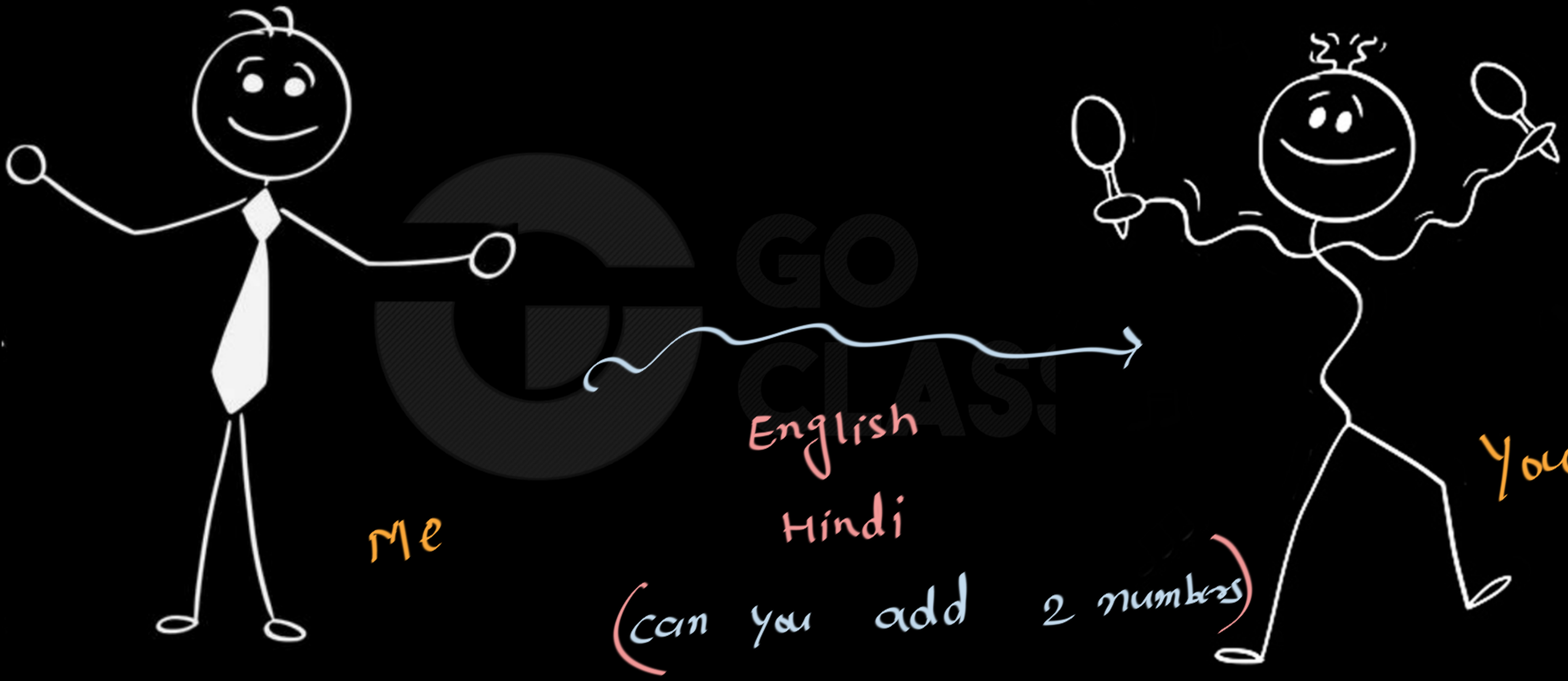
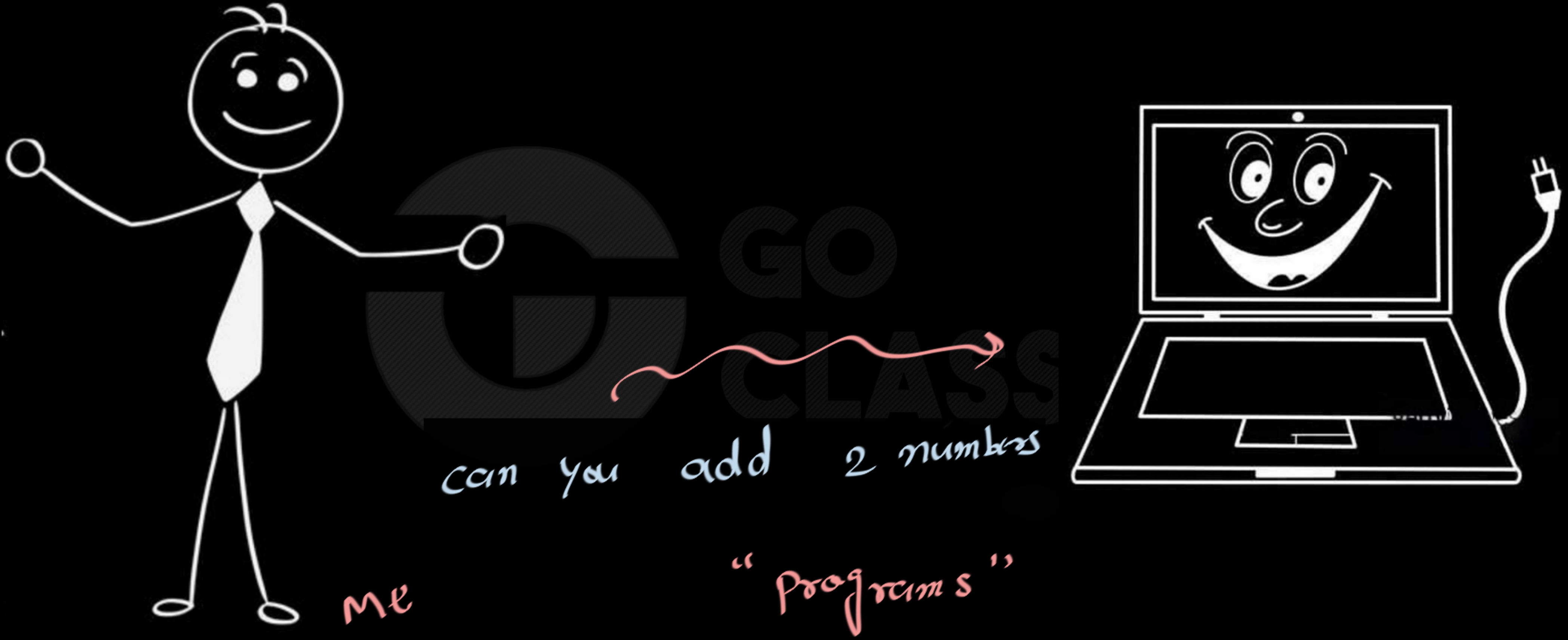
C programming

C Programming




can you add 2 numbers
Me
"programs"

$$\frac{x_1 + x_2 + x_3 + x_4}{4}$$

Steps
- add 4 numbers
- divide by 4
- output

program

Set of steps

Algorithm

english / hindi / ...

flow chart

pseudo code

informal way

Steps

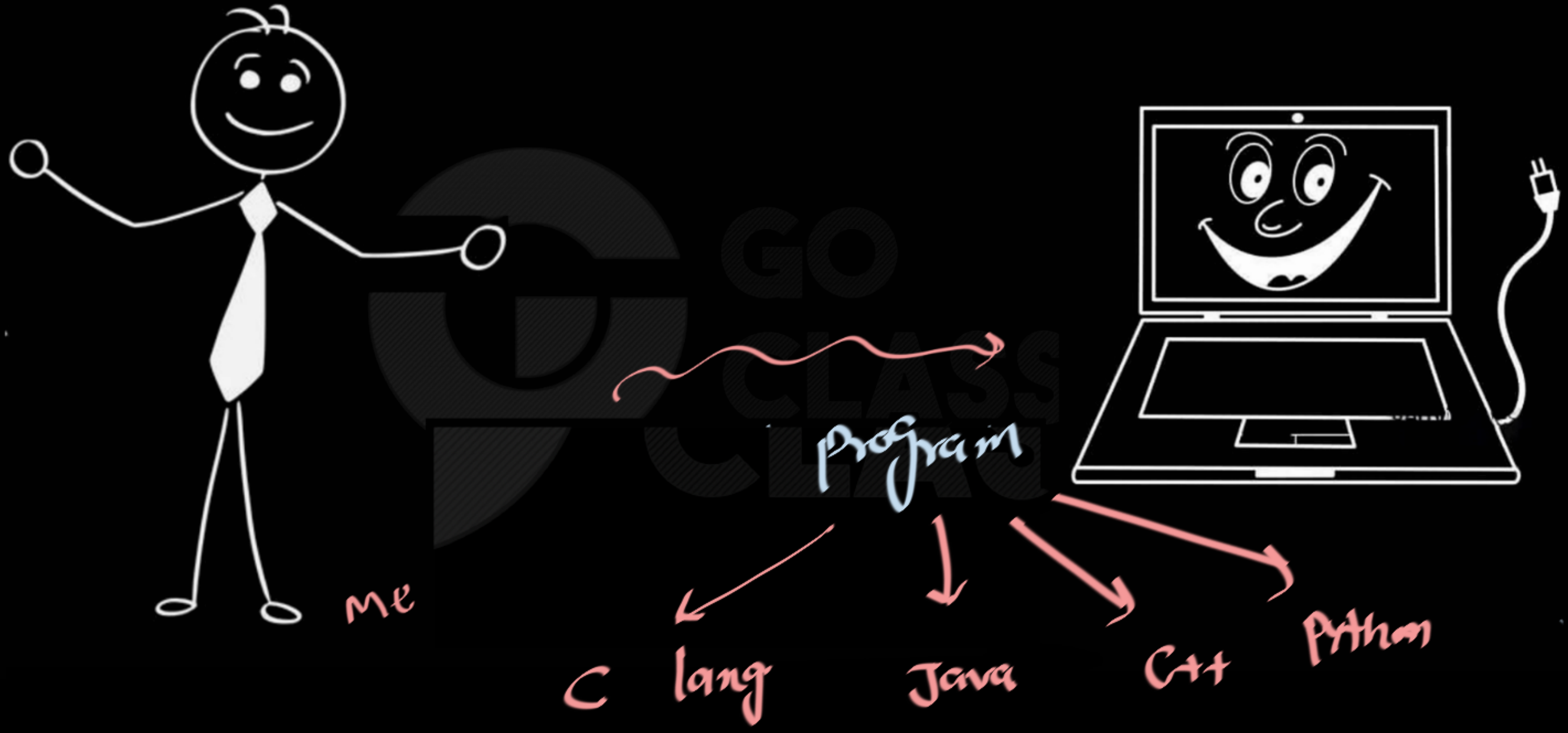
- add 4 numbers
- divide by 4
- output

program

for ( )

{ sum += x_i

}


Me
Program
C lang
Java
C++
Python

why we need C language?

we want computer to perform some tasks.

(we want to communicate to the computer)

Practical Significance

Why we study – GATE CSE Subjects ?

A brief introduction to all

GATE CSE Syllabus

- Programming in C
- Data Structures
- Algorithms
- Compiler Design
- Operating System
- Computer Organisation
- Digital Logic
- DBMS
- Computer Networks
- Theory of Computation
- Discrete Mathematics
- Engineering Mathematics

GATE CSE Syllabus

- Programming in C
- Data Structures
- Algorithms

we want to solve problems efficiently

we want to implement algorithms using DS.

- is my algo correct
- different ways to solve a prob

Sorting

Problem

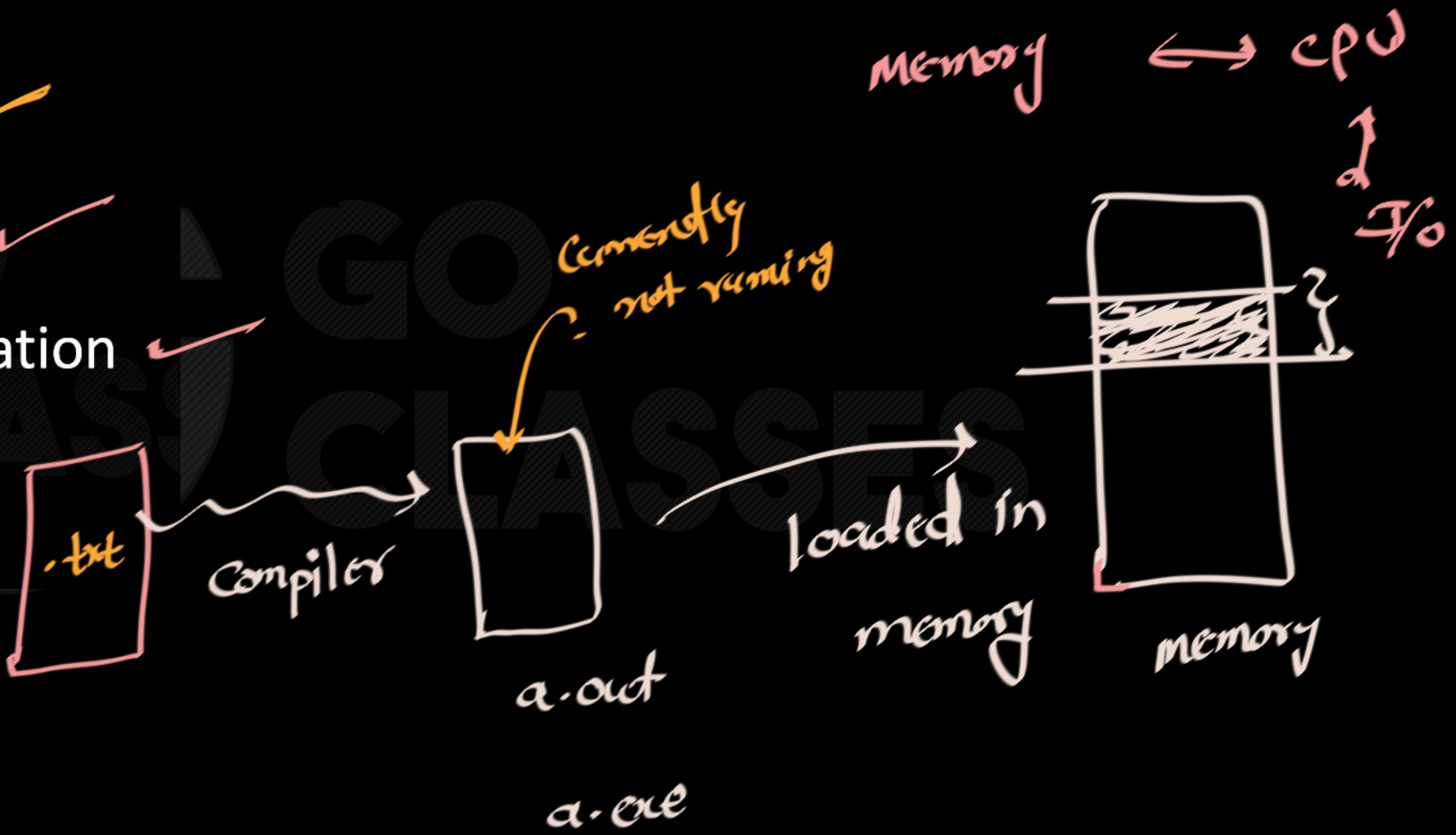
Algorithms

merge sort

quick sort

GATE CSE Syllabus

- Compiler Design
- Operating System
- Computer Organisation
- Digital Logic



GATE CSE Syllabus

- DBMS → structured way to manage our data
  - → SQL
  - → ER, Relational algebra
- Computer Networks → we can communicate among multiple machines

GATE CSE Syllabus

- Theory of Computation

limitations of computers
possibilities " "
types of problems.

- Discrete Mathematics

- $\boxed{\text{Engineering Mathematics}}$

LA : everything (Data) is matrix

Prob: Data follows prob distribution

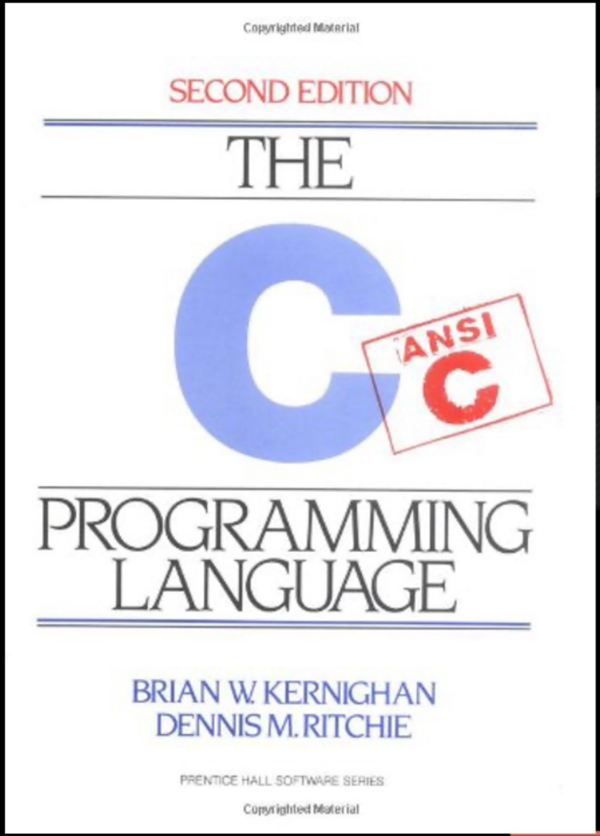
Calculus : Optimisation

AFTER THE GATE CSE PREPARATION,

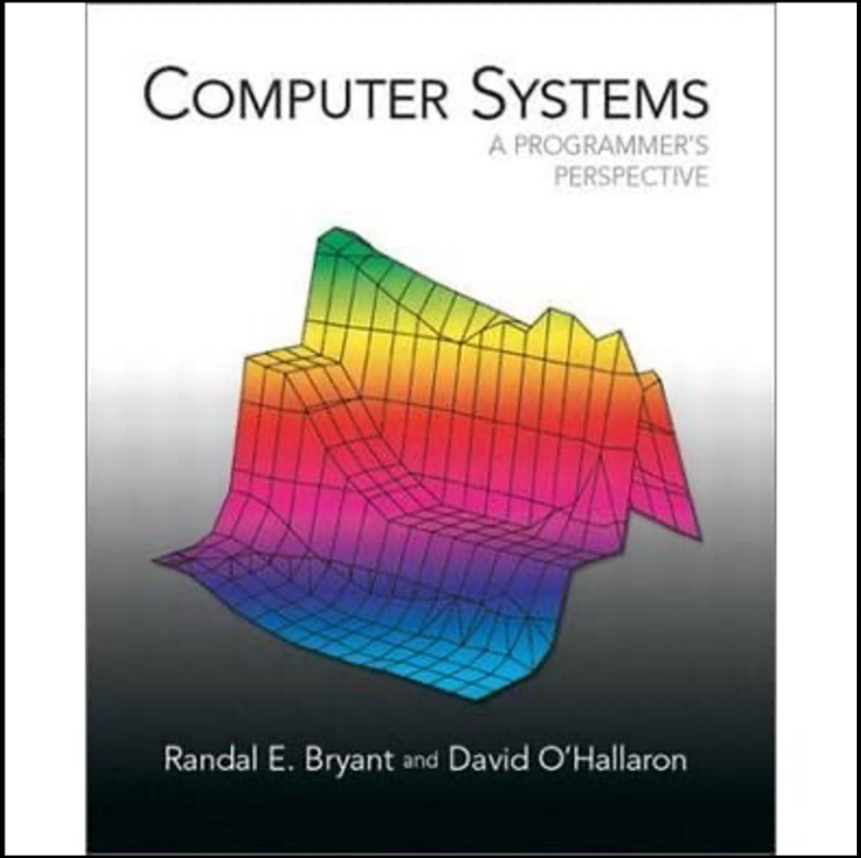
YOU WILL KNOW WHAT A SMART CS STUDENT KNOWS.

GO CLASSES

Reference books



K & R



Lecture Plan

- Unsigned and Signed Integers
- Data types
- Control statements
- Operator Precedence
- Functions
- Memory layout and storage classes
- Recursion
- Pointer
- Arrays (1D, 2D, 3D, passing arrays to functions)
- Memory leak and dangling pointer
- Char array vs strings
- Pointer to array vs array of pointers
- Structs and Union
- Complex declarations
- Miscellaneous

First C program

```c
#include <stdio.h>

int main(void)
{
  printf("Hello World!\n");
}
```

```
printf("Hey 1 = 2");
```

Hey 1 = 2

Keywords ← Reserve words

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

Data Types

- int (4 Bytes)
  - signed
  - unsigned
- char (1 Byte)
  - signed
  - Unsigned
- short(2 Bytes)
  - signed
  - Unsigned

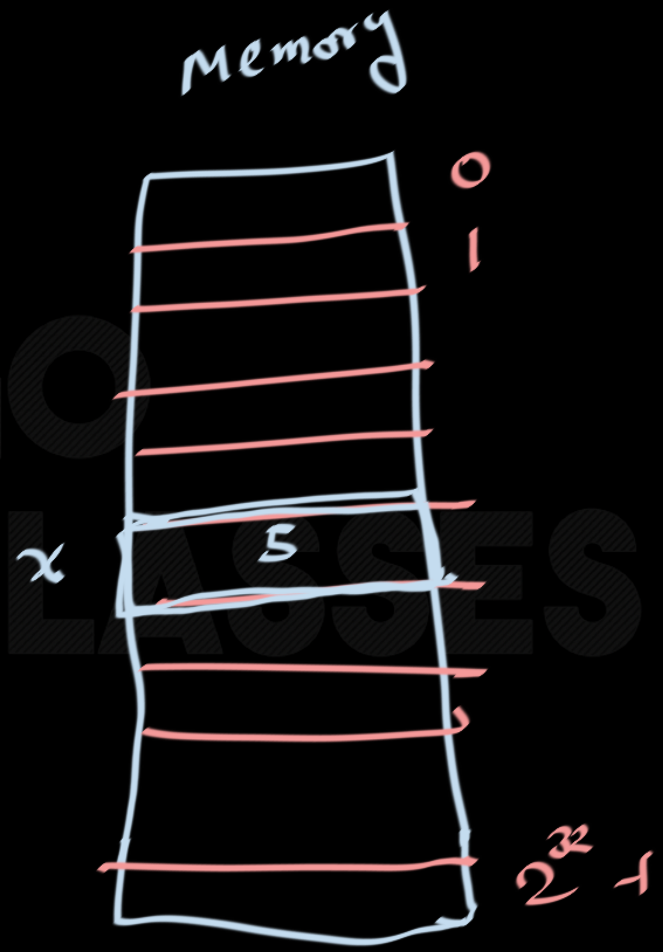
- float(4 Bytes)
- double(8 Bytes)
- long double(10 Bytes)

Assigning values to variables

variable names

```c
int final_value = 100;
char yes = 'x';
double balance = 75.84;
```

int x = 5;



Format specifiers

- char %c
- int %d
- unsigned int %u
- float %f

- Hexadecimal format %x
- addresses %p
- String %s

```c
#include <stdio.h>
int main() {

    int a = 5;

    printf(" %d ", a);

    return 0;
}
```

output _ 5 _

pen and paper

```
#include <stdio.h>
int main() {

    printf("3+2 equals %d and 3-2 equals %d \n", 3+2, 3-2);

    return 0;
}
```

output: 3+2 equals 5 and 3-2 equals 1

```c
#include <stdio.h>

int main(void){

    printf("If I have %d bills worth %d dollars each
            then I have %d dollars.",3,5,3*5);

    return 0;
}
```

int x = -5;

int a = 3;

Memory

int x = -5;

int a = 3;

Memory

011001

A brief detour to number system
(Details in Digital logic)

Decimal to Binary

ex. 29

$29 \div 2 = 14 \quad R = 1$

$14 \div 2 = 7 \quad R = 0$

$7 \div 2 = 3 \quad R = 1$

$3 \div 2 = 1 \quad R = 1$

$2^4 + 2^3 + 2^2 + 2^1 \times 0 + 2^0$

$16 + 8 + 4 + 1$

$= 29$

$\boxed{11101}$

$$29 = \underset{16}{2^4} + \underset{8}{2^3} + \underset{4}{2^2} + \underset{1}{2^0}$$

$$29 \rightarrow 11101$$

$$35 = 2^5 + 2 + 1$$

$$100011 \Leftarrow \underline{\underline{35}}$$

$$\begin{array}{r|ll}
2 & 35 & \\
\hline
2 & 17 & 1 \\
\hline
2 & 8 & 1 \\
\hline
2 & 4 & 0 \\
\hline
2 & 2 & 0 \\
\hline
 & 1 & 0
\end{array}$$

	Remainders
2 | 29	
2 | 14	1
2 | 7	0
2 | 3	1
2 | 1	1
0	1

Binary to Decimal

$2^4 \quad 2^3 \quad 2^2$

$1\ 0\ 0\ 0\ 1\ 1$

$2^5 \qquad 2^1 \quad 2^0$

$2^5 + 2^1 + 2^0$

$= 32 + 2 + 1$

$= \underline{\underline{35}}$

1	0	1	1	0	1
$\downarrow$	$\downarrow$	$\downarrow$	$\downarrow$	$\downarrow$	$\downarrow$
2^5	2^4	2^3	2^2	2^1	2^0

1	0	1	1	0	1
$\downarrow$	$\downarrow$	$\downarrow$	$\downarrow$	$\downarrow$	$\downarrow$
2^5	2^4	2^3	2^2	2^1	2^0

$32 + 8 + 4 + 1 = 45$

1 0 1 1 0 1

$$1 \times 2^0 = 1$$
$$0 \times 2^1 = 0$$
$$1 \times 2^2 = 4$$
$$1 \times 2^3 = 8$$
$$0 \times 2^4 = 0$$
$$1 \times 2^5 = 32$$

SUM → 45

Decimal ⇄ Binary ✓

```c
int a = 4;
```

```c
int a = 130;
```

```c
int a = -4;
```

2’s Complement System

2’s complement system

If number is positive –

Represent it in binary in usual way

If number is negative –

Represent it using 2’s complement

2’s complement system

MSb will indicate the sign of the number

- $0 \Rightarrow$ positive
- $1 \Rightarrow$ negative

2's Complement of number

How to compute the 2's complement of a number?

- Complement every bit of the number (1 → 0 and 0 → 1), and then add one to the resulting number

Example-

2’s complement of given binary `0100` ?

$$\begin{array}{r} 1011 \\ +\quad 1 \\ \hline 1100 \end{array}$$

$$0100 \xrightarrow{\text{complement}} 1011 \xrightarrow{+1} 1100$$

2's complement of 0100 is 1100.

Example

find 2's complement of 101101

$101101 \xrightarrow[\text{complement}]{} 010010 \xrightarrow[+1]{} 010011$ ✓

Examples

Represent 5 into 2's complement system ?

$5 \equiv \underline{00101}$

$5 \equiv \underline{0101}$

$5 \neq 101$ in 2's Complement System

Examples

Represent 5 into 2's complement system ?

$5 \equiv 00101$

$5 \neq 101$ in 2's complement System

$5 \equiv 0101$

we can not represent 5 using 3 bits in 2's complement system.

Examples(Contd..)

Represent -5 into 2's complement system ?

Memory

$\boxed{1011}$

int a = -5;

$5 \rightarrow 0101 \xrightarrow[\text{complement}]{\text{2's}} 1011$

$$\begin{array}{r} 1010 \\ 1 \\ \hline 1011 \end{array}$$

int a = -5;

$\boxed{1011}$

Question 1

GATE CSE 2019 | Question: 4

14

In 16-bit 2's complement representation, the decimal number -28 is:

A. 1111 1111 0001 1100
B. 0000 0000 1110 0100
C. 1111 1111 1110 0100
D. 1000 0000 1110 0100

GATE CSE 2019 | Question: 4

14

In 16-bit 2's complement representation, the decimal number −28 is:

A. 1111 1111 0001 1100
B. 0000 0000 1110 0100
C. 1111 1111 1110 0100
D. 1000 0000 1110 0100

28 in binary is 0000 0000 0001 1100

1111 1111 1110 0011
+ 1

1111 1111 1110 0100

Question 2

GATE CSE 2000

The number 43 in $2's$ complement representation is

A. 01010101
B. 11010101
C. 00101011
D. 10101011

$32 + 8 + 2 + 1$

2^5 2^4 2^3 2^2 2^1 2^0

0 0 1 0 1 0 1 1

Question 2

GATE CSE 2000

The number 43 in $2's$ complement representation is

A. 01010101
B. 11010101
C. 00101011
D. 10101011

$32 + 8 + 2 + 1$

$2^5 \quad 2^4 \quad 2^3 \quad 2^2 \quad 2^1 \quad 2^0$

0 0 1 0 1 0 1 1

01010111 $\xrightarrow{\text{2's complement}}$ 10101001

Question 3

GATE CSE 2002

The $2's$ complement representation of the decimal value -15 is

15 ≡ 01111

A. 1111
B. 11111
C. 111111
D. 10001

Question 3

GATE CSE 2002

The $2's$ complement representation of the decimal value -15 is

A. 1111
B. 11111
C. 111111
D. 10001

15 ≡ 01111
10000
+ 1
10001

$$10001 \xrightarrow{\quad} 2^4 + 2^0 = \underline{\underline{17}}$$

(usual binary)

$$10001 \xrightarrow{\quad} -15$$

??

(signed number)

2's Complement to Decimal

- Method1
- Method2

$10001 \longrightarrow -15$

Method1

-2^3 $\quad 2^0$

$$0101 \;=\; -0\cdot 2^3+1\cdot 2^2+0\cdot 2^1+1\cdot 2^0 \;=\; 0+4+0+1 \;=\; 5$$

1011

Method1

$$0101 = -0 \cdot 2^3 + 1 \cdot 2^2 + 0 \cdot 2^1 + 1 \cdot 2^0 = 0 + 4 + 0 + 1 = 5$$

-2^3

$$1011 = -1 \cdot 2^3 + 0 \cdot 2^2 + 1 \cdot 2^1 + 1 \cdot 2^0 = -8 + 0 + 2 + 1 = -5$$

$$-2^4 \quad\quad 2^0$$

$$10001$$

$$-2^4 \times 1 + 2^0$$

$$= -16 + 1$$

$$= -15$$

$28 \equiv$ 01 1100

$-28 \equiv$ 10 0011

$+ \quad\quad\quad 1$

100100

$\overset{-2^5}{1}00\overset{2^2}{1}00 \longrightarrow$??

(signed)

$-2^5 + 2^2 = -32 + 4 = -28$

usual binary $\quad 2^5 + 2^2 = 32+4$

$= 36$

Method2

- If the number is positive (the most significant bit is **0**), convert the number into decimal format normally.

- If the number is negative –

  Take 2's complement of number and then convert to decimal

  Put the minus sign.

Method 2

$0\overset{2^2}{1}0\overset{2^0}{1}$ if number is positive

then convert usually $\Rightarrow$ $2^2 + 2^0 = 5$

GO CLASSES

Another example : 1101

if the number is negative then take 2's complement

$$1101 \xrightarrow[\text{2's complement}]{} \begin{array}{r} 0010 \\ +\quad 1 \\ \hline 0011 \end{array} \rightarrow -3$$

Example 3

$$1011 \rightarrow \begin{array}{r} 0100 \\ +\ \ \ 1 \\ \hline 0101 \end{array} \rightarrow -5$$

since it is negative

take 2's compl.

Method 1

$-2^5 \quad 2^2$

100100 $\longrightarrow$??

(signed)

$-2^5 + 2^2 = -32 + 4 = -28$

Method 2

10 0100

since it is neg. 2's C.

$$\begin{array}{r} 011011 \\ + \quad\quad 1 \\ \hline 011100 \end{array}$$

$2^4\ 2^3\ 2^2$

$16 + 8 + 4 = -28$

Method2

$$0101 \quad = \quad 0 \cdot 2^3 + 1 \cdot 2^2 + 0 \cdot 2^1 + 1 \cdot 2^0 \quad = \quad 0 + 4 + 0 + 1 \quad = \quad 5$$

$$1011 \quad = \quad 0101 \quad -5$$

27

Here is the process to convert a negative two's complement number back to decimal:

(1) flip all the bits,

Method 2

(2) add 1, and

(3) interpret the result as a binary representation of the magnitude and add a negative sign

So, for your example, we have:

$$1111\ 1111\ 1011\ 0101 \xrightarrow{(1)} 0000\ 0000\ 0100\ 1010 \xrightarrow{(2)} 0000\ 0000\ 0100\ 1011 \xrightarrow{(3)} -75$$

It looks like you wrote the wrong binary and meant:

$$1111\ 1111\ 1011\ 1011\ 0101 \xrightarrow{(1)} 0000\ 0000\ 0100\ 0100\ 1010 \xrightarrow{(2)} 0000\ 0000\ 0100\ 0100\ 1011 \xrightarrow{(3)} -1099$$

Of course, in Hex, you can invert all the bits and add 1 and take a negative magnitude.

Regards

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edited Jan 24, 2013 at 0:52

answered Jan 24, 2013 at 0:45
Amzoti
55.6k 25 76 111

Given a representation in bit form 1010, what is the corresponding value ?

1010

Given a representation in bit form 1010, what is the corresponding value ?

$2^3 \; 2^1$

What do you mean ? - unsigned or signed ?

Unsigned – $2^3 + 2^1 = 8 + 2 = 10$

Signed (assuming 2s complement form) - $-2^3 + 2^1 = -8 + 2 = -6$

What You Know

Unsigned Decimal $\rightleftarrows$ Binary ✓

Signed Decimal $\rightleftarrows$ 2's compl Binary

2 methods

$5 \xrightarrow{\text{(usual) Binary}} 101$

$5 \xrightarrow{\text{2's Comp. Binary system}} 0101$ (101 is wrong)

Copying Number to higher bit representation

- Copying Unsigned Number (zero extension)-

0101 4 bit

we want to copy it to 8 bits

_ _ _ _ 0101

Copying Number to higher bit representation

- Copying Unsigned Number (zero extension)-

0101 4 bit

we want to copy it to 8 bits

0 0 0 0

0101

(ALWAYS fill with zeros)

Question

1010 4 bit unsigned number

Copy it to 8 bits

Always zeros

$\boxed{\underline{0}\ \underline{0}\ \underline{0}\ \underline{0}\ 1010}$

Copying Number to higher bit representation

- Copying signed Number (sign extension)–

Need to copy sign bit (0 or 1) as it is

eight-bit representation of some integer: 1001 0110

Copying Number to higher bit representation

- Copying signed Number (sign extension)–

    Need to copy sign bit (0 or 1) as it is

eight-bit representation of some integer: 1001 0110

copy it to 9-bits

$\boxed{\_\ 1001\ 0110}$

??

-2^7

1001 0110

1 1001 0110

-2^8 2^7

$$-2^8 + 2^7 = 2^7(-2+1) = -2^7$$

-2^7

1001 0110 $\equiv$ 1 1001 0110 $\equiv$ 11 1001 0110

$$-2^9 + 2^8 + 2^7$$

$$-2^2 \cdot 2^7 + \underline{2 \cdot 2^7 + 2^7} = -2^7$$

Copying Number to higher bit representation

- Copying signed Number (sign extension)–

  Need to copy sign bit (0 or 1) as it is

eight-bit representation of some integer: 1001 0110

9-bit representation of the same integer: **1** 10010110

Copying Number to higher bit representation

- Copying signed Number (sign extension)–

Need to copy sign bit (0 or 1) as it is

eight-bit representation of some integer: 1001 0110

9-bit representation of the same integer: 1 10010110

eight-bit representation of some integer: 0101 0110

9-bit representation of the same integer: ________

Copying Number to higher bit representation

- Copying signed Number (sign extension)–

Need to copy sign bit (0 or 1) as it is

eight-bit representation of some integer: 1001 0110

9-bit representation of the same integer: **1** 10010110

eight-bit representation of some integer: 0101 0110

9-bit representation of the same integer: 0 0101 0110

Signed numbers

101101 → 1111 101101

10 bits

0100101 → 000 0100101

10 bits

Copying Number to higher bit representation

- Copying signed Number (sign extension)–

  Need to copy sign bit (0 or 1) as it is

eight-bit representation of some integer: 1001 0110
9-bit representation of the same integer: **1** 10010110

eight-bit representation of some integer: 0101 0110
9-bit representation of the same integer: **0** 01010110

Signed

4-bit	8-bit	16-bit	Decimal
0111			
1110			

4-bit	8-bit	16-bit	Decimal
0111	00000111	0000000000000111	+7
1110	11111110	1111111111111110	-2

$-2 + 0 = -2$

Question 4

GATE CSE 2002

Sign extension is a step in

A. floating point multiplication
B. signed 16 bit integer addition
C. arithmetic left shift
D. converting a signed integer from one size to another

Min and Max number in Unsigned form with k bits

_ _ _ _ } → unsigned

min 0

max 15

_ _ _ _ } → signed

min

max

Min and Max number in signed (2C) form with k bits

Question 5

GATE CSE 2013

The smallest integer that can be represented by an 8-bit number in $2's$ complement form is

A. -256
B. -128
C. -127
D. 0

Question 6

GATE CSE 1994

Consider n-bit (including sign bit) $2's$ complement representation of integer numbers. The range of integer values, N, that can be represented is ______ $\leq N \leq$_____ .

Question 7

GATE CSE 2005 ISRO2009-18, ISRO2015-2

The range of integers that can be represented by an n bit $2's$ complement number system is:

A. -2^{n-1} to $(2^{n-1} - 1)$

B. $-(2^{n-1} - 1)$ to $(2^{n-1} - 1)$

C. -2^{n-1} to 2^{n-1}

D. $-(2^{n-1} + 1)$ to $(2^{n-1} - 1)$