Parul® University

Programming for Problem Solving **(PPS)**

Chapter-2

Constants, Variables, Data types, Operators and Expressions

Introducing C

- C program is developed by Dennis Ritchie in 1972 at Bell laboratory in USA.
- Designed for systems programming
    - Operating systems
    - Utility programs
    - Compilers
    - Filters
- Evolved from B, which evolved from BCPL

Why C Language is Used

- Currently, the most commonly-used language for embedded systems is C language.
- Very portable: compilers exist for virtually every processor
- Easy-to-understand compilation
- Produces efficient code

Features of C

01

Portability:

- C Programs are portable i.e. they can be run on any Compiler with Little or no Modification.

02

Powerful:

- Provides Wide variety of ‘**Data Types**‘
- Provides Wide variety of ‘Functions’
- Provides useful Control & Loop Control Statements

03

Bit Manipulation :
C Programs can be manipulated using bits. We can perform different operations at bit level. We can manage memory representation at bit level.

Why C Language is Used

- **Effective use of pointers:**

  Pointers has direct access to memory.

  C Supports efficient use of pointer

- **Structured programming language**

  C is a structured programming language in the sense that **we can break the program into parts using functions.** So, it is easy to understand and modify.

Why C Language is Used

- **Memory Management**

  It supports the feature of **dynamic memory allocation.** In C language, we can free the allocated memory at any time by calling the **free()** function.

PROGRAM STRUCTURE

A sample C Program

```
#include<stdio.h>
#include<conio.h>
Void main()
{
   --other statements
}
```

HEADER FILES

- The files that are specified in the include section is called as header file
- These are precompiled files that has some functions defined in them
- We can call those functions in our program by supplying parameters
- Header file is given an extension .h
- C Source file is given an extension .c

MAIN FUNCTION

- This is the entry point of a program
- When a file is executed, the start point is the main function
- From main function the flow goes as per the programmers choice.
- There may or may not be other functions written by user in a program
- Main function is compulsory for any C program

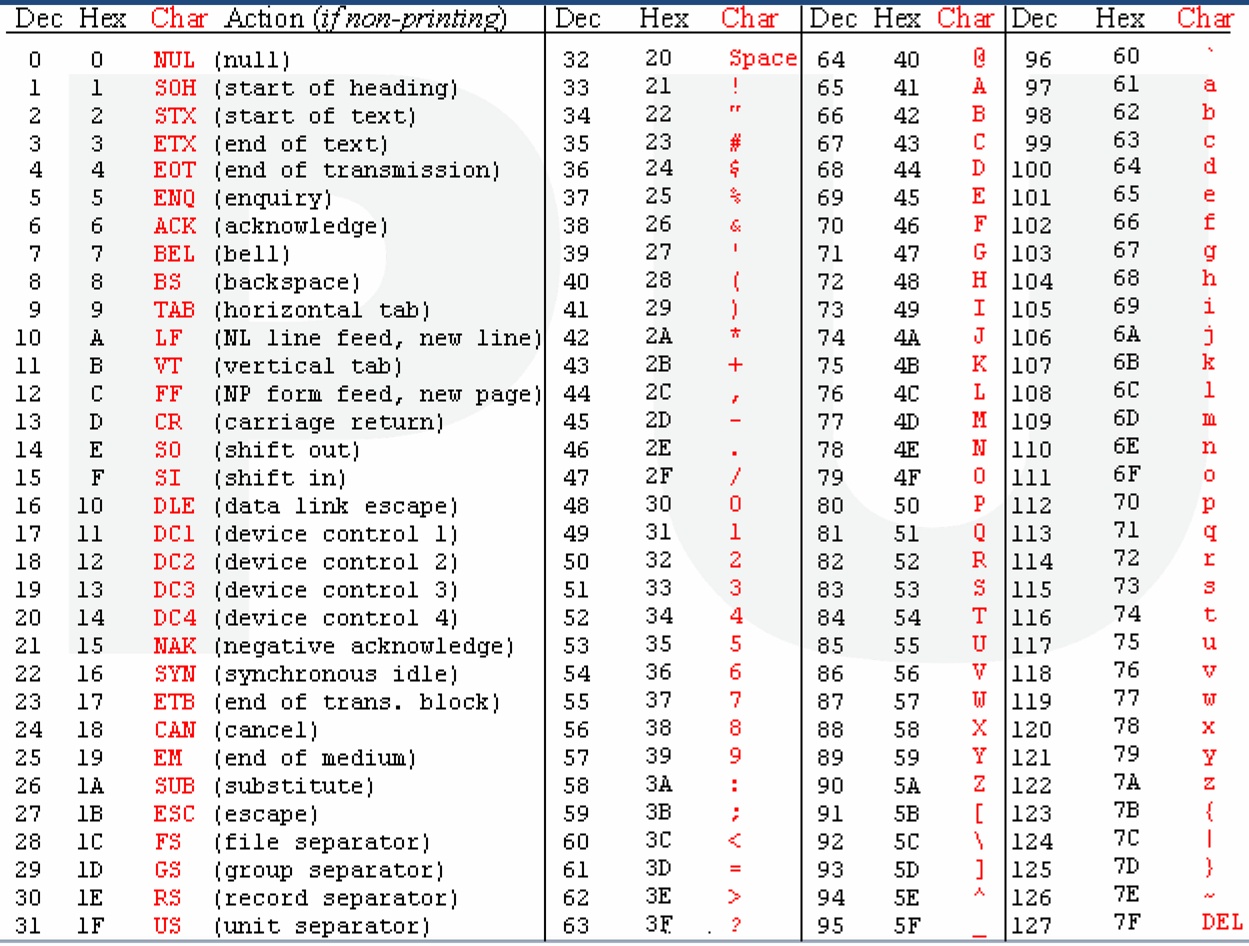
RUNNING A ‘C’ PROGRAM

- Type a program
- Save it
- Compile the program – This will generate an exe file (executable)
- Run the program (Actually the exe created out of compilation will run and not the .c file)
- In different compiler we have different option for compiling and running. We give only the concepts.

DATA TYPES

- Character Set
- C Tokens
- Keywords and Identifiers
- Constants
- Variables
- Data Types
- Declaration of Variables
- Assigning Values to Variables
- Typedef
- Defining Symbolic Constants

Character Set



Dec	Hex	Char	Action (*if non-printing*)	Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char
0	0	NUL	(null)	32	20	Space	64	40	@	96	60	`
1	1	SOH	(start of heading)	33	21	!	65	41	A	97	61	a
2	2	STX	(start of text)	34	22	"	66	42	B	98	62	b
3	3	ETX	(end of text)	35	23	#	67	43	C	99	63	c
4	4	EOT	(end of transmission)	36	24	$	68	44	D	100	64	d
5	5	ENQ	(enquiry)	37	25	%	69	45	E	101	65	e
6	6	ACK	(acknowledge)	38	26	&	70	46	F	102	66	f
7	7	BEL	(bell)	39	27	'	71	47	G	103	67	g
8	8	BS	(backspace)	40	28	(	72	48	H	104	68	h
9	9	TAB	(horizontal tab)	41	29	)	73	49	I	105	69	i
10	A	LF	(NL line feed, new line)	42	2A	*	74	4A	J	106	6A	j
11	B	VT	(vertical tab)	43	2B	+	75	4B	K	107	6B	k
12	C	FF	(NP form feed, new page)	44	2C	,	76	4C	L	108	6C	l
13	D	CR	(carriage return)	45	2D	-	77	4D	M	109	6D	m
14	E	SO	(shift out)	46	2E	.	78	4E	N	110	6E	n
15	F	SI	(shift in)	47	2F	/	79	4F	O	111	6F	o
16	10	DLE	(data link escape)	48	30	0	80	50	P	112	70	p
17	11	DC1	(device control 1)	49	31	1	81	51	Q	113	71	q
18	12	DC2	(device control 2)	50	32	2	82	52	R	114	72	r
19	13	DC3	(device control 3)	51	33	3	83	53	S	115	73	s
20	14	DC4	(device control 4)	52	34	4	84	54	T	116	74	t
21	15	NAK	(negative acknowledge)	53	35	5	85	55	U	117	75	u
22	16	SYN	(synchronous idle)	54	36	6	86	56	V	118	76	v
23	17	ETB	(end of trans. block)	55	37	7	87	57	W	119	77	w
24	18	CAN	(cancel)	56	38	8	88	58	X	120	78	x
25	19	EM	(end of medium)	57	39	9	89	59	Y	121	79	y
26	1A	SUB	(substitute)	58	3A	:	90	5A	Z	122	7A	z
27	1B	ESC	(escape)	59	3B	;	91	5B	[	123	7B	{
28	1C	FS	(file separator)	60	3C	<	92	5C	\	124	7C	|
29	1D	GS	(group separator)	61	3D	=	93	5D	]	125	7D	}
30	1E	RS	(record separator)	62	3E	>	94	5E	^	126	7E	~
31	1F	US	(unit separator)	63	3F	?	95	5F	_	127	7F	DEL

C Tokens

- C tokens are the basic buildings blocks in C language which are constructed together to write a C program.
- Each and every smallest individual units in a C program are known as C tokens.

Type of Tokens

Keywords

Example: float, double, integer, etc..

Identifiers

Example: main, amount, etc..

Constants

Example : 12.4, 3.14, etc..

Strings

Example : “Thursday”

Operators

Example : +,*,/,-

THE KEYWORDS

- "**Keywords**" are words that have special meaning to the **C** compiler.
- Their meaning cannot be changed at any instance.
- Serve as basic building blocks for program statements.
- All keywords are written in <u>**only lowercase.**</u>

THE KEYWORDS IN ANSI C

auto
break
case
char
const
continue
default
do

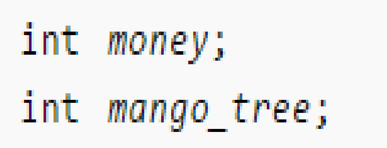
double
else
enum
etern
float
for
goto
if

register
return
short
signed
sizeof
static
struct
int

switch
typedef
union
unsigned
void
volatile
while
long

THE IDENTIFIERS

- Identifier are created to give unique name to C entities to identify it during the execution of program.



```
int money;
int mango_tree;
```

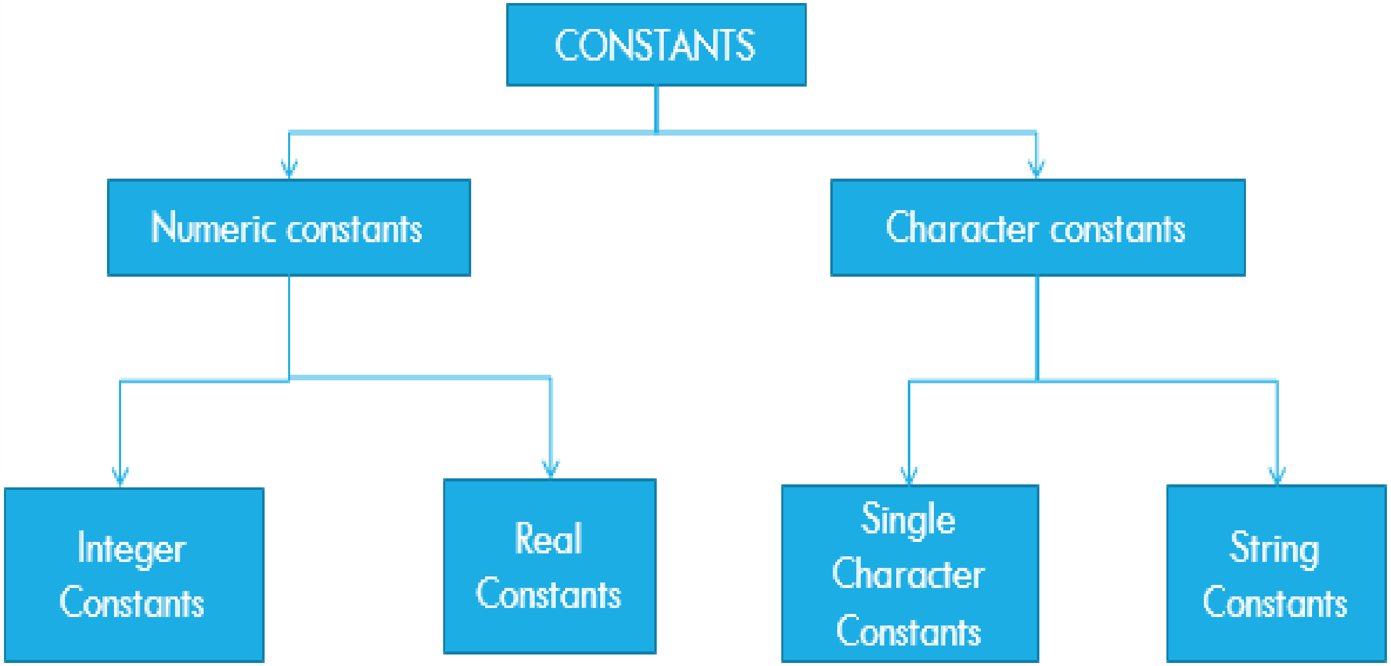
- Cannot use C keywords as identifiers
- Must begin with alpha character or _, followed by alpha, numeric, or _
- Upper- and lower-case characters are important (case-sensitive)
- Must consist of only letters, digits or underscore (_).
- Only first 31 characters are significant.
- Must NOT contain spaces (   ).

THE IDENTIFIERS - EXAMPLES

IDENTIFIER	VALID?	REASON IF INVALID
`totalSales`	Yes	
`total_Sales`	Yes	
`total.Sales`	No	Cannot contain .
`4thQtrSales`	No	Cannot begin with digit
`totalSale$`	No	Cannot contain $

CONSTANTS

Constants in C are the fixed values that do not change during the execution of a program.



CONSTANTS EXAMPLES

Integer Constants

Refers to sequence of digits such as decimal integer, octal integer and hexadecimal integer.

Some of the examples are 112, 0551, 56579u, 0X2 etc.

Real Constants

The floating point constants such as 0.0083, -0.78, +67.89 etc.

Single Character Constants

A single char const contains a single character enclosed within pair of *single quotes* [‘ ’]. For example, ‘8’, ‘a’ , ‘i’ etc.

String Constants

A string constant is a sequence of characters enclosed in double quotes [“ ”]; For example, “0211”, “Stack Overflow” etc.

Variables and Identifiers

- **Variable**

  A variable is a type of identifier that specifically represents a named memory location where data can be stored and manipulated. Variables have a data type (e.g., int, float, char) which determines the kind of data they can hold

- **Identifier**

  An identifier is a name given to any entity in a C program, such as variables, functions, arrays, structures, unions, and so on. It serves to uniquely identify that entity within the program. Identifiers must follow specific naming rules (e.g., starting with a letter or underscore, no special characters except underscore).

Variables and Identifiers

- **All variables are identifiers,**
  - because a variable needs a name (an identifier) to be referred to in the code.
- **Not all identifiers are variables.**
  - For example, function names, structure names, and preprocessor macros are also identifiers, but they are not variables in the sense of holding a modifiable data value in memory.
- Analogy:
  - Think of it like this: "Vehicle" is a broad category (like "identifier"). "Car" is a specific type of vehicle (like "variable"). All cars are vehicles, but not all vehicles are cars (there are also trucks, motorcycles, etc.). Similarly, all variables are identifiers, but not all identifiers are variables.

Variables and Identifiers

```
#include <stdio.h>

// Function identifier

int  add(int  x,  int  y)  {     //  'add'  is  an identifier (function name)

    return  x  +  y;           //  'x'  and  'y'  are variables

}

// Constant identifier

#define  PI  3.14159      //  'PI'  is  an identifier (macro constant, not a variable)

int main() {

// Variable identifiers

 int a = 5;  // 'a' is a variable (stores value 5)

 int b = 10; // 'b' is a variable (stores value 10)

// Function call

int result = add(a, b);  // 'result' is a variable

                        //  'add'  here  is  an identifier for a function

    printf("Result = %d\n", result);

    printf("Value of PI = %.2f\n", PI);

    return 0;

}
```

DATE TYPES

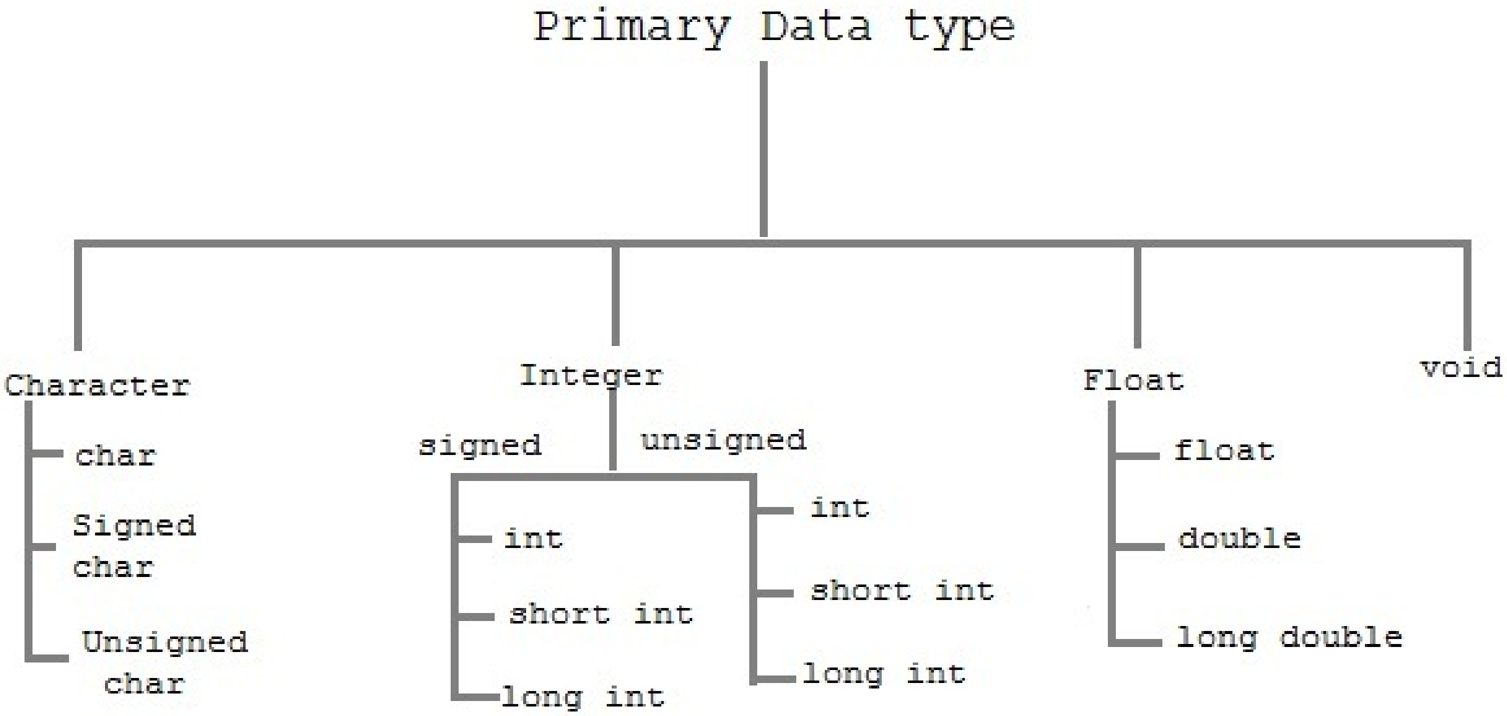
- A data type is
  - A set of values AND
  - A set of operations on those values
- A data type is used to
  - Identify the type of a variable when the variable is declared
  - Identify the type of the return value of a function
  - Identify the type of a parameter expected by a function

DATE TYPES

ANSI C supports three classes of data types.

1. Primary or Fundamental data types.
2. User-defined data types.
3. Derived data types.

PRIMARY DATA TYPES IN C



Primary Data type

Character
- char
- Signed char
- Unsigned char

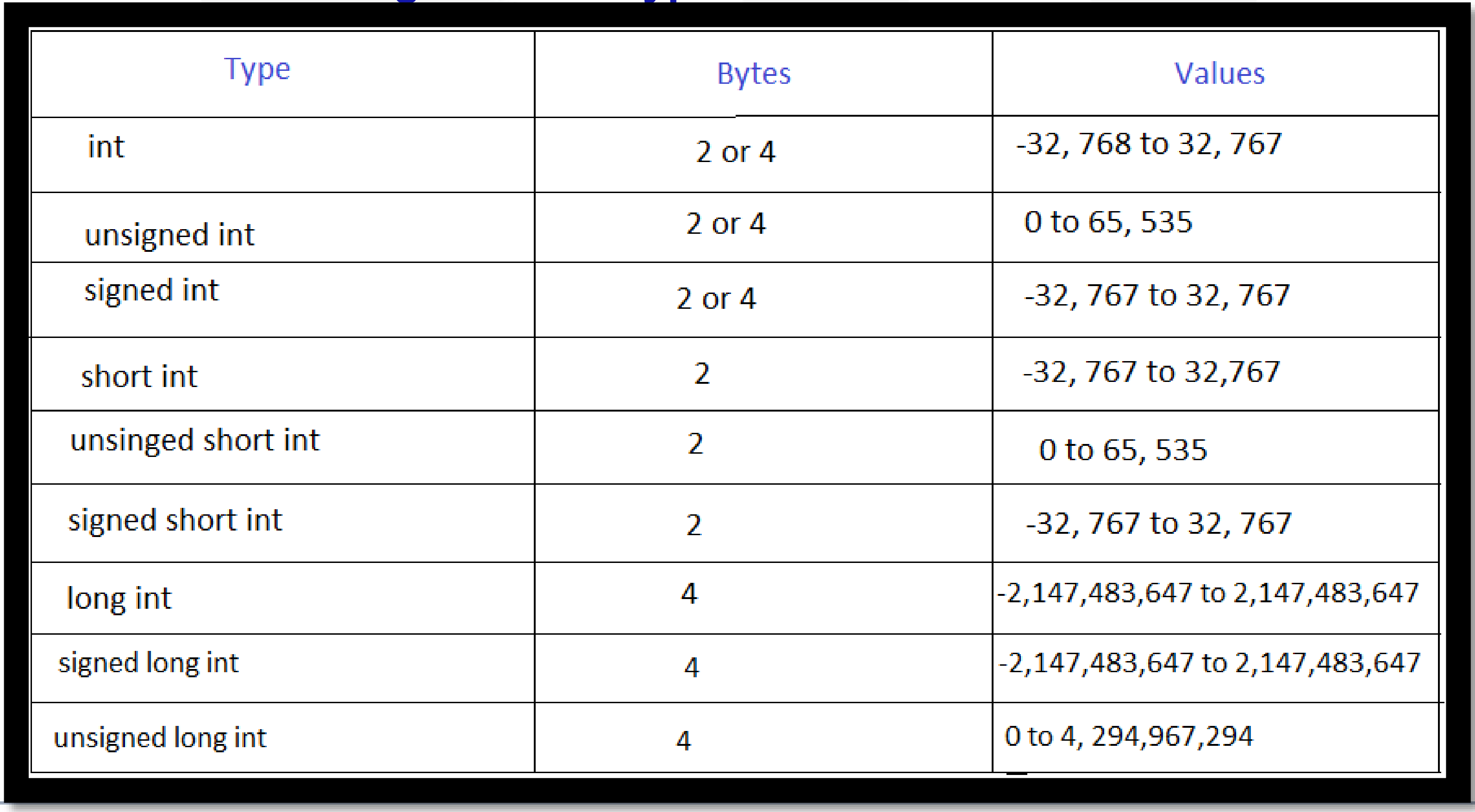
Integer
- signed
  - int
  - short int
  - long int
- unsigned
  - int
  - short int
  - long int

Float
- float
- double
- long double

void

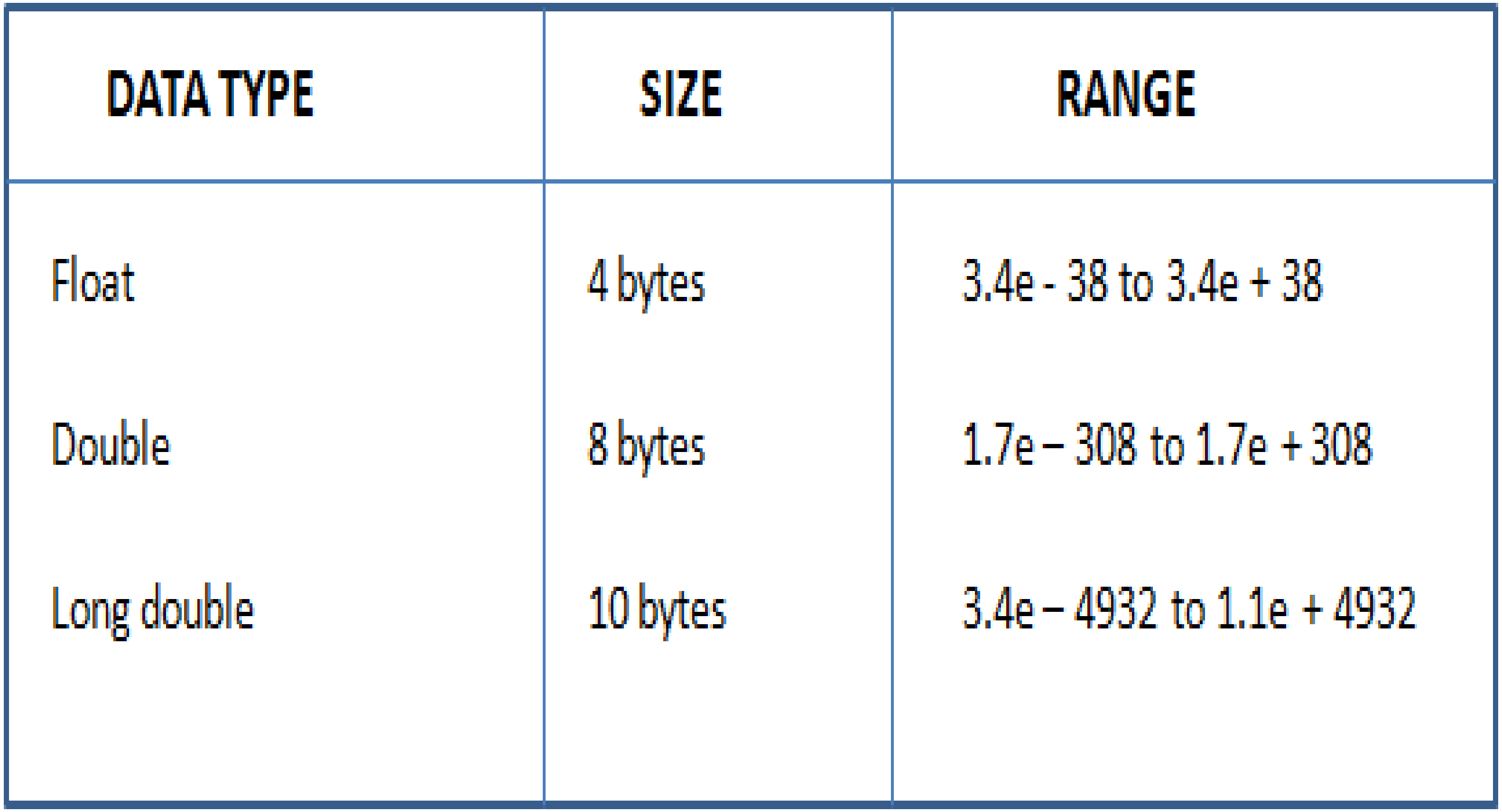
INTEGER TYPES

Size and Range Of Data types on 16 bit machine



Type	Bytes	Values
int	2 or 4	-32, 768 to 32, 767
unsigned int	2 or 4	0 to 65, 535
signed int	2 or 4	-32, 767 to 32, 767
short int	2	-32, 767 to 32,767
unsinged short int	2	0 to 65, 535
signed short int	2	-32, 767 to 32, 767
long int	4	-2,147,483,647 to 2,147,483,647
signed long int	4	-2,147,483,647 to 2,147,483,647
unsigned long int	4	0 to 4, 294,967,294

FLOATING POINT TYPES



DATA TYPE	SIZE	RANGE
Float	4 bytes	3.4e - 38 to 3.4e + 38
Double	8 bytes	1.7e – 308 to 1.7e + 308
Long double	10 bytes	3.4e – 4932 to 1.1e + 4932

USER-DEFINED TYPE DECLARATION

- typedef (**Type Definition**)
- enum (**Enumerated Data Type**)
- struct (**Structure**)
- union (**Union Data Type**)

USER-DEFINED TYPE DECLARATION

- C allows user to define an identifier that would represent an existing **data type.**
- The general form is **typedef type identifier;**

Eg:

```
typedef int units;
typedef float marks;
```

- Another user defined data types is enumerated data type which can be used to declare variables that can have one of the values enclosed within the braces.
- **enum identifier {value1,value2,……valuen};**

USER-DEFINED TYPE DECLARATION

typedef (Type Definition)

- Used to give an alias (new name) to an existing data type.
- Increases readability.

```
#include <stdio.h>
typedef unsigned int uint;  // new name 'uint' for 'unsigned int'

int main() {
    uint age = 25;  // age is the variable.
    printf("Age: %u", age);
    return 0;
}
```

USER-DEFINED TYPE DECLARATION

enum (Enumerated Data Type)

- Used to assign names to integral constants for better readability.

```
#include <stdio.h>
enum Days { MON=1, TUE, WED, THU, FRI, SAT, SUN };
//This defines an enum (enumeration) called Days.
int main() {
    enum Days today = WED;
//Variable today is assigned the enumeration value WED.
    printf("Day: %d", today); // Output: 3
    return 0;
}
```

DERIVED DATA TYPE

- C allows a different types of derived data structure
- Different types of datatypes are
- array
- Functions
- Pointer
- Structure

DECLARATION OF VARIABLES

DECLARATION OF VARIABLES

- **Declarations does two things:**
- ➢ It tells the compiler what the variable name is
- ➢ It specifies what type of data the variable will hold

- ➢ **Primary Type Declaration**
- The syntax is
- **Data-type v1,v2…..vn;**

Eg:

```
int count;
double ratio, total;
```

DECLARATION OF VARIABLES

Declaring a variable as constant

Eg:

```
  const int class_size=40;
```

- This tells the compiler that the value of the int variable class_size must not be modified by the program.

Declaring a variable as volatile

- By declaring a variable as volatile, its value may be changed at any time by some external source.

Eg:

```
    volatile int date;
```

DECLARATION OF VARIABLES - CONSTANT

```
#include <stdio.h>
int main() {
    // Defining constant variable
    const int a = 10;
    printf("%d", a);
    return 0;
}
```

DECLARATION OF VARIABLES - CONSTANT

```
#include <stdio.h>
int main() {
    // Not initializing a constant variable
    const int a;
    // printing value
    printf("%d", a);
    return 0;
}
```

Output: Garbage value. Here 0. It can be anything depending upon environment

DECLARATION OF VARIABLES - CONSTANT

```
#include <stdio.h>
int main() {
     // Declaring a constant variable
    const int a;
     // Initializing constant variable after declaration
    a = 20;
    printf("%d", a);
    return 0;
}
```

Output: error: assignment of read-only variable 'a'

DECLARATION OF VARIABLES - VOLATILE

```
#include <stdio.h>
#include <stdbool.h>
volatile int flag = 0;   // Volatile:
    value may change anytime
// Simulated hardware interrupt

void hardware_event() {
    flag = 1;  // Hardware
    changes the value
}
```

```
int main() {
    printf("Waiting for hardware
event...\n");

    // Loop until hardware sets flag
    while (flag == 0) {
        // Busy wait (polling)
    }

    printf("Hardware event
detected!\n");
    return 0;
}
```

Assigning Values to Variables

- Assigning values to variables in C involves using the assignment operator =.
- This operator takes the value on its right-hand side and stores it in the variable on its left-hand side.

Assigning Values to Variables

1. Assigning a value at declaration:

- Variables can be assigned a value at the same time they are declared. This is known as initialization.
- int age = 30; // Declares an integer variable 'age' and initializes it with the value 30.
- char grade = 'A'; // Declares a character variable 'grade' and initializes it with 'A'.
- float pi = 3.14f; // Declares a float variable 'pi' and initializes it with 3.14.

Assigning Values to Variables

2. Assigning a value to an existing variable:

- You can change the value of an already declared variable at any point in your program.
- int score; // Variable declared but not initialized
- score = 100; // Assigns the value 100 to 'score‘
- score = 95; // Changes the value of 'score' to 95

Assigning Values to Variables

3. Assigning the value of one variable to another:

- The value of one variable can be assigned to another of the same or compatible data type
- int num1 = 5;
- int num2;
- num2 = num1; // Assigns the value of 'num1' (which is 5) to 'num2'

Assigning Values to Variables

4. Compound Assignment Operators:

- C also provides compound assignment operators that combine an arithmetic operation with an assignment.

-
  ```
  int x = 10;
  x += 5; // Equivalent to x = x + 5; (x becomes 15)
  x *= 2; // Equivalent to x = x * 2; (x becomes 30)
  ```

OPERATORS AND EXPRESSION

OPERATORS AND ITS TYPE IN C

- Operators are the verbs of a language that help the user perform computations on values.
- C language supports a rich set of operators.

Different types of operators in C are :

1. Arithmetic operators
2. Relational operators
3. Logical operators
4. Assignment operators
5. Increment and decrement operators
6. Conditional operators
7. Bitwise operators
8. Special operators

ARITHMETIC OPERATORS

- These are used to perform arithmetic operations.
- All of these can be used as binary operators. These are :

+	add
-	subtract
*	multiply
/	divide(divisor must be non zero)
%	modulo(gives remainder after div)

- The parenthesis() are used to clarify complex operations.
- The operators + and - can be used as unary plus and unary minus arithmetic operators also. The unary – negates the sign of it’s operand

ARITHMETIC OPERATORS

Note : C language has no operator for exponentiation.

- The function pow(x,y) which exists in math.h returns

$$x^y$$

- Following are some examples of arithmetic operators :

x+y, x-y, x*y, x/y, x%y, -x*y

- Here x and y are operands. The % operator cannot be used on floating point data type.

ARITHMETIC OPERATORS

- An expression consisting of numerical values(either any number, variable or even some function call) joined together by arithmetic operators is known as an arithmetic expression.
- For example , consider the following expression :
  (x-y)*(x+y)/5
- Here x,y and 5 are operands and the symbols -,*,+,/ are operators.
- The precedence of operators for the expression evaluation has been given by using parenthesis which will over rule the operators precedence. If x=25 and y=15,then the value of this expression will be 80.

ARITHMETIC OPERATORS

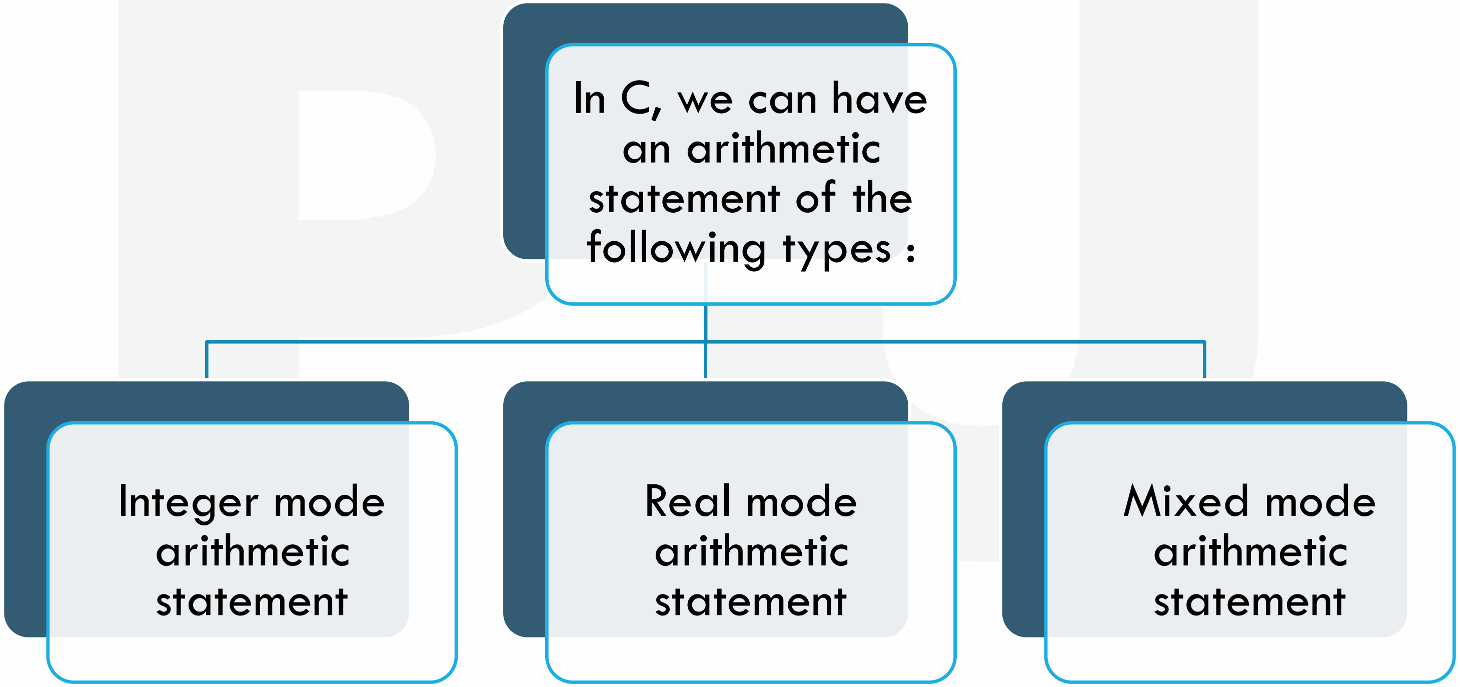
Consider the following expression :

```
3*((i%4)*(5+(j-2)/(k+3)))
```

- Where i, j, k are integer variables.
- If i, j, k have values   9 ,14 and 16 respectively then above expression would be evaluated as

```
=    3 * ((9%4) * (5 + (14 – 2) / (6 +3 )))
=    3 * ( 1 * (5 + (12 / 9) ) )
=    3 * ( 1 * (5 + 1))
=    3 * ( 1 * 6 )
=    3 * 6
=    18
```

MODES OF OPERATION



In C, we can have an arithmetic statement of the following types :

Integer mode arithmetic statement

Real mode arithmetic statement

Mixed mode arithmetic statement

INTEGER MODE ARITHMETIC STATEMENT

- It consist of all operands as either integer constants or integer variables. For example ,

  ```
  int  s, y, i, j, result ;
  x=50;
  y=x+10;
  i=2;
  j=i*3;
  result=x/7 – y%j + i;
  ```

- In case of integer division, result is turnicated towards zero when both the operands are of the same sign.
- When one of the operands is negative the turnication depends upon the implementation.

INTEGER MODE ARITHMETIC STATEMENT

Example

3/5 = 0 and   -3/-5 =0

But -3/5 can result into 0 or -1 (it is machine dependent)

For modulo division, the sign of result is always that of the first operand or dividend. For example,

  13 % - 5 = 3
- 13 % - 5 = - 3
- 13 % 5 = - 3

INTEGER MODE ARITHMETIC STATEMENT

```
/*sum of 4 digit number*/
#include<stdio.h>
main()
{int num,digit,sum=0;
clrscr();
printf(“Enter 4 digit no”);
scanf(“%d”, &num);
digit=num%10;
sum=sum+digit;
num=num/10;
digit=num%10;
sum=sum+digit;
num=num/10;
digit=num%10;
sum=sum+digit;
num=num/10;
digit=num%10;
sum=sum+digit;
printf(“sum is %d”,sum);
getch();}
```

Output

```
----------
Enter 4 digit no
3275
Sum is 17
```

REAL MODE ARITHMETIC STATEMENT

It consist of all operands as either real variables or real constants

For example,

```
float   a,b,d;
a=5.0;
b=a*20.5;
d=a / 2.0 * b – 10.0;
```

- In C, real operand may store value in either of the two forms i.e., in fractional form or exponential form.
- The rounding takes place in such cases and the final result of an expression in real mode is always an approximation of the calculation performed.
- We cannot use % operator with real operands.

REAL MODE ARITHMETIC STATEMENT

The following program illustrates the use of real mode arithmetic :

```
/*conversion of centigrade temperature to
fahrenheit */
#include<stdio.h>
main()
{float cent,fahr;
clrscr();
printf(“Enter centegrade “);
scanf(“%f”,&cent);
fahr=1.8*cent+32.0;
printf(“Centegrade temp is : %f”,cent);
printf(“fahr temp is : %f”,fahr); }
```

MIXED MODE ARITHMETIC STATEMENT

- It consists of operands of both types i.e., integers and reals. When any one of the two operands is real, the expression is known as mixed mode arithmetic expression and the operation performed in such a case results in a real value as the answer.
- For example, consider the following division:

  24/10.0=24
- If we write 24/10 then the result will be 2 as seen earlier.

The following program illustrates the use of mixed mode arithmetic :

MIXED MODE ARITHMETIC STATEMENT

```
/*sum and average of three numbers */
#include<stdio.h>
main()
{int num1,num2,num3,sum=0;
float avg=0.0;
printf(“enter three numbers”);
scanf(“%d%d%d”,&num1,&num2,&num3);
sum=num1+num2+num3;
avg=sum/3.0;
printf(“sum is %d:”,sum);
printf(“average is %f”,avg);
}
```

MIXED MODE ARITHMETIC STATEMENT

```
/*illustration of arithmetic operations on char data type */
#include<stdio.h>
main()
{   int i,j;
    char ch1,ch2;
    clrscr();
    i=10;
    ch1=‘A’; /* ASCII value of A is 65 */
    j=ch1-i;
    ch2=j+42;
    printf(“%d%d %c %c”,I,j,ch1,ch2);
}  output :  10   55   A   a
```

ARITHMETIC OPERATORS PRECEDENCE

In C, the arithmetic operators have the priority as shown
below:

First priority	*	/	%
Second priority	+	-	
Third priority	=		

- The sequence of operations in evaluating an arithmetic expression is also known as hierarchy of operations. This is necessary to avoid any doubt while evaluating an expression.
- The following precedence rules are followed in expression evaluation

ARITHMETIC OPERATORS ASSOCIATIVITY

- When an expression contains multiple operators with the same precedence level, associativity determines the order of evaluation.
- Operators can be left-to-right associative (e.g., +, -, *, /) OR
- right-to-left associative (e.g., assignment operators =, +=, -=, ?: ternary operator).
- e.g. a - b + c is evaluated from left to right as (a - b) + c due to the left-to-right associativity of + and -.
- e.g. 100 / 10 * 2 is evaluated from left to right as (100/10) * 2 due to left-to-right associativity of / and *.
- For example a=b=c is evaluated from right to left as c=5, then b=c -> b=5 and finally a=b -> a=5.

EXPRESSIONS in C

- In C programming, an expression is a combination of operators, operands, and variables that, when evaluated, produces a single value.
- It's a fundamental building block for performing calculations, making comparisons, and controlling program flow.

1. Arithmetic expressions: a + b, x * 5, (y - z) / 2
2. Relational expressions: age > 18, x == y, score <= 100
3. Logical expressions: (a > 0) && (b < 10), !is_empty
4. Assignment expressions: x = 10, sum = a + b
5. Function call expressions: printf("Hello"), calculate_area(radius)

EVALUATION OF EXPRESSION

(i) All the subexpressions within the parentheses are evaluated first. Nested parenthesized subexpressions are evaluated inside-out, with the innermost expression being first to be evaluated.

(ii) Operators in the same sub expression are evaluated as given : *, / ,% perform first +, - performed next. Any function referenced (i.e. invoked)in the expression gets the highest precedence over all the arithmetic operators.

(iii) Operators in the same expression with the same priority are evaluated from left to right.

EVALUATION OF EXPRESSION

For example : consider the following expression for checking the operators precedence.

```
=    15 * 7 / ( 2 – 3 * 5 / 7 + 4 ) – 7 * 9 % 4
=   15 * 7 / (2 – 15 / 7 + 4 ) – 7 * 9 % 4
=   15 * 7 / (2 – 2 + 4) – 7 * 9 % 4
=   15 * 7 / 4 – 7 * 9 % 4
=    105 / 4  -  63 % 4
=    26 – 3
=    23
```

INCREMENT AND DECREMENT OPERATOR

- C language has two useful operators called increment(++) and decrement (--) that operate on integer data only.
- The increment (++) operator increments the operand by 1, while the decrement operator (--) decrements the operand by 1, for example ,:

```
         int  i  , j;
         i = 10;
        j = i++ ;
        printf(“ %d  %d “,  i, j);
```

OUTPUT: 11   10 .

First   i   is assigned to j and then i is incremented by 1 i.e. ,post-increment takes place

INCREMENT AND DECREMENT OPERATOR

If we have :

```
int  i,  j ;
i  =  20;
j =  ++i;
printf(“%d %d”, i,  j);
```

OUTPUT :   21   21.

First i is incremented by 1 and then assignment take place i.e., pre-increment of i.

now, consider the example for (--) operator :

```
int  a,b;
a=10;
b= a--;
printf(“%d %d”, a  , b)
```

OUTPUT :   9   10.

First *a* is assigned to *b* then *a* is decremented by 1. i.e.,post decrement takes place

INCREMENT AND DECREMENT OPERATOR

If we have :

```
int  i,  j ;
i  =  20;
j =  --i;
printf(“%d %d”, i,  j);
```

OUTPUT :   19   19.

First i is decremented by 1 and then assignment take place i.e., pre-decrement of i.

Note : on some compilers a space is required on both sides of ++i or i++ , i--   or --i

RELATIONAL OPERATOR

- These are used to compare two variables or constants .
- C has the following relational operators :

OPERATOR	MEANING
==	Equals
!=	Not Equals
<	Less than
>	Greater than
<=	Less than or equals
>=	Greater than or equals

LOGICAL OPERATORS

- In C, we can have simple conditions (single) or compound conditions(two or more).
- The logical operators are used to combine conditions.
- The notations for these operators is given below :

Operator	Notation in C
NOT	!
AND	&&
OR	||

The notation for the operator OR is given by two broken lines. These follow the same precedence as in other language. NOT(!) is evaluated before AND(&&) which is evaluated before OR(||). Parenthesis( ) cab be used to change this order.

PRECEDENCE OF RELATIONAL OPERATORS AND LOGICAL OPERATORS

- Each operator in C has a precedence of its own. It helps in evaluation of an expression.
- Higher the precedence of the operator, earlier it operates.
- The operators having same precedence are evaluated either from left to right or from right to left, depending on the level, known as the associativity of the operator.

! , < , <= , > , >=, ==, !=, ==, !=, &&, ||

THE CONDITIONAL OPERATOR

- This operator ? And : together forms a ternary operator called as the conditional operator.

Syntax : (test-expression) ? T-expr : F-expr ;
// T – expr means true expression and F-expr means false expression

Let us see example program :

THE CONDITIONAL OPERATOR

```
#include<stdio.h>
main()
{
int age;
clrscr();
printf)(“Enter ur age”);
scanf(“%d”,&age);
(age>18) ? printf(“Eligible to vote”) : printf(“Not
Eligible”);
getch();
}
```

BITWISE OPERATORS

These are used to perform bitwise operations such as testing the bits, shifting the bits to left to right, one’s complement of bits etc.

These operations can be applied only on int and char data types but not on float and double data types. Various bitwise operators in C language are :

~	Bitwise (1’s) complement)
<<	shift left
>>	shift right
&	bitwise AND
^	bitwise XOR(Exclusive OR)
|	bitwise OR

SPECIAL OPERATORS

C provides the following special operators

- Comma Operator
- sizeof operator
- Address operator
- Dereferencing operator
- Dot operator
- Member selection operator
- Pointer

THE COMMA OPERATOR

The comma operator (,) has the lowest precedence.
The comma operator is mainly used in for statement.
For example :

```
        int  i , j;
        for(i=1 ,  j=400  ; i<=10 ; ++I , j/=2)
        printf("%d\n", i+j ) ;
```

- The initial value of i is 1 and that of j is 400 and every time the value of i is incremented by 1 and that of j is divided by 2 after execution of the body of the for loop .
- The distinct expression on either side of the comma operator are evaluated from left to right.
- The associativity of comma operator is from left to right

THE SIZEOF OPERATOR

It is a unary operator which provides the size , in bytes, of the given operand. The syntax of sizeof operator is :

```
sizeof(operand)
```

- Here the operand is a built in or user defined data type or variable.
- The sizeof operator always precedes its operand.
- For example, sizeof (float) returns the value 4 .
- The sizeof operator mainly used in dynamic memory allocation for calculating the number of bytes used by some user defined data type.

DATA TYPE CONVERSIONS IN EXPRESSION - TYPECAST

- Data type conversion in C, also known as type casting, is the process of converting a value from one data type to another.

- This is essential when performing operations involving different data types within an expression to ensure correct calculations and prevent data loss or unexpected behavior.

- There are two main types of data type conversion in C

IMPLICIT TYPE CONVERSION (COERCION)

- This occurs automatically by the compiler when an expression involves operands of different data types.
- The compiler promotes the "smaller" data type to the "larger" data type to avoid loss of precision.
- For example, when an int is added to a float, the int is implicitly converted to a float before the addition.

```
int num_int = 10;
float num_float = 5.5;
float result = num_int + num_float;
// num_int is implicitly converted to float
```

EXPLICIT TYPE CONVERSION (TYPECASTING)

- This is performed manually by the programmer using the cast operator ().
- It allows the programmer to explicitly convert a value to a desired data type, even if it might lead to a loss of precision.
- This is often used when a specific data type is required for an operation or when converting a larger data type to a smaller one.

```
int dividend = 5;
int divisor = 2;
float result = (float)dividend / divisor;
// dividend is explicitly cast to float
```

Precedence of operators among themselves and across all sets of operators

The TURBO C operators are divided into the following 16 categories : these are ordered from the highest precedence to the lowest precedence. The operation within each category have equal precedence.

Precedence of operators among themselves and across all sets of operators

Category	Operator	What it does ?
1. Highest precedence	()	Function call
	[]	Array subscript
	->	C indirect component selector
2.Unary	!	NOT
	~	Bitwise(1's) component
	+	Unary plus
	-	Unary minus
3.Member acces	.*	Dereference
	->*	Dereference
4.Multiplication	*	Multiply
	/	Divide
	%	Remainder (Modulus)

Precedence of operators among themselves and across all sets of operators

Category	Operator	What it does ?
5.Additive	+	Binary plus
	-	Binary minus
6.Shift	<<	Shift left
	>>	Shift right
7.Relational	<	Less than
	<=	Less than or equal to
	>	Greater than
	>=	Greater than equal to
8.Equality	==	Equal to
	!=	Not equal to
9.Bitwise AND	&	Bitwise AND
10.Bitwise XOR	^	Bitwise XOR
11.Bitwise OR	|	Bitwise OR

Precedence of operators among themselves and across all sets of operators

Category	Operator	What it does ?
12.Logical AND	&&	Logical AND
13.Logical OR	||	Logical OR
14.Conditional	?:	(exp?x:y)
15.Assignment	=	Simple assignment
	*=	Assign product
	/=	Assign quotient
	%=	Assign remainder (modulus)
	+=	Assign sum
	-=	Assign difference
	&=	Assign bitwise AND
	^=	Assign bitwise XOR
	|=	Assign bitwise OR
	<<=	Assign left shift
	>>=	Assign right shift
16.Comma	,	Evaluate

THE ASSOCIATIVITY OF OPERATORS

In C , the operators having the equal precedence are evaluated either from left to right or from right to left, depending on the level. It is known as associativity property of the operator.

THE ASSOCIATIVITY OF OPERATORS

Category	Operator	Associativity
1.Highest precedence	( )	Left to Right
	[ ]	
	->	
	::	
	.	
2.Unary	!	Right to left
	~	
	+	
	-	
	++	
	--	
	&	
	*	
	sizeof	

THE ASSOCIATIVITY OF OPERATORS

Category	Operator	Associativity
3.Member access	.*	Left to Right
	->*	
4.Multiplication	*	Left to right
	/	
	%	
5.Additive	+	Left to Right
	-	
6.Shift	<<	Left to Right
	>>	
7.Relational	<	Left to Right
	<=	
	>	
	>=	

THE ASSOCIATIVITY OF OPERATORS

Category	Operator	Associativity
8.Equality	==	Left to Right
	!=	
9.Bitwise AND	&	Left to right
10.Bitwise XOR	^	Left to Right
11.Bitwise OR	|	Left to Right
12.Logical AND	&&	Left to Right
13.Logical OR	| |	Left to Right
14.Conditional	?:	Right to Left
15.Assignment	=	Right to Left
	*=	
	/=	
	%=	
	+=	
	-=	

THE ASSOCIATIVITY OF OPERATORS

Category	Operator	Associativity
	&=	Right to Left
	^=	
	|=	
	<<=	
	>>=	
16.Comma	.	Left to Right