Algorithm Library | C++ Magicians STL Algorithm

For all those who aspire to excel in competitive programming, only having a knowledge about containers of STL is of less use till one is not aware what all STL has to offer.

STL has an ocean of algorithms, for all < algorithm > library functions : Refer **here**.

Some of the most used algorithms on vectors and most useful one's in Competitive Programming are mentioned as follows :

Non-Manipulating Algorithms

1. **sort(first_iterator, last_iterator)** – To sort the given vector.
2. **reverse(first_iterator, last_iterator)** – To reverse a vector.
3. ***max_element (first_iterator, last_iterator)** – To find the maximum element of a vector.
4. ***min_element (first_iterator, last_iterator)** – To find the minimum element of a vector.
5. **accumulate(first_iterator, last_iterator, initial value of sum)** – Does the summation of vector elements

```
// A C++ program to demonstrate working of sort(),
// reverse()
#include <algorithm>
#include <iostream>
#include <vector>
#include <numeric> //For accumulate operation
using namespace std;

int main()
{
    // Initializing vector with array values
    int arr[] = {10, 20, 5, 23 ,42 , 15};
    int n = sizeof(arr)/sizeof(arr[0]);
    vector<int> vect(arr, arr+n);

    cout << "Vector is: ";
    for (int i=0; i<n; i++)
        cout << vect[i] << " ";
```

```
    // Sorting the Vector in Ascending order
    sort(vect.begin(), vect.end());

    cout << "\nVector after sorting is: ";
    for (int i=0; i<n; i++)
       cout << vect[i] << " ";

    // Reversing the Vector
    reverse(vect.begin(), vect.end());

    cout << "\nVector after reversing is: ";
    for (int i=0; i<6; i++)
        cout << vect[i] << " ";

    cout << "\nMaximum element of vector is: ";
    cout << *max_element(vect.begin(), vect.end());

    cout << "\nMinimum element of vector is: ";
    cout << *min_element(vect.begin(), vect.end());

    // Starting the summation from 0
    cout << "\nThe summation of vector elements is: ";
    cout << accumulate(vect.begin(), vect.end(), 0);

    return 0;
}
```

Run on IDE

Output:

```
Vector before sorting is: 10 20 5 23 42 15
Vector after sorting is: 5 10 15 20 23 42
Vector before reversing is: 5 10 15 20 23 42
Vector after reversing is: 42 23 20 15 10 5
Maximum element of vector is: 42
Minimum element of vector is: 5
The summation of vector elements is: 115
```

6. **count(first_iterator, last_iterator,x)** – To count the occurrences of x in vector.
7. **find(first_iterator, last_iterator, x)** – Points to last address of vector ((name_of_vector).end()) if element is not present in vector.

```cpp
// C++ program to demonstrate working of count()
// and find()
#include <algorithm>
#include <iostream>
#include <vector>
using namespace std;

int main()
{
    // Initializing vector with array values
    int arr[] = {10, 20, 5, 23 ,42, 20, 15};
    int n = sizeof(arr)/sizeof(arr[0]);
    vector<int> vect(arr, arr+n);

    cout << "Occurrences of 20 in vector : ";

    // Counts the occurrences of 20 from 1st to
    // last element
    cout << count(vect.begin(), vect.end(), 20);

    // find() returns iterator to last address if
    // element not present
    find(vect.begin(), vect.end(),5) != vect.end()?
                          cout << "\nElement found":
                      cout << "\nElement not found";

    return 0;
}
```

Run on IDE

Output:

```
Occurrences of 20 in vector: 2
Element found
```

8. **binary_search(first_iterator, last_iterator, x)** – Tests whether x exists in sorted vector or not.
9. **lower_bound(first_iterator, last_iterator, x)** – returns an iterator pointing to the first element in the range [first,last) which has a value not less than ‘x’.
10. **upper_bound(first_iterator, last_iterator, x)** – returns an iterator pointing to the first element in the range [first,last) which has a value

greater than ‘x’.

```cpp
// C++ program to demonstrate working of lower_bound()
// and upper_bound().
#include <algorithm>
#include <iostream>
#include <vector>
using namespace std;

int main()
{
    // Initializing vector with array values
    int arr[] = {5, 10, 15, 20, 20, 23, 42, 45};
    int n = sizeof(arr)/sizeof(arr[0]);
    vector<int> vect(arr, arr+n);

    // Sort the array to make sure that lower_bound()
    // and upper_bound() work.
    sort(vect.begin(), vect.end());

    // Returns the first occurrence of 20
    auto q = lower_bound(vect.begin(), vect.end(), 20);

    // Returns the last occurrence of 20
    auto p = upper_bound(vect.begin(), vect.end(), 20);

    cout << "The lower bound is at position: ";
    cout << q-vect.begin() << endl;

    cout << "The upper bound is at position: ";
    cout << p-vect.begin() << endl;

    return 0;
}
```

Run on IDE

Output:

```
The lower bound is at position: 3
The upper bound is at position: 5
```

Some Manipulating Algorithms

11. **arr.erase(position to be deleted)** – This erases selected element in vector and shifts and resizes the vector elements accordingly.
12. **arr.erase(unique(arr.begin(),arr.end()),arr.end())** – This erases the duplicate occurrences in sorted vector in a single line.

```
// C++ program to demonstrate working of erase()
#include <algorithm>
#include <iostream>
#include <vector>
using namespace std;

int main()
{
    // Initializing vector with array values
    int arr[] = {5, 10, 15, 20, 20, 23, 42, 45};
    int n = sizeof(arr)/sizeof(arr[0]);
    vector<int> vect(arr, arr+n);

    cout << "Vector is :";
    for (int i=0; i<6; i++)
        cout << vect[i]<<" ";

    // Delete second element of vector
    vect.erase(vect.begin()+1);

    cout << "\nVector after erasing the element: ";
    for (int i=0; i<5; i++)
        cout << vect[i] << " ";
```

```
    // sorting to enable use of unique()
    sort(vect.begin(), vect.end());

    cout << "\nVector before removing duplicate "
             " occurrences: ";
    for (int i=0; i<5; i++)
        cout << vect[i] << " ";

    // Deletes the duplicate occurrences
    vect.erase(unique(vect.begin(),vect.end()),vect.end());

    cout << "\nVector after deleting duplicates: ";
    for (int i=0; i< vect.size(); i++)
        cout << vect[i] << " ";

    return 0;
}
```

Run on IDE

Output:

```
Vector before erasing the element:5 20 5 23 20 20
Vector after erasing the element: 5 5 23 20 20
Vector before removing duplicate occurrences: 5 5 20 20 23
Vector after deleting duplicates: 5 20 23
```

13. **next_permutation(first_iterator, last_iterator)** – This modified the vector to its next permutation.
14. **prev_permutation(first_iterator, last_iterator)** – This modified the vector to its previous permutation.

```
// C++ program to demonstrate working of next_permutation()
// and prev_permutation()
#include <algorithm>
#include <iostream>
#include <vector>
using namespace std;

int main()
{
    // Initializing vector with array values
    int arr[] = {5, 10, 15, 20, 20, 23, 42, 45};
    int n = sizeof(arr)/sizeof(arr[0]);
```

```
    vector<int> vect(arr, arr+n);

    cout << "Given Vector is:\n";
    for (int i=0; i<n; i++)
        cout << vect[i] << " ";

    // modifies vector to its next permutation order
    next_permutation(vect.begin(), vect.end());
    cout << "\nVector after performing next permutation:\n";
    for (int i=0; i<n; i++)
        cout << vect[i] << " ";

    prev_permutation(vect.begin(), vect.end());
    cout << "\nVector after performing prev permutation:\n";
    for (int i=0; i<n; i++)
        cout << vect[i] << " ";

    return 0;
}
```

Run on IDE

Output:

```
Given Vector is:
5 10 15 20 20 23 42 45
Vector after performing next permutation:
5 10 15 20 20 23 45 42
Vector after performing prev permutation:
5 10 15 20 20 23 42 45
```

14. **distance(first_iterator,desired_position)** – It returns the distance of desired position from the first iterator.This function is very useful while finding the index.

```
// C++ program to demonstrate working of distance()
#include <algorithm>
#include <iostream>
#include <vector>
using namespace std;

int main()
{
```

```
    // Initializing vector with array values
    int arr[] = {5, 10, 15, 20, 20, 23, 42, 45};
    int n = sizeof(arr)/sizeof(arr[0]);
    vector<int> vect(arr, arr+n);

    // Return distance of first to maximum element
    cout << "Distance between first to max element: ";
    cout << distance(vect.begin(),
                     max_element(vect.begin(), vect.end()));
    return 0;
}
```

Run on IDE

Output:

```
Distance between first to max element: 7
```

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