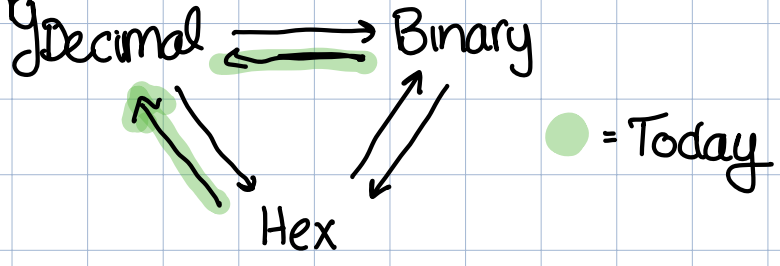
Agenda

Professor Hamlin

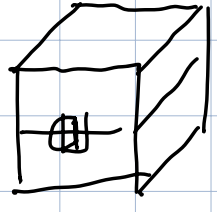
Day 1

1) CS1800 Logistics
2) Math as fun - box, eve, and two locks
3) Topics
   - (All your) bases (belong to us) - Bin/Hex
   - Converting



Math as fun

Alice has a secret they want to share with Bob, but can only pass messages through Evesdropping Eve.



1) Locking box
2) Two padlocks w/ keys (Alice has on Bob Another)

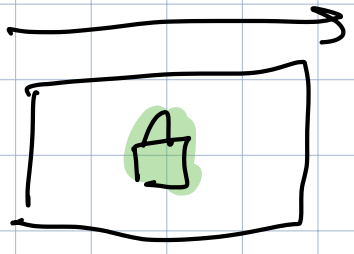
How can Alice get her secret to Bob without Eve learning?

Work on this in groups - also think how you approached this problem and how it made you feel?

Alice

1)

3) remove her lock



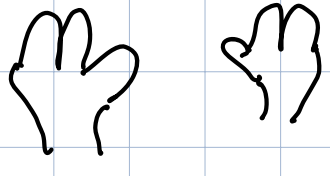
Bob can now open it

Decimal - Give me a few examples of (base-10) numbers?

10

19, 17, 101, etc.

What if we had 3 fingers or 8?



base-6

base-16

Count to 13 in base-10

0 1 2 3 4 5 6 7 8 9 10 11 12 13

Count to 13_6 in base-6

0 1 2 3 4 5 10 11 12 13$_6$

0 1 2 3 4 5 6 7 8 9

6 + 3

	Digits
Base 10	0-9
Base 6	0-5

We can think about any base, but we mostly use Binary (base 2) and Hex (base 16)

Base 10	0-9
Base 6	0-5
Base 2	0, 1
Base 16	0-9 ??

why? Because comp run on electricity
0 (off) 1 (on)

Binary

101110_2 ← use subscript to say 'base-2'

Counting in binary

Dec ← Bin
↑
Hex

Base 10	0	1	2	3	4	5	6	7
Base 2	0	1	10	11	100	101	110	111

Let's back up a step:

X^0 is always 1

$1982 \rightarrow 1 \cdot 1000 + 9 \cdot 100 + 8 \cdot 10 + 2 \cdot 1$

$1 \cdot 10^3 + 9 \cdot 10^2 + 8 \cdot 10^1 + 2 \cdot 10^0$

we use 10 because this is base 16

So back to base-2 - 1110_2

Bin	Dec
1_2	2^0
10_2	2^1
100_2	2^2
1000_2	2^3

↑

$1110 \rightarrow 0 \cdot 1_2$

$1 \cdot 10_2$

$1 \cdot 100_2$

$1 \cdot 1000_2$

$1 \cdot 1000_2 + 1 \cdot 100_2 + 1 \cdot 10_2 + 0 \cdot 1_2$

$1 \cdot 2^3 + 1 \cdot 2^2 + 1 \cdot 2^1 + 0 \cdot 2^0$

$8 + 4 + 2 + 0$

14

Bin → Dec

1. Break down binary into digits
2. what digits represent in powers of 2
3. Add up to get decimal

What is 10110_2? (work together in groups)

$1 \cdot 10000_2 + 0 \cdot 1000_2 + 1 \cdot 100_2 + 1 \cdot 10_2 + 0 \cdot 1_2$

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

$16 + 4 + 2$

$\boxed{22}$

Vocab alert

Bit - single binary digit (0/1)

Byte - 8 bits e.g. Megabyte

Hex - base - 16

Remember

Base 10	0 - 9
Base 6	0 - 5
Base 2	0 - 1
Base 16	??

We have more than 10 digits - need more characters!

Base-10	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Base-16	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

So BED_{16} is a valid hex number!

What is it in decimal?

$$BED_{16} = B \cdot 100_{16} + E \cdot 10_{16} + D \cdot 1_{16}$$
$$11 \cdot 16^2 + 14 \cdot 16^1 + 13 \cdot 16^0$$
$$2816 + 224 + 13$$

3053

$1_{16} = 16^0$

$10_{16} = 16^1$

$100 = 16^2$

$1000_{16} = 16^3$

Why Hex? $16 = 2^4$ (useful later for Hex ⇔ Bin)

Can represent Bigger number in fewer digits

2 Hex is one byte

what is $12BA_{16}$?

$$1 \cdot 1000_{16} + 2 \cdot 100_{16} + B \cdot 10_{16} + A \cdot 1_{16}$$
$$1 \cdot 16^3 + 2 \cdot 16^2 + 11 \cdot 16^1 + 10 \cdot 16^0$$

4794

Practice!

1 2 4 8 16 32

1) What is the smallest and largest decimal number can represent w/ 3 bits? 4 bits?
(Hint try listing them all out)

111
7
$2^2 + 2^1 + 2^0$

1111 = 1000 + 111
15
$2^3 + 7 + 16 = 31$
$8 \quad 7 = 15$

2) How about w/ 2 digit base-6 numbers

0_6 to 55_6 in dec?

0_{10} $\quad 5 \cdot 6^1 + 5 \cdot 6^0$

35 $\quad = 36 - 1$

Extra fun: is the largest decimal num.
1) What ~~are all the values~~ you can represent w/ N-binary digits?

hint: start w/ 6-digits, 7-digits, see if you can see a pattern

3-digit - 7
4-digits - 15
5-digits - 31
6-digits - 63
....
$2^N - 1$

2) Same as above but now in base-b?