

C++'s Built-In Data Structures

arrays

Arrays in C++ are used to store a collection of values of the same type. The size of an array is specified when it is declared and cannot change afterward.

Use `[]` and an integer index to access an array element. Keep in mind: array indices start with 0 , not 1 !.

A multidimensional array is an “array of arrays” and is declared by adding extra sets of indices to the array name.

```
#include <iostream>

using namespace std;

int main()
{
    char vowels[5] = {'a', 'e', 'i',
                     'o', 'u'};

    std::cout << vowels[2];

    //Outputs: i

    char game[3][3] = {
        {'x', 'o', 'o'} ,
        {'o', 'x', 'x'} ,
        {'o', 'o', 'x'}
    };

    std::cout << game[0][2];

    // Outputs: o

    return 0;
}
```

vectors

In C++, a vector is a data structure that stores a sequence of elements that can be accessed by index.

Unlike arrays, vectors can dynamically shrink and grow in size.

The standard `<vector>` library provide methods for vector operations:

- `.push_back()` : add element to the end of the vector.

```
#include <iostream>
#include <vector>

int main () {
    std::vector <int> primes = {2, 3, 5,
                                7, 11};
```

- `.pop_back()` : remove element from the end of the vector.
- `.size()` : return the size of the vector.
- `.empty()` : return whether the vector is empty.

```
std::cout << primes[2];

//Outputs: 5

primes.push_back(13);
primes.push_back(17);
primes.pop_back();

for (int i = 0; i < primes.size();
i++) {
    std::cout << primes[i] << " ";
}

// Outputs: 2 3 5 7 11 13

return 0;
}
```

Stacks and Queues

In C++, *stacks* and *queues* are data structures for storing data in specific orders.

Stacks are designed to operate in a **Last-In-First-Out** context (LIFO), where elements are inserted and extracted only from one end of the container.

- `.push()` add an element at the top of the stack.
- `.pop()` remove the element at the top of the stack.

Queues are designed to operate in a **First-In-First-Out** context (FIFO), where elements are inserted into one end of the container and extracted from the other.

- `.push()` add an element at the end of the queue.
- `.pop()` remove the element at the front of the queue.

```
#include <iostream>
#include <stack>
#include <queue>

int main()
{
    std::stack<int> tower;

    tower.push(3);
    tower.push(2);
    tower.push(1);

    while(!tower.empty()) {
        std::cout << tower.top() << " ";
        tower.pop();
    }

    // Outputs: 1 2 3

    std::queue<int> order;

    order.push(10);
    order.push(9);
```

```

order.push(8);

while(!order.empty()) {
    std::cout << order.front() << " ";
    order.pop();
}
// Outputs: 10 9 8

return 0;
}

```

Sets

In C++, a *set* is a data structure that contains a collection of unique elements. Elements of a set are indexed by their own values, or *keys*.

A set cannot contain duplicate elements. Once an element has been added to a set, that element cannot be modified.

The following methods apply to both `unordered_set` and `set`:

- `.insert()` : add an element to the set.
- `.erase()` : removes an element from the set.
- `.count()` : check whether an element exists in the set.
- `.size()` : return the size of the set.

```

#include <iostream>
#include <unordered_set>
#include <set>

int main()
{
    std::unordered_set<int> primes({2,
3, 5, 7});

    primes.insert(11);
    primes.insert(13);
    primes.insert(11); // Duplicates
are not inserted

    primes.erase(2);
    primes.erase(13);

    // Outputs: primes does not contain
2.
    if(primes.count(2))
        std::cout << "primes contains
2.\n";
    else
        std::cout << "primes does not
contain 2.\n";

    // Outputs: Size of primes: 4

```

```

        std::cout << "Size of
primes.size() << "\n";

        return 0;
    }

```

Hash Maps

In C++, a *hash map* is a data structure that contains a collection of unique elements in the form of *key-value* pairs. Elements of a hash map are identified by key values, while the *mapped values* are the content associated with the keys. Each element of a map or unordered_map is an object of type pair. A pair object has two member variables:

- .first is the value of the key
- .second is the mapped value

The following methods apply to both unordered_map and map :

- .insert() : add an element to the map.
- .erase() : removes an element from the map.
- .count() : check whether an element exists in the map.
- .size() : return the size of the map.
- [] operator:
 - If the specified key matches an element in the map, then access the mapped value associated with that key.
 - If the specified key doesn't match any element in the map, add a new element to the map with that key.

```

#include <iostream>
#include <unordered_map>
#include <map>

int main() {
    std::unordered_map<std::string, int>
country_codes;

    country_codes.insert({"Thailand",
65});
    country_codes.insert({"Peru", 51});
    country_codes["Japan"] = 81;
    // Add a new element
    country_codes["Thailand"] = 66; //
Access an element

    country_codes.erase("Peru");

    // Outputs: There isn't a code for
Belgium
    if (country_codes.count("Belgium"))
    {
        std::cout << "There is a code for
Belgium\n";
    }
    else {
        std::cout << "There isn't a code
for Belgium\n";
    }

    // Outputs: 81
    std::cout << country_codes["Japan"]
<< "\n";

```

```
// Outputs: 2
std::cout << country_codes.size() <<
"\n";

// Outputs: Japan 81
//           Thailand 66
for(auto it: country_codes){
    std::cout << it.first << " " <<
it.second << "\n";
}

return 0;
}
```