LIS-3353

From Numbers to Thinking:
The Concepts, Illustrated

HUGE CONCEPT #1

All computers do is "numbers"

- you put numbers into them
- it messes with the numbers
- it gives you some numbers back

Binary System

0 and 1

How many light switches..

..would it take to store “what season is it?”

A minimum of 2:

Winter	OFF-OFF	00
Fall	OFF-ON	01
Spring	ON-OFF	10
Summer	ON-ON	11

Consider this

5

Humans counting!

Humans counting!

In the beginning, there was...probably just a buncha lines, right?

THEN....Tally Marks

THEN ...Roman Numerals

THEN..Arabic Numerals

Humans counting!

In the beginning, there was...probably just a buncha lines, right?

THEN....Tally Marks

THEN ...Roman Numerals

V

THEN..Arabic Numerals?

Humans counting!

In the beginning, there was...probably just a buncha lines, right?

THEN....Tally Marks

THEN ...Roman Numerals

V

THEN..Arabic Numerals

uh... 5.

Humans counting!

THEN...

Arabic Numerals

and (this is huge)

“Place Value”

Humans counting!

THEN...

Arabic Numerals

and (this is huge)

“Place Value”

05.00

Let’s get weird:

Let’s get weird:

5

V

5.0

2 + 3

Let's get weird:

5

V

5.0

2 + 3

cinco

"five"

"dedos en su mano"

"number of fingers on one hand for the majority of people."

.

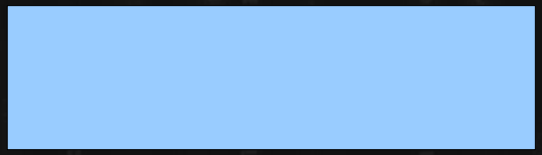
.

```
101    (wtf)
```

Place Value

Arabic numerals include ZERO.
This is important for two related reasons:

ONE: Sometimes you want to talk about nothing.
TWO: This enables place value. That is, 10 unique symbols, but both SYMBOL and its LOCATION are important: (would you take the following salary?)



101 (Dalmatians)

(100s) (10s) (1s)

100x1 + 10x0 + 1x1

(10^2)x1 + (10^1)x0 + (10^0)x1

“101” (fingers)

(4s) (2s) (1s)

4x1 + 2x0 + 1x1

(2^2)x1 + (2^1)x0 + (2^0)x1

decimal (base 10) v. binary (base 2)

0	1	2	3	4	5	6	7	8	9	10	11
0	1	10	11	100	101	110	111	1000	1001	1010	1011

Let's get even weirder...

So, decimal is good because "people,

Binary is good because computers.

What about both?
(e.g, something "binary-like"
but also "compact and easy to read?"

Let's get even weirder...

We need a power of 2 that's close to 10.

Could do 8, but why not go with 16?'

We just need 6 more familiar symbols...

hexadecimal.

(6 + 10)

decimal (base 10) v. binary (base 2) v. hexadecimal (base 16)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0	1	10	11	100	101	110	111	1000	1001	1010	1011	...						
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	10	11	12

Quick Binary Review and some bad jokes

How many fingers and toes do you have?

In Base Ten(10) or Decimal?

20

(Twenty)

10x2 + 1x0

Quick Binary Review and some bad jokes

How many fingers and toes do you have?

In Base Two (2) or Binary?

10100

- 16x1 8x0 4x1 2x0 1x0

Quick Binary Review and some bad jokes

How many fingers and toes do you have?

In Base Sixteen (16) or Hexadecimal?

14

$16 \times 1 + 1 \times 4$

Place Value

Decimal	4-bit Binary	Hexadecimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F
16	0001 0000	10 (1+0)
17	0001 0001	11 (1+1)

The jokes...

“There are 10 kinds of people, those who understand binary, and those who don't.”

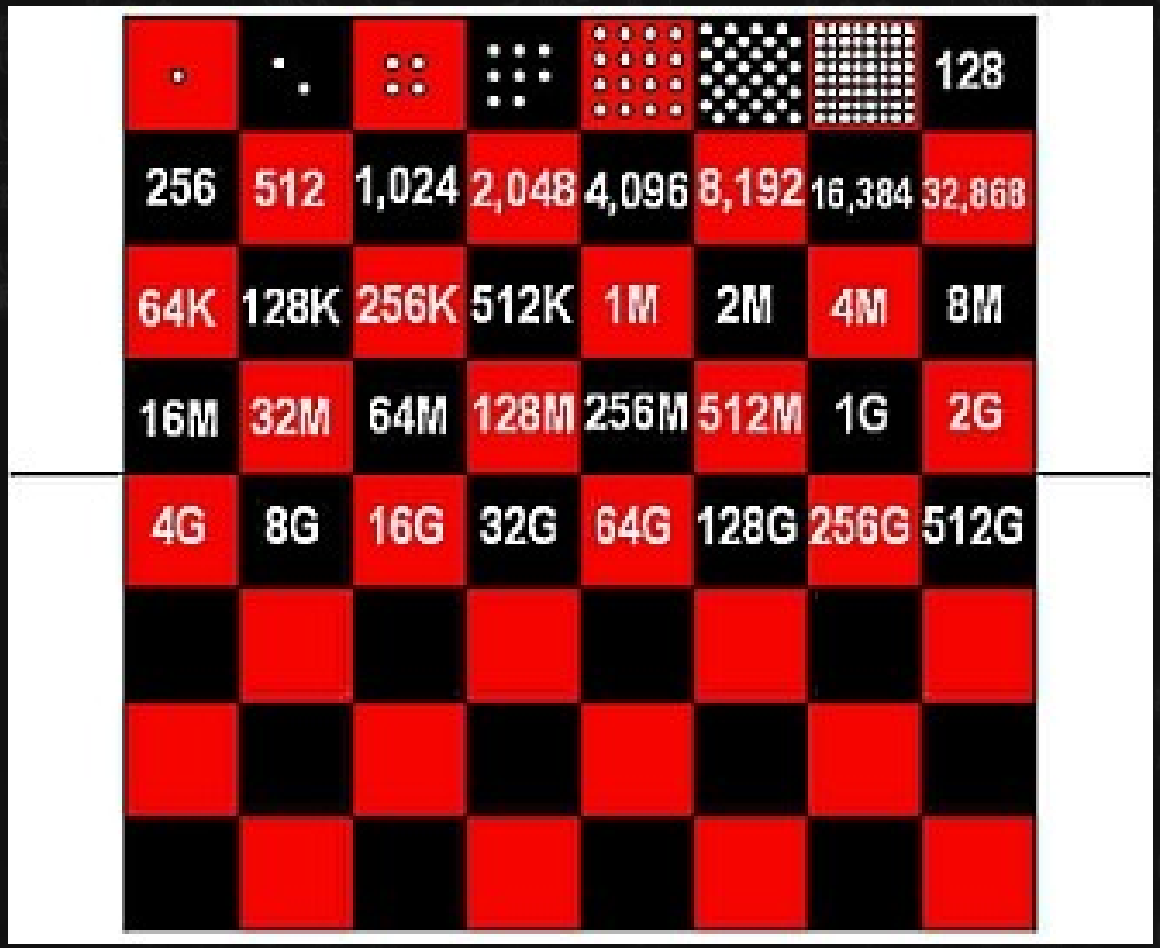
If you want to get technical, ALL bases are Base 10.

Is Binary Enough?

(exponential growth and the legend of Paal Paysam)

Is Binary Enough?

(exponential growth and the legend of Paal Paysam)



2^{1}	=	2	2^{11}	=	2,048	2^{21}	=	2,097,152
2^{2}	=	4	2^{12}	=	4,096	2^{22}	=	4,194,304
2^{3}	=	8	2^{13}	=	8,192	2^{23}	=	8,388,608
2^{4}	=	16	2^{14}	=	16,384	2^{24}	=	16,777,216
2^{5}	=	32	2^{15}	=	32,768	2^{25}	=	33,554,432
2^{6}	=	64	2^{16}	=	65,536	2^{26}	=	67,108,864
2^{7}	=	128	2^{17}	=	131,072	2^{27}	=	134,217,728
2^{8}	=	256	2^{18}	=	262,144	2^{28}	=	268,435,456
2^{9}	=	512	2^{19}	=	524,288	2^{29}	=	536,870,912
2^{10}	=	1,024	2^{20}	=	1,048,576	2^{30}	=	1,073,741,824

Why is this important?

Why is this important?

1) Exponential Growth

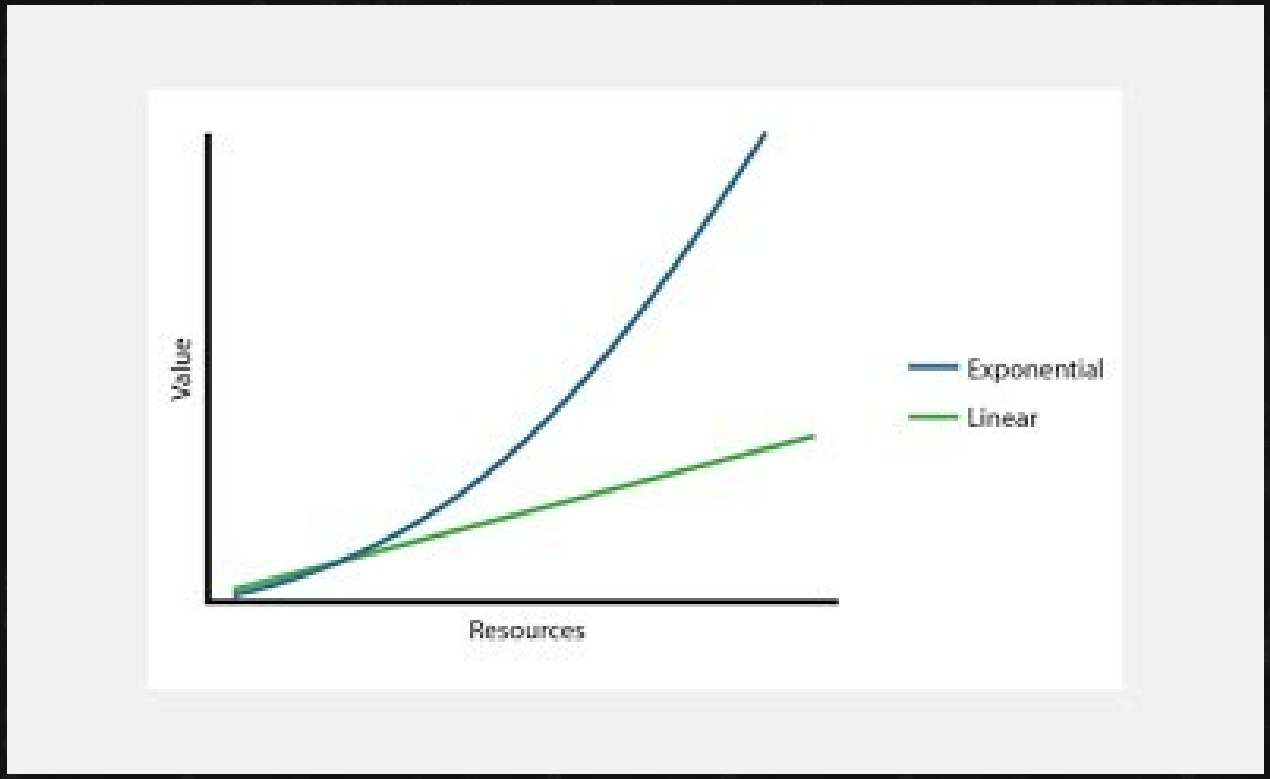
2) The “shape” of computer numbers.

Exponential growth =
Wide range of possibilities

Exponential REDUCTION =
“Easy to specify things”

Why is this important?

1) Exponential Growth (and reduction)
e.g. perception of volume



The “shape” of computer numbers

e.g. – 128, 256, 1024, etc.

(why hard drive sizes are “wrong”)

Also, computer gibberish?

Like bitcoin addresses?
(3kKno34bvEl...?) –
base 64 numbers

Or Blue screens of death?
(923E0BC902...)
base 16 numbers.

Where this comes up today...

IP addresses -

MAC addresses

(are more similar than you thought)

Where this comes up today...

IP addresses:

127.0.0.1

192.168.0.1

146.201.195.214

Where this comes up today...

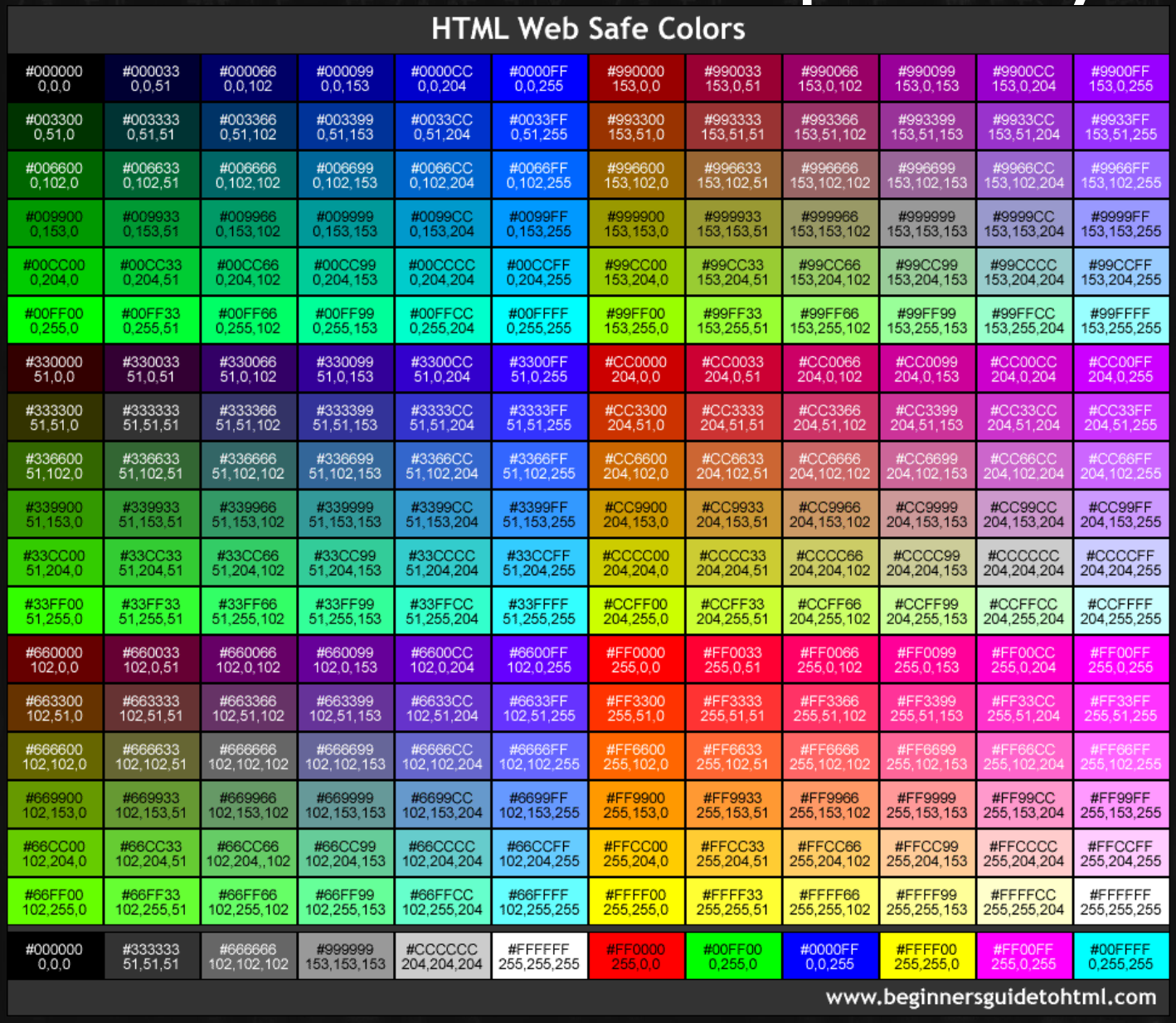
0-255!

BUT, MAC addresses are like:
ac:d5:b8:c0:e1:03

0-FF?

SAME THING! See, also RGB Colors!

Where this comes up today...



LIS-3353

From Instructions to AI

HUGE CONCEPT #2

All computers do is follow a very precise list of instructions that one or more people wrote.

Understanding Power

```
10 PRINT “John is AWESOME”;
20 GOTO 10
```

Teaching the robots to escape

1) If there's a door in arms-reach, exit – you're done, else

2) If you can, take one step forward then goto 1), else

3) Rotate to the left until there's not a wall in front of you then goto 1)

(this will get you out of any “regular” empty room)

An almost random bit on recursion

- In computers, it's actually okay to define something with itself.

  PSUEDOCODE!

  Define function=”EscapeFromRoom”{

  1) If there's a door in arms-reach, exit – you're done, else

  2) If you can, take one step forward then EscapeFromRoom, else

  3) Rotate to the left until there's not a wall in front of you then EscapeFromRoom

  }

  (this will get you out of any “regular” empty room)

Go to the store; if they have 2% lactose free chocolate milk, then get me a carton.

Misusing Power

```
go to the store;

if  [[ they have 2% lactose free
chocolate milk]]

then

      get me a carton.
```

The Magic Genie
Recursion, trees, and "crowdsourcing"

{0) Start with "Is it Batman"?}

1) Ask my (yes/no) questions down the tree

2) If win, "yay"

3) If lose, add/replace new last question to one for which my guess was wrong and her guess was right *(optionally, try to be general or"half-y"?)*

- repeat until genius

The Magic Genie
(can be used for evil too...)

- What about instead of

  “Is your person a DC character?”

  you ask real questions about real people?

  (more on this later, but this demonstrates why surveillance is easy and anonymity is hard.)