

Day 1

Classification of languages:

1. Machine level languages
 - Binary language(1, 0)
2. Low level languages
 - Assembly
3. High level languages
 - C, C++, java

Chracteristics of Language

1. It has own syntax
2. It has its own rule(semantics)
3. It contain tokens:
 1. Identifier
 2. Keyword
 3. Constant/literal
 4. Operator
 5. Seperator / punctuators
4. It contains built in features.
5. We use language to develop application(CUI, GUI, Library)
6. If we want to implement business logic then we should use language.

Classification of high languages:

1. Procedure Oriented Programming Languages
 - PASCAL, FORTRAN, COBOL, C, ALGOL, BASIC etc
 - FOTRAN is first high level pop language.
2. Object Orineted Programming Languages
 - Simula, Smalltalk, C++, Java, Python, C# etc.
 - Simula is first object oriented programming language. It is developed in 1960 by Alan kay.
 - Smalltalk is first pure object oriented programming language which is developed in 1967.
 - More 2000 languages are object oriented.
3. Object based programming languages
 - Ada, Modula-2, Java Script, Visual Basic etc.
 - Ada is first object based programming language.
4. Rule based programming languages
 - LISP, Prolog etc
5. Logic Orineted programming languages
6. Constraint oriented programming languages
7. Functional programming languages
 - Java, Python etc.

C Language Revision

History

- Inventor of C language is Dennis Ritchie
- It is developed in 1969-1972
- It is developed at AT&T Bell Lab USA
- It is developed on DEC-PDP11(Hardware)
- It is developed on Unix(Operating System)

ANSI Standards

- Set of rules is called standard and standard is also called as specification.
- American National Standard Institute(ANSI) is an organization which is responsible for standardization of C/C++ and SQL.
- ANSI is responsible for updating language ie. adding new features, updating existing features, deleting unused features.
- ANSI C standards:

1. Before 1989 : The C Prog Lang Book
2. C89 : 1989
3. C90 : 1990
4. C95 : 1995
5. C99 : 1999
6. C11 : 2011
7. C18 : 2018

C Language Basics

```
#include<stdio.h>
int main( void )
{
    printf("Hello World!!!");
    return 0;
}
```

- Set of statement is called program.
- An instruction given to the computer is called statement.
- Every instruction is made up of token.
- Token is basic unit of program.
- Tokens in C:

1. Identifiers

- Name given to variable, array, function, pointer, union structure, enum etc is called identifier.
- "main" is name of function hence it is considered as identifier.

2. Keyword

- It is reserved word that we can not use as a identifier.
- Keywords in C:

1. The C Prog Language (1st Edition) : 28 keywords

2. The C Prog Language (2nd Edition) : 27 keywords(entry keyword was removed)
3. C89 : 5 keywords
4. C99 : 5 keywords
5. C11 : 7 Kewords

3. Constant / Literal

- An entity whose value we can not change is called constant.
- Types:
 1. Character constant. e.g 'A'
 2. Integer constant
 1. Decimal Constant
 2. Octal Constant
 3. Hexadecimal Constant
 3. Floating Point Constant
 1. Float constant. e.g 3.14f
 2. Double constant. e.g 3.14
 4. String constant. e.g "CDAC"
 5. Enum Constant

```
enum ShapeType
{
    EXIT, LINE, RECT, OVAL //Enum constant
};
```

4. Operator

- If we want to create expression then we should use operator
- Types:
 1. Unary Operator e.g ++, --, ~, !, sizeof, & etc
 2. Binary Operator
 1. Arithmetic operator e.g +, -, *, /, %
 2. Relational Operator e.g <, >, >=, <=, ==, !=
 3. Logical Operator e.g &&, ||
 4. Bitwise operator e.g &, |, ^, <<, >>
 5. Assignment operator e.g =, Shorthand operators
 3. Ternary OPERator e.g Conditional operator(? :)

5. Punctuator / Seperator

- ; : , space, tab, { } [] < > etc

Software Development Kit

- SDK = Language tools + Documentation + Supporting Library + Runtime Env.
- Language tools
 1. Editor
 - Notepad, Edit Plus, gedit, vim, TextEdit, MSVS Code etc
 - It is used to develop/edit source code.

2. Preprocessor

- CPP(C/C++ preprocessor)
- Job of preprocessor:
 1. To remove the comments
 2. To expand macros

3. Compiler

- For Microsoft Visual Studio : cl.exe
- For Linux : gcc
- For Intel : icc
- For Borland : tcc
- Job of Compiler:
 1. To check syntax
 2. To convert high level source code into low level code(Assembly)

4. Assembler

- For Borland : TASM
- For MSVS : MASM
- For Linux : as
- Job of Assembler:
 1. To convert low level code into machine code.

5. Linker

- For Borland : TLINK.exe
- For MSVS : Link.exe
- For Linux : ld
- Job of linker
 1. .obj/.o file contains machine code. This file is also called as almost executable. Linker is responsible for linking .o file to glibc.so.

6. Loader

- It is operating system API, which is responsible for loading executable file from HDD into RAM.

7. Debugger:

- For Linux : gdb
- For Windows : windbg
- Job of Debugger:
 1. It is used to find the bug.

8. Profiler:

- For Linux : valgrind
- Job of profiler:
 1. To debug the memory and detecting memory leakage.

- Documentation:

1. For Windows : MSDN
2. For Linux : man pages

- Supporting Library:

1. glibc.so
2. BOOST, QT

- Runtime Environment

- It is responsible for managing execution of C application.

- Runtime Environment for C is "C runtime".

Data Type

- It describes 3 things about variable / object
 1. Memory : How much memory is required to store the data.
 2. Nature : Which type of data memory can store
 3. Operation : Which operations are allowed to perform on data stored inside memory.
- Types of data types:
 1. Fundamental Data Types
 2. Derived Data Types
- Fundamental Data Types(5)
 1. void : Not Specified
 2. char : 1 byte
 3. int : 4 bytes
 4. float : 4 bytes
 5. double : 8 bytes
- Derived Data Types(5)
 1. Array
 2. Function
 3. Pointer
 4. Union
 5. Structure

Type Modifiers(4)

1. **short**
2. **long**
3. **signed**
4. **unsigned**

Type Qualifiers(2)

1. **const**
2. **volatile**

Constant and variable

- An entity whose value we can not modify is called constant.
- constant is also called as literal.
- e.g 'A', "Pune", 3.14, 0 etc.
- An entity whose value we can modify is called variable.
- Variable is also called as object/instance.

- e.g. `int number;` Here number is variable.

Comments

- If we want to maintain documentation of source code then we should use comments.
- Types:
 1. `//`Single line comment
 2. `/*` Multiline comment. `*/`

Main function

- According to ANSI, main should be entry point function of C/C++.
- Programmer is responsible for defining main function hence it is considered as user defined function.
- Calling/invoking main function is responsibility of operating system. Hence it is also called as Callback function.
- Since main function is responsible to give call to the other functions, it is also called as calling function.
- Signature of main function;

1. `void main();`
2. `void main(void);`
3. `int main(void);`
4. `□`);
5. `□`);

- Standard Syntax of main function is:

```
int main( void )
{
    return 0;
}
```

Function Declaration and Definition

```
//Function Definition
int main( void )          //Calling Function
{
    void print( void );    //Local Function Declaration

    print( );              //Function Call
    return 0;
}
//Function Definition
void print( void )        //Called Function
{
    printf("Inside print function\n");
}
```

- Implementation of function is called function definition.
- Local definitions are not allowed in C/C++. In other words, we can not define function inside another function.
- If we use function before its definition then it is mandatory to provide its signature to the compiler. It is called function declaration.
- It is possible to declare function locally as well globally.
- Without definition, if we try to access any element then linker generates error.

```
//Function Definition
int main( void )      //Calling Function
{
    //Local Function Declaration
    void print( void );

    //Function Call
    print( );          //Linker error

    return 0;
}
```

- If we try to build and execute project without main function then linker generates error.

Variable Declaration and Definition

- Declaration refers to the place where nature of the variable is stated but no storage is allocated.
- Definition refers to the place where memory is assigned or memory is allocated.

```
int main( void )
{
    int num1;    //Declaration as well as definition

    int num2 = 20; //Declaration as well as definition

    extern int num3;    //Declaration
    return 0
}
int num3 = 30;    //Declaration as well as definition
```

Variable Initialization and Assignment

```
int num1 = 10;    //Initialization
```

- Initialization is the process of storing value inside variable during its declaration.
- We can initialize variable only once.

```
int num1 = 10; //Initialization
num1 = 20;  //Assignment
num1 = 30;  //Assignment
```

- Assignment is process of storing value inside variable after its declaration.
- we can assign value to the variable multiple times.

Day 2

L-Value(Locator Value)

- Non constant(editable/modifiable) memory location which is available at left hand side of assignment operator is called locator value(L-Value).
- Consider Following code:

```
2 + 3 = 5;  //Error - L-Value Required
```

- Consider Following code:

```
5 = 2 + 3;  //Error - L-Value Required
```

- Consider Following code:

```
const int number = 10;
number = number + 5; //Error - L-Value Required
```

- Consider Following code:

```
int number = 10;
number = number + 5; //OK - number is L-Value
```

R-Value(Reference Value)

- A constant, variable or expression which is used at right hand side of assignment operator is called R-Value.

```
int num1 = 10;  //10 - R-Value
```



```
int num1 = 10; //10 - R-Value
int num2 = num1; //num1 - R-Value
```

```
int num1 = 10; //10 - R-Value
int num2 = num1; //num1 - R-Value
int num3 = num1 + num2; //(num1 + num2) - R Value
```

5 keywords introduced in C89

1. `const`
2. `volatile`
3. `void`
4. `enum`
5. `signed`

Constant in C

```
int num1 = 10;
num1 = num1 + 5; //15
```

- Once initialized, if we don't want to modify value/state of the variable/object then we should use `const` keyword.
- `const` keyword is introduced by ANSI in C89.

```
const int num1 = 10;
num1 = num1 + 5; //Not OK
```

- Constant variable is also called as read only variable.
- In C, it is optional to initialize constant variable.
- In C, we can declare variable constant but we can not declare function constant.

Pointer in C

- Named memory location is called variable.
- `&` is a unary operator which is used to get address of variable/object.
- If we want to store address then we need to declare pointer in a program.
- A pointer is a variable which is used to store address of another variable.
- Size of any type of pointer on 16-bit compiler is 2 bytes, on 32-bit compiler 4 bytes and on 64 bit compiler 8 bytes.
- Uninitialized pointer is called wild pointer

```
int main( void )
{
    int *ptrNum1;    //Wild Pointer
    return 0;
}
```

- NULL is a macro whose value is 0 address

```
#define NULL ((void*) 0)
```

- If pointer contains NULL value then such pointer is called NULL pointer.

```
int main( void )
{
    int *ptrNum1 = NULL; //ptr1Num1 : NULL Pointer
    return 0;
}
```

- Pointer initialization:

```
int main( void )
{
    int num1 = 10; //Initialization
    int *ptrNum1 = &num1; //Initialization
    return 0;
}
```

- Pointer assignment:

```
int main( void )
{
    int *ptrNum1 = NULL; //Initialization
    int num1 = 10; //Initialization
    ptrNum1 = &num1; //Assignment
    return 0;
}
```

- Process of accessing value of the variable using pointer is called dereferencing.

Constant and pointer combination

```
int *ptr
```

- In above statement, ptr is non constant pointer variable which can store address of non constant integer variable.
- Consider following example:

```
int main( void )
{
    int *ptr = NULL;
    int num1 = 10;
    ptr = &num1;
    *ptr = 50;        //Dereferencing
    printf("Num1      :      %d\n", *ptr); //Dereferencing

    int num2 = 20;
    ptr = &num2;
    *ptr = 60;        //Dereferencing
    printf("Num2      :      %d\n", *ptr); //Dereferencing
    return 0;
}
```

```
const int *ptr
```

- In above statement, ptr is non constant pointer variable which can store address on constant integer variable.

```
int main( void )
{
    const int *ptr = NULL;

    const int num1 = 10;
    ptr = &num1;    //OK
    /*ptr = 50;    //Not OK
    printf("Num1      :      %d\n", *ptr); //Dereferencing : OK

    const int num2 = 20;
    ptr = &num2;    //OK
    /*ptr = 60;    //Not OK
    printf("Num2      :      %d\n", *ptr); //Dereferencing : OK
    return 0;
}
```

```
int const *ptr
```

- Above is 100% same as "const int *ptr"

```
const int const *ptr
```

- Above state is same as "const int *ptr" or "int const *ptr"
- For above compiler will generate warning: "Duplicate const qualifier".

```
int *const ptr
```

- In above statement, ptr is constant pointer variable which can store address of non constant integer variable.

```
int main( void )
{
    int num1 = 10;
    int *const ptr = &num1; //OK
    *ptr = 50;           //Dereferencing : OK
    printf("Num1      :      %d\n", *ptr); //Dereferencing : OK

    int num2 = 20;
    //ptr = &num2; //Not OK
    return 0;
}
```

```
int *ptr const
```

- Above syntax is invalid.

```
const int *const ptr
```

- In above statement, ptr is constant pointer variable which can store address of constant integer variable.

```
int main( void )
{
    const int num1 = 10;

    const int *const ptr = &num1; //OK
    // *ptr = 50; //Not OK
    printf("Num1      :      %d\n", *ptr); //Dereferencing : OK

    const int num2 = 20;
```

```
    //ptr = &num2;    //Not OK
    return 0;
}
```

```
int const *const ptr
```

- This statement is same as "const int *const ptr"

Structure

- If we want to group related data elements together then we should use structure. Related data elements may be of same type or different type.
- Structure is derived data type.
- if we want to define structure then we should use struct keyword.

```
struct Employee
{
    char name[ 30 ];
    int empid;
    float salary;
};
```

- We can declare structure inside function. It is called local structure.
- We can not use object and pointer of local structure outside function.
- We can define/declare function inside structure.
- If we want to store value inside structure then we must create its object.

```
struct Employee emp;
```

- If we create object structure then all the variables declared inside structure get space inside it.
- If type allows us to initialize its element using initializer list then it is called aggregate type and object is called aggregate object.

```
struct Employee emp = {"Abc", 33, 45000.50f};
```

- Following types are aggregate types:
 1. Array
 2. Structure
 3. Union
- Using object, if we want to access members of the structure then we should use dot/member selection operator.

```
printf("Name    :    %s\n", emp.name );
printf("Empid   :    %d\n", emp.empid);
printf("Salary  :    %f\n",emp.salary);
```

- Using pointer, if we want to access members of structure then we should use arrow/dereferencing operator.

```
printf("Name    :    %s\n", ptr->name );
printf("Empid   :    %d\n", ptr->empid);
printf("Salary  :    %f\n",ptr->salary);
```

- Parameter and argument

```
//a,b -> Function parameter / parameter
void sum( int a, int b )
{
    int c = a + b;
    printf("Result  :    %d\n",c);
}
```

```
sum( 10,20 );    //Function Call
//10,20 -> Function argument / argument
```

```
int x = 10, y = 20;
sum( x, y );    //Function Call
//x,y -> Function argument / argument
```

- In C language, we can pass argument to the function using 2 ways:
 1. By Value
 2. By Address/Reference
- If we declare structure outside function then it is called global structure. We can create object and pointer of global structure anywhere in the program.
- Procedure oriented programming is a kind of programming in which we try to solve real world problems using structure and function.
- Object oriented programming is a kind of programming in which we try to solve real world problems using class and object.
- If we want to control visibility of members of structure/class then we should use access specifier.
- Access specifiers in C++
 1. private(-)
 2. protected(#)
 3. public(+)

Day 3

- In C++, structure members are by default considered as public.

Data Member

- Variable declared inside class scope is called data member.

```
int num1;    //Global Variable
class Test
{
    int num2;    //Data Member
    int num3;    //Data Member
};
int main( void )
{
    int num4;    //Local Variable
    return 0;
}
```

- Data member is also called as field, attribute, property etc.

Member Function

- A function implemented inside class scope is called member function.

```
class Test
{
public:
    void print( )    //Member Function
    {
    }
};
//For class Test, "main" is a non member fn.
int main( void )    //Global Function
{
    Test t;
    t.print( );
    return 0;
}
```

- Member function is also called as method, operation, behavior or message.

Class and Object

- Class is collection of data member and member function.
- Class can contain:
 1. Nested Type

- enum
- structure
- union
- class

2. Data Member

3. Member Function

- constructor
 - destructor
 - copy constructor
 - user defined function
- Variable/ instance of a class is called object.
 - Process of creating object in C:

```
struct Employee emp;
```

- Process of creating object in C++:

```
Employee emp;
```

- Process of creating object in Java:

```
Employee emp = new Employee( );
```

- Process of creating object from a class is called instantiation.

```
int main( void )
{
    Employee emp;    //Instantiation
    return 0;
}
```

- In above code, class Employee is instantiated and name of the instance is emp.
- During instantiation use of class keyword is optional

```
int main( void )
{
    class Employee emp1;    //OK
    Employee emp2;    //OK
    return 0;
}
```


Naming / Coding Convention

1. Hungarian Notation(For C/C++)
2. Camel Case Convention(Java and .NET)
3. Pascal Case Convention(Java and .NET)

Camel Case Convention

- Consider following example
 1. main()
 2. parseInt()
 3. showInputDialog
 4. addNumberOfDays(int days)
- In this case, except word, first Character of each word must be in upper case.
- We should use this convention for:
 1. Data member
 2. Member function
 3. Function Parameter
 4. Local and global variable

Pascal Case Convention

- Consider following example
 1. System
 2. StringBuilder
 3. NullPointerException
 4. IndexOutOfBoundsException
- In this case, including first word, first character of each word must be in upper case.
- We should use this convention for:
 1. Type Name:
 1. Union Name
 2. Structure Name
 3. Class Name
 4. Enum Name
 2. File Name

Convention For macro and constant:

- Name of constant, enum constant and macro should be in upper case.

```
#define NULL 0
#define EOF  -1
#define SIZE 5
```

```
const float PI = 3.142
```

```
enum ShapeType
{
    EXIT, LINE, RECT, OVAL
};
```

Naming Convention for namespace

- Name of the namespace should be in lowercase.
- Consider example

```
namespace collection
{
    class Stack
    {    };
}
```

Naming Convention for global function

- Consider example:
 1. void print(void);
 2. void print_record(void);

Message Passing

- Process of calling member function on object is called message passing

```
int main( void )
{
    Employee emp;
    emp.acceptRecord();    //Message Passing
    emp.printRecord();    //Message Passing
    return 0;
}
```

- In above code, acceptRecord() and printRecord() is called on object emp.

```
int main( void )
{
    Employee emp;
    emp.Employee::acceptRecord();    //OK
    emp.Employee::printRecord();    //OK
    return 0;
}
```

- Syntax to define member function globally: `ReturnType ClassName::FunctionName(){ }`

Difference between `<abc.h>` and `"abc.h"`:

- `"/usr/include"` directory is called standard directory for header files.
- It contains all the standard header files of C/C++
- e.g
 - `stdio.h`
 - `string.h`
 - `stdlib.h`
 - `iostream`
- If we include header file in angular bracket (e.g `#include<abc.h>`) then preprocessor try to locate and load header file from standard directory only(`/usr/include`).
- If we include header file in double quotes (e.g `#include"abc.h"`) then preprocessor try to locate and load header file first from current project directory if not found then it try to locate and load from standard directory.

Header Guard

- If we want to expand contents of header file only once then we should use header guard:
- Syntax:

```
#ifndef HEADER_FILE_NAME_H_
#define HEADER_FILE_NAME_H_
    //TODO : Type declaration here
#endif
```

Class and Object

- Member function do not get space inside object.
- If we create object of the class then only data members get space inside object. Hence size of object is depends on size of all the data members declared inside class.
- Data members get space once per object according to the order of data member declaration.
- Structure of the object is depends on data members declared inside class.
- Member function do not get space per object rather it gets space on code segment and all the objects of same class share single copy of it.
- Member function's of the class defines behavior of the object.
- Class:
 1. It is a collection of data member and member function.
 2. Structure and behavior of an object is depends on class hence class is considered as a template/model/blueprint for an object.
 3. Class represents set/group of such objects which is having common structure and common behavior.
 4. Class is a imaginary/logical entity.
 5. Class represents encapsulation.
 6. Example:

- Mobile Phone
 - Laptop
 - Car
- Object
 1. Object is a variable/instance of a class.
 2. An entity, which get space inside memory is called object.
 3. An entity which has state, behavior and identity is also called as object.
 4. It is physical entity.
 5. With the help of instantiation we achieve abstraction.
 6. Example:
 - Nokia 1100
 - MacBook Pro
 - Maruti 800

Empty class

- A class which do not contain any member is called empty class

```
class Test
{   };
```

- Size of object depends on size of all the data members declared inside class.
- According to above definition size of object of empty class should be zero.
- To differentiate object from class, object must get space inside memory.
- According to Bjarne Stroustrup, size of object of empty class should be non zero.
- But due to compilers optimization, object of empty class get one byte space inside memory.

Characteristics of object

1. State
 - * Value stored inside object is called state of the object.
 - * Value of data member represent state of the object.
2. Behavior
 - * Set of operation that we perform on object is called behavior of an object.
 - * Member function of class represent behavior of the object.
3. Identity
 - * Value of any data member, which is used to identify object uniquely is called its identity.
 - * If state of object is same the its address can be considered as its identity.

"this" pointer

1. First we define the class.
2. Then we declare data members inside class.

3. We instantiate class.
4. To process state of the object we should call member function on object. Hence we must define member function inside class.
5. If we call member function on object then compiler implicitly pass address of that object as a argument to the function implicitly.

```
Employee emp;  
emp.printRecord( );//emp.printRecord(&emp);
```

6. To store address of object compiler implicitly declare one pointer as a parameter inside member function. Such parameter is called this pointer.
7. this is a keyword. "this" pointer is a constant pointer.
8. General type of this pointer is:

```
ClassName *const this;
```

- "this" pointer is implicit pointer, which is available in every non static member function of the class which is used to store address of current object or calling object.
- Following functions do not get this pointer:
 1. Global Function
 2. Static Member function
 3. Friend Function.
- this pointer is considered as first parameter of member function.
- Using this pointer, data member and member function can communicate with each other hence "this" pointer is considered as a link / connection between data member and member function.
- Use of this keyword, to access members is optional.