



COMP 150: Basics of Computer Organization

Week 01, Lecture 02



Agenda

1. Quiz (5 minutes)
2. History of Computers
3. How does a computer work?

Quiz (5 min)

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2. History of Computers
 - a. What is a computer?
 - b. Ancient devices, the Industrial Revolution
 - c. Binary Interlude
 - d. WWII
 - e. The transistor
 - f. The internet
 - g. Today
3. How does a computer work?

History of Computers

This is, surprisingly, contentious.

What *is* a computer?

Britannica: “an apparatus that performs routine calculations automatically.”

Wikipedia: “A computer is a machine that can be programmed to automatically carry out sequences of arithmetic or logical operations (computation)”

Merriam-Webster: “a programmable usually electronic device that can store, retrieve, and process data”

History of Computers

Why do we *care*?

- In order to use them well, we must understand *how* they work
- In order to understand *how* they work, we have to understand details
- Details are memorization exercises without context, and we are more than memory machines

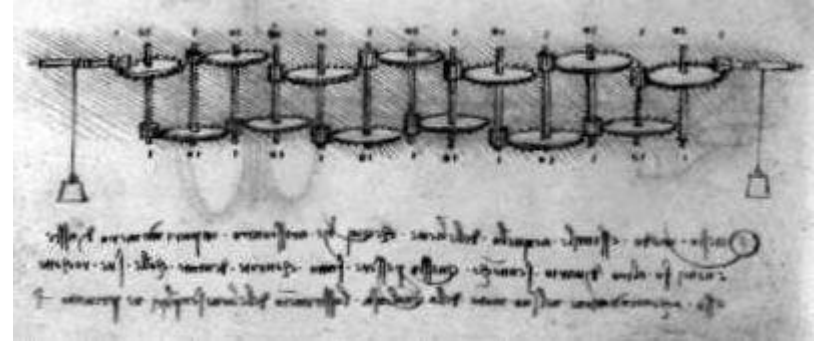
History of Computers: Ancient Technology

1100 BCE: Devices (abacus, slide rule)

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Historically interesting.
Modern curiosities.

but

Everything up to this point was *numeric*.

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Very briefly: The Industrial Revolution

- Industrial revolution:

- Technically, there were two (18-19th centuries, late 19th-early 20th centuries)
- Do more
- Make more
- Do it faster
- Do it cheaper
- More, more, more, more

- Mechanization (instead of tooling) became the push

- Textiles (spinners, looms, weaving, chemical processing)
- Steam engine
- Iron production
- Machining tools (lathe, bore, mill)

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The Jacquard Loom

- Patented in 1804
- Binary in practice, not just mathematics
- Machine attached to a loom
- Moved threads through a series of steps
- Punch cards
 - Each set represented a step in the weave
 - Holes instructed the threads to be “forward” or “behind”
 - Simple but devastatingly effective



The Jacquard Loom (1804)



Binary

Decimal, or “base-10”:

- Ten “options” exist (0-9)
- When we exhaust our options, “hold a ten” and continue counting

Binary, or “base-2”:

- Two “options” exist (0-1)
- When we exhaust our options, “hold a two” and continue counting

Without binary, we don't have computers.

Computers and WWII

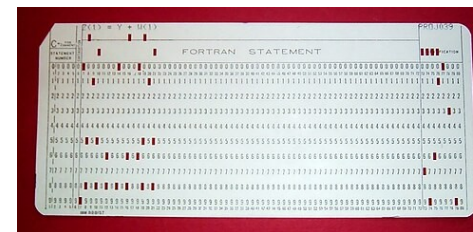
- Technology push driven by war
- Forced union of computational theory and mathematics
- Really was like it's shown in the films
 - Electro-mechanical devices
 - Mathematicians surrounded by chalk boards covered in symbols and equations
 - Alan Turing and Bletchley Park really, really did change the world
- End-result was a lot of mathematicians and engineers steeped in intense training - and several nations to rebuild



The Golden Age

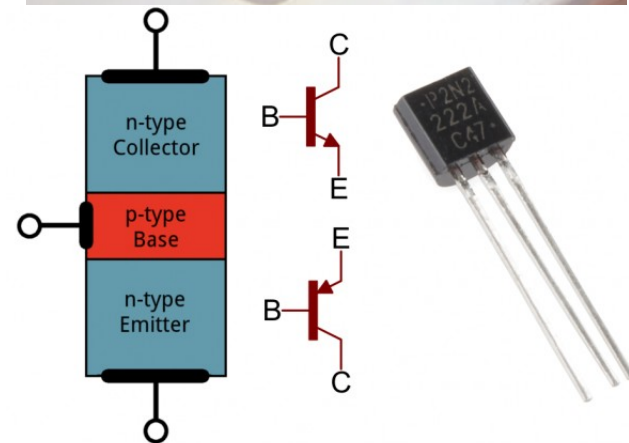
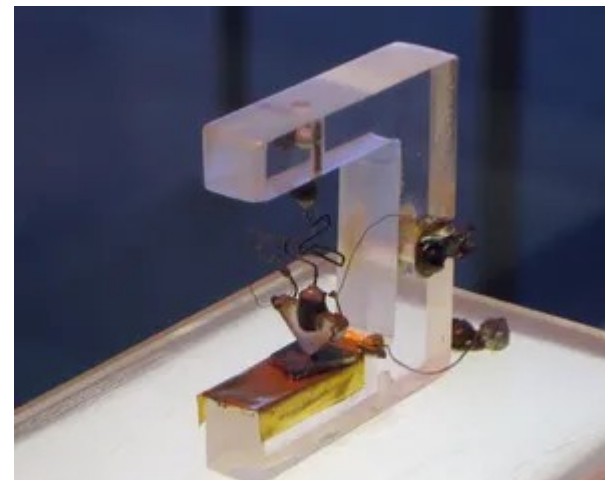
- 1960s:
 - Vacuum tubes, early transistors
 - Lots of theory, lots of massive machines
 - Assembly programming, early functional programming
- 1970s:
 - Personal computers emerge
 - Punch-cards are back!
 - Assembly and functional programming (FORTRAN, C)
 - Mainframes rule the world
- 1980s:
 - If every mainframe evaporated, the world would have stopped
 - Supercomputers rule tech
 - Personal computers are taking off

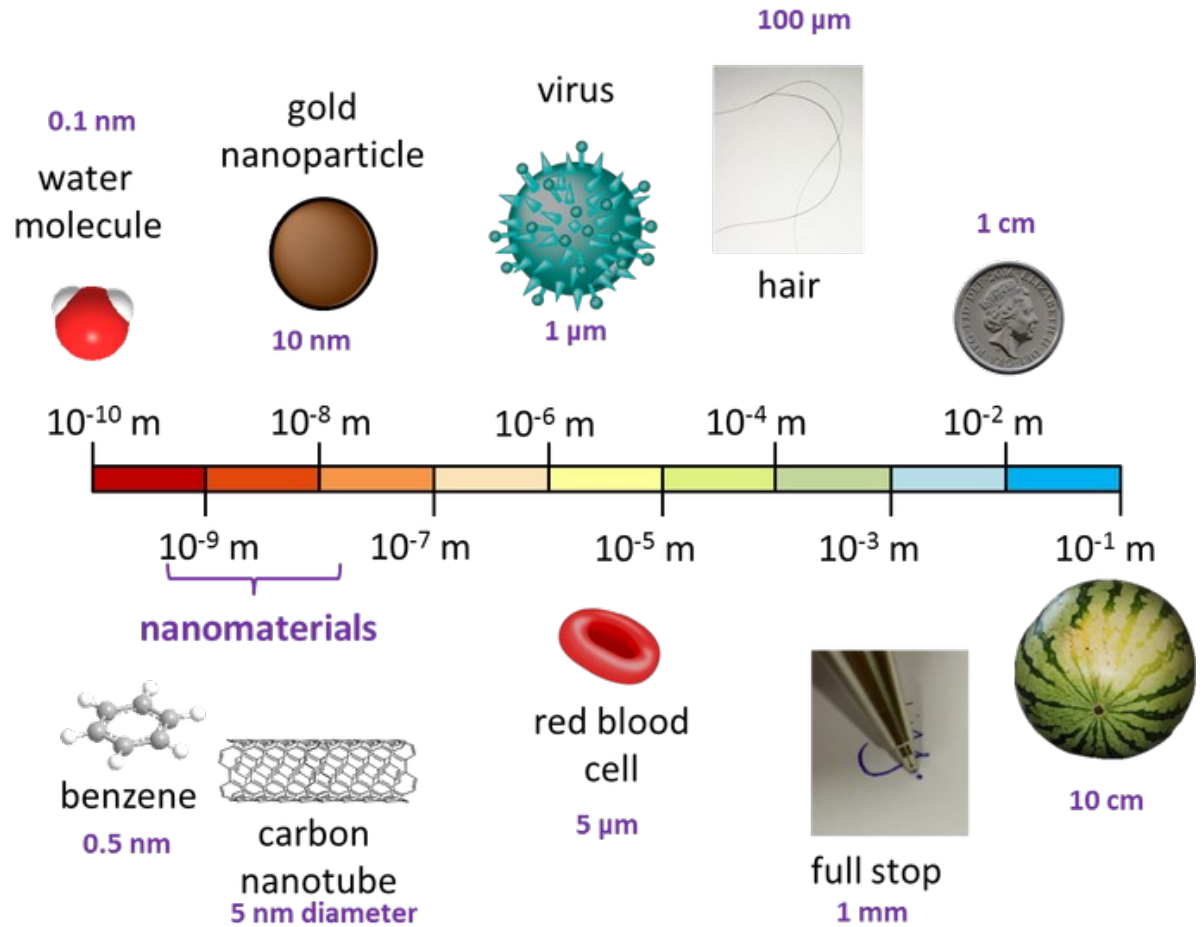
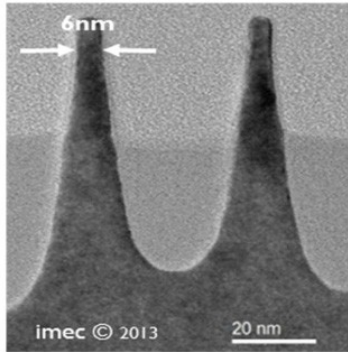
More on this shortly...



The Transistor

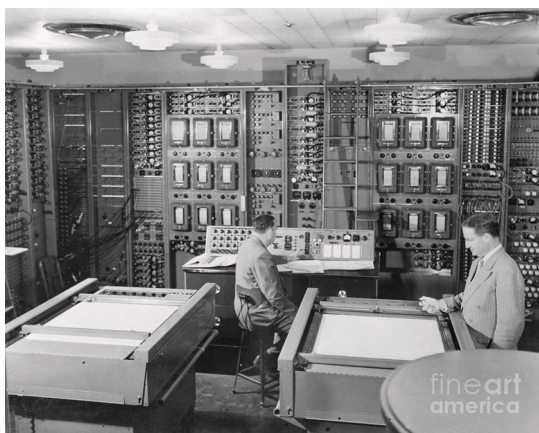
- Replaced the vacuum tube
- Patented in 1947 by Bell Labs
 - Fraught with corporate issues
- Stores 0 or 1
- In essence:
 - Apply a small voltage to the base
 - Open the channel
- We have become *very, very* good at making them tiny

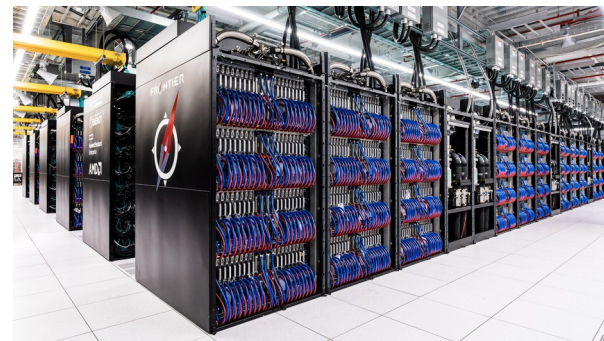
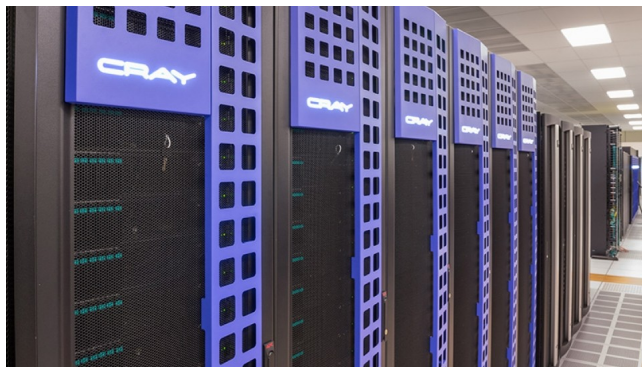
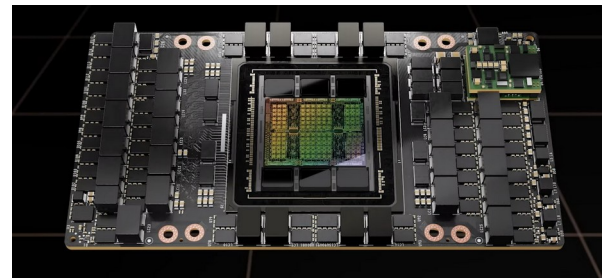
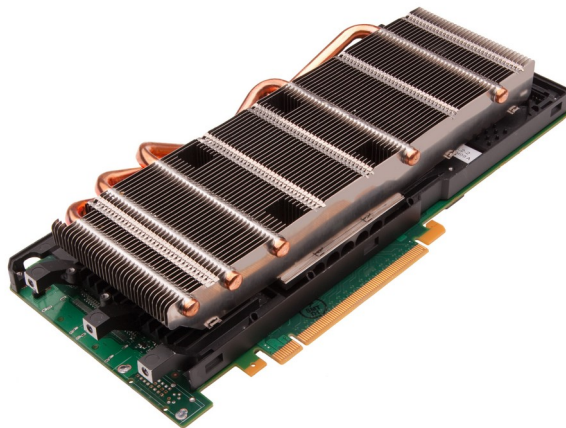
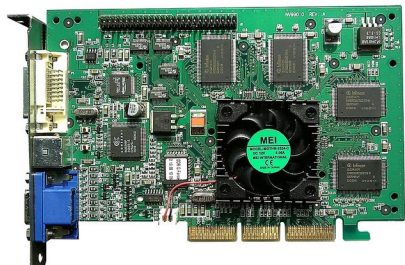




Computers through the Late 20th Century

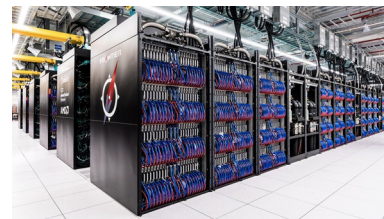
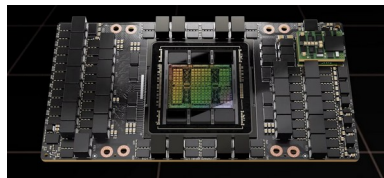
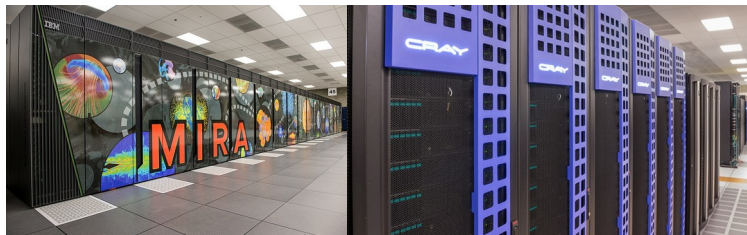
- 1960s:
 - Massive purpose-built machines
- 1970s:
 - Mainframes
- 1990s:
 - PCs
 - Supercomputers
 - (Et tu, Brute: mainframes)
- 2000s:
 - PCs, but more portable!
 - Supercomputers
 - Unfortunately, yes, *still* mainframes.
- 2010s:
 - PCs
 - Supercomputers! Big ones!
 - *Graphics cards*
- 2020s:
 - PCs*
 - Supercomputers of many shapes and sizes
 - Accelerators are key





Commonalities

- Interface
- Input
- Interconnect
- Compute
- Scale



The Computer - In Pictures

Board Discussion

And now: The Internet!

- ARPANET: 1969

- DoD ARPA
- Idea of “packets” of information
- Concept of a massive interconnect
- Protocols emerge (and TCP/IP have stayed)

- NSFNET: 1986

- National Science Foundation
- Major arteries interconnect supercomputers across mainland USA
- Internet Service Providers start up, offering inlets

- World Wide Web: 1989

- CERN
- Hypertext documents shared across a file-folder-like system
- Optical cables laid across the ocean in 1990 enabled true global traffic

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 - Hypertext documents shared across a file-folder-like system
 - Optical cables laid across the ocean in 1990 enabled true global traffic
- Then: web was transport, local machines were workers
- Now: nearly *everything* is web-based

The Internet - In Pictures

Board Discussion

In Review: That was a lot.

1. Ancient computers were calculators
2. Industrial revolution pushed the technology (binary -- looms)
3. WWII forced the mathematicians and engineers into the same room
4. Tech races in the early cold war era meant more and better machines
5. Corporate needs ruled the 80s and 90s
6. WWW : 1990
7. From 1940 to 2000, went from:
 - a. Massive machines
 - b. Mainframes and terminals, supercomputers
 - c. PCs and workstations, supercomputers
 - d. PCs, supercomputers, and browser-based computing
8. General structure of a computer
9. General structure of the internet

Friday:

- Our first lab: Hello World
- Should take less than 15 minutes