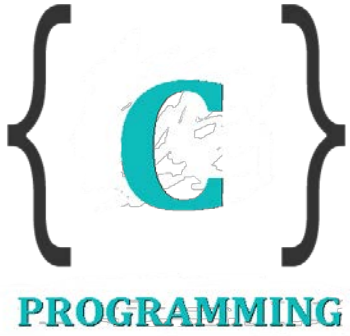
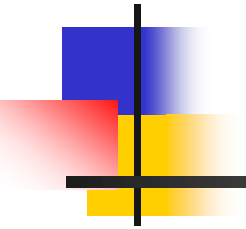


IT 112: Introduction to Programming

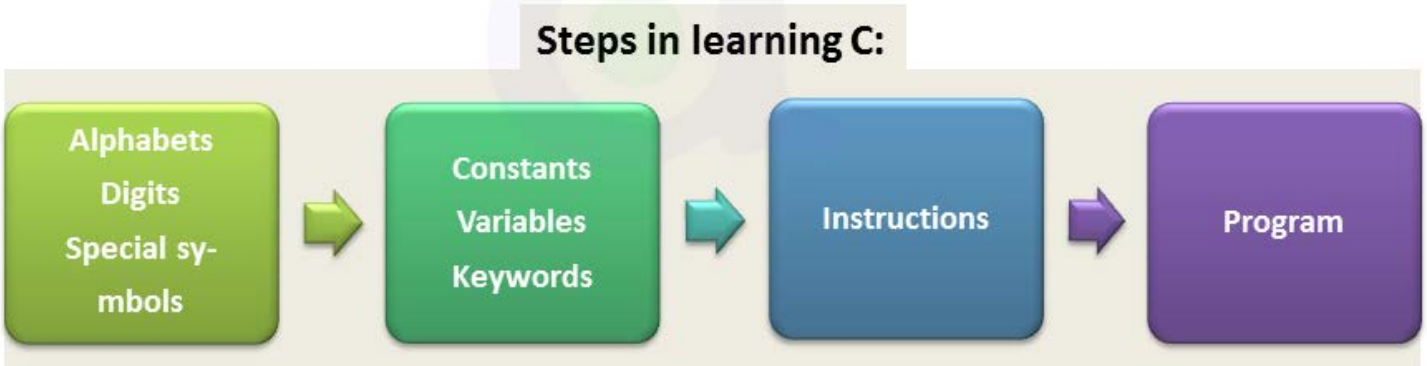
Dr. Manish Khare
Dr. Bakul Gohel

Lecture 4



Programming in C

Language



C word vocabulary is limited

Grammatical mistake is not allowed. Computer have no I.Q. !

Let us do C programing

Lets ask computer to compute a area of circle

Give instruction to computer

```
#include<stdio.h>
#define PI 3.14

int main() {
   float radius, area;

   radius = 10 ; // mm

   area = PI * radius * radius;

   printf("\nArea of Circle : %f mm", area);

   return (0);
}
```

Computer output

```
Area of Circle : 314.000000  mm
```

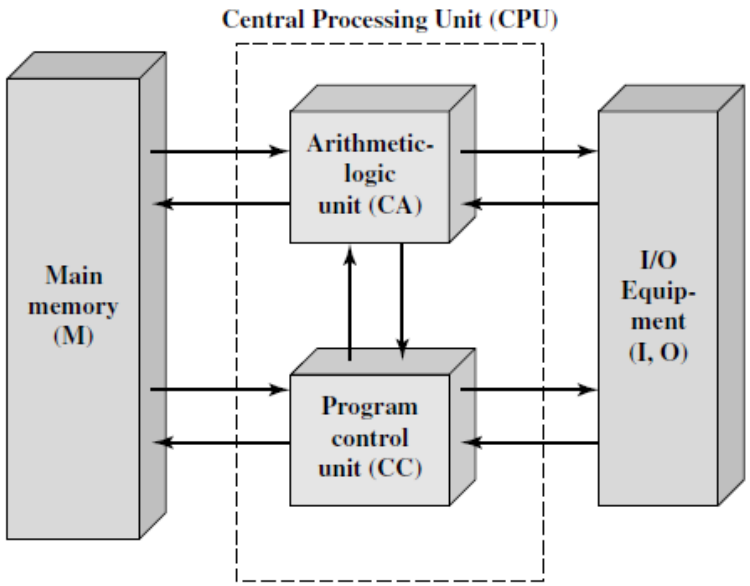
Does computer understand the C language ?

https://ideone.com/OAfGmq

C programing

Does computer (CPU) understand the C language ?
Answer: No ..!

what language computer (CPU) can understand ?
Answer: Machine Code / Binary Code



So we need a translator / converter……

C programing

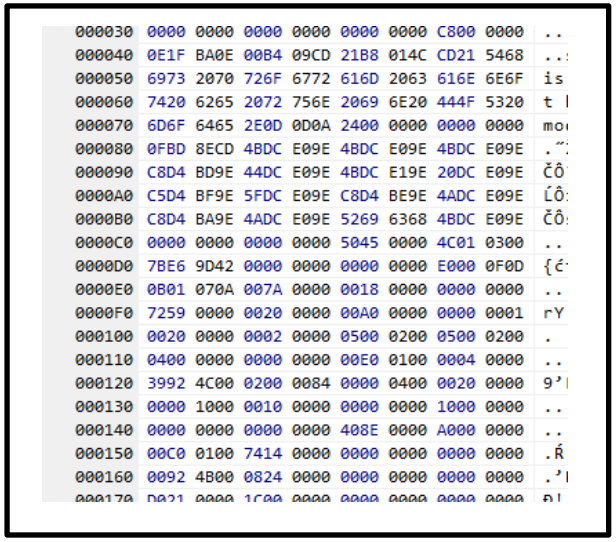
C-program File_name.C

```c
#include<stdio.h>

#define PI 3.14
int main() {
  float radius, area;

  radius = 10 ; // mm

  area = PI * radius * radius;

  printf("\nArea of Circle : %f mm", area);

  return (0);
}
```

Assembly code File_name.s

```
LC2:
        .string "\nArea of Circle : %f mm"
main:
        pushq   %rbp
        movq    %rsp, %rbp
        subq    $16, %rsp
        movss   .LC0(%rip), %xmm0
        movss   %xmm0, -4(%rbp)
        cvtss2sd        -4(%rbp), %xmm1
        movsd   .LC1(%rip), %xmm0
        mulsd   %xmm0, %xmm1
        cvtss2sd        -4(%rbp), %xmm0
        mulsd   %xmm1, %xmm0
        cvtsd2ss        %xmm0, %xmm0
        movss   %xmm0, -8(%rbp)
        cvtss2sd        -8(%rbp), %xmm2
        movq    %xmm2, %rax
        movq    %rax, %xmm0
        movl    $.LC2, %edi
        movl    $1, %eax
        call    printf
        movl    $0, %eax
        leave
        ret
.LC0:
        .long   1092616192
.LC1:
        .long   1374389535
        .long   1074339512
```

Machine Code File_name.exe



In Hexadecimal format
That is read by the operating system and convert it to binary format while executing it

Machine Independent code

Machine Dependent code

Understand and processed by computer

C programing

C-program
File_name.C

```
#include<stdio.h>

#define PI 3.14
int main() {
  float radius, area;

  radius = 10 ; // mm

  area = PI * radius * radius;

  printf("\nArea of Circle : %f mm", area);

  return (0);
}
```

Assembly code
File_name.s

```
LC2:
        .string "\nArea of Circle : %f mm"
main:
        pushq   %rbp
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        subq    $16, %rsp
        movss   .LC0(%rip), %xmm0
        movss   %xmm0, -4(%rbp)
        cvtss2sd        -4(%rbp), %xmm1
        movsd   .LC1(%rip), %xmm0
        mulsd   %xmm0, %xmm1
        cvtsd2ss        %xmm1, %xmm0
        cvtss2sd        -4(%rbp), %xmm0
        mulsd   %xmm1, %xmm0
        cvtsd2ss        %xmm0, %xmm0
        movss   %xmm0, -8(%rbp)
        cvtss2sd        -8(%rbp), %xmm2
        movq    %xmm2, %rax
        movq    %rax, %xmm0
        movl    $.LC2, %edi
        movl    $1, %eax
        call    printf
        movl    $0, %eax
        leave
        ret
.LC0:
        .long   1092616192
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        .long   1374389535
        .long   1074339512
```
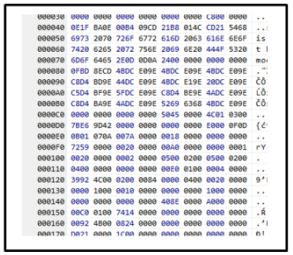

Machine Code
File_name.exe



In Hexadecimal format
That is read by the operating system and convert it to binary format while executing it

Machine Independent code

Machine Dependent code

Understand and processed by computer

C Compiler

Assembler

High/Medium Level Language

Medium/Low Level Language

Low / Instruction Level Language

IDE

Integrated Development Environment (**IDE**) is the software that allow editing and managing of the codes (programmes) and compilation of the codes(programmes)

IDE → Editor + Compiler

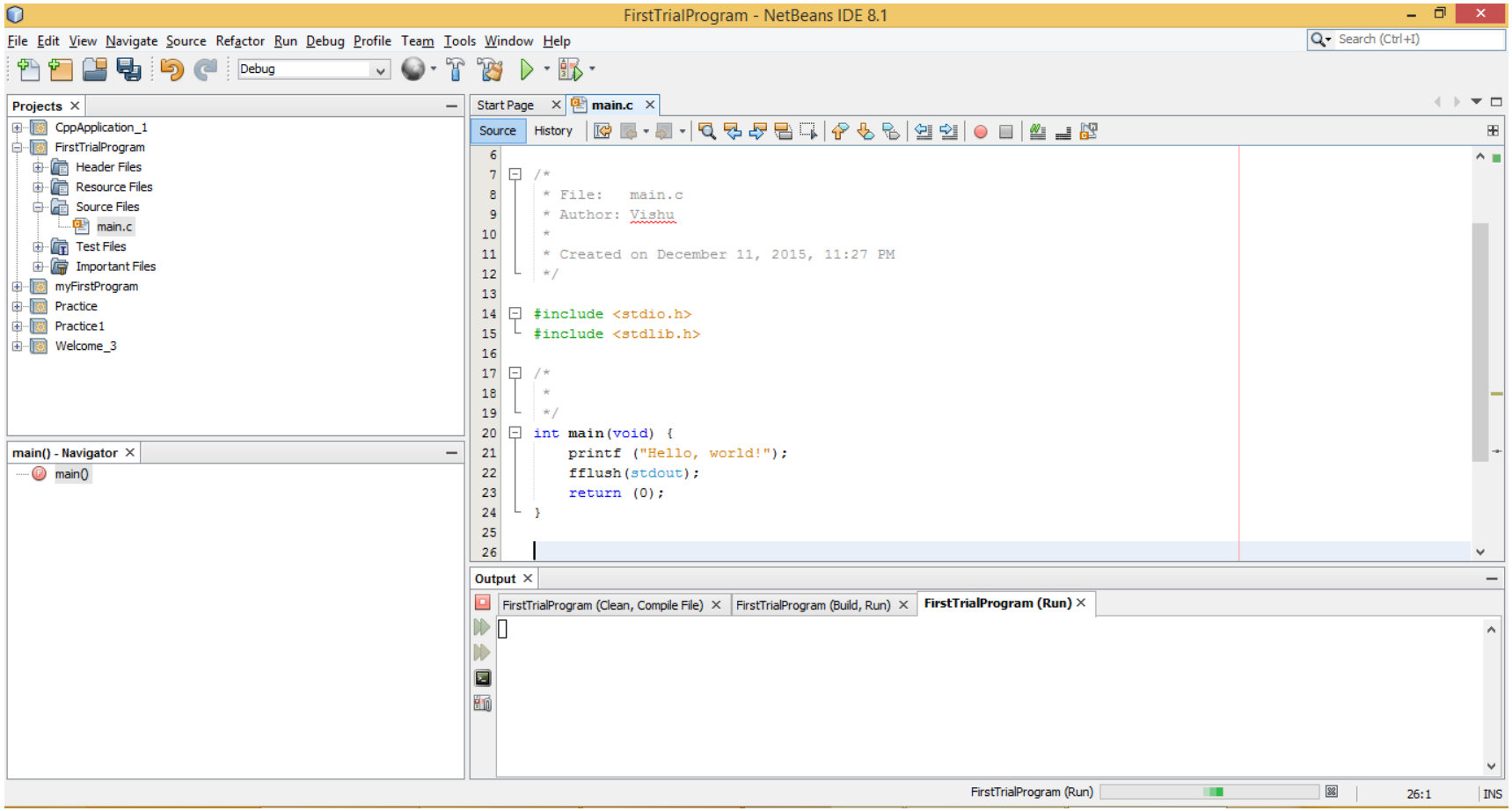
IDE provides all comprehensive functionalities required for software development

- *Visual Studio Code.*
- *Eclipse*
- *NetBeans*
- *Sublime Text*
- *Atom*
- *Code::Blocks*
- *CodeLite*

And many more...

IDE

- Example, NetBean IDE 8.1



The C Character Set

- A character denotes any alphabet, digit or special symbol used to represent information.

Types	Character Set
Uppercase Alphabets	A, B, C, ... Y, Z
Lowercase Alphabets	a, b, c, ... y, z
Digits	0, 1, 2, 3, ... 9
Special Symbols	~ ‘ ! @ # % ^ & * ( ) _ - + = | \ { } [ ] : ; " ' < > , . ? /
White spaces	Single space, tab, new line.

Structure of a C program

- Every C program consists of one or more functions.
  - One of the functions must be called *main*.
  - The program will always begin by executing the main function.
  - Each compound statement is enclosed within a pair of braces: '{' and '}'

```
int main()
{
  statement 1;
  Statement 2;
        .
        .
  Statement n;

  return 0;              //end of the programme ; handover control to OS
}
```

Structure of a C program..

- Each compound statement is enclosed within a pair of braces: '{' and '}'
  - The braces may contain combinations of elementary statements and other compound statements.

- Comments may appear anywhere in a program, enclosed within delimiters '/*' and '*/'.

- "//" can be used for single line comment

C Keywords

- As every language has words to construct statements, C programming also has words with a specific meaning which are used to construct c program instructions.
- In the C programming language, keywords are special words with predefined meaning.
- Keywords are also known as reserved words in C programming language.
- In C programming language, there are **32 keywords**. All the 32 keywords have their own meaning which is already known to the compiler.

32 Keywords in C

auto	break	case	char
const	continue	default	do
double	else	enum	extern
float	for	goto	if
int	long	register	return
short	signed	sizeof	static
struct	switch	typedef	union
unsigned	void	volatile	while

No need to remember at present ; you naturally learn these keywords as course and lab progresses...

Identifier

- Identifier refer to names given to identify various programme elements such as **variables**, **functions**, structures, constants etc.
- It is user defined
- It must be different from keywords
- May consist of letters, digits and underscore (‘_’) character with no space between
- Case sensitive e.g. ‘area’, ’AREA’, ‘Area’ are all different

Identifiers

Valid identifiers

- abc
- simple_interest
- Aa_123
- X
- LIST
- Stud_Name
- Empl_1
- avg_empl_sal
- average_employee_salary
- _delay
- __speed

Invalid Identifiers

- 10abc
- Simple interest
- “Aa_123”
- (X)
- %LIST

Variables

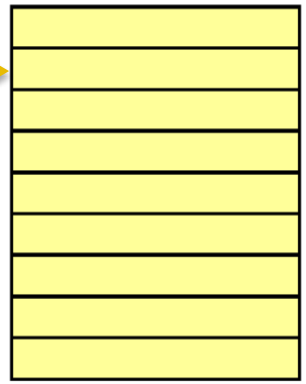
- It is a data name that can be used to store a data value.
- Variable may take different values in memory during execution.
- Variable names follow the naming convention for identifiers.
  - Examples :: temp, speed, name_2, Current
- We need to define the data type of the variable(s) during their initialization

Declaration of Variables

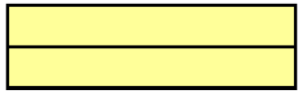
- we need to declare variable before using it
  - It tells the compiler what the variable name is.
  - It specifies what type of data the variable will hold.
- General syntax:
  - **data-type** variable-list;
- Examples:
  - **int** velocity, distance;
  - **int** X;
  - **float** radius, area;
  - **char** flag, option;

Memory Map

```
#include<stdio.h>
#define PI 3.14

int main() {
   float radius, area;

   radius = 10 ; // mm

   area = PI * radius * radius;

   printf("\nArea of Circle : %f mm", area);

   return (0);
}
```



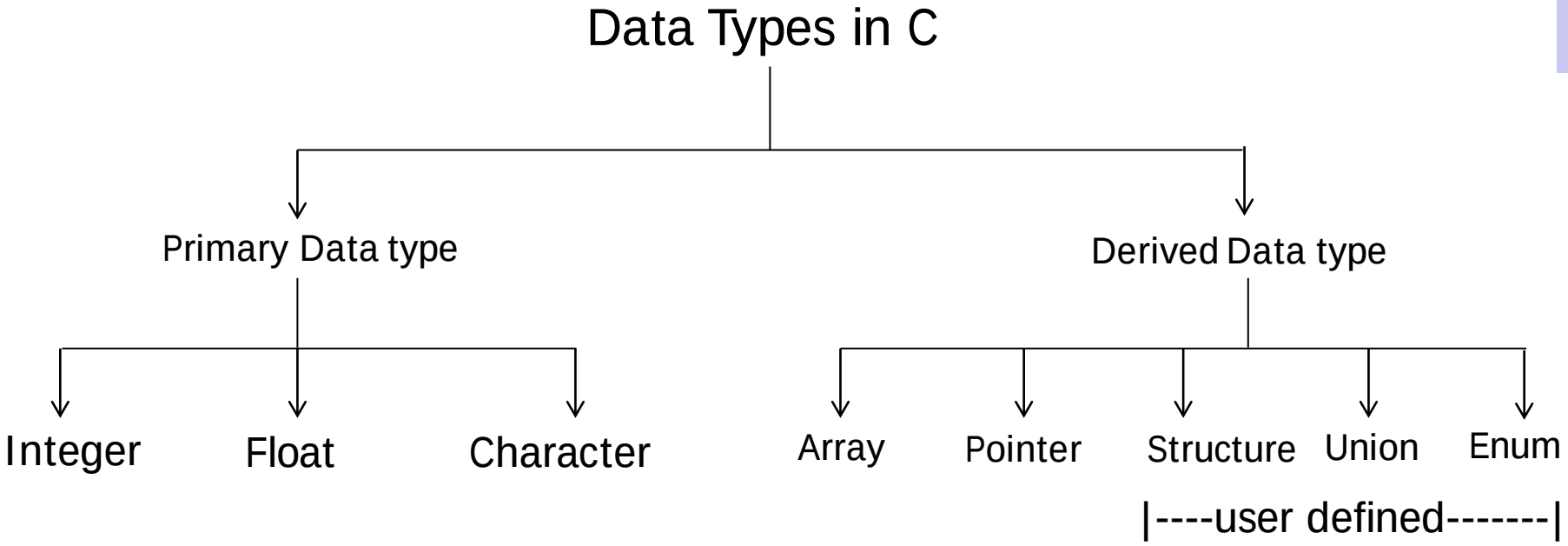
Address 0
Address 1
Address 2
Address 3
Address 4
Address 5
Address 6



Address N-1

Every variable is mapped to a particular memory address

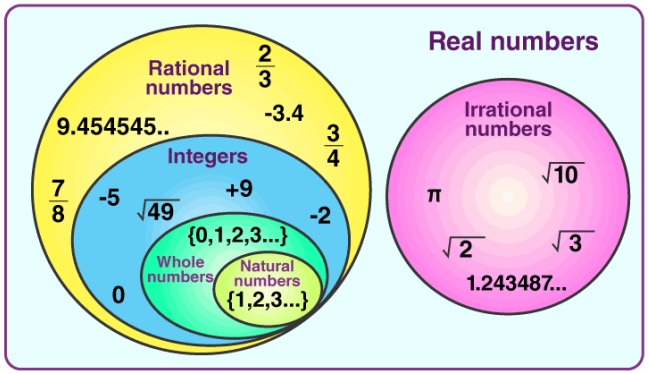
Data Types in C



integer: integer number
e.g. 0, -125, 9999, -5555 etc.

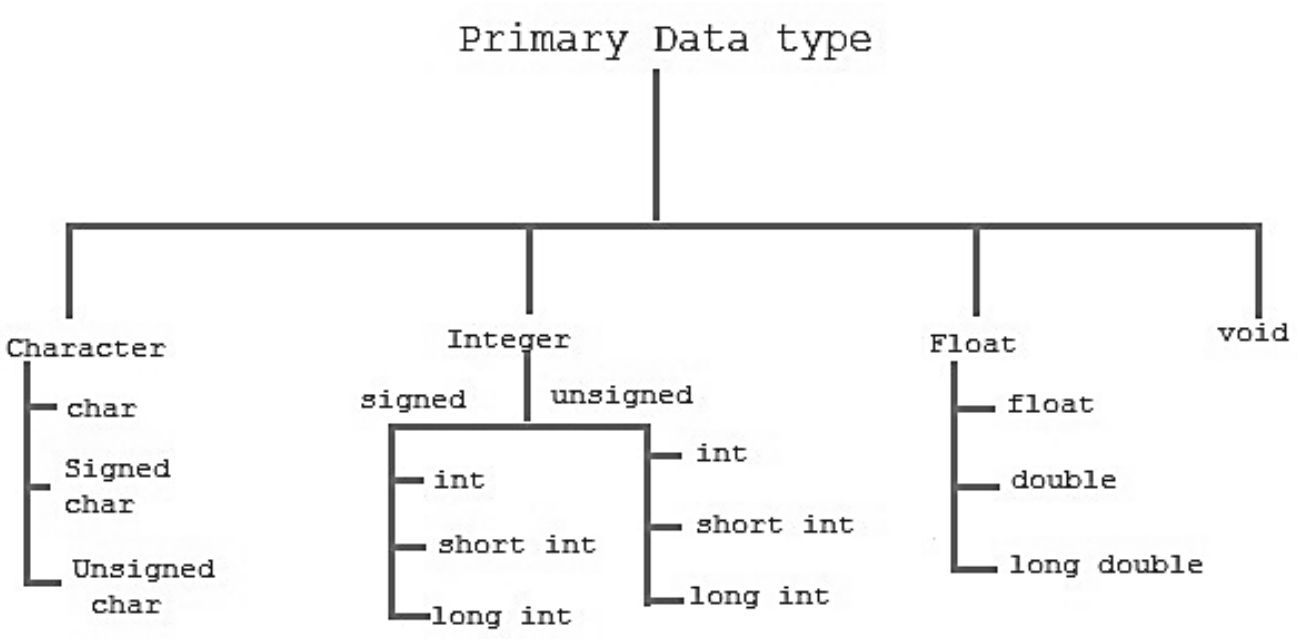
float: point with decimal number
e.g. 0.11, 0, -99.25, 123.3333 etc.

char: single character
e.g. 'A', '2', '%', '\n' etc.



Data Types in C

- Some of the basic data types can be augmented by using certain data type qualifiers:
  - short
  - long
  - signed
  - unsigned



Data Types in C

- Based on system (CPU 8 vs16 vs 32 vs 64) configuration, number of bits or bytes for each data may varies
- Data type representation size for 32-bit and 64-bit system as follow

Type Name	32–bit Size	64–bit Size
char	1 byte	1 byte
short	2 bytes	2 bytes
int	4 bytes	4 bytes
long	4 bytes	8 bytes
long long	8 bytes	8 bytes

Type Name	32–bit Size	64–bit Size
float	4 bytes	4 bytes
double	8 bytes	8 bytes
long double	16 bytes	16 bytes

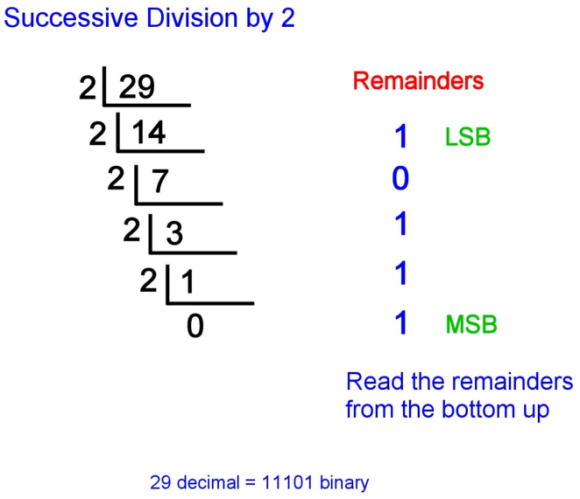
Data Types in C

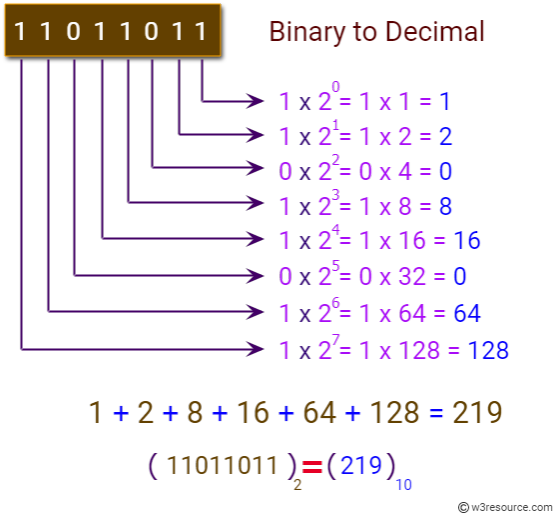
Type	Storage size	Value range
char	1 byte	-128 to 127 or 0 to 255
unsigned char	1 byte	0 to 255
signed char	1 byte	-128 to 127
int	2 or 4 bytes	-32,768 to 32,767 or -2,147,483,648 to 2,147,483,647
unsigned int	2 or 4 bytes	0 to 65,535 or 0 to 4,294,967,295
short	2 bytes	-32,768 to 32,767
unsigned short	2 bytes	0 to 65,535
long	8 bytes or (4bytes for 32 bit OS)	-9223372036854775808 to 9223372036854775807
unsigned long	8 bytes	0 to 18446744073709551615

Type	Storage size	Value range	Precision
float	4 byte	1.2E-38 to 3.4E+38	6 decimal places
double	8 byte	2.3E-308 to 1.7E+308	15 decimal places

Binary Representation

- Integer to Binary





(decimal ↔ binary conversion here is just for understanding… not the part of the syllabus)

- Integer to Binary

$$(\mathbf{99})_{10} = (\mathbf{00000000\ 00000000\ 00000000\ 01100011})_2$$

- Float to Binary *(Self study…)*

$$(\mathbf{99.0})_{10} = (\mathbf{01000010\ 11000110\ 00000000\ 00000000})_2$$

Binary Representation (ASCII)

- Character as integer value

ASCII TABLE

Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char
0	0	[NULL]	32	20	[SPACE]	64	40	@	96	60	`
1	1	[START OF HEADING]	33	21	!	65	41	A	97	61	a
2	2	[START OF TEXT]	34	22	"	66	42	B	98	62	b
3	3	[END OF TEXT]	35	23	#	67	43	C	99	63	c
4	4	[END OF TRANSMISSION]	36	24	$	68	44	D	100	64	d
5	5	[ENQUIRY]	37	25	%	69	45	E	101	65	e
6	6	[ACKNOWLEDGE]	38	26	&	70	46	F	102	66	f
7	7	[BELL]	39	27	'	71	47	G	103	67	g
8	8	[BACKSPACE]	40	28	(	72	48	H	104	68	h
9	9	[HORIZONTAL TAB]	41	29	)	73	49	I	105	69	i
10	A	[LINE FEED]	42	2A	*	74	4A	J	106	6A	j
11	B	[VERTICAL TAB]	43	2B	+	75	4B	K	107	6B	k
12	C	[FORM FEED]	44	2C	,	76	4C	L	108	6C	l
13	D	[CARRIAGE RETURN]	45	2D	-	77	4D	M	109	6D	m
14	E	[SHIFT OUT]	46	2E	.	78	4E	N	110	6E	n
15	F	[SHIFT IN]	47	2F	/	79	4F	O	111	6F	o
16	10	[DATA LINK ESCAPE]	48	30	0	80	50	P	112	70	p
17	11	[DEVICE CONTROL 1]	49	31	1	81	51	Q	113	71	q
18	12	[DEVICE CONTROL 2]	50	32	2	82	52	R	114	72	r
19	13	[DEVICE CONTROL 3]	51	33	3	83	53	S	115	73	s
20	14	[DEVICE CONTROL 4]	52	34	4	84	54	T	116	74	t
21	15	[NEGATIVE ACKNOWLEDGE]	53	35	5	85	55	U	117	75	u
22	16	[SYNCHRONOUS IDLE]	54	36	6	86	56	V	118	76	v
23	17	[ENG OF TRANS. BLOCK]	55	37	7	87	57	W	119	77	w
24	18	[CANCEL]	56	38	8	88	58	X	120	78	x
25	19	[END OF MEDIUM]	57	39	9	89	59	Y	121	79	y
26	1A	[SUBSTITUTE]	58	3A	:	90	5A	Z	122	7A	z
27	1B	[ESCAPE]	59	3B	;	91	5B	[	123	7B	{
28	1C	[FILE SEPARATOR]	60	3C	<	92	5C	\	124	7C	|
29	1D	[GROUP SEPARATOR]	61	3D	=	93	5D	]	125	7D	}
30	1E	[RECORD SEPARATOR]	62	3E	>	94	5E	^	126	7E	~
31	1F	[UNIT SEPARATOR]	63	3F	?	95	5F	_	127	7F	[DEL]

No need to remember….