Specialized Numerical Methods for Transport Phenomena

Advanced C++ Programming - Additional Topics

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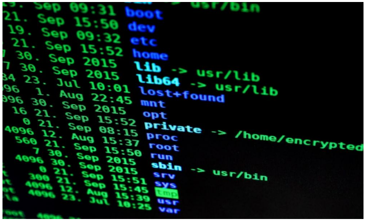

Outline

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Vectors, lists and maps

Functions in classes

STL containers

There are three categories:

- Sequence containers: maintain the ordering of the elements and you can choose where to insert your element by position, e.g., `std::array`, `std::vector`, `std::list`.
- Associative containers: automatically sort their inputs, e.g., `std::set`, `std::map`.
- Container adapters: adapted to specific uses, e.g., `std::stack`, `queue`.

std::vector

Similar to dynamic arrays but with the ability to resize itself automatically when an element is inserted or deleted:

```cpp
#include <iostream>
#include <vector>
void print_vector(const std::vector<int>& v)
{
    for (int n : v)
        std::cout << n << " ";
    std::cout << std::endl;
}
int main()
{
    std::vector<int> v = {8, 4, 5, 9};
    std::cout << "Size : " << v.size() << std::endl;
    std::cout << "Capacity : " << v.capacity() << std::endl;
    std::cout << "Max_Size : " << v.max_size() << std::endl;
    print_vector(v);
    return 0;
}
```

std::vector (Cont.)

What else can we do with these containers?

```
// Add two more integers
v.push_back(6);
v.push_back(2);
print_vector(v);

// Overwrite element at position 1
v[1] = -2;
print_vector(v);

// Resize vector (more space)
v.resize(7);
print_vector(v);
std::cout << "Size : " << v.size() << std::endl;
std::cout << "Capacity : " << v.capacity() << std::endl;
std::cout << "Max_Size : " << v.max_size() << std::endl;
```

Let's see the code!

std::list

Sequence containers that allow non-contiguous memory allocation:

```cpp
#include <iostream>
#include <list>
void print_list(const std::list<int>& l)
{
    for (auto i : l)
        std::cout << i << " ";
    std::cout << std::endl;
}
int main()
{
    std::list<int> l{12, 45, 8, 6};
    print_list(l);

    return 0;
}
```

`std::list` (Cont.)

What else can we do with these containers?

```
l.push_back(5);
l.push_front(50);
print_list(l);

l.pop_front();
l.pop_back();
print_list(l);

l.reverse();
print_list(l);

l.sort();
print_list(l);
```

Let's see the code!

std::map

Store elements in a specific order by a combination of two things:

- Key value: used to sort and uniquely identify the elements
- Map value: store content associated to this key

The types of the key and the value may differ.

```cpp
#include <iostream>
#include <map>
#include <string>
void print_map(const std::map<std::string, int>& m)
{
    for (const auto& [key, value] : m)
        std::cout << key << "," << value << std::endl;
}
int main()
{
    std::map<std::string,int> m {{"Laura", 15}, {"Bruno", 19}};
    print_map(m);
    return 0;
}
```

std::map (Cont.)

What else can we do with these containers?

```
// Change mapped value according to key
m["Laura"] = 17;
print_map(m);
// Add a new entry to the map
m["Olivier"] = 20;
print_map(m);
// Delete an entry in the map
m.erase("Bruno");
print_map(m);
// Clear map
m.clear();
print_map(m);
```

Let's see the code!

Outline

Creating a class

```
class Rectangle
{
public:
    Rectangle(int w, int h)// Constructor
    {
        width = w;
        height = h;
    }
    // Member functions
    int calculate_area()
    {
        return width*height;
    }
private:
    // Member variables
    int width;
    int height;
};
```

Using a class

Use the public function of the class in main:

```
int main()
{
    Rectangle rectangle_1(4,2);
    std::cout << "Area of rectangle = " << rectangle_1.calculate_area()
        << std::endl; // Area of rectangle = 8
}
```

What if I try to access the width or the height?

```
std::cout << "Width of rectangle = " << rectangle_1.width << std::endl;
rectangle_1.height = 2;
```

This will not compile! The member variables are `private`! This is why we have getter functions, e.g., `get_width()` or `get_height()` .