History & Ethics

# Introduction and History of Computer Science

CS51 – Spring 2026

# Welcome!

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# Who are you?

- Preferred name and pronouns
- Programming experience
  - Concurrently enrolled in CSCI050, or
  - Placed out of CSCI050 after talking with Prof. Chen

# Nice to meet you!

# Talk to your neighbor

- When do you think the first computer was invented?
- What names come to mind when thinking of people that have influenced technology?

# What is CS51?

- An introduction to computer science through a survey of fundamental topics and a glimpse into our curriculum.
  - Week 1: History and Ethics of Computer Science
  - Weeks 2-5: Computer Systems (CSCI105)
  - Weeks 6-9: Mathematical Foundations of Computer Science (CSCI054)
  - Weeks 10-13: Data Structures and Algorithms (CSCI062 and CSCI140)
  - Weeks 13-15: Theory of Computation & Programming Languages (CS101)
  - Weeks 15-16: Machine Learning (electives)

# Some examples of what you will learn

- Origins of computation, influential historical figures that shaped computer science and ethical implications.
- How computers process and store information and the main components of modern computers
- Not only to write programs but prove their correctness and analyze their running time
- Fundamental data structures to organize data
- Simple computational models

# How can I succeed in CS51?

- Sleep well the night before, eat, attend class, be on time for class and lab
- Take notes, participate, ask questions, don't stay confused
- Review slides and do practice problems after each lecture
- Start the assignments **early**
- Come to office hours/mentor sessions
- Budget at least 8 hours outside class time
- Read email/Slack for announcements and bookmark course website:
  - https://cs.pomona.edu/classes/cs51/

# How can I be a good citizen in CS51?

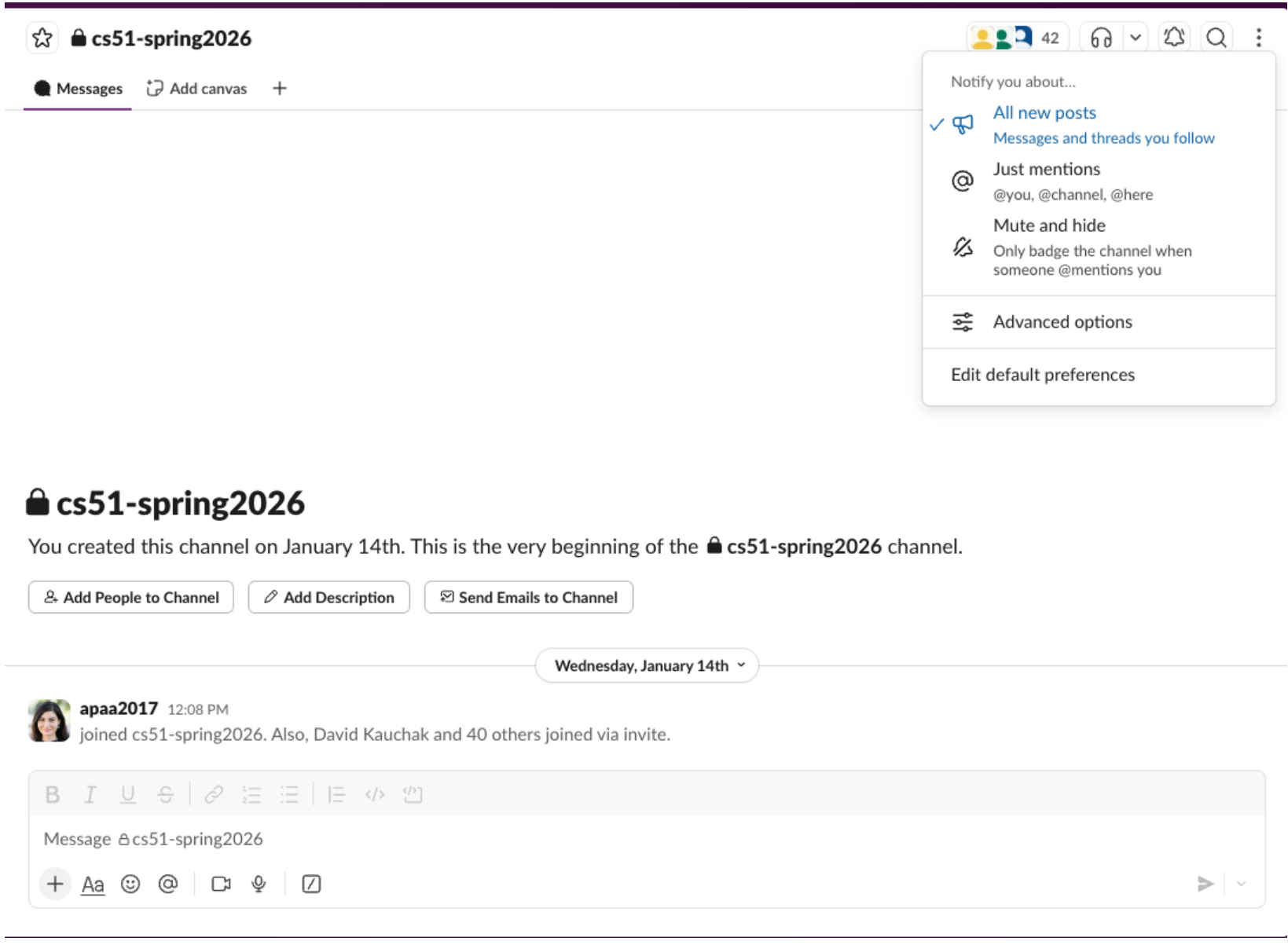
- Use laptops/tablets/phones/other fancy electronics only for note taking/live coding.
- Be mindful when in office hours/mentor sessions of other students waiting for help.
  - Come with specific questions after you tried the problem!
- TAs are students, too. Respect their time outside mentor sessions.
- We encourage collaboration but we want you to submit your own assignments.
- We monitor assignments for plagiarism. This includes using code from other students, websites, or tools like coPilot or chatGPT.
  - Academic honesty violations are reported to the Dean of Students. Assignments/grades will receive a zero and half a letter grade is reduced. Second infraction leads to failure of the course.
  - If unsure about what's allowed, talk to us!

# Grading summary

- Weekly Assignments: 35%
  - Four free days - can stack on one assignment or use across different assignments.
  - If group assignment, both partners have to use a free day.
  - Let us know **before** the deadline if you will take a late day pass.
- Checkpoint I: 15% (February 14th)
- Checkpoint II: 15% (April 14th)
- Final Exam: 30% (Section I: May 13th at 2-5pm. Section II: May 15th at 2-5pm)
  - If traveling, please book your tickets accordingly to avoid conflicts.
- Lab Attendance: 5%
  - You have to attend lab in person to receive credit. Can skip one lab, no questions asked.
  - Assignments will start with deliverables due **at the beginning of each lab.**

# Slack channels

- If registered, you have been invited to cs51-spring2026 channel in http://slack.pomona.edu
- Department-wide Slack workspace https://tinyurl.com/PomonaCSSlack

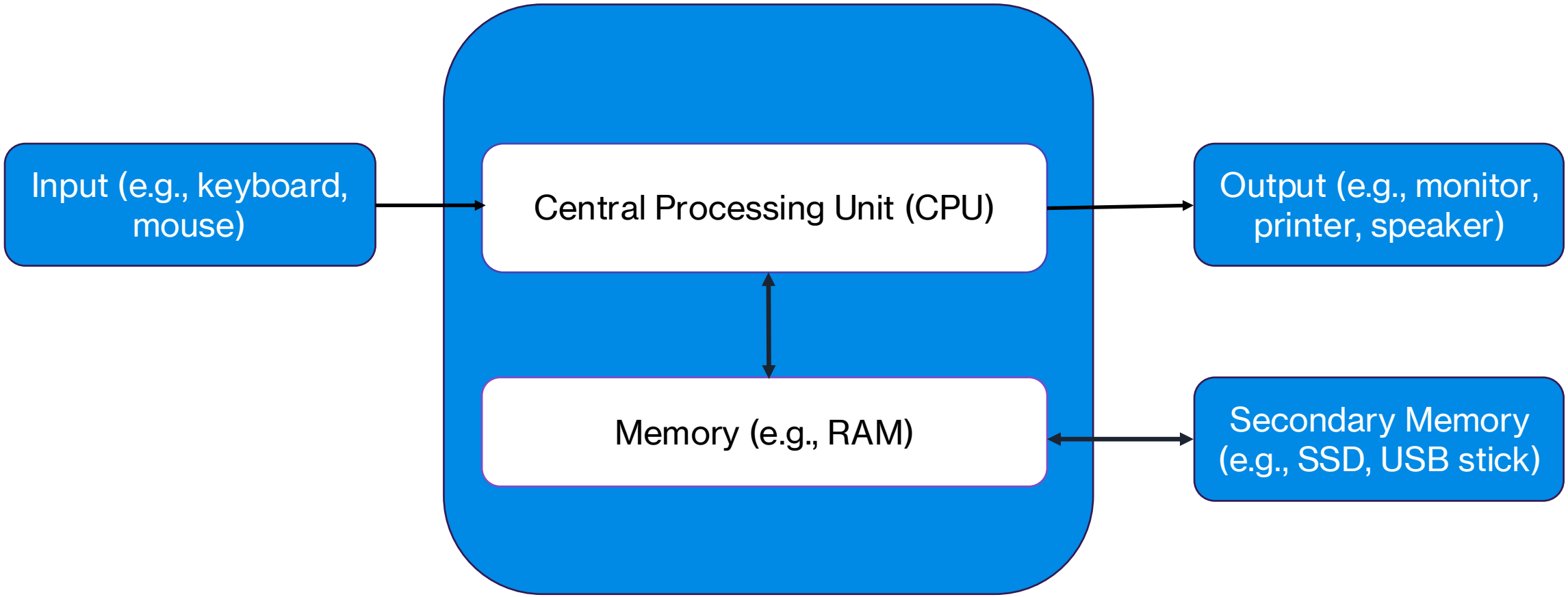


# Computer Science History

# What is a computer?

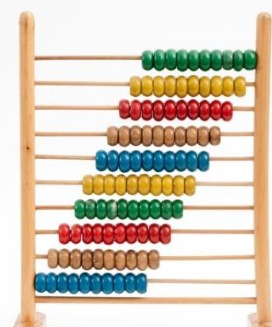
- A **programmable** electronic device that can process, store, and retrieve data.
- A computer processes data according to a set of instructions or a **program**.
- **Hardware**: physical parts of the computer (e.g., CPU, RAM, motherboard, graphics card).
  - **Peripherals**: auxiliary devices that can provide **input** (e.g., mouse, keyboard, microphone, webcam, game controller), receive **output** (e.g., monitor, printer, speaker), provide **storage** (e.g., external drives), and facilitate transmission of data across **networks** (e.g., routers and modems).
- **Software:** programs that instruct the computer what to do.
  - **Operating system (OS)**: intermediary programs managing resources between hardware and applications (e.g., Windows/macOS/Linux for desktops).
  - **Application software**: programs that perform specific tasks for users. (e.g., word processor, media player, Web browser etc.).

# A simplified view of a computer

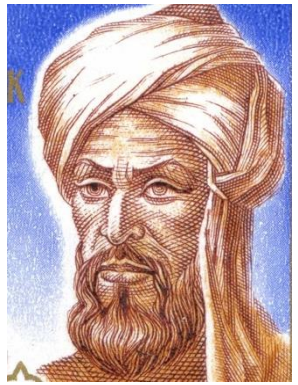


# In the beginning was the calculation

- Before computer science was an academic discipline, key ideas in computing existed in the form of **calculation**.
- Early societies had a limited vocabulary for counting, often employing the fingers of one hand, of two hands, or counting all fingers and toes to count in **bases** of 5, 10, or 20, respectively.
  - Western societies today use the decimal system (base 10).
  - But languages like English and French still carry remnants of the base 20 system, For example, the Gettysburg Address starts: "Four *score* (i.e. twenty) and seven years ago”
- The next numeric system that arose about 5000 years ago was base 60 (sexagecimal) and passed from ancient Sumerians to Babylonians in Mesopotamia.
  - Base 60 is used today in the subdivision of 1 hour into 60 minutes, and of 1 minute into 60 seconds.
- Babylonians did basic calculations for agricultural purposes on the **abacus**.



# Numeral systems


Al-Khwarizmi

- In the four millennia that followed, tremendous progress was done in mathematics.
- **Numeral systems** allowed to encode numbers and other symbols using consistent mathematical notation.
- By 9$^{th}$ century, Islamic mathematicians extended arithmetic contributions made by Indian mathematicians and popularized the **Hindu-Arabic numeral system** we use today.
  - We owe the origin of words like algebra and algorithm to the Persian mathematician **Al-Khwarizmi**.

# Computing devices throughout the millennia

- Humans also continued creating computing devices, such as **analog machines** built to do specific calculations or **automata** built to to assist in commerce, navigation, military, and science.
- Each improvement made computations and tasks faster and easier than it was previously possible, amplifying our mental abilities.
- This is a common theme within computer science.
  - In the 19$^{th}$ century, Charles Babbage famously said,
    *"At each **increase of knowledge**, as well as of the contrivance of a **new tool**, human **labor becomes abridged**".*

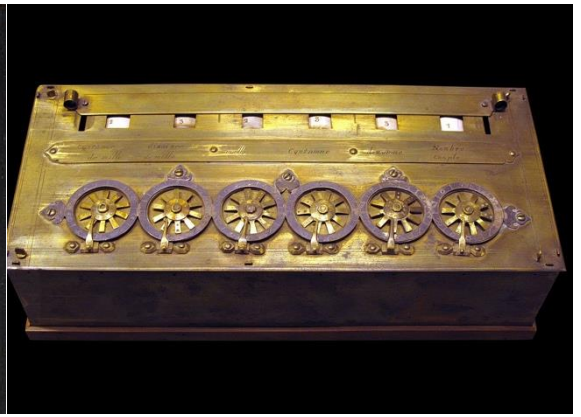
# When computers were people

- None of these computing devices were called computers.
- The earliest documented use of the word “computer” is from 1613 in a book by English poet Richard Braithwait, where he describes the profession of a person as
  *"the truest **computer** of all times, and the **best arithmetician** that ever breathed and he reduced thy dayes into a short number."*
- In those days, **computer was a person who carried calculations swiftly and accurately**, sometimes with machines but often not.
- The job title persisted till mid 20$^{th}$ century when it shifted to describe devices instead of people.
- Most computers were women because they could be paid less than their male counterparts.
- This trend continued with the first programmers who were often Black women since they could be paid less than their white counterparts.

# Cogs and wheels

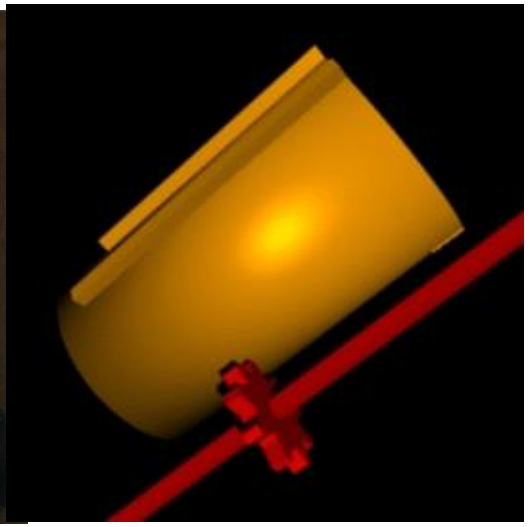
- In 1642, **Blaise Pascal** invented the first practical mechanical calculator, the **Pascaline**, to help his tax-collector father with additions and subtractions. Pascaline used cogs, gear wheels with teeth around their edges.
- In 1671, **Wilhelm Gottfried Leibniz**, built a more advanced machine, the **Stepped Reckoner**, that used a stepped drum, a cylinder with teeth of increasing length around its edge. The Leibniz machine could also multiply, divide, and calculate square roots. It also pioneered the idea of memory storage. **Calculators** used this design for the next three centuries.

Blaise Pascal



Pascaline

Wilhelm Gottfried Leibniz



stepped drum

# Binary arithmetic and Boolean algebra

- Leibniz also invented the **binary system** which allows us to represent any decimal number using only the two digits, **zero** and **one**, and described how binary arithmetic, such as addition, subtraction, multiplication, and division can be performed.
- In 1854, **George Boole** used binary numbers to invent a new branch of mathematics called **Boolean algebra** (stay tuned for next week!).
- Binary numbers and Boolean algebra are at the heart of modern computers which use them to perform arithmetic and logical operations.

George Boole

# The Analytical Engine

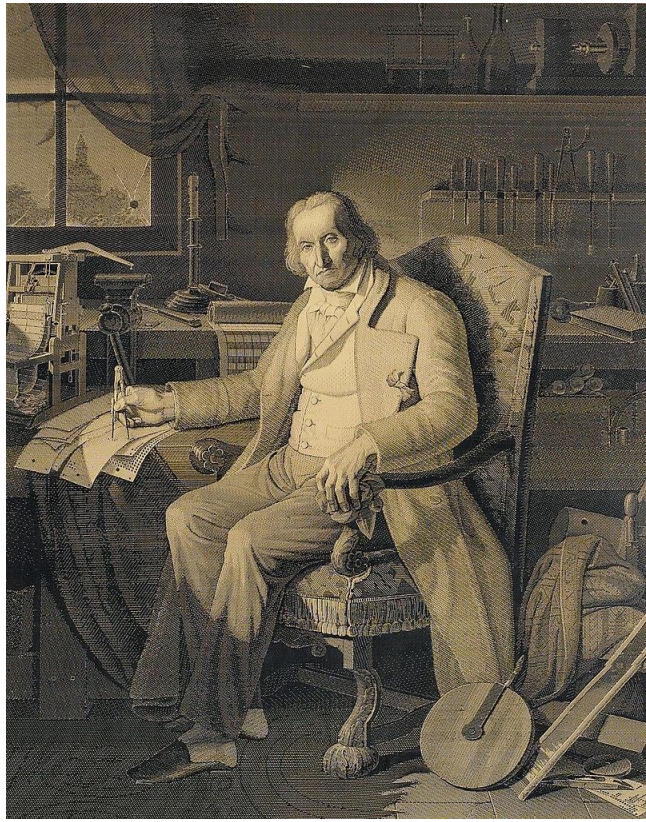
- Pascal's and Leibniz's calculators sped up calculations but required a human operator.
- Instead, computers are machines that operate automatically, without needing human aid, by following instructions written in a program.
- In 1834-36, **Charles Babbage** designed the **Analytical Engine**, the first design for a general computing device that could perform any mathematical calculation.
- It could be used for more than one particular computation, could be given data and run operations in sequence, had memory, branches, looping, and even a primitive printer!
- Babbage's Analytical Engine influenced the first generation of computer scientists. He is considered the "father of the computer."

Charles Babbage

# Drawing inspiration from Jacquard's looms

Punched cards

- The Analytical Engine could be programmed using **punched cards**, a technology that had been developed to provide instructions for weaving on a mechanical loom in 1805 by **Joseph-Marie Jacquard**.
- These cards could provide input for different weave patterns, to easily produce complex results. Babbage envisioned using them to provide instructions for a program.
- None of Babbage's programmable "engines" were completed during his lifetime due to the scale and cost they required.



Joseph-Marie Jacquard

# The first program and programmer

- In 1843, one of Babbage's correspondent's, **Ada Lovelace**, was hired to translate lecture notes on the Analytical Engine from French to English.
- She added extensive notes to this paper with her own thoughts. One of these notes contained an example that showed how the Analytical Engine could be used to calculate Bernoulli numbers.
- This was the first (hypothetical) **program** to be written for a computer, so Lovelace is considered the first **programmer**.

Ada Lovelace

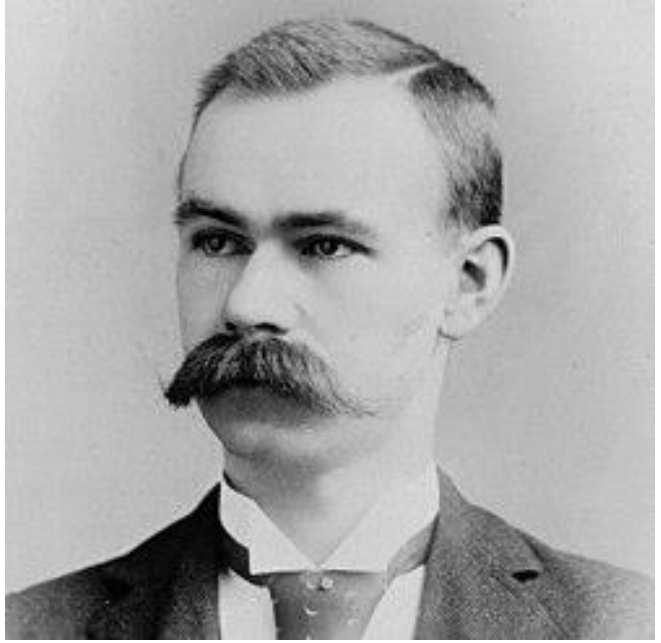
# Computational thinking

- Ada Lovelace is also credited as being the first person to realize that **computers could be used for more than just math**. One of her notes read:
- *"[The Analytical Engine] might act upon other things besides number... Supposing, for instance, that the fundamental relations of **pitched sounds** in the **science of harmony and of musical composition** were susceptible of such expression and adaptations, the engine might compose **elaborate and scientific pieces of music** of any degree of complexity or extent."*

Ada Lovelace

# Engines of calculation go big

- In the late 1880s, American statistician **Herman Hollerith** built one of the world's first practical calculating machines, which he called a **tabulator**, to help compile census data.
- A U.S. census was taken every 10 years, but the growth of the population meant that it took 7.5 years to tally people by hand!
- Hollerith's tabulating machine tallied the entire census in only six weeks and completed the full analysis in just two and a half years.
- Hollerith set up the Tabulating Machine Company in 1896 which was renamed in 1924 as **IBM** (International Business Machines).



Herman Hollerith

tabulator

# A general model of computers

- Actual physical general-purpose computers would not be developed until mid-20th century.
- But just before the first computers were built, in 1936, American mathematician **Alonzo Church** and English mathematician **Alan Turing** developed a general model of what can be computed.
  - This is now referred to as the **Church-Turing Thesis**.
- Turing invented the concept of a 'Turing Machine,' a simple abstract machine that manipulates symbols on a tape according to a set of rules.
- It is widely acknowledged today that ***all general-purpose computers can be reduced to the idea of a Turing Machine***.
- If a computer is as powerful as a Turing machine, it's **Turing complete**. Your laptop, phone, microwave, thermostat, are all Turing complete.

Alonzo Church

Alan Turing

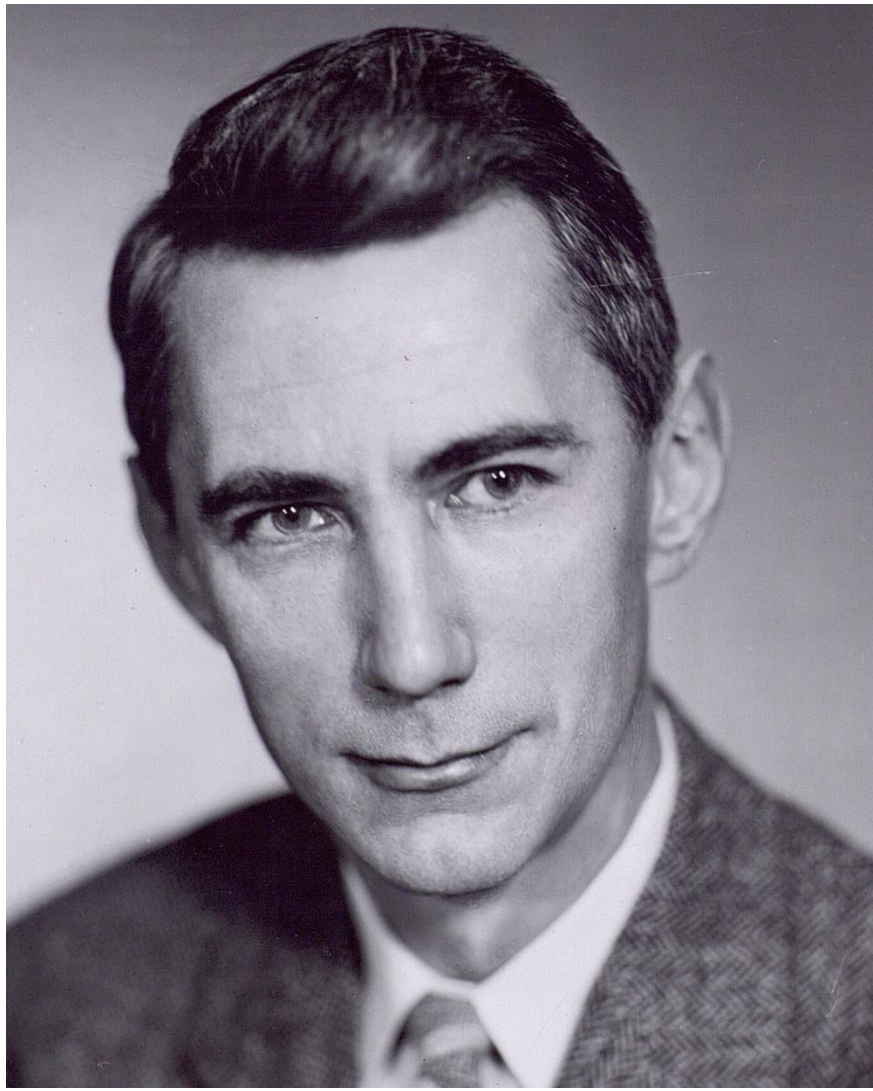
# Limits of computation

Kurt Gödel

- Earlier, in 1931, logician **Kurt Gödel** proved the Incompleteness Theorems, which showed that every formal system whose theorems can be listed by an algorithm will have some statements that are unprovable within the system.
- Church used Lambda calculus to prove that Hilbert's Entscheidungs/decision problem is unsolvable.
  - *Is there an algorithm that takes as input a statement and provides a yes or no answer so that's always accurate?*
- Turing approached the problem differently and demonstrated that not everything is computable by a Turing machine (i.e. a computer) by formulating the **Halting problem**.
  - He used a proof by contradiction to show that it's impossible to write a program that can *always* determine whether another program with a given input will run forever or halt (stop).
  - **This proves that not all problems can be solved by computation!**

# Circuits

- In 1937, **Claude Shannon** translated Boolean logic into a physical format with electronics.
- This work became the foundation of **circuit design** and made it possible to design the computers we know today.
- Shannon also introduced many of the core ideas of abstraction, encoding, and compression we use today.



Claude Shannon

# Computing Devices in World War II

- Shortly after this electronic breakthrough, World War II began. Computing was used to gain advantages in wartime efforts.
- Computing played the most powerful role in code-breaking, as Allied forces attempted to decipher German messages and vice versa.
- The German forces used a device called the **Enigma Machine** to encrypt communications. This encryption used a type of substitution cipher with a shared key. German officers were given key lists ahead of time and would set a new key every day.
- The Allied forces were able to reconstruct the physical device. However, they had to check all possible keys by hand every day, which took too long to be useful. This lasted until someone noticed a pattern in German messages – they always sent a weather report at 6am each day. The common words in this report made it easier to check possible keys computationally.

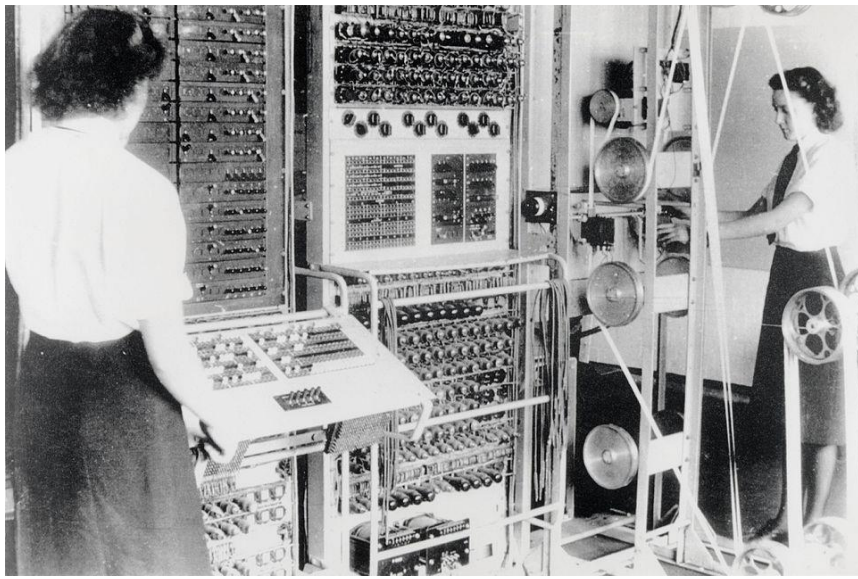
# The Bombe and Alan Turing

- The original deciphering machine, the Bomba, was designed by Marian Rejewski in Poland in 1938. Due to improvements in the Enigma and a lack of funds, the idea was passed to Britain.
- In 1939, Alan Turing worked with a team to develop ***the Bombe***, which checked all possible settings to see if they could find one that matched the expected words.
- This process was dramatized in the movie “The Imitation Game.”
- Turing later on was convicted because he was gay and given the choice between imprisonment or probation with hormonal treatment to suppress his sexuality. He chose the latter but took his own life in 1954.
  - The highest distinction bestowed on a computer scientist is the **Turing award**, in honor of Alan Turing.

# The Colossus

- Later in the war, German forces started using a new encryption system for high-security messages. The **Lorenz cipher** proved much harder to crack, as the Allied forces had no information about the machine used to produce them.
- From 1943-1945, English engineer **Tommy Flowers** led a team to design the **Colossus**, which was used to break Lorenz ciphers.
- Colossus is widely considered to be the **first electronic programmable computer**. However, it could only be programmed for cipher-breaking, not general tasks.
- As with many war-time inventions, the existence of the Colossus machines was kept secret until the mid-1970s

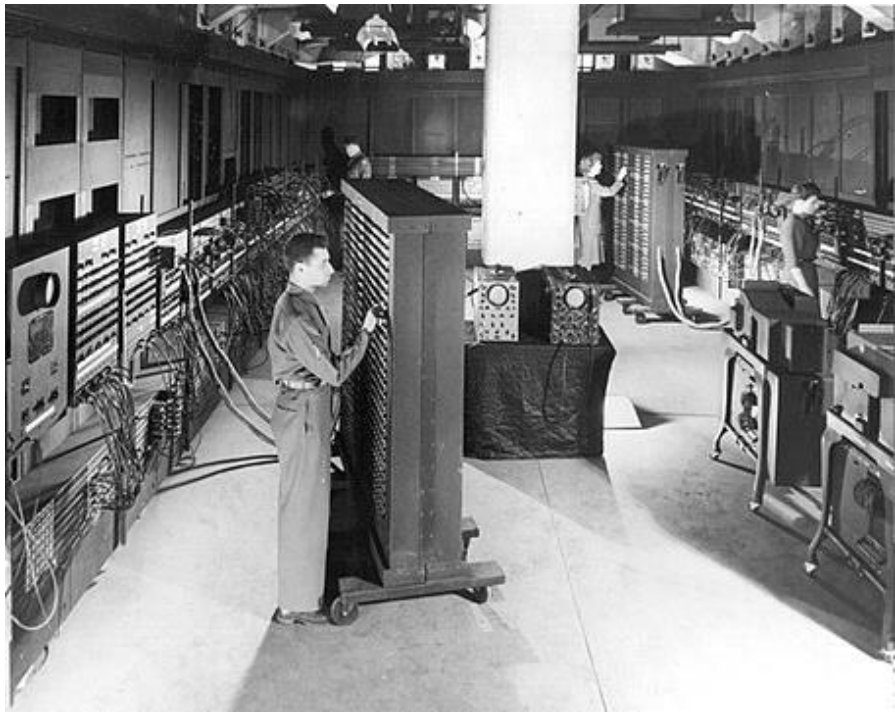
Tommy Flowers



Colossus MK-2

# ENIAC - The first modern computer

- In 1945, after the war ended, companies and research groups worked on designing computers for corporate and military use.
- At University of Pennsylvania, **John Mauchly** and **J. Presper Eckert** designed the **ENIAC**, the world's first electronic truly **general-purpose** programmable electronic computer. It influenced many machines that came after it.
- This machine was programmable (by moving wires) and had input and output in the form of punched cards. It could only hold up to 200 decimal digits in memory at first. That's around 80 bytes!
  - ENIAC took 1,800 sq. ft of space and weighed around 30 tons.
- It was operational for half a day at a time due to mechanical failures but led to more computations in 10 years than the entire human race before that!

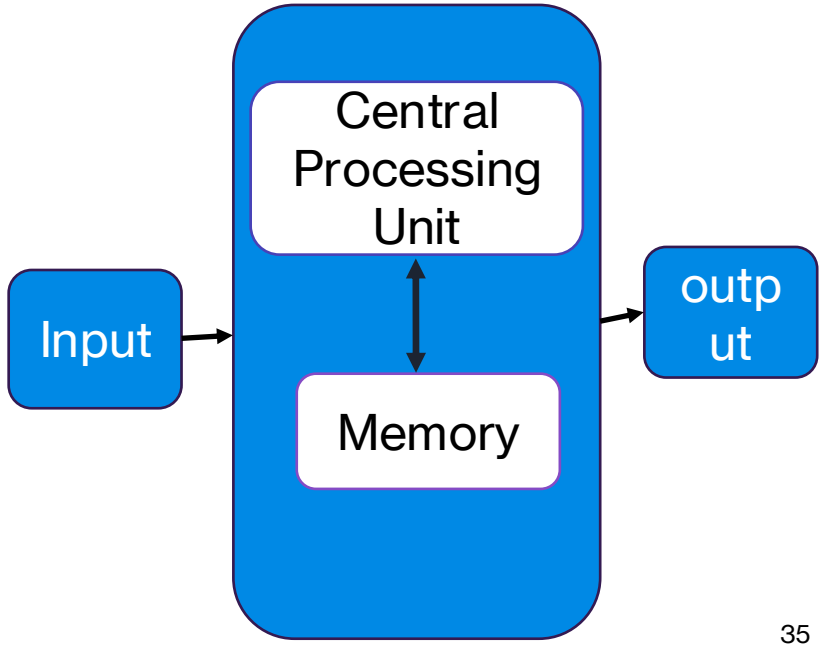


ENIAC

# Modern software architecture

- With the introduction of general-purpose computers came the need for software systems to support programming. In 1945, the **software architecture** of computers that we use today was designed.
- **John von Neumann** introduced the **von Neumann architecture**, which organized the CPU, memory, and input/output.
- This also introduced the idea of representing machine code by running instructions sequentially until a conditional jump is reached.

John von Neumann



# Programming languages

- Computers can only understand **machine language/code** which is sequences of 0s and 1s specific to their machine.
- In early days, translated pseudo-code written in English into machine code.
- By mid-20$^{th}$ century, programmers created reusable helper programs in machine code that read text-based instructions and assemble them into corresponding machine code.
- These programs are called **assemblers** and they read programs written in an **assembly language** and convert them into native machine code.
- Assembly language was still not versatile enough and higher-level programming languages slowly developed but their instructions still needed to be converted to assembly or machine code.
- Grace Hopper developed the first **compiler**, a program that reads **source code** in a high-level language and translates it into a low-level language like assembly or machine code.

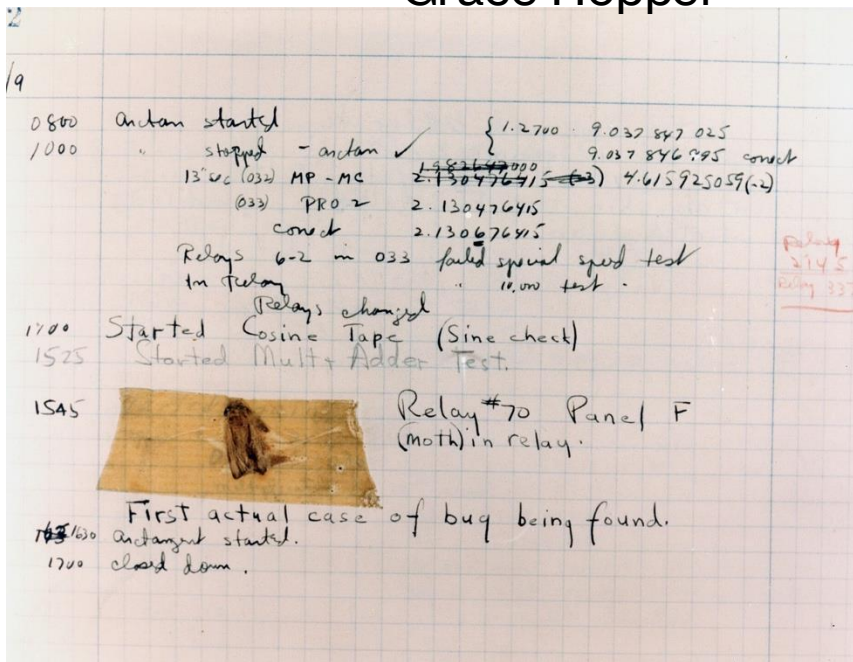
# Evolution of programming languages

- In 1959, IBM released **FORTRAN** which dominated early programming but could only be compiled on IBM machines.
- In 1959, **Grace Hopper** led the Committee on Data Systems & Languages, that created **COBOL** the first programming language that could be used across different types of machines.
  - This paradigm is known as “Write Once, Run Everywhere.”
- This led to an evolution of higher-level programming languages, e.g.,
  - 60s: ALGOL, LISP, BASIC
  - 70s: Pascal, C, Smalltalk
  - 80s: C++, Objective C, Perl
  - 90s: Python, Ruby, Java, JavaScript
  - 2000s: Swift, C#, Go, and so on.

# Bugs

- **Grace Hopper** also worked on Harvard Mark II, an early electromechanical computer that used relays. In 1947, operators pulled out a dead moth from a malfunctioning relay. Grace Hopper noted *“from the on, when anything went wrong with a computer, we said it had **bugs** in it."*

Grace Hopper




The first recorded bug

# Association of Computing Machinery (ACM)

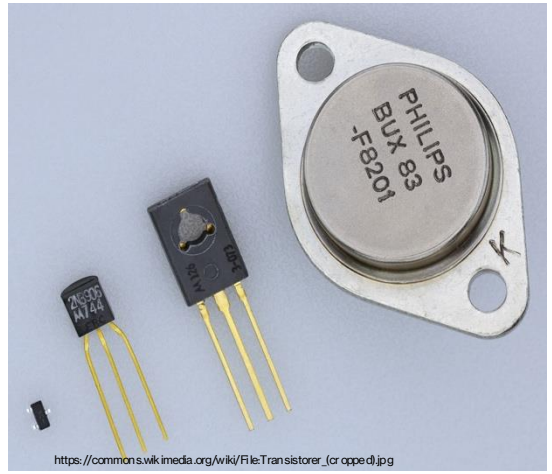

- In 1947, the Association of Computing Machinery (**ACM**) was founded as a U.S.-based international computing society. It has more than 100k members, half outside the U.S.
- It oversees the publishing of journals, sponsoring of conferences, and distribution of awards, like the Turing award.
- As a Pomona student, you have access to the articles published in the ACM Digital Library through the Claremont Colleges Library.
  - If you major or conduct research in computer science, this will be an invaluable tool.
- Other computing societies include the IEEE-CS, AAAI (Association for the Advancement of Artificial Intelligence), International Association for Cryptologic Research (IACR), Association for Computational Linguistics, American Academy of Arts & Sciences (AAA&S), and American Association for the Advancement of Science (AAAS).

# Artificial Intelligence (AI)

- *Can we create a thinking machine that is intelligent, has consciousness, can learn, has free will and is ethical*?
- Alan Turing in the 1950s devised the “Turing Test” to judge whether a machine was conscious and intelligent raising the possibility of programming a computer to behave intelligently.
- The term AI was coined in 1956 by **John McCarthy** in the Dartmouth Summer Research Project on Artificial Intelligence.
- Artificial Intelligence research has also given birth to related fields like Machine Learning, Natural Language Processing, Computer Vision, Robotics, etc. that tackle different aspects of human intelligence and capabilities.
- **AI winter** cycles are accompanied by new booms. We are currently amidst a boom brought by neural networks and deep learning.

# The transistor

- Originally, computers were only used for corporate or government purposes. Individuals did not own computers, because they were far too large and difficult to interact with.
- This changed due to two events: invention of technology that made computers smaller, and invention of interaction modalities that made computers easier to work with.
- In 1947, **John Bardeen**, **William Shockley** and **Walter Brattain** at AT&T Bell Labs designed the **transistor**. This device could be used to switch electric signals.
- Previously, computers had to use vacuum tubes, which were very large. The invention of the transistor made it possible to make computers smaller.

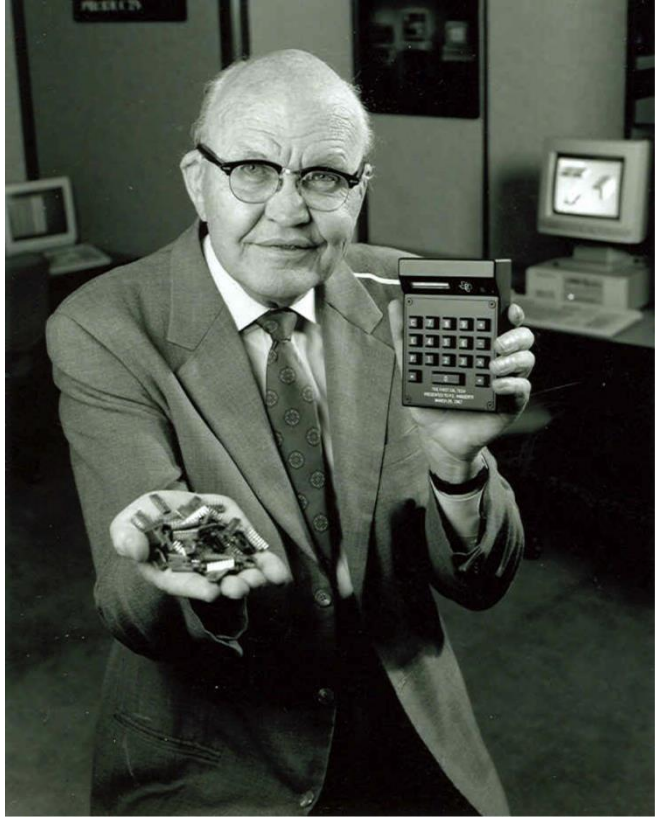



transistors

John Bardeen
William Shockley
Walter Brattain

# The integrated circuit

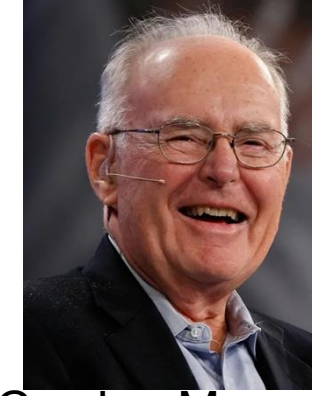
- In 1958, **Jack Kilby** invented the **Integrated Circuit** (IC). This is a small electronic device (or 'chip') that can contain many circuits and is easy to produce. It was possible to make ICs because of the invention of the transistor.
  - Kilby also co-invented the handheld calculator.
- A few months later, **Robert Noyce** made ICs practical by building them out of the abundant and stable **silicon** instead of the rare and unstable germanium Kilby used.
  - Noyce was nicknamed “the Mayor of Silicon Valley”
- The IC again made it possible to make computers much smaller, as more electronics could be fit onto a smaller surface.



Jack Kilby holding ICs

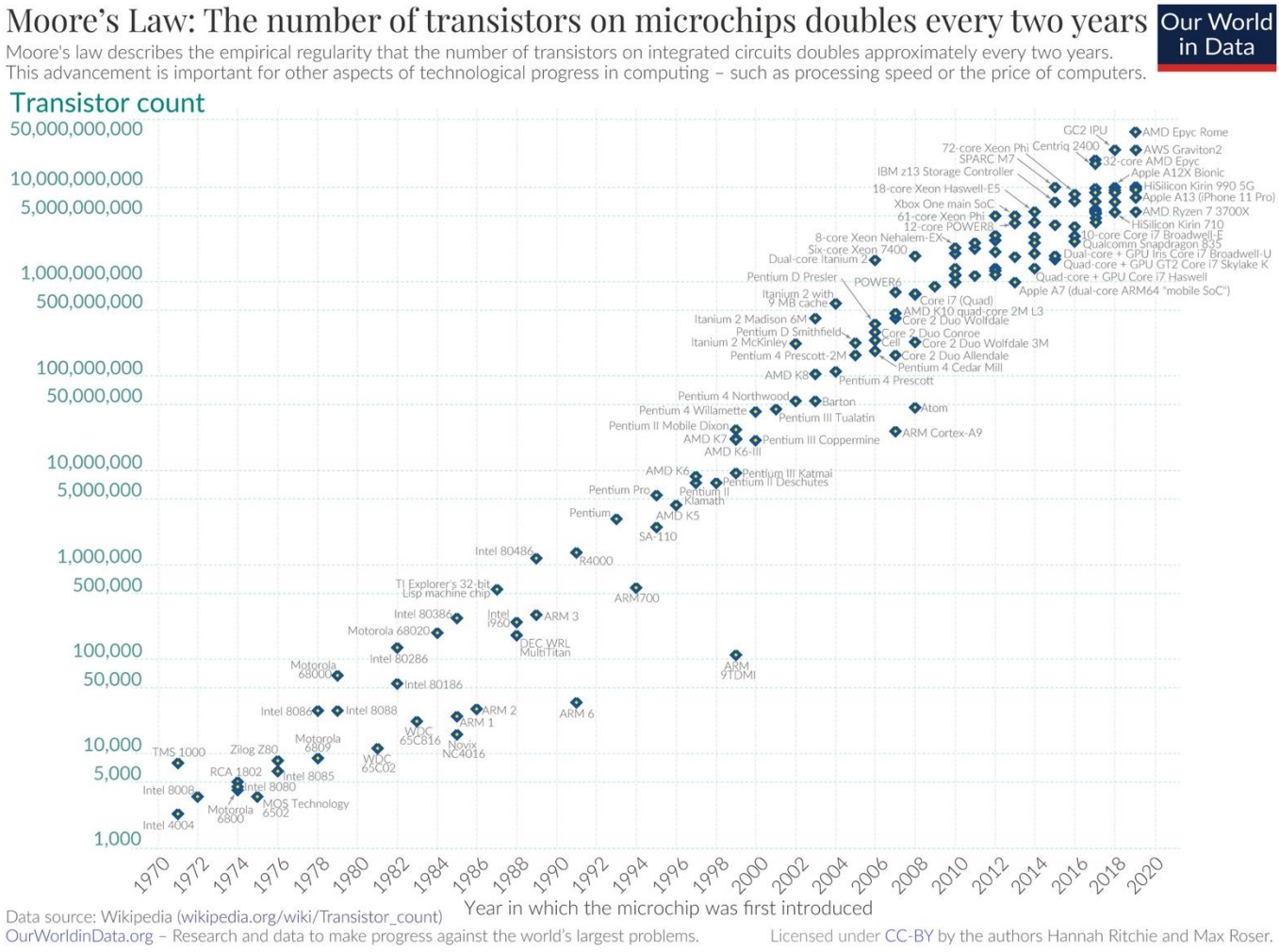
Robert Noyce

# Moore's Law and The Microprocessor



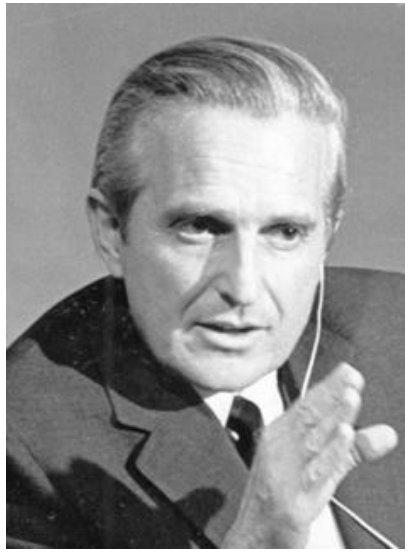
Gordon Moore

- In 1965, **Gordon Moore** introduced the **Moore's Law**, a business model which states that "*the number of transistors on an IC doubles every two years*."
- By 1971, this led to the invention of the **microprocessor** at **Intel** (which was co-founded by Moore and Noyce). A microprocessor is a whole processor that can fit onto a single chip.
- This breakthrough made it possible to put chips in many new devices, like calculators and clocks.



# The mother of all demos

- In 1968, **Douglas Engelbart** presented work he had done at Stanford to a group of engineers at a computer conference. This presentation later became known as the **Mother of All Demos** because it introduced an astounding number of technologies:
  - The computer mouse
  - The GUI (Graphical User Interface)
  - The WYSIWIG (What You See Is What You Get) text editor
  - The concept of multiple windows
  - Revision control
  - Video conferencing
  - Real-time collaborative editing
- You can watch the demo for yourself online: https://www.youtube.com/watch?v=yJDv-zdhzMY



Douglas Engelbart

# Commercially successful personal computer

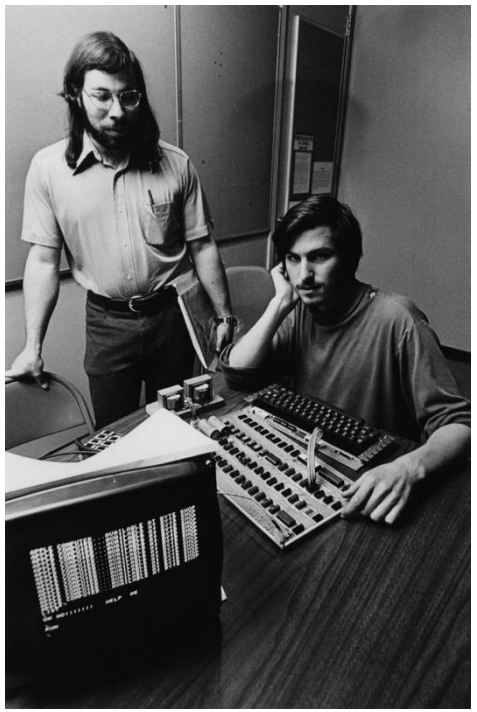
- It is hard to pinpoint the exact time that personal computers made an appearance since there are multiple contenders.
- But in 1975, MITS released **Altair 8800**, the first commercially successful personal computer. Priced about $2000 today's dollars, it came as a built-it-yourself kit.
- Tens of thousands of kits were sold to computer hobbyists and soon accessories were sold, leading to a rise of a movement of computer enthusiasts.
- The most famous one is the **Homebrew Computer Club** which first met in 1975.

Altair 8800

# Computing companies

Bill Gates and Paul Allen

- In 1975, **Bill Gates** and **Paul Allen** founded **Microsoft**.
- They convinced MITS for Altair 8800 programs were written in BASIC. To do so, they created an **interpreter**, a program that translated code written in BASIC to low-level machine code.
  - Interpreters translate as the program runs instead of beforehand, like compilers.
- At the first meeting of the Homebrew Computer Club, **Steve Wozniak** was so inspired by Altair 8800 that he set to create his own personal computer. In 1976, he demonstrated his prototype to the Club. It could connect with a TV and included a text interface.
- Interest was high. Fellow Club member **Steve Jobs** convinced Wozniak to sell an assembled motherboard (you still needed to add a keyboard and monitor) instead of sharing the designs for free. It was sold as **Apple I** and Steve Jobs and Steve Wozniak founded **Apple**.



Steve Wozniak and Steve Jobs with Apple I

# The 1977 trinity and open/closed architecture

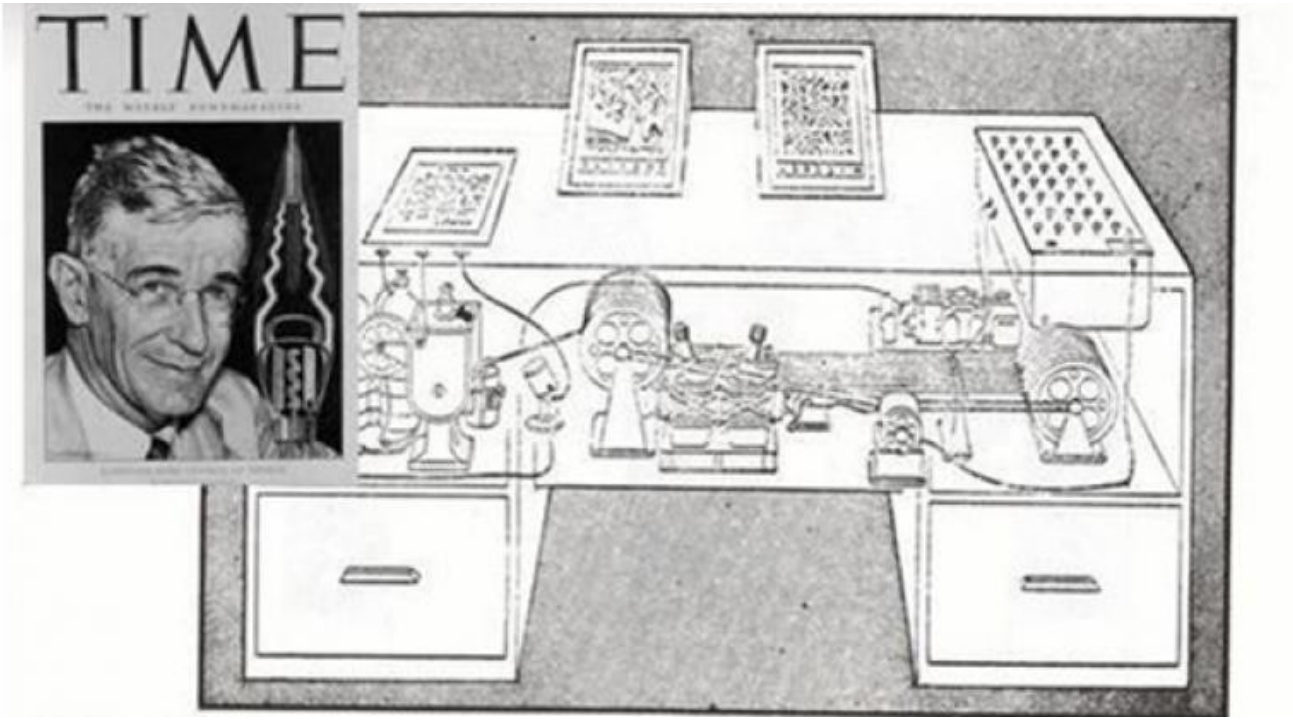
- Apple I was also sold like a kit which appealed to hobbyists and tinkerers but not to the masses. This changed with three computers known as the **1977 trinity**.
  - The first, **Apple II**, was professionally designed and manufactured, offering color graphics and sound. Millions of computers were sold, propelling Apple at the forefront of the personal computer industry.
  - The second, **TRS-80 model I**, was less sophisticated but sold at half-price of Apple II.
  - The third, **Commodore PET 2001**, combined computer, monitor, keyboard, and tape drive into one device.
  - All three came with BASIC interpreters which allowed less technical audience to create programs and targeted households, small businesses, and schools.
- IBM took notice and designed the IBM PC which used Microsoft's operating system **MS-DOS** and offered an **open architecture** with expansion slots, allowing third parties to create hardware and peripherals like graphics and sound cards, joysticks, external hard drives, etc.
  - **IBM compatible** computers took over most of the market. IBM's approach was in contrast with Apple's **closed architecture**. This led to the rise of the "**MAC vs PC**" debate.

# Graphical user interface (GUI)


- After the Mother of All Demos, several people on Engelbart's team went to work at **Xerox PARC**, to further develop the concepts into the first GUI computer, the **Xerox Alto**.
- Xerox established the **desktop metaphor** that emulated one's desk on a 2D screen and the **WIMP interface** (windows, icons, menus, pointer) along with **buttons**.
- In 1979, Apple employees were invited to PARC and were shown their GUI. Steve Jobs said:
  - *"It was like a veil being lifted from my eyes. I could see the future of what computing was destined to be."*
- They implemented similar ideas into the Apple Lisa (1983, commercial flop) and ultimately into the **Apple Macintosh** (released in 1984) to great acclaim.
- In 1981, Microsoft visited Apple and helped them develop some apps. They took the GUI idea from Apple and used it in their first operating system, MS-DOS, released in 1985.
  - A rivalry between Microsoft and Apple would start then, with Microsoft dominating 95% of personal computers.

# Ideating the Internet

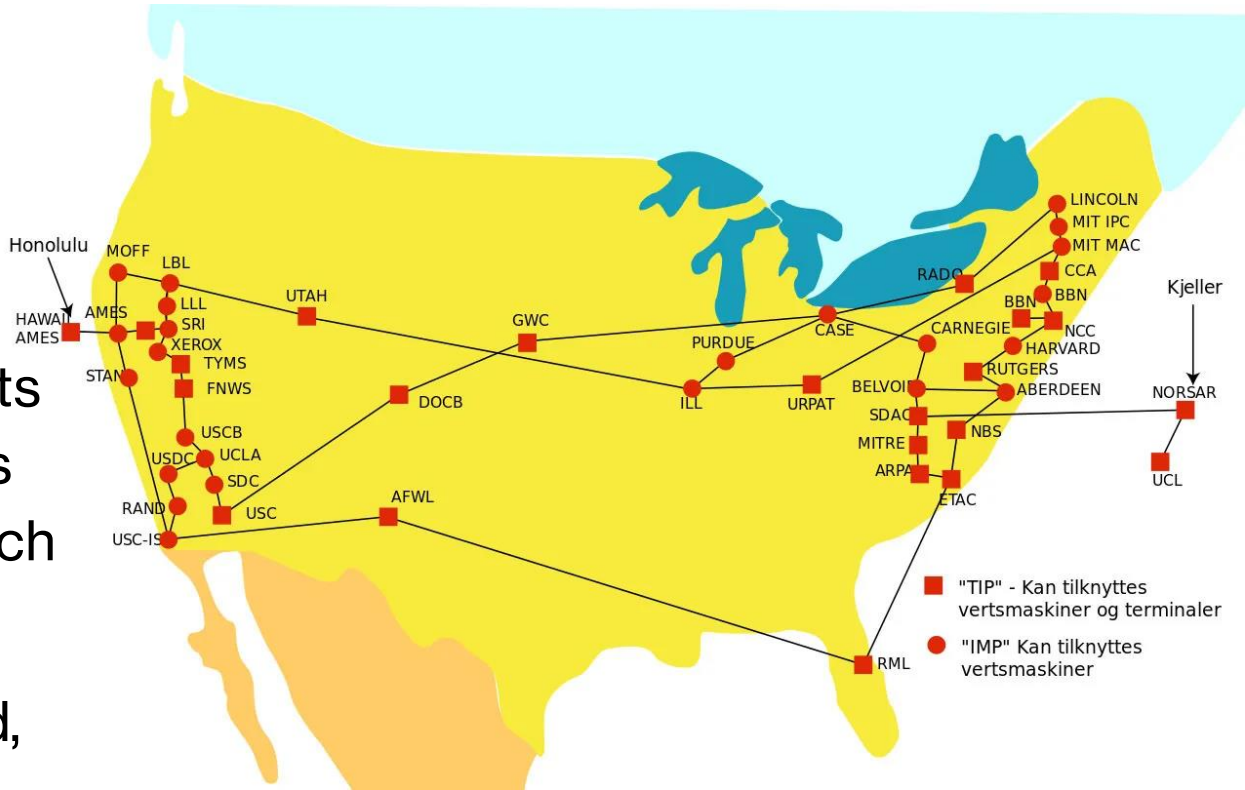
- Some of the core concepts of how the Internet would work were introduced well before it was implemented.
- In 1945, **Vannevar Bush** published As We May Think on the Atlantic, which envisioned a system (**Memex**) to aid in research work. Bush invented the concept of **hypertext** (or link)!
  - *"Consider a future device... in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory."*




Vannevar Bush and Memex

# ARPANET

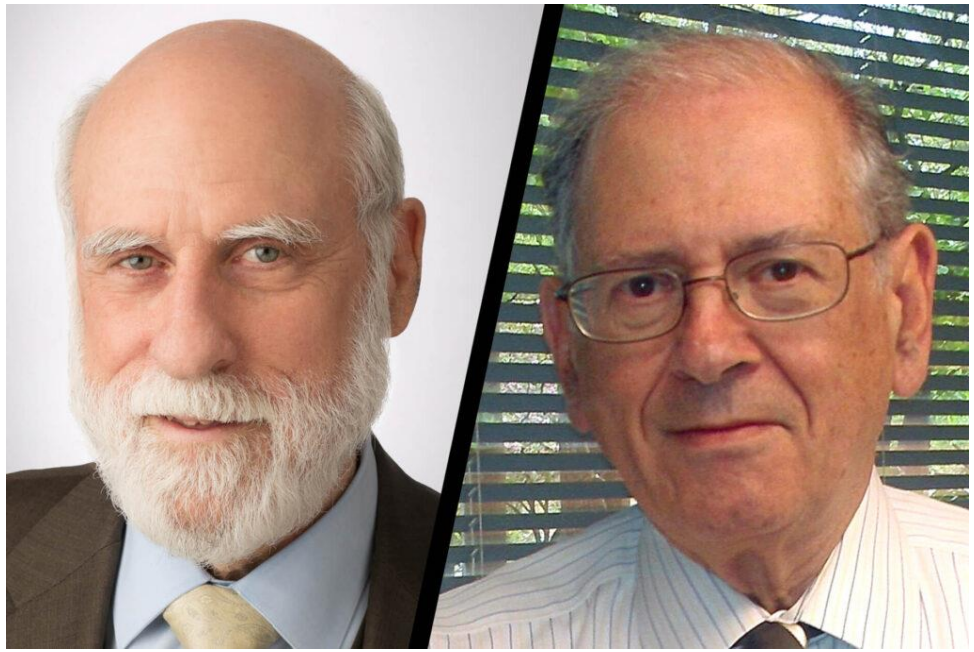
- In 1969, the US military wanted to create a decentralized communication system so that communications could not be knocked out entirely by a nuclear attack.
- DARPA (Defense Advanced Research Projects Agency) collaborated with several universities to build the **ARPANET**, the Advanced Research Projects Agency Network.
- First connection between UCLA and Stanford, but it grew quickly.
- The first email was sent over ARPANET in 1971!




ARPANET

# Communication protocols

- In 1982, **Vinton Cerf** and **Robert Kahn** designed and advocated for the **TCP/IP** protocol.
- TCP organizes data that is being sent between computers; IP delivers that data to the correct destination (based on IP addresses).
- The invention of TCP/IP made it much easier to connect computers together, which helped ARPANET expand its reach.
- Because of this, Vint Cerf and Bob Kahn are known as the “fathers of the Internet.”
- By 1984, the US military broke off from ARPANET to form their own private network, MILNET.
- More organizations and companies started to join the public network, forming the **Internet** as we know it.



Vint Cerf and Robert Kahn

# 1990s: the World-Wide Web

- In 1989, **Tim Berners-Lee** invented a new language, **HTML** (HyperText Markup Language), and a new notation, **URL**, that would revolutionize how people communicated over the Internet.
- Berners-Lee also created the first **web browser** and **web server**. This led to the beginning of **websites** as we know them and the creation of the **World-Wide Web**, an information system that enables content sharing over the Internet.
- For this contribution, he is known as “the father of the World-Wide Web.”
- The first web browser that allowed graphics to be embedded along text was **Mosaic**. Others, like Netscape Navigator, Internet Explorer, Opera, Mozilla, followed.
- New websites popped up continuously with the most famous one being **Yahoo!**.
- Search engines also started popping up in the 1990s. **Google** wasn't founded until 1998, and **Wikipedia** wasn't created until 2001!

# 2000s: social media and cloud computing

- As more people got on the Internet, **social media networks** started to pop up.
- Some started in the late 90s with **MySpace** being the first truly global one.
- Of the current big networks, **LinkedIn** started in 2003, **Facebook** in 2004, and **Twitter** in 2006.
- **Cloud Computing** also started in the 2000s. Amazon's Elastic Compute Cloud started in 2006; Microsoft Azure started in 2008.

# 2010s: smartphones, tablets, and autonomous vehicles

- The growth of the Internet and the desire to remain connected led to portable computing devices.
- Smartphones first appeared in 2007 with iPhone and gained widespread popularity in the 2010s.
- Tablets also became popular in this timeframe.
- Autonomous robots and self-driving vehicles with intelligent sensors became more mainstream.

Steve Jobs holding an iPhone

# 2020s: XR, artificial intelligence, and ?

- Although, still mid-way, 2020s already have left their mark on the history of computing.
- Big companies are pushing for **XR** which encompasses, **augmented reality** (e.g., Pokemon Go) and **virtual reality** (e.g., Meta Quest and Apple Vision Pro) to become the new computing paradigm.
- Companies like Google, Open AI, Anthropic are advancing and commercializing **artificial intelligence** at a frantic pace (e.g., ChatGPT, Claude, Gemini).
  - We will learn more about AI at the end of the course.
- *What will the next five years bring?*

# Further reading

- Online
  - https://criticallyconsciouscomputing.org/history
  - https://www.explainthatstuff.com/historyofcomputers.html
  - https://www.computerhistory.org/timeline/

- Books
  - Introduction to the History of Computing by Gerard O' Regan

- Acknowledgments
  - Some slides have been adapted from material from CMU CS110 – Principles of Computing. Shared by permission by instructor Dr. Kelly Rivers.