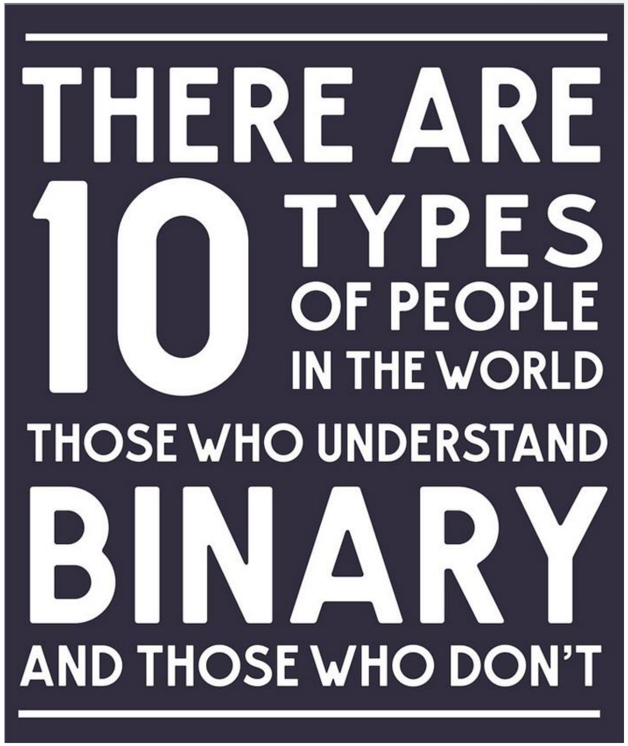


THERE ARE 10 TYPES OF PEOPLE IN THE WORLD

THOSE WHO UNDERSTAND BINARY AND THOSE WHO DON'T

CMPT 120

Lecture 30 – Computer Visions - Under the Hood

Binary Encoding

Last Lectures

- We continued our exploration of **Computer vision**
  - We started developing a **jellybean computer vision program** using the following concepts:
    - Problem-solving Strategies
      1. **Divide and conquer**
      2. **Incremental development and testing**
      3. **Debug as you go, using `print()` to inspect the value of your variables**
    - Added to lists with append
  - We recycled the idea of colour functions we created last time.

Today's Menu

- We continue our exploration of **Computer vision**
  - We shall finish developing a **jellybean computer vision program** using the following concepts:
    - Multiplying and dividing in Python with * and /
    - String formatting when we output float values

- Start looking ***under the hood*** of the computer and have a look at how the computer memory remembers!

Source: https://www.dreamstime.com/stock-photos-car-open-hood-hand-drawn-sketch-cartoon-illustration-image36401843

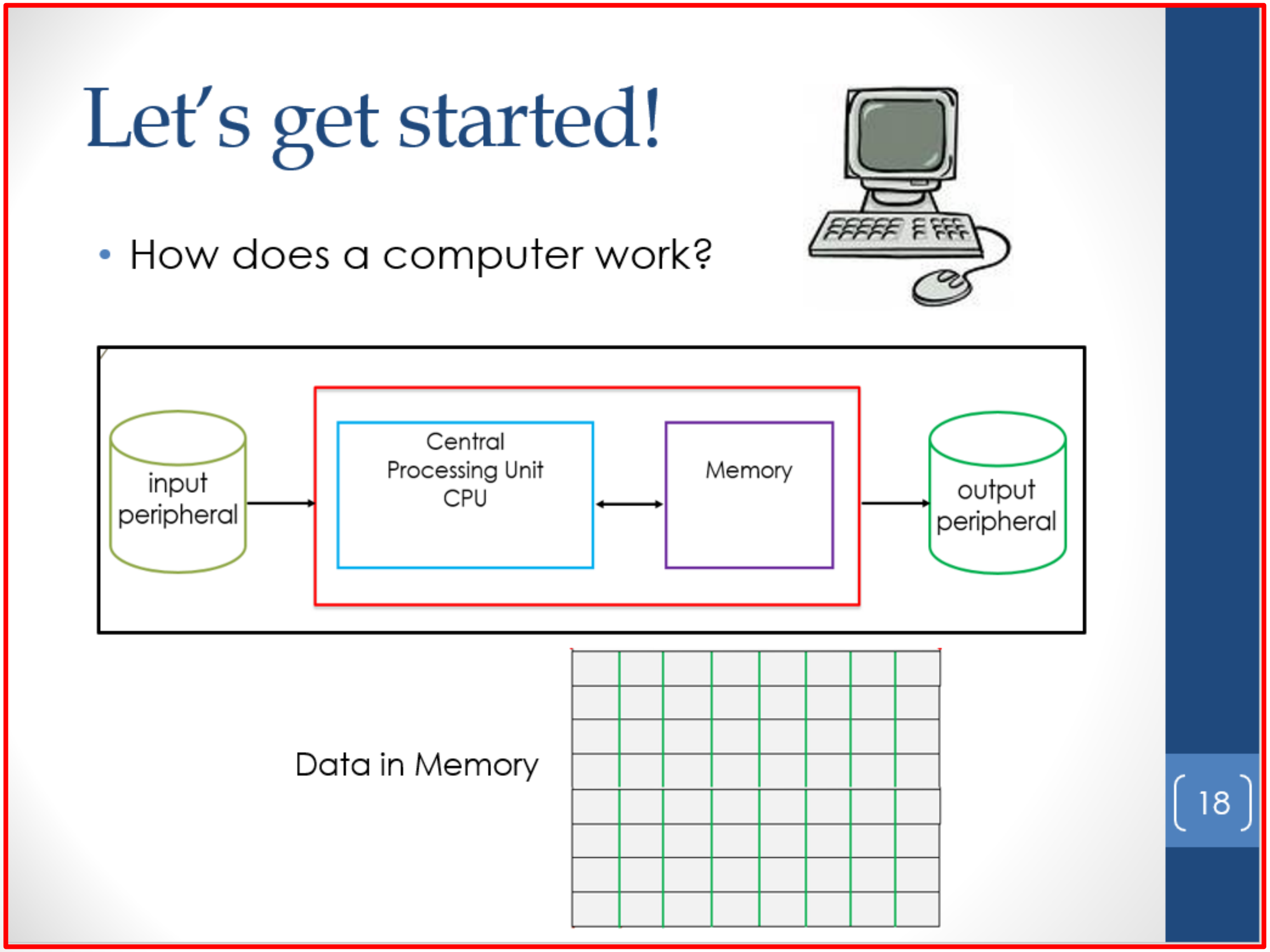
Under the hood!

Under the Hood

- Ever wonder how computers represent data?
  - You got it! -> Computers use 0’s and 1’s to represent everything

- In this module, we shall discover
  - Why computers use 0’s and 1’s to represent everything
  - How to count in binary
  - ASCII, Unicode
  - Why does **255** mean ***full on green***?
  - What does Kb, Mb, Gb, etc. stand for?

Remember our first lecture?



Let’s get started!

- How does a computer work?

input peripheral

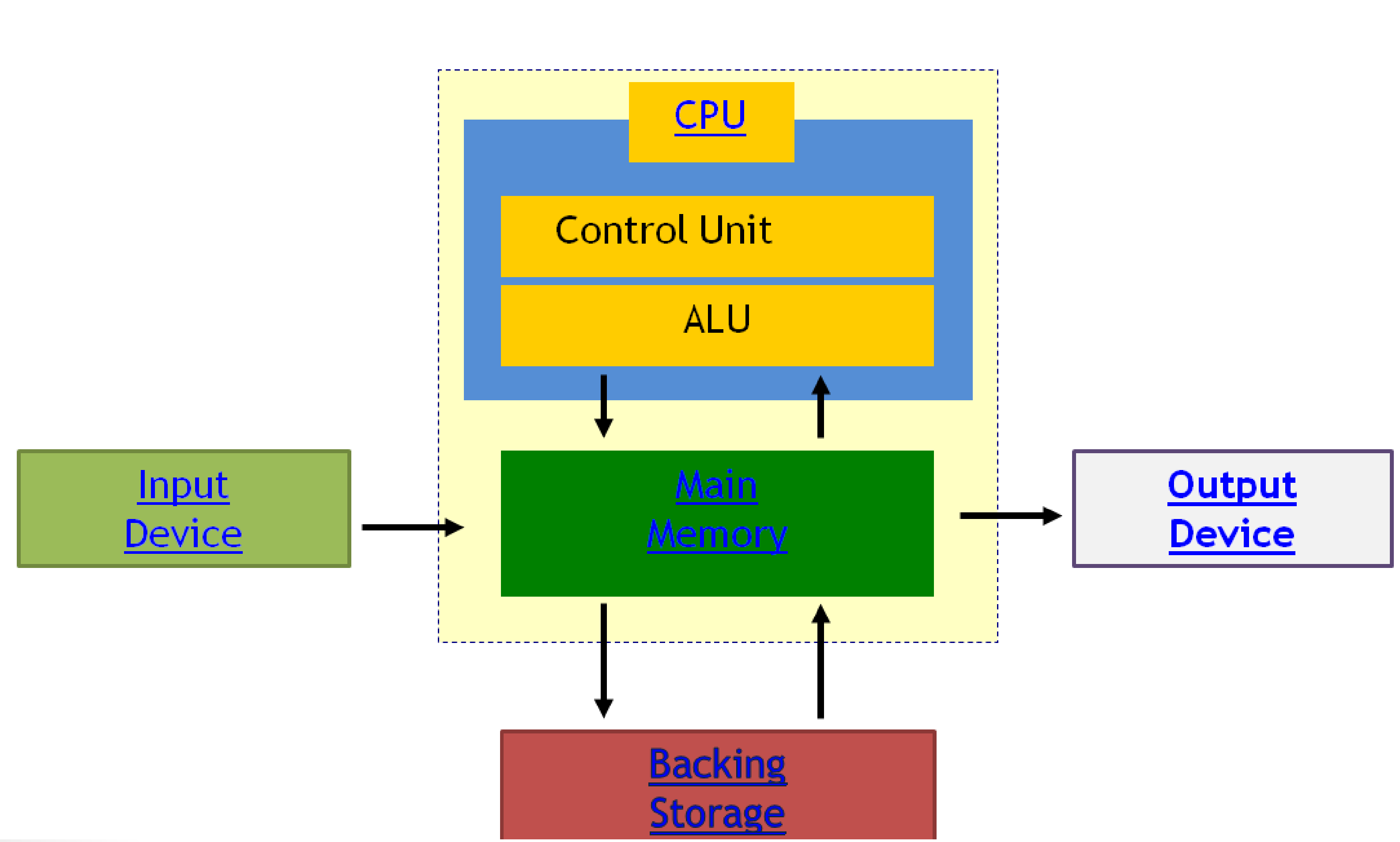
Central Processing Unit CPU

Memory

output peripheral

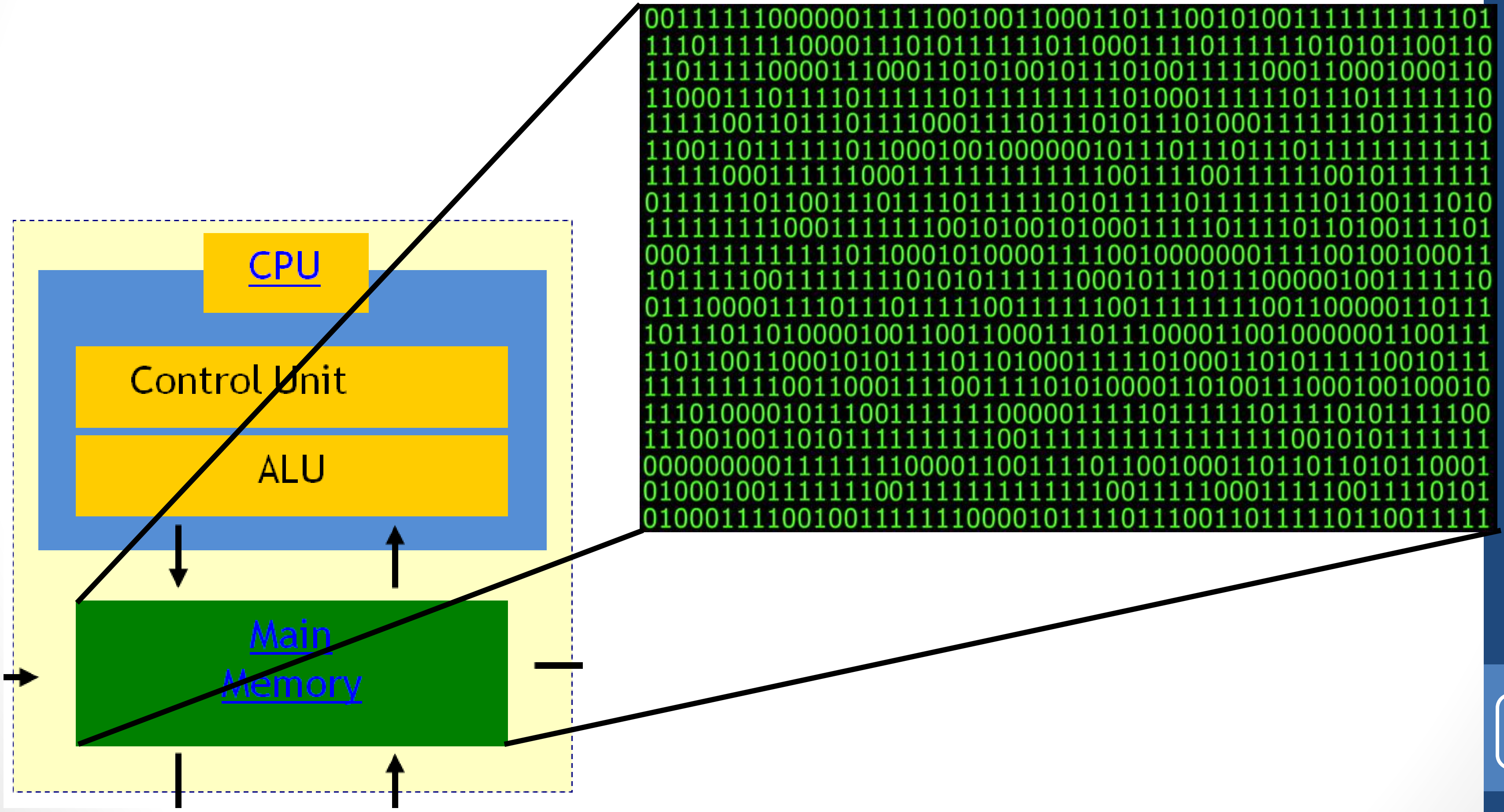
Data in Memory

Let's lift the hood!



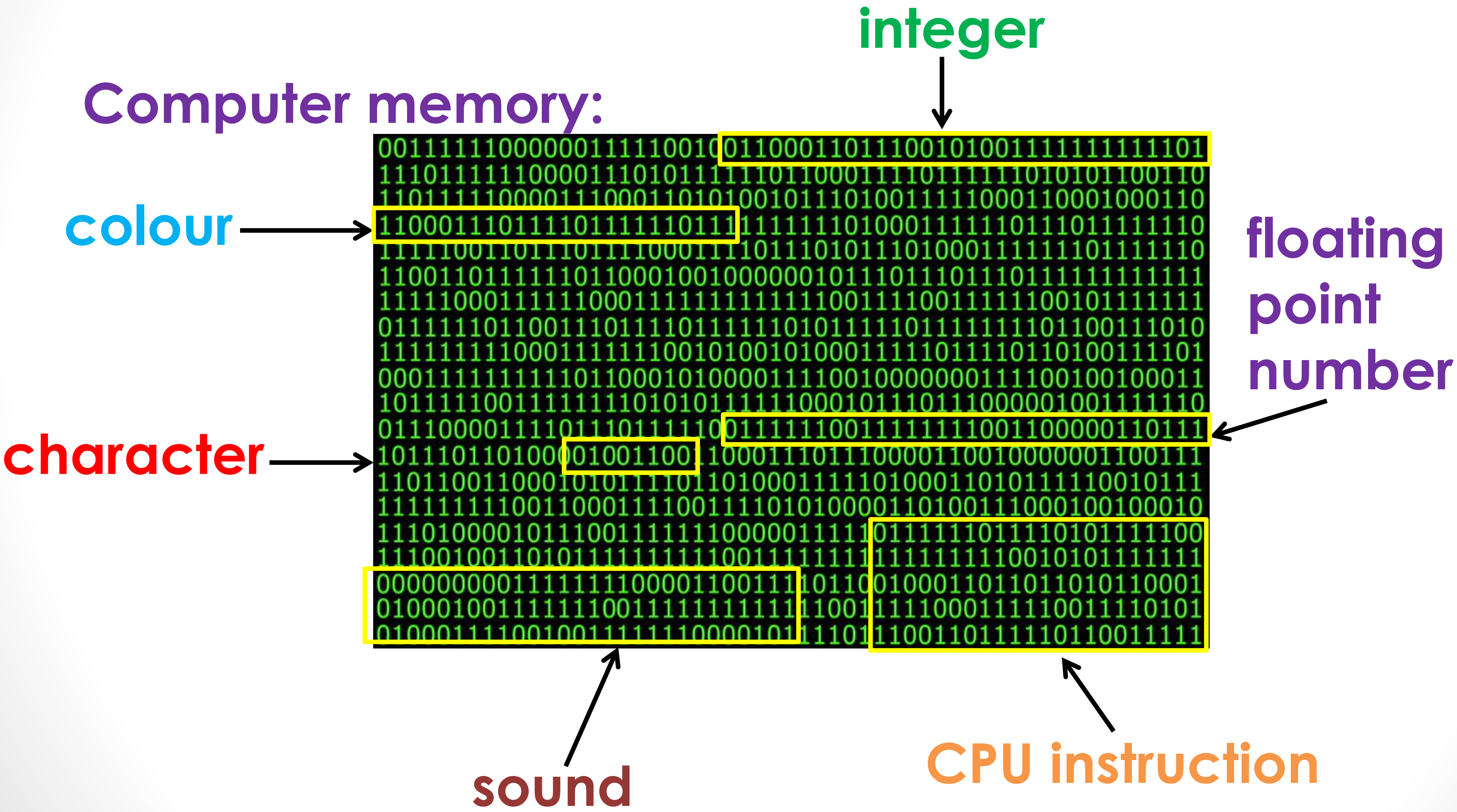
Source: http://ryanscomputersystem.blogspot.com/p/data-flow-diagram.html

Main Memory



“Computers use 0’s and 1’s to represent everything“

Computer memory:



integer

colour

floating point number

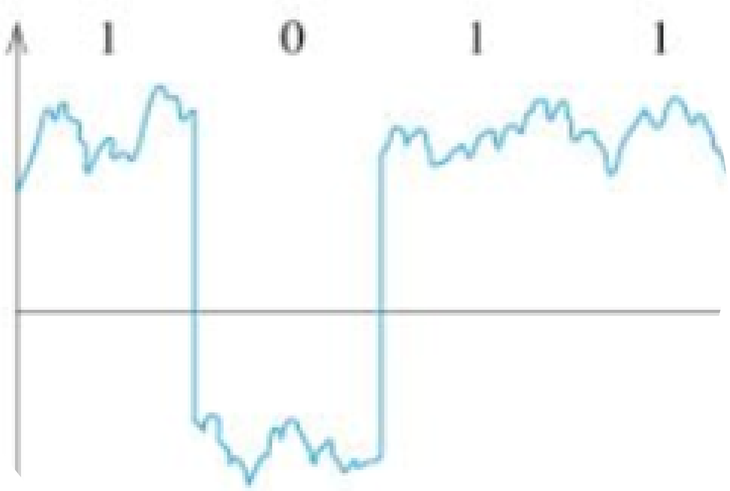
character

sound

CPU instruction

Why the 0’s and the 1’s

Fundamentally, digital computers are machines that convert high and low electrical signals (called **voltage**) into 0’s and 1’s.



- Let’s learn to speak its native language!

Decimal numeral system

- **Decimal** -> 10 (Base 10)
- Ten symbols (digits):
- Positional system
  - When counting:

0, 1, 2, 3, 4, 5, 6, 7, 8, 9,
10,11,12,13,14,15,16,17,18,19,
20,21,22,23,24,25,26,27,28, 29,
…

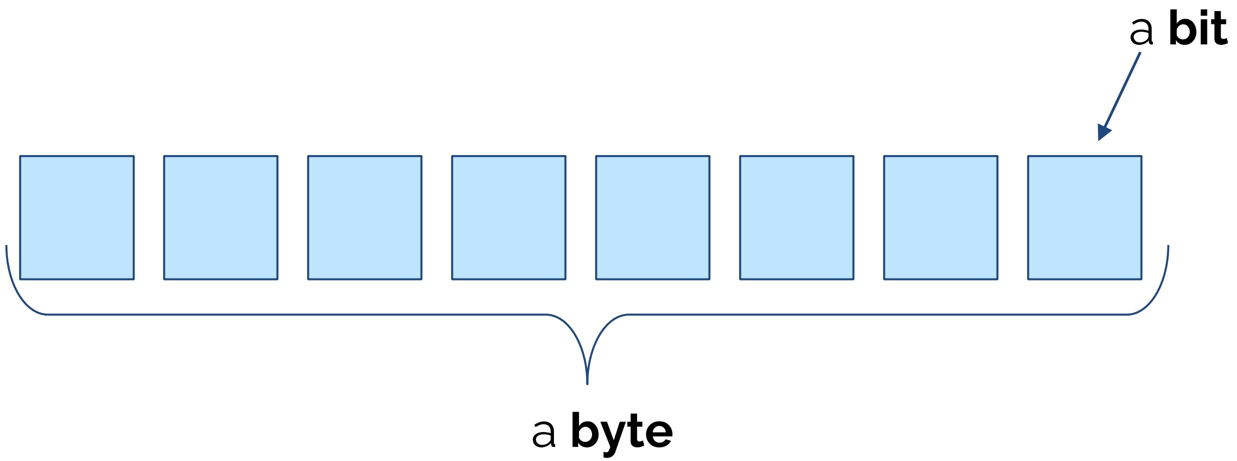
Binary numeral system

- **Binary** -> 2 (Base 2)
- Two symbols (bits):
- Positional system
  - When counting:

bits -> binary digits

0, 1,
10, 11,
100, 101,
110, 111, …

Can you read this 01001100?

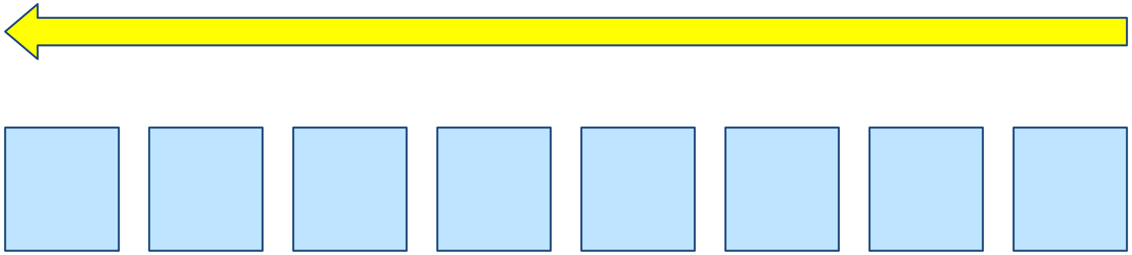


a **bit**

a **byte**

- a **bit** is the smallest memory location.
- a **byte** is 8 bits.

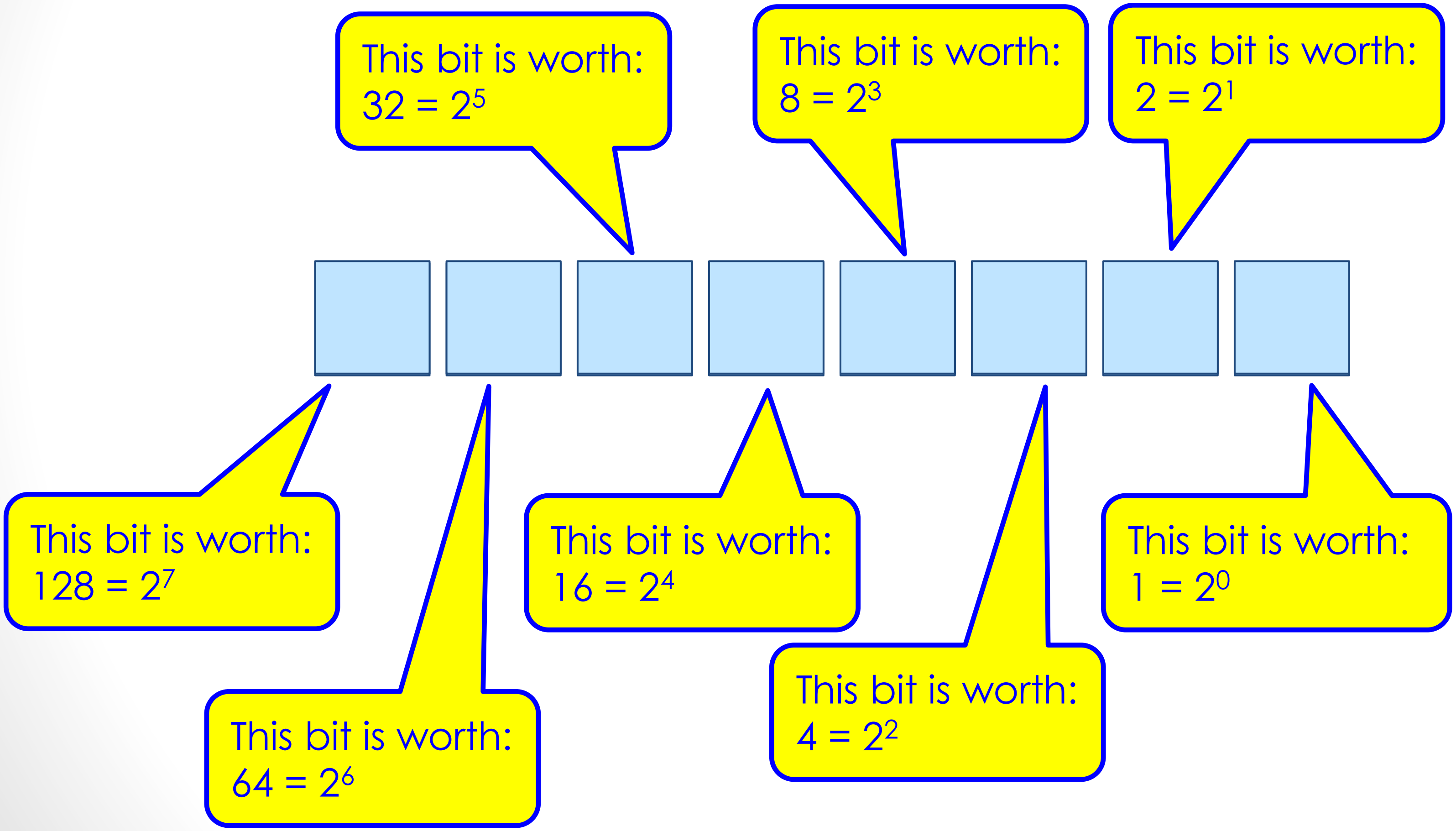
Can you read this 01001100 ?



In decimal, each digit, from right to left, represents a power of ten (10): 1's (x 10^0), 10's (x 10^1), 100's (x 10^2), 1000's (x 10^3), etc.

In binary, each bit, from right to left, represents a power of two (2): 1 (x 2^0), 2 (x 2^1), 4 (x 2^2), 8 (x 2^3), 16 (x 2^4), etc.

Can you read this 01001100?



This bit is worth: $32 = 2^5$

This bit is worth: $8 = 2^3$

This bit is worth: $2 = 2^1$

This bit is worth: $128 = 2^7$

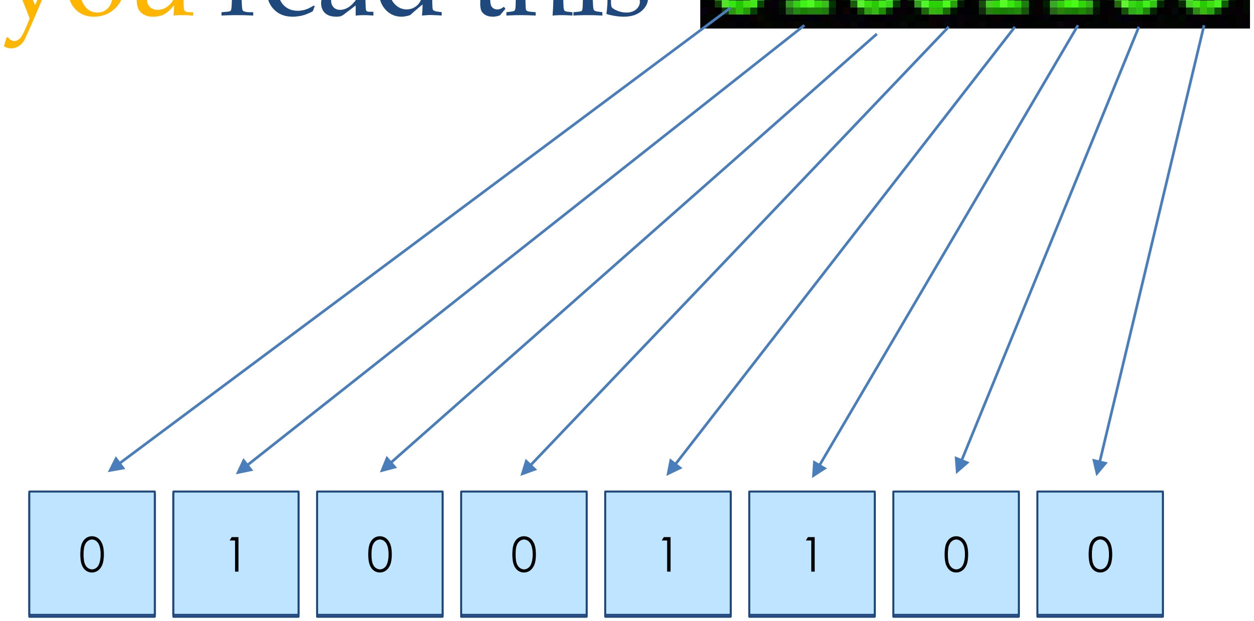
This bit is worth: $16 = 2^4$

This bit is worth: $1 = 2^0$

This bit is worth: $64 = 2^6$

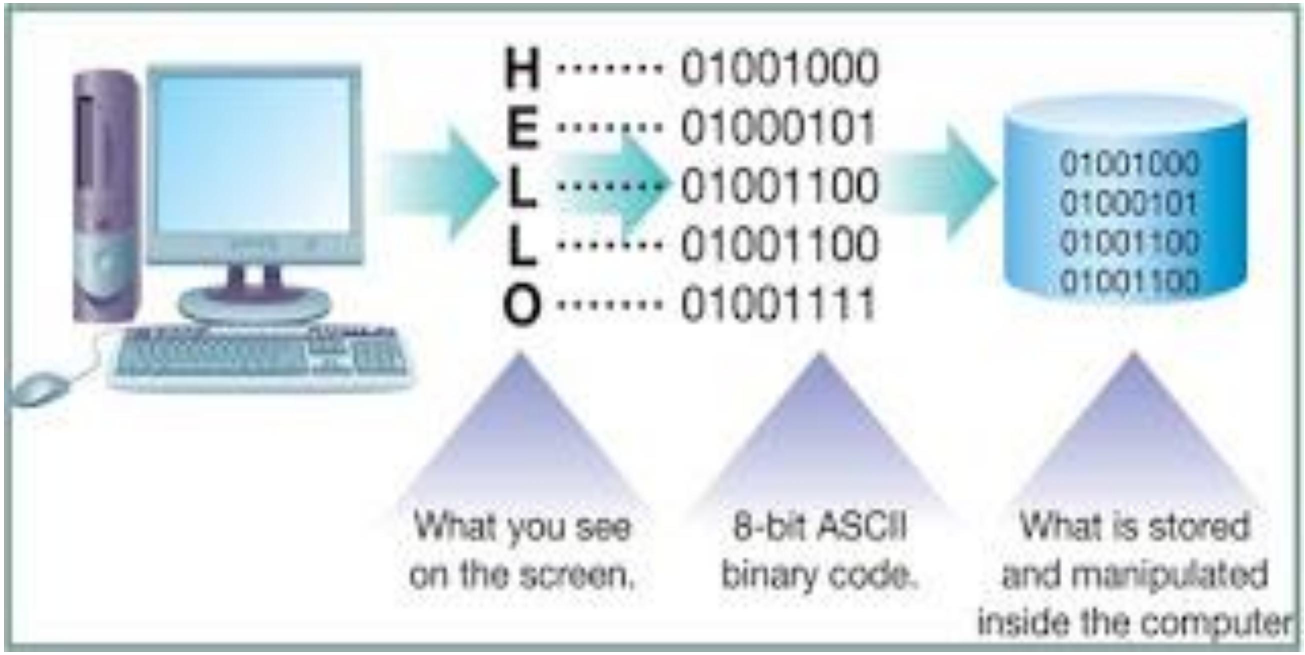
This bit is worth: $4 = 2^2$

Can you read this 01001100?



0	1	0	0	1	1	0	0

How computers represent **characters**



Source: http://1.bp.blogspot.com/_e8aZh22zXKM/TMeR_fFL8aI/AAAAAAAAAAo/pIR08vVLkz0/s320/Hello_World.jpg

See ASCII Table: https://www.ascii-code.com/

Next Lecture

- More about Binary Numeral System
  - Binary -> Decimal
  - Decimal -> Binary
- Can we write a converter program that convert binary numbers into decimal numbers?