Mini Lesson #1

Computer Number Systems & Recursive Functions

Binary & Decimal Number System

Have you heard of computer number systems before?

Systems that relate unique symbols to specific values, and this technique is used to represent and manipulate numbers in computer science.

A number system must have unique symbols for every value, be consistent, provide comparable values, and be easily reproducible. No repeats!

What number systems do computers use?

- Decimal (Base 10)
- Binary (Base 2)
- Octal (Base 8)
- Hexadecimal (Base 16)

Decimal (Base 10)*

In this system we use numbers from 0 to 9 and form other numbers with them. They are integers as we know them.

0 1 2 3 4 5 6 7 8 9

*Base 10 means writing numbers using 10 different digits.

Binary (Base 2)

Computers use the system which consists of 0 and 1 to do their operations. 0 means closed (false), 1 means open (true), they make up many combinations with them to do their transactions.

How do we count in binary?

0
1
10
11
100
101
110

(the moment you get to 11, it is like when you go from 9, which zero 0's to 10, you need to start again at 1, except this time with another 0).

Can you guess what would come next?

This is *counting* in binary, do you know how to *convert* any decimal number into binary without counting from the beginning?

Decimal numbers are base **10**, binary numbers are base **2**.

$2^0 = 1$ $2^2 = 4$ $2^4 = 16$ $2^6 = 64$

$2^1 = 2$ $2^3 = 8$ $2^5 = 32$ $2^7 = 128$

Converting from Decimal to Binary

If you wanted to know what 10 is in binary…

1) What is the number you can raise 2 to that gives you the greatest possible number less than or equal to 10?
   a) Answer: 3
      $2^3 = 8$ (8 is the greatest possible number less than 10 for base 2)
2) Subtract the number from 10.
   a) Answer: 2
      10 - 8 = 2
3) What is the next number you can raise 2 to that gives you the greatest possible number less than or equal to 2 now?
   a) Answer: 1
      $2^1 = 2$ (2 is less than or equal to 2)
4) Subtract that number from 2.
   a) Answer: 0
      2-2 = 0

It is good to visualize it this way:

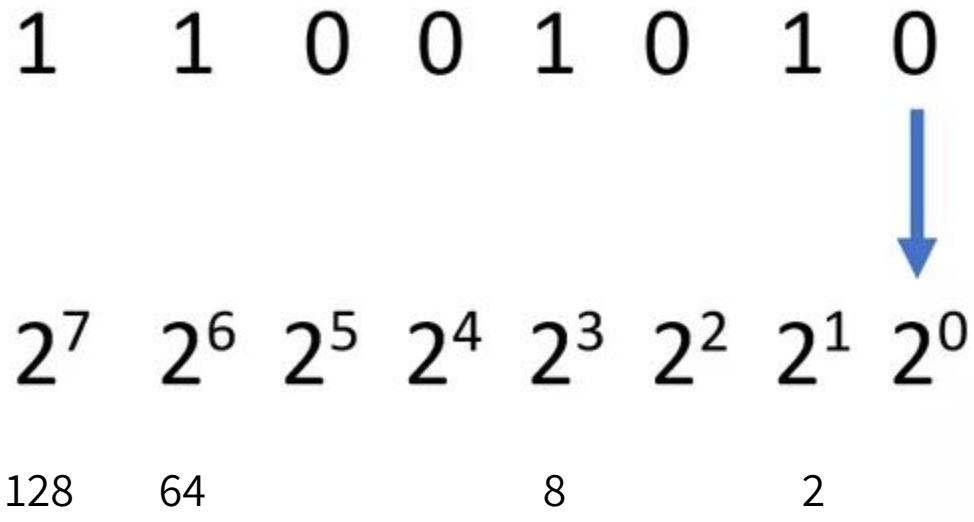
2^3	~~2^2~~	2^1	~~2^0~~
1	0	1	0

Whatever powers of 2 we don't use add a 0! Ignore the ones that are greater than 2^3.

Answer: 1010

What number is this in decimal?

Answer: 202



Converting Letters to Binary

Every symbol and letter on a keyboard has a corresponding ASCII value (American Standard Code for Information Interchange)!

ASCII Code: Character to Binary

0	0011 0000	O	0100 1111	m	0110 1101
1	0011 0001	P	0101 0000	n	0110 1110
2	0011 0010	Q	0101 0001	o	0110 1111
3	0011 0011	R	0101 0010	p	0111 0000
4	0011 0100	S	0101 0011	q	0111 0001
5	0011 0101	T	0101 0100	r	0111 0010
6	0011 0110	U	0101 0101	s	0111 0011
7	0011 0111	V	0101 0110	t	0111 0100
8	0011 1000	W	0101 0111	u	0111 0101
9	0011 1001	X	0101 1000	v	0111 0110
A	0100 0001	Y	0101 1001	w	0111 0111
B	0100 0010	Z	0101 1010	x	0111 1000
C	0100 0011	a	0110 0001	y	0111 1001
D	0100 0100	b	0110 0010	z	0111 1010
E	0100 0101	c	0110 0011	.	0010 1110
F	0100 0110	d	0110 0100	,	0010 0111
G	0100 0111	e	0110 0101	:	0011 1010
H	0100 1000	f	0110 0110	;	0011 1011
I	0100 1001	g	0110 0111	?	0011 1111
J	0100 1010	h	0110 1000	!	0010 0001
K	0100 1011	I	0110 1001	'	0010 1100
L	0100 1100	j	0110 1010	"	0010 0010
M	0100 1101	k	0110 1011	(	0010 1000
N	0100 1110	l	0110 1100	)	0010 1001
				space	0010 0000

What do you think “CS” would be in binary?

Clue: Check out the ASCII Table on GC if you haven’t already!

Solution

1) Figure out what “CS” is in ASCII code.
2) Take those numbers and convert them to binary.

67	83
$2^6 \ldots 2^1\ 2^0$	$2^6 \ldots 2^4 \ldots 2^1\ 2^0$
1000011	1010011

For example:

72-64=8-8=0 105-64=41-32=9-8=1-1=0

“Hi” => “H” “i” => 72 105 => **72** = 2^6, which is 64, + 2^3, which is 8; **105** = $2^6 + 2^5$, which 32, $+2^3 + 2^0$ => 2^6 ~~2^5~~ ~~2^4~~ 2^3 ~~2^2~~ ~~2^1~~ ~~2^0~~ 2^6 2^5 ~~2^4~~ 2^3 ~~2^2~~ ~~2^1~~ 2^0

1 0 0 1 0 0 0 1 1 0 1 0 0 1