uniquePtr3` and `uniquePtr4` go out of scope, and their destructor will automatically be executed.

Now that we have a sense of this technique, let's dig into a few details of `std::unique_ptr` in the example below.

Example 2

`std::unique_ptr` has a specialization for arrays. The access is transparent, meaning that if the `std::unique_ptr` manages the lifetime of an object, the operators for the object access are overloaded (`operator*` and `operator->`). If `std::unique_ptr` manages the lifetime of an array, the index operator `[]` is overloaded. The invocations of the operators are, therefore, transparently forwarded to the underlying resource.

```
// uniquePtrArray.cpp

#include <iomanip>
#include <iostream>
#include <memory>

class MyStruct{
public:
  MyStruct(){
    std::cout << std::setw(15) << std::left << (void*) this << " Hello "  << std::endl;
  }
  ~MyStruct(){
    std::cout << std::setw(15) << std::left << (void*)this << " Good Bye " << std::endl;
  }
};

int main(){

  std::cout << std::endl;

  std::unique_ptr<int> uniqInt(new int(2011));
  std::cout << "*uniqInt: " << *uniqInt << std::endl;
  std::cout << "uniqInt: " << uniqInt << std::endl;

  std::cout << std::endl;

  {
    std::unique_ptr<MyStruct[]> myUniqueArray{new MyStruct[5]};
  }

  std::cout << std::endl;

  {
    std::unique_ptr<MyStruct[]> myUniqueArray{new MyStruct[1]};
    MyStruct myStruct;
    myUniqueArray[0]=myStruct;
  }

  std::cout << std::endl;

  {
    std::unique_ptr<MyStruct[]> myUniqueArray{new MyStruct[1]};
    MyStruct myStruct;
    myStruct= myUniqueArray[0];
  }

  std::cout << std::endl;

}
```

Explanation

- We dereference (line 22) a `std::unique_ptr` and get the value of its resource.

- In lines 7 - 15, `MyStruct` acts as the base of an array of `std::unique_ptr`'s. If we instantiate a `MyStruct` object, we will get its address. The destructor gives the output. Now it is easy to observe the life cycle of the objects.

- In lines 26 - 28, we create and destroy five instances of `MyStruct`.

- The lines 32 - 36 are more interesting. We create a `MyStruct` instance on the heap (line 33) and on the stack (line 34). Therefore, both objects have addresses from different ranges.

- Afterward, we assign the local object to the `std::unique_pr` (line 35). The lines 40 - 44 follows a similar strategy. Now we assign, the local object, the first element of `myUniqueArray`. The index access to the `std::unique_ptr` in the lines 35 and 43 feels like familiar to index access to an array.

Let’s move on to the second type of smart pointers in this section, called shared pointers.