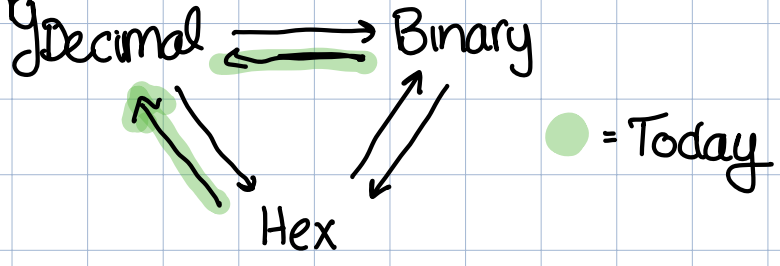
Agenda

Professor Hamlin

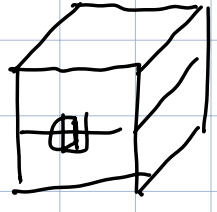
Day 1

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

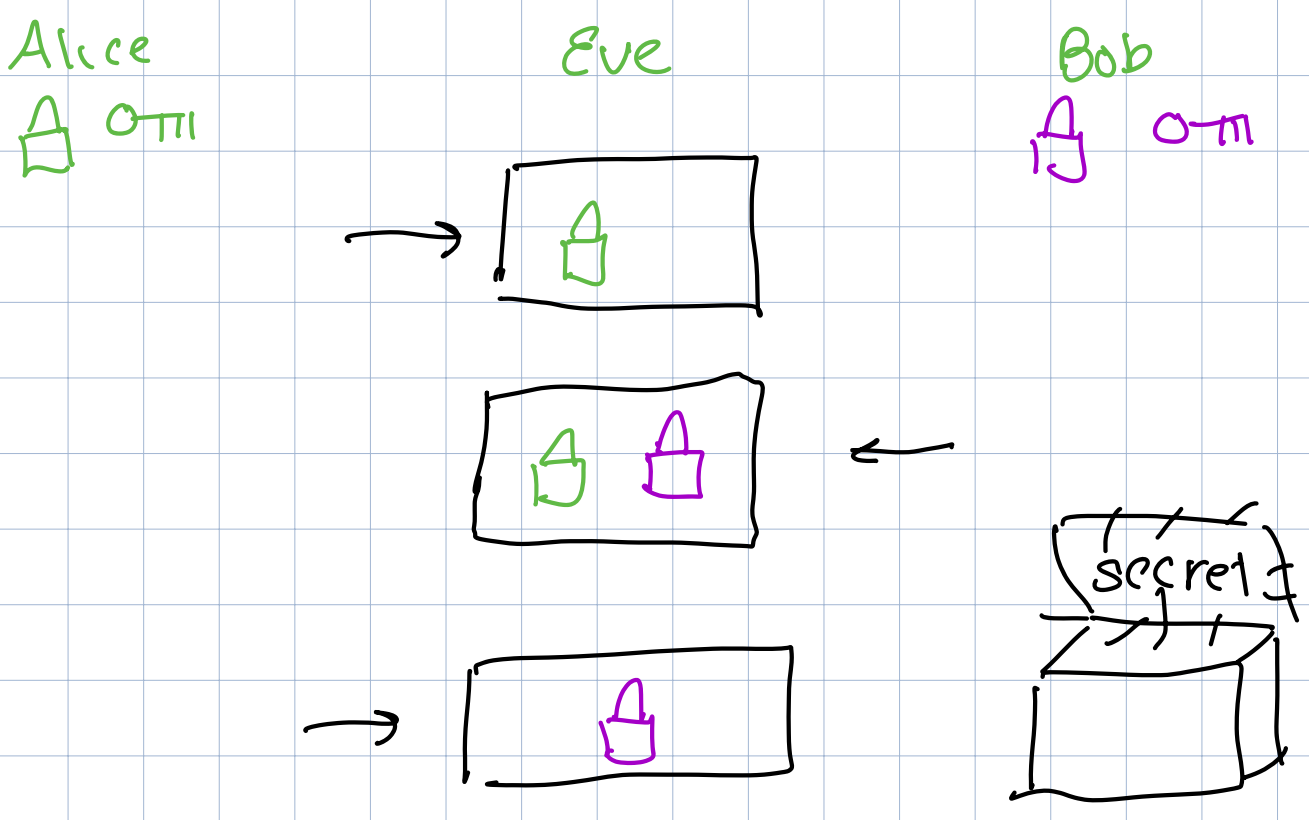
Alice has a secret they want to share with Bob, but can only pass messages through Evesdropping Eve.



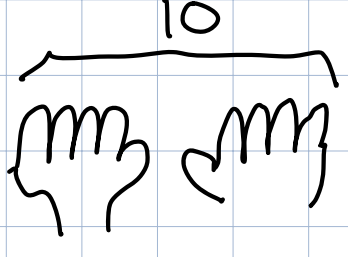
1) Locking box
2) Two padlocks w/ keys (Alice has on Bob Another)

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?

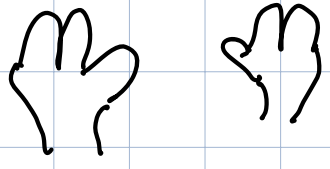


Decimal - Give me a few examples of (base-10) numbers?



19, 17, 101, etc., 42

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

0_{10} 1_{10} 2_{10} 3_{10} 4_{10} 5_{10} 6_{10} 7_{10} 8_{10} 9_{10}

	Digits
Base 10	0 - 9
Base 6	0 - 5

We can think about any base, but we mostly use Binary and Hex

(base 2) (base 16)

Base 10	0 - 9
Base 6	0 - 5
Base 2	0, 1
Base 16	0, 9 .. ?? → will cover soon

why? Binary b/c run on electricity

0 (off) vs 1 (on)

Binary

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

Counting in binary

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 →
$1 \cdot 1000$
$9 \cdot 100$
$8 \cdot 10$
$2 \cdot 1$

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

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

we use 10 because this is base 16

So back to base-2 - 1110_2

1110_2 →
$1 \cdot 1000_2$
$1 \cdot 100_2$
$1 \cdot 10_2$
$0 \cdot 1_2$

Binary	Dec
1_2	$1 \cdot 2^0$
10_2	$2 - 2^1$
100_2	$4 - 2^2$
1000_2	$8 - 2^3$
10000_2	$2^4 - 16$

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

$1 \cdot 8 + 1 \cdot 4 + 1 \cdot 2 + 0 \cdot 1$

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

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What is 10110_2? (work together in groups)

1) break number into 1's 10's 100's etc
2) convert 1s 10s etc to base 10
3) add up everything

0s = power on base

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

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

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Vocab alert

Bit - single binary digit (0/1)
Byte - 8 bits e.g Megabyte

$\underbrace{01011110_2}_{\text{byte}}$

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?

Hex	Dec
1_{16}	$1 = 16^0$
10_{16}	$16 = 16^1$
100_{16}	16^2
1000_{16}	16^3

$BED_{16} = B \cdot 100_{16} + E \cdot 10_{16} + D \cdot 1_{16}$

$11 \cdot 16^2 + 14 \cdot 16^1 + 13 \cdot 16^0$

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Why Hex? $2^4 = 16$ (useful later for Bin $\leftrightarrow$ Hex conversion)

can store bigger numbers in less digits

Convert $12BA_{16}$ to decimal?

$1 \cdot 1000_{16} + 2 \cdot 100_{16} + B \cdot 10_{16} + A \cdot 1_{16}$

$1 \cdot 16^3 + 2 \cdot 16^2 + 11 \cdot 16 + 10 \cdot 1$

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Practice!

1) What is the smallest and largest decimal number can represent w/ 3 bits? 4 bits?

Hint 1: what is the largest decimal number w/ 3-digits? Now think base-2

Hint 2: Convert those numbers to base 10

3-bits

$0_2 - 111_2$

$0_{10} - 7_{10}$

4-bits

$0_2 - 1111_2$

$0_{10} - 15$

$1111_2 - 1 \cdot 1000_2 + 1 \cdot 100_2 + 1 \cdot 10_2 + 1 \cdot 1_2$ (7 = 8 + 7)

5 bits

$0_2 - 11111_2 = 31_{10}$ (16 + 15)

$8 + 7 = 15$

Largest and Smallest 2-digits in numbers using Base 6? Now, in Decimal? convert

$0 - 55 \rightarrow 5 \cdot 6^1 + 5 \cdot 6^0 = 35$

Extra fun:

1) What are all the values you can represent with 3 digits in base 6?

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