

Computer:=

UNIT-1

→ the term computer is derived from the word compute

A computer is an electronic device that takes data and instructions as an input from the user and process the data and provides useful information known as output

Data → Input → Process → output (Information)
↓
(Instruction)

Introduction to components of a computer system:=

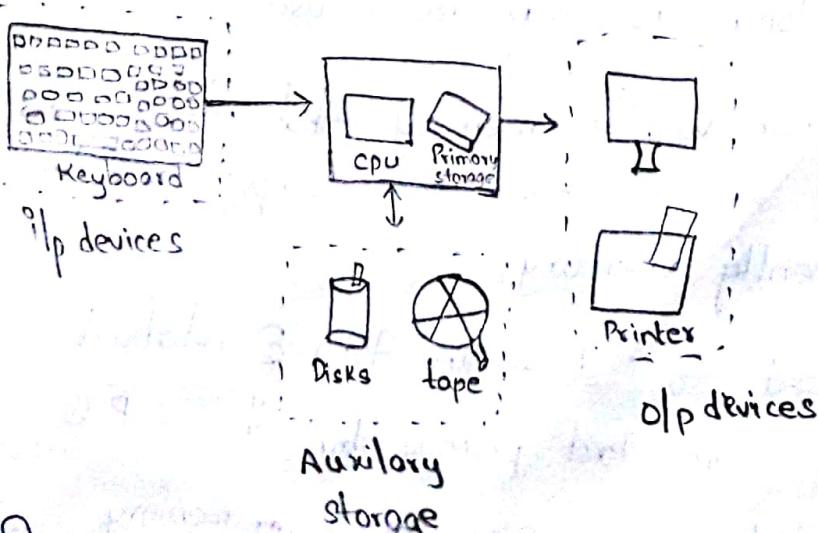
→ Computer system is made up of two major components

* Hardware

* Software

Hardware:=

hardware refers to the physical components of the computer system. It consists of 5 major parts



1. Input devices
2. Output devices
3. CPU
4. Primary storage
5. Secondary storage

Input devices :-

The input device is usually a keyboard where programs and data are entered into the computer.

Ex :- Keyboard, mouse, touchscreen, trackball

Processor (C.P.U) :-

It is responsible for executing instructions such as arithmetic calculations, comparisons among data & moment of data inside the system.

Note: Today's computers have one or more C.P.U

Primary storage :- (in bits)

It is also known as main memory. It is a place where the programs and data store temporarily during processing.

The data in primary storage is erased whenever we turn off the personal computer.

Ex :- RAM

RAM :- RAM is called Random Access memory. It is volatile memory that temporarily stores data & applications as long as they are in use.

ROM :- ROM is non-volatile memory that stores data and instructions even when the computer is turned off. It is permanent memory.

Caches :- It is used to store the data & related applications that were last processed by the C.P.U

It is placed between C.P.U and main memory.

Note :- When the processor performs processing it first searches the cache memory and then RAM for an instruction.

Auxiliary storage device :- It is also known as secondary memory. It is a place where the programs and data are stored permanently. When we turn off computer our programs remain in computer.

Hard disk :-

A magnetic based on which we can store computer data. Hard disk holds more data and also faster than floppy disc. A hard disk can store anywhere from 10 to more than 100 gigabytes.

Floppy disk :-

Whereas most floppies have a maximum storage capacity of 1.4 megabytes.

Output devices :-

The output device is usually a monitor or a printer to show output. If the output is shown on the monitor it is a softcopy and if the output is printed on the printer it is hardcopy.

Computer software :-

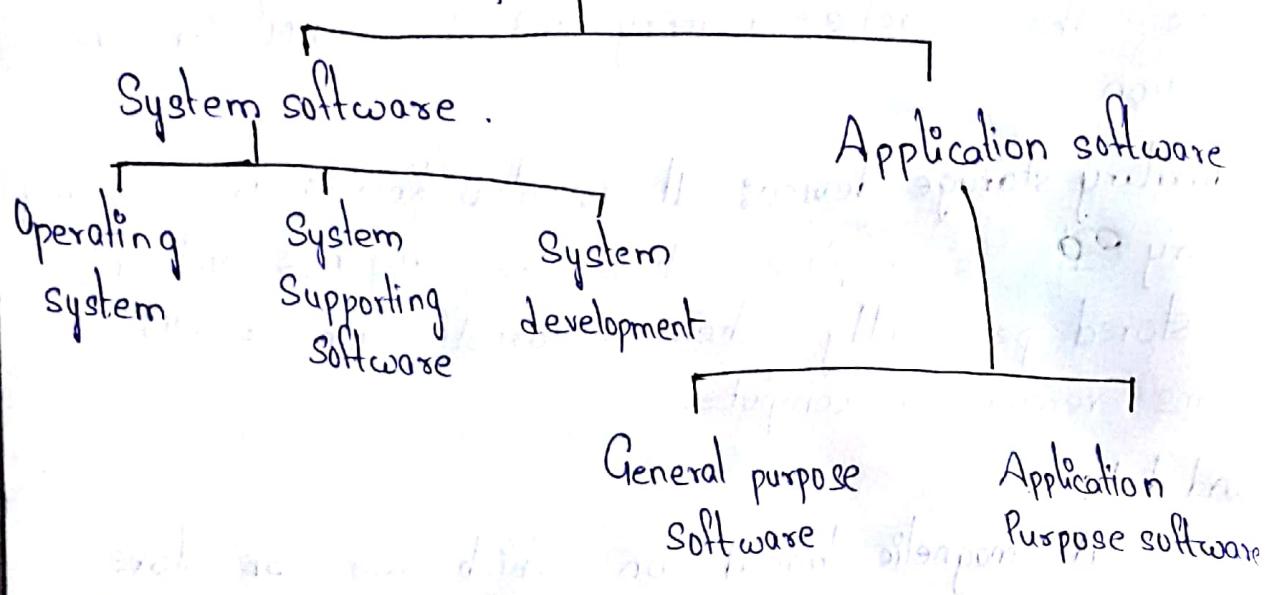
Software is the collection of programs or instructions that allow hardware to do its job.

Software divided into 2 types :-

System software.

Application Software.

Computer Software



System Software:-

It consists of programs that manage the hardware resources of a computer and perform required information processing task.

These programs are divided into 3 types:-

1. OS

2. System supporting software.

3. System development

Operating System:-

The O.S provides the interface between an user and System to communicate.

It provides services such as user interface, file and database access and interfaces to communication system such as internet protocol.

The primary purpose of this software is to keep the system operating in most efficient manner by allowing the user access to the system.

System support software:-

It provides system utilities and other operating services. The system utilities are sort programs and desk formate programs. The operating services include providing security monitors to protect the system and data.

System development software:-

It includes the language translator that converts programs into machine language for execution debugging tools to insure that programs are error free.

Application Software:-

It divided into two types:

1. General purpose software
2. Application specific software

General purpose software:-

It is purchased from a software developer and can be used for more than one application.

Example of General purpose software include, workprocess

database management system,

Application purpose software:-

It can be used only for its intended purpose. These softwares are used for specific applications for which they are designed they cannot be used for other generalised task.

System development tools:-

1. Language translators.
2. Linkers.
3. Debuggers
4. Editors.

Language translators :-

It is divided into 3 types :-

Assembler

Compiler - decompiler

Interpreter

Assembler

It converts middle level language to machinery language

Compiler

It converts high level language to machinery language

decompiler

It converts machinery language to high level language

Interpreter

It converts high level statement to machinery

according to step by step.

Linkers :-

All header files in computer are called linkers

Ex:- <stdio.h>

<conio.h>

<Math.h>

Debuggers:

It shows the errors in program.

It is divided into 2 types:

1. Machine level debuggers 2. High level debuggers

editor:

It is special program that allow the user to work text in a computer system.

Computer Languages: (to communicate with computer)

Low level language (understood by computer).

Binary language

Assembly language / symbolic language.

* It is 1st generation language. * It consists of symbols. (1950)
Ex:- ADD, SUB (mnemonics)

* It consists of '0' and '1' * It is 2nd generation language.
Ex:- 01010

Machine language by using compiler converts to high level
Assembly language by using Assembler converts to machine

then again using compiler converts to high level.

Ex:- 010101 → compiled → high level
ADD, SUB → Assembly → 010101

* Low level language is machine dependent language.

High level language

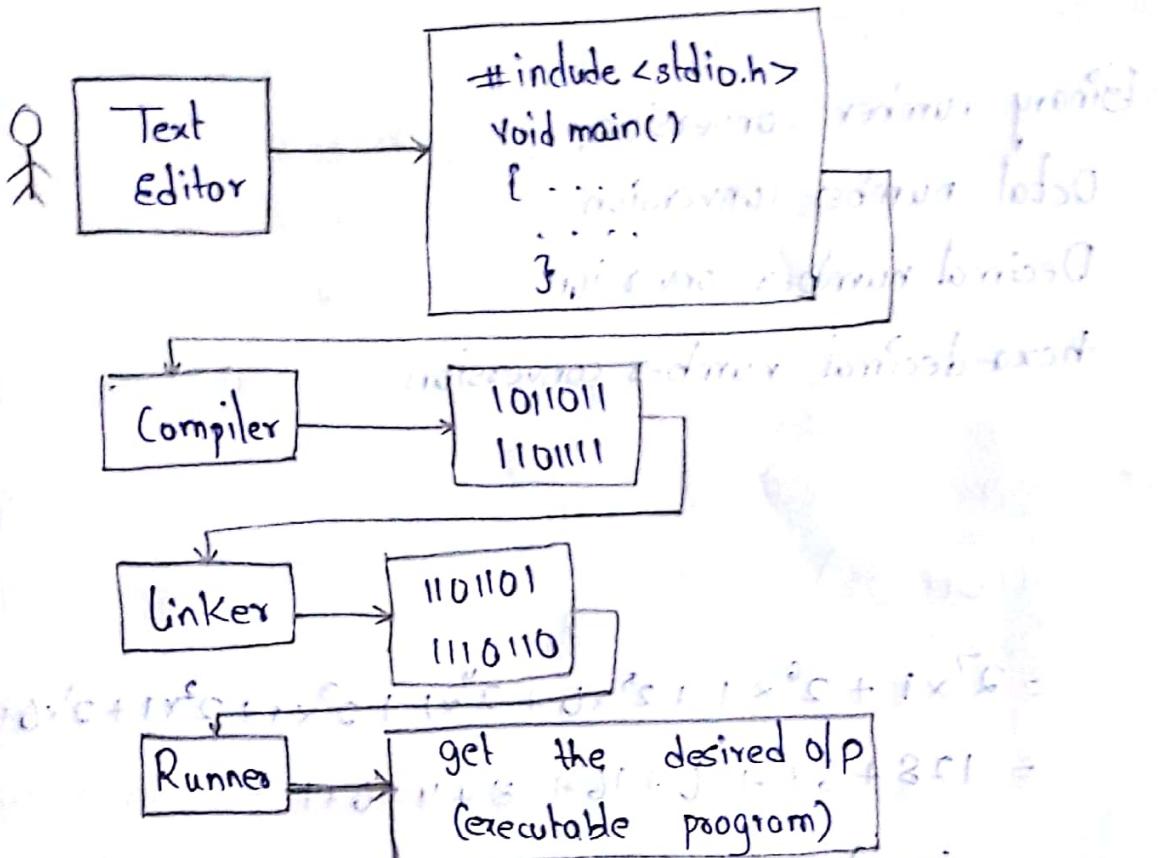
* User can understand this language.

* It consists of English words.

* It is machine independent language

Creating And Running Program

- * Writing and Editing programs
- * Compiling programs
- ** Linking programs
- ** Runner [executing the programs]



Data measurement. ($2^{10} = 1024$)

8 bits = 1 byte

1024 bytes = 1 Kilo byte

1024 KB = 1 MB (mega)

1024 MB = 1 Giga Byte

1024 GB = 1 Tera Byte.

Computing environments :-

- * Personal computing environment commonly used for office
- ** Time sharing environment commonly used
- *** Client - server environment commonly used
- **** Distributed environment uses various servers

Number Systems :-

- * Binary number conversion $\{0, 1\}$ base = 2
- ** Octal number conversion $\{0, \dots, 7\}$ base = 8 size = 3
- *** Decimal number conversion $\{0, 1, \dots, 9\}$ base = 10
- **** Hexa-decimal number conversion $\{0, 1, \dots, 9\} \cup \{A-F\}$ base = 16 size = 4

Conversion of Binary to decimal.

$$(11011101)_2 = (?)_{10}$$

$$= 2^7 \times 1 + 2^6 \times 1 + 2^5 \times 0 + 2^4 \times 1 + 2^3 \times 1 + 2^2 \times 1 + 2^1 \times 0 + 2^0 \times 1$$

$$= 128 + 64 + 0 + 16 + 8 + 4 + 0 + 1$$

$$= (221)_{10}$$

$$(101111101)_2 = (?)_{10}$$

$$= 2^8 \times 1 + 2^7 \times 0 + 2^6 \times 1 + 2^5 \times 1 + 2^4 \times 1 + 2^3 \times 1 + 2^2 \times 1 + 2^1 \times 0 + 2^0 \times 1$$

$$= 256 + 0 + 64 + 32 + 16 + 8 + 4 + 0 + 1$$

$$= (385)_{10}$$

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$$\begin{aligned}
 (11010111)_2 &= 2^8 \times 1 + 2^7 \times 1 + 2^6 \times 1 + 2^5 \times 0 + 2^4 \times 1 + 2^3 \times 0 + 2^2 \times 1 + \\
 &\quad 2^1 \times 1 + 2^0 \times 1 \\
 &= 256 + 128 + 64 + 0 + 16 + 0 + 4 + 2 + 1 \\
 &= (471)_{10} \quad \text{Ans (Ans)}
 \end{aligned}$$

$$\begin{aligned}
 (110101010) &= () \quad \text{Ans (Ans)} \\
 &= 2^8 \times 1 + 2^7 \times 1 + 2^6 \times 0 + 2^5 \times 1 + 2^4 \times 0 + 2^3 \times 1 + 2^2 \times \\
 &\quad 2^1 \times 1 + 2^0 \times 0 \quad (Ans) = (410101010) \\
 &= 256 + 128 + 0 + 32 + 0 + 8 + 0 + 2 + 0 \\
 &= (426)_{10} \quad \text{Ans (Ans)}
 \end{aligned}$$

Conversion of binary to octal.

$$(11011101)_2 = (335)_8 \quad \text{Ans (Ans)}$$

0	1	1		0	1	1		1	0	1
2 ⁰	2 ¹	2 ²	2 ³	2 ⁴	2 ⁵	2 ⁶	2 ⁷	2 ⁸	2 ⁹	2 ¹⁰

3 | 3 | 5 .

$$(101111101)_2 = (575)_8 \quad \text{Ans (Ans)}$$

1	0	1		1	1	1		1	0	1
2 ⁰	2 ¹	2 ²	2 ³	2 ⁴	2 ⁵	2 ⁶	2 ⁷	2 ⁸	2 ⁹	2 ¹⁰

5 | 7 | 5 .

Computer languages.

These languages are used to communicate with the user and computer to implement his ideas and logics.

These are classified into two types:-
low level language
high level language.

The low level language :- These are again divided into 2 types.

1. Binary or machine level language
2. Symbolic or assembly language.

Binary or machine level language:

It is a first generation programming language of contains a sequence of binary digits, such as zero's and one's. These developed in 1940's.

Advantages:-

Computer understands binary program or binary language directly.

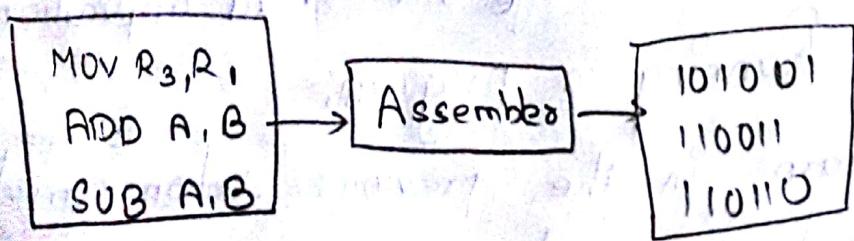
Disadvantages:

It is very difficult to remember the operational codes and address of the memory locations, user cannot modify the program easily. It is suitable for only simple applications.

Assembly or Symbolic languages:

Computer engineers development a new language such as Assembly or Symbolic in 1950's. It overcome the drawbacks of machine language. This is a second generation computer programming language. This language contains symbolic code to represent instructions.

Ex:- IN, OUT, ADD, SUB, MUL



Advantages:-

User can remember the symbol codes rather than the sequence of binary code. It is quite easy to understand and develop the program. user can modify the program very easily.

Disadvantages:-

It is machine dependent language.
High level language.

Engineers develop another kind of programming languages known as high level languages. These are like English languages.

These are developed to overcome the difficulties of low level languages. These are machine independent languages. The elements of these languages are alphabets, digits and other special symbols. It is not directly understandable by the computer.

Ex:- Java, C++

Advantages:-

It is easy to modify and write the programs. It is suitable for large and small applications.

Creating and Running a program:-

As we learn in the previous section computer does not understand human languages. Computer understands a program if it is coded in its machine.

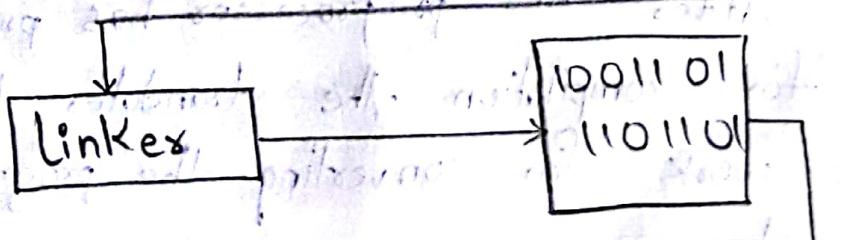
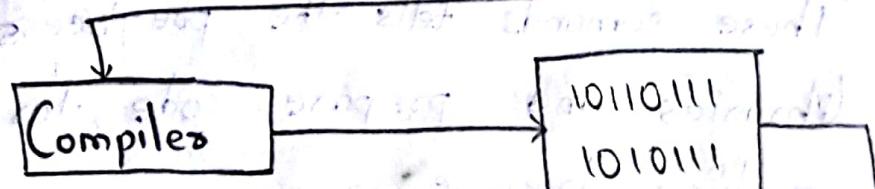
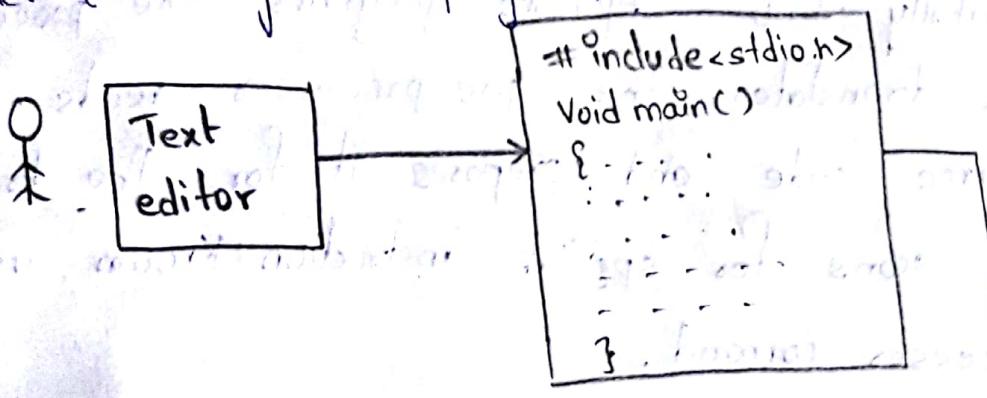
language. It is a job of a programmer, to write and test the program. There are 4 steps in the process.

1. writing and editing programs.

2. Compiling programs.

3. linking programs.

4. Runner (executing the program)



Writing & editing program:

Create a text file using any word processing software, with its name ending with .c, execute and type a C program in that file.

we are writing the source program
the turbo c text editor

Compiling program:

The code in a source file stored on the desk must be translated into machine language. This is the job of Compiler. The C compiler is actually two separate programs. The pre-processor and the translator. The pre-processor reads the source code and prepares it for the translator. It scans for special instruction known as pre-processor command.

These commands tell the pre-processor to look for libraries and prepare code for translation into machine language.

After the pre-processor has prepared the code for compilation the translator does the actual work for converting the program into machine language.

Linking the program:

A C program is made up of many functions we write some of these functions and they are part of our source program.

Input, output functions are included in <stdio.h> headerfile. and we will be using mathematical library functions

The linker assembles all these functions with the system and creates a code called as executable code or executable program.

Executing the program:

To execute a program we need an operating system command such as run, to load the program into primary memory and execute it.

Getting the program into memory is the function of an operating system program known as loader.

Loader locates the executable program and reads into the memory. When everything is loaded the program takes control and begins execution.

Computing Environments:

It contains 4 types of environments. They are:

1. personal computing environment.
2. Time-sharing environment
3. Client server environment
4. distributed Computing environment.

1. personal computing environment:

In this all of the computer hardware components are grouped together in our personal computer.

In this situation we have the whole computer for our self.

2. Time sharing environment.

In this the central computer has many duties. It must control share resources.

It must manage the shared data and printing.

In the time sharing environment many users are connected to one or more computers.

Ex: printer

3. Client server environment:-

A client server computing environment divides the computing functions between the central computer

In this the micro computers are called the clients

The central computer which may control main frames is known as servers because the work is known shared by the user and central computer.

4. Distributed Computing environment

The internet provides connectivity to different servers to the world

NUMBER SYSTEM:

A number can be denoted using different symbols a system of symbols used to represent numbers is called number system.

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These number system are classified according to the values of base of no: system.

In digital system following number systems are frequently used.

1. Binary number conversion

2. Octal number conversion

3. Decimal number conversion

4. hexa-decimal number conversion.

Algorithm

Algorithm is a method of representing step by step logical procedure for solving a problem. An algorithm must follow the following properties

Input, Output:

Each algorithm must take one or more quantities as input data and procedure one or more output values

Finiteness:

An algorithm must terminate in a finite no: of steps

Definiteness:

Each step of the algorithm must be clear and ambiguous. (no confusion)

Effectiveness

each step must be effective and produce the correct results and can be performed exactly in a finite amount of time.

Ex:- write an algorithm for finding average of three numbers (a, b, c)

Step1: Input values a, b, c .

Step2: Add a, b, c .

Step3: Divide by 3

Step4: The result is stored in d

Step5: print the result.

* write an algorithm biggest of two numbers

Step1: Take input values a, b

Step 2: Compare $a < b$, if true b else a

Step 3: result will be stored in c

Step4: print the c value.

* biggest of 3 numbers

Step1: Take input values a, b, c

Step2: Compare a, b and go to step 4

Step3: otherwise compare b, c check $b > c$

then print b is biggest else c is big

Step4: Compare a, c , check $a > c$ then

Print a is big else c is big

Step 5: The result will be stored in C

Step 6: Print C value.

Flowchart :=

It is a diagrammatic representation of an algorithm.

It is constructed using different types of boxes.

↳ Symbols

All symbols are connected by arrows to indicate the flow of information and processing.

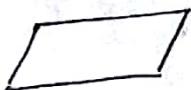
Front or terminal is 

Oval or terminal



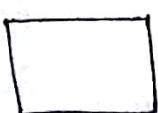
to start and end.

Input or output



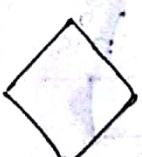
making data available for processing of the informal

Rectangle or Process box



Any process

Rombus or decision



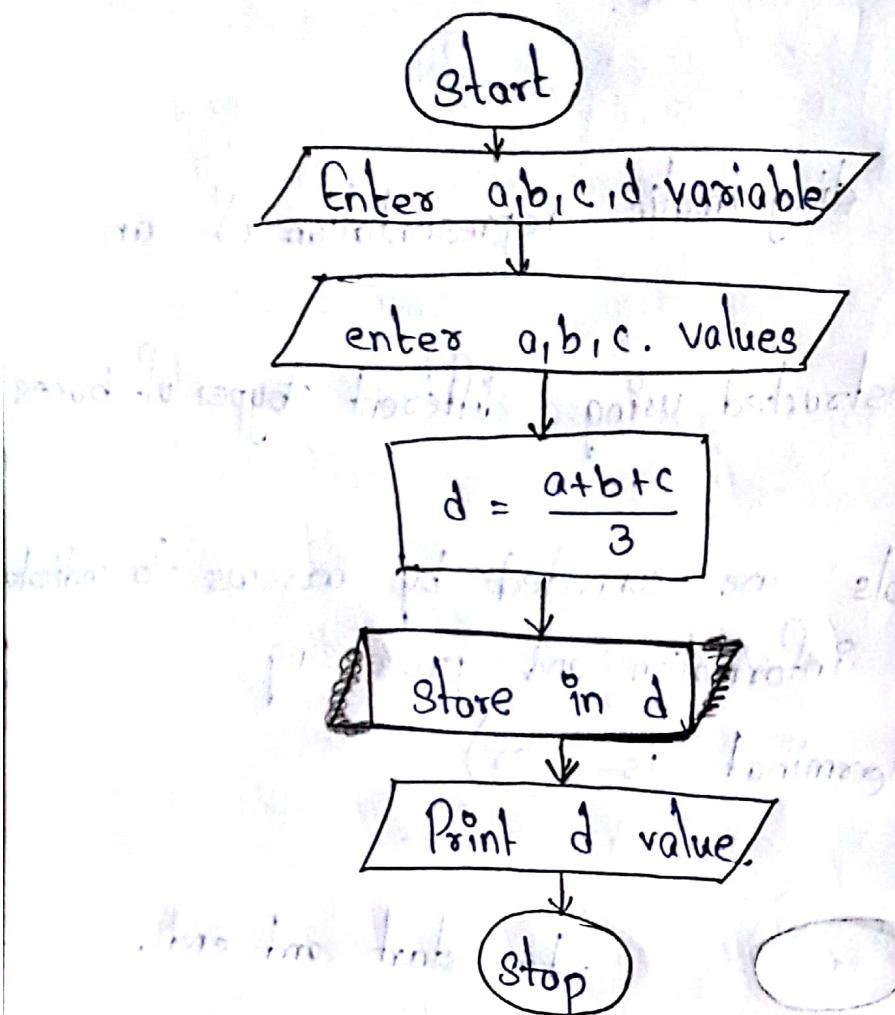
decision of operations that determines which of the path is to be followed

Arrow

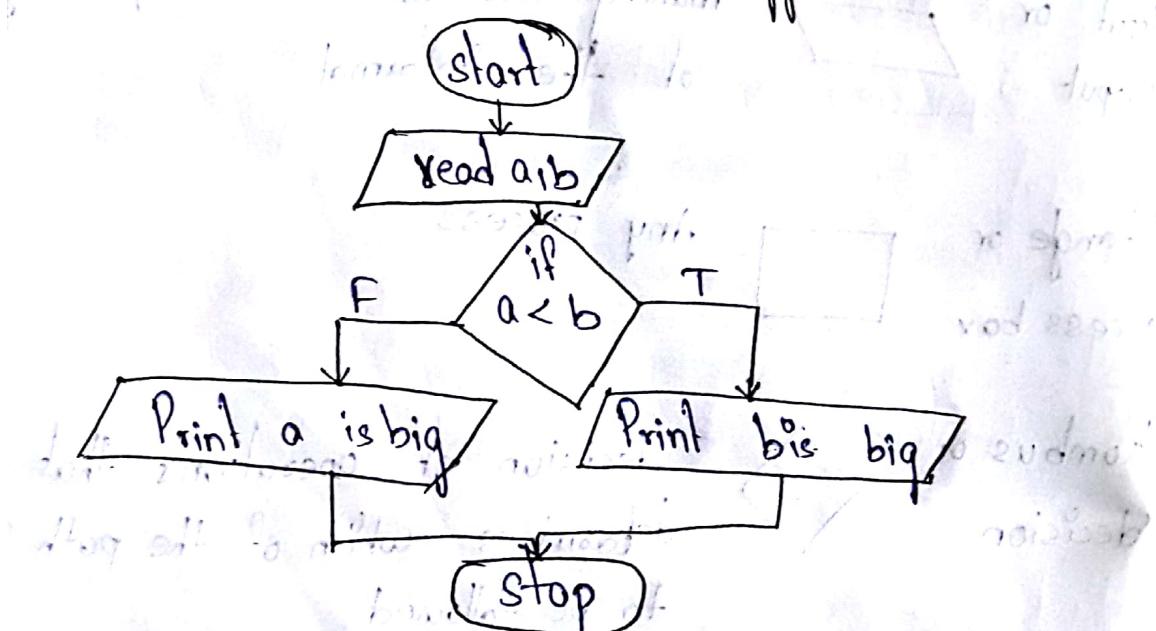


used to connect different parts of flowchart

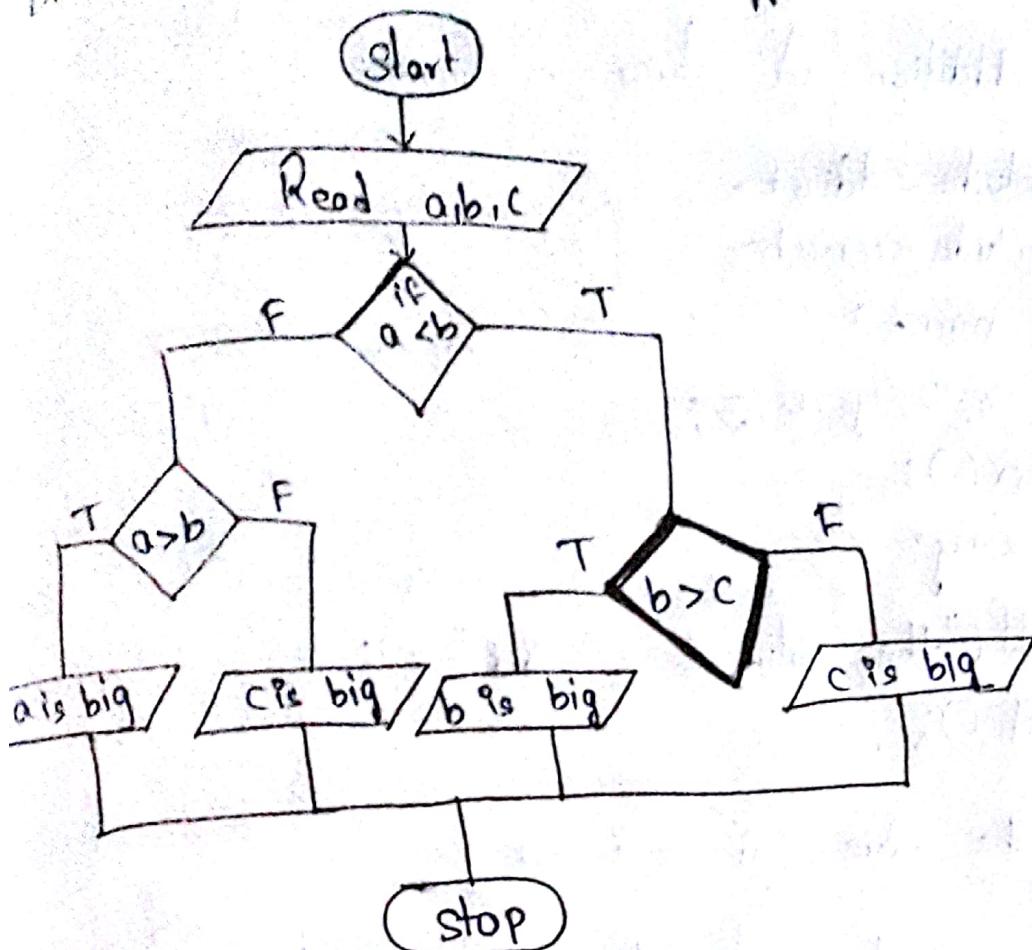
Draw the flowchart for average of 3 numbers.



Draw the flowchart for biggest of 2 numbers.



Show the flowchart for biggest of 3 numbers



Structure of C Programme.

Document Section	/* Addition of two numbers */
Link Section	headerfiles. [printf(), scanf(), sqrt()]
Definite Section	#PI=3.14, (constants, values)
Global declaration	giving variable before main(), so that we can use anywhere in the program.
main() { declaration execution }	
functions	

Programme 1

/* Addition of two numbers */

```
#include <stdio.h>
```

```
#include <conio.h>
```

```
Void main()
```

```
{ int x=10, y=20, z;
```

```
clrscr();
```

```
z=x+y;
```

```
printf("the value of z is %d", z);
```

```
getch();
```

```
}
```

Output: the value of z is 30

Programme 2:

/* Subtraction of two numbers */

```
#include <stdio.h>
```

```
#include <conio.h>
```

```
Void main()
```

```
{
```

```
int x=10, y=20, z;
```

```
clrscr();
```

```
z=y-x;
```

```
printf("the value of z is %d", z);
```

```
getch();
```

```
}
```

Output: ~~the~~ the value of z is 10.

Programme 3 /* multiplication of two numbers */

```
#include <stdio.h>
#include <conio.h>
Void main()
{
    int x=5, y=4, z;
    clrscr();
    z=x*y;
    printf("the value of z is %d", z);
    getch();
}
```

Output: Value of z is 20
Programme: 4

/* division of two numbers */

```
#include <stdio.h>
#include <conio.h>
Void main()
{
    int x=15, y=3, z;
    clrscr();
    z=x/y;
    printf("the value of z is %d", z);
    getch();
}
```

Output: the value of z is 2.

Programme 5

* Addition of two numbers */

```
#include <stdio.h>
#include <conio.h>
Void main()
{
    int a,b,c;
    clrscr();
    printf ("Enter the value of a");
    Scanf ("%d", &a);
    printf ("Enter the value of b");
    Scanf ("%d", &b);
    c=a+b;
    printf ("the value of c is %d", c);
    getch();
}
```

Programme 6

* Subtraction of two numbers */

```
#include <stdio.h>
#include <conio.h>
Void main()
{
    int a,b,c;
    clrscr();
    printf ("enter the value of a");
    Scanf ("%d", &a);
    printf ("enter the value of b");
    Scanf ("%d", &b);
    c=a-b;
    printf ("the value of c is %d", c);
    getch();
}
```

/* Multiplication of two numbers */ Programme 7

```
#include <stdio.h>
#include <conio.h>
void main()
{
    int a,b,c;
    clrscr();
    printf ("enter the value of a,b");
    scanf ("%d %d", &a, &b);
    c=a*b;
    printf ("the value of c is %d", c);
    getch();
}
```

output: enter the value of a,b
value of c is 8

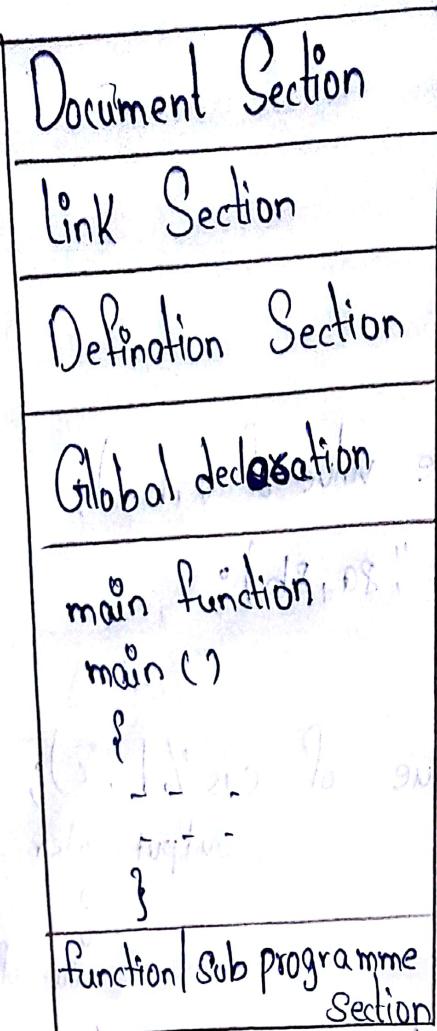
Programme 8

/* division of two numbers */

```
#include <stdio.h>
#include <conio.h>
Void main()
{
    int a,b,c;
    clrscr();
    printf ("enter the value of a,b");
    scanf ("%d %d", &a, &b);
    c=a/b;
    printf ("the value of c is %d", c);
    getch();
}
```

output: enter the value of a,b
value of c=5

Structure of C programme



Documentation Section:

This section contains a set of comment lines used to specify the name of the programme, include files etc.

/*.....*/

→ These statements are not executable; rather they are ignored by the compiler.

→ Comments can be used in two different formats

* block comments

* line comments

→ A block comment is nothing but a set of comment lines enclosed between opening and closing comment.

→ Example: /* This is a program to print even or odd */

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- The one comment uses two slashes (//) to identify a comment.
 - Example : Int a; // declaration of variable a.

Link Section :=

- It is also called as preprocessor, headerfile.
- This is used to link system library files, for defining the conditional instructions.
- A headerfile has an extension of '.h'.
- These files are included in the programme using the preprocessors directive #include.

Definition Section :=

- In this section we are going to define few constant values like $\pi = 3.14$.

Global declaration :=

- This section is used for declaring global variable.
- There are some variables that are used in one or more functions, Such variables are called global variables.

- These variables are declared outside of main function.

Main programme Section :=

- Every C programme must have one function which specifies starting of C programme the group of statements in main are executed sequentially.
- The main function consists of declaration and executable statement.

declaration part:

→ Is used to declare all variables that are used in the function and these are local variable

execution part:

→ This section contains all variables used during execution

→ The execution of a program begins with opening brace { } and closing brace }

Sub programme Section:

It is userdefined in the main file

C language provides the facility to define their own function

This section is also called as userdefined function section.

Variables:

A variable is an entity that may vary in memory location, where the data value of the variable is stored

What is a variable? It is an entity that may vary during program execution.

Syntax:	datatype variable name;
Ex-	datatype variable name = constant;

Ex- int a;

float a = 3.1;

char ch = 'Y';

A declaration is used to name an object such as

Variable
Definitions are used to create an object

A variable type can be any of the datatypes
such as character, integer (or) real.

We don't use void data type to declare
variables.

Syntax : datatype variable;

Variable Initialization :-

Initialization of variable can be using
assignment operator (=)

Syntax : datatype variable = constant;

Ex:- int x=50;

Scope of Variables :-

The scope of variables implies availability of
variables within the programme.

There are two scopes.

1. Local variables
2. Global variable

Local Variables:-

The variables that are defined within a
function is called local variables

Ex:- fun()
{
 int a;
}

a is local variable.

Global Variables:-

These are the variable defined before the main(), these variables can be used in any number of functions.

Global variables are also called as external variables.

Ex:-
int x,y;
main()
{
int a,b
}

x,y are global variables

Rules for creating variable names:-

- Variable names consists of letters, digits and underscore
- Variable names must begin with an alphabet and (or) underscore.
- The length of the variable name can be upto 31 characters
- No commas, blank spaces are allowed with in a variable name.

Ex:- My college (Invalid)

Mycollage (Valid)

- Key words shouldnot be used as variable names
- Variable names are case sensitive
SUM & sum are not equivalent

Data types: C language is rich in datatypes. The different datatypes are available and allows the programmer to select the type appropriate to the needs of application.

Datatype is used for representation of data. ANSI C supports 3 basic classes of datatypes. They are

- * Primary datatypes

- * derived datatypes

- * userdefined datatypes

Primary datatypes:

These are ~~some~~ types of primary datatypes.

- * **integer**

- * **character**

- * **float**

- * **Void**

Integer (int)

integers are whole numbers with a range of values supported by a particular machine.

C supports four different sizes of the int datatype

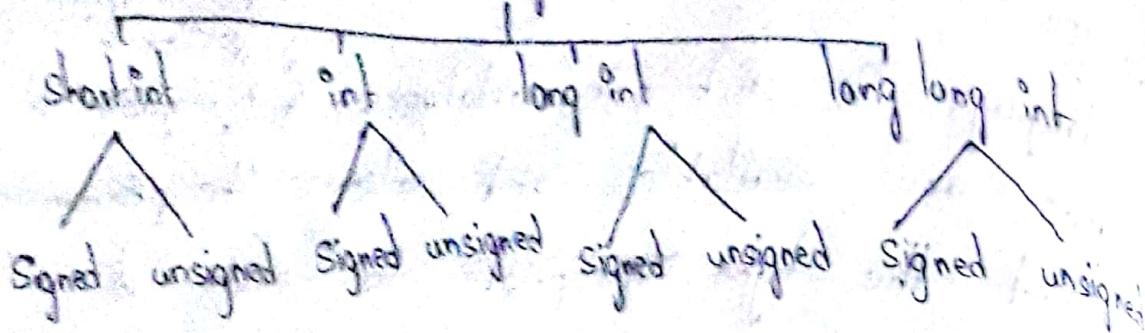
- a) **Short int**

- b) **int**

- c) **long int**

- d) **long long int**

Integer



These are two categories in integer they are
Signed and unsigned

If the integer is signed then one bit must
be used for sign (+ or -)

If we need to know the size of any
datatype C provides an operator called 'sizeof'
which will tell us exactly size in bits

Signed Values (integers) store both negative and
Positive values

Unsigned integers have only positive values

Type	Size	Range	Format specifier
Signed short int	2 bytes (or) 16 bits	-32768 to +32767	%d
Signed int	4 bytes (or) 32 bits	-2^{31} to $2^{31}-1$ -2147483648 to 2147483647	%d
Signed long int	4 bytes (or) 32 bits	-2^{31} to $2^{31}-1$	%ld
Signed long long int	8 bytes (or) 64 bits	-2^{63} to $2^{63}-1$	%lld

Type	Size	Range	Format
unsigned short int	2 bytes (or) 16 bits	0 to $2^{16}-1$	% u
unsigned int	4 bytes (or) 16 bits	0 to $2^{32}-1$	% u
unsigned long int	4 bytes (or) 32 bytes	0 to $2^{32}-1$	% lu
unsigned long long int	8 bytes (or) 64 bits	0 to $2^{64}-1$	% llu

Syntax:-

datatype Identifier / variable;

Ex:-

short a;

Signed short a;

short int a;

Signed short int a;

unsigned short a;

unsigned short int a;

Q program to implement datatype

```
#include <stdio.h>
#include <conio.h>
Void main()
{
    short int a=20;
    clrscr();
    printf("%d", a);
    getch();
}
```

Output - 20

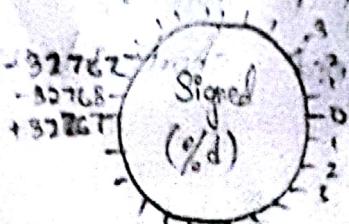
Signed datatype (short) with in a range

```
#include <stdio.h>
#include <conio.h>
Void main()
{
    signed short int x=32768;
    clrscr();
    printf("%d", x);
    getch();
}
```

Output - 32766

Datatype short beyond range

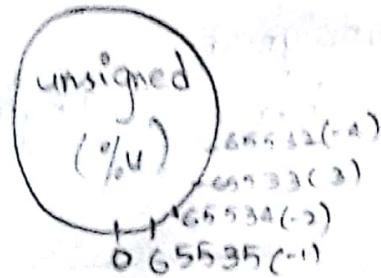
```
#include <stdio.h>
#include <conio.h>
Void main()
{
    Short int x=32769;
    clrscr();
    printf("%d", x);
    getch();
}
```



Output → 32767

```
#include <stdio.h>
#include <conio.h>
void main()
```

```
{ unsigned short int x = -4;
char c;
printf ("%u", x);
getch();
}
output = 65532.
```



Character:-

- character occupies one byte of memory
- C standard provides 2 character types i.e 'char' and 'wchar-t'
- wchar-t is wide character type
- most computers use the ASCII (American Standard Code for Information Interchange) called as ASCII alphabet for converting characters into numbers.

ASCII

A-65	a-97	0-48	② #-35
B-66	b-98	1-47	
:	:	:	
Z=90	Z=122	9-57	
26	26	10	+ 15 < 256 (2^8) one bytes

- characters must be enclosed in single quotes ('').

Syntax:-

datatype Variable;

char x;

(or)

char char's;

Type	Size	Range	Format specifier
char (or) Signed char	1 byte	-2 ⁷ to 2 ⁷ -1 -128 to 127	%d %c %o %x %u %f
unsigned char	1 byte	0 to 2 ⁸ -1 (or) 0 to 255	%u %c %x %u %f

Programme to print character

```
#include<stdio.h>
```

```
#include <conio.h>
```

```
Void main()
```

```
{
    clrscr();
    char ch='X';
    getch();
```

```
    printf("%c",ch);
}
Output - X
```

Printing character value in terms of integer

```
#include<stdio.h>
```

```
#include <conio.h>
```

```
Void main()
```

```
{
    char ch='A';
    clrscr();
    printf("%c",ch);
```

```

    printf("%d",ch);
    getch();
}
```

Output - A

Programme for checking the range of a character

```
#include<stdio.h>
#include<conio.h>
void main()
{
    char ch = 258;
    clrscr();
    printf("%d\n", ch);
    printf("%c", ch);
    getch();
}
```

Output : 2

Garbage value

Float

Floating points are stored in 32 bits or 4 bytes

Type	size	range	format specifier
float	4 bytes	3.4×10^{-38} to 3.4×10^{38}	%f
double	8 bytes	1.7×10^{-308} to 1.7×10^{308}	%lf
long double	10 bytes	3.4×10^{-4932} to 3.4×10^{4932}	%lf

out put is not in expected result A
(a) float value

Programme 1:

Programme to calculate average of two numbers

```
#include <stdio.h>
#include <conio.h>
Void main()
{
    int a=20, b=5;
    float avg;
    clrscr();
    avg = a+b/2;
    printf (" avg=%f , avg");
    getch();
}
```

Output → avg = 12.5

Constant:

Constants are fixed values that cannot be changed during execution of programme.

Constant representation:

We use symbols to represent the constants we have different types of constant representation such as

1. Boolean constants → T or F
2. Character constants → 'A' / 'B' / 'C' / 'D'
3. Integer constants → 10, -10, +58, -1
4. Real / floating point constants → 3.14, 3.4e4
5. String constants → "Hello"

Boolean Constants:

A boolean data type can take only two values (i) T or F (o)

We use constant T or F in our program

character constant :-

character constants are enclosed between two single quotes. In addition to character we can also use backslash (\) and it is known as escape character.

Some of escape characters are listed below

Ascii character	symbolic name
null character	'\0'
alert	"\a" - Bell ('a')
backspace	'\b' - Backspace ('b')
horizontal tab	'\t' - Tab ('t')
Vertical tab	'\v' - Vertical tab ('v')
new line	'\n' - New line ('n')
backslash	'\\' - Backslash ('\\')
Single Quote	'\' - Single quote ('\'')
double quote	'\" - Double quote ('\"')

Integer Constant:

These constants does not contain a decimal point

If contain digits , must be minimum of one digit

Blank spaces and commas are not allowed

within the integer constants the integers can be either positive or negative.

Ex:- +123, -378 etc

Real constants:-

Real constants are those which accept decimal values (fractional) and exponential.

Ex:- 3.1416, +342E-4

String constants

With double quotes are examples of string.

It is a sequence of 0 or more characters

enclosed in double quotes

Ex:- `char c[10] = "xyz";`

or
`c = "HelloWorld";`

Operators:-

C operators are classified into following categories

Arithmetic operator

Logical operator

Relational operator

Assignment operator

Increment or decrement operator

Bitwise operator

Conditional operator

Special operator

Arithmetic operator:-

This is divided into 8 types

* Integer with distinct operator with

* Real

* mixed mode

operator	symbol	operation
Add	+	Addition
sub	-	Subtraction
Mul	*	Multiplication
div	/	Division
Modulos	%	Modulus

all programs ch. been app working. In this
here (%) modulus produces remainder as a value.

A

Integer Arithmetic

These arithmetic operations are done between two integer values.

$$\text{Ex:- } \text{int } a = 10 \quad b = 10;$$

$$a+b = 10+10=20$$

$$a-b = 10-10=0$$

$$a*b = 10*10=100$$

$$a/b = 10/10=1$$

$$a \% b = 10 \% 10=0$$

Real Arithmetic

These arithmetic operations are done between two real values.

$$\text{Ex:- } \text{float } a = 10.5, b = 11.6$$

$$a+b = 10.5 + 11.6$$

$$a/b = 10.5 / 11.6$$

RUN JAVA

!

Mixed mode arithmetic

The arithmetic operation done between integer value and real value

Ex:- int $a = 5;$

float $b = 2.5;$

$a + b = 5 + 2.5;$

$a - b = 5 - 2.5;$

Relational operators

Relational operators are used to compare the two quantities or two values

Relational operator	meaning
<	less than
\leq	less than or equal to
>	greater than
\geq	greater than or equal to
=	equal to
\neq	not equal to

Ex:- int $a = 6, b = 10;$

$a > b$ false

$a \leq b$ true

$a < b$ true

$a \neq b$ true

Logical operators

There are 3 types of logical operators.

logical operator	meaning
$\&\&$	LOGICAL AND
$\ $	LOGICAL OR
!	LOGICAL NOT

LOGICAL AND (&)

The result of logical and expression is true when both expressions are true.

Syntax:-

$\text{exp1} \& \text{exp2}$

exp1	exp2	result
T	T	T
T	F	F
F	T	F
F	F	F

LOGICAL OR (||)

The result of logical or expression is false when both expressions are false.

Syntax:-

$\text{exp1} \mid\mid \text{exp2}$

exp1	exp2	result
T	T	T
T	F	T
F	T	T
F	F	F

e.g. - $a = 10, b = 5, c = 15$

$$y = (a > b) \mid\mid (b > c)$$

$$= T \mid\mid F \Rightarrow 0$$

$$y = 1(T) \mid\mid 0$$

LOGICAL NOT (!)

The result of logicalnot. expression is true if the expression is false.

Syntax:- $! \text{exp}$

Exp 1	Exp 2
T	F
F	T

Assignment Operators:

These are used to assign the result of an expression to a variable.

There are two forms of assignment operators:

* Simple * Compound

Syntax

1. Variable = expression; // simple assignment

Ex:- $a=10$ $b=5$

$c=a+b$

2. Variable = variable operator expression;
(or)

Variable operator = expression; // compound

Ex:- $a = a + (c * d);$

or

$a += b;$

Compound expression + simple expression

$a += b$

$a = a + b$

$a -= b$

$a = a - b$

$a *= c$

$a = a * c$

$a \% b$

$a = a \% b$

$a \rightarrow 0$

$a = a - 10$

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Increment and decrement operators:

These operators are represented as '++' & '--'

'++' means increments the value by 1

-- decrements the value by 1

exp	meaning
a++	Post increment
++a	Pre increment
a--	Post decrement
--a	Pre decrement

Example:= int a=6;

b = ++a; // first increment

Value of b is 7 and a is 6

Note: a++ is same as a=a+1 or a+=1

Bitwise operators:=

These are applied on bits. bitwise operators does calculation on bits and stores in the memory

Bitwise operator	meaning
&	bitwise AND
	bitwise OR
^	Exclusive OR (XOR)
~	bitwise NOT
<<	left shift
>>	right shift

Bitwise AND

a	b	$a \& b$	from and both 1 then 1
1	0	0	from both 0 then 0
0	1	0	from both 0 then 0
0	0	0	from both 0 then 0

Bitwise NOT

a	\bar{a}
1	0
0	1

XOR

from and both 1 then 0	$a \oplus b$
from both 0 then 1	0
from both 1 then 0	1
from both 0 then 0	0

Conditional or ternary operators

These are also known as ternary operators

These take three operands and it is used to check the condition between two statements.

Syntax:

$exp1 ? exp2 : exp3;$

Ex:- int a=5, b=10, c=15;

$y = (a > b) ? b : c;$

The operator (?) works as follows

Exp 1 is evaluated first, if it is true then the Exp 2 is evaluated and becomes the value of expression. (either Exp 2 or Exp 3) is evaluated

C supports some special operators such as Comma operator, size of operator, member or selection operator.

Comma operator

It has lowest priority among all operators. This operator is used to separate the expressions.

Ex:- int a=5, b=10, c=20;

Size of operators.

It returns the number (of bytes) of an operant. An operant may be a variable, constant or datatype.

Syntax:

size of (operator);

Ex:- size of (int);

x = 2 (\because size of int is 2 bytes)

member selection operators.

These are used to access members of Pointers, structures, unions

Ex:- Variable member

Unary operator

A unary operator is an operation with only one operand i.e., (++, --).

The unary operators include, increment (++), decrement (--), address (&), logical not (!), size of operator.

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Binary Operators:
These requires two operands and one operator
between them.

Ex: $a * b$, a/b

Programme to implement Arithmetic operators

```
#include<stdio.h>
#include <conio.h>
void main()
{
    int a=10, b=15;
    float c;
    clrscr();
    c = a+b;
    printf("the value of c is %f", c);
    getch();
}
```

Programme to implement logical operator

```
#include<stdio.h>
#include <conio.h>
void main()
{
    int num1=20, num2=30;
    clrscr();
    if (num1 > 20 & & num2 > 20)
        printf("This is logical AND");
    if (num1 > 20 || num2 > 20)
        printf("This is logical OR");
    if (num1 < 20) {
        printf("This is logical NOT");
    }
    getch();
}
```

Programme to implement Assignment operator.

```
#include<stdio.h>
#include<conio.h>
void main()
{
    int a=5 b=2;
    float d;
    clrscr();
    d = a/b;
    printf ("the value of d is %f",d);
    getch();
}
```

Programme to implement all the Arithmetic operators

```
#include <stdio.h>
#include <conio.h>
Void main()
{
    int a,b,x,y,z;
    clrscr();
    printf("enter the value of a and b");
    Scanf ("%d %d", &a, &b);
    x=a+b;
    y=a-b;
    z=a*b;
    printf ("x=%d,y=%d,z=%d",x,y,z);
    getch();
}
```

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Programme to implement conditional operator.

```
#include <stdio.h>
#include <conio.h>
void main()
{
    int a=10, b=50;
    clrscr();
    if (a>b)
        printf ("a is greater");
    else
        printf ("b is greater");
    getch();
}
```

Programme to implement increment and decrement operators

```
#include <stdio.h>
#include <conio.h>
void main()
{
    int y, a=10;
    clrscr();
    y=a++;
    printf ("the value of y=%d a=%d", y, a);
    y++;
    printf ("the value of y=%d a=%d", y, a);
    y--;
    printf ("the value of y=%d a=%d", y, a);
    getch();
}
```

4-9-18

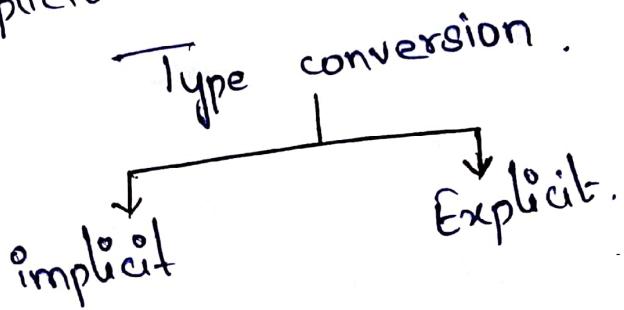
implement
Program to implement bitwise operators and off the
bitwise operators

```
#include <stdio.h>
#include <conio.h>
void main()
{
    int a,b;
    clrscr();
    printf("Enter the values of a&b");
    scanf("%d %d", &a, &b);
    printf("AND OPERATION : %d \n", a&b);
    printf("OR OPERATION : %d \n", a|b);
    printf("NOT OPERATION : %d \n", a^b);
    getch();
}
```

Type Conversion: Implicit

Converting data from one form to another form is called type conversion.

- * They are divided into 2 types.
- * Explicit
- * Implicit



Implicit

If the data is converted from one form to another automatically it is called Implicit type conversion.

Ex: $\text{int } m = 15$

float = x=3.1, y=,

$$y = mx + c;$$

Explicit

If the data is converted from one form to another by us (using CAD/CAM) then

If we want to convert data from one form to another we use following syntax,

Syntax:
Var 1 = (datatype) var 2

Ex: $\int x=5$;

float y;

$$y = x^{\frac{1}{2}}$$

$$y = \text{float}(5\frac{1}{2})$$

= 5.5

399pt

$\int_0^{\infty} g(x) dx$

noizyenvos

100

Program to implement type conversion:

```

#include <stdio.h>
#include <conio.h>
Void main()
{
    int a,b;
    float c,d;
    a = 1;
    c = 3.14;
    b = (int)c;
    d = (float)a / (float)b;
    printf ("%f",d);
    getch();
}

```

Expression and precedence and expression evaluation

$$\text{Ex: } x = a * (b - c) + d$$

$$\text{After substituting values, we get } a=10, b=15, c=8, d=6$$

$$x = 10 * (15 - 8) + 6$$

$$= 10 * 7 + 6$$

$$= 70 + 6$$

$$= 76$$

1st preference is given to bracket and evaluated

2nd preference is given to *

3rd preference is given to +

Inorder to evaluate the above example

according to the rules.

Highest priority of arithmetic operators:

/

%

*

lowest priority + , -

Rules of evaluation:

- * parenthesized sub expression is evaluated from left to right.
- * if the parenthesis is nested, the evaluation begins with innermost sub expression.
- * Determining the order the application of operator and evaluating sub expression.
- * Associative rule is applied: $(a-d) \times e = a \times e - d \times e$
- * Arithmetic operations are evaluated from left to right
- * when parenthesis is used, the expression within priority assumes highest priority.

Programme to implement relational operators:

```
#include<stdio.h>
```

```
#include<conio.h>
```

```
Void main()
```

```
{
```

```
int a,b,c,d,e,f,g,h;
```

```
clrscr();
```

```
Print(" enter values of a,b");
```

```
scanf("%d %d ", &a, &b);
```

```

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c = a == b;
d = a != b;
e = a > b;
f = a < b;
g = a >= b;
h = a <= b;
printf("It checks equal to %d", c);
printf("It checks not equal to %d", d);
printf("It checks greater than %d", e);
printf("It checks less than %d", f);
printf("It checks greater than or equal to %d", g);
printf("It checks less than or equal to %d", h);
getch();

```

3

Program to implement all types of operators.

```

#include <stdio.h>
#include <conio.h>
Void main()
{
    operation to display function is as follows
    int a,b;
    clrscr();
    printf("enter the values of a,b");
    scanf("%d%d", &a, &b);
    printf("The addition of two numbers %d \n", a+b);
    printf("Subtraction of 2 numbers %d \n", a-b);
    printf("multiplication of 2 numbers %d \n", a*b);
    printf("division of 2 numbers %d \n", a/b);
    printf("modulus of 2 numbers %d \n", a%b);
    printf("greater than %d \n", a>b);
}

```

printf("less than %d\n", a < b);
printf("greater than (or) equal to %d\n", a ≥ b);
printf("less than (or) equal to %d\n", a ≤ b);
printf("equal to %d\n", a = b);
printf("not equal to %d\n", a != b);
printf("the post increment of a is %d\n", a++);
printf("the pre increment of a is %d\n", ++a);
printf("post decrement of b is %d\n", b--);
printf("pre decrement of b is %d\n", --b);
printf("logical AND is %d\n", a & b);
printf("logical OR is %d\n", a | b);
printf("logical NOT is %d\n", ~a);

getch();

Storage classes:

There are 4 different types of storage classes

* Automatic

* Register

* static

* external

(They help us to understand about the memory allocation, default value, scope, lifetime of variables if we don't specify any type it is automatically considered as auto)

Syntax:-

Ex- Auto int n;

Auto Variables :-

- * Auto variables are always local variables.
- * They occupy space in the primary memory.
- * They are alive only until the block in which they are defined is in control.
- * default value of Auto variable is Garbage.

Programme to implement Auto storage class:

```
#include <stdio.h>
```

```
#include <conio.h>
```

```
auto int a;
```

```
Void main()
```

```
{  
    auto int a=10; → method scope  
    clrscr();  
}
```

```
    auto int a; → block scope.
```

```
    printf ("a=%d\n", a); → Garbage value.
```

```
}
```

```
    printf ("a=%d\n", a); → 10
```

```
    getch();  
}
```

Registers :-

Registers type storage class is used to access the variables much faster and it can be used in a case where a variable is repeatedly used.

* The scope of register variables is confined to the block in which they are defined.

* Variables are allocated space in the C.P.U registers then default value is garbage value.

* The keyword used is register.

* Lifetime of register variables is till the control remains in the block in which it is defined.

Syntax:

register int a; // usage of register

static int b; // life of variable is limited to the function

Syntax: static int x;

* Static variables are allocated space in the Primary memory.

* Default value is zero

* Scope of static variables is confined to the block in which they are defined

* The value of variable remains as long as the completion of the programme

Programme to implement static variables

#include <stdio.h>

#include <conio.h>

void main ()

{
increment();
increment();
increment();
getch();

increment();

static int a=0;

a=a+1;

printf ("a=%d", a);

getch(); return 0;

extern:-

Keyword used is extern

Extern variables are allocated memory in main memory.

default value is zero

Extern variables are accessible throughout the programme (global variables)

Programme (global variables)

The value of extern variables remains as long as the completion of the programme.

The completion of the programme.

Syntax:-

Extern int x;

Programme to implement extern variables.

```
#include <stdio.h>
```

```
#include <conio.h>
```

```
void main()
```

```
{  
    int x=3;
```

```
    extern int y;
```

```
    printf ("x=%d", x); → 3
```

```
    printf ("y=%d", y); → 10
```

```
    getch();
```

```
    y=10; displays value 10
```

```
    getch();
```

```
    printf ("x=%d", x); → 3
```

```
    printf ("y=%d", y); → 10
```

```
    getch();
```

```
    printf ("x=%d", x); → 3
```

```
    printf ("y=%d", y); → 10
```

Command line argument:

To pass command line arguments, we typically define main() with two arguments.
1st argument is the no: of command line arguments.
2nd is list of command line arguments.
`int main(int argc, char *argv[])`

Argc: Argument count

It is int and stores no: of Command line arguments passed by the user including the name of the programme.

Value of Argc should non-negative

Argv: Argument vector

It is array of character pointers listing the arguments. If argc is greater than 0, the array elements from argv[0] to argv[argc] will contain pointers to strings.

argv[0] is the name of the programme, after that till argv[argc-1] every element is command line arguments.

Properties of command line arguments:

- They are passed to main().
- They are parameters / arguments supplied to the programme when it is invoked

→ They are used to control programme from outside instead of hard coding those values inside the code.

→ Argv[argc] is a null pointer

→ argv[0] ~~is~~ holds the name of the programme

→ argv[i] points to the first command line argument and argv[n] points last arguments.

cmd > hello <> hello 10 { } x 6
↓ ↓ ↓ ↓ ↓ ↓
argv[0] argv[1] argv[2] argv[3] argv[4]

Programme to implement command line arguments.

```
#include <stdio.h>
```

```
#include <conio.h>
```

```
Void main (int argc , char * argv [ ] )  
{
```

```
    printf (" Program name is : %s ", argv [0] );
```

```
    if (argc == 1)
```

```
        printf (" No extra command line arguments passed  
                except program name " );
```

```
    if (argc >= 2)
```

```
{
```

```
        printf (" no. of arguments passed %d ", argc );
```

```
        getch ();
```

```
}
```

```
        getch ();
```

```
}
```

```
        getch ();
```

cd \

cd tc

cd bin

tcc programme.c

Programme arg1 arg2 arg3

Conditional branching and looping

There are different conditional statements

In C. They are.

- * if
- * if else.
- * else_if ladder
- * switch.

- If

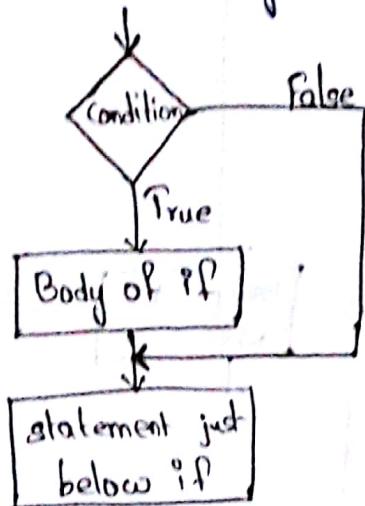
Syntax:-

```
if (condition / test expression) { statement  
{  
    if (another condition)  
        statements;  
    }  
    statements
```

The if statements evaluates the test expression

Condition inside the parenthesis. If the test expression is evaluated to true (non-zero), statement inside the body of if is executed

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if the test expression is evaluated to false then statement inside the body of if is skipped.



* if else

Syntax:

```
if (test expression)  
{
```

statements / body of if ;
}

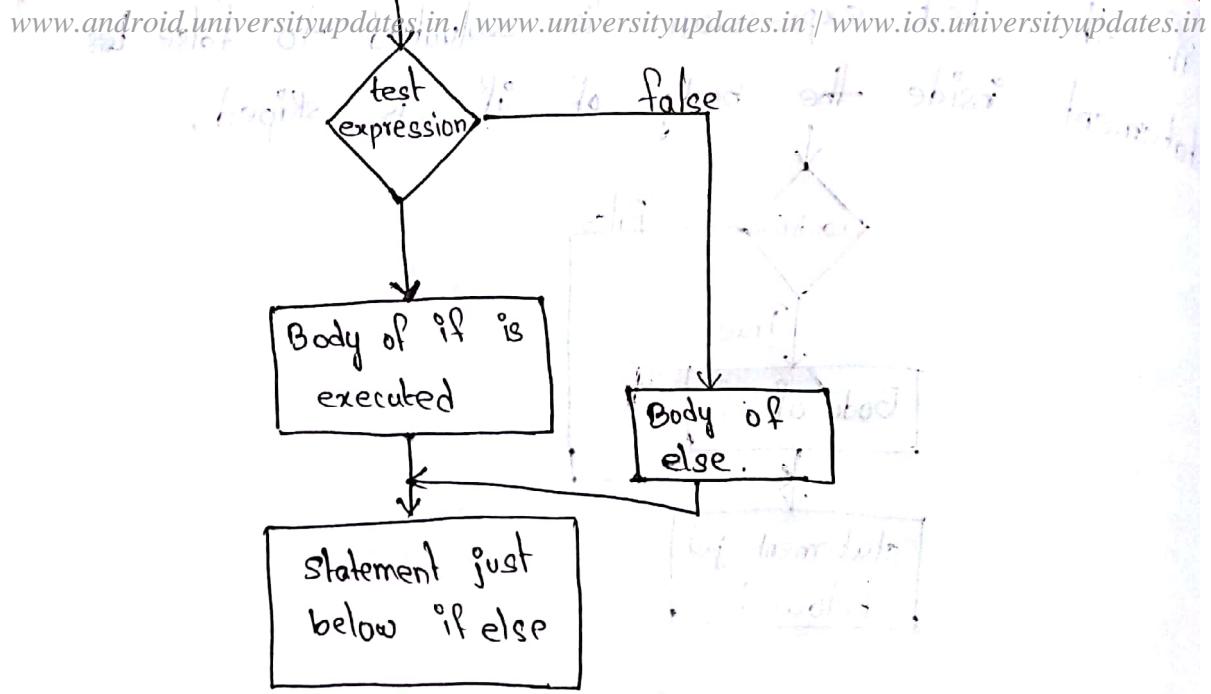
else .

```
{ statements / Body of else ; }
```

statements ;

The if else statement evaluates the test expression inside the parenthesis. If the test expression is evaluated to True statement inside the body of if is excuted. and statements inside the body of else is skipped

If the test expression is evaluated to False Statement inside the body of if is skipped and Statement inside the body of else is excuted.



Programme to (implement) print even or odd.

```

#include <stdio.h>
#include <conio.h>
Void main()
{
    int n;
    printf ("Enter n value");
    Scanf ("%d", &n);
    if (n%2==0)
        printf ("n=%d is even", n);
    else
        printf ("n=%d is odd", n);
    getch();
}

```

To print a number is +ve

```

#include <stdio.h>
#include <conio.h>
void main()
{
    int n;
    printf ("enter the n value");
    Scanf ("%d", &n);
    if (n > 0)
    {
        printf ("n = %d is positive", n);
    }
    getch();
}
else -if ladder:
    if (test exp1)
    {
        statement ;
    }
    else if (test exp 2)
    {
        statement ;
    }
    else if (test exp3)
    {
        statement ;
    }
    else
    {
        statement ;
    }
}

```

goto:
The goto statement is used to transfer or jump
the control from one statement to the other
in the program.

Syntax:

```

graph TD
    A["goto label1;"] --- B["statements;"]
    B --- C["label1:"]
    C --> D["forward jump"]

```

The diagram illustrates a forward jump statement. It consists of three main parts: a label at the top, a block of statements in the middle, and a label at the bottom. An arrow points from the top label down to the statements, and another arrow points from the statements up to the bottom label, indicating the flow of control.

A diagram illustrating a control flow from a label to a `goto` statement. On the left, the word "label:" is followed by a colon and a vertical line. An arrow points from this vertical line down to a horizontal line that spans three lines of code below. The first line of code is "Statements;" followed by three blank lines. The second line of code is also "Statements;" followed by three blank lines. The third line of code is "Statements;" followed by three blank lines. To the right of the horizontal line, the text "Backward jump" is written vertically.

Programme to implement goto. (Implementation)

```
#include<stdio.h>
#include <conio.h>
void main()
{
    int i=1;
    xyz:
    i++;
    if (i<=10)
    {
        printf ("%d",i);
        goto xyz;
    }
}
```

Switch

switch case statements are a substitute for long if statements that compare a variable to several integral values.

→ The switch statement is a multiway branch statement

→ It provides an easy way to dispatch execution to different parts of code based on the value of expression.

→ Switch is a control statement that allows a value to change control of execution

Syntax :-

Switch (n)

{
 fallthrough {
 case 1 : // code to be executed if n=1
 statements;
 break;

 case 2 : // codes to be executed if n=2
 statements;
 break;

 default : // if n does not match any case
 }

 // fallthrough

(d) And also

 //

(e) And also

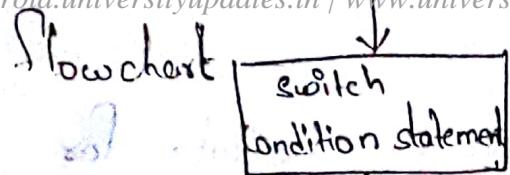
 //

(f) And also

 //

(g) And also

 //



Program

Constant expressions are allowed in switch case

Ex :- switch (1+2+3)

switch (1*2+3%4)

Switch (ab+cd) } not valid
Switch (a+b+c)

Variable expressions are not valid in switch

Simple programme to implement switch case:

```

#include<stdio.h>
#include<conio.h>
Void main()
{
    int x=2;
    switch (2)
    {
        Case 1: printf("choice is 1");
        break;
    }
  
```

case 2: printf ("choice is 2");

break;

default :

printf ("out of range");

}
getch();

}

Output: choice is 2.

write a C program for all arithmetic operators using switch.

```
#include <stdio.h>
```

```
#include <conio.h>
```

```
Void main()
```

```
{  
int a,b,c;
```

```
char oper;
```

```
Printf ("enter the operator");
```

```
Scanf ("%c", &oper);
```

```
Printf ("enter the value of a,b");
```

```
Scanf ("%d %d", &a, &b);
```

```
Switch (oper)
```

```
{
```

```
Case '=' : c=a+b;
```

```
Printf ("sum is %d\n", c);
```

```
break;
```

```
Case '-' : c=a-b;
```

```
Printf ("difference is %d\n", c);
```

```
break;
```

```
Case '*' : c=a*b;
```

```
Printf ("multiplication is %d\n", c);
```

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Case '1': $c = ab;$

```
printf("division is %d\n", c);  
break;
```

default;

Printf ("operator is not valid").
↳:

break;

```
    }  
    return  
    getch();
```

}

formatted io:

It refers to the conversion data to form a stream of characters for printing in plane text format.

Output with printf:

printf ("format string", variable name);

Conversion Specifiers:

It is a symbol that is used as a space holder, in a formatting string.

%d → int (signed decimal integer)

%u → unsigned int

%f → float, double

%c → character

%s → string

Scanf

Syntax:-

scanf ("format string", list of variables & address);

Standard input and output streams:-

→ i/o is essentially done one character or bit at a time.

Stream:

A sequence of characters flowing from one point to another.

when the main function of our program is invoked it already has predefined streams open and available for use. These represents stdio.h channels that have been established for process.

These stream files are declared in the header stdio.h.

Variable: file * stdin

The std input stream which is the normal source of input for the programme (default is keyboard)

Variable: file * stdout

The std output stream which is used for normal output from the programme (default is monitor)

Variable: file * stderr

The stderr stream which is used for diagnosis and displaying of error messages.

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While writing a C programme to find the given is leap year
or not

```
#include <stdio.h>
#include <conio.h>
void main()
{
    int year;
    printf ("Enter the year");
    scanf ("%d", &year);
    if (year % 4 == 0)
        printf ("The given year is leap year", year);
    else
        printf ("It is not leap year");
    getch();
}
```

To find the largest among two numbers.

```
#include <stdio.h>
#include <conio.h>
void main()
{
    int num1, num2;
    printf ("enter numbers");
    scanf ("%d %d", &num1, &num2);
    if (num1 > num2)
    {
        printf ("num1 is largest %d", num1);
    }
    else
    {
        printf ("num2 is largest %d", num2);
    }
    getch();
}
```

written a C programme to calculate total of marks, print average & grade.

```
#include <stdio.h>
#include <conio.h>
Void main()
{
    int s1,s2,s3,s4;
    int tot;
    float avg;
    char grade;
    clrscr();
    printf("Enter the marks in s1,s2,s3,s4");
    scanf("%d %d %d %d", &s1, &s2, &s3, &s4);
    tot = s1+s2+s3+s4;
    Avg. = tot / 4;
    if (avg >= 60)
    {
        grade = 'A';
    }
    else if (avg >= 50 && avg < 60)
        grade = 'B';
    else if (avg >= 40 && avg < 50)
        grade = 'C';
    else
        grade = 'D';
    printf("total marks %d", tot);
    printf("Average %.2f", Avg);
    printf("The grade is %c", grade);
    getch();
}
```

for

the general form of for loop is

syntax:-

for (initialization ; condition ; modify)

{

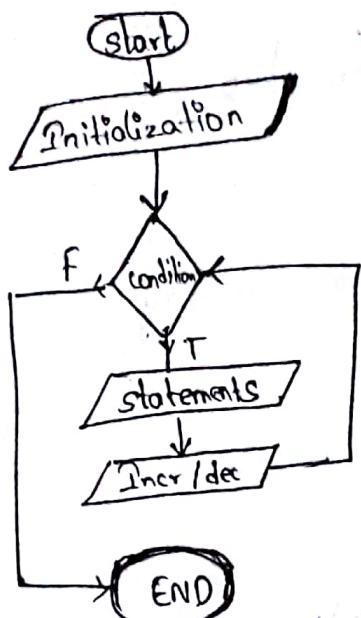
body of loop/statements;

}

In for loop first it initialises the values and later checks the condition if it is true. and execute the body of the loop. if the condition is false the loop is terminated. Then the control variable is incremented or decremented the new value is again tested if the condition is true. the process continues and stops when condition becomes false.

Programme to calculate Factorial of given number.

```
#include<stdio.h>
#include<conio.h>
Void main()
{
    int n, i, fact = 1;
    clrscr();
    printf("enter the value of n");
    scanf("%d", &n);
    for (i=1; i<=n; i++)
    {
        fact = fact * i;
    }
    printf("the value of Factorial of %d is %d", n, fact);
    getch();
}
```



While:

The while is an entry control statement if the test control is true, the body of the loop is executed.

write a C programme to calculate sum of n natural numbers using while.

```
#include<stdio.h>
#include <conio.h>
void main()
{
    int i=0, sum=0, n;
    clrscr();
    printf("enter the value of n");
    scanf("%d", &n);
    while (i<=n)
    {
        sum = sum + i;
        i++;
    }
    printf ("sum is %d", sum);
    getch();
}
```

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write a programme to calculate sum of the squares

of all integers.

```
#include <stdio.h>
```

```
#include <conio.h>
```

```
void main()
```

```
{
```

```
int i=0, n, sum=0, a;
```

```
clrscr();
```

```
printf("enter the value of n");
```

```
scanf("%d", &n);
```

```
while (i<=n)
```

```
{sum+=i*i;
```

```
i++;
```

```
}
```

```
printf("The sum is %d\n", sum);
```

```
getch();
```

```
}
```

do while :

It is similar to that of while except
it always executes the statements atleast once. in do
while after executing statement the condition
will be checked.

Syntax:-

```
do
```

```
{
```

```
statements;
```

```
=
```

```
incre/decrement;
```

```
}
```

```
while (condition);
```

Programme to implement to while.

```
#include <stdio.h>
#include <conio.h>
Void main()
{
    int i=1;
    clrscr();
    do
    {
        printf ("%d\n", i);
        i++;
    }
    while (i<=10)
    printf ("out of loop");
    getch();
}
```

ARRAYS UNIT-11

10/10/18

An array is a fixed size of sequence or collection of elements of some data-type. It is simply a grouping like data types / like type data.

Some examples where the concept of array can be used

- list of temp recorded every hours in a day/month/year.
- list of employees in an organisation.
- test score of a class of students.
- list of customers and telephone numbers.

Syntax :-

```
datatype Identity [size];
where Identity is the private identifier
      datatype is the variable type
      size is the number of elements
```

datatype VariableName [size];

we can use arrays to represent not only simple list of values but also tables of data, in two, three or more dimensions.

The following are the types of arrays.

- (i) One dimensional array
- (ii) 2-dimensional array
- (iii) multi-dimensional array.

Accessing an array:-

You can access elements of an array by indices. Suppose you have declared an array "mark" as given below → mark [5].

First element is mark of 60.



mark[0] mark[1] mark[2] mark[3] mark[4]

Few Key notes:

- Array have 'zero' as the first index not '1'.
- If the size of an array is n then to access the last element [n-1] index is used.
- Suppose the starting address of mark[0] is 2120d then the next address a[1] 2124d.
- So it is of type float as it allocated 4 bytes each.

Initialization of values into array :-

→ Int mark[5] = {10, 20, 40, 60, 80};

Program to (implement) calculate average of ~~two~~ numbers using arrays.

```
#include<stdio.h>
```

```
#include<conio.h>
```

```
Void main()
```

```
{
```

```
int marks[10], i, n, sum=0;
```

```
float average;
```

```
printf ("enter the numbers.");
```

```
Scanf ("%d", &n);
```

```

for (i=0 ; i<n ; i++)
{
    printf ("enter number %d ", i+1);
    scanf ("%d", &marks [i]);

    sum = sum + mark [i];
}

average = sum/n;
printf (" Average = %d ", Average);

getch();
}

```

alias

Two-dimensional Array :-

In C programming you can create a array of arrays known as multi-dimensional arrays.

$\rightarrow \text{int } a[3][4]$

here a is a two dimensional array and it can hold 12 elements. you can think the array has table with 3 rows and 4 columns.

$\rightarrow R_1 \ a[0][0] \ a[0][1] \ a[0][2] \ a[0][3]$

$R_2 \ a[1][0] \ a[1][1] \ a[1][2] \ a[1][3]$

$R_3 \ a[2][0] \ a[2][1] \ a[2][2] \ a[2][3]$

Initialization of two-dimensional arrays:-

There are different ways for initializations.

$\text{int } c[2][3] = \{ \{1,3,0\}, \{-1,5,9\} \}$

$\text{int } c[2][3] = \{ \{1,3,0\}, \{-1,5,9\} \}$

$\text{int } c[2][3] = \{ \{1,3,0, -1,5,9\} \}$

Programme to add two matrices:

```

#include <stdio.h>
#include <conio.h>
Void main()
{
    int r, c, a[100][100], b[100][100], sum[100][100], i, j;
    clrscr();
    printf("Enter No: of rows, (between 1 and 100):");
    scanf("%d%d", &r, &c);
    printf("In Enter elements of 1st matrix:\n");
    for (i=0; i<r; i++)
    {
        for (j=0; j<c; j++)
            printf("Enter element a[%d][%d]", i+1, j+1);
            scanf("%d", &a[i][j]);
    }
    printf("In Enter elements of 2nd matrix:\n");
    for (i=0; i<r; i++)
    {
        for (j=0; j<c; j++)
            printf("Enter element b[%d][%d]", i+1, j+1);
            scanf("%d", &b[i][j]);
    }
    for (i=0; i<r; i++)
    {
        for (j=0; j<c; j++)
            sum[i][j] = a[i][j] + b[i][j];
    }
    for (i=0; i<r; i++)
    {
        for (j=0; j<c; j++)
            printf("%d", sum[i][j]);
    }
}

```

```
Sum[i][j] = a[i][j] + b[i][j];
```

{

{

```
printf("sum of two matrix is :\n");
```

```
for(i=0; i<r; i++)
```

{

```
for(j=0; j<c; j++)
```

{

```
printf("%d\n", sum[i][j]);
```

```
if(j == c-1)
```

{

```
printf("\n\n");
```

}

{

```
getch();
```

}

Manipulating on elements of an array:-

Interchanging the position of elements in an array is called manipulating an array.
Write the C programme to find the transpose of a matrix.

```
#include <stdio.h>
```

```
#include <conio.h>
```

```
Void main()
```

{

```
int a[10][10], transpose[10][10], r, c, i, j; // declare
```

```
printf("Enter no. of rows and columns);
```

```
Scanf ("%d %d", &r, &c);
```

```
printf ("Now enter elements of matrix :\n");
```

```
for(i=0; i<r; i++)
```

```

for (j=0; j<c; j++)
{
    printf ("Enter element at %d,%d", i+1, j+1);
    scanf ("%d", &a[i][j]);
}
}

printf ("Entered matrix :\n");
for (i=0; i<r; i++)
{
    for (j=0; j<c; j++)
    {
        printf ("%d ", a[i][j]);
        if (j==c-1)
            printf ("\n\n");
    }
}

printf ("Transpose of matrix :\n");
for (i=0; i<r; i++)
{
    for (j=0; j<c; j++)
    {
        transpose[i][j] = a[j][i];
    }
}

for (i=0; i<r; i++)
{
    for (j=0; j<c; j++)
    {
        printf ("%d ", transpose[i][j]);
    }
}

```

```
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if (j == r - 1);
printf("\n\n");
}
else for (i = 0; i < n; i++)
getch();
}
```

String :=

Strings are defined as an array of characters
the difference b/w a character array and string
is that the string is terminated with a
special character '\0'.

Declaration of a string.

Declaring a string is as simple as declaring a
one dimensional array.
Syntax: char strname [size];
Please note that there is an extra terminating
character which is the null character [\0] used to
indicate termination of string which differs strings
from normal character arrays.

Initialization:

```
char str [] = "Hello";
char str [50] = "Hello";
char str [] = {'H', 'E', 'L', 'L', 'O'};
char str [5] = {'H', 'E', 'L', 'L', 'O'};
```

The c language doesn't provide 'inbuilt' data types for strings but it has an access specifier which can be used to directly point and read strings.

Ex :-

```
#include <stdio.h>
#include <conio.h>
```

```
void main()
{
    char str[50];
    scanf("%s", str);
    printf("%s", str);
    getch();
}
```

we know that the '&' is used to provide the address of the variable to the scanf function to store the value read in the memory as str[] is a character array so using str without braces nor with giving the base address of string that is another reason we have not used '&' in this case as we are already providing the base address of the string to scanf.

String manipulation:

You need to often manipulate string. Due to the need of a problem, most, if not all, of the string manipulation can be done manually but this makes programming complex and large to solve this, C++ supports a large no. of string handling functions in the standard library.

"string.h"

- * strlen() → Calculates length of the string.
- * strcpy() → Copies a string to another string
- * strcat() → Concatenates (joins) two strings

Function gets and puts() are two string functions to take string input from the user and display it respectively.

It is present in stdio.h

Ex:- #include <stdio.h>

#include <conio.h>

{

```
char name[30];
clrscr();
printf("Enter the name");
gets(name);
Pointf("Name");
Puts(name);
```

getch(); // function to display string

}

Strlen()

The `strlen()` function calculates the length of the string. The function takes a single argument i.e. the string variable whose length has to be found and returns the length of the string fast. The `strlen()` is defined in `<string.h>`. The following program illustrates it.

Ex: programs to find length of a string.

```
#include <stdio.h> //include stdio.h for output operations
#include <conio.h> //include conio.h for input operations
#include <string.h> //include string.h for strlen() function
Void main()
{
    char a[20] = "Program"; //char array a containing string Program
    char b[20] = {"P','R','O','G','R','A','M"}; //char array b containing string Program
    char c[20];
    printf ("Enter string"); //printing message
    gets(c); //getting string from user
    printf ("length of string a=%d\n", strlen(a)); //printing length of string a
    printf ("length of string b=%d\n", strlen(b)); //printing length of string b
    printf ("length of string c=%d\n", strlen(c)); //printing length of string c
}
```

Note: Output of the above program is (Screenshot) as follows

strcpy()

This function copies the string to the another character array.

Syntax:-

`char *strcpy (char *destination, const char *source)`

The strcpy() copies the string pointed by source (including the null character) to the character array destination. The function returns character array destination.

→ strcpy() is defined in <string.h>

Ex:- Program to implement strcpy();

```
#include<stdio.h>
#include<conio.h>
#include<string.h>
```

Void main()

```
    {
```

```
        char str1[10] = "awesome";
```

```
        char str2[10];
```

```
        char str3[10];
```

```
        strcpy(str2, str1);
```

```
        strcpy(str3, "well");
```

```
        Put s(str2);
```

```
        Put s(str3);
```

```
        Getch();
```

```
}
```

strcmp()

It compares two strings and returns 0 if both strings are identical.

Syntax:-

```
int strcmp(const char *str1, const char *str2);
```

The strcmp function takes two strings and returns an integer.

The strcmp function compares two strings char by char. If the first char of two strings are equal, next char of two strings are compared this continuous until the corresponding characters of two strings are different or a null character '\0' is reached. It is defined in <string.h>

return value	Remark
0	if both strings are equal. e.g. "abcde" < [0] abcde
Negative	if ascii value of first unmatched char is less than second.
Positive	if ascii value of first unmatched char is greater than second.

```
#include <stdio.h>
#include <conio.h>
#include <string.h>
void main()
{
    char str1[10] = "abcd", str2[10] = "aB cd", str3[10] = "abcd";
    int result;
    else if (strcmp(str1, str2) == 0)
        result = strcmp(str1, str2);
    else
        result = strcmp(str1, str3);
    printf("strcmp (str1, str2)=%d \n", result);
    printf("strcmp (str1, str3)=%d \n", result);
    getch();
}
```

Strcat()
The function strcat() concatenates (joins) two strings.

Syntax :-

```
char* strcat (char* dest , const char* src);
```

It takes two arguments i.e., two strings or char arrays, and stores the resultant concatenated string in the first string specified in the argument.

The pointer to the resultant string is passed as returned value to your call of strcat().
Note To append memory of dest to other pointer or not to copy and assign it to another dest.
If transferred back and same alignment is done.

Program to concatenate given two strings.

```
#include <stdio.h>
#include <conio.h>
#include <string.h>
void main()
{
    char str1[10] = "This is", str2[10] = " ECE-CV";
    strcat (str1, str2);
    puts (str1);
    puts (str2);
    getch();
}
```

Arrays of strings :-

A string is a 1-D array of characters, so an array of strings is 2-Dimensional array of characters.

Syntax:-

```
char ch-arr[3][10] = {{'S','P','I','K','E',10}, {"T","O","M",10}, {"J","E","R","R","Y",10}};
```

Character by character (or) string by string (or)

The first subscript of array i.e., 3 denotes the no. of strings in the array and second subscript holding value 10 denotes the maximum length of string.

Each character occupies one byte of data so when the compiler sees the above statement it

allocates [3x10] bytes of memory

ch-arr + 0

1000	1001	1002	1003	-	-	-	-	-	1009
S	P	I	K	E	\0	\0	\0	\0	\0

ch-arr + 1

1010	-	-	-	-	-	-	-	-	-
T	O	M	\0	\0	\0	\0	\0	\0	\0

Program to print array of strings and their addresses

```
#include <stdio.h>
```

```
#include <conio.h>
```

```
#include <string.h>
```

```
Void main()
```

```
{
```

```
char ch[3][10], i;
```

```
clrscr();
```

```
printf ("Enter 3 strings");
```

```
for (i=0, i<3, i++)
```

```
{
```

```
scanf ("%s", ch[i]);
```

```
}
```

```
printf ("strings are");
```

```
for (i=0, i<3, i++)
```

```
{
```

```
printf ("%s address = %u \n", ch[i], ch[i]);
```

```
}
```

```
getch();
```

```
}
```

Write a program to find the sum of n natural numbers.

```
#include <stdio.h>
#include <conio.h>
Void main()
{
    int n, i, sum=0;
    clrscr();
    printf ("Enter a positive integer");
    scanf ("%d", &n);
    for(i=1; i<=n; i++)
    {
        sum = sum + i;
    }
    printf ("sum=%d", sum);
    getch();
}
```

Structure

It is a collection of variables of different types under a single name.

Ex: If you want to store some information about a person, i.e., the name, citizenship no, salary you can easily create different variables, name, salary, CITNO to store these information separately with the help of structures.

If you want to store information about multiple persons you need to create different variables for each information per person.

name₁, CITNO₁, salary₁, name₂, CITNO₂, salary₂

This collection of all related information under a single name person is a structure.

→ Keyword "struct" is used for creating a structure

```
struct structure name  
{  
datatype member1;  
datatype member2;  
—  
datatype membern;  
};
```

Structure variable declaration and accessing

when a struct is defined, it creates a userdefined type but no storage is allocated yet. up to the time it is declared it is not stored in memory.

available storage is known as block.

Ex:- 1.

```
struct emp {
    int eno;
    char ename[20];
    float esalary;
};
```

Code:-

```
void main() { }
```

Output:-

```
struct emp Emp1, Emp2;
getch();
```

Ex:- 2;

Struct emp block

{

int eno; float esalary;

char ename[20];

float esalary;

Emp1, Emp2;

In the both cases two variables emp1, emp2

of type struct emp are created.
member operation(.) is used for accessing members
of a structure.

Initializing structure variables

we can directly initialize the structure
variables as shown below:

Ex: struct emp emp1 = {1000, "RAM", 63047};

Basic program to implement structures.

```
#include<stdio.h>
#include<conio.h>
void main()
{
    struct emp
    {
        int eno;
        char name[20];
        float esalary;
    };
}
```

```
void main()
```

```
struct emp e={1001, "RAM", 5000};
```

```
printf ("Emp details:\n");
```

```
printf ("Eno %d\n", e.eno);
```

```
printf ("ename %s\n", e.name);
```

```
printf ("esalary %.2f\n", e.salary);
```

```
getch();
```

```
}
```

Program to find size of structure.

```
#include <stdio.h>
#include <conio.h>
struct emp
{
    int eno;
    char ename[20];
    float esalary;
};

main()
{
    struct emp e;
    printf ("%d", sizeof(e));
    getch();
}
```

Array of structures:

Declaring an array of structure is same as declaring an array of fundamental type.

Since an array is collection of elements of the same type.

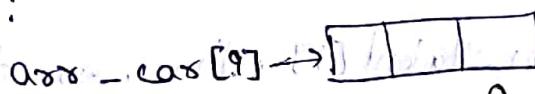
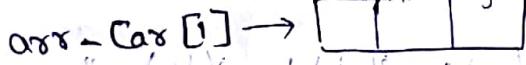
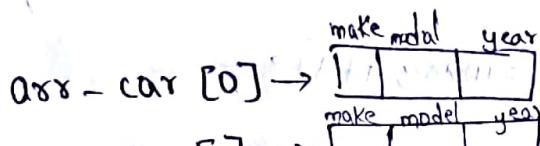
In an array of structures each element of an array is of the structure type.

(Syntax: struct car arr-car[10])

struct car arr-car[10]

here, arr_car is an array of 10 elements, where each element is of type struct car. we can use arr_car to store 10 structure variables of type struct car. To access individual elements we will use subscript notation ([]) to access the members of each element we will use (.) operator as usual.

struct car arr_car[10]



Program to implement array of structure.

```
#include <stdio.h>
#include <conio.h>
#include <string.h>
#define max 2
struct student
{
    char name[20];
    int roll_no;
    float marks;
};
void main()
{
    struct student arr_student[max];
    int i;
    for (i=0; i<max; i++)
    {
        printf("Enter details of student %d\n", i+1);
        printf("Enter name");
        scanf("%s", arr_student[i].name);
    }
}
```

```

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scanf ("%s", arr_student[i].name);
printf ("Enter roll no:");
scanf ("%d", &arr_student[i].rollno);
printf ("Enter marks");
scanf ("%f", &arr_student[i].marks);
}
printf ("\n\n");
printf ("name\t rollno\t marks\n");
for (i=0; i<=max; i++)
{
    printf ("%s\t %d\t %.2f\n", arr_student[i].name,
           arr_student[i].rollno, arr_student[i].marks);
}
getch();
}

```

Unions:

Unions are quite similar to structures. Like structures unions are also derived types.

Syntax:

```
union car
```

```
{
```

```
char name[50];
```

```
int price;
```

```
}
```

Defining a union is as easy as replacing the keyword struct with the keyword union.

union variables can be created in similar manner as structure variables

Ex:- union car
{
char name [50];
int price;
};
and int *car1, *car2, *car3; with additional or union in the form

From the above diagram we can see that there is two ways to declare union variable.
one is direct char name [50]; the second is int price;
which both are same. Then main function void main ()
{
union car car1, car2, car3; and
getch();
}

In both cases union variables car1, car2 and union pointer variable car3 of type union car is created.

Accessing members of a union:-

Again, the member of unions can be accessed in similar manner as structure.

In the above example suppose you want to access price for union variable car1. It can be accessed as car1.price

Difference between union and structure.

The amount of memory required to store a structure variable is the ~~sum~~ sum of memory size of all members.

But, the memory required to store a union variable is the memory required for the largest element of an union.

In the case of structures all of its members can be accessed at ~~any~~ time but in case of unions only one of its members can be accessed at a time and all other members will contain garbage values.

Program to implement unions:

```
#include <stdio.h>
#include <conio.h>
union un
{
    short a;
    short b;
};

void main()
{
    union un var;
    var.a = 10;
    printf("%d", var.b);
    var.b = 20;
    printf("%d", var.a);
    getch();
}
```

Program to demonstrate primary difference between structure & union.

```
#include<stdio.h>
#include<conio.h>
union union job
{
    char name[32];
    float salary;
    int worker_no;
    struct sjob;
};

struct sjob
{
    char name[32];
    float salary;
    int worker_no;
    union job;
};

void main()
{
    printf("size of union = %d, size of (ujob) = %d", sizeof(union job), sizeof(ujob));
    printf("size of structure = %d, size of (sjob) = %d", sizeof(struct sjob), sizeof(sjob));
    getch();
}
```

Pointers

Pointers in c language is a variable that stores / points the address of another variable.

A pointer in c is used to allocate memory dynamically i.e., at run time. the pointer variable might be belonging to any datatype such as int, float, char, double, short, etc.

Syntax:-

datatype * variable;
(or)

datatype * variable;

Ex:- int *p;

where * is used to denote that p is a pointer variable and not a normal variable.

Use of pointers:

→ Pointers are used to access memory and manipulate the address.

→ To create dynamic datastructures

→ To pass and handle variable parameters passed to functions.

→ To access information stored in arrays

Program to implement pointers:

```
#include <stdio.h>
#include <conio.h>
void main()
{
    int i=100;
    int *ptr;
    ptr = &i;
    printf ("%d", i);
    printf ("%d", *ptr);
    printf ("%d", &i);
    printf ("%d", &ptr);
    printf ("%d", *ptr);
    printf ("%d", *(ptr));
    getch();
}
```

Types of pointers:

There are two types of pointers they are typed and untyped pointers.

Typed pointers:

Points to specific type of data.

int * → int data

struct emp * → Employee data.

Untyped pointers:

Points to any type of data.

(Generic pointer) void * → Any data

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* , * are the symbols to be focused in the
case of pointers.

* → stores address of a variable

* → stores value of variable.

Pointers to pointers:

A pointer to pointer is a form of multiple
in direction. or a chain of pointers.

Normally A pointer contains the address of a
variable. when we define a pointer to pointer
the first pointer contains the address of the
second pointer, which points to the address of
location that contains the actually value as
shown below.



int **a;

A variable that is a pointer to pointer must
be declared as asterisk. this is done by placing an
additional asterisk

Pointers to arrays.

Arrays are closely related to pointers in
C but the important difference b/w them is
that a pointer variable takes different addresses

as values where as in the case of array it is fixed.

Relation between Arrays and pointers:

Consider an array



In C programming name of the array always points to address of first element of array.

In the above example `arr` and `arr[0]` and `&arr[0]` points to the address of the first element.

`&arr[0]` is equivalent to `arr`.

Since the address of both are same the values of `arr` and `&arr[0]` are also the same.

`*arr[0]` is equivalent to `*arr`
[value of an address of pointer]

Similarly

$$arr = &arr[0] \quad *arr = arr[0]$$

$$arr + 1 = &arr[1] \quad *(arr + 1) = arr[1]$$

$$arr + 2 = &arr[2] \quad *(arr + 2) = arr[2]$$

⋮

⋮

n

n

In C you can declare any array and can use pointer to alter the data of any array.

* Program to find sum of n, with arrays and pointers

```
#include <stdio.h>
```

```
#include <conio.h>
```

```
Void main()
```

```
{
```

```
int i, classes [20], sum = 0, n = 15;
```

```
Printf ("enter numbers: \n")
```

```
for (i = 0; i < n; i++)
```

```
{
```

```
Scanf ("%d", &(classes + i));
```

```
Sum = Sum + *(classes + i);
```

```
}
```

```
Printf ("sum = %d", sum);
```

```
getch();
```

```
}
```

* In this program the elements are stored in the integer array data then using the for loop each element is traversed and print using the pointer method.

Pointers to Structures :-

Structures can be created and accessed using pointers a pointer variable of a struct can be created as below.

```
Struct name
```

{

```
member 1;
```

```
member 2;
```

```
member 3;
```

```
}; // definition of struct
```

```
void main()
```

{

```
struct name *ptr;
```

}

here the pointer variable of type struct name

is created.

~~Accessing structure members through pointers:~~

A structure member can be accessed through pointer in two ways.

1. Referencing pointer to another address to access memory
2. Using dynamic memory allocation.

Program to access structure members using pointers.

```
#include<stdio.h>
```

```
#include<conio.h>
```

```
void main()
```

```
struct Person
```

```
{ int age;
```

```
float weight;
```

```
}; // end of structure definition
```

```
void main()
```

```
{ struct Person *ptr, person1;
```

```
ptr->age = 20; // setting value of age
```

```
ptr->weight = 60; // setting value of weight
```

Person Ptr - & person1;

```

    printf ("Enter integer");
    scanf ("%d", &(personPtr).age);
    printf ("Enter number");
    scanf ("%f", &(*personPtr).weight);
    printf ("Display");
    printf ("%d %f", (*personPtr).age, (*personPtr).weight);
    getch();
}

```

In this example, the pointer variable of type struct person is referenced to the address of Person1. Then only the structure member through Pointer can be accessed.

Structure pointer member can also be accessed using array (\rightarrow) operator

$(*personptr.age)$ is same as $Personptr \rightarrow age$

$(*personptr.weight)$ is same as $Personptr \rightarrow weight$

Self referential structures in C:

structures can be A self referential structures are those structures that have one or more Pointers which points to the same type of Structure as their members. In other words structures pointing to same type of structures are called self referential structures

Struct / node

```

{ int data1;
  char data2;
  struct node *link;
};
```

```
Void main()
```

```
{
  struct node obj;
  getch();
}
```

In the above example link is a pointer to a structure of type node. hence this structure node is a self referential structure with link as a referencing pointer.

Types of self referential structures:

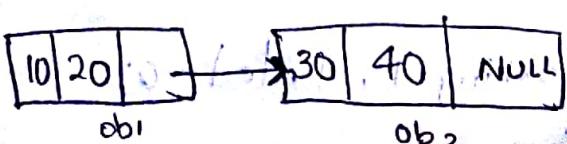
- * Self referential structures with single link.

- * Self referential structures with multiple link.

Self referential structure with single link.

These structures can have only one self pointer as their member.

the following example will show us how to connect the objects of a self referential structure with single link and access the corresponding data members. the connection formed is shown in following fig.



Program to implement self referential structures with single link.

```
#include<stdio.h>
#include<conio.h>
struct node
{
    int data1;
    char data2;
    struct node *link;
};
void main()
{
    struct node obj1;
    obj1.link=NULL;
    obj1.data1=10;
    obj1.data2='A';
    struct node obj2;
    obj2.link=NULL;
    obj2.data1=20;
    obj2.data2='B';
    obj1.link=&obj2;
    printf("%d", obj1.link->data1);
    printf("%d", obj1.link->data2);
    getch();
}
```

Enumeration in C (enum): A user defined datatype in C. It is mainly used to assign names to integral constants, the names make a program easy to read and maintain.

Syntax:- enum

```
{ working=1, failed=0 }
```

following is an example of enum declaration.

```
enum flag {constant1, constant2 ...};
```

The name of enumeration is flag and the constant are the values of the flag.

By default the values of the constant are as follows.

constant 1 = 0	constant 2 = 1	constant 3 = 2
----------------	----------------	----------------

(i) Variables of type enum can also be defined in two ways

```
enum week {mon, tue, wed};
```

```
enum week day,
```

or

```
enum week {mon tue, wed} day;
```

An example program to demonstrate working of enum in C

```
#include<stdio.h>
#include<conio.h>
enum week{mon, tue, wed, thu, fri, sat, sun};
void main()
{
    enum week day;
    day = wed;
    printf("%d", day);
    getch();
}
```

Output \Rightarrow 2

In the above example, we declared "day" as the variable and the value of "wed" is allocated to day, which is 2. So, as a result 2 is printed.

Interesting facts about initialization of enum.

- Two enum names can have same value. For example, in the following C program both "Failed" and "freezed" have same value zero.

```
#include<stdio.h>
#include<conio.h>
void main()
{
    enum state {working=1, failed=0, freezed=0};
    void main()
    {
        printf("%d %d %d", working, failed, freezed);
        getch();
    }
}
```

Output:

100

- If we don't explicitly assign values to enum name, the compiler by default assigns value starting from zero.

- we can assign value to some name in any order all unassigned names gets value as Value of previous name + 1.

```
#include <stdio.h>
#include <conio.h>
enum day {sun=1, mon, tue = 5, wed, thur = 10, fri, sat};
void main()
{
    printf("%d,%d,%d,%d,%d,%d,%d", sun, mon, tue, wed,
           getch(), thur, fri, sat);
}
```

Output = 1, 2, 5, 6, 10, 11, 12.

→ The value assigned to enum names must be some integral constant i.e., the value must be in range from min + integer value to max + integer value

→ All enum constants must be unique in their scope

for example the following program fails in compilation.

```
enum state {working, failed};
enum result {failed, passed};
void main()
{
    getch();
}
```

Output

Compilation error: 'failed' has a previous declaration as state failed.

Str str

`strstr()` is a predefined function used for string handling. `string.h` is the headerfile used for string functions.

This function takes two strings s_1 & s_2 as an argument and finds the first occurrence of the substring s_2 in the string s_1 .

The process of matching does not include the terminating null characters '\0' but function stops their

Syntax :-

`strstr(s1, s2);`

Program to implement strstr

```
#include <stdio.h>
#include <conio.h>
#include <string.h>
Void main()
{
    char str[20] = "this is ECE";
    char *sub;
    clrscr();
    printf("enter sample");
    scanf("%s", sample);
    sub = strstr(str, sample);
    printf("%s", sub);
    getch();
}
```

UNIT-111

PRERROCESSER COMMANDS

The C preprocessor is the macro processor that is used automatically by the C compiler to transform the our program before actual compilation it is called a macro processor because it allows you to define macros which are brief abstractions for longer.

A macro is a segment of code which is replaced by the value of macro. macro is defined by #define directive.

Preprocessing directives are lines in your program that start with '#'. '#' is followed by an identifier that is the directive name. for example '#define' is the directive that defines a macro.

All preprocesser directives starts with '#' symbol.

List of preprocesser directives.

- * #include,
- * #define
- * #undef
- * #if def
- * #if undef
- * #if
- * #else
- * #elif
- * #end if

The #include preprocessor directive is used to paste code of given file into current file. It is used by include, system-defined and user-defined headerfiles if included file is not found compiler renders error. It has 3 variants.

#include<file>

This variant is used for system headerfiles. It searches for a file name 'file' in a list of directories specified by you. Then in a standard list of system directories.

#include"file"

This variant is used for headerfiles of your own program. It searches for a file named file first in the current directory then in the same directories used for system headerfiles. The current directory is the directory of the current input file.

macros (#define)

macro is defined by # define directives.

Syntax.

#define token value,

files:**edit project**

In C programming file is a place on your physical disk where information is stored.

Why files are needed:

When a program is terminated the entire data is lost, storing in a file will preserve your data even if the program terminates. If you have to enter a large number of data it will take a lot of time to enter them all however if you have a file containing all the data you can easily access the contents of the file using few commands in C.

You can easily move your data from one computer to another computer without any changes.

Types of files:

When dealing with files there are two types of files you should know about

1. Text files

2. Binary files.

Text files:

Text files are the normal "txt" files that you can easily create using notepad or any simple text editors, when you open those files you will see all the contents within the file as plain texts you can easily edit accelerate the contents. They take minimum effort to maintaining are easily readable and provide least security and takes bigger storage space.

Binary Files:

Binary files are "bin" files in your computer. Instead of storing data in plain text they store it in the binary form (0's & 1's).

They can hold higher amount of data as not readable easily and provides better security than text files.

File Operations:-

In C you can perform four major operations on the file either text or binary.

1. Creating a new file
2. Opening an existing file
3. closing a file
4. Reading from writing information to a file.

Working with files

when working with files you need to declare a pointer of type FILE. This declaration is needed for communication b/w file and program.

```
FILE *fptr;
```

Opening a file for creation and edit

Opening a file is performed using the library function in the stdio.h headerfile i.e., fopen()

The syntax for opening a file in standard I/O is

```
fptr = fopen ("file open", "mode");
```

Ex:-

```
fopen ("E:\11c\program\new program.txt", "w");
```

```
fopen ("E:\11c\program\old program.bin", "rb");
```

let us suppose the file new program.txt doesn't exist in the location E:\11c\program.

The first function creates a new file named new program.txt and opens it for writing as per mode 'w'.

The writing mode allows you to create & edit (over write) the contents of file. Now let's suppose the second binary file old program exists in the location E:\11c\program. The second function opens an existing file reading in binary mode "rb". The reading mode only allows you to read the file. You cannot write into the file.

Closing file

The file both text and binary should be closed after reading or writing closing a file is performed using a library function fclose().

```
fclose(fptr);
```

Opening modes in standard input / output

File mode	Meaning	During non-existence of file
r	open for reading	if file doesn't exist fopen() returns NULL
r b	open for reading in binary mode	if file doesn't exist fopen() returns NULL
w	open for writing	if file exists its contents are over written if file doesn't exist it will be created.
w b	open for writing in binary mode	if file exists " " if file doesn't exist it will be created.
a	open for appending i.e., data is added to end of the file	if file doesn't exist it will be created.
a b	open for appending in binary mode	" "
r +	open for both reading and writing	if file doesn't exist, fopen() returns null
r b +	open for both read and write in binary mode	" "
w t	open for both read and write	if file exists the contents are over written if file doesn't exist creates new file.
w b t	" in binary mode	"
a t	open for both reading and appending	if file doesn't exist it will create a file.
a b t	"	"

For reading & writing to the text file we using the function fptr

They are just the file version of printf & scanf. The only difference is that fprintf & fscanf expects the pointer to the structure file.

Example:

Write to a text file using fprintf.

```
#include <stdio.h>
```

```
#include <conio.h>
```

```
Void main ()
```

```
{
```

```
int num;
```

```
FILE *fptr;
```

```
fptr = fopen ("c:\\Excel\\program\\33311.txt", "w");
```

```
if (fptr == NULL)
```

```
{
```

```
printf ("Error!");
```

```
}
```

```
printf ("Enter number");
```

```
scanf ("%d", &num);
```

```
fprintf (fptr, "%d", num);
```

```
fclose (fptr);
```

```
getch();
```

This program takes a number from user and stores in the file program.txt. After you compile and run this program you can a txt file program.txt created in C drive, ece folder in your computer when you open the file you can see the integer you entered.

Example 2:

Reading from the text file.

Read from a text file using fscanf.

```
#include<stdio.h>
#include<conio.h>
Void main()
{
    int num,
    file *fptr;
    fptr = fopen ("c://ece//program.txt", "r");
    if (fptr == NULL)
    {
        printf ("Error!");
    }
    fscanf (fptr, "%d", &num);
    printf ("value of n=%d", num);
    fclose (fptr);
    getch();
}
```

This program reads the integer present in the program.txt file and prints it on to the screen.

If you successfully created a file from ex-1 running will get you the integers you entered.

Other functions like `fgetchar()`, `putc()` etc. can be used in similar way.

Example 3.

To read multiple characters

```
#include<stdio.h>
#include<conio.h>
void main()
{
    FILE *fp;
    int num;
    char ch;
    fp = fopen ("c:\\ece\\program.txt", "r");
    if (fp == NULL)
    {
        printf ("Error!");
    }
    while ((ch = fgetc (fp)) != EOF)
    {
        printf ("%d", ch);
    }
    fclose (fp);
    getch();
}
```

Reading and writing to a binary file.

functions `fread()` and `fwrite()` are used for reading and writing to a file on the disc respectively in case of binary file.

To write into binary function you need to use `fwrite()`.

The function takes four arguments.

Address of data to be written in discy size of data to be written in disc(), No: of such type of data and pointer to the file where you want to write.

`fwrite`:
Syntax:
`fwrite (address-data, size-data ,numbers-data ,Pointer-to-file)`

Example 3.

Writing to a binary file using `fwrite()`.

```
#include<stdio.h>
#include<conio.h>
struct threenum
{
    int n1,n2,n3;
}
Void main()
{
    int n ;
    struct threenum num;
    FILE *fptr;
    if((fptr=fopen ("S:\ECE-211 program\l.bin","wb"))==NULL)
    {
        printf("error");
    }
}
```

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```
for (n=1; n<5; n++) {
    num.n1 = n;
    num.n2 = 5*n;
    num.n3 = 15*n+1;
    fwrite(&num, sizeof(struct threenum), 1, fptr);
}
fclose(fptr);
getch();
}.
```

In this program, you create a new file program1.bin in the C drive.

We declare a structure threenum with three numbers n, n2, n3 and define it in the main function as num.

Now inside the for loop we store the value into the file using fwrite.

The first parameter takes the address of num and the second parameter takes the size of the structure threenum.

Since we are only inserting one instance of num the third parameter is one. and the last parameter *fptr points to the file we are storing the data.

Finally we close the file.

Reading from a binary file.

Function fread also takes four arguments, similar to fwrite() function as above.

Syntax:

fread (address-data, size-data, numbers-data, Pointer-to-File);

Example 4 := reading from a binaryfile using fread.

```
#include <stdio.h>
```

```
#include <conio.h>
```

```
struct threenum
```

```
{
```

```
int n1,n2,n3;
```

```
}
```

```
Void main
```

```
{
```

```
int n;
```

```
struct threenum num;
```

```
FILE *fptr;
```

```
if ((fptr = fopen ("c:\ece-c\program1.bin","rb"))=NULL)
```

```
printf ("Error");
```

```
}
```

```
for (n=1; n<5; n++)
```

```
{
```

```
fread (&num , size of (struct threenum), 1, fptr);
```

```
printf ("n1=%d \t n2=%d \t n3=%d", num.n1,
```

```
num.n2 , num.n3);
```

```
}
```

```
fclose (fptr);
```

```
getch();
```

In this program you read the same file programming and loop through the records one by one. In simple terms you read one Ienumer record. If Ienumer size from the file pointed by *fptr into the structure num.

You will get the same records you inserted in example 3.

If you have many records inside file and needs to access a record at a specific position you need to loop through all the records before it to get the record. This will waste a lot of memory and operation time. An easier way to get the required data can be achieved using fseek function.

This function is used for seeking the pointer position in the file at the specified bite.

`fseek(file pointer, displacement, ipointer position);`
where, file pointer is the pointer which points to the file.

displacement → It is positive or negative and this is the no. of bite which are skiped (Backward if -ve or forward if positive from current position)

This is attached with L because it is a long integer.

Pointed position → This sets the pointer position in the file. Value pointer position.

0 means begining of file

1 last position current position

2 end of file.

Example 1.

fseek (P, 10L, 0)

'0' means pointer position is on the begining of the file. From this statement pointer position is skipped 10 bits from the begining of the file.

Example 2.

fseek (P, -5L, 1);

From this statement pointer position is skipped 5 bit backward from the current position.

ftell () :

This function returns the value of the current pointer position in the file. The value is count from the begining of the file in clockwise direction.

Syntax:- ftell (filepointer);

rewind ();

This function is used to move the file pointer to the begining of the given file.

Syntax:- rewind (file pointer);

Program to implement fseek function, ftell(), and rewind()

```
#include<stdio.h>
#include<conio.h>
void main()
{
    FILE *P;
    char ch;
    int n,c,b;
    clrscr();
    P = fopen ("f:\\ccc\\file1.txt", "r");
    if (P == NULL)
    {
        printf ("file is not available");
    }
    else
    {
        printf ("Enter the value of n");
        scanf ("%d", &n);
        c = ftell (P);
        printf ("%d", c);
        fseek (P, n, 0);
        c = ftell (P);
        printf ("%d\n", c);
        printf ("Enter no. of bytes");
        scanf ("%d", &b);
        fseek (P, b, 1);
        while ((ch = fgetc (P)) != EOF)
        {
            printf ("%c", ch);
        }
        printf ("\n");
        c = ftell (P);
```

```
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Pointf ("%d", c);  
rewind (p);  
c = ftell (fp);  
printf ("%d\n", c);  
fclose (fp);  
getch();  
};
```

UNIT-IVFunction:

Function is a named part of a program which can be called whenever needed.

Function is a program which performs specific task and sometimes return a value.

These are two types of functions.

1. built-in (or) library function

2. Userdefined function.

Syntax:

return-type function-name (Parameter)

{

the body of function

}

Example:-

int max (int a, int b)

{

 point result; // define I am using backslash

 if (a > b)

 result = a;

 else

 result = b.

 return result;

Declaration:

A function declaration tells the compiler about the function name, and how to call function without having to implement it at the same time.

function declaration is required when you define a function in one source file and you call that function in another file. In such case, you should declare the function at the top of the file calling the function.

Calling a function:

When a program calls a function, the program control is transferred to the called function. A called function performs a defined task and when its return statement is executed or when its function-ending closing brace is reached, it returns the program control back to the main program.

To call a function, you simply need to pass the required parameters along with the function name. If the function returns a value, then you can store the returned value.

Example :-

```
#include<stdio.h>
#include<conio.h>
int max(int num1, int num2);
void main()
{
    int a=100;
    int b=200;
    int ret;
    ret = max(a,b);
    printf("Max value : %d \n",ret);
    return 0;
}
```

```
int max(int num1, int num2)
```

```
{
```

```
    int result;
```

```
    if (num1 > num2)
```

```
        result = num1;
```

```
    else
```

```
        result = num2;
```

```
    return result;
```

```
}
```

1. Call by value

2. Call by reference.

These are two call types in function in which arguments can be passed to a function.

Call by value:

The call by value method of passing arguments to a function copies the actual value of an argument into the formal parameter of the function. In this case, changes made to the parameters inside the function have no effect on the argument.

By default, C programming uses call by value to pass arguments.

Example:-

```
#include <stdio.h>
```

```
#include <conio.h>
```

```
void swap(int x, int y);
```

```
int main()
```

```

{
    int a=100
    int b=200
    printf ("Before swap, value of a : %d \n", a);
    printf ("Before swap, value of b: %d\n", b);
    Swap(a,b);
    printf ("After swap , value of a: %d \n", a);
    printf ("After swap , value of b: %d\n", b);
    return 0;
}

void swap(int x,int y)
{
    printf("Inside the swap, value of x: %d \n", x);
    int temp; //local variable
    temp=x; //at step 1 after execution of x = y;
    x=y;
    y=temp; //at step 2 after execution of y = temp;
    printf("Inside the swap, value of x: %d \n", x);
    return; //at step 3 after execution of return;
}

```

Call by reference:

The call by reference is method of passing arguments to a function copies the address of an argument into the formal parameters. Inside the function, the address is used to access the actual argument used in the call. It means the changes made to the parameters affect the passed argument.

Call by reference | passing pointers as arguments

#include <stdio.h>

#include <conio.h>

Void swap (int *, int *);

Void main ()

{

int a, b;

clrscr ();

printf ("Enter a & b");

scanf ("%d %d", &a, &b);

swap (&a, &b);

printf ("%d %d", a, b);

getch();

}

Void swap (int *x, int *y)

{

int t;

t = *x;

*x = *y;

*y = t;

printf ("%d %d", *x, *y);

}

Passing arrays as arguments in function:

```
#include <stdio.h>
#include <conio.h>
void function (int arr[], int n);
void main()
{
    int arr[5], i;
    clrscr();
    printf ("Enter values in array");
    for (i=0; i<5; i++)
    {
        scanf ("%d", &arr[i]);
    }
    function (arr, 5);
    getch();
}

void function (int arr[], int n)
{
    int i, sum=0;
    printf ("Elements are");
    for (i=0; i<n; i++)
    {
        printf ("\n %d", arr[i]);
    }
    printf ("\n Elements are");
    sum = sum + arr[i];
}
printf ("total = %d", sum);
```

Program to Find Factorial of given number using recursion.

```
#include <stdio.h>
```

```
#include <conio.h>
int fact(int);
void main()
```

```
{
```

```
int n,res;
clrscr();
```

```
printf ("Enter the value of n");
scanf ("%d ", &n);
```

```
res = fact(n);
```

```
printf ("Factorial of %d = %d",n,res);
getch();
```

```
}
```

```
int fact (int x)
```

```
{
```

```
int res;
```

```
if (x==0)
```

```
{
```

```
res=1;
```

```
}
```

```
else
```

```
{
```

```
res = x * fact(x-1);
```

```
}
```

```
return res;
```

```
}.
}
```

Program to print fibonacci series using recursion.

```
#include <stdio.h>
```

```
#include <conio.h>
```

```
void int fib(int);
```

```
void main()
```

```
{
```

```
int n;
```

```
clrscr();
```

```
printf ("Enter n value");
```

```
scanf ("%d", &n);
```

```
printf ("The Fibonacci series");
```

```
for (i=0; i<n; i++)
```

```
{
```

```
printf ("%d.\n", fib(i));
```

```
}
```

```
getch();
```

```
}
```

```
int fib(int x);
```

```
{
```

```
int res;
```

```
if (x==0 || x==1)
```

```
{
```

```
return x;
```

```
}
```

```
else
```

```
{
```

```
res=fib (x-2) + fib(x-1);
```

```
return res;
```

```
}
```

```
}
```

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Dynamic Memory Allocation

Program to point the sum of n elements by user using dynamic memory allocation.

```
#include <iostream.h>
#include <conio.h>
#include <stdlib.h>
{
    int num, i, *ptr, sum=0;
    printf ("Enter no: of elements");
    scanf ("%d", &sum);
    ptr = (int *) malloc (num * size of (int));
    if (ptr == NULL)
    {
        printf ("Error, memory not allocated");
        exit (0);
    }
    printf ("Enter elements of array");
    for (i=0; i<num; i++)
    {
        scanf ("%d", ptr+i);
        sum = sum + *(ptr+i);
    }
    printf ("Sum=%d", sum);
    free (ptr);
    getch();
}
```

Program to print sum of n elements using
calloc.

```
#include <stdio.h>
#include <conio.h>
#include <stdlib.h>

{ start by taking input with int quantity of array elements
int num, i, *ptr, sum=0;
printf ("Enter no: of elements");
scanf ("%d", &sum);
ptr = (int *) calloc (num, sizeof (int));
if (ptr==NULL)
{
    printf ("Error! memory not allocated");
    exit (0);
}
printf ("Enter elements of array");
for (i=0; i<num; i++)
{
    scanf ("%d", ptr+i);
    sum = sum + *(ptr+i);
}
printf ("Sum = %d", sum);
free (ptr);
getch();
}
```

The code is a C program that calculates the sum of 'n' elements entered by the user. It uses the `calloc` function to dynamically allocate memory for an array of integers. If memory allocation fails, it exits with an error message. It then prompts the user to enter 'n' elements and calculates their sum using a loop and pointer arithmetic. Finally, it prints the sum and frees the allocated memory.

Dynamic Memory Allocation

Dynamic memory management refers to memory management. This allows you to obtain more memory when required and release it when not necessary.

There are 4 library functions defined under `<stdlib.h>` for dynamic memory allocation, `malloc()`

The name `malloc()` stands for "memory allocation". The function `malloc()` reserves a block of memory of specified size and return a pointer of type `void` which can be casted into pointer of any form.

Syntax:

```
ptr = (cast-type*) malloc (byte-size);
```

The `malloc()` returns a pointer to an area of memory with size of byte size. If space is insufficient, allocation fails and returns `NULL`.

`calloc()`

The name `calloc()` stands for "contiguous allocation".

The only difference between `malloc()` and `calloc()` is that `malloc()` allocates single block of memory whereas `calloc()` allocates multiple blocks of memory each of same size and sets all bytes

to zero

Syntax:
 $\text{ptr} = (\text{cast-type}^*) \text{calloc}(\text{n}, \text{element-size})$

This statement allocates contiguous space in memory for an array of n elements.

free()

Dynamically allocated memory created with either calloc() or malloc() doesn't get freed on its own. You must explicitly use free() to release the space.

Syntax of free()

free(ptr);

This statement frees the space allocated in memory pointed by ptr.

realloc()

If the previously allocated memory is insufficient or more than required, you can change the previously allocated memory size using realloc()

Syntax:

$\text{Ptr} = \text{realloc}(\text{ptr}, \text{newsize});$

here, ptr is reallocated with size of newsize

Program to implement `realloc()`.

```
#include <stdio.h>
#include <conio.h>
#include <stdlib.h>

Void main()
{
    Unsigned int *ptr;
    Int n1, n2;
    Printf("Enter size of an array");
    Scanf("%d", &n1);
    ptr = (int *) malloc(n1 * size of (int));
    Printf("Address of previously allocated memory");
    For(i=0; i<n1; i++)
    {
        Printf("%u", ptr+i);
    }
    Printf("Enter new size of array");
    Scanf("%d", &n2);
    ptr = ptr = realloc(ptr, n2 * size of (int));
    For(i=0; i<n2; i++)
    {
        Printf("%u", ptr+i);
    }
    getch();
}
```

Allocating memory for character type dynamically.

```
#include <stdio.h>
#include <conio.h>
#include <stdlib.h>
void main()
{
    int n=5;
    char *Pvowels = (char *) malloc (n * size of (char));
    clrscr();
    Pvowels [0] = 'A';
    Pvowels [1] = 'E';
    Pvowels [2] = 'I';
    Pvowels [3] = 'O';
    Pvowels [4] = 'U';
    for (i=0; i<n; i++)
    {
        printf ("%c", Pvowel[i]);
    }
    printf ("\n");
    free (Pvowels);
    getch();
}
```

so let's discuss the process

of allocation of memory

and deallocation of memory

(Deallocation)

memory leak if

if we work like

memory there will be

memory leak

Free system efficiency

increase (10%)

(10% of 100) = 10%

Program to allocate memory dynamically

array of double datatype.

```
#include <stdio.h>
#include <conio.h>
#include <stdlib.h>

void main()
{
    int argc, argv[];
    int i;
    double *p;
    P = malloc (10, sizeof (double));
    for (i=0; i<10; i++)
        *(P+i) = i;
    for (i=0; i<10; i++)
        printf ("%lf\n", *(P+i));
    free(p);
    Putchar ('\n');
    P = malloc (4, sizeof (double));
    for (i=0; i<4; i++)
        *(P+i) = i*i;
    for (i=0; i<4; i++)
        printf ("%lf\n", *(P+i));
    free(P);
}
```

INTRODUCTION TO ALGORITHMS

In programming algorithm is a set of well defined instructions in sequence to solve the problem.

Qualities of good algorithm:

- * Input and Output should be defined precisely
- * Each step in algorithm should be clear and unambiguous.
- * Algorithm should be most effective among many different ways to solve a problem.
- * An Algorithm shouldn't have computer code. Instead the Algorithm should be written in such a way that it can be used in similar programming languages.

Algorithm for finding roots of quadratic equation

Step 1: Start

Step 2: Read a,b,c

Step 3: find discriminant = $b \times b - 4 \times a \times c$

Step 4: if discriminant is greater than 0

$$4.1: \text{root 1} = (-b + \sqrt{\text{discriminant}}) / (2 \times a)$$

$$4.2: \text{root 2} = (-b - \sqrt{\text{discriminant}}) / (2 \times a)$$

4.3: Print root 1 and root 2 values and goto 7

Step 5: else if discriminant is equal to 0

$$5.1: \text{root 1} = \text{root 2} = -b / (2 \times a)$$

5.2: Print roots are equal and Print root 1 and root 2 and goto Step 7

Step 6: else roots are imaginary and goto step 7

Step 7: Stop

Algorithm to find the maximum and minimum from a given set.

Step 1: Start

Step 2: declare arr[max-size], i, max, min, size

Step 3: Read size

Step 4: Input elements in array and store in arr using for loop i.e., for($i=0; i < \text{size}; i++$)

Step 5: Declare two variables max & min to store

maximum and minimum. Assume first array element as max and min both

max = arr[0]

min = arr[0]

Step 6: Inside loop for each array element check

for maximum and minimum assign current

array element to max if ($\text{arr}[i] > \text{max}$) and

assign current array element to min

if ($\text{arr}[i] < \text{min}$)

Step 7: Print max and minimum with segregate

Step 8: Print min

Step 9: Stop.

Step 1 := start

Step 2 := Declare num, i, count = 0

Step 3 := read num

Step 4 := for($i=0$; $i \leq num$; $i++$)

4.1 := if $num \% i == 0$ then

4.2 := increment count

4.3 := goto step 4

Step 5 := Repeat 4.1 step 4.2 and 4.3 until the condition

is false

Step 6 := if count == 2 then Print num is prime

Step 7 := otherwise Print num is not Prime

Step 8 := stop

Basic Searching techniques

Introduction to searching:

Searching means to find whether a particular value is present in an array or not.

If the value is present in the array then searching is said to be successful and searching process gives the location of that value in the array.

However, if the value is not present in the array the searching process displays an appropriate message and this in case searching is said to be unsuccessful.

There are two popular methods for searching the array elements.

1. Linear search
2. Binary search

The algorithm that should be used depends entirely on how the values are organised in the array.

Search type

Linear search also called as sequential search is a very simple method used for searching an array for a particular value. It works by comparing the value to be searched with every element of array one by one in a sequence until a match is found. Linear search is mostly used to search an unsorted list of elements.

For example if an array $a[5]$ is declared as

initialised as:

$$\text{int } a[5] = \{10, 40, 50, 30, 20\}$$

If Key = 30 Pos = 3

Linear search Algorithm:

linearSearch(a, n, key)

Step 1: [Initialize] set $pos = -1$

Step 2: [Initialize] set $i = 0$

Step 3: Repeat step 4 while $i < n$

Step 4: if $a[i] = key$ then set $pos = i$

set $pos = i$

Print Pos else go to step 5

Step 5: If $pos = -1$ then go to step 6

(End of if)

set $i = i + 1$

(End of loop)

Step 6: If $pos = -1$

Print Key is not present in array (End of if)

Step 6: Exit

```
#include<stdio.h>
#include<conio.h>
Void main()
{
    int a[5] = {40, 30, 80, 60, 90};
    int Pos = -1, i=0, Key;
    clrscr();
    printf("Enter Key");
    scanf("%d", &Key);
    while(i<5)
    {
        if(a[i]==Key)
        {
            Pos=i;
            printf("Key is present in %d Position", Pos);
            break;
        }
        i=i+1;
    }
    if(Pos == -1)
        printf("Key is not found");
    getch();
}
```

Binary Search :-

It is a searching algorithm that works efficiently with a sorted list.

The mechanism of binary search can be better understood by an analogy of a telephone directory. When we are searching for a particular name in directory we first open the directory from the middle and then decide whether to look for the name in the first part of directory or in second part. Again we open some page in the middle and the hole process is repeated until we finally find the whole name.

The same mechanism is applied in the binary search.

Now let's consider how this mechanism is applied to search for a value in a sorted array with the help of the algorithm.

Binary search algorithm.

Binary-search (a, lower-bound, upper-bound, key)

Step 1: [Initialize] set low = lower_bound,

high = upper_bound

flag = 0

Step 2: Repeat step 3 and 4 while $low \leq high$

Step 3: If ($key = a[mid]$)

set flag = 1

break

goto step 6

Step 4: else If ($key < a[mid]$)

set high = mid - 1

else set low = mid + 1

(End of if)

(End of loop)

step 5: If flag = 0

Print "value is not Present"

(end of if)

step 6: Exit

Program to implement binary search.

```
#include<stdio.h>
```

```
#include<conio.h>
```

```
void main()
```

```
{
```

```
int a[5] = {10, 20, 30, 40, 50};
```

```
int low = 0, high = 4, mid, key, flag = 0;
```

```
clrscr();
```

```
printf("Enter Key");
```

```
scanf("%d", &key);
```

```
while (low <= high)
```

```
{
```

```
mid = (low + high) / 2;
```

```
if (key == a[mid])
```

```
{
```

```
flag = 1;
```

```
if (flag == 1)
```

```
{
```

```
if (key < a[mid])
```

```
{
```

```
high = mid - 1;
```

```
{
```

```
else
```

```
{
```

```

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low = mid + 1;
}
}
if (flag == 1)
{
    printf ("Key is found");
}
else
{
    printf ("Key is not found");
}
getch();
}

```

Sorting

1. Bubble sort.

C programming code for bubble sort is used to sort numbers or arrange them in ascending order. you can modify it to print numbers in descending order. you can also sort strings using bubble sort, it is less efficient as its average and worst case complexity is high. there are many other fast sorting algorithms like quick sort, heap sort e.t.c.

Sorting simplifies problem solving in computer

Programming Algorithm:-

let 'a' be a linear array of 'n' numbers swap is a temporary variable for swaping((or) interchange) the position of the numbers.

Algorithm for bubble sort.

Step 1 := Input n number of an array a

Step 2 := Initialize i=0 and repeat through step 4 if ($i < n$)Step 3 := Initialize j=0 and repeat through step 4 if ($j < n-1$)Step 4 := If ($a[j] > a[j+1]$)

step 4.1 := swap = a[j]

step 4.2 := a[j] = a[j+1]

step 4.3 := a[j+1] = swap

Step 5 := Display the sorted numbers of array a

Step 6 := exit.

Program to implement bubble sort.

```
#include<stdio.h>
#include<conio.h>
Void main()
{
    int a[100], n, i, j, swap;
    clrscr();
    printf("Enter no. of elements");
    scanf("%d", &n);
    for(i=0; i<n; i++)
    {
        scanf("%d", &a[i]);
    }
    for(i=0; i<n-1; i++)
    {
        for(j=0; j<n-1; j++)
        {
            if (a[j] > a[j+1])
            {
                swap = a[j];
                a[j] = a[j+1];
                a[j+1] = swap;
            }
        }
    }
}
```

```
a[j+1] = swap;
```

```
} // from n to 0, so we are changing list
for (j=n-1; j>=0; j--) {
    if (a[j] > a[j+1]) { // if not sorted
        swap(a[j], a[j+1]);
    }
}
printf ("Sorted list ");
for (i=0; i<n; i++) {
    printf ("%d \n", a[i]);
}
getch(); // to pause before exit
}
```

Insertion Sort:

C program for insertion sort is `#include <stdio.h>`.
 This code given numbers or elements in an array. It implements insertion sort algorithm to arrange numbers in ascending order with a little modification. It will arrange numbers in descending order best case complexity of insertion sort is $O(n)$ (average and worst case complexity is $O(n^2)$).

Program to implement insertion sort.

```
#include <stdio.h>
#include <conio.h>
Void main()
{
    int n, a[100], i, j, t;
    printf ("Enter no: of elements");
    Scanf ("%d", &n);
    printf ("Enter %d integers", n);
    for (i=1; i<n; i++) {
        for (j=i-1; j>=0; j--) {
            if (a[j] > a[j+1]) {
                t = a[j];
                a[j] = a[j+1];
                a[j+1] = t;
            }
        }
    }
}
```

```
for (i=0; i<n; i++)  
{  
    scanf ("%d", &a[i])  
}  
for (i=1; i<=n; i++)  
{  
    j=i;  
    while (j>0 && a[j-1]>a[j])  
    {  
        t=a[j];  
        a[j]=a[j-1];  
        a[j-1]=t;  
        j=j-1;  
    }  
}  
printf ("Sorted list");  
for (i=0; i<n; i++)  
{  
    printf ("%d\n", a[i]);  
}  
getch();  
}
```

Algorithm

Let arr is an array of n elements.

Step 1: Read arr and sort it using bubble sort.

Step 2: Repeat step 3 to 8 for i=1 to n-1 times.

Step 3: Step temp = arr[i]

Step 4: Step j=i-1

Step 5: Repeat step 6 and 7 while temp < arr[j] and j>=0

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Step 6: Set $\text{arr}[j+1] = \text{arr}[i]$ (moves element forward)

Step 7: Set $i = j - 1$

(end of step 5 inner loop)

Step 8: Set $\text{arr}[j+1] = \text{temp}$ (insert element in proper place)

(end of step 2 outer loop)

Step 9: Exit

Selection Sort:

One of the simplest technique is the Selection sort as the name suggest is the selection of an element and arranging it in selected order.

In this the strategy is to find the smallest number in the array and exchange it with the value in the first position of array now find the second smallest element in the remaining array of elements. and exchange it with a value in the second position, carry on till you have reached the end of the array. Now all the elements have been sorted in ascending order.

Algorithm for Selection sort.

Let arr is an array having n elements.

Step 1: Read arr

2: Repeat step 3 to 6 for $i=0$ to $n-1$

3: Set $\text{MIN} = \text{arr}[i]$ and set $\text{LOC} = i$

4: Repeat step 5 for $j = i+1$ to n

5: If $\text{MIN} = \text{arr}[j]$, then

(a) Set $\text{MIN} = \text{arr}[j]$

(b) Set $\text{LOC} = j$

[End of if]

: If true - go back

[End of step 4 loop]

: If false - go to 6.

6. Interchange arr[i] and arr[loc] using temporary variable

[End of step 2 outer loop]

: If false - go to 7.

7. Exit.

Program to implement selection sort.

#include <stdio.h>

#include <conio.h>

Void main()

{

int i, j, n, loc, temp, min, a[30];

printf ("Enter no: of elements");

scanf ("%d", &n);

printf ("\n Enter the elements");

for (i=0; i<n; i++)

to find the smallest element from the remaining

Scanf ("%d", &a[i]);

}

for (i=0; i<n-1; i++)

swapping elements at the steps of 1.

min = a[i];

loc = i; // to store index of minimum element

for (j=i+1; j<n; j++)

to find the smallest element among all

if (min > a[j])

swap two. {only if the current element is

less than the min = a[j]; and continue to

loc = j;

}

}

```

temp = a[i];
a[i] = a[lo];
a[lo] = temp;
}
printf (" sorted list ");
for (i=0 ; i<n ; i++)
{
    printf ("%d", a[i]);
}
getch();
}

```

Order of Complexity:

Generally an algorithm has an asymptotic computational complexity. Assuming the input is of size N we can say that the algorithm will finish at $O(N)$, $O(N^2)$, $O(N^3)$, $O(N \log N)$ etc. This means that it is a certain mathematical expression of the size of the input and the algorithm finishes between two factors of it.

Generally the smaller the order of complexity of programs underlying algorithm the faster it will run and the better it will scale as the input gets larger. Thus, we should often seek more efficient algorithms in order to reduce the order of complexity.

We will go through some of basic and most common time complexity such as

- 1) Constant time complexity $O(1)$: constant running time.
- 2) Linear time complexity $O(n)$: linear running time.
- 3) Logarithmic time complexity $O(\log n)$: logarithmic running time.
- 4) Loglinear time complexity $O(n \log n)$: loglinear running time.
- 5) Polynomial time complexity $O(n^c)$: Polynomial running time
(c is a constant)
- 6) Exponential time complexity $O(c^n)$: Exponential running time
(c is a constant being raised to a power based on size of input)

Constant time Complexity:

The code that runs in fixed amount of time or has fixed no. of steps of execution no matter what is the size of input has constant time complexity.

For instances lets try and derive a time complexity

for following code.

```
def sum(a,b):
```

```
    return a+b;
```

If we call this function by $\text{sum}(2,5)$, it will

return sum in one step. That single step of computation

is summing a and b . No matter how large is the size of

input i.e. a & b is. It will always return sum in

one step so time complexity of above code is $O(1)$

or constant time complexity

Linear time complexity:

The code whose time complexity is of order of growth increases linearly as the size of the input is increased has linear time complexity.

Example def my_list_sum(a):

result = 0

for i in a:

result = result + i;

return result;

here we are providing a list to the function if I pass the list of size 10 the no. of steps would be considering the size of list is 10

One step for initializing the result

second step loop over the result and statement inside loop is excited 10 times.

One step for return statements.

for list of size N time complexity would be $1+N+1 = N+2$ we can safely neglect the additional 2 and say that. Over all time complexity is $O(N)$ because we saw that as N becomes

large the steps with constant time have negligible effect on running time of the code.

Logarithmic time complexity:
when the size of input is N but the no. of steps to execute the code is $\log N$ such code is said to be executing in logarithmic time. This definition is quite confusing but it can be understood clearly with an example code.

lets, say we have a very large number which is power of 2 that is we have 2^x we want to find x . for example $64 = 2^6$

```
def power_of_2(a):  
    x=0  
    while a>1:  
        a=a/2  
        x=x+1  
    return x
```

Now if I call $\text{power_of_2}(16)$ the whole loop will run 4 times because we keep dividing $a/2$. In first iteration a will become 8. In second iteration $a=4$ in 3rd iteration $a=2$ and in 4th iteration $a=1$ that's when the loop will break.

Now there are two instructions inside loop so total no. of steps would be 8. So total no. of steps would be 8.

```
for x=0  
    2x4 for statements inside the loop  
    1 for return statement, total 2x4 + 2
```

If we increase the size of a to 1024 it will take $2 \times 10 + 2$ steps.

The pattern behind this is $\log_{10} = \log_2 = 4$

$$\log_{10} 2^4 = \log_2 16 = 4$$

Overall time complexity of the above (Considering \log_2)

code: $2 \times \log N + 2$

for every large value of capital N , and multiplied by additional 2 can be neglected.

Hence it is $\log N$ to base 2 to be exact.

log linear time complexity:

when we call a logarithm time algorithm inside a loop it would result into a log linear time complexity.

For example let us say I have long sorted list of size $[N]$ and I have Q numbers for each of those Q numbers I have to find the index of it in the given list.

for i in Q list

Point `binary search(x, search, list)` // this statement is executed Q times.

Analyzing above code we know that the call to binary search function takes $O(\log N)$ time we are calling it Q times, hence the overall time complexity is $Q \times O(\log N)$. Simplifying we have $O(Q \log N)$

Polynomial.

When the computation time increases as function of n raised to some power N being the size of the input. Such a code has polynomial time complexity. For example let say we have a list of size N , and we have nested loops on that list.

For i in N :

for j in N :

In the above code the processing part is executed $n \times n$ times that is n^2 times such a code has $O(N^2)$ time complexity

Exponential time complexity

When the computation time of a code increases as function of x^N , N being the size of the input. Such a code has exponential time complexity

Example) def f(n):
if $n=0$:
return 0
else if $n=1$:
return 1
else
return $f(n-1) + f(n-2)$ // every call to f ,

we make 2
more calls to
 f itself.

In the above code for every call to ' f ' we make 2 more calls to function ' f ' in the else part. So if I call $f(4)$ The three of calls to function f would look like this.

$f(4)$

$$\begin{array}{c}
 f(4) \\
 | \\
 f(3) + f(2) \\
 | \quad | \\
 (f_{21} + f_{11}) + (f_{11} + f_{01}) \\
 | \\
 f_{11} + f_{01}
 \end{array}$$