

History of Computer Science

AN ABRIDGED LOOK AT THE PIONEERS AND ACHIEVEMENTS

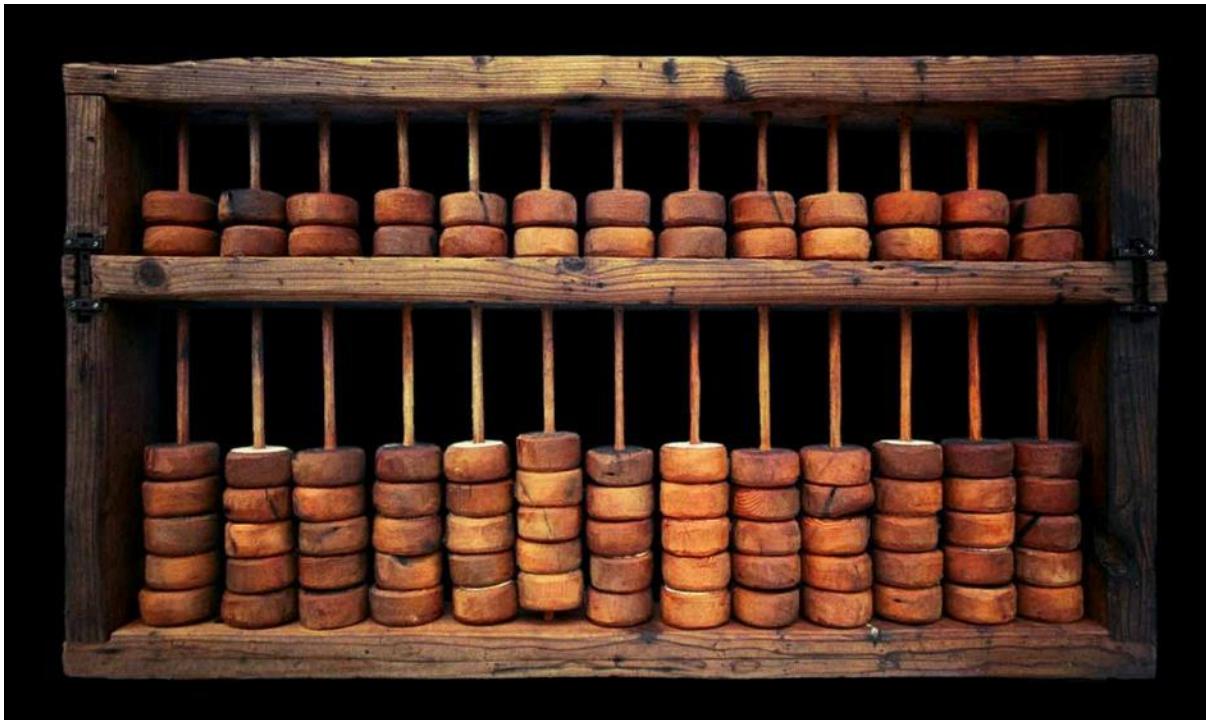
Learning Objectives

- ▶ I will understand how computers have evolved in society...
...and changed society.
- ▶ I will become familiar with Computer Science Pioneers...
...and their principal achievements.
- ▶ I will know the Five Generations of Digital Computing...
...and my place in this history.

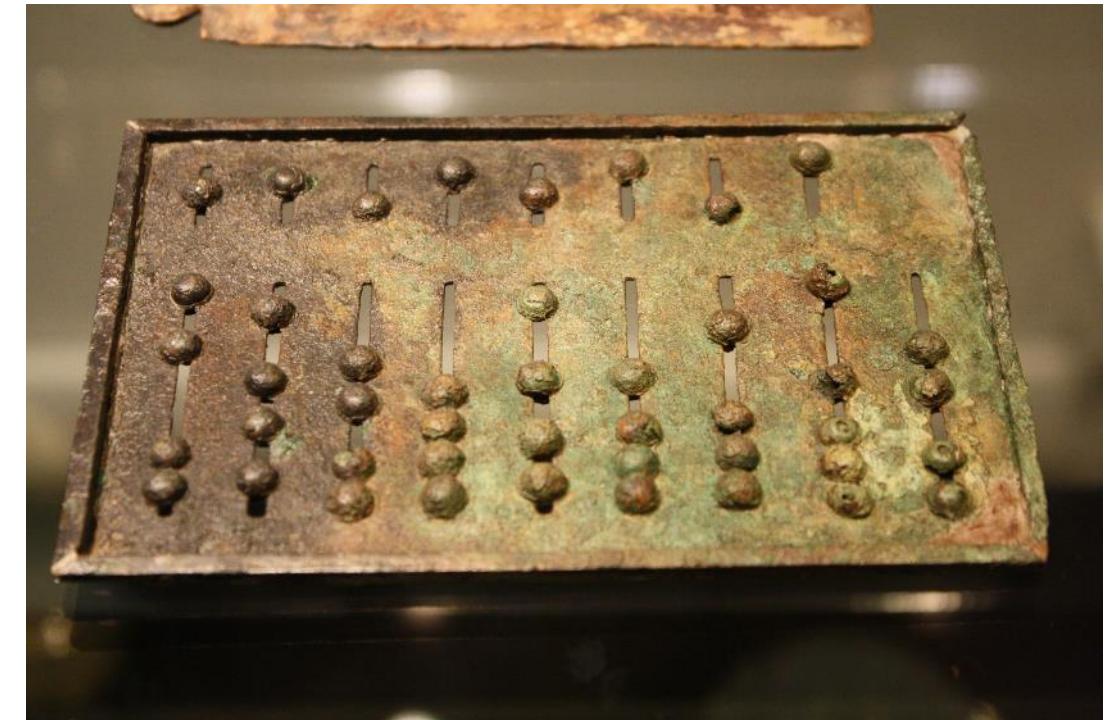


Ishango Bone:
Tally Stick from the
Paleolithic era
~20,000 BC

Abacus



Sumerian Abacus ~2700-2300 BC



Roman Abacus 1st Century AD

Greek Antikythera Mechanism ~200-70 BC



Found shipwrecked in 1901

First analog computer

Used to predict
astronomical positions

Modern Replica



Al-Khwarizmi, Polymath, 783-850 AD

Grandfather of Algorithms



Codified **Arabic Numbering System** starting with **ZERO** which we use today

Head of Baghdad House of Wisdom

Father of Algebra
Wrote works on
Mathematics,
Trigonometry,
and Astronomy

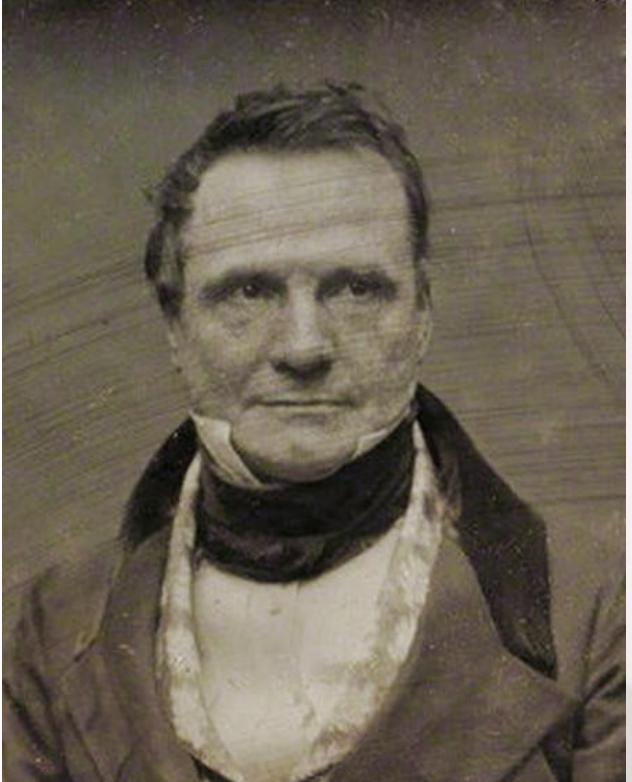
Ichon Kala complex in Khiva, Uzbekistan
image by Matthew Goulding, Flickr



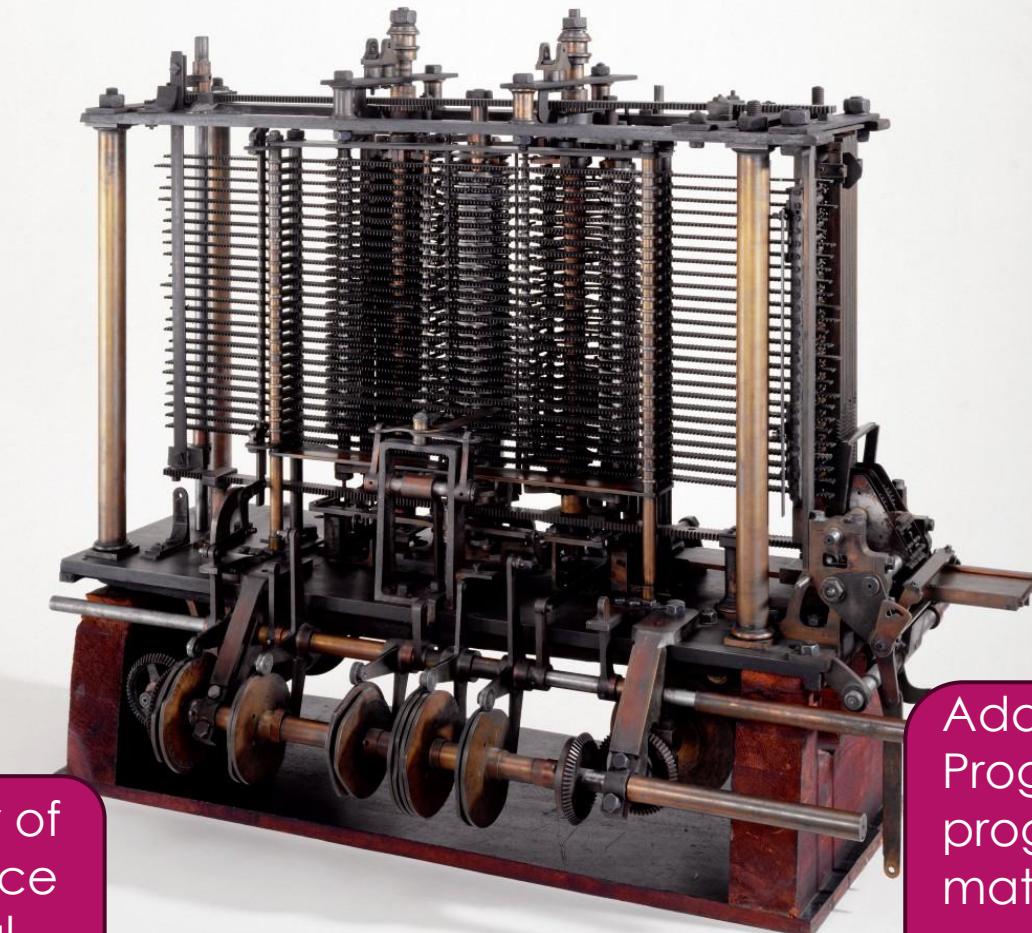
Wikimedia Commons

The word “Algorithms” is derived from his name.
First solution of linear and quadratic equations.

Difference Engine: 1820 AD First Mechanical Computer



Charles Babbage, “Father of Computers”, built Difference Engine for mathematical calculations



Ada Lovelace, “First Computer Programmer”, first to recognize programming applications beyond mathematical calculations. Her notes are the theoretical underpinnings for computer programming.

Alan Turing: Father of Computer Science

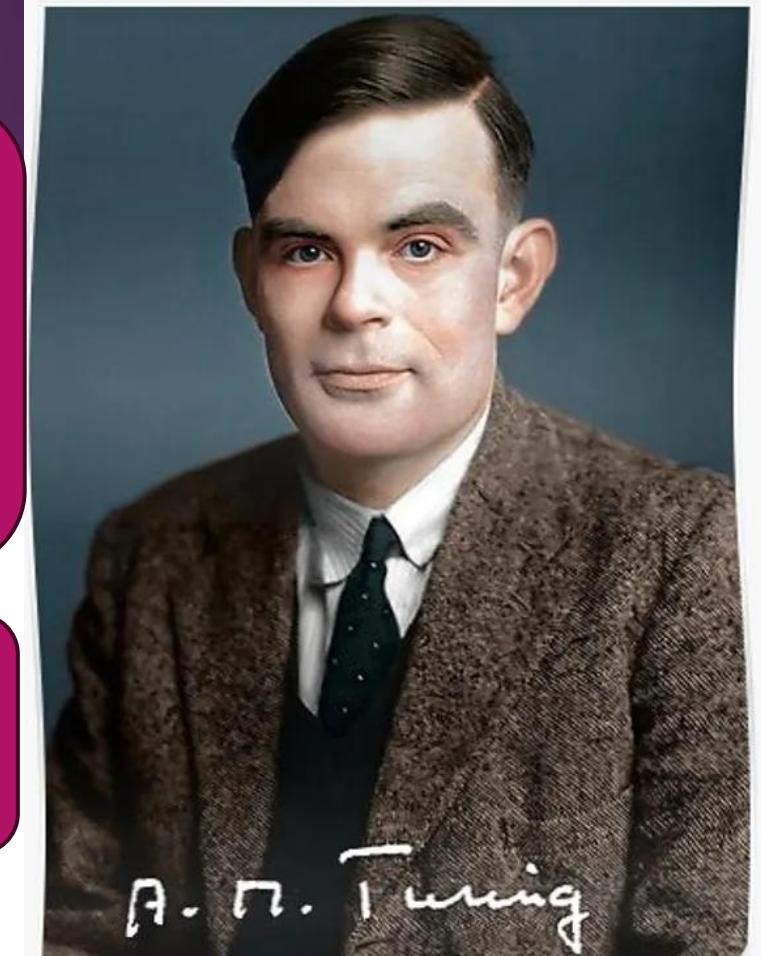
1912-1954



Bombe: Computational Engine that broke the WWII German Enigma Code
Pivotal for defeating Hitler

Turing Test:
A computer could be said to "think" if a human interrogator could not tell it apart, through conversation, from a human being.

Openly gay when that was illegal in the UK



Developed Algorithms, Computation, & Artificial Intelligence Concepts

Hedy Lamarr: Hollywood Actress & Inventor



Invented frequency-hopping for torpedo guidance in 1942, now used in Bluetooth, GPS, and Wi-Fi

Improved Wing Design for Howard Hughes WWII fighter planes

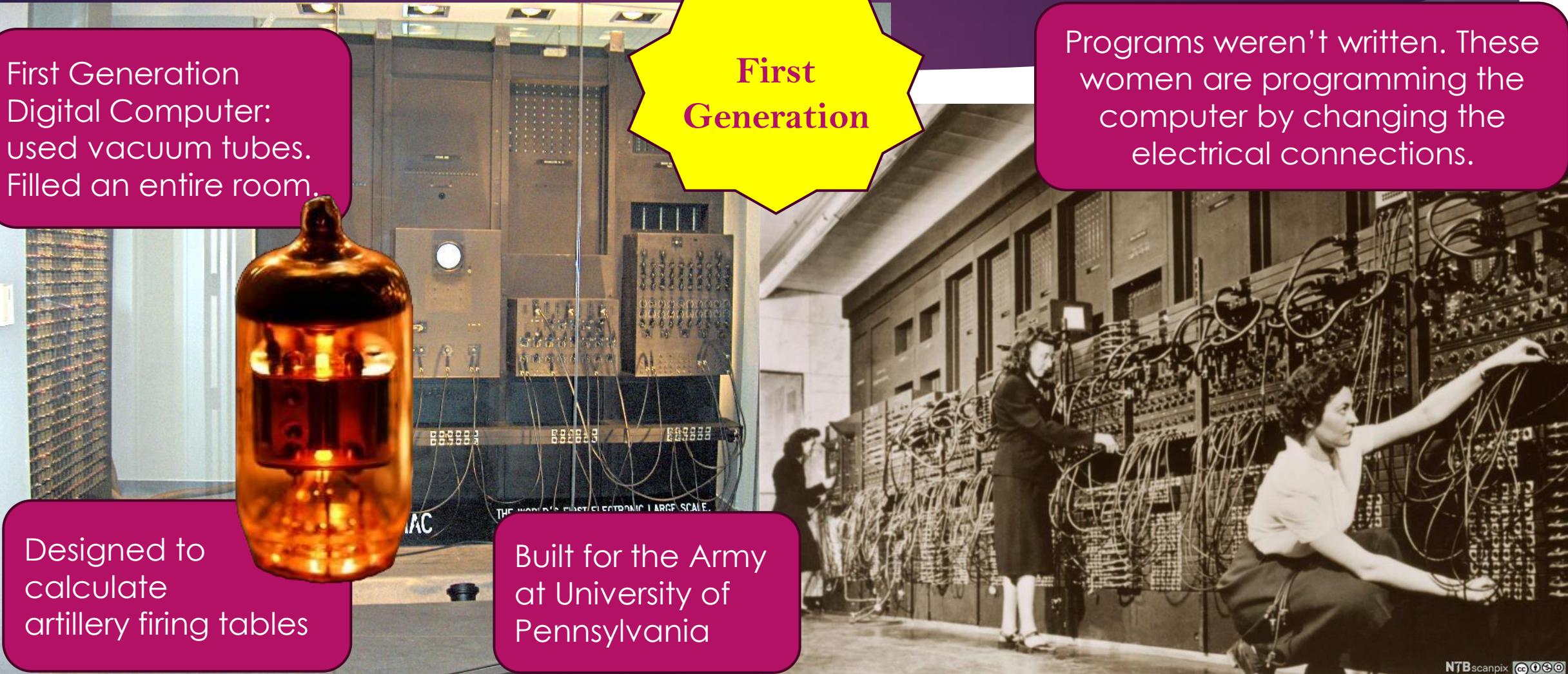


ENIAC: First Digital Computer: 1945

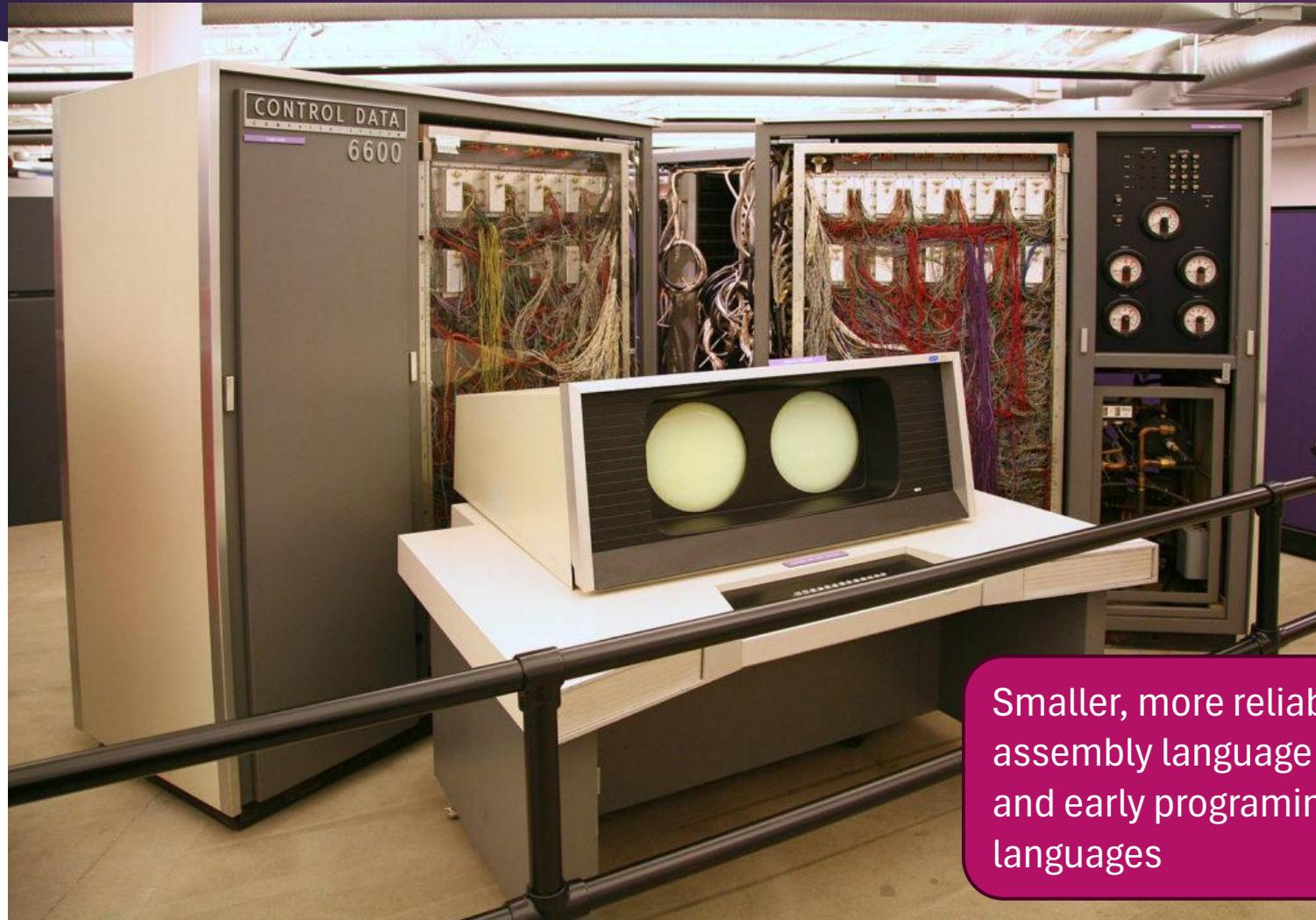
First Generation
Digital Computer:
used vacuum tubes.
Filled an entire room.

First
Generation

Programs weren't written. These women are programming the computer by changing the electrical connections.



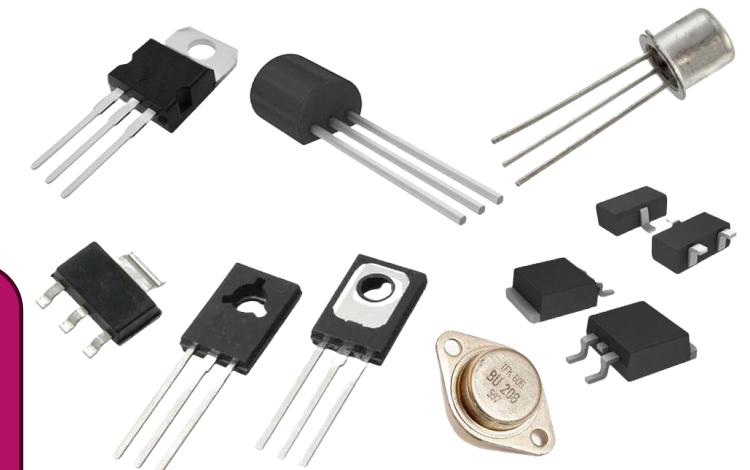
Transistors: IBM 7094



Smaller, more reliable,
assembly language
and early programming
languages

Programs written
in assembly
language

Second
Generation



Grace Hopper 1959 COBOL Programming Language

Third
Generation

COBOL: Common
Business-Oriented
Language



First modern high-level language. She believed programming languages should be machine independent and human readable.

```
PERFORM Z0001-CLOS-FILES THRU Z0001-EXIT.  
  
A0001-MAIN-EXIT.  
  EXIT.  
  
0001-OPEN-FILES.  
  
  OPEN INPUT IN001.  
  
  IF WS-IN-STAT NOT EQUAL ZEROES  
    SET WS-MSG-OP-IN TO TRUE  
    MOVE WS-IN-STAT TO WS-ERR-CDE  
    SET WS-PROC-OPEN TO TRUE  
    PERFORM Y0001-ERR-HANDLING THRU Y0001-EXI  
  END-IF.  
  
  OPEN OUTPUT OUT001.
```

NOT EQUAL ZEROES
-OP-OU TO TRUE
-STAT TO WS-ERR-CDE
-OPEN TO TRUE



Mathematician, Computer Scientist, and Navy Rear Admiral

Frank S. Green: Fastest Microchip 1962

Third
Generation



"Success in life is not about 'me,' but about what you can do to help others."

Developed the fastest microchip working for Fairchild in 1962

Air Force Captain: First Commissioned Black Air Force ROTC cadet

Founded software companies as well as a venture capital firm that focused on investments in minority- and female-led companies

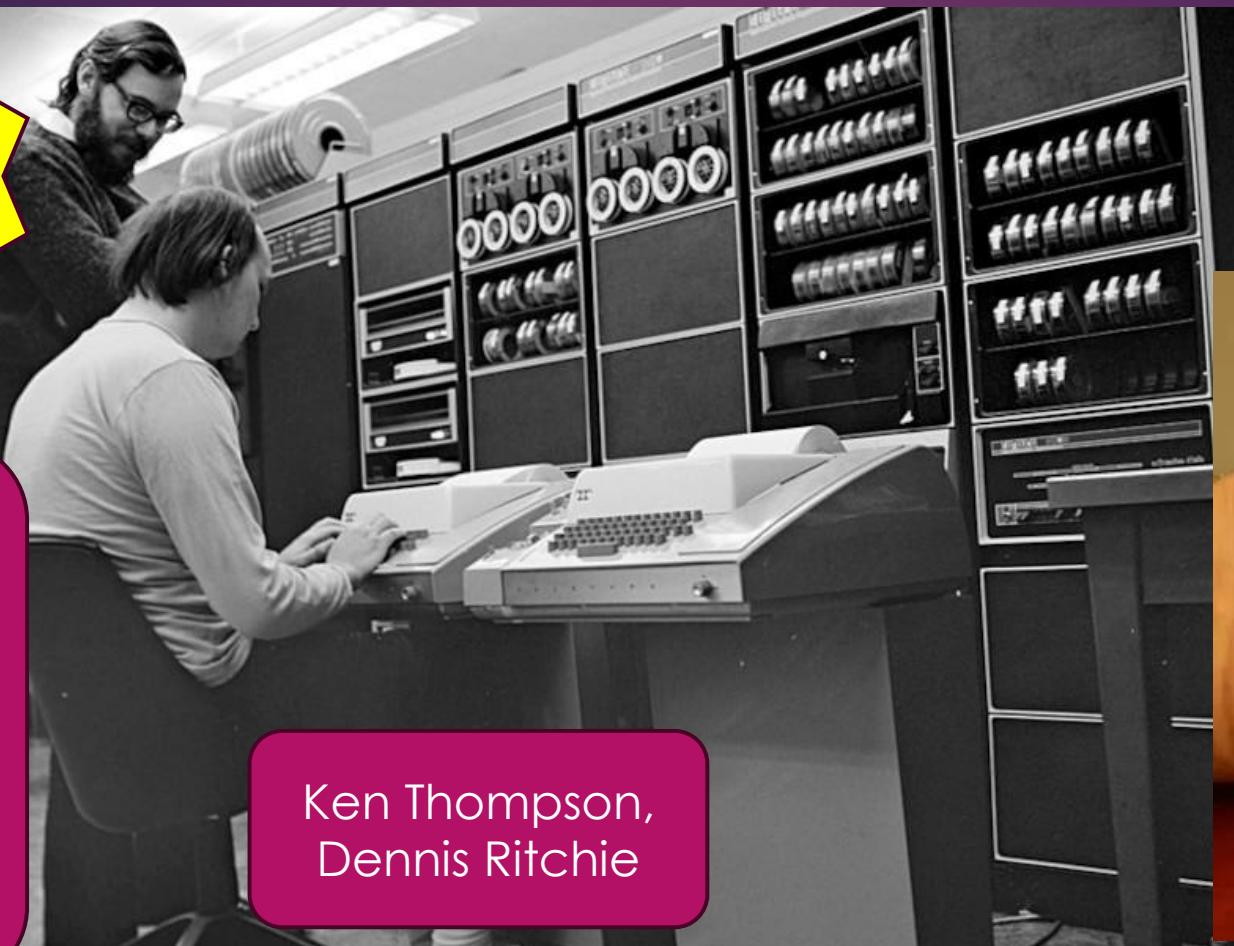
UNIX: 1969 – Bell Laboratories

Third Generation

Programs stored
in disk drive

Unix operating
system made
networking
possible

Ken Thompson,
Dennis Ritchie

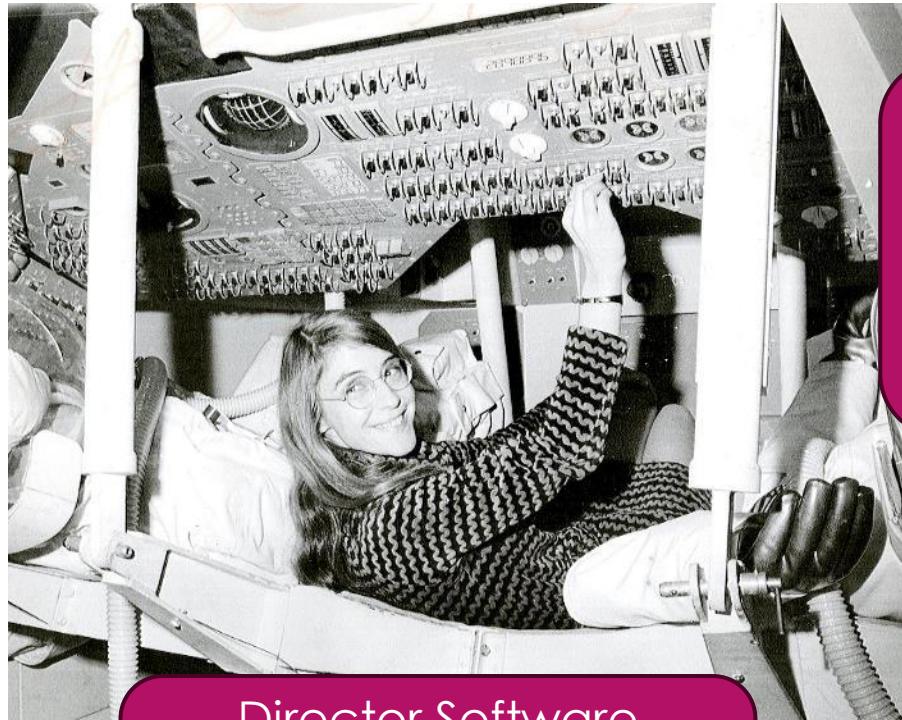


Integrated Circuit or
Microchip: multiple
interconnected
transistors, resistors, and
capacitors etched
onto a silicon
semiconductor



Size comparison: early
microchip, transistor, and
a vacuum tube.

Margaret Hamilton: 1963



Director Software Engineering, MIT Instrumentation Laboratory

Directed the team that developed the on-board flight software for NASA's Apollo program

Coined the term *Software Engineering*



Standing next to a printout of her team's software code

Annie Easley: NASA Computer Programmer 1970s

One of NASA's "hidden figures". Developed the code essential to operating NASA's Centaur rocket and powering early hybrid vehicle battery technology.

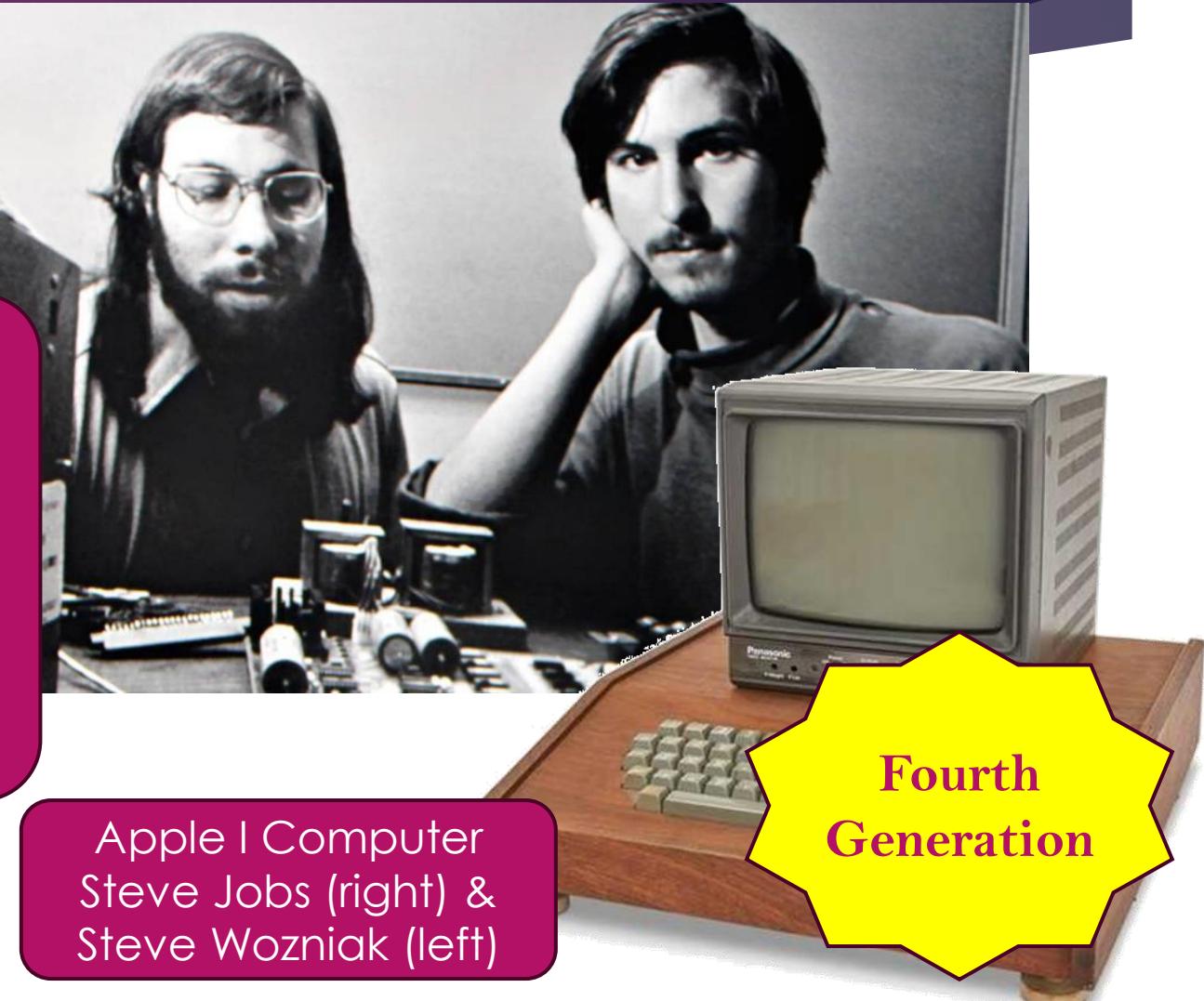


1970s: Microprocessors & Personal Computers



Microsoft MS-DOS
Bill Gates & Paul Allen

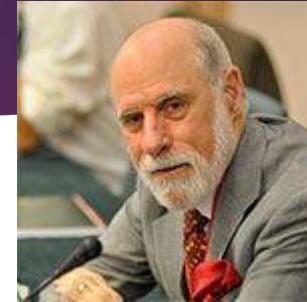
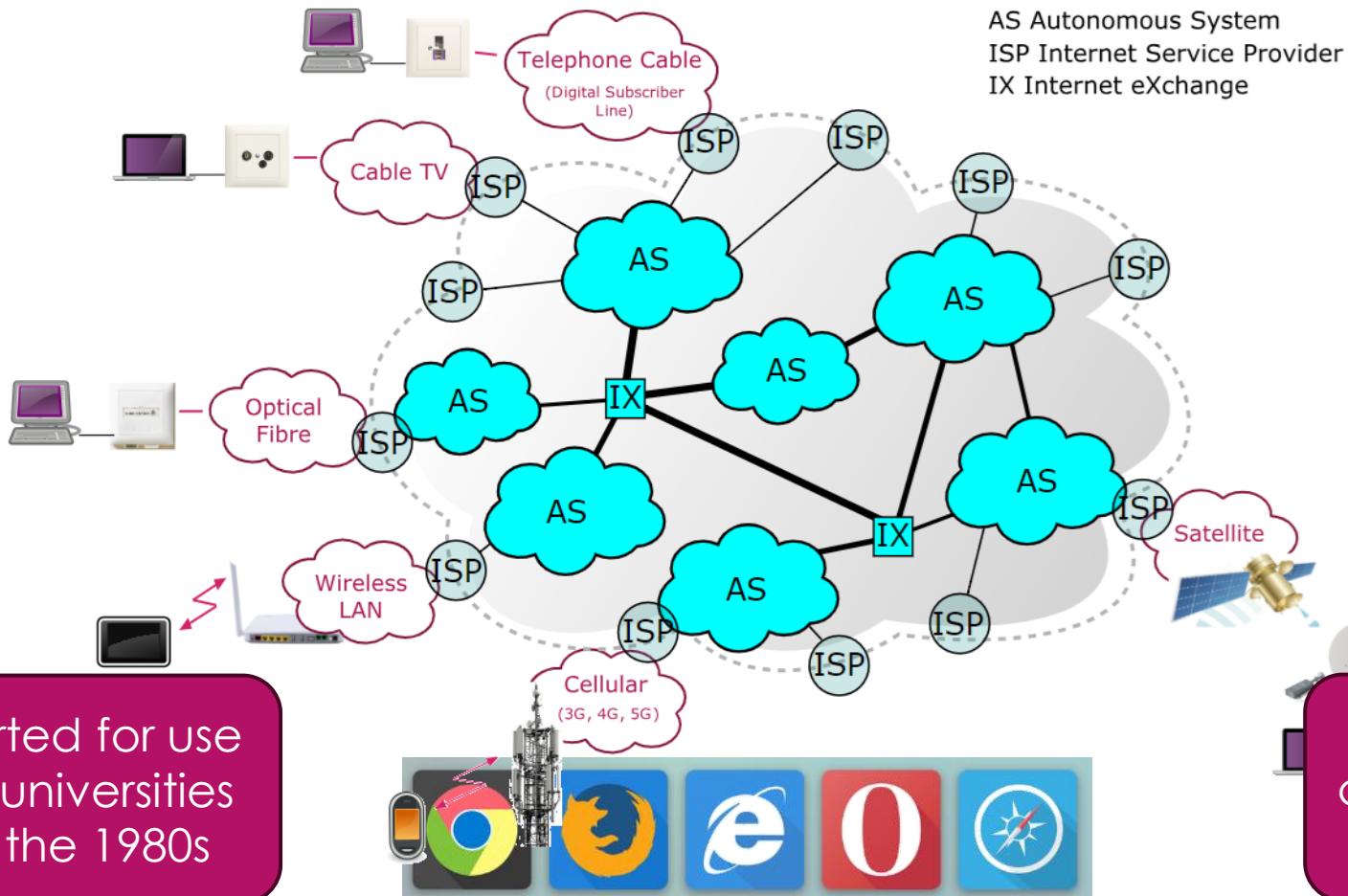
"A computer
on every
desk and in
every
home."
original
Microsoft
Mission
Statement



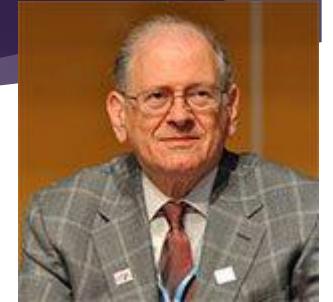
Apple I Computer
Steve Jobs (right) &
Steve Wozniak (left)

Fourth
Generation

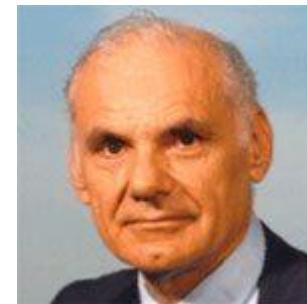
The Fathers of the Internet & World Wide Web 1983



Vinton Cerf



Bob Kahn



Larry Roberts

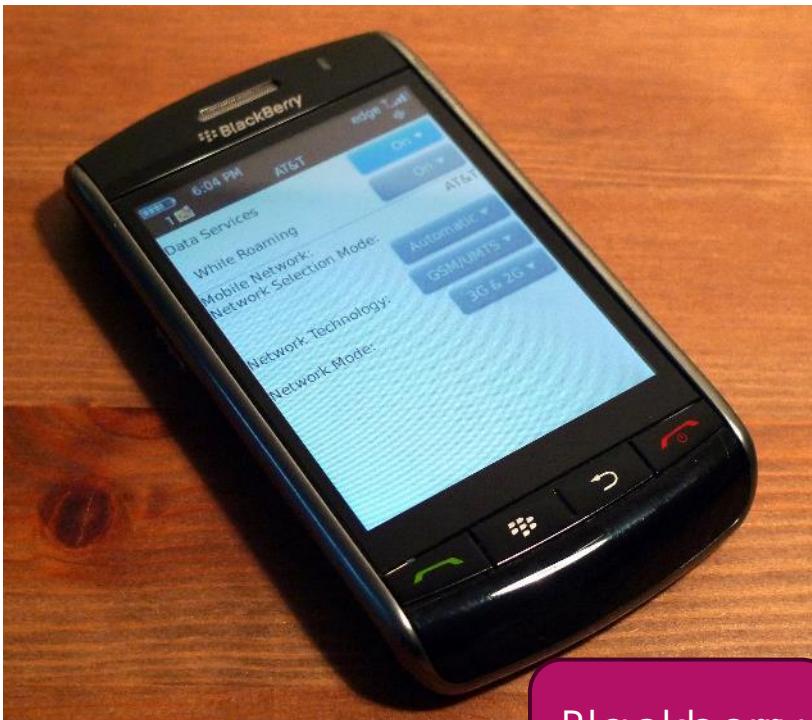


Sir Tim Berners-Lee

Became commercial in 1990s



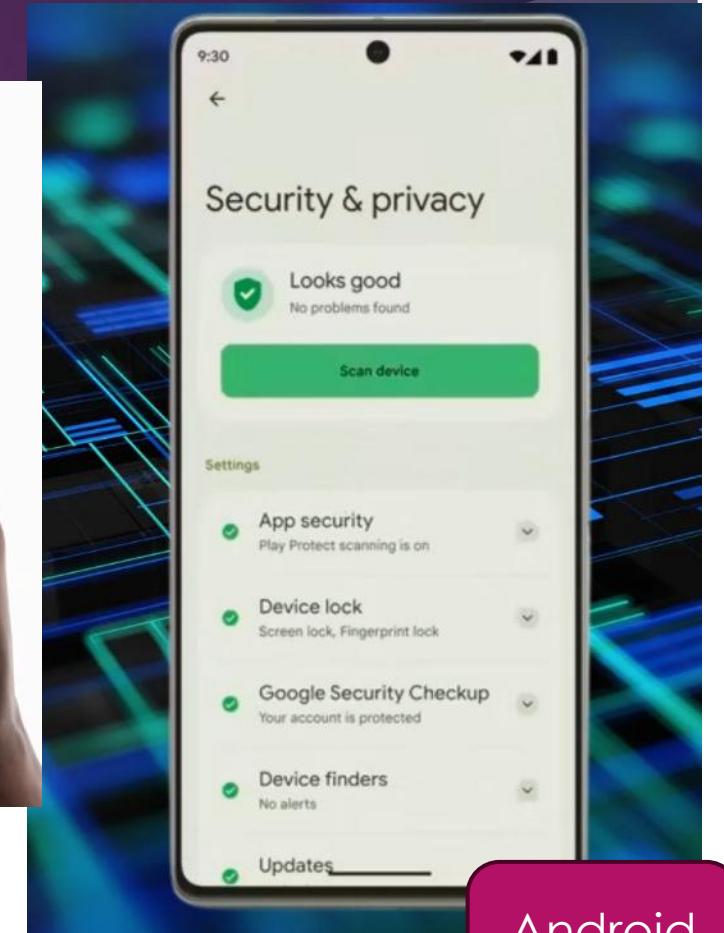
Smartphones & Mobile Computing 1992



Blackberry
1999



iPhone
2007



Android
2008

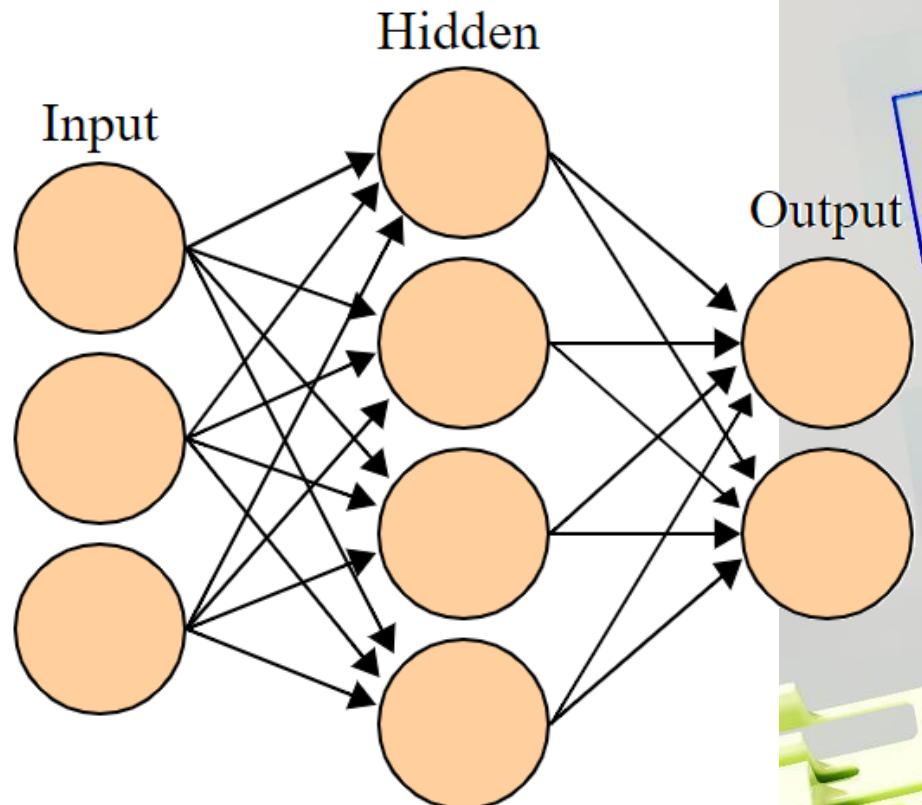
James Gosling: Java 1995

Write Once,
Run Anywhere

- ▶ One of the first Object Oriented Programming (OOP) languages
- ▶ Most widely used high-level programming language in the world
- ▶ Runs on a Java virtual machine (JVM) so that compiled code can run on any platform that supports Java without the need to recompile.
- ▶ Robust, secure, general-purpose language with syntax based on C
- ▶ Managed code: no pointers, handles memory allocation/deallocation, garbage collection
- ▶ Microsoft modeled C# after Java



Generative AI: Large Language Models and Neural Networks



Model of a Neural Network



Quantum Computing – Still Experimental



QPU operates in base 3: On, Off,
and Both

Fifth
Generation

Uses Quantum
Mechanics to
manipulate
probabilistic
states on an
atomic level

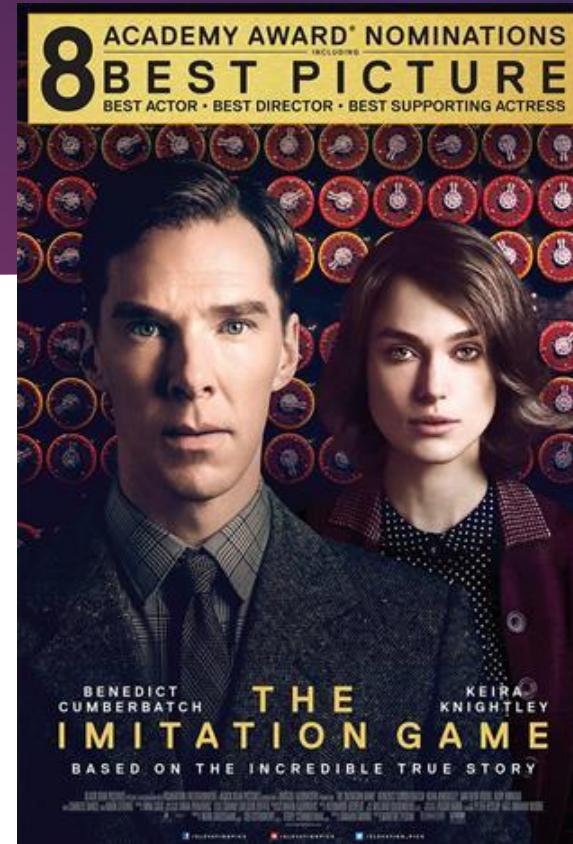
Millions of times faster than
any modern computer

Computers and Computerized Devices



And many more...

- ▶ More on Computer Science History:
<https://www.livescience.com/20718-computer-history.html>
- ▶ Computer Science Pioneers:
<https://www.rasmussen.edu/degrees/technology/blog/famous-computer-scientists-who-impacted-the-industry/>
- ▶ Black Computer Science Pioneers:
<https://elective.collegeboard.org/black-computer-science-pioneers-everyone-needs-know>
- ▶ Women in Computer Science:
<https://www.computerscience.org/resources/most-influential-women-computer-science/>



Life story of Alan Turing,
Father of Computer
Science



Story of the Black Women
who helped America get
to the moon

Awesome movies
about Computer
Science Pioneers

Computer Generations

	Technology	Characteristics	Time
First Generation	Vacuum Tubes	Large, bulky, programming in machine code	1940s-1950s
Second Generation	Transistors	Smaller, more reliable, assembly language and early programming languages	1950s-1960s
Third Generation	Integrated Circuits	Increased speed, efficiency, reliability, multiprogramming & multitasking, high level programming languages	1960s-1970s
Fourth Generation	Microprocessors	Drastic reduction in size and cost, development of personal computers, storage improvements	1970s-Present
Fifth Generation	Quantum Computing, Nanotechnology, AI	Focus on artificial intelligence: machine learning, neural networks, & Large Language Model (LLM). Cloud computing, continued miniaturization, increased connectivity, and integration with the Internet of Things	Present and Beyond

The History of
Computer
Science is the
human story
of what we
can build &
achieve



And the Next Great Advance is by ???

Leonard Adleman	Gottfried Leibniz	Joseph Sifakis	Ivan Sutherland	John Cocke	Al-Jazari	John Henry Thompson
Howard Aiken	J. C. R. Licklider	Elizabeth Feinler	Robert Tarjan	Edgar F. Codd	William Kahan	Alonzo Church
Al-Khwarizmi	Barbara Liskov	Tommy Flowers	Charles P. Thacker	Lynn Conway	Bob Kahn	Wesley A. Clark
Frances E. Allen	Ramon Llull	Robert W. Floyd	Ken Thompson	Stephen Cook	Maurice Karnaugh	Edmund M. Clarke
John Atanasoff	Ada Lovelace	Sally Floyd	Chai Keong Toh	James Cooley	Richard M. Karp	Bjarne Stroustrup
Charles Babbage	Percy Ludgate	Gottlob Frege	Cuthbert Hurd	Allen Coombs	Jacek Karpinski	Per Brinch Hansen
Charles Bachman	Per Martin-Löf	Stephen Furber	Linus Torvalds	Rózsa Péter	Alan Kay	Frank Wilfred Jordan
John Backus	John Mauchly	Sophie Wilson	John W. Tukey	Seymour Cray	Tom Kilburn	Michael O. Rabin
Banū Mūsā	John McCarthy	Seymour Ginsburg	Alan Turing	David N. Cutler	Gary Kildall	George R. Stibitz
Paul Baran	John Bardeen	Kurt Gödel	Leslie Valiant	Ole-Johan Dahl	Russell Gray Kirsch	Edward J. McCluskey
Émile Baudot	Bertrand Meyer	Shafi Goldwasser	Ramón Verea	Donald Davies	Leonard Kleinrock	Hsu Feng-hsiung
Friedrich L. Bauer	Silvio Micali	Frank Gray	Wang An	Whitfield Diffie	Stephen Cole Kleene	Fernando J. Corbató
William Shockley	Robin Milner	Jim Gray	Willis Ware	Edsger W. Dijkstra	Donald Knuth	James H. Wilkinson
Yoshua Bengio	Marvin Minsky	John Gustafson	David Huffman	William Eccles	Simon S. Lam	Alexander Stepanov
Hinton Geoffrey	Charles H. Moore	Margaret Hamilton	George K. Zipf	Raj Reddy	Hedy Lamarr	Katherine Johnson
Yann LeCun	Satoshi Nakamoto	Richard Hamming	Maurice Wilkes	J. Presper Eckert	Leslie Lamport	Guido van Rossum
Tim Berners-Lee	Nakashima Akira	Wolfgang Pauli	Walter Brattain	E. Allen Emerson	Butler W. Lampson	Michael Stonebraker
Manuel Blum	Peter Naur	Pat Hanrahan	Klaus Fuchs	Douglas Engelbart	Peter Landin	Dorothy Vaughan
Corrado Böhm	John von Neumann	Juris Hartmanis	Alan T. Cromie	Federico Faggin	David Packard	Shima Masatoshi
George Boole	Allen Newell	Anders Hejlsberg	Heinz Zemanek	Dennis Ritchie	Bill Hewlett	Sergei Alekseyevich Lebedev
Kathleen Booth	Max Newman	Martin Hellman	Konrad Zuse	Ron Rivest	Annie Easley	Luitzen Egbertus Jan Brouwer
Noam Chomsky	Kristen Nygaard	John L. Hennessy	John von Neumann	Saul Rosen	Frank S. Greene	Edward Feigenbaum
Fred Brooks	Blaise Pascal	Geoffrey Hinton	Edsger Dijkstra	Philip Rubin	Evelyn Boyd Granville	Joseph Marie Jacquard
Rediet Abebe	Pāṇini	C. A. R. Hoare	Bill Gates	Bertrand Russell	Clarence "Skip" Ellis	Richard E. Bellman
Arthur Burks	David Patterson	Betty Holberton	Steve Jobs	Jean E. Sammet	Gladys West	Adriaan van Wijngaarden
Vannevar Bush	Judea Pearl	Herman Hollerith	Vinton G. Cerf	Amir Pnueli	Roy L. Clay Sr.	Charles Sanders Peirce
David Caminer	Alan Perlis	John Hopcroft	James Gosling	Dana Scott	Mark Dean	Leonardo Torres Quevedo
Edwin Catmull	Radia Perlman	Grace Hopper	Brian Kernighan	Adi Shamir	Marian R. Croak	Joseph Weizenbaum
Mary Jackson	Richard E. Stearns	Richard Stallman	Herbert A. Simon	Claude Shannon	Emil L. Post	Larry Roberts
Steve Wozniak	Paul Allen	Larry Page	Sergey Brin	Kenneth Iverson	Harry Huskey	