Computer Science

CPSC 217: Introduction to Computer Science for Multidisciplinary Studies I
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What is a Computer?

What is a Computer?

- Definitions vary
- **Boring definition:**
  - A boxy device with a typewriter-like interface that stores and processes information

What is a Computer?

- **Criminal Code of Canada (s. 342.1):**
  - “computer system” means a device that, or a group of interconnected or related devices one or more of which,
    a) contains computer programs or other data, and
    b) pursuant to computer programs,
       i. performs logic and control, and
       ii. may perform any other function;
  - “computer program” means data representing instructions or statements that, when executed in a computer system, causes the computer system to perform a function;

What is a Computer?

- **Legal definition under the Uniform Computer Information Transactions Act (UCITA), USA:**
  - An electronic device that accepts information in digital or similar form and manipulates it for a result based on a sequence of instructions

- **Dictionaries:**
  1. One who computes
  2. A tool that receives, processes and presents data


JEAN RUDDLE MACGRAULT
ULMER STABLER

What is a Computer?

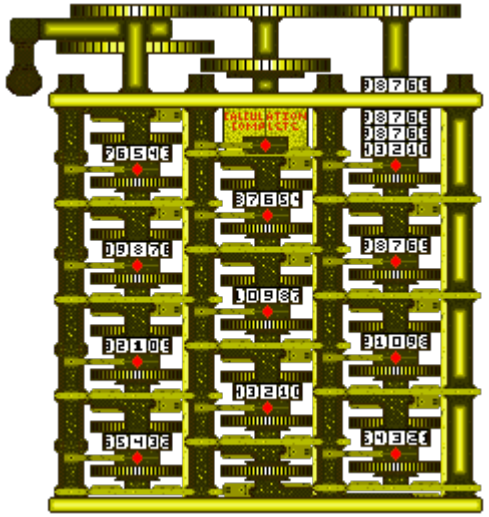
- **Does not need to be “electronic”**
  - **(can also be mechanical, optical, biological, …).**
- **“Digital or similar form” not accurate either (may be quantum data, DNA).**

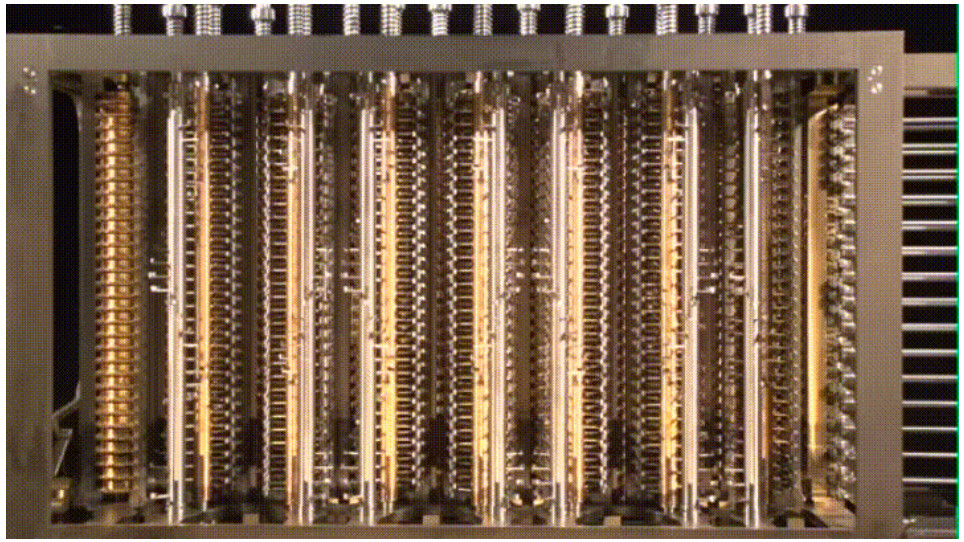
- **“Tool” succinct, accurate description.**
  - Example:
  - What is a car? How many people drive? Why do you drive?
  - Car is a tool that makes living in Calgary easier
  - Computers are the same, but for scientific investigation.

Abacus
inv. ~300-400 BCE

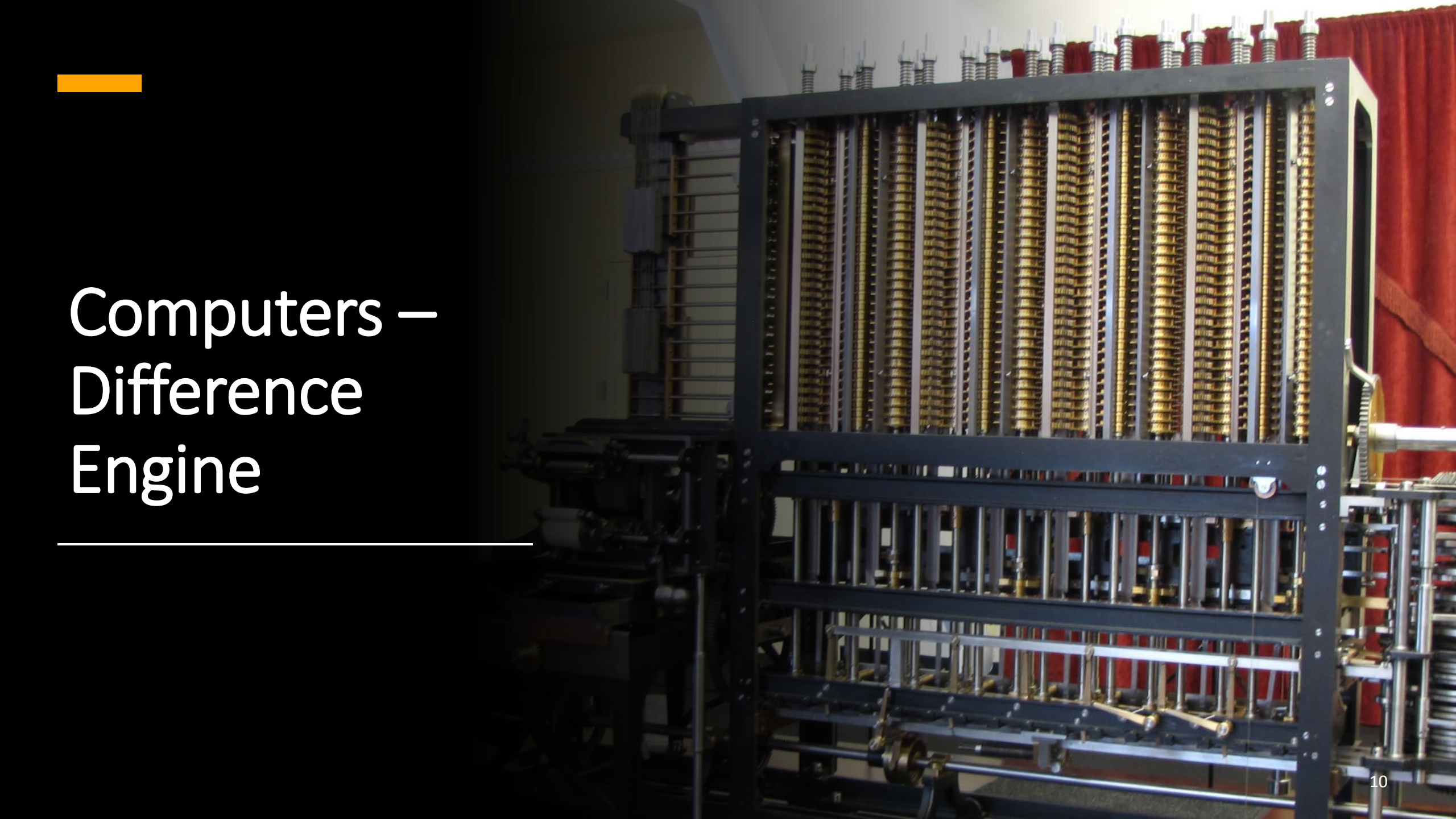
Difference Engine (Charles Babbage)

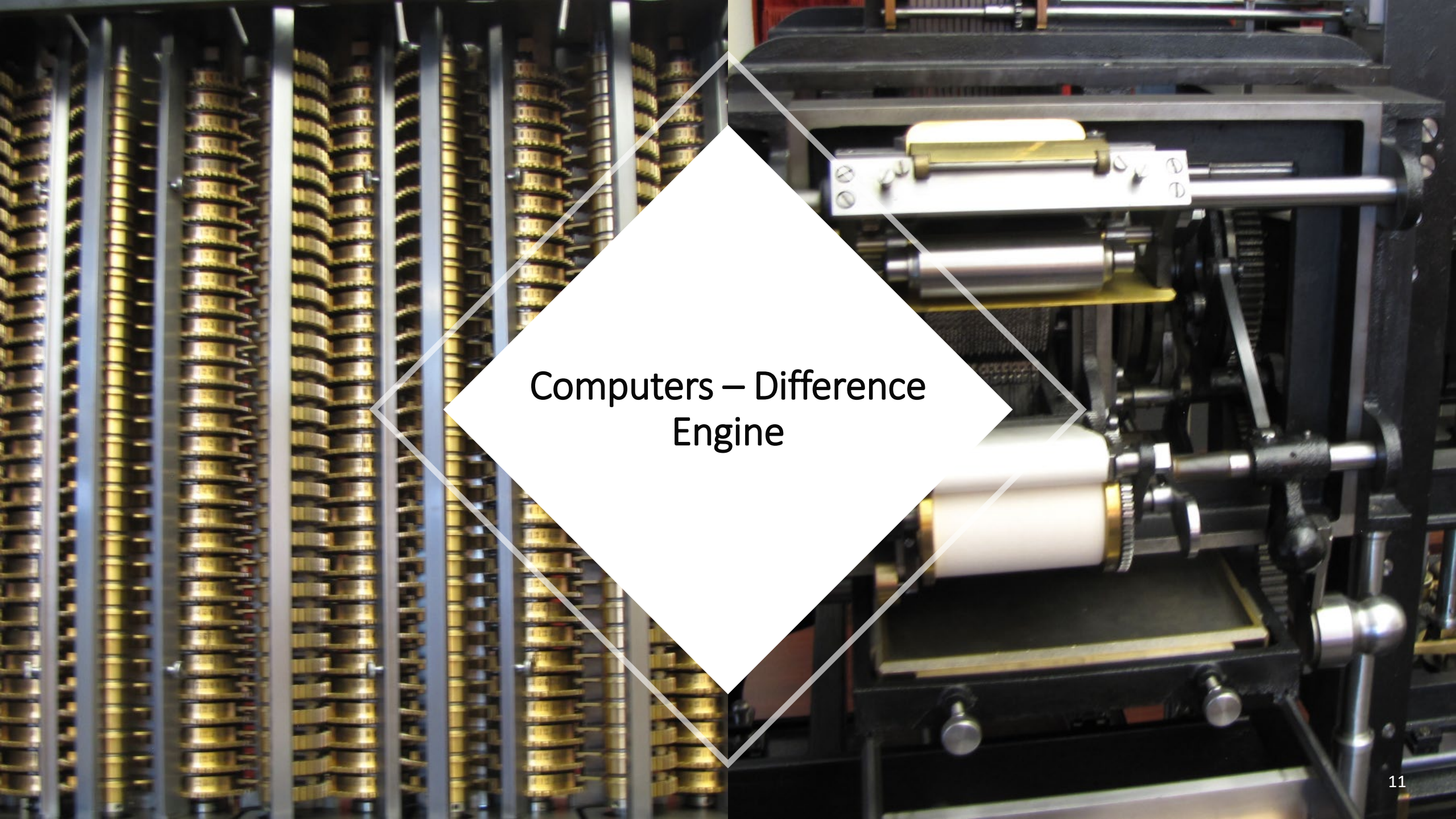
- A **difference engine** is an automatic **mechanical calculator** designed to tabulate **polynomial functions**. (~1822)
- A mathematician, philosopher, inventor and mechanical engineer, Babbage originated the concept of a **digital programmable computer**.
- **“father of the computer“**
- In **1991**, a **functioning** difference engine was constructed from Babbage's original plans.





Computers – Difference Engine

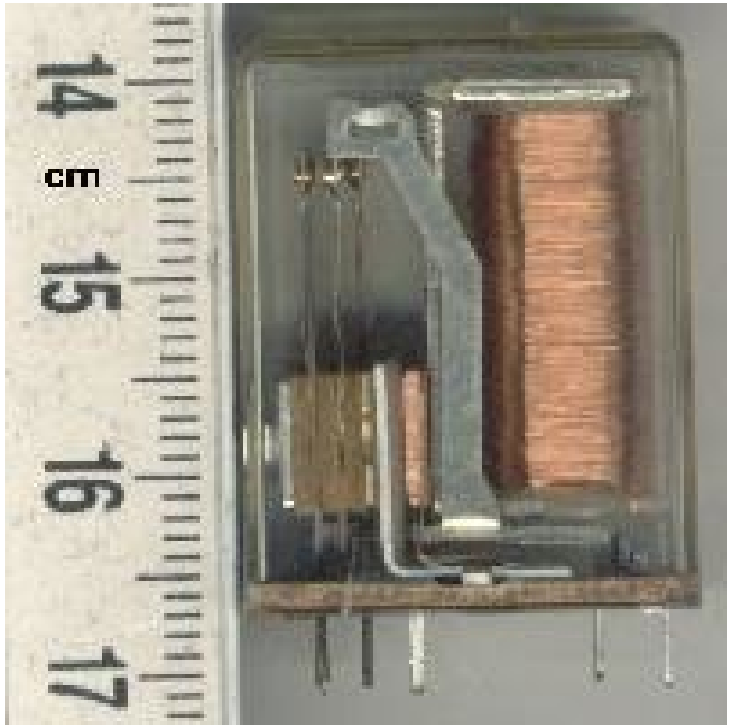


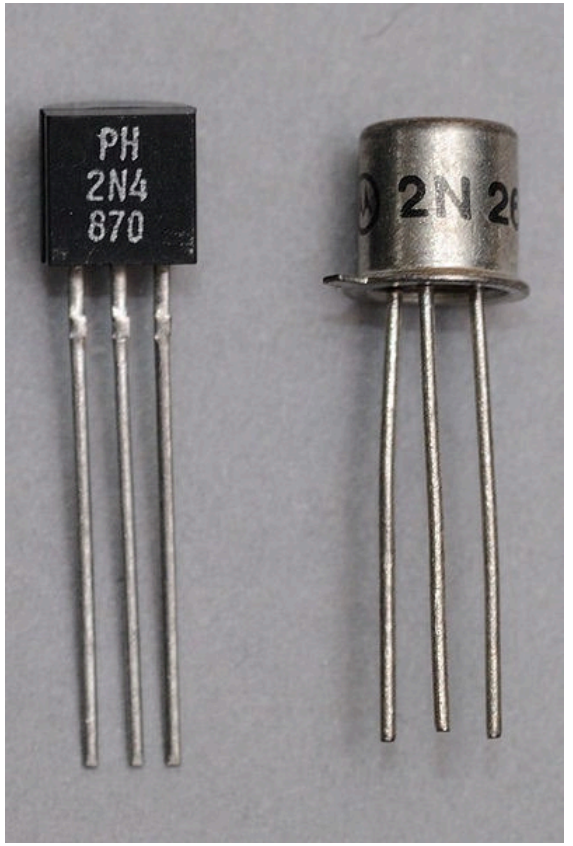


Computers – Difference Engine

Ada Lovelace

- Mathematician and writer
- Daughter of Lord Byron (*interesting fellow*)
- **Worked with Charles Babbage**
- **Maybe the first programmer (a person who writes computer programs)**
  - (At least first evidence of)
- Early **philosophy** of computer science (**The effects of technology on people**)
- ‘Halt and Catch Fire’ trivia -> Cameron wants to name BIOS Lovelace





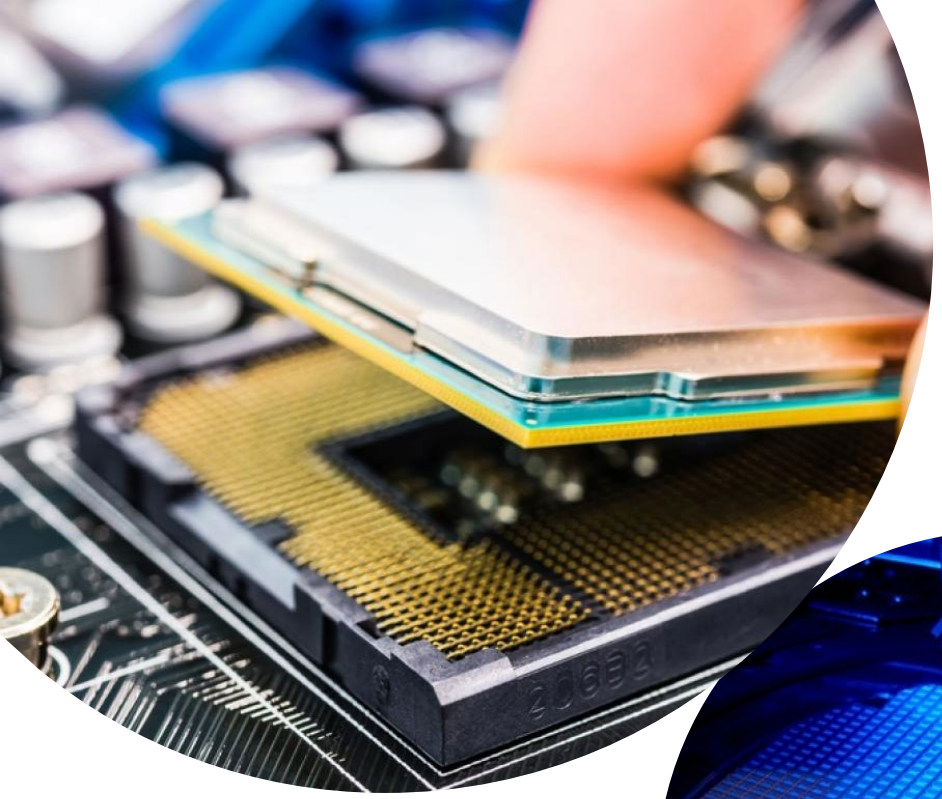
Electric Switches

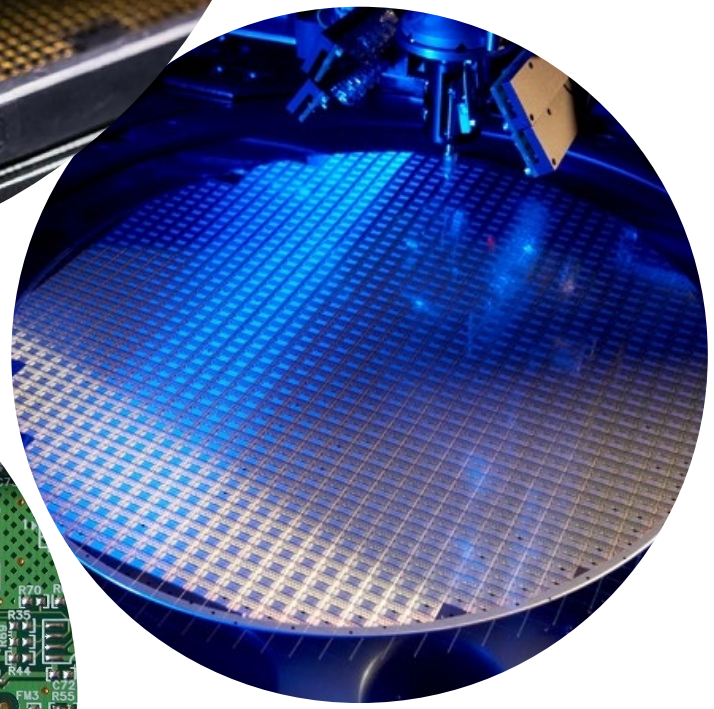
(Fundamental early computer HARDWARE)

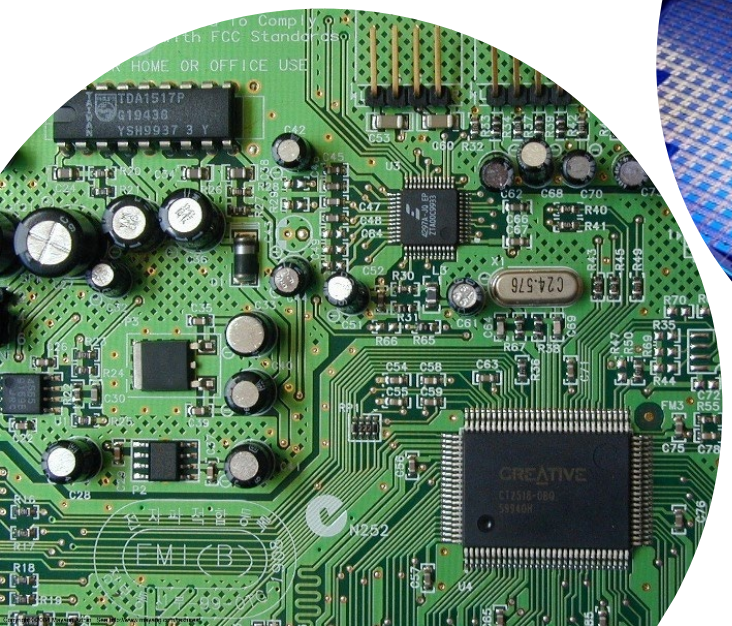
(Left to Right) Relay, vacuum tube, transistor

Computers - ENIAC

Modern Computers







Modern Computers

- **Integrated Circuits** (1959) patent by Robert Noyce. Co-inventor **of integrated circuit** made of **silicon.**
- William Shockley was the manager of a research group at Bell Labs that included John Bardeen and Walter Brattain. The three scientists were jointly awarded the 1956 Nobel Prize in Physics for "their researches on semiconductors and their discovery of the transistor effect.“
- Considered founder of **silicon valley,** his company spawned **Intel/AMD**/National Semi conductors

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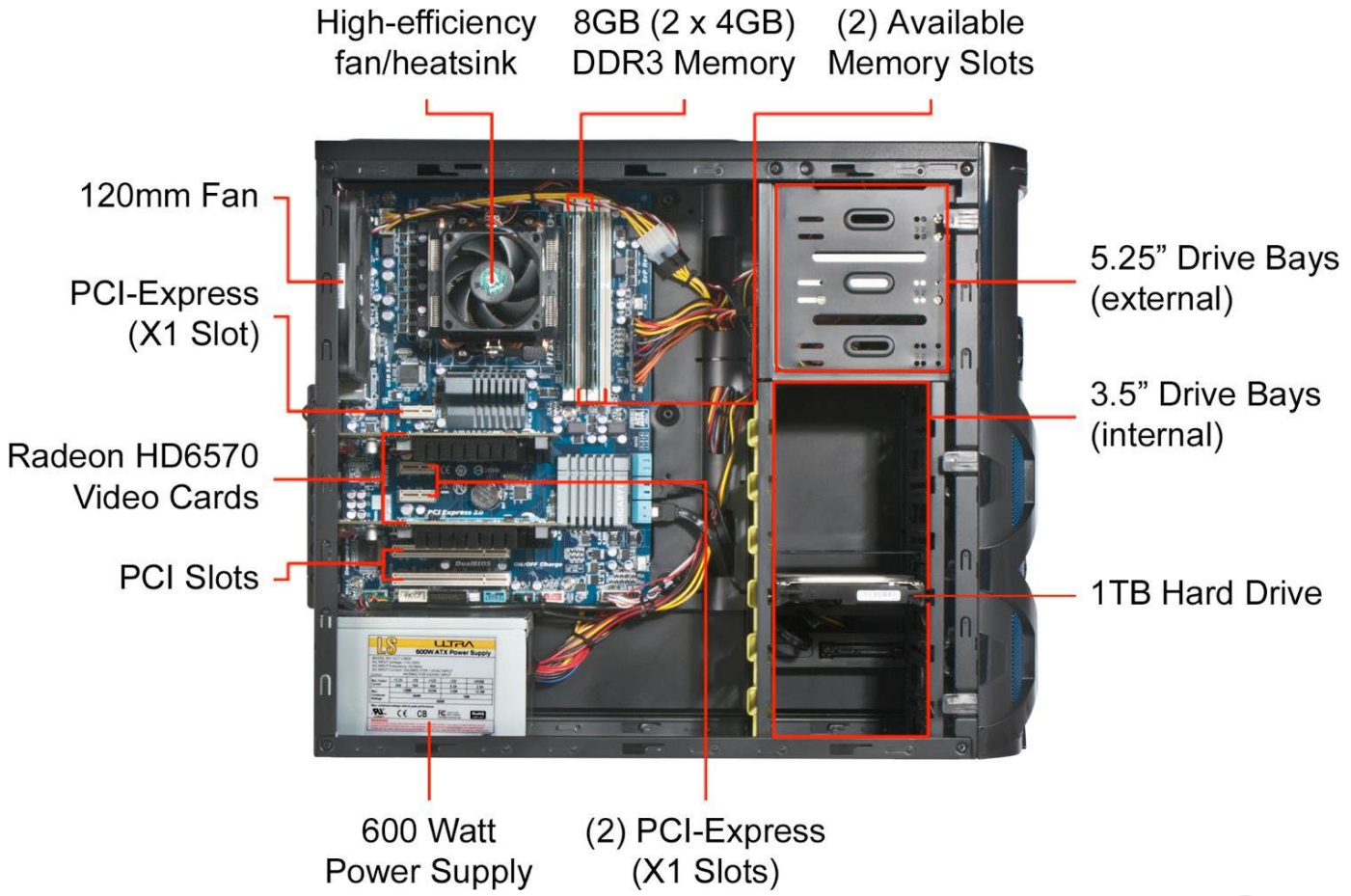
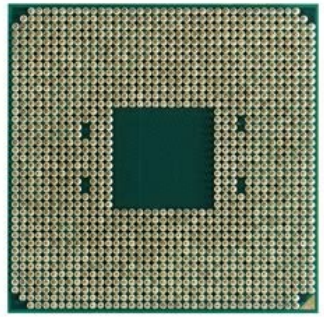
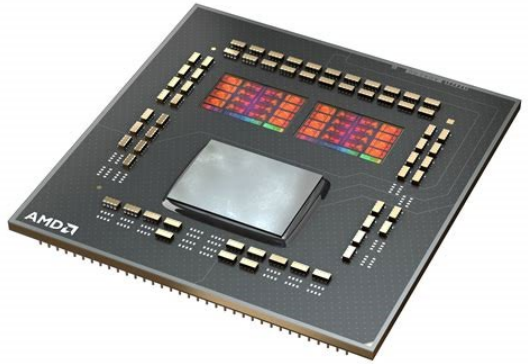
Modern Desktop Computer

- Typical major components:
  - Central processing unit (CPU)
  - Main memory
  - Secondary storage devices
  - Input and output devices



Motherboard and CPU (body & brain)



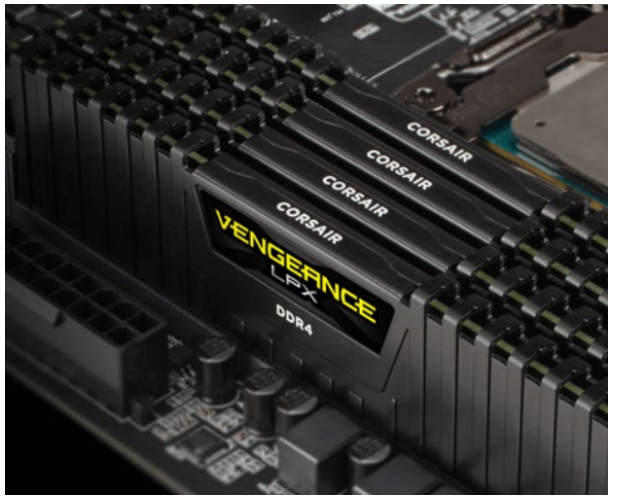


- Central processing unit (CPU): the part of the computer that actually runs programs

Memory – RAM (short term memory)

•<u>Main memory</u>: where computer stores a program while program is running, and data used by the program

Random access (volatile) memory (RAM)
Quick but disappears when off



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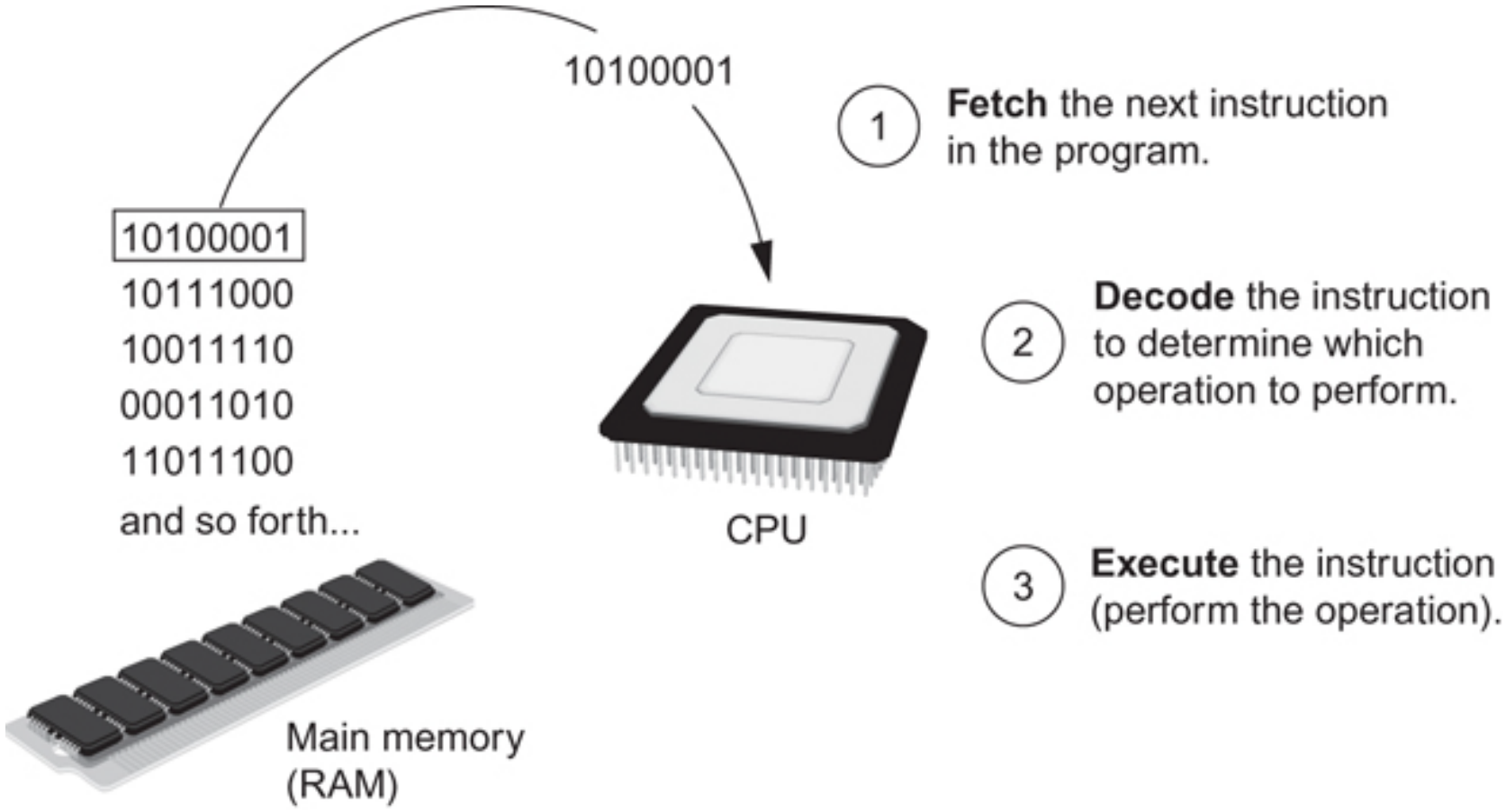
Fetch – Decode - Execute



- **Figure 1-16** The fetch-decode-execute cycle

Memory – Hard Drive (long term memory)

HDD (hard disk drive)
[mechanical,slow,$,big]

SSD (solid state drive)
[non-mech,fast,$$,medium]

Non-volatile memory (long-term RAM)
[non-mech,fastest,$$$,small]

<u>Secondary storage</u>: can hold data for long periods of time
Programs normally stored here and loaded to main memory when needed

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Power – Power Supply Unit (electricity)

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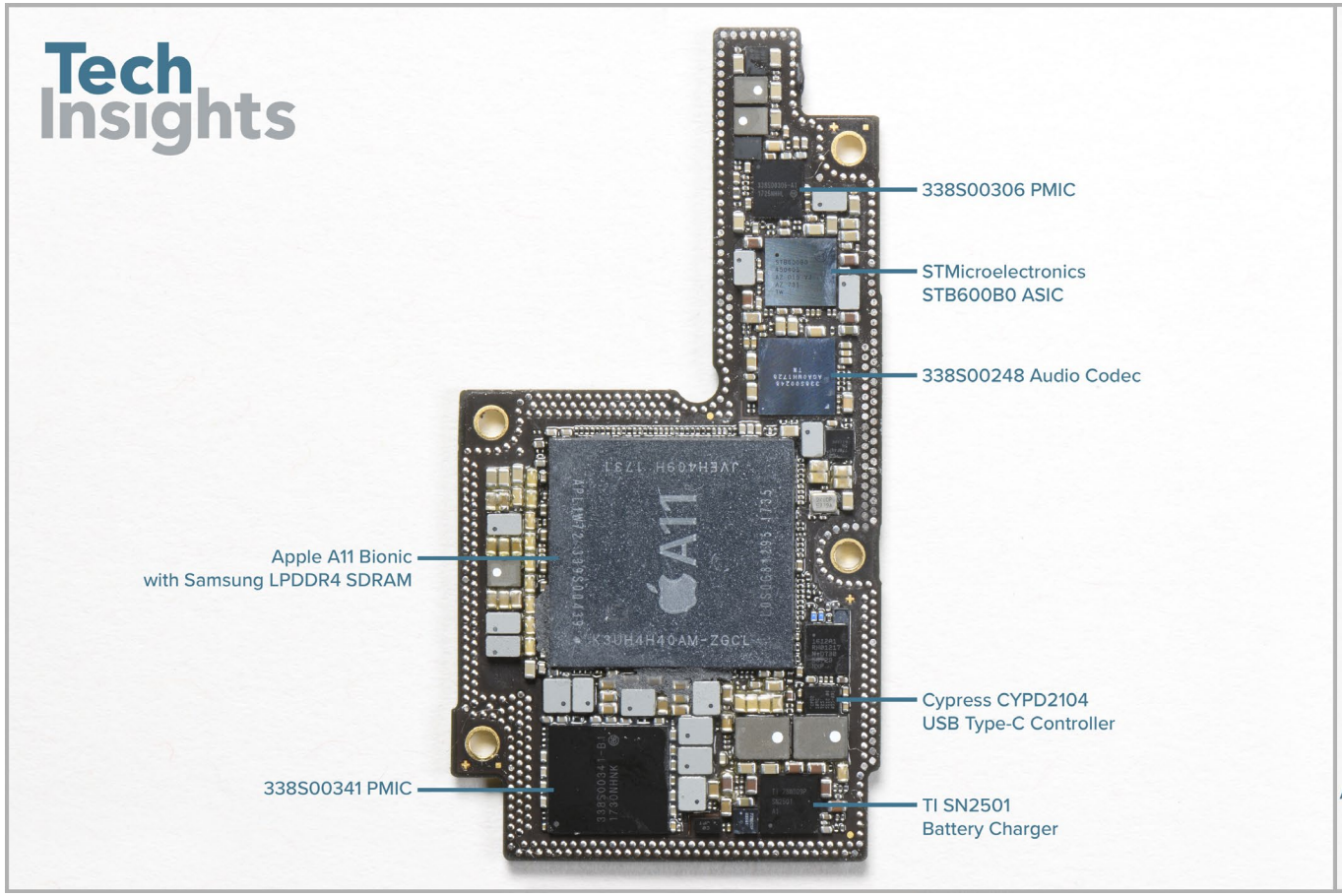
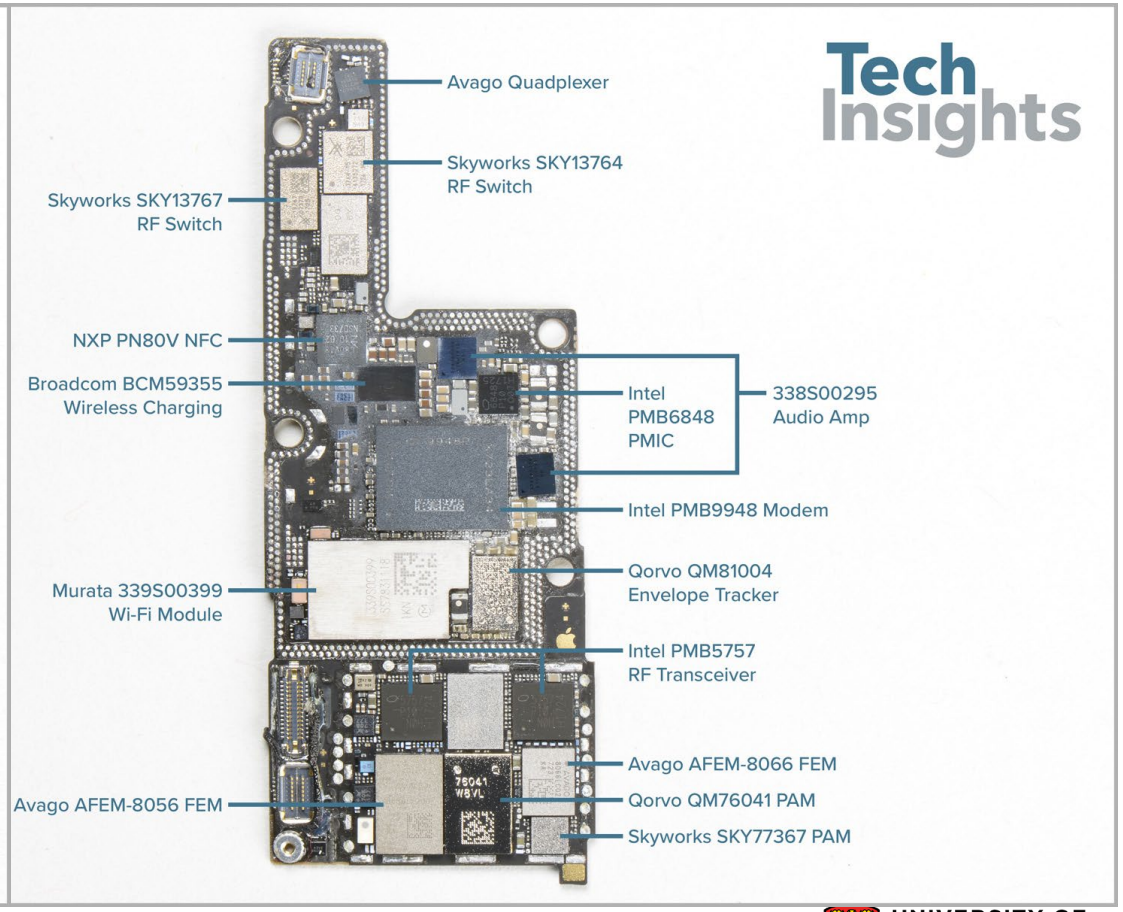
Graphics (visual output)

iPhone X Teardown

iPhoneX (computer)





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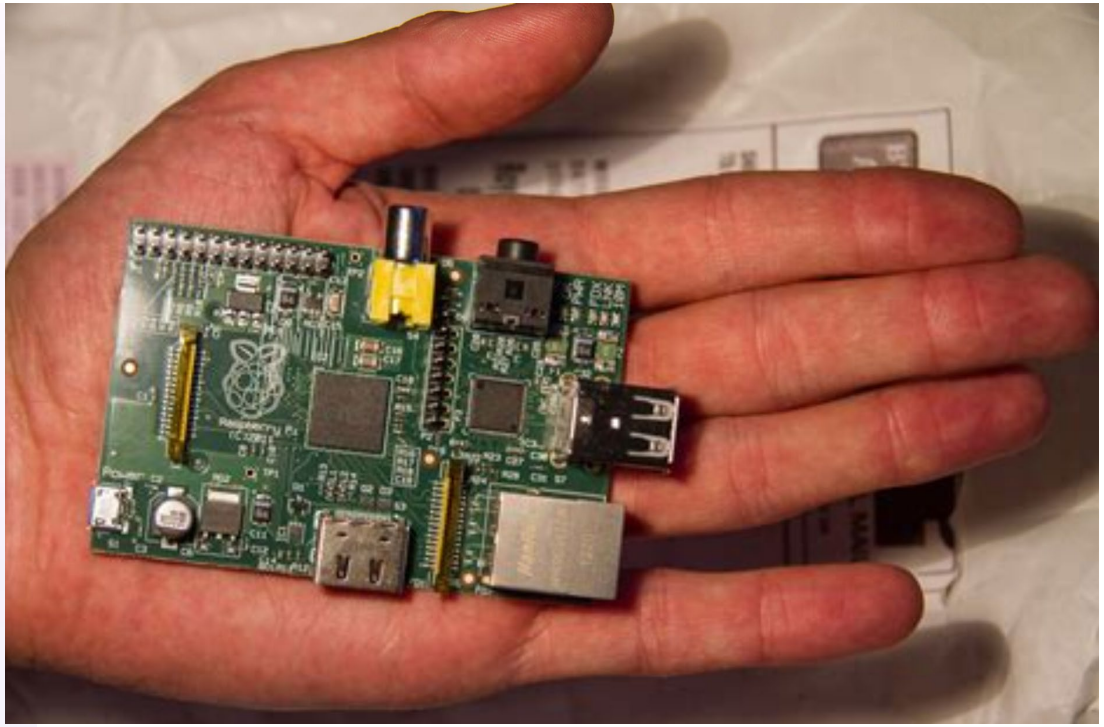
Raspberry PI

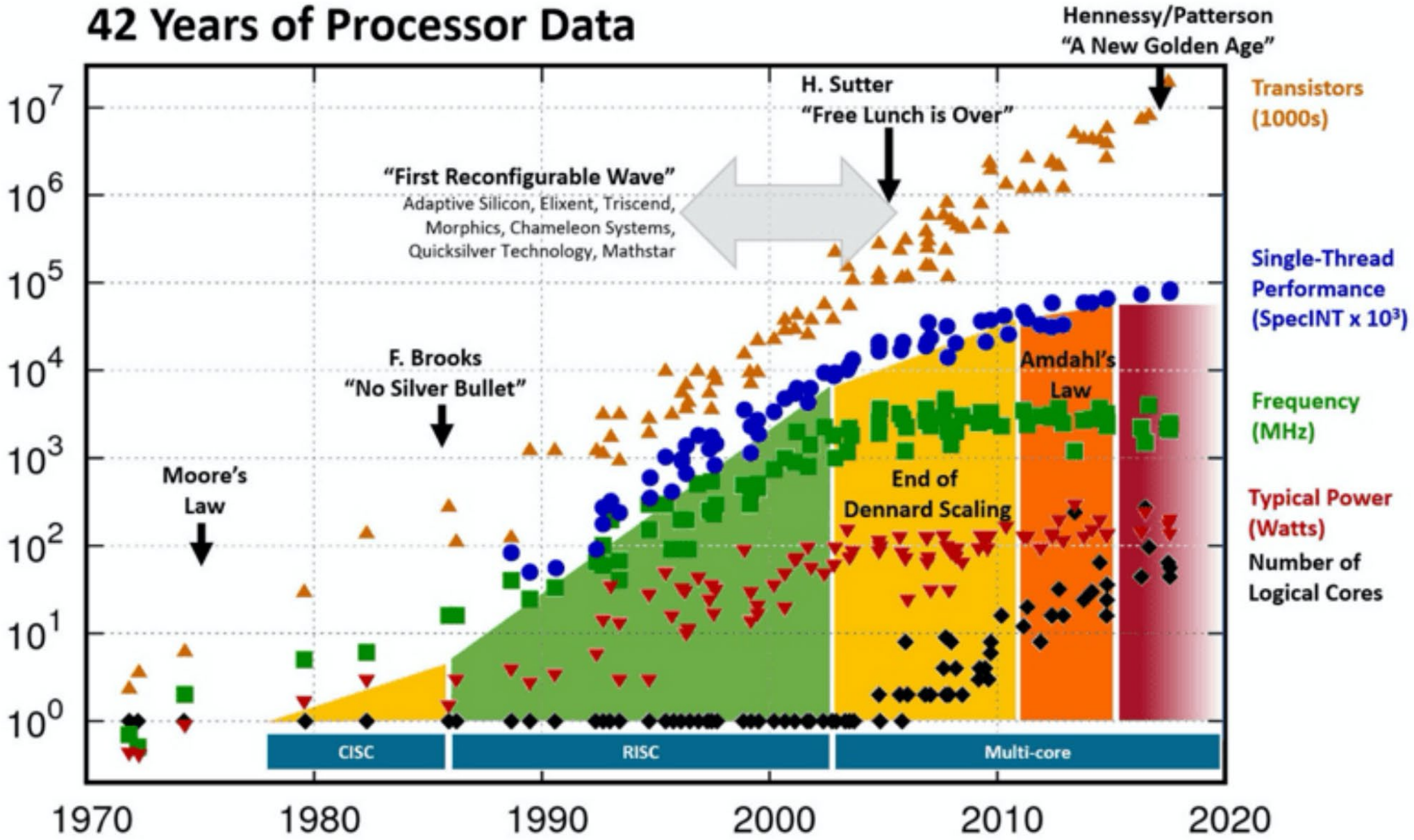


Moore’s Law

Moore's Law

- "**The complexity for minimum component costs has increased at a rate of roughly a factor of two per year** ... Certainly over the short term this rate can be expected to continue, if not to increase. Over the longer term, the rate of increase is a bit more uncertain, although there is no reason to believe it will not remain nearly constant for at least 10 years." **Gordon Moore 1965**

42 Years of Processor Data



Hennessy and Patterson, Turing Lecture 2018, overlaid over "42 Years of Processors Data"
https://www.karlrupp.net/2018/02/42-years-of-microprocessor-trend-data/;"First Wave" added by Les Wilson, Frank Schirrmeister
Original data up to the year 2010 collected and plotted by M. Horowitz, F. Labonte, O. Shacham, K. Olukotun, L. Hammond, and C. Batten
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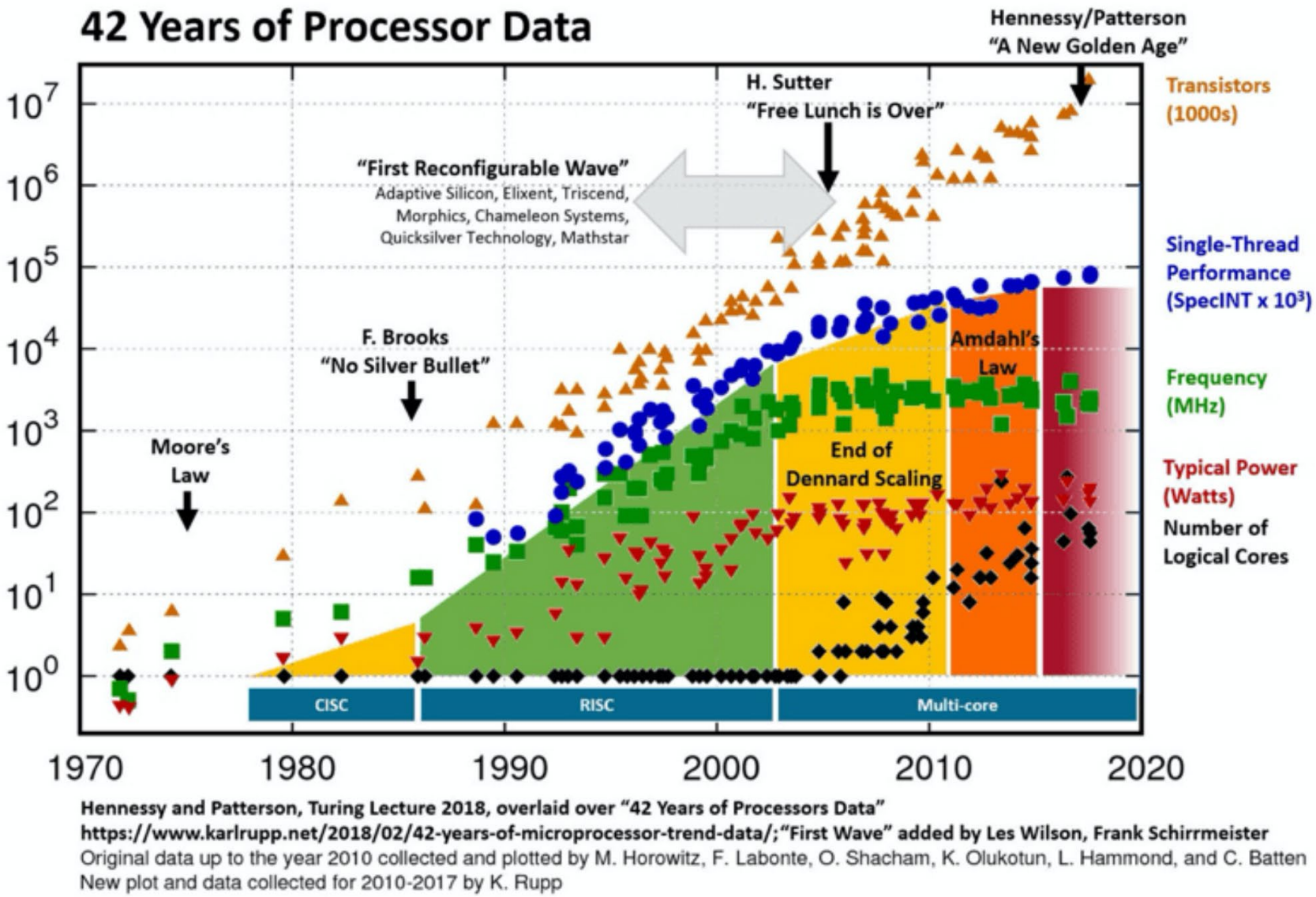

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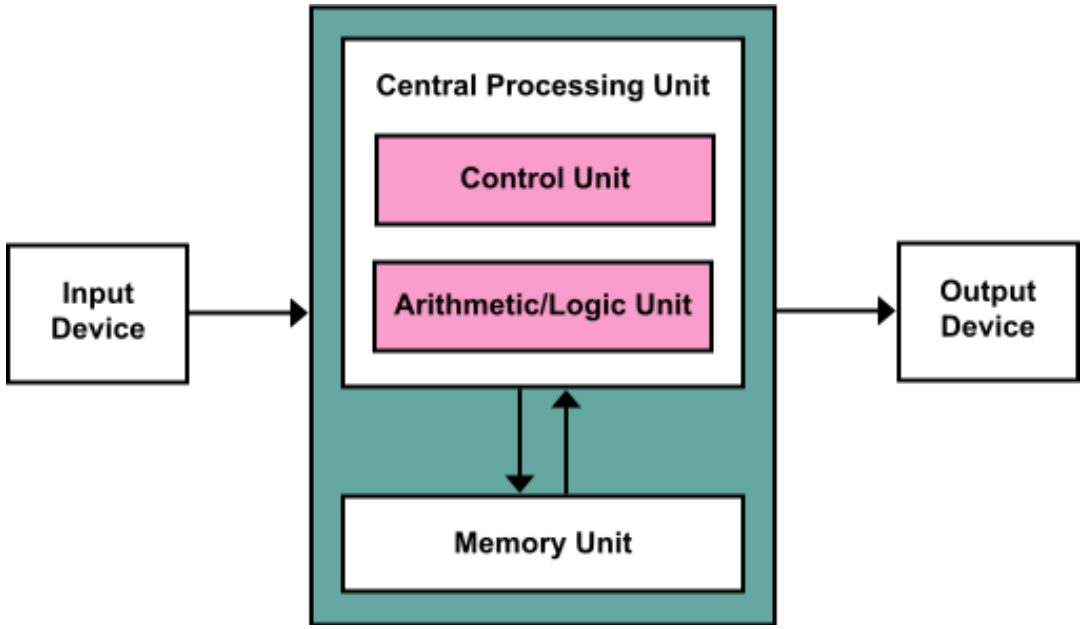
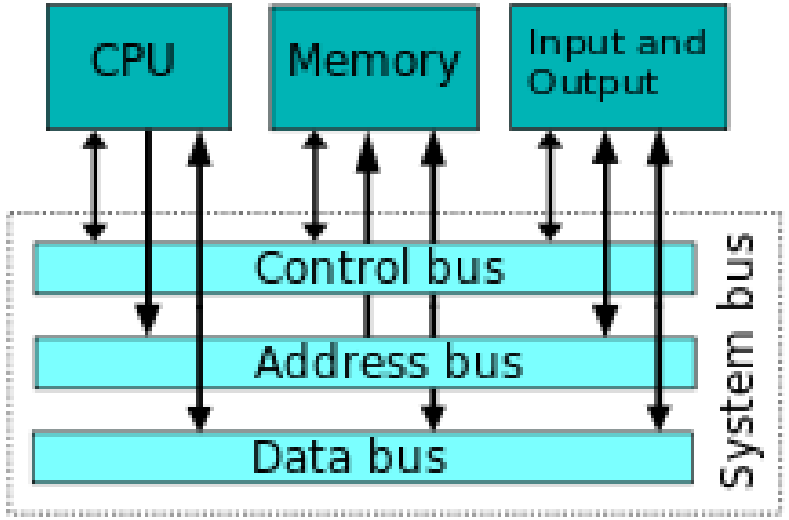
Amdahl's (parallelization has limits)
Dennard end (power leakage at smaller sizes)
Currently -> Domain specific chips is way forward (ex. Google Pixel Tensor)
-> More integration (ex. Apple M1)

Von Neumann

- Mathematician and Physicist
- **Modern CPUs are based off of Von Neumann (Princeton) Architectures** (1945)
  - Program instructions are data just like data processed by program
  - Control Unit tracks current step of program in memory
- **Stored-program architecture** (versus ENIAC types where you'd input program by physical configuration each time)





What is Computer Science?

“Science” is:

What is Computer Science?

- **Science: The effort to discover and increase understanding of how something works through controlled methods (experimentation), observation, and analysis.**

Computer Science

- Definition:
  - **The scientific study of computation and computer technology, hardware and software**
  - **The study of the theoretical foundations of information and computation, and their implementation and application in computer systems**
- **Combination of mathematics and engineering disciplines (even some philosophy!)**

Computer Science

“Computer science is no more about computers than astronomy is about telescopes.”

- **Edsger Dijkstra**

Portrait of Edsger W. Dijkstra
Photograph by Hamilton Richards

Onward to … Programming!

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