History of Computers

Dr. Sarah Harris

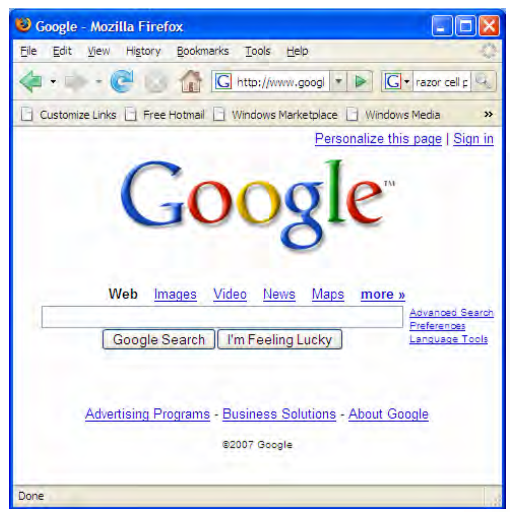
UNLV | Department of ELECTRICAL & COMPUTER ENGINEERING

My Background

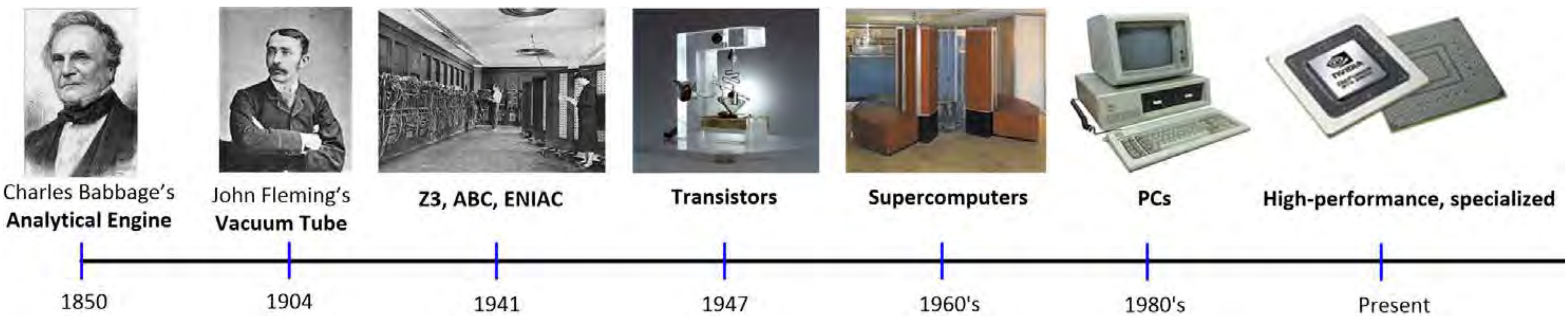
- **Stanford University:** Ph.D. & M.S.. 1998, 2005 (Electrical & Computer Engineering)
- **Harvey Mudd College:** Assistant/Associate Professor (2004-2014)
- **UNLV:** Associate Professor (2014 - present)
- **Industry experience:** Hewlett-Packard, Nvidia, Intel, Sierra Wireless, Southwest Research Institute, Qualcomm, etc.

Introduction

- Computers have revolutionized our world.
  - Smart phones, internet, rapid advances in medicine, etc.
- The semiconductor industry has grown from $21 billion in 1985 to $335 billion in 2016.

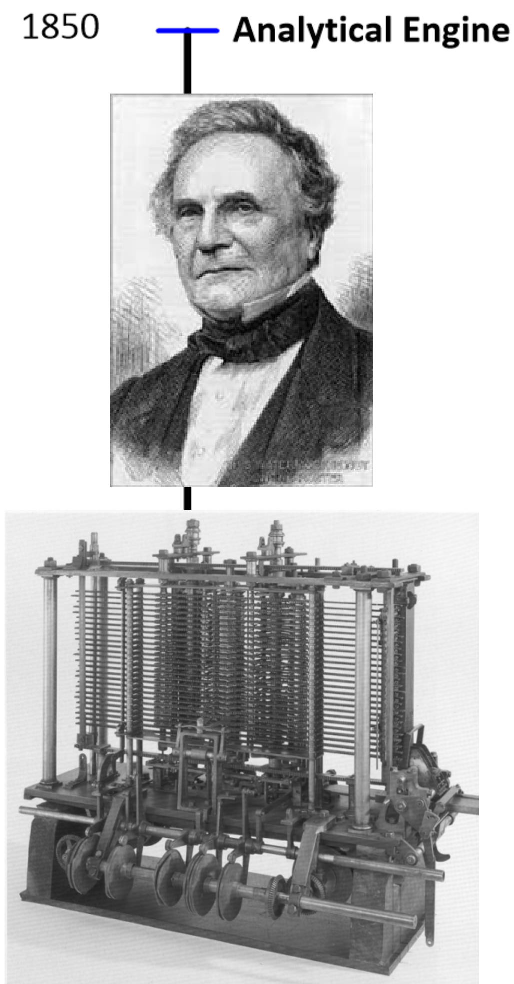


History of Computers



The First Digital Computer

- Designed by Charles Babbage, British mathematician, inventor
- He worked on it from 1834 – 1871
- Considered to be the first digital computer
- Built from mechanical gears, where each gear represented a discrete value (0-9)
- Babbage died before it was finished

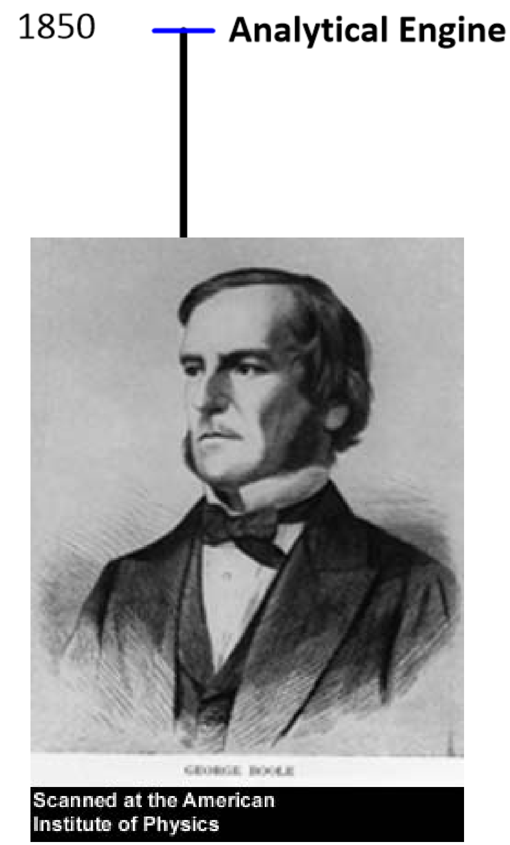


The First Computer Program

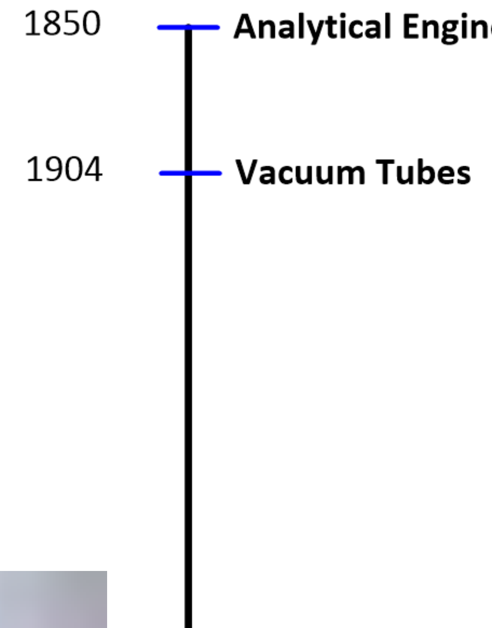
- Ada Lovelace wrote the first computer program.
- Her program calculated the Bernoulli numbers on Charles Babbage's Analytical Engine.
- She was the daughter of the poet Lord Byron.

Boolean Algebra – George Boole

- Born to working class parents
- Taught himself mathematics and joined the faculty of Queen’s College in Ireland
- Wrote *An Investigation of the Laws of Thought* (1854)
- Introduced binary variables (1’s, 0’s)
- Introduced the three fundamental logic operations: AND, OR, and NOT



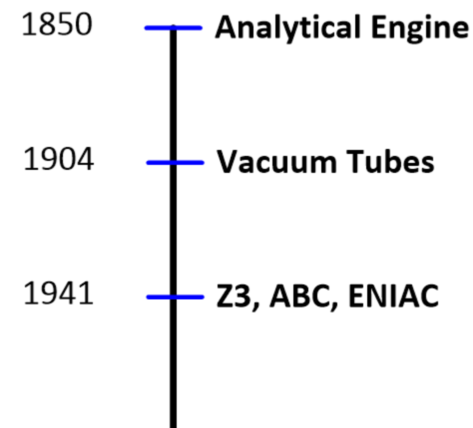
Vacuum Tube

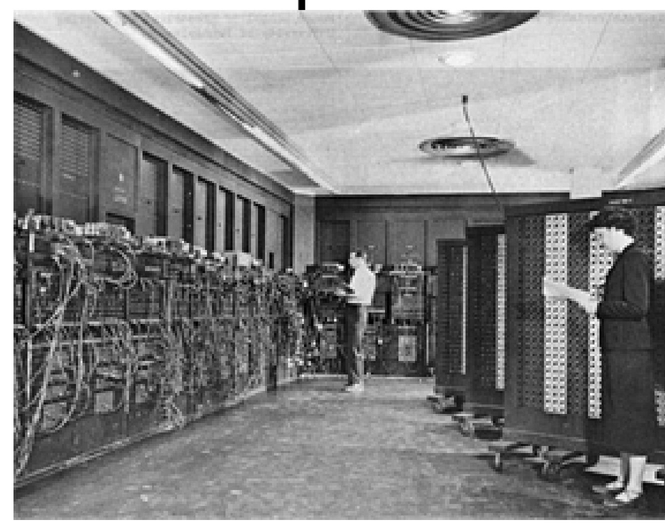


- Invented by John Fleming, a British electrical engineer and physicist
- Basic component of electronics in first half of 20th century

Vacuum Tube-Based Computers

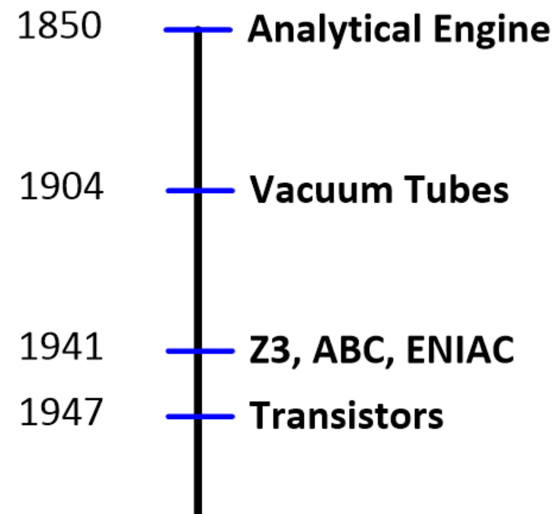
- **Z3 computer**, invented by Konrad Zuse in 1941
- **ABC** (Atanasoff-Berry Computer), 1942
- **ENIAC**, 1946 – weighed 30 tons and had 18,000 vacuum tubes





Transistors

- John Bardeen, Walter Brattain, and William Shockley invent the transistor at **Bell Labs**
- The first transistor was huge – about the size of the palm of your hand
- Now you can fit billions of transistors in the palm of your hand

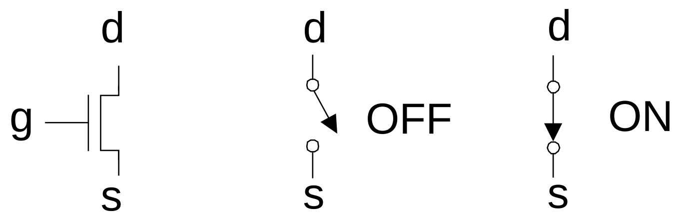


Transistors

- 3-terminal voltage-controlled device

Operation:

g = 0 g = 1



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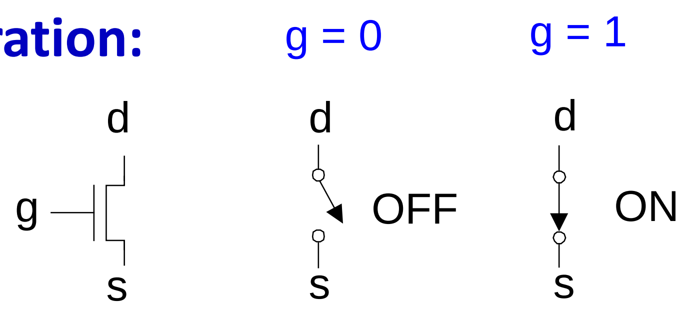
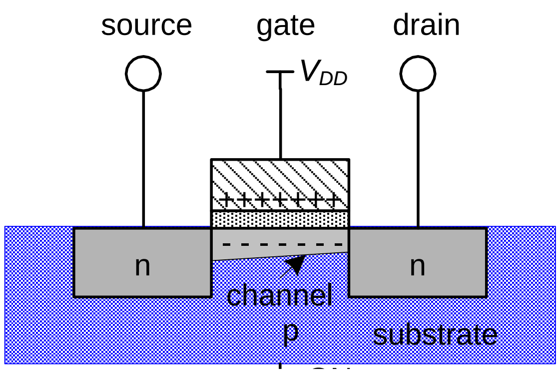


Physical Device:



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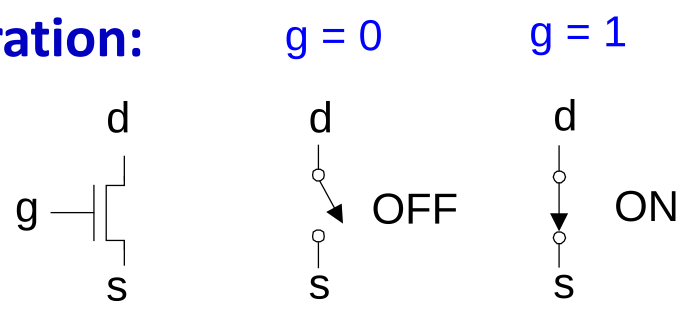

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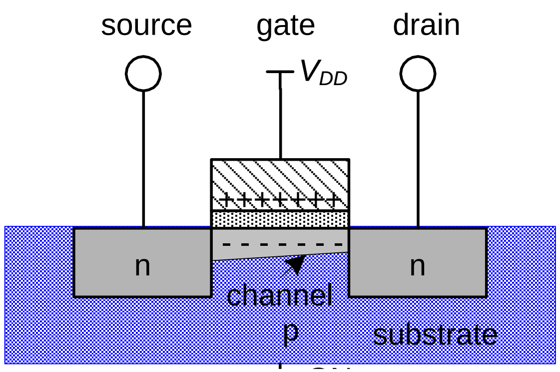
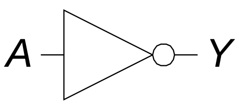


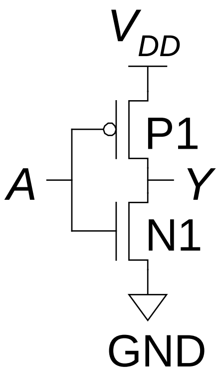
Example:

NOT

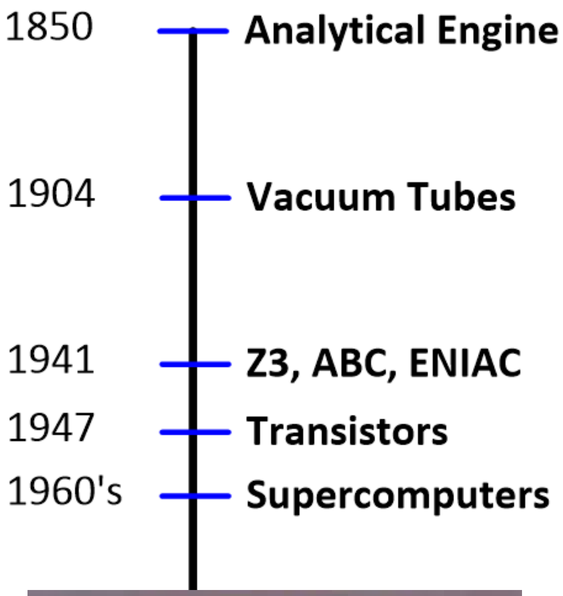


$Y = \overline{A}$

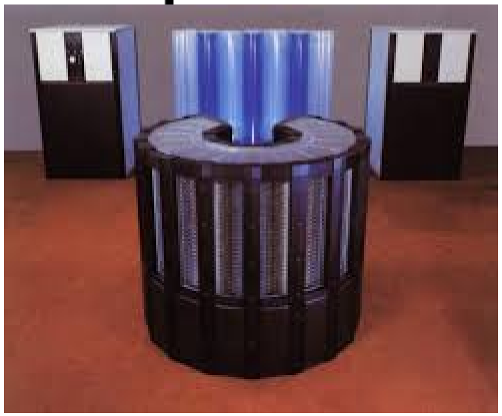
A	Y
0	1
1	0



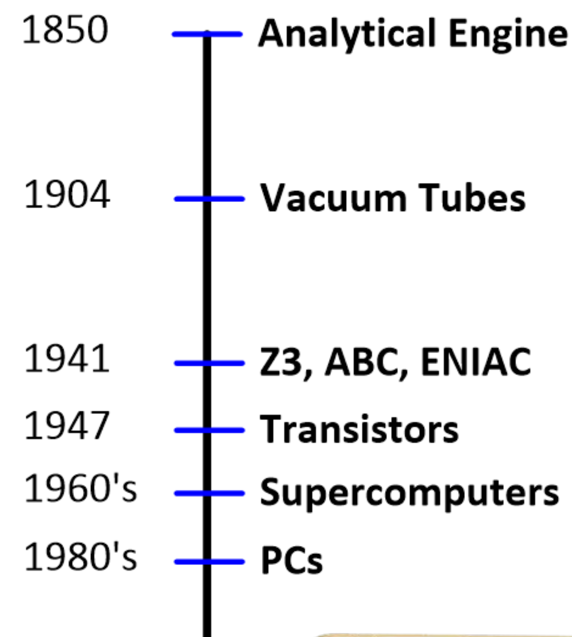
Supercomputers



- **High-performance computers**
- **Expensive**
- **Examples:**
- Cray-1 built in 1975
  - Cost: $8 million
  - Performance:160 MFLOPS (millions of floating point operations per second)
- Cray-2 (1985)
  - Cost: $32 million
  - Performance: 9 GFLOPS



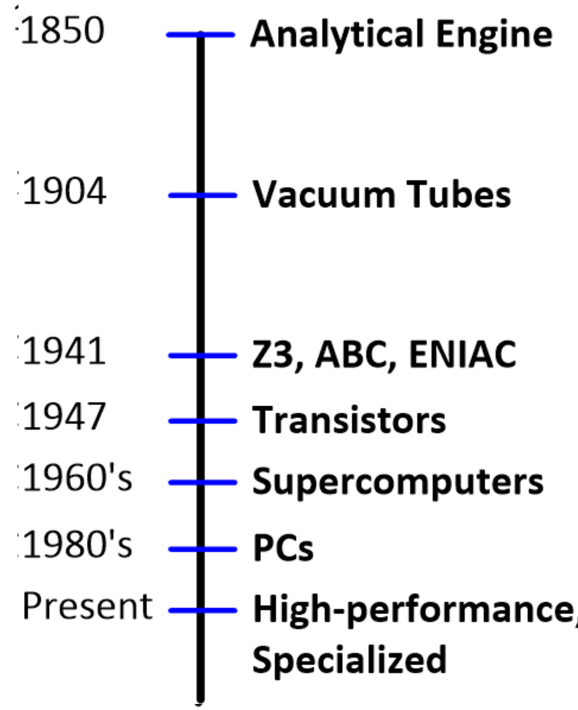
Personal Computers (PCs)



- **Low-cost, low-performance**
- IBM PC (1981)
  - Cost: $1,500 (~ $3,600 in current USD)
  - 5 MHz clock
  - 1 MIPS (million instructions per second)
- Mac (1984)
  - Cost: $2,500 (~$5,000 in current USD)
  - 7.8 MHz clock
  - 128 KB RAM

Modern Computers

- **High-performance:**
  - E.g., Core i7 (4 core) 161,000 MIPS
- **Specialized:**
  - Graphics processor (GPU)
  - Digital signal processor (DSP)
  - Multi-core
- **Low-cost:**
  - Microcontrollers (in dishwashers, toasters, etc.)
  - Internet of Things (IoT)

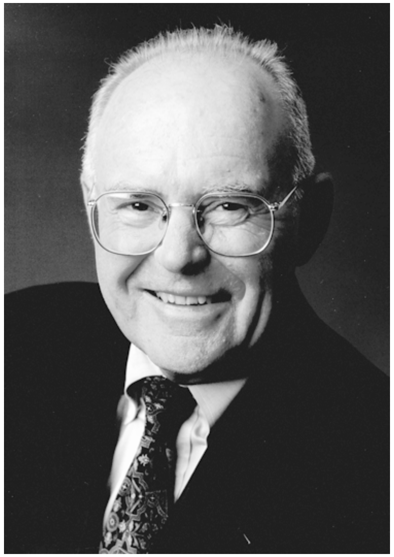


Big Question

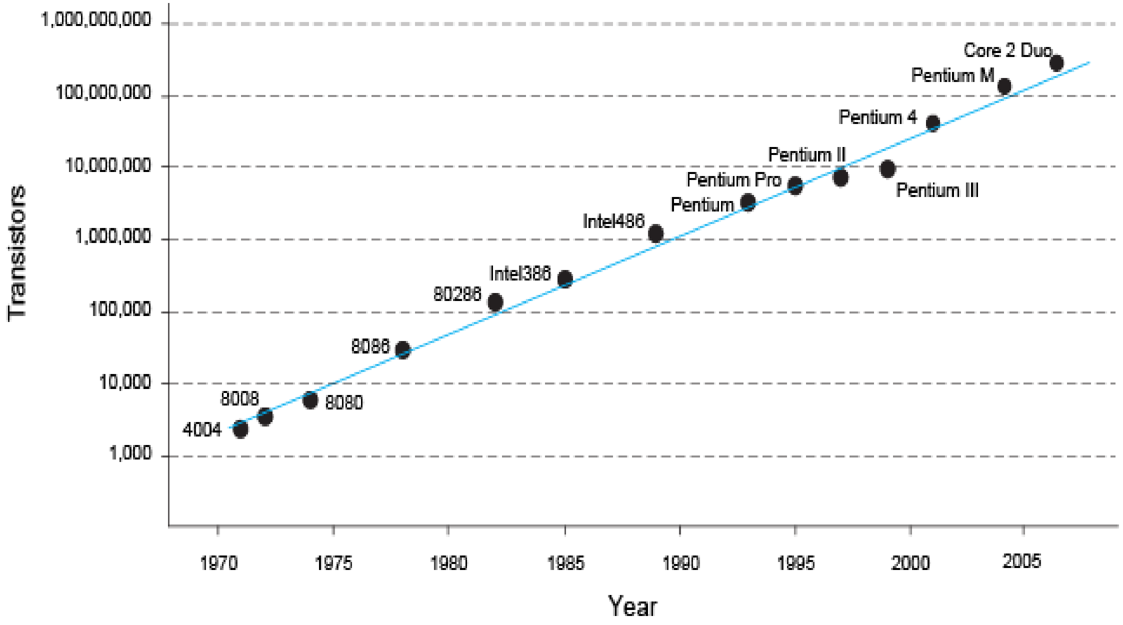
- **Used to be:** How to we get **more capability** (i.e., more transistors)?
- **Now:** **How do we use** all of these transistors?

Moore's Law

The number of transistors **doubles** every year (now every two years)



Gordon Moore, co-founded Intel in 1968 with Robert Noyce



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Research Topics

- **Hardware-accelerating** algorithms
  - Examples: DSPs, GPUs
- Efficiently **coding algorithms** to take advantage of underlying hardware
- **Interdisciplinary** research
  - Robotics, prosthetics
  - Informatics: managing large amounts of data, prediction, large computations (e.g., human genome)
  - Machine learning

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Robotics and Prosthetics

- **Challenge:** passive prosthetics are inefficient and can cause further dysfunction.

Robotics and Prosthetics

- **Solution:** active prosthetics mimic heel-toe push off, enabling more natural function and less compensation

BionX BiOM

SpringActive's Odyssey

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Robotics and Prosthetics

SpringActive’s Odyssey prosthetic ankle

https://www.youtube.com/watch?v=ncVi9El1pnE&feature=youtu.be

Robotics and Prosthetics

- **Control algorithm:** works pretty well, but must be manually adjusted / tuned.
- Humans use **feedback** (e.g., speed, force, terrain, etc.) to adjust.
- **Research objective:** instrument prosthetic leg with sensors to mimic real-time feedback of biological systems. Implement bio-inspired control algorithm.

Robotics and Prosthetics

- **Objective:** Implement bio-inspired control algorithm.
  - **Instrument prosthesis**
  - **Modify software to adjust velocity and force**

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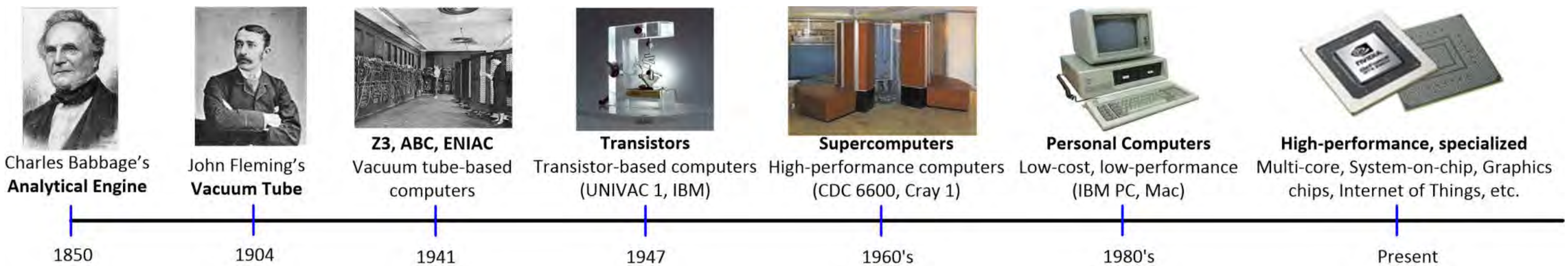

Where do we go from here?

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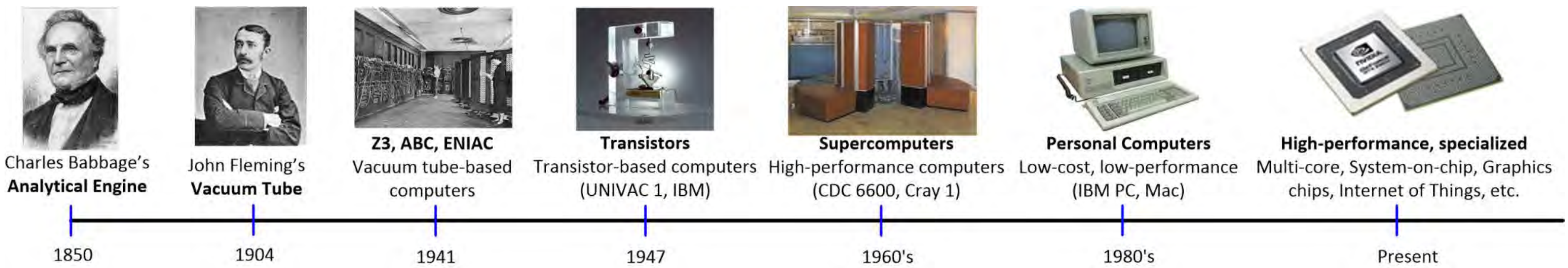
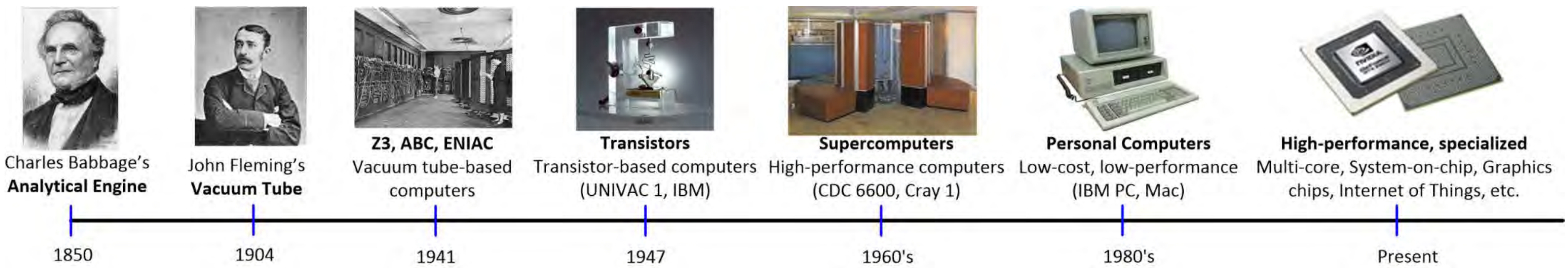


Where do we go from here?

…Many possibilities

Questions?



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