C++ Basics

Comparator function for priority queue

```cpp
#include <bits/stdc++.h>
using namespace std;

auto it=[](int a, int b){
    //comparison logic
    if(a<b)     // Default priority queue (max heap) uses this < symbol
        return true;
    else
        return false;
};
int main(){
    priority_queue<int> pq1;
    priority_queue<int, vector<int>, decltype(it)> pq2(it);
    int i=1;
    while(i<=5){
        pq1.push(i);
        pq2.push(i);
        i++;
    }
    while(pq1.empty()==0){
        cout<<pq1.top()<<", ";
        pq1.pop();
    }
    cout<<endl;
    while(pq2.empty()==0){
        cout<<pq2.top()<<", ";
        pq2.pop();
    }
}
```

PROBLEMS 6 OUTPUT DEBUG CONSOLE TERMINAL

```
5, 4, 3, 2, 1,
5, 4, 3, 2, 1,
```

```cpp
#include <bits/stdc++.h>
using namespace std;

auto it=[](int a, int b){
    //comparison logic
    if(a>b)     // To represent min heap, reverse the sign
        return true;
    else
        return false;
};
int main(){
    priority_queue<int> pq1;
    priority_queue<int, vector<int>, decltype(it)> pq2(it);
    int i=1;
    while(i<=5){
        pq1.push(i);
        pq2.push(i);
        i++;
    }
    while(pq1.empty()==0){
        cout<<pq1.top()<<", ";
        pq1.pop();
    }
    cout<<endl;
    while(pq2.empty()==0){
        cout<<pq2.top()<<", ";
        pq2.pop();
    }
}
```

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```
5, 4, 3, 2, 1,
1, 2, 3, 4, 5,
```

```cpp
#include <bits/stdc++.h>
using namespace std;

struct Node{
    int data; Node* next;
    Node(int val){
        data = val;
        next = NULL;
    }
};

void f(Node*head){
    while(head!=NULL){
        cout<<head->data<<" ";
        head=head->next;
    }
    cout<<endl;
}

auto it=[](Node* a, Node* b){
    //comparison logic
    if(a->data < b->data)       // a < b means max heap and a->data < b->data means the node having more value of data will be placed at higher position
        return true;
    else
        return false;
};
```

P.T.O

```cpp
int main(){
    Node*head = new Node(5);
    Node*ptr1 = new Node(4);
    Node*ptr2 = new Node(3);
    Node*ptr3 = new Node(2);
    Node*ptr4 = new Node(1);
    head->next = ptr1;
    ptr1->next = ptr2;
    ptr2->next = ptr3;
    ptr3->next = ptr4;
    ptr4->next = NULL;
    //f(head);
    priority_queue<Node*> pq1;  // here the node having bigger address value will be placed at top
    priority_queue<Node*, vector<Node*>, decltype(it)> pq2(it);
    while(head!=NULL){
        pq1.push(head);
        pq2.push(head);
        head=head->next;
    }
    while(pq1.empty()==0){
        Node*temp = pq1.top();
        pq1.pop();
        int res = temp->data;
        printf("%d, ",res);
    }
    printf("\n");
    while(pq2.empty()==0){
        int res = (pq2.top())->data;
        pq2.pop();
        printf("%d, ",res);
    }
}
```

PROBLEMS 6 OUTPUT DEBUG CONSOLE TERMINAL

```
1, 2, 3, 4, 5,
5, 4, 3, 2, 1,
```

```cpp
#include <bits/stdc++.h>
using namespace std;

struct Node{
    int data; Node* next;
    Node(int val){
        data = val;
        next = NULL;
    }
};

void f(Node*head){
    while(head!=NULL){
        cout<<head->data<<" ";
        head=head->next;
    }
    cout<<endl;
}

auto it=[](Node* a, Node* b){
    //comparison logic
    if(a->data > b->data)       // a > b means min heap and a->data > b->data means the node having lesser value of data will be placed at higher position
        return true;
    else
        return false;
};

```

P.T.O

```cpp
int main(){
    Node*head = new Node(5);
    Node*ptr1 = new Node(4);
    Node*ptr2 = new Node(3);
    Node*ptr3 = new Node(2);
    Node*ptr4 = new Node(1);
    head->next = ptr1;
    ptr1->next = ptr2;
    ptr2->next = ptr3;
    ptr3->next = ptr4;
    ptr4->next = NULL;
    //f(head);
    priority_queue<Node*> pq1;  // here the node having bigger address value will be placed at top
    priority_queue<Node*, vector<Node*>, decltype(it)> pq2(it);
    while(head!=NULL){
        pq1.push(head);
        pq2.push(head);
        head=head->next;
    }
    while(pq1.empty()==0){
        Node*temp = pq1.top();
        pq1.pop();
        int res = temp->data;
        printf("%d, ",res);
    }
    printf("\n");
    while(pq2.empty()==0){
        int res = (pq2.top())->data;
        pq2.pop();
        printf("%d, ",res);
    }
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS Codes testing\" ; if ($?) { g++ Untitled-1.cpp
1, 2, 3, 4, 5,
1, 2, 3, 4, 5,
```

How to customize sort() function ?

```cpp
#include <bits/stdc++.h>
using namespace std;

class Node{
    public:
        int data;
};

bool f(Node a, Node b){
    if(a.data<b.data)
        return true;
    return false;
}

int main(){
    Node o1,o2,o3;
    o1.data = 45; o2.data = 23; o3.data = 2;
    vector<Node> v {o1,o2,o3};
    sort(v.begin(), v.end(), f);
    for(int i=0;i<3;i++)
        cout<<v[i].data<<" ";
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS
) { g++ Untitled-2.cpp -o Untitled-2 } ; if ($?) { .\U
2 23 45
```

Rounding Floating Point Number To two Decimal Places in C and C++

C++

```cpp
#include <iostream>
using namespace std;
float round(float var)
{
    // 37.66666 * 100 =3766.66
    // 3766.66 + .5 =3767.16    for rounding off value
    // then type cast to int so value is 3767
    // then divided by 100 so the value converted into 37.67
    float value = (int)(var * 100 + .5);
    return (float)value / 100;
}

int main()
{
    float var = 37.66666;
    cout << round(var);
    return 0;
}
```

Output:

37.67

Precedence	Operator	Description	Associativity
1	`::`	Scope resolution	Left-to-right →
2	`a++` `a--`	Suffix/postfix increment and decrement	
	type`()` *type*`{}`	Functional cast	
	`a()`	Function call	
	`a[]`	Subscript	
	`.` `->`	Member access	
3	`++a` `--a`	Prefix increment and decrement	Right-to-left ←
	`+a` `-a`	Unary plus and minus	
	`!` `~`	Logical NOT and bitwise NOT	
	(*type*)	C-style cast	
	`*a`	Indirection (dereference)	
	`&a`	Address-of	
	`sizeof`	Size-of[note 1]	
	`co_await`	await-expression (C++20)	
	`new` `new[]`	Dynamic memory allocation	
	`delete` `delete[]`	Dynamic memory deallocation	
4	`.*` `->*`	Pointer-to-member	Left-to-right →
5	`a*b` `a/b` `a%b`	Multiplication, division, and remainder	
6	`a+b` `a-b`	Addition and subtraction	
7	`<<` `>>`	Bitwise left shift and right shift	
8	`<=>`	Three-way comparison operator (since C++20)	
9	`<` `<=` `>` `>=`	For relational operators < and ≤ and > and ≥ respectively	
10	`==` `!=`	For equality operators = and ≠ respectively	
11	`a&b`	Bitwise AND	
12	`^`	Bitwise XOR (exclusive or)	
13	`|`	Bitwise OR (inclusive or)	
14	`&&`	Logical AND	
15	`||`	Logical OR	
16	`a?b:c`	Ternary conditional[note 2]	Right-to-left ←
	`throw`	throw operator	
	`co_yield`	yield-expression (C++20)	
	`=`	Direct assignment (provided by default for C++ classes)	
	`+=` `-=`	Compound assignment by sum and difference	
	`*=` `/=` `%=`	Compound assignment by product, quotient, and remainder	
	`<<=` `>>=`	Compound assignment by bitwise left shift and right shift	
	`&=` `^=` `|=`	Compound assignment by bitwise AND, XOR, and OR	
17	`,`	Comma	Left-to-right →

2 types of memory allocation:

1) Stack: Automatic memory. The program **automatically** allocates **and** deallocates **stack** memory when an **object** comes into or goes out of scope.
2) Heap: Dynamic memory. Memory management for dynamic objects is under direct programmer control. Memory is allocated on and deallocated from the heap with the new and delete operators respectively.

From an object instance stand point, **there is no difference between calling its constructor on the stack and calling it on the heap**. Means in both cases the constructor is called automatically.

Differences in delete and free are:

delete()	free()
It is an operator.	It is a library function.
It de-allocates the memory dynamically.	It destroys the memory at the runtime.
It should only be used either for the pointers pointing to the memory allocated using the **new** operator or for a NULL pointer.	It should only be used either for the pointers pointing to the memory allocated using **malloc()** or for a NULL pointer.
This operator calls the destructor after it destroys the allocated memory.	This function only frees the memory from the heap. It does not call the destructor.
It is faster.	It is comparatively slower than delete as it is a function.

Note: *The most important reason why free() should not be used for de-allocating memory allocated using* ***new*** *is that, it does not call the destructor of that object while delete operator does.*

new vs malloc

We use new and delete operators in C++ to dynamically allocate memory whereas malloc() and free() functions are also used for the same purpose in C and C++. The functionality of the **new or malloc()** and **delete or free()** seems to be the same but they differ in various ways.
The behavior with respect to constructors and destructors calls differ in the following ways:
malloc() vs new():

- **malloc():** It is a C library function that can also be used in C++, while the **"new"** operator is specific for C++ only.

- Both **malloc()** and **new** are used to allocate the memory dynamically in heap. But **"new"** does call the constructor of a class whereas **"malloc()"** does not.

new vs malloc (cont.)

```cpp
// C++ program to illustrate malloc() and new operator in C++
#include "bits/stdc++.h"
using namespace std;

class A {
    int a;
    public:
    int* ptr;

    // Constructor of class A
    A()
    {
        cout << "Constructor was Called! ";
    }
};

int main(){
  // Create an object of class A using new operator
  A* a = new A;
  cout << "Object of class A was created using new operator!"<< endl;

  // Create an object of class A using malloc operator
  A* b = (A*)malloc(sizeof(A));
  cout << "Object of class A was created using malloc()!"<< endl;
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS Codes testing\" ; if ($?) {
Constructor was Called! Object of class A was created using new operator!
Object of class A was created using malloc()!
```

&ptr vs *ptr

- (&) : address of operator(which gives address of operator). It is a unary operator that returns the address of the variable specified by its operand.

- (*) : dereference operator which gives value particularly stored in memory location

- let's assume ptr is an pointer to an integer x whose memory location is 100 which store any integer let's take 10 now ptr also has their own memory location which is 200. So address of ptr (&ptr) which is 200 after dereferencing *(&ptr) = *(200) = 100

1) *&ptr = ptr !!!! (where ptr stores address of the variable).

2) *(ptr)= data stored in the variable (where ptr stores address of the variable).

3) To access a data from a pointer, use ptr->data or (*ptr).data

4) ptr->data is equivalent to (*ptr).data

5) -> is designed to provide ease to the programmers because (*ptr).data is difficult to type.

6) To initialize a pointer, declare the data type of whose address the pointer wants to store, then declare astrick (*) and then declare the pointer name. e.g:
   i. To declare an integer pointer: int*ptr = # where num is an integer variable.
   ii. To declare an object 'obj' pointer whose class is 'Mother': Mother*ptr= &obj.

Function arguments: Pass by reference vs Pass by value

```
Func1(int &a)
// accepts arguments by reference.
// changes to a inside Func1 is reflected in the caller
// a cannot bind to an Rvalue e.g. can't call Func1(5)
// a can never be referring to something that is not a valid object

Func2(int *a)
// accept arguments by value
// change to a inside Func1 not reflected in caller, changes to *a are
// a can bind to an Rvalue e.g. Func1(&localvar)
// a can be NULL. Hence Func2 may need to check if a is NULL
```

Beware of negative sign while calculating modulus !!!

```cpp
#include <iostream>
#include <bits/stdc++.h>
#include <cmath>
using namespace std;

int main(){
    int r= (-56)%23;
    cout<<r<<endl;
    r= abs((-56)%23);
    cout<<r;
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\C
-10
10
PS D:\Codes (Python, C)\VS Codes te
```

Bitwise operators

For using bitwise operator (say XOR) use parentheisis:

int c = (a^b); **Correct**

int c = a^b; **Wrong !!!**

```
 7   int main(){
 8       cout<<(27<<1)<<endl;
 9       cout<<(27<<2)<<endl;
10       cout<<(27<<3)<<endl<<endl;
11
12       cout<<(27>>1)<<endl;
13       cout<<(27>>2)<<endl;
14       cout<<(27>>3)<<endl;
15       cout<<(27>>4)<<endl;
16       cout<<(27>>5)<<endl;
17   }
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Py
54
108
216

13
6
3
1
0
```

pow() function

```
8   int main(){
9       int val= pow(89,0.5);
10      cout<<val<<endl;
11      double val1= pow(89,0.5);
12      cout<<val1<<endl;
13  }
```

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PS D:\Codes (Python, C)\VS codes\C++ Bas
9
9.43398
```

Comparing int variable to double value

```
 8  int main(){
 9      double val1= pow(89,0.5);
10      cout<<val1<<endl;
11      for(int i=1; i<=val1; i++){
12          cout<<i<<" ";
13      }
14  }
```

```
PROBLEMS 2   OUTPUT   DEBUG CONSOLE   TE

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PS D:\Codes (Python, C)\VS codes\C++ Bas
9.43398
1 2 3 4 5 6 7 8 9
```

To convert decimal to binary: Use 'bitset' from std library.

To convert string to integer: Use 'stoi' from std library.

To convert integer to string: Use to_string(int val)

To convert character digit to integer: Use int num = (int)ch-48;

```cpp
#include <iostream>
#include<bits/stdc++.h>
using namespace std;

int main(){
    int a=5;
    string s= bitset<11>(a).to_string();    // Here, 11 represents theat length of binary equivalent of integer a will be 11.
    int n= stoi(s);         // to convert string to int
    cout<<s<<endl;
    cout<<n<<endl;
}
```

```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS codes\C++ Basics\" ; if ($?) { g++ ghi.cpp -o ghi } ; if ($?) { .\ghi }
00000000101
101
```

```cpp
int main(){
    int a=34566;
    string s=to_string(a);
    cout<<s[1]<<endl;
}
```

```c
#include <bits/stdc++.h>
using namespace std;

int main()
{
    int n = 98;
    char c = (char)n;
    printf("char c = (char)98 = %c\n", c);
    c = n;
    printf("char c = 98 = %c\n", c);
    n = 9;
    c = (char)n;
    printf("char c = (char)9 = %c\n", c);       // nothing will be printed
    c = n;
    printf("char c = 9 = %c\n", c);             // nothing will be printed
    char ch1 = 'a';
    int num1 = (int) ch1;
    int num2 = (int) ch1;
    printf("num1= (int) 'a' = %d\n",num1);
    printf("num2= 'a' = %d\n",num2);
    char ch2 = '7';
    int num3 = (int) ch2;
    printf("num3= (int) '7'= %d\n",num3);
    num3 = (int) ch2 - 48;
    printf("num3= (int) '7' - 48= %d\n",num3);
    num3 = ch2 - 48;
    printf("num3= '7' - 48= %d\n",num3);
    num3 = ch2;
    printf("num3= '7'= %d\n",num3);
}
```

```
char c = (char)98 = b
char c = 98 = b
char c = (char)9 =
char c = 9 =
num1= (int) 'a' = 97
num2= 'a' = 97
num3= (int) '7'= 55
num3= (int) '7' - 48= 7
num3= '7' - 48= 7
num3= '7'= 55
```

To convert integer to char: In order to convert 7 to '7' use:
char ch = 7+48;

Add 48 to every integer digit !!!

```
#include <bits/stdc++.h>
using namespace std;

int main()
{
    int n = 48;
    char c = (char)n;
    printf("(char)48 = %c\n",c);
    c = (char)52;
    printf("(char)52 = %c\n",c);
    c = 57;
    printf("char c = 57 = %c\n",c);

    int num_digit = 7;
    char ch = num_digit+48;
    printf("numeric to char for 7 = char ch = 7+48 = %c\n",ch);
    ch = 9+48;
    printf("numeric to char for 9 = char ch = 9+48 = %c\n",ch);
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS Codes testing\" ; if
(char)48 = 0
(char)52 = 4
char c = 57 = 9
numeric to char for 7 = char ch = 7+48 = 7
numeric to char for 9 = char ch = 9+48 = 9
```

bitset function can't include a variable in its size parameter, it can only include const variable !!!

```cpp
#include <iostream>
#include <bits/stdc++.h>
#include <cmath>
using namespace std;


int main(){
    int n=5;
    int a=4;
    string s= bitset<n> (a).to_string();
    cout<<s<<endl;
}
```

```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS Codes testing\" ; if ($?) { g++
Untitled-1.cpp: In function 'int main()':
Untitled-1.cpp:10:19: error: the value of 'n' is not usable in a constant expression
   10 |  string s= bitset<n> (a).to_string();
      |                   ^
Untitled-1.cpp:8:6: note: 'int n' is not const
    8 |  int n=5;
      |      ^
Untitled-1.cpp:10:20: error: the value of 'n' is not usable in a constant expression
   10 |  string s= bitset<n> (a).to_string();
      |                    ^
Untitled-1.cpp:8:6: note: 'int n' is not const
    8 |  int n=5;
      |      ^
Untitled-1.cpp:10:20: note: in template argument for type 'unsigned int'
   10 |  string s= bitset<n> (a).to_string();
      |                    ^
```

```cpp
#include <iostream>
#include <bits/stdc++.h>
#include <cmath>
using namespace std;


int main(){
    const int n=5;
    int a=4;
    string s= bitset<n> (a).to_string();
    cout<<s<<endl;
}
```

```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\
00100
```

Decimal division

```
8   int main(){
9       int a=3, b=8;
10      double f;
11      f=b/a;
12      cout<<f<<endl;
13      f=(double)b/a;
14      cout<<f<<endl;
15      f=b/(double)a;
16      cout<<f<<endl;
17      f=b/(1.0*a);
18      cout<<f;
19  }
```

How to use log in C++ ?

If you want to find **log a to the base 2**, then you can use inbuilt function: log2(a). For using this, you have to import <cmath> header file.

To find log of a to base b: Use inbuilt log2 function:

1.Find the log of **a** to the base 2 with the help of log2() method

2.Find the log of **b** to the base 2 with the help of log2() method

3.Divide the computed log **a** from the log **b** to get the $\log_b a$, i.e,

```
1   #include <iostream>
2   #include<cmath>
3   using namespace std;
4
5   int main(){
6       cout<<log2(33)<<endl;
7       cout<<log2(25)/log2(5);
8   }
```

```
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PS C:\Users\Sushant Singh> cd "d:\Codes
5.04439
2
```

1) min() and max() takes only 2 parameters. Don't pass 3 parameters inside them!!!!
2) long and long int are identical. So are long long and long long int . In both cases, the int is optional.
3) A variable name should not be a reserved word!!!! 'new' is a reserved word, so avoid using it as a variable.
4) In C++, 5.2//2 won't give 2, infact there is no operator like // in C++. To get integer divisor, use: (int) 5.2/2 or int res= 5.2/2. res will automatically store integer as it itself is an integer. Similarly, to get double divisor, use (double)5/2.
5) Multiple variables assignment in C++:

```
int c1,c2,c3=0;
int c1=c2=c3=0;
int c1=c2=c3=0,0,0;
```

Wrong

```
int c1=0, c2=0, c3=0;
```

Right

6) While online coding, if you have declared a global data type and there are multiple test cases to be tested for your code then **don't forget to clear data from that global data type after the end of each test case** otherwise it will affect other test cases. This is the reason that your code fails the test case while you submit your code but when you manually test that test case it gives the right output.
7) Be careful while using conditional statements and properly use brackets with them: if(a>b && g>h || m>n) and if(a>b && (g>h || m>n)) are different. The former statement is equal to: if((a>b && g>h) || m>n).

Global and Local scope !!!!

```
1   int mn = INT_MAX, curr_cost;
2   for(int j=i; j<=n-1; j++){
3       if(matrix[i][j]==-1)
4           break;
5       if(j==n-1)
6           curr_cost= matrix[i][j];
7       else
8           curr_cost= matrix[i][j] + min_cost[j+1];
9       int mn = min(mn, curr_cost);
10  }
11  min_cost[i] = mn;
```

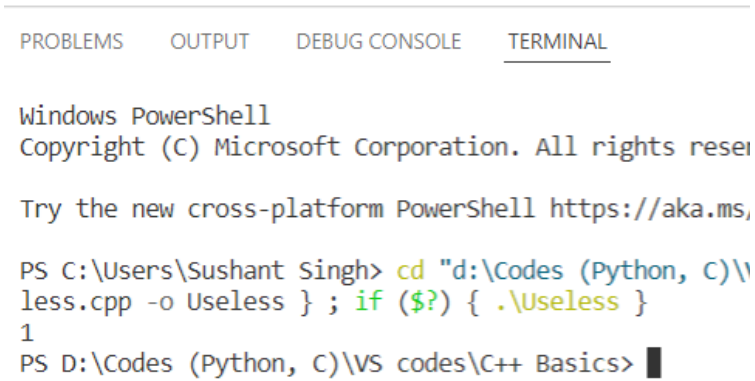
beaware of the variable 'mn' initialized at line 1 and then at line 9!!!! 'mn' at line 9 is not visible in the scope of 'mn' at line 1. 'mn' at line 9 will only be valid inside the body of for loop. Therefore, min_cost[i] at line 11 will store the value of 'mn' at line 1, i.e, min_cost[i]= INT_MAX!!!!

Recursion: Pass by value vs pass by reference

You should always pass vector by reference to a function.
If a vector is passed by value, a new temporary vector will be copied. And copying a vector means dynamically allocating new memory for a new vector, copying all elements so it's much more slower.
If the vector is small, there is no problem, but if it is large, then the parameter-passing itself could consume a lot of resources.

```cpp
#include<iostream>
#include <bits/stdc++.h>
using namespace std;

int main(){
    deque<int> deq;
    deque<int> :: iterator it=deq.begin();
    deq.push_back(1);
    deq.push_front(2);
    cout<<*it;
}
```



As STL data structure changes, iterator also **automatically** relocates itself !!!!!!!

Assigning NULL to integer variables (Note: NULL for integers =0 !!!!!!!)

```
5   int main(){
6       int a=NULL;
7       if(a==NULL){
8           printf("yes\n");
9       }
10      else{
11          printf("no\N");
12      }
13      if(1==a){
14          printf("YES");
15      }
16      else{
17          printf("NO");
18      }
19  }
```

```
yes
NO
```

```
1   #include<iostream>
2   #include <vector>
3   #include<algorithm>
4   using namespace std;
5
6   int main(){
7       int n=NULL;
8       if(n==0){
9           printf("Yes");
10      }
11      else{
12          printf("No");
13      }
14  }
```

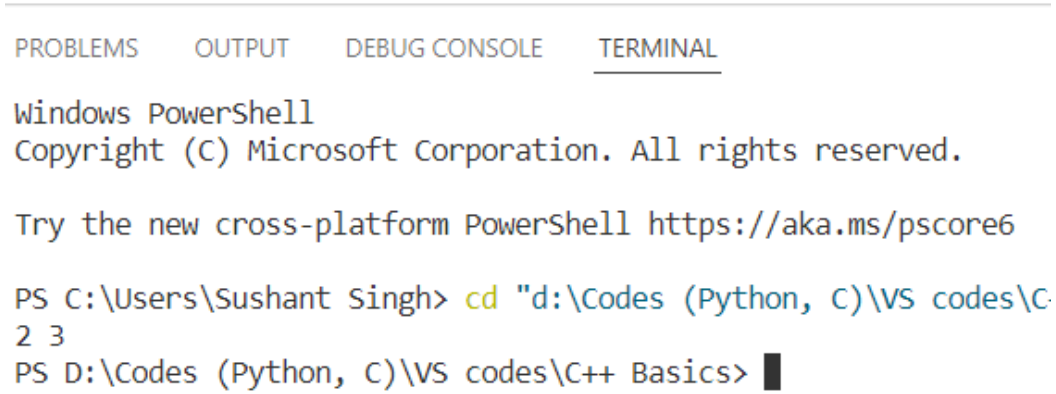
```
Yes
```

Vector

How to slice a vector and store it in the same vector ?

```cpp
#include<iostream>
#include <bits/stdc++.h>
using namespace std;

int main(){
    vector<int> v;
    v.push_back(1);
    v.push_back(2);
    v.push_back(3);
    v=vector<int> (v.begin()+1,v.end());
    cout<<v[0]<<" "<<v[1];
}
```



How to return elements in the form of a vector from a function ?

```
int ele1=5;
return vector<int> {ele1};
```
(To return single element as vector)

```
int ele1=5, ele2=9;
return vector<int> {ele1, ele2};
```
(To return multiple elements as vector)

```
return vector<int> {};
```
(To return an empty vector)

How to initialize values in vector ?

```
5   int main(){
6       vector<int> v;
7       vector<int> :: iterator it;
8       printf("hi 1\n");
9       it=v.begin();
10      printf("hi 2\n");
11      *it=1;
12      printf("hi 3\n");
13      it++;
14      printf("hi 4\n");
15      *it=2;
16      printf("hi 5\n");
17      cout<<v[0]<<" "<<v[1];
18      printf("hi 6\n");
19  }
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python,
hi 1
hi 2
PS D:\Codes (Python, C)\VS codes\C++ Basics>
```

Wrong!!!!!

```
5   int main(){
6       vector<int> v;
7       vector<int> :: iterator it;
8       v.push_back(1);
9       v.push_back(2);
10      cout<<v[0]<<" "<<v[1];
11  }
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Pyt
1 2
PS D:\Codes (Python, C)\VS codes\C++ Basics>
```

Correct!!!!!

How to erase a vector ?
Ans: Use vector.erase()

```
Input  : myvector= {1, 2, 3, 4, 5};
         myvector.clear();
Output : myvector= {}

Input  : myvector= {};
         myvector.clear();
Output : myvector= {}
```

Note: Don’t manipulate with the iterator of the vector while iterating using it in loop else your program may enter in infinite execution:

```
#include<iostream>
#include <bits/stdc++.h>
using namespace std;
 int main(){
    vector<int> v;
    v.push_back(1);
    vector<int> :: iterator it=v.begin();
    while(it!=v.end()){
        printf("Entered the loop\n");
        v.push_back(2);
        it++;
    }
    cout<<v[0]<<v[1];
}
```

Here, program will crash because it will go into infinite loop. This is because you are manipulating vector while you are iterating over it. So, when you push an element into a vector, the value of iterator will change and this will affect the code.

Conclusion: Never add or remove element from a vector while you are in loop.

1) To copy set ‘s’ into a vector: `vector<int> v(s.begin(), s.end());`

2) Copy set elements into vector manually using iterator:

```cpp
#include<iostream>
#include <bits/stdc++.h>
using namespace std;

int main(){
    set<int> s;
    s.insert(1);
    s.insert(2);
    s.insert(3);
    vector<int> v;
    set<int>::iterator it;
    for(it=s.begin(); it!=s.end(); it++){
        v.push_back(*it);
    }
    cout<<v[0]<<" "<<v[1]<<" "<<v[2];
}
```

```cpp
int main()
{
    vector<int> v={1,2};
    vector<int>::iterator it1,it2;
    it1=v.begin();
    it2=v.end();
    cout<<it2-it1;
}

```

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2
```

Note: To access an element at a particular index in a set, use iterator. You can't directly access elements in set from their indexes like: s[2] etc.

```cpp
#include<iostream>
#include <bits/stdc++.h>
using namespace std;

int main(){
    set<int> s;
    s.insert(1);
    s.insert(2);
    s.insert(3);
    cout<<s[1];
}
```

To pass/return an array from function:

```cpp
#include <iostream>
using namespace std;

int* fun()
{
    int arr[100];

    /* Some operations on arr[] */
    arr[0] = 10;
    arr[1] = 20;

    return arr;
}

int main()
{
    int* ptr = fun();
    cout << ptr[0] << " " << ptr[1];
    return 0;
}
```

Warning:

```
In function 'int* fun()':
6:8: warning: address of local variable 'arr' returned [-Wreturn-local-addr]
    int arr[100];
        ^
```

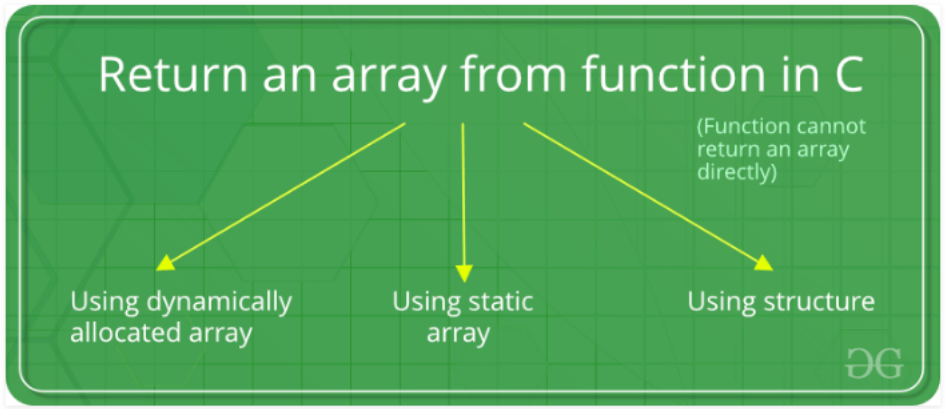
Output:

```
10 20
```

The above program is **WRONG**. It may produce values 10 20 as output or may produce garbage values or may crash. The problem is, **we return address of a local variable which is not advised as local variables may not exist in memory after function call is over**.

So in simple words, **Functions can't return arrays in C.** However, inorder to return the array in C by a function, one of the below alternatives can be used.

Following are some correct ways of returning array:



To pass a vector to a function: Pass by value

```cpp
// C++ program to demonstrate that when vectors
// are passed to functions without &, a copy is
// created.
#include <bits/stdc++.h>
using namespace std;

// The vect here is a copy of vect in main()
void func(vector<int> vect) {
    vect.push_back(30);
}

int main()
{
    vector<int> vect;
    vect.push_back(10);
    vect.push_back(20);

    func(vect);

    // vect remains unchanged after function
    // call
    for (int i = 0; i < vect.size(); i++)
        cout << vect[i] << " ";

    return 0;
}
```

When we pass an array to a function, a pointer is actually passed.
However, to pass a vector there are two ways to do so:
Pass By value
Pass By Reference

Output
10 20

Passing by value keeps the original vector unchanged and doesn't modify the original values of the vector. However, the above style of passing might also take a lot of time in cases of large vectors. So, it is a good idea to pass by reference.

```cpp
#include <iostream>
#include<climits>
#include<bits/stdc++.h>
#include<algorithm>
using namespace std;

void f(vector<int> v){
    v[0]=23;
}

int main(){
    vector<int> v(3,1);
    f(v);
    cout<<v[0]<<" "<<v[1]<<" "<<v[2]
}
```

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```
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1 1 1
PS D:\Codes (Python, C)\VS codes\C++ Basics>
```

To pass a vector to a function: Pass by reference

CPP

```cpp
// C++ program to demonstrate how vectors
// can be passed by reference.
#include <bits/stdc++.h>
using namespace std;

// The vect is passed by reference and changes
// made here reflect in main()
void func(vector<int>& vect) { vect.push_back(30); }

int main()
{
    vector<int> vect;
    vect.push_back(10);
    vect.push_back(20);

    func(vect);

    for (int i = 0; i < vect.size(); i++)
        cout << vect[i] << " ";

    return 0;
}
```

Output

```
10 20 30
```

Passing by reference saves a lot of time and makes the implementation of the code faster.

To return a vector from a function

```cpp
#include <bits/stdc++.h>
using namespace std;

// The vect here is a copy of vect in main()
vector<int> func(vector<int> vect) {
    vect.push_back(30);
    return vect;
}

int main()
{
    vector<int> vect;
    vect.push_back(10);
    vect.push_back(20);
    vect=func(vect);
    for (int i = 0; i < vect.size(); i++)
        cout << vect[i] << " ";

    return 0;
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS codes\
10 20 30
PS D:\Codes (Python, C)\VS codes\C++ Basics>
```

```cpp
#include <iostream>
#include <stdlib.h>
using namespace std;



class stack{
    public:
    int data;
};

void f(stack obj){
    obj.data=56;
}

int main(){
    stack obj;
    obj.data = 90;
    f(obj);
    cout<<obj.data<<endl;
}
```

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```
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PS D:\Codes (Python, C)\VS Codes t
90
```

```cpp
class Node{
    public:
    int data;
    Node*prev;
    Node*next;
};
void f(Node*root){
    Node*temp = root->next;
    root->next = root->prev;
    root->prev = temp;
}
void g(Node*root){
    root->data = 56;
}
int main(){
    Node*root = (Node*)malloc(sizeof(Node*));
    Node*a = (Node*)malloc(sizeof(Node*));
    Node*b = (Node*)malloc(sizeof(Node*));
    root->data=1;
    root->prev=a;    root->next=b;
    a->data=2;
    a->prev=NULL;    a->next=NULL;
    b->data=3;
    b->prev=NULL;    b->next=NULL;
    cout<<root->next->data<<" "<<root->prev->data<<endl;
    f(root);
    cout<<root->next->data<<" "<<root->prev->data<<endl;
    cout<<root->data<<" ";
    g(root);
    cout<<root->data<<endl;
}
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

```
PS D:\Codes (Python, C)\VS Codes testing> cd "d:\Codes (Python, C)\V
3 2
2 3
1 56
```

```cpp
#include <iostream>
#include <stdlib.h>
using namespace std;
class Node{
    public:
    int data;
    Node*prev;
    Node*next;
};
void f(Node*root){
   root=root->next;
}

int main(){
    Node*root = (Node*)malloc(sizeof(Node*));
    Node*a = (Node*)malloc(sizeof(Node*));
    Node*b = (Node*)malloc(sizeof(Node*));
    root->data=1;
    root->prev=a;    root->next=b;
    a->data=2;
    a->prev=NULL;    a->next=NULL;
    b->data=3;
    b->prev=NULL;    b->next=NULL;
    cout<<root->data<<" ";
    f(root);
    cout<<root->data<<endl;
}
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

```
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PS D:\Codes (Python, C)\VS Codes testing> cd "d:\Codes (P
1 1
```

 # Note: If there is an option of choosing between vector of vectors and vector of pairs, choose pair as pair is faster than vector of vectors.

Strings

```cpp
#include <iostream>

using namespace std;

int main()
{
    string s="My name";
    cout<<s.length();
    s[0]='H';
    cout<<"\n";
    cout<<s;
    return 0;
}

```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes
Basics }
7
Hy name
```

```cpp
#include <iostream>

using namespace std;

int main()
{
    string s="My name";
    cout<<s.find("am");
    return 0;
}
```

```
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PS C:\Users\Sushant Singh> cd "c
Basics }
4
```

means find “am” starting from 5th index

```cpp
#include <iostream>

using namespace std;

int main()
{
    string s="My name";
    cout<<s.find("am",5);
    return 0;
}
```

```
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PS C:\Users\Sushant Singh> cd "d:\C
Basics }
4294967295
```

```cpp
#include <iostream>

using namespace std;

int main()
{
    string s="My name";
    cout<<s.find("am",4);
    return 0;
}
```

```
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PS C:\Users\Sushant Singh> cd "d:
4
```

```cpp
#include <iostream>

using namespace std;

int main()
{
    string s="My name";
    cout<<s.substr(1,5);
    return 0;
}

```

PROBLEMS OUTPUT DEBUG CONSOLE

```
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Try the new cross-platform PowerS

PS C:\Users\Sushant Singh> cd "d:
y nam
```

cout<<
(trick: cout=leftist)

Remember: Use greater than sign for cin and less than for cout

```cpp
#include <iostream>

using namespace std;

int main()
{
    cout<<1/2;
    cout<<"\nStarting 2nd\n";
    cout<<1.0/2.0;
    cout<<"\nStarting 3rd\n";
    cout<<1.0/2;
    cout<<"\nStarting 4th\n";
    cout<<1/2.0;
    cout<<"\nStarting 5th\n";
    cout<<(double)(1/2);
    cout<<"\nStarting 6th\n";
    cout<<(double)1/2;
    return 0;
}
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMIN

```
Try the new cross-platform PowerShell ht

PS C:\Users\Sushant Singh> cd "d:\Codes
0
Starting 2nd
0.5
Starting 3rd
0.5
Starting 4th
0.5
Starting 5th
0
Starting 6th
0.5
```

```cpp
#include <iostream>

using namespace std;

int main()
{
    cout<<45.97 + 2;
    return 0;
}
```

PROBLEMS 4 OUTPUT DEBUG

```
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PS C:\Users\Sushant Singh> co
47.97
```

Using Math functions

Use header: #include <cmath>

For using ceil() include header: include<cmath>.

Also do note that ceil() works for float quantities, not for integer quantities as under:

```cpp
#include <iostream>
#include<cmath>
using namespace std;

int main() {
    cout<<ceil(3/2);
}
```

```
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PS C:\Users\Sushant Singh> cd "
1
PS D:\Codes (Python, C)\VS code
```

```cpp
#include <iostream>
#include<cmath>
using namespace std;

int main() {
    cout<<ceil(3/2.0);
}
```

```
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PS C:\Users\Sushant Singh> cd "d:
2
PS D:\Codes (Python, C)\VS codes\
```

```cpp
#include <iostream>
#include<cmath>
using namespace std;

int main() {
    cout<<ceil(3.0/2);
}
```

```
PROBLEMS    OUTPUT    DEBUG CONSOLE    TE

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PS C:\Users\Sushant Singh> cd "d:\Coc
2
PS D:\Codes (Python, C)\VS codes\C++
```

```cpp
#include <iostream>
#include <cmath>

using namespace std;

int main()
{
    cout<<pow(4,3);
    cout<<"\nStarting 2nd\n";
    cout<<sqrt(65);
    cout<<"\nStarting 3rd\n";
    cout<<round(4.45);
    cout<<"\nStarting 4th\n";
    cout<<round(4.5);
    cout<<"\nStarting 5th\n";
    cout<<round(4.65);
    cout<<"\nStarting 6th\n";
    cout<<ceil(4.0);
    cout<<"\nStarting 7th\n";
    cout<<ceil(4.1);
    cout<<"\nStarting 8th\n";
    cout<<fmax(34.5,34.6);          // Similarly fmin()
    return 0;
}
```

```
PS C:\Users\Su
64
Starting 2nd
8.06226
Starting 3rd
4
Starting 4th
5
Starting 5th
5
Starting 6th
4
Starting 7th
5
Starting 8th
34.6
```

In C++, pow(a, b) = a^b. Use <include cmath> header.

Taking inputs from user

Use header: cin<<

```cpp
#include <iostream>
#include <cmath>

using namespace std;

int main()
{
    int age;
    double weight;
    char blood;
    string name;
    cout<<"Enter your age\n";
    cin>>age;
    cout<<"Enter your weight\n";
    cin>>weight;
    cout<<"Enter your blood grp\n";
    cin>>blood;
    cout<<"Enter your name\n";
    cin>>name;
    cout<<"========== Now displaying ==========\n";
    cout<<"Age is "<<age<<", weight is "<<weight<<", blood grp is "<<blood<<" and name is "<<name;
    return 0;
}
```

```
Enter your age
23
Enter your weight
67.7
Enter your blood grp
A
Enter your name
Sushant
========== Now displaying ==========
Age is 23, weight is 67.7, blood grp is A and name is Sushant
```

Don’t use cin<< to read a string because it will only read one word, not whole line. To read a string use getline(cin, name)

```cpp
#include <iostream>
#include <cmath>

using namespace std;

int main()
{
    string name;
    cout<<"Enter your name\n";
    cin>>name;
    cout<<"Name is "<<name;
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes
Basics }
Enter your name
Sushant Singh
Name is Sushant
```

```cpp
#include <iostream>
#include <cmath>

using namespace std;

int main()
{
    string name;
    cout<<"Enter your name\n";
    getline(cin,name);
    cout<<"Name is "<<name;
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes
Basics }
Enter your name
Sushant Singh
Name is Sushant Singh
```

Arrays

Declaring array:

- int arr[]={1,2,3};
- int arr[5]={1,2,3};
  arr[3]=4;
  arr[4]=5;
- int arr[10];

How to assign 1 array to other array ?

```
int arr[3] = {1,2,3};
int temp[] = arr;
```

Wrong !!!

```
int arr[3] = {1,2,3};
int temp[3] = arr;
```

Wrong !!!

```
int arr[3] = {1,2,3};
int temp[];
temp = arr;
```

Wrong !!!

```
int arr[3] = {1,2,3};
int temp[3];
temp = arr;
```

Wrong !!!

```
int arr[3] = {1,2,3};
int *temp;
temp = arr;
```

Correct !!!

 # Note: Arrays are passed by reference to the functions in C++ !!!!

2D Arrays

Note: Its very important to specify the outer dimension of 2D array (means no. of rows) inside the block while initialization.

Correct

```
int arr[][1]={{1},{2},{3}};

int arr[3][1]={{1},{2},{3}};

int arr[3][2]={{1},{2},{3}};
```

Incorrect

```
int arr[][]={{1},{2},{3}};

int arr[3][]={{1},{2},{3}};
```

if else

```cpp
#include <iostream>
#include <cmath>

using namespace std;

int main()
{
    bool a=true;
    int b=0;
    if(a)
    cout<<"Bool is true\n";
    if(!b)
    cout<<"int is false\n";
}

```

```
PROBLEMS 4   OUTPUT   DEBUG CONSOLE

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PS C:\Users\Sushant Singh> cd "d:\Coc
Basics }
Bool is true
int is false
```

switch statement

```cpp
#include <iostream>
#include <cmath>
using namespace std;
int main()
{
    int n,a,b;
    cout<<"Enter the integer\n";
    cin>>n;
    string day;
    switch(n){
        case 1:
        day="Monday";
        break;
        case 2:
        day="Tuesday";
        break;
        case 3:
        day="Wednesday";
        break;
        case 4:
        day="Thursday";
        break;
        case 5:
        day="Friday";
        break;
        case 6:
        day="Saturday";
        break;
        case 7:
        day="Sunday";
        break;
        default:
        day="Wrong Choice";
    }
    cout<<day;
}
```

```
Enter the integer
8
Wrong Choice
PS D:\Codes (Python, C)\CodeBlocl
Enter the integer
4
Thursday
PS D:\Codes (Python, C)\CodeBlocl
Enter the integer
2
Tuesday
```

while loop

```cpp
#include <iostream>
#include <cmath>
using namespace std;
int main()
{
    int n=5;
    while(n){
        cout<<"Value of n is "<<n<<endl;
        n--;
    }
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)
Value of n is 5
Value of n is 4
Value of n is 3
Value of n is 2
Value of n is 1
```

Pointers

Pointers is a variable that stores (and are used to access) the physical memory address of an object.

How to print physical memory address of a variable?

```
1   #include <iostream>
2   #include <cmath>
3   using namespace std;
4   int main()
5   {
6       int a=5;
7       cout<<&a;
8   }
9
10
```

```
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PS C:\Users\Sushant Singh> cd "
0x61ff0c
```

Memory addresses are in the form of hexadecimal numbers. To store memory address, we need a pointer variable.

A pointer variable is initialized by specifying an **asterisk** sign before it. The pointer variable has the same data type as the data stored inside that memory location.

De-referencing a pointer: means trying to access what's inside the physical memory location. De-referencing is done using asterisk '*'.

```
1   #include <iostream>
2   #include <cmath>
3   using namespace std;
4   int main()
5   {
6       int a=5;
7       int *pointer=&a;        // declaring pointer and storing address of 'a'
8
9       cout<<pointer<<endl;
10      cout<<*pointer<<endl;
11      cout<<&*pointer<<endl;  // & tells address of the data *pointer
12      cout<<*&*pointer<<endl;
13      cout<<&*&*pointer<<endl;
14  }
```

```
0x61ff08
5
0x61ff08
5
0x61ff08
```

Class

```cpp
#include <iostream>
using namespace std;

class Book{
    public:
        int pages;
        string title;
        string author;
};

int main()
{
    Book book1;
    book1.pages=231;
    book1.title="Harry Potter";
    book1.author="JK Rowling";
    cout<<book1.title;
}

```

important to declare public otherwise all the attributes would be considered private

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes
Harry Potter
```

Constructor

```cpp
#include <iostream>
using namespace std;

class Book{
    public:
        int pages;
        string title;
        string author;
};

class Book_using_Constructor{
    public:
        int pages;
        string title;
        string author;
        Book_using_Constructor(int Pages, string Title, string Author){
            pages=Pages;
            title=Title;
            author=Author;
        }
};

int main()
{
    Book book1;
    book1.pages=231;
    book1.title="Harry Potter";
    book1.author="JK Rowling";

    Book_using_Constructor book2(356,"Lord of the Rings","Unknown");

    cout<<book1.title<<endl;
    cout<<book2.title;
}
```

Constructor body

4 lines of code without using constructor

1 line of code using constructor

```
Harry Potter
Lord of the Rings
```

Using multiple Constructor

```cpp
#include <iostream>
using namespace std;

class Book_using_Constructor{
    public:
        int pages;
        string title;
        string author;
        Book_using_Constructor(int Pages, string Title, string Author){
            pages=Pages;
            title=Title;
            author=Author;
        }

        Book_using_Constructor(){
            pages=0;
            title="No title";
            author="No author";
        }
};

int main()
{
    Book_using_Constructor book1;
    Book_using_Constructor book2(356,"Lord of the Rings","Unknown");

    cout<<book1.title<<endl;
    cout<<book2.title;
}
```

```
No title
Lord of the Rings
```

```cpp
#include <iostream>
#include<algorithm>
#include<vector>
#include<set>
using namespace std;

int main(){
    set <int> m;
    m.insert(23);
    m.insert(3);
    set<int> :: iterator it=m.begin();
    cout<<*it<<" ";
    it++;
    cout<<*it<<" ";

```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS c
3 23
```

max() or min()

```
int max=5;
cout<<max(max,3);
```

Wrong!!!!

```
int max1=5;
cout<<max(max1,3);
```

Right!!!!

Declaring infinity and minus infinity

Use: int a= (int)INFINITY;
Use: int a= -(int)INFINITY;

for using these, you have to include header: #include<bits/stdc++.h>

OR
int a= INT_MAX;
int b= INT_MAX;

for using these, you have to include header: #include<climits>

 # Note: Error prone area: If you declare some variable int a= INT_MAX; and perform this: a=a+4; Then you will get integer overflow error because a is already at its max limit, you can't add anything more into it.

~~**# Note:** Better to use INT_MAX rather than INFINITY as leetcode does not supports INFINITY but does support INT_MIN. However, don't forget to include header <climits> before using INT_MAX.~~

 # Note: With INFINITY, do explicitly convert it into the required datatype because some online IDEs like gfg, leetcode don't do it themselves unlike VS Code.

e.g: long long a=-INFINITY; **Wrong!!!!**
long long a= -(long long)INFINITY; **Correct !!!!**
long long a= (-long long)INFINITY; **Wrong !!!!**

```cpp
#include <iostream>
#include<climits>       // for using INT_MAX and INT_MIN
#include<bits/stdc++.h>     // for using INFINITY
using namespace std;

int main(){
    cout<<"INT_MIN= "<<INT_MIN<<endl;
    cout<<"INT_MAX= "<<INT_MAX<<endl;
    cout<<"INFINITY= "<<INFINITY<<endl;
    cout<<"-INFINITY= "<<-INFINITY<<endl;   // this will give 1 value less that the minimum value.
    cout<<"(int)INFINITY= "<<(int)INFINITY<<endl;
    cout<<"-(int)INFINITY= "<<-(int)INFINITY<<endl;     // this will give 1 value less that the actual minimum value stored in integer.
    cout<<"(long long)INFINITY= "<<(long long)INFINITY<<endl;
    cout<<"-(long long)INFINITY= "<<-(long long)INFINITY<<endl;     // this will give 1 value less that the minimum value stored in long long.
    int a= -(int)INFINITY;  // this will give 1 value less that the minimum value stored in integer.
    int b= (int)INFINITY;
    cout<<a<<endl;
    cout<<b<<endl;
}
```

```
INT_MIN= -2147483648
INT_MAX= 2147483647
INFINITY= inf
-INFINITY= -inf
(int)INFINITY= 2147483647
-(int)INFINITY= -2147483647
(long long)INFINITY= 9223372036854775807
-(long long)INFINITY= -9223372036854775807
-2147483647
2147483647
```

-2^{31} to $2^{32} - 1$

or

$-2*10^9$ to $2*10^9$

integer range

-2^{63} to $2^{63}-1$

long long range

+-2*10^9

V Imp: What happen when you add something to (+-)Infinity or INT_MAX, INT_MIN

Ans: **Addition and subtraction happens in circular order in these!!!!**

```cpp
#include <iostream>
#include<climits>
using namespace std;

int main(){
    int i=INT_MAX;
    int j=INT_MIN;
    cout<<i<<endl;
    cout<<i+1<<endl;
    cout<<i-1<<endl<<endl;

    cout<<j<<endl;
    cout<<j+1<<endl;
    cout<<j-1<<endl;
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes
2147483647
-2147483648
2147483646

-2147483648
-2147483647
2147483647
```

```cpp
#include <iostream>
#include<bits/stdc++.h>
using namespace std;

int main(){
    int i=(int)INFINITY;
    int j=-(int)INFINITY;
    cout<<i<<endl;
    cout<<i+1<<endl;
    cout<<i-1<<endl<<endl;

    cout<<j<<endl;
    cout<<j+1<<endl;
    cout<<j-1<<endl;
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Cod
2147483647
-2147483648
2147483646

-2147483647
-2147483646
-2147483648
```

Array is passed by reference!!!

```
1   #include <bits/stdc++.h>
2   using namespace std;
3
4   void add(int arr[]){
5       arr[0]+=5;
6   }
7   int main(){
8      int arr[]={1,2,3};
9      add(arr);
10     cout<<arr[0];
11  }
```

How to assign one array to another as a pointer?

```
int arr1[ ]={1,2,3};
```

```
int arr2=arr1;
```

```
int arr2[ ]=arr1
```

```
int arr2[3]=arr1
```

```
int arr2[3]=arr1[ ]
```

Wrong !!

```
int *arr2=arr1;
```

Right !!

```
#include <bits/stdc++.h>
using namespace std;

void add(int temp[]){
    temp[0]+=5;
}
int main(){
   int arr[]={1,2,3};
    int *temp=arr;
   add(temp);
   cout<<arr[0]<<endl;
   cout<<temp[0];
}
```

```
#include <bits/stdc++.h>
using namespace std;

void add(int arr[]){
    arr[0]+=5;
}
int main(){
   int arr[]={1,2,3};
    int *temp=arr;
   add(arr);
   cout<<arr[0]<<endl;
   cout<<temp[0];
}
```

```
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PS C:\Users\Sushant Singh> cd "d:
6
6
PS D:\Codes (Python, C)\VS codes\
```

```
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PS C:\Users\Sushant Singh> cd "d:\Cod
6
6
PS D:\Codes (Python, C)\VS codes\C++
```
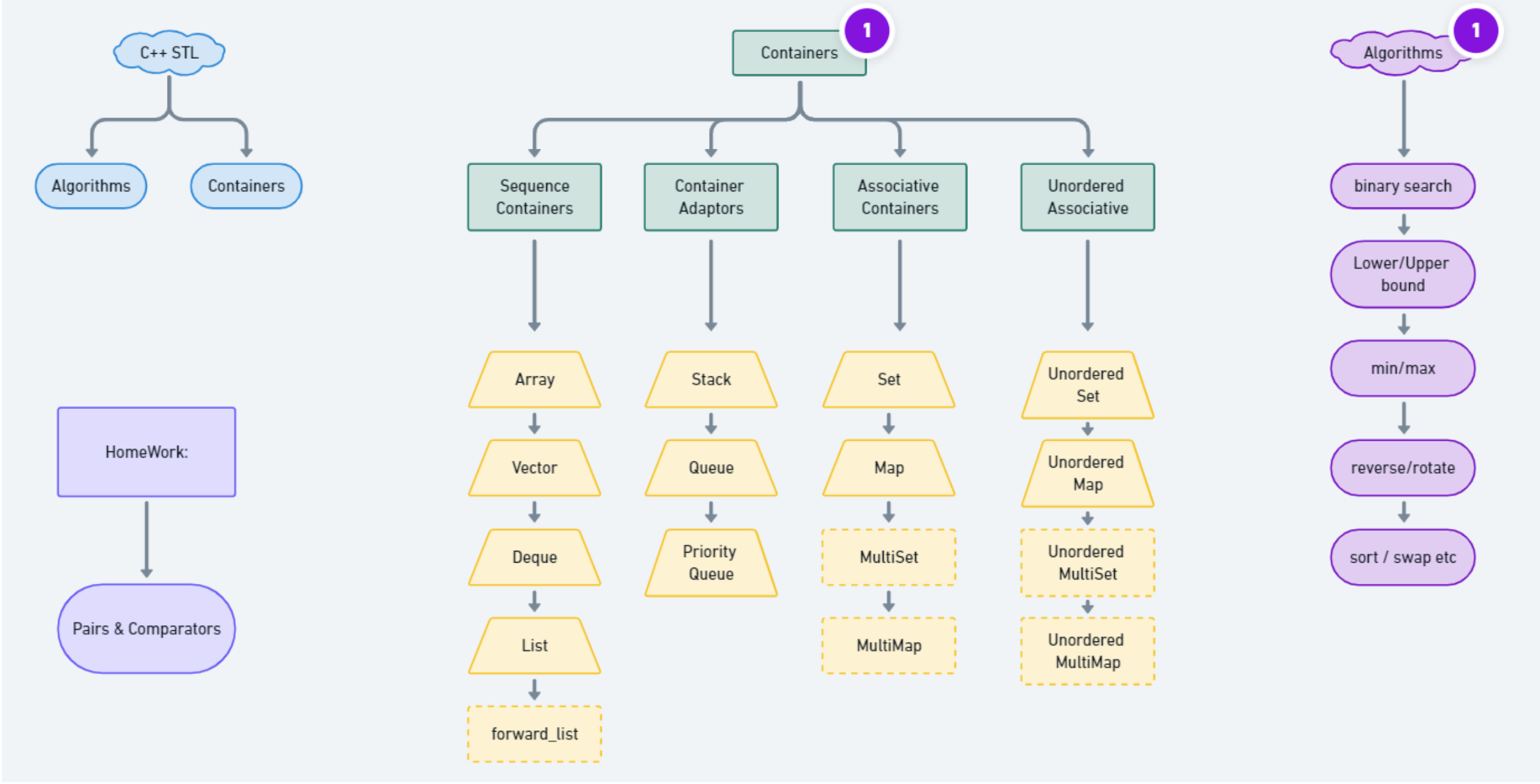
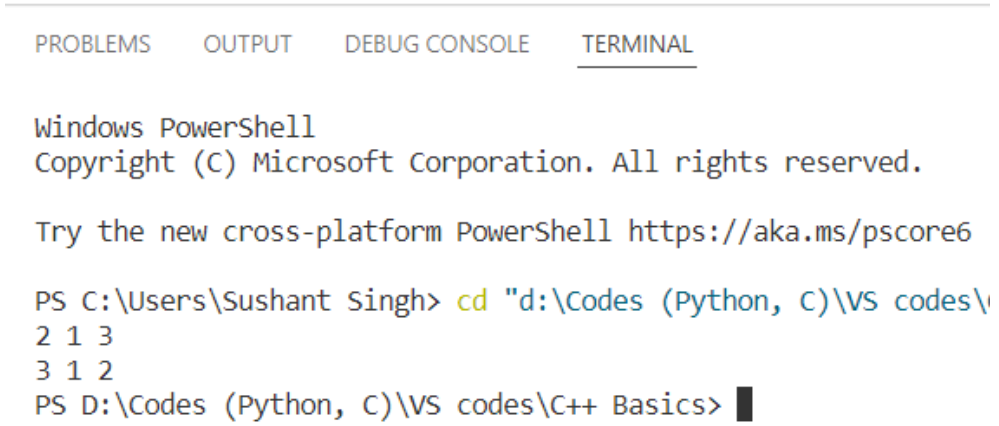

STL

Containers: Pre-built data strucures



How to reverse an STL Data structure

```cpp
#include<iostream>
#include <bits/stdc++.h>
using namespace std;

int main(){
    deque<int> deq;
    deq.push_back(1);
    deq.push_front(2);
    deq.push_back(3);
    cout<<deq[0]<<" "<<deq[1]<<" "<<deq[2]<<endl;
    reverse(deq.begin(), deq.end());
    cout<<deq[0]<<" "<<deq[1]<<" "<<deq[2]<<endl;
}
```



Note: Suppose a vector ‘v’ with iterator ‘it’. Then, it=v.end() => it points next to the last element of the vector. It does not mean that it points to the last element of the vector!!!!

Array STL

STL library used: #include <array>

Static arrays **have their size or length determined when the array is created and/or allocated**. For this reason, they may also be referred to as fixed-length arrays or fixed arrays. Array values may be specified when the array is defined, or the array size may be defined without specifying array contents.

STL array is static, and for this reason we don’t generally use it in competitive coding.

```cpp
#include <iostream>
#include<array>
using namespace std;

int main()
{
    array<int,4> a={1,2,3,4};
    cout<<"size= "<<a.size()<<endl;
    cout<<"first element= "<<a.front()<<endl;
    cout<<"last element= "<<a.back()<<endl;
    cout<<"Is array empty? "<<a.empty()<<endl;
    cout<<"Element at index 2= "<<a.at(2)<<" or "<<a[2]<<endl;
}
```

<int,4> not <4,int> !!!!!!

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\CodeBlocks\" ; if ($?)
size= 4
first element= 1
last element= 4
Is array empty? 0
Element at index 2= 3 or 3
```

To find sum of an array

array<int> arr is STL array but int arr[] is simple arrray

```cpp
#include<iostream>
#include <bits/stdc++.h>
using namespace std;

int main(){
    int a[]={1,2323,23,23,24};
    cout<<a.size();

}
```

```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)
ghi.cpp: In function 'int main()':
ghi.cpp:7:13: error: request for member 'size' in '
    7 |     cout<<a.size();
      |             ^~~~
```

```cpp
#include<iostream>
#include <bits/stdc++.h>
using namespace std;

int main(){
    array<int,2> arr={1,2};
    cout<<arr.size();
}
```

```
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PS C:\Users\Sushant Singh> cd "d:\Codes
2
```

Vector STL

STL library used: #include <vector>

Vectors are same as dynamic arrays with the ability to resize itself automatically when an element is inserted, with their storage being handled automatically by the container. Vector elements are placed in contiguous storage so that they can be accessed and traversed using iterators. In vectors, data is inserted at the end.

In vector, everytime the size becomes equal to the capacity and some new element is to be inserted, the capacity becomes double the present one.

Initially the size and the capacity of the vector is 0.

Size specifies the number of elements present in the vector and capacity specifies the number of elements the vector can hold at max.

After clearing vector, the size becomes 0 but capacity remains unchanged.

Assign array to a vector:
vector <int> v(arr, arr+n); # not vector<int> v= vector<int> arr; !!!

Assign set to a vector:
vector <int> v(s.begin(), s.end()); # not vector<int> v= vector<int> s; !!!

To find size of a vector: int len = v.size(); // Won't work for an array

To empty a vector, use v.clear();

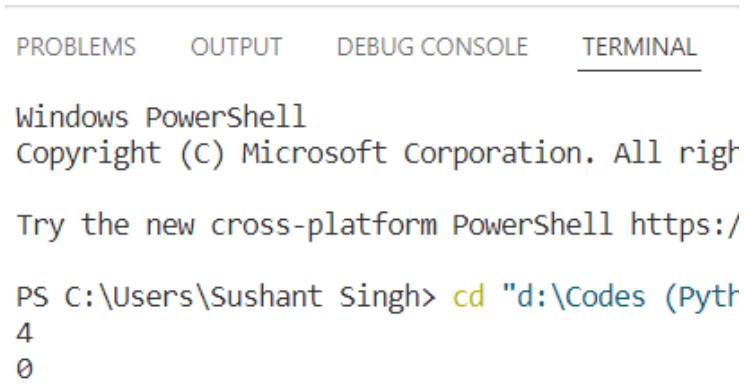
To empty stack or queue or deque, don't use clear() as it meant for set and map only. Empty using pop() or use v.empty(v.begin()).

Note: if vector or any data structure is empty, then don't access anything in in (like v[0], etc) else your program will terminate !!!!

vector.erase()

```cpp
#include<bits/stdc++.h>
using namespace std;

int main(){
    vector<int> v= {1,2,3,4,5};
    v.erase(v.begin());
    cout<<v.size()<<endl;
    v.erase(v.begin(),v.end());
    cout<<v.size()<<endl;
}
```

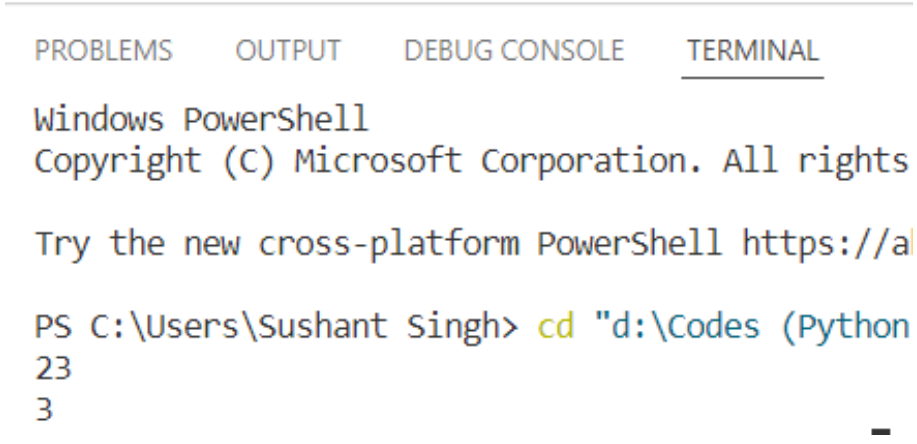


Note: Don't do this: v.erase(v.end()) else system will terminate !!!

To find first and last element in a vector

```cpp
#include <bits/stdc++.h>
using namespace std;

int main(){
    vector<int> v;
    v.push_back(23);
    v.push_back(3);
    cout<<v.front()<<endl;
    cout<<v.back();
}
```



To find sum of a vector

```cpp
#include <numeric>
#include <vector>
#include <iostream>
using namespace std;

int main(){
    vector <int> v;
    v.push_back(1);
    v.push_back(2);
    v.push_back(3);
    cout<<accumulate(v.begin(), v.end(), 0);
}
```

```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS codes\
6
PS D:\Codes (Python, C)\VS codes\C++ Basics>
```
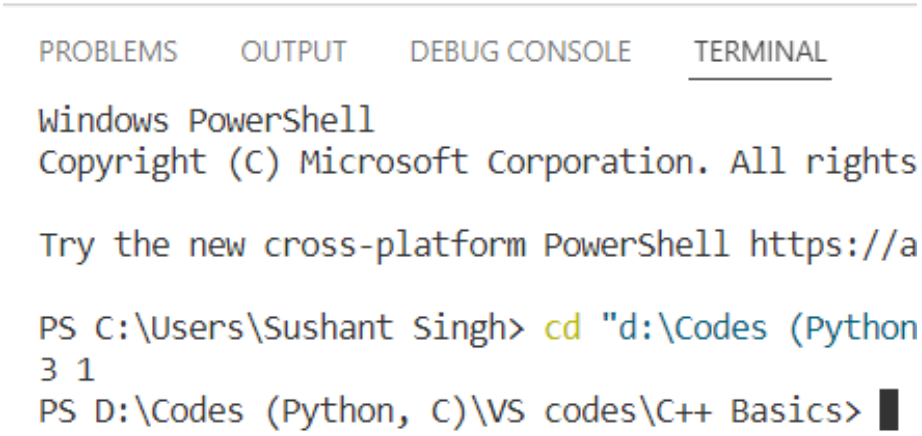

To swap 2 elements in a vector or array (both STL and non STL) or variable

```cpp
#include <numeric>
#include <vector>
#include <iostream>
using namespace std;

int main(){
    vector <int> v;
    v.push_back(1);
    v.push_back(2);
    v.push_back(3);
    swap(v[0],v[2]);
    cout<<v[0]<<" "<<v[2];
}
```



 # Note: swap() function is provided by STL library, so do import it before using it.

```cpp
#include <iostream>
#include<vector>
using namespace std;

int main()
{
    vector<int> a;
    cout<<"Initially:\n";
    cout<<"size= "<<a.size()<<endl;
    cout<<"capacity= "<<a.capacity()<<endl;

    a.push_back(1);
    cout<<"After inserting 1st element:\n";
    cout<<"size= "<<a.size()<<endl;
    cout<<"capacity= "<<a.capacity()<<endl;

    a.push_back(2);
    cout<<"After inserting 2nd element:\n";
    cout<<"size= "<<a.size()<<endl;
    cout<<"capacity= "<<a.capacity()<<endl;

    a.push_back(3);
    cout<<"After inserting 3rd element:\n";
    cout<<"size= "<<a.size()<<endl;
    cout<<"capacity= "<<a.capacity()<<endl;

     a.push_back(4);
    cout<<"After inserting 4th element:\n";
    cout<<"size= "<<a.size()<<endl;
    cout<<"capacity= "<<a.capacity()<<endl;

     a.push_back(5);
    cout<<"After inserting 5th element:\n";
    cout<<"size= "<<a.size()<<endl;
    cout<<"capacity= "<<a.capacity()<<endl;

    cout<<"\nElement at index 2= "<<a.at(2)<<" or "<<a[2]<<endl;
    cout<<"last element= "<<a.back()<<endl;
    cout<<"front element= "<<a.front()<<endl;

    cout<<"\nBefore popping, size= "<<a.size()<<" and vector is:\n";
    for(int i=0;i<a.size();i++){
        cout<<a[i]<<" ";
    }
    a.pop_back();
    //cout<<"\n The popped element is "<<a.pop_back()<<endl;
    cout<<"\nAfter popping, size= "<<a.size()<<" and vector is:\n";
    for(int i=0;i<a.size();i++){
        cout<<a[i]<<" ";
    }

    cout<<"\n\nIs vector empty? "<<a.empty()<<endl;
    cout<<"\nSize of vector before clearing= "<<a.size()<<" and capacity = "<<a.capacity()<<endl;
    cout<<"Clearing vector\n";
    a.clear();
    cout<<"Size of vector after clearing= "<<a.size()<<" and capacity = "<<a.capacity()<<endl;
    cout<<"\nIs vector empty? "<<a.empty();
}
```

```
Initially:
size= 0
capacity= 0
After inserting 1st element:
size= 1
capacity= 1
After inserting 2nd element:
size= 2
capacity= 2
After inserting 3rd element:
size= 3
capacity= 4
After inserting 4th element:
size= 4
capacity= 4
After inserting 5th element:
size= 5
capacity= 8

Element at index 2= 3 or 3
last element= 5
front element= 1

Before popping, size= 5 and vector is:
1 2 3 4 5
After popping, size= 4 and vector is:
1 2 3 4

Is vector empty? 0

Size of vector before clearing= 4 and capacity = 8
Clearing vector
Size of vector after clearing= 0 and capacity = 8

Is vector empty? 1
```

v[0]=1;
v[1]=2;

V imp: Don’t assign a vector like this else execution will stop!!!!

How to update the value in vector?

```cpp
# include <iostream>
# include <map>
# include <vector>

using namespace std;

int main(){
    vector<int> v={1,23,4};
    vector <int>::iterator it=v.begin()+1;
    *it=56;
    cout<<v[0]<<endl;
    cout<<v[1]<<endl;
    cout<<v[2]<<endl;
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\v
1
56
4
```

```cpp
#include <iostream>
#include<algorithm>
#include<vector>
using namespace std;

void Display(vector<int> v){
    for(int i=0;i<v.size();i++){
        cout<<v[i]<<" ";
    }
    cout<<endl<<endl;
}

int main() {
    vector<int> v1={1,2,3};
    vector<int> v2=v1;
    Display(v2);
    v1.push_back(56);
    Display(v2);
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Py
1 2 3

1 2 3
```

Deleting a particular iterator in a vector

```cpp
#include <iostream>
#include<vector>
using namespace std;

int main(){
    vector<int> v;
    v.push_back(23);
    v.push_back(56);
    v.push_back(34);
    vector<int>::iterator it=v.begin();
    v.erase(it);
    it=v.begin();
    cout<<*it<<" ";
    it++;
    cout<<*it<<" ";
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, (
56 34
```

vector::begin() and vector::end()

dsa.begin() stores the front pointer (i.e physical memory address of the first element of the data structure (dsa)) and dsa.end() stores the next physical memory address after the address of the last element of the data structure.

=> dsa.end()-1 stores the memory address of the last element of the data structure.

```
1   #include <iostream>
2   #include<vector>
3   using namespace std;
4
5   void Display(vector<int> v){
6       vector<int>::iterator it;
7       printf("The vector elements are:\n");
8       for ( it = v.begin(); it != v.end(); ++it)
9           cout << *it << " "<<endl; // printing the values of v vector
10      printf("\n");
11  }
12
13  int main() {
14     vector<int> v = { 50,60,70,80,90}, v1;   //declaring v (with values), v1 as vector.
15     vector<int>::iterator it;        //declaring an iterator
16
17     printf("Inserting element 40 at the beginning\n");
18     it = v.insert(v.begin(), 40);        // If we try to insert at 'nth' position from starting,
19     // then insert() will insert at 'nth' index by shifting the already existing elements starting from index 'n' to right by 1
20     Display(v);
21
```

```
22      //inserting a value in v vector at specified position using the function begin()).
23       printf("Inserting 20 at 3rd index from starting\n");
24       it = v.insert(v.begin()+2, 20);
25       Display(v);
26
27       //inserting a value with its frequency in v vector with specified the position at the beginning using the function begin().
28       printf("Inserting 30 with frequency 4 at second-last position from starting\n");
29       it = v.insert(v.begin()+v.size()-1, 4, 30);
30       Display(v);
31       //inserting all values from beginning to end, by using begin() and end() function, of v vector in v1 vector pointing at the beginning using begin() function.
32       v1.insert(v1.begin(),v.begin(),v.end());
33       cout << "The vector2 elements are:\n";
34       for (it = v1.begin(); it != v1.end(); ++it)
35           cout << *it << " "<<endl; // printing the values of v1 vector
36   return 0;
37   }
```

```
Inserting element 40 at the beginning
The vector elements are:
40
50
60
70
80
90

Inserting 20 at 3rd index from starting
The vector elements are:
40
50
20
60
70
80
90

Inserting 30 with frequency 4 at second-last position from starting
The vector elements are:
40
50
20
60
70
80
30
30
30
30
90

The vector2 elements are:
40
50
20
60
70
80
30
30
30
30
90
```

```cpp
#include <iostream>
#include<vector>
using namespace std;

void Display(vector<int> v){
    vector<int>::iterator it;
    printf("The vector elements are:\n");
    for ( it = v.begin(); it != v.end(); ++it)
        cout << *it << " "<<endl; // printing the values of v vector
    printf("\n");
}

int main() {
   vector<int> v(5,2);  // => 2 will be stored for 5 times
   Display(v);
   v.push_back(4);
   Display(v);
}
```

PROBLEMS 6 OUTPUT DEBUG CONSOLE TERMINAL

```
Try the new cross-platform PowerShell https://aka.ms/pscore6

PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\CodeBlocks\" ; if ($?) { g++
The vector elements are:
2
2
2
2
2

The vector elements are:
2
2
2
2
2
2
4
```

How to rotate a vector ?

Use std::rotate(v.begin(), v.begin()+k, v.end()); #Note this will rotate to right (clockwise) and this won't work for an array.
Here, k represents the number of times you want to rotate elements to the right.

```cpp
#include <bits/stdc++.h>
using namespace std;

int main(){
    vector<int> arr;
    arr.push_back(1);
    arr.push_back(2);
    arr.push_back(3);
    arr.push_back(4);
   std::rotate(arr.begin(),arr.begin()+1, arr.end());
   cout<<arr[0]<<" "<<arr[1]<<" "<<arr[2]<<" "<<arr[3]<<endl;
   std::rotate(arr.begin(),arr.begin()+2, arr.end());
   cout<<arr[0]<<" "<<arr[1]<<" "<<arr[2]<<" "<<arr[3]<<endl;
   std::rotate(arr.begin(),arr.begin()+4, arr.end());
   cout<<arr[0]<<" "<<arr[1]<<" "<<arr[2]<<" "<<arr[3]<<endl;
}
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS codes\C++ Basics\" ;
2 3 4 1
4 1 2 3
4 1 2 3
3 4 1 2
```

erase() function

```cpp
#include<iostream>
#include <bits/stdc++.h>
using namespace std;

void Display(vector<int> v){
    vector<int>::iterator it;
    printf("The vector elements are:\n");
    for ( it = v.begin(); it != v.end(); ++it)
        cout << *it << " "; // printing the values of v vector
    printf("\n");
}

int main() {
    vector<int> v = { 50,60,70,80,90}, v1; //declaring v(with values), v1 as vector.
    vector<int>::iterator it;
    printf("Before erasing ");
    Display(v);
    v.erase(v.begin(), v.begin()+2);
    printf("After erasing ");
    Display(v);
    return 0;
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS codes\C++ Basics\" ; if ($?) { g++ abc.cpp
Before erasing The vector elements are:
50 60 70 80 90
After erasing The vector elements are:
70 80 90
```

```cpp
#include<iostream>
#include <bits/stdc++.h>
using namespace std;

void Display(vector<int> v){
    vector<int>::iterator it;
    printf("The vector elements are:\n");
    for ( it = v.begin(); it != v.end(); ++it)
        cout << *it << " "; // printing the values of v vector
    printf("\n");
}

int main() {
    vector<int> v = { 50,60,70,80,90}, v1; //declaring v(with values), v1 as vector.
    vector<int>::iterator it;
    printf("Before erasing ");
    Display(v);
    v.erase(v.begin());
    printf("After erasing ");
    Display(v);
    return 0;
}
```

This will erase only the front element

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS codes\C++ Basics\" ; if ($?) { g++ abc.cpp
Before erasing The vector elements are:
50 60 70 80 90
After erasing The vector elements are:
60 70 80 90
```

Checking whether the change in vector is also reflected in its duplicate vector

```cpp
#include <iostream>
#include<vector>
using namespace std;

void Display(vector<int> v){
    vector<int>::iterator it;
    printf("The vector elements are:\n");
    for ( it = v.begin(); it != v.end(); ++it)
        cout << *it << " "; // printing the values of v vector
    printf("\n");
}

int main() {
   vector<int> v(5,2);  // => 2 will be stored for 5 times
   Display(v);
   vector<int> dup(v);  // => elements from vector 'v' will be copied to vector dup
   Display(dup);
   v.push_back(56);
   Display(dup);
   v.pop_back();
   Display(dup);
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\CodeBlocks\" ; if ($?) { g++ Basics.cpp -o Ba
The vector elements are:
2 2 2 2 2
The vector elements are:
2 2 2 2 2
The vector elements are:
2 2 2 2 2
The vector elements are:
2 2 2 2 2
```

```cpp
#include <iostream>
#include<vector>
using namespace std;

void Display(vector<int> v){
    vector<int>::iterator it;
    printf("The vector elements are:\n");
    for ( it = v.begin(); it != v.end(); ++it)
        cout << *it << " "; // printing the values of v vector
    printf("\n");
}

int main() {
   vector<int> v(5,2);  // => 2 will be stored for 5 times
   Display(v);
   vector<int> v1;
   v1.insert(v1.begin(),v.begin(),v.end());
   v.push_back(45);
   Display(v1);
   v.pop_back();
   Display(v1);
}
```

PROBLEMS 6 OUTPUT DEBUG CONSOLE TERMINAL

```
PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\CodeBlocks\" ; if ($?
The vector elements are:
2 2 2 2 2
The vector elements are:
2 2 2 2 2
The vector elements are:
2 2 2 2 2
```

Inserting vector at a particular index using insert()

```cpp
#include <iostream>
#include<algorithm>
#include<vector>
#include<map>
using namespace std;

int main(){
    vector<int> v;
    v.insert(v.begin(),34);
    v.insert(v.begin(),56);
    cout<<v[0]<<" ";
    cout<<v[1]<<" ";
}
```

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```
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PS D:\Codes (Python, C)\VS codes> cd "d:\Codes
56 34
```

```cpp
#include <iostream>
#include<algorithm>
#include<vector>
#include<map>
using namespace std;

int main(){
    vector<int> v;
    v.insert(v.begin(),34);
    v.insert(v.begin()+1,56);
    cout<<v[0]<<" ";
    cout<<v[1]<<" ";
}
```

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```
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Try the new cross-platform PowerShell https://aka

PS D:\Codes (Python, C)\VS codes> cd "d:\Codes (P
34 56
```

```cpp
#include <iostream>
#include<algorithm>
#include<vector>
#include<map>
using namespace std;

int main(){
    vector<int> v;
    v.insert(v.begin()+1,34);
    v.insert(v.begin(),56);
    cout<<v[0]<<" ";
    cout<<v[1]<<" ";
}
```

This causes error and program will terminate because there is no 1th index initially in the array.
There is only 0^{th} index initially in the array

PROBLEMS 1 OUTPUT DEBUG CONSOLE TER

```
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PS D:\Codes (Python, C)\VS codes> cd "d:\
PS D:\Codes (Python, C)\VS codes\OS>
```

How to insert element in vector at a particular index?

Sol: Temporarily create an array, insert elements at desired position and then make a vector and copy elements of array into that vector.

```cpp
#include <iostream>
#include<algorithm>
#include<vector>
#include<map>
using namespace std;

int main(){

   int arr[4]={1,2,3,4};
   int n=sizeof(arr)/sizeof(arr[0]);
   vector<int> v(arr,arr+n);
   cout<<v[0]<<" "<<v[1]<<" "<<v[2]<<" "<<v[3]<<" ";
}
```

```
PROBLEMS 1  OUTPUT  DEBUG CONSOLE  TERMINAL

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PS D:\Codes (Python, C)\VS codes> cd "d:\Codes (Python, C)\VS codes\C
1 2 3 4
PS D:\Codes (Python, C)\VS codes\OS>
```

```cpp
#include <iostream>
#include<algorithm>
#include<vector>
#include<map>
using namespace std;

int main(){

   int arr[4]={1,2,3,4};
   vector<int> v(arr,arr+4);
   cout<<v[0]<<" "<<v[1]<<" "<<v[2]<<" "<<v[3]<<" ";
}
```

```
PROBLEMS 4  OUTPUT  DEBUG CONSOLE  TERMINAL

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PS D:\Codes (Python, C)\VS codes> cd "d:\Codes (Python, C)\VS codes\OS
1 2 3 4
PS D:\Codes (Python, C)\VS codes\OS>
```

How to declare 2D vector

```
vector<vector<int>> vect;
```

Deque STL

Double-ended queues are sequence containers with the feature of expansion and contraction on both ends [unlike vectors which supports only push_back() and pop_back()]. They are similar to vectors, but are more efficient in case of insertion and deletion of elements. Unlike vectors, contiguous storage allocation may not be guaranteed.

A double-ended queue (std::deque) **doesn't have a capacity, it only has a size**.

```cpp
#include <iostream>
#include<deque>
using namespace std;

void Display(deque<int> deq){
    deque<int>::iterator it;
    printf("The deque elements are:\n");
    for ( it = deq.begin(); it != deq.end(); ++it)
        cout << *it << " "; // printing the values of v vector
    printf("\n");
}

int main() {
    deque<int> deq;
    deq.push_back(2);
    deq.push_back(3);
    deq.push_front(1);
    Display(deq);
    printf("Element at index 0 = %d\n",deq.at(0)," or %d\n",deq[0]);
    printf("Front element = %d\n",deq.front());
    printf("Rear element = %d\n",deq.back());
    printf("Is deque empty = %d\n",deq.empty());
    printf("*deq.begin() = %d and *deq.end() = %d and *(deq.end()-1) = %d\n",*deq.begin(), *deq.end(), *(deq.end()-1));
    printf("deque size before erasing = %d\n",deq.size());
    deq.erase(deq.begin(), deq.end()-1);      // in erase function, we have to specify the starting address and (ending address+1) of the items to be erased
    printf("deque size after erasing=%d\n",deq.size());
    Display(deq);
}
```

```
The deque elements are:
1 2 3
Element at index 0 = 1
Front element = 1
Rear element = 3
Is deque empty = 0
*deq.begin() = 1 and *deq.end() = 34603536 and *(deq.end()-1) = 3
deque size before erasing = 3
deque size after erasing=1
The deque elements are:
3
```

List STL

Lists are sequence containers that allow non-contiguous memory allocation. As compared to vector, the list has slow traversal, but once a position has been found, insertion and deletion are quick. Normally, when we say a List, we talk about a doubly linked list. For implementing a singly linked list, we use a forward list.

include <list>

1) l.push_front()
2) l.push_back()
3) l.pop_front()
4) l.pop_back()
5) l.empty()
6) l.size()
7) To copy list l into l1: list<int> l1 (l);
8) l.erase(<>, <>)

Stack STL

include <stack>

1) l.push()
2) l.pop()
3) l.empty()
4) l.size()
5) l.top(): returns the top element of the stack
6) To copy stack l into l1: stack<int> l1 (l);

```cpp
#include <iostream>
#include<stack>
using namespace std;

void Display(stack<int> st){
    for (int i=0; i<st.size();){
        cout << st.top() << " "; // printing the values of v vector
        st.pop();
    }
    printf("\n");
}

int main() {
    stack<int> st;
    st.push(1);
    st.push(2);
    st.push(3);
    stack<int>st1 (st);
    Display(st1);
}
```

 # stack<int> st(3,54): error!!!

 # st[0]: error, you can only access stack using top()

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS codes\C++ Basics\" ; if (
3 2 1
```

Queue STL

include <queue>

1) l.push(): Adds at the last
2) l.pop(): Removes the 1st element
3) l.empty()
4) l.size()
5) l.front(): returns the top element of the stack

Priority Queue STL

Priority queue is implemented using heap data structure. By default, it is max heap type. A priority queue always returns the max element in the queue (if it is max heap) and min element (if it is min heap) when we use top() command.

```
#include <queue>
priority_queue<int> q;          => max heap
priority_queue<int, vector<int>, greater<int>> q;    => min heap (if instead of int you want priority queue of vector<int> then replace int by vector<int> everywhere in the statement).
```

1) l.push()
2) l.pop(): Removes the topmost element (greatest element in case of max heap and smallest in case of min heap) of the priority queue. **Doesn't return anything!!!!**
3) l.empty()
4) l.size(): Tells the number of elements in the priority queue
5) l.top(): returns **(not pop)** the top element of the max heap/min heap of the priority queue

Iteration isn't part of the queue interface so if you want iteration you need to choose something else.

```cpp
#include <iostream>
#include<queue>
using namespace std;

void Display_for_max(priority_queue<int> q){
    for (int i=0; i<q.size();){
        cout << q.top() << " ";
        q.pop();
    }
    printf("\n");
}

void Display_for_min(priority_queue<int, vector <int>, greater<int>> q){
    for (int i=0; i<q.size();){
        cout << q.top() << " ";
        q.pop();
    }
    printf("\n");
}

int main() {
    priority_queue<int> q_max;
    priority_queue<int, vector<int>, greater<int>> q_min;
    q_max.push(5);      q_min.push(5);
    q_max.push(56);     q_min.push(56);
    q_max.push(15);     q_min.push(15);
    q_max.push(1);      q_min.push(1);
    q_max.push(12);     q_min.push(12);

    printf("Displaying q_max\n");
    Display_for_max(q_max);
    printf("Displaying q_min\n");
    Display_for_min(q_min);
}
```

Note: You need to create a different functions for q_max and q_min because even though they both are priority queues, yet their syntaxes are different, so they will be considered as different data types.

```
Displaying q_max
56 15 12 5 1
Displaying q_min
1 5 12 15 56
```

For Max heap

```cpp
#include <iostream>
# include <queue>
# include <vector>
# include <set>

using namespace std;

int main(){
    priority_queue<vector<int>> q;
    q.push({23,56});
    q.push({21,67});
    q.push({23,7});
    for(int i=1;i<=q.size();){
        cout<<(q.top())[0]<<" "<<(q.top())[1]<<endl;
        q.pop();
    }
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS codes\C+-
23 56
23 7
21 67
```

For Min heap

```cpp
#include <iostream>
# include <queue>
# include <vector>
# include <set>

using namespace std;

int main(){
    priority_queue<vector<int>,vector<vector<int>>, greater<vector<int>>> q;
    q.push({23,56});
    q.push({21,67});
    q.push({23,7});
    for(int i=1;i<=q.size();){
        cout<<(q.top())[0]<<" "<<(q.top())[1]<<endl;
        q.pop();
    }
}
```

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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS codes\C++ Basics\" ; if ($?) { g++
21 67
23 7
23 56
```

Set STL

Sets are a type of associative containers in which each element has to be unique because the value of the element identifies it. The values are stored in a specific order.

Syntax:

```
set<datatype> setname;
```

Datatype: Set can take any data type depending on the values, e.g. int, char, float, etc.

Example:

```
set<int> val; // defining an empty set
set<int> val = {6, 10, 5, 1}; // defining a set with values
```

> ***Note:*** *set<datatype, greater<datatype>> setname; is used for storing values in a set in de scending order.*

Properties:

1. The set stores the elements in **sorted** order.
2. All the elements in a set have **unique values**.
3. The value of the element cannot be modified once it is added to the set, though it is possible to remove and then add the modified value of that element. Thus, the values are **immutable**.
4. Sets follow the **Binary search tree** implementation.
5. The values in a set are **unindexed**.

> ***Note:*** *To store the elements in an unsorted (random) order,* ***unordered_set()*** *can be used.*

Some Basic Functions Associated with Set:

- begin() – Returns an iterator to the first element in the set.
- end() – Returns an iterator to the theoretical element that follows the last element in the set.
- size() – Returns the number of elements in the set.
- max_size() – Returns the maximum number of elements that the set can hold.
- empty() – Returns whether the set is empty.

clear() – To empty a set. This is beneficial when you have defined a global set data structure and there are multiple test cases to be tested. So after each test case, you have to clear() the set else it will effect other test cases!!!

set<int>::iterator it = s.find(int n): This function returns the iterator of the element n if it is present in the set s, else the iterator points to the position just after the last element in the set if the element is not present in the set. The time complexity of find(key) is **O(log N)**.

```cpp
#include <iostream>
#include<set>
using namespace std;

void Display(set<int> s){
    set<int>::iterator it;
    for(it=s.begin(); it!=s.end();it++){
        cout<<*it<<" ";
    }
    cout<<"\n";
}

int main() {
    set<int> s={4,3,5,4,3};
    Display(s);

    s.insert(7);
    s.insert(7);
    Display(s);

    s.erase(4);
    Display(s);

    printf("Is 5 present in the set s? %d\n",s.count(5));

    set<int>::iterator it;
    it=s.find(3);
    for(;it!=s.end();it++){
        cout<<*it<<" ";
    }
    printf("\n");

    it=s.find(8);
    for(;it!=s.end();it++){
        cout<<*it<<" ";
    }
    printf("\n");
}
```

```
3 4 5
3 4 5 7
3 5 7
Is 5 present in the set s? 1
3 5 7
```

ement is present in the set or not.

```cpp
#include <iostream>
#include<set>
using namespace std;

int main() {
    set<int> s={4,3,5,4,3};
    set<int>::iterator it;
    it=s.find(787);
    cout<<*it<<" ";
}
```

PROBLEMS OUTPUT DEBUG CONSOLE TEF

```
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PS C:\Users\Sushant Singh> cd "d:\Cod
3
```

?????

Vector inside a Set

```cpp
#include <iostream>
# include <queue>
# include <vector>
# include <set>
using namespace std;

int main(){
    priority_queue<int, vector<int>, greater<int>> q;
    int n,i;
    printf("Enter the number of houses\n");
    cin>>n;
    printf("Enter the coordinates of the houses\n");
    set<vector<int>> s;
    for(i=1;i<=n;i++){
        vector<int> v;
        int x,y;
        cin>>x>>y;
        v.push_back(x);
        v.push_back(y);
      //  v[0]=x;     //v[1]=y;
        s.insert(v);
    }
    set<vector<int>>::iterator it=s.begin();
    for(;it!=s.end();it++){
        cout<<(*it)[0]<<" "<<(*it)[1]<<endl;
    }
}
```

```
Enter the number of houses
3
Enter the coordinates of the houses
1
2
3
4
5
6
1 2
3 4
5 6
```

V imp: Don’t assign a vector like this else execution will stop!!!!

```cpp
#include <iostream>
# include <queue>
# include <vector>
# include <set>
using namespace std;

int Input(set <vector<int>> s){
    int n,i;
    printf("Enter the number of houses\n");
    cin>>n;
    printf("Enter the coordinates of the houses\n");
    for(i=1;i<=n;i++){
        vector<int> v;
        int x,y;
        cin>>x>>y;
        v.push_back(x);
        v.push_back(y);
        s.insert(v);
    }
    return n;
}
int main(){
    set<vector<int>> s;
    priority_queue<int, vector<int>, greater<int>> q;
    int n=Input(s);
    set<vector<int>>::iterator it=s.begin();
    cout<<"s.size= "<<s.size()<<endl;
    for(;it!=s.end();it++){
        cout<<(*it)[0]<<" "<<(*it)[1]<<endl;
    }
}
```

Passing STL datatype inside a function and modifying it.

Conclusion: The real datatype outside the function won't get modified.

```
Enter the number of houses
2
Enter the coordinates of the houses
1
2
3
4
s.size= 0
```

<Cont.>

Set stores result in stored order

```cpp
#include <iostream>
# include <queue>
# include <vector>
# include <set>
using namespace std;

set <vector<int>> Input(){
    set<vector<int>> s;
    int n,i;
    printf("Enter the number of houses\n");
    cin>>n;
    printf("Enter the coordinates of the houses\n");
    for(i=1;i<=n;i++){
        vector<int> v;
        int x,y;
        cin>>x>>y;
        v.push_back(x);
        v.push_back(y);
        s.insert(v);
    }
    return s;
}
int main(){
    priority_queue<int, vector<int>, greater<int>> q;
    set<vector<int>> s = Input();
    set<vector<int>>::iterator it=s.begin();
    cout<<"s.size= "<<s.size()<<endl;
    for(;it!=s.end();it++){
        cout<<(*it)[0]<<" "<<(*it)[1]<<endl;
    }
}
```

```
Enter the number of houses
5
Enter the coordinates of the houses
789 900
789 901
34 56
35 67
1 4345

s.size= 5
1 4345
34 56
35 67
789 900
789 901
```

Each line contains 2 numbers which will be stored in the form of vector in the set, i.e v[0]=789, v[1]=900. Similarly, v[0]=789, v[1]=901. Now, once this vector of size 2 is stored in the set, it would be stored in sorted order everytime we insert the new vector. That's why the result displayed is inn sorted manner.

Map STL

Maps are associative containers that store elements in a mapped fashion. Each element has a key value and a mapped value. No two mapped values can have the same key values.

Some basic functions associated with Map:

- begin() – Returns an iterator to the first element in the map.
- end() – Returns an iterator to the theoretical element that follows the last element in the map.
- size() – Returns the number of elements in the map.
- max_size() – Returns the maximum number of elements that the map can hold.
- empty() – Returns whether the map is empty.
- pair insert(keyvalue, mapvalue) – Adds a new element to the map.
- erase(iterator position) – Removes the element at the position pointed by the iterator.
- erase(const g) – Removes the key-value 'g' from the map.
- clear() – Removes all the elements from the map.

To access the key in map given an iterator it: Key=(*it).first and Value=(*it).second
Map stores the data in sorted order (sorting is based on the key)

```cpp
int main(){
    map<int,int> m;
    m[1]=34;
    cout<<m[288];
}
```

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```
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PS C:\Users\Sushant Singh> cd "
0
```

```cpp
#include <iostream>
#include<map>
using namespace std;

void Display(map<int,string> m){
    map<int,string>::iterator it;
    for(it=m.begin(); it!=m.end();it++){
        cout<<(*it).first<<" "<<(*it).second<<"\n";
    }
    printf("\n");
}

int main() {
    map<int,string> m;
    m[78]="John";
    m[51]="Dechler";
    m[13]="Hipo";
    Display(m);

    m.insert({5,"Tanya"});
    m.insert({1,"Herp"});
    Display(m);

    m.erase(51);
    Display(m);

    printf("Is 5 present in the map m? %d\n\n",m.count(5));
    map<int,string>::iterator it;
    it=m.find(13);
    for(;it!=m.end();it++){
        cout<<(*it).first<<" "<<(*it).second<<"\n";
    }
    printf("\n\n");

    it=m.find(8);
    for(;it!=m.end();it++){
        cout<<(*it).first<<" "<<(*it).second<<"\n";
    }
}
```

```
13 Hipo
51 Dechler
78 John

1 Herp
5 Tanya
13 Hipo
51 Dechler
78 John

1 Herp
5 Tanya
13 Hipo
78 John

Is 5 present in the map m? 1

13 Hipo
78 John
```

```cpp
#include <iostream>
#include<algorithm>
#include<vector>
#include<map>
using namespace std;

int main(){
    map<int, int> m;
    m[1]=12;
    m[2]=323;
    m[45]=456;
    map<int, int>::iterator it;
    for(it=m.begin();it!=m.end();it++)
        cout<<(*it).first<<" ";
        cout<<(*it).second<<"\n";
    }
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python,
1 12
2 323
45 456
```

```cpp
#include <iostream>
#include<algorithm>
#include<vector>
#include<map>
using namespace std;

int main(){
    map<int, int> m;
    m[1]={12,3};
    m[2]={45};
    m[45]={6,456};
    map<int, int>::iterator it;
    for(it=m.begin();it!=m.end();it++){
        cout<<(*it).second<<" ";
    }
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS
def.cpp: In function 'int main()':
def.cpp:9:15: error: cannot convert '<brace-enclosed
    9 |     m[1]={12,3};
      |               ^
def.cpp:11:17: error: cannot convert '<brace-enclosed
   11 |     m[45]={6,456};
      |                 ^
PS D:\Codes (Python, C)\VS codes\C++ Basics>
```

```cpp
#include <iostream>
#include<algorithm>
#include<vector>
#include<map>
using namespace std;

int main(){
    map<int, vector<int>> m;
    m[1]={12,3};
    m[2]={45};
    m[45]={6,456};
    map<int, vector<int>>::iterator it;
    for(it=m.begin();it!=m.end();it++){
        cout<<((*it).second)[0]<<" ";
    }
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C
12 45 6
```

```cpp
#include <iostream>
#include<algorithm>
#include<vector>
#include<map>
using namespace std;

int main(){
    map<int, vector<int>> m;
    m[1]={12,3};
    m[2]={45};
    m[45]={6,456};
    map<int, vector<int>>::iterator it;
    for(it=m.begin();it!=m.end();it++){
        cout<<(*it).second<<" ";
    }
}
```

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```
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S C:\Users\Sushant Singh> cd "d:\Codes (Python, C)"
ef.cpp: In function 'int main()':
ef.cpp:14:13: error: no match for 'operator<<' (ope
  14 |         cout<<(*it).second<<" ";
     |         ~~~~^~~~~~~~~~~~~~~~~~
     |             |
```

map vs unordered_map

When it comes to efficiency, there is a huge difference between maps and unordered maps.

Use std::map when
You need ordered data.
You would have to print/access the data (in sorted order).
You need predecessor/successor of elements.

Use std::unordered_map when
You need to keep count of some data (Example – strings) and no ordering is required.
You need single element access i.e. no traversal.

Difference :

	map	unordered_map
Ordering	increasing order (by default)	no ordering
Implementation	Self balancing BST like Red-Black Tree	Hash Table
search time	log(n)	O(1) -> Average O(n) -> Worst Case
Insertion time	log(n) + Rebalance	Same as search
Deletion time	log(n) + Rebalance	Same as search

Algorithms STL

```cpp
#include <iostream>
#include<algorithm>
#include<vector>
using namespace std;

int main() {
    int i;
    // reverse()
    printf("Reversing string\n");
    string s="Sushant";
    reverse(s.begin()+1,s.end()); // reverses and the change is reflected in the same string
    cout<<s<<endl<<endl;

    // sort()
    vector<int> arr={1,6,3,5,5,5,8};
    printf("Sorting vector\n");
    sort(arr.begin(), arr.end());
    for(i=0;i<arr.size();i++){
        cout<<arr[i]<<" ";
    }
    cout<<"\n\n";

    // Binary search
    cout<<"Applying Binary search: Is 34 present? "<<binary_search(arr.begin(),arr.end(),34)<<endl<<endl;

    // find()
    printf("Applying find(6)\n");
    vector<int>::iterator it=find(arr.begin(),arr.end(),6);
    for(;it!=arr.end();it++){
        cout<<*it<<" ";
    }

    // max()
    cout<<"\n\nmax(45,32)= "<<max(45,32)<<endl<<endl;

    // swap()
    printf("Swapping a and b\n");
    int a=4;
    int b=56;
    swap(a,b);      // swap() can be applied on all data types
    cout<<"a= "<<a<<" and b= "<<b<<endl<<endl;

}
```

```
Reversing string
Stnahsu

Sorting vector
1 3 5 5 5 6 8

Applying Binary search: Is 34 present? 0

Applying find(6)
6 8

max(45,32)= 45

Swapping a and b
a= 56 and b= 4
```

To generate random numbers in C++: Like we want to generate a random number between 1-6 then we use this function like −
Num = rand() % 6 + 1;

The rand() function is used in C/C++ to generate random numbers in the range [0, RAND_MAX).
Note: If random numbers are generated with rand() without first calling srand(), your program will create the same sequence of numbers each time it runs.

To measure running time of code:

```
#include <iostream>
#include <chrono>

int main(){
    std::chrono::steady_clock::time_point begin = std::chrono::steady_clock::now();
    //<<<<<<<<<< Write your Code >>>>>>>>>>
    std::chrono::steady_clock::time_point end = std::chrono::steady_clock::now();
    std::cout << "Time difference = " << std::chrono::duration_cast<std::chrono::nanoseconds> (end-
begin).count() << "[ns]" << std::endl;
}
```

Do include #include<bits/stdc++.h> header before using these functions.

1) To sort a non STL array: sort(arr,arr+n);
2) To sort an STL array: sort(arr.begin(), arr.end());
3) To find GCD of 2 numbers: int ans= _ _gcd(int a, int b);
4) To insert 1 vetor v1 into another vector v2: v2.insert(v2.end(), v1.begin(), v1.end()); # This will insert whole vector v1 to the end of v2
5) To reverse an array: reverse(v.begin(), v.end());
6) To reverse a string: string str="hello";
   reverse(str.begin(),str.end());
   // Now str="olleh"
7) To initialize 2D vector with all 0's using parameterized constructor with x rows and y columns:

```
vector<vector<int>> mat(x, vector<int>(y,0));
```

Note: The following points must be noted regarding the STL functions **min()** and **max()**:

1) They **only take 2 arguments**, not more or less than that.
2) The arguments passed inside them must be of **exactly same data type**. e.g: **if one is long long then other can't be int**, it should also be long long.

upper_bound() and lower_bound()

Do include #include<bits/stdc++.h> header before using these functions.

upper_bound(): returns the iterator of first such element which is > n. If all numbers are > n then it returns v.begin(). If all numbers are <= n then it returns v.end()

```cpp
int main()
{
    std::vector<int> v{ 10, 20, 30, 40, 50 };
    std::vector<int>::iterator upper;
    cout<<"*v.end()= "<<*v.end()<<endl<<endl;
    upper = std::upper_bound(v.begin(), v.end(), 35);
    cout<<"*upper for "<<35<<" = "<<*upper<<endl;
    upper = std::upper_bound(v.begin(), v.end(), 50);
    cout<<"*upper for "<<50<<" = "<<*upper<<endl;
    upper = std::upper_bound(v.begin(), v.end(), 10);
    cout<<"*upper for "<<10<<" = "<<*upper<<endl;
    upper = std::upper_bound(v.begin(), v.end(), 5);
    cout<<"*upper for "<<5<<" = "<<*upper<<endl;
    upper = std::upper_bound(v.begin(), v.end(), 60);
    cout<<"*upper for "<<60<<" = "<<*upper<<endl;
    upper = std::upper_bound(v.begin(), v.end(), 1001);
    cout<<"*upper for "<<1001<<" = "<<*upper<<endl;
    upper = std::upper_bound(v.begin(), v.end(), 20);
    cout<<"*upper for "<<20<<" = "<<*upper<<endl;
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS codes\C++ B
*v.end()= 8089368

*upper for 35 = 40
*upper for 50 = 8089368
*upper for 10 = 20
*upper for 5 = 10
*upper for 60 = 8089368
*upper for 1001 = 8089368
*upper for 20 = 30
```

lower_bound(): returns the iterator of first such element which is >= n. If all numbers are >= n then it returns v.begin(). If all numbers are < n then it returns v.end()

```cpp
int main()
{
    std::vector<int> v{ 10, 20, 30, 40, 50 };
    std::vector<int>::iterator lower;
    cout<<"*v.end()= "<<*v.end()<<endl<<endl;
    lower = std::lower_bound(v.begin(), v.end(), 35);
    cout<<"*lower for "<<35<<" = "<<*lower<<endl;
    lower = std::lower_bound(v.begin(), v.end(), 50);
    cout<<"*lower for "<<50<<" = "<<*lower<<endl;
    lower = std::lower_bound(v.begin(), v.end(), 10);
    cout<<"*lower for "<<10<<" = "<<*lower<<endl;
    lower = std::lower_bound(v.begin(), v.end(), 5);
    cout<<"*lower for "<<5<<" = "<<*lower<<endl;
    lower = std::lower_bound(v.begin(), v.end(), 60);
    cout<<"*lower for "<<60<<" = "<<*lower<<endl;
    lower = std::lower_bound(v.begin(), v.end(), 1001);
    cout<<"*lower for "<<1001<<" = "<<*lower<<endl;
    lower = std::lower_bound(v.begin(), v.end(), 20);
    cout<<"*lower for "<<20<<" = "<<*lower<<endl;
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS codes\C++ Ba
*v.end()= 15101720

*lower for 35 = 40
*lower for 50 = 50
*lower for 10 = 10
*lower for 5 = 10
*lower for 60 = 15101720
*lower for 1001 = 15101720
*lower for 20 = 20
```

```
int lo,hi;
   if(binary_search(arr,arr+n,x)==0)
      return {-1,-1};
   lo=lower_bound(arr,arr+n,x)-arr;       // gives lower index of element x
   hi=upper_bound(arr,arr+n,x)-arr-1;    // gives higher index of element x
   return {lo,hi};
}
```

binary_search(start_ptr, end_ptr, num) : This function returns boolean **true if the element is present** in the container, else returns false.

Strings

https://www.tutorialspoint.com/cplusplus/cpp_strings.htm

Operations on C++ Strings

Column 1	Column 2
strcpy(string1, string2)	copies all the characters of string2 to string1.
strcat(string1, string2)	returns a string joining string1 and string2.
strlen(string1)	returns int length of the given string1.
strcmp(string1, string2)	compares string1 and string2, if they are equals it returns 0, if string1 is greater than string2, it returns 1 else returns -1.
strchr(string1, char)	returns the pointer pointing to the first appearance of character char in string1.
strrchr(string1, char)	returns the pointer pointing to the last appearance of character char in string1.
strstr(string1, substring2)	returns the pointer pointing to the first appearance of substring2 in string1.
strlwr(string1)	converts all the characters of string1 to lowercase.
strupr(string1)	converts all the characters of string1 to lowercase.
strncat(string1, string2, n)	appends first n characters of string2 at the end of string1.
strncpy(string1, string2, n)	copies first n characters of string2 into string1.
strset(string1, ch)	sets all the characters of string1 to ch.
strnset(string1, ch, n)	sets first n characters of string1 to ch.
getline(istream& is, string& str)	takes a stream of characters as input from the user, in the object memory.
push_back()	adds a character at the end of the given string.
pop_back()	deletes the last character of the given string.
begin()	returns an iterator to the beginning of the given string.
capacity()	returns the capacity allocated to the string at the initialization, which can be equal to or more than the size of the string.
resize()	This function changes the size of the string, the size can be increased or decreased.
length()	This function finds the length of the string.

Taking input a string in C++

```cpp
#include <iostream>
#include<vector>
#include<algorithm>
#include<string>
using namespace std;

int main(){
    string s;
    printf("Enter\n");
    cin>>s;
    cout<<s.size()<<endl;
    reverse(s.begin(),s.end());
    cout<<s;
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS codes\C
Enter
Sushant Singh
7
tnahsuS
```

Note: “\n” wasn’t considered as a string !!!!!!!!!!!!!!!!!!!

Beware of char to int type conversion !!!!!

```cpp
#include <iostream>
#include<vector>
#include<algorithm>
#include<string>
using namespace std;

int main(){
    string s;
    printf("Enter the string\n");
    cin>>s;
    int i=0;
    while(i<s.size()){
        int num=s[i];       // or int num=(int)s[i]  they are one and same thing
        cout<<num<<endl;
        i++;
    }
}
```

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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS codes\C++ Basics\" ; if ($?) { g++ Use
Enter the string
1092
49
48
57
50
```

```cpp
#include <iostream>
#include<vector>
#include<algorithm>
#include<string>
using namespace std;

int main(){
    string s;
    printf("Enter the string\n");
    cin>>s;
    int i=0;
    while(i<s.size()){
        int num=s[i]-48;       // or int num=(int)s[i]  they are one and same thing
        cout<<num<<endl;
        i++;
    }
}
```

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```
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PS C:\Users\Sushant Singh> cd "d:\Codes (Python, C)\VS codes\C++ Basics\" ; if ($?) { g++ Useless
Enter the string
1092
1
0
9
2
```

string functions

1) To reverse a string: reverse(S.begin(),S.end());
2) To find length of string: int len= str.length();
3) To add character at the end of string: str.push_back(ch);
4) Note: str=str+"hi" or str+="hi" will work in c++ just like java !!!

```
 7  int main()
 8  {
 9      string st="abc";
10      st=st+" efg";
11      cout<<st;
12  }
```

```
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PS C:\Users\Sushant Singh> c
abc efg
```

```
 7  int main()
 8  {
 9      string st="abc";
10      st=st+'i';
11      cout<<st;
12  }
```

```
PROBLEMS    OUTPUT    DEBUG CONS

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PS C:\Users\Sushant Singh> cd
abci
```

```
 7  int main()
 8  {
 9      string st="abc";
10      st=st+"i";
11      cout<<st;
12  }
```

```
PROBLEMS    OUTPUT    DEBUG CONSO

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PS C:\Users\Sushant Singh> cd '
p -o def } ; if ($?) { .\def }
abci
```

C++ automatically appends '\0' to the end of the string in STL

```
7   int main()
8   {
9       string st="abc";
10      if(st[3]=='a')
11          printf("yes");
12      else    printf("no");
13  }
```

PROBLEMS OUTPUT DEBUG CONSOLE T

```
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PS C:\Users\Sushant Singh> cd "d:\Co
no
```

```
1   #include <iostream>
2   #include<climits>
3   #include<bits/stdc++.h>
4   #include<algorithm>
5   using namespace std;
6
7   int main()
8   {
9       string st="abc";
10      if(st[3]=='\0')
11          printf("yes");
12      else    printf("no");
13  }
```

PROBLEMS OUTPUT DEBUG CONSOLE T

```
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PS C:\Users\Sushant Singh> cd "d:\Co
yes
```

str.erase()

```
int main(){
    string s="abc";
    s.erase(2,2);
    cout<<s<<endl;
}
```

Output: ab

```
int main(){
    string s="abc";
    s.erase(1,1);
    cout<<s<<endl;
}
```

Output: ac

```
int main(){
    string s="abc";
    s.erase(0,0);
    cout<<s<<endl;
}
```

Output: abc

erase(0,0) does not work !!!!

```
int main(){
    string s="abc";
    s.erase(0,7);
    cout<<s<<endl;
}
```

Output:

```
int main(){
    string s="india";
    s.erase(0,4);
    cout<<s<<endl;
}
```

Output: a

```
int main(){
    string s="india";
    s.erase(-1);
    cout<<s<<endl;
}
```

Output: error

```
int main(){
    string s="india";
    s.erase(-1,3);
    cout<<s<<endl;
}
```

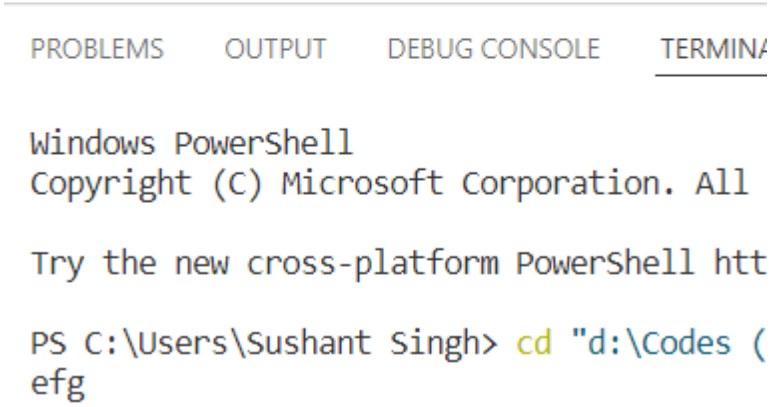
Output: error

```
int main(){
    string s="india";
    s.erase(-1,3);
    cout<<s<<endl;
}
```

Output: error

str.substr(a,b): returns the substring of length b from the starting index a.

```
7   int main(){
8       string s="abcdefghijkl";
9       cout<<s.substr(4,3);
10  }
```




```
int main(){
    string s="india";
    s=s.substr(0,0);
    cout<<s;
}
```

Output: india

substr(0,0) does not work !!!!

```
int main(){
   string s="india";
   s=s.substr(0);
   cout<<s;
}
```

Output: india

```
int main(){
   string s="india";
   s=s.substr(3);
   cout<<s;
}
```

Output: ia

```
int main(){
   string s="india";
   s=s.substr(-1);
   cout<<s;
}
```

Output:

```
int main(){
   string s="india";
   s=s.substr(5);
   cout<<s;
}
```

Output:

```
int main(){
   string s="india";
   s=s.substr(4);
   cout<<s;
}
```

Output: a

```
int main(){
   string s="india";
   s=s.substr(-1,2);
   cout<<s;
}
```

Output: error!!

```
int main(){
   string s="india";
   s=s.substr(0,3);
   cout<<s;
}
```

Output: ind

```
int main(){
   string s="india";
   s=s.substr(3,0);
   cout<<s;
}
```

Output:

```
int main(){
   string s="india";
   s=s.substr(0,7);
   cout<<s;
}
```

Output: india

sort(str.begin(), str.end());

```
int main(){
   string s="india";
   sort(s.begin(), s.end());
   cout<<s;
}
```

Output: adiin

```
int main(){
   string s="india";
   sort(s,s+5);
   cout<<s;
}
```

Error!!!

map/set vs vector

Avoid using map/set (both ordered and unordered) as far as possible and use vector/array instead to avoid TLE !!!

The C++ standard library contains two map implementations that correspond to the set implementations: the structure map is based on a balanced binary tree and accessing elements takes O(logn) time **on average**, while the structure unordered_map uses hashing and accessing elements takes O(1) time **on average**.

First thing to note is, although the average time to query an unordered_map is constant, the worst case is not O(1). As you can see here it actually rises to the order of O(N), N denoting the size of the container.
Secondly, as vector allocates sequential portions of memory, accessing to that memory is highly efficient and actually is constant, even in the worst-case. (i.e. simple pointer arithmetic, as opposed to computing the result of a more complex hash function) There is also the possibility of various levels of caching of sequential memory that may be involved (i.e. depending on the platform your code is running on) which may make the execution of a code using vector even faster, compared to one that is using unordered_map.
In essence, in terms of complexity, the worst-case performance of a vector is more efficient than that of unordered_map. On top of that, most hardware systems offer features such as caching which give usage of vector an even bigger edge. (i.e. lesser constant factors in O(1) operations)