

DSA using C++

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1 Basics Of Programming Languages

Programming is the process of creating a set of instructions which tells a computer how to perform a task.

1.1 Types Of Programming Languages

- Low Level Languages.
- High Level Languages.

1.1.1 Low Level Programming Languages

Assembly Level Programming Language Low-level programming that is intended to communicate directly with hardware.

1.1.2 High Level Programming Languages

Easy to understand and less complex than assembly level language/machine code.

Types Of High Level Programming Languages.

- Procedural
- Functional
- Object-Oriented

Procedural:

- It is written in set of procedures which executes in a structure/serial order.
- Procedures are also known as subroutine/function.
- e.g. C, Basic, Pascal etc.

Functional:

- We functions to write the code.
- Functions are chunks/block of code which can use over and over again.
- They can also take parameters.
- e.g. Python, JavaScript etc.

Object-Oriented:

- We use object and classes.
- Classed are user defined prototype/blueprints which can be used to create objects.
- Object are real life entity.
- e.g. C++, Java, C# etc.

Class: We can define some properties, attributes, methods etc.

Object: Instance of a class which allows to use variables and methods from class.

2 CPP Programming Language.

- It is Object-Oriented Programming Language.
- But it also has support for procedural programming.
- Initially it was intended to developed as a superset of C but later on it became a new programming language.
- Developed by **Bjarne Stroustrup** in **1979**.

2.1 C++ Sample Program.

```
#include<iostream>    /*iostream is directive & it is processed by
                        preprocessor.
                        Preprocessor is program that compiler runs.
                        #include telling our program to include the header
                        files like iostream.
                        iostream contains input output functions.
                        */
using namespace std; /*It is telling our program that there is namespace of
                        name std which we have to use in our program.
                        e.g cout belongs to std namespace
                        - std:cout
                        */
int main() {          /*'int main' is the main function which the entry point
                        of a program.*/
    int val;          //declaring a variable.
    cout<<"Hello";    //printing the output.
    cin>>val;         //taking input.
    cout<<val;        //printing the output.
    return 0;         //return 0 indicates, program has executed successfully.
    cout<<"Hi";       //this won't be executed.
}
```

2.2 C++ Variables

- Variables are just containers to store our value where our code is executed.
- As C++ is statically typed language, so you can't store different type of value in different type of container.
e.g.

```
int a = 5;           // correct
int b = "f";         // incorrect
int e = "6";         // incorrect
char c = "a"         // correct
char d = "4"         // correct
```

2.3 C++ Data Types

Primary	Derived	User Defined
Integer	Function	Class
Character	Array	Structure
Boolean	Pointer	Union
Floating Point	Reference	Enum
Double Floating Point	-	-
Void	-	-
Wide Character		

2.4 C++ Operators

- Arithmetic Operators
 - e.g. +, -, *, /, %, ++, - etc.
- Relational Operators
 - e.g. ==, !=, >, <, >=, <= etc.
- Logical Operators
 - e.g. &&, ||, ! etc.
- Assignment Operators
 - e.g. =, +=, -=, /=, %= etc.
- Bitwise Operators
 - e.g. ~, <, >, |, &, ^ etc.
 - $a \ll b = a \times 2^b$
 - $a \gg b = a / 2^b$
- Misc Operators
 - e.g. sizeof, ?exp1:exp2, comma Operator, dot & arrow Operators, casting Operator, & Address Operator, * Pointer Operator etc.
- Unary Operators
 - e.g. +, -, ++, --, ! etc.

3 Conditionals Statements

- If else Statements.
- Nested If else Statements
- Ternary Statements

3.1 If else Statements

```
if (condition) {  
    // block of code if condition is true  
}  
else {  
    // block of code if condition is false  
}
```

3.2 Nested If else Statements

```
if (condition1) {  
    // code block 1  
}  
else if (condition2){  
    // code block 2  
}  
else {  
    // code block 3  
}
```

3.3 Ternary Statements

```
int number = -4;  
string result;  
// Using ternary operator  
result = (number > 0) ? "Positive Number!" : "Negative Number!";
```

3.4 Switch Case Statements

```
switch (expression) {  
    case x:  
        // code  
        break;  
    case y:  
        // code  
        break;  
    default:  
        // code  
}
```

4 C++ Loops/Iterative Statements

Loops are used when you want to do repetitive task in the program.

4.1 Types Of Loops

- While Loop
- For Loop
- Do-while Loop

4.2 While Loop

```
while(codition){  
    //code  
}
```

4.3 For Loop

```
for (init-statement; condition; final-expression) {  
    //code  
}
```

4.3.1 Multiple Variables in For Loop

```
for (int i=0, j=4; i<4, j>0; i++, j--) {  
    // code  
}
```

4.4 For Loop vs While Loop

```
// For Loop  
for (init-statement; condition; final-expression) {  
    //code  
}  
  
// while Loop  
init-statement  
while(condition) {  
    // code  
    final-expression  
}
```

4.5 Do-while Loop

```
do {  
    code  
} while(condition);
```


5 Function

5.1 How to declare a function.

```
returnType functionName(parameter1, parameter2){  
    // Statements  
}
```

5.2 Function Prototype

Like if you want define your function-A after the function-B but you want to call function-B inside of function-A.

e.g.

```
#include<iostream>  
using namespace std;  
  
int add(int, int);    // prototype  
  
int main() {  
    cout<<add(2,3)<<endl;  
}  
  
int add(int a, int b){  
    return a+b;  
}
```

5.3 Scope of Variables

5.3.1 Accessing global variable.

We access the global variable by using **scope resolution** operator (::).

e.g.

```
#include<iostream>  
using namespace std;  
  
int a = 6;  
int main() {  
    int a = 5;  
    cout<<a<<endl;    //5  
    cout<<::a<<endl;  //6  
}
```

5.4 Parameters

5.4.1 Formal Parameters & Actual Parameters.

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

void add(int param1, int param2){ // param1 & param2 are formal parameters.
    cout<<param1+param2<<endl;
}

int main() {
    int a = 5;
    int b = 7;    // Actual parameters.
    add();
}
```

5.5 Pass by Value and Pass by Reference.

5.5.1 Pass by Value.

Copy of the actual variable get copied into the formal variable.

e.g.

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

void add(int param1, int param2){ // param1 & param2 are formal parameters.
    cout<<param1+param2<<endl;
}

int main() {
    int a = 5;
    int b = 7;    // Actual parameters.
    add(a,b);
}
```

5.5.2 Pass by Reference.

Variables it self gets used in the function.

e.g.

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

void print(int &param) {
    cout << param << endl;
    param = 2;
}

int main() {
    int a = 5;

    print(a);
    cout<<a<<endl;
}
```

5.5.3 Default values of parameters in a function.

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

void add(int a, int b=0, int c=2){ // b & c default values
    return a+b+c;
}

int main() {
    add(3);        // 5
    add(3,2)       // 7
    add(3,2,3)     // 8
}
```

6 Data Structures

6.1 Array

- Array
- An array is data structure which stores a collection of items.
- It store homogeneous items(same data type).
- It has contiguous memory.
- **Representation of Array**
 - |1|2|3|4|5|
 - Length of this array is 5.
- We access the elements by their indexes(starts from 0).

6.1.1 Syntax Of An Array

```
// datatype arrayName[arraySize];  
int array[5];
```

6.1.2 Array Literal

```
int array[] = { 1, 2, 3, 4, 5 };
```

6.1.3 Types Of Array

- Single dimensional or One-dimensional array.
- Multidimensional array.

6.1.4 Sample Array Program

```
#include<iostream>  
using namespace std;  
  
int main() {  
    int array[] = {1, 2, 3, 4, 5};  
  
    cout << sizeof(array) << endl;           // size of the array.  
                                              // 20 bits.  
    cout << sizeof(array[0]) << endl;        // size of an elements  
                                              // 4 bits  
    cout << sizeof(array)/sizeof(array[0]) << endl; // length of the array.  
                                              // 5  
}
```

6.2 Vectors

- Vectors are dynamic arrays.

6.2.1 Basic operations in Vectors

1. Declaration

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

int main() {
    vector<int> vec(4);
}
```

2. Size

- v.size() -> length

3. Resize

- v.resize(new size)

4. Capacity

- v.capacity()
- Capacity gets increased in multiple of 2's.

5. Add Elements

- v.push_back(5);

6. Insert Elements

- v.insert(position, elements)

7. Beginning and end of a Vector

- v.begin()
- v.end()

8. Delete Elements

- v.pop_back()

9. Delete Elements using index

- v.erase(position)

10. Delete All Elements

- v.clear()

11. Taking input from user

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

int main(){
    vector<int> v;
    for(int i=0; i<5; i++){
        int element;
        cin>>element;
        v.push_back(element);
    }
}
```

6.2.2 Sample Program Of Vector

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

int main() {
    vector<int> v;

    // Adding Elements
    v.push_back(1);
    v.push_back(2);
    v.push_back(3);
    v.push_back(4);
    v.push_back(5);

    cout << "Size : " << v.size() << endl;          // Size Of vector
    cout << "Capacity : " << v.capacity() << endl; // Capacity Of vector

    cout << "Elements : ";
    for (int i = 0; i < v.size(); i++)
        cout << v[i] << " "; // Printing the elements

    v.resize(10); // Resize the vector.
    cout << endl << "After Resize : " << v.size() << endl;

    v.insert(v.begin() + 1, 0);

    cout << "Elements : ";
    for (int i = 0; i < v.size(); i++)
        cout << v[i] << " "; // Printing the elements

    v.erase(v.begin() + 2);

    cout << "Elements : ";
    for (int i = 0; i < v.size(); i++)
        cout << v[i] << " "; // Printing the elements
}
```