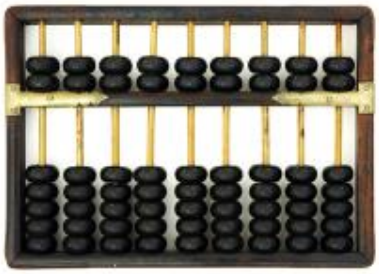

# From the abacus to the iPhone

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Computer Systems

**Some major pioneers & milestones in Computer Science**

## Contents

## The Abacus

It's widely accepted that **The Abacus** is the first known counting fame/calculator

- in use centuries before the adoption of the written modern numeral system
- It does simple addition and subtraction and was around centuries before the adoption of the written numeral systems.

Please take under 2 minutes to have admire at these amazing Abacus math kids

https://goo.gl/rXnWvu

## 400BC:Pānini's Formal Language Theory

Formal Language Theory was introduced to the world by Pāṇini – an ancient Indian grammarian

He formulated the grammar of the language of ancient India, Sanskrit, (in 3959 rules) which was highly systematised and technical.

A formal language is basically **a finite set of sequences (incl. grammars, regular expressions …)**

- Therefore a formal language ***is*** a computable se t of sequences.

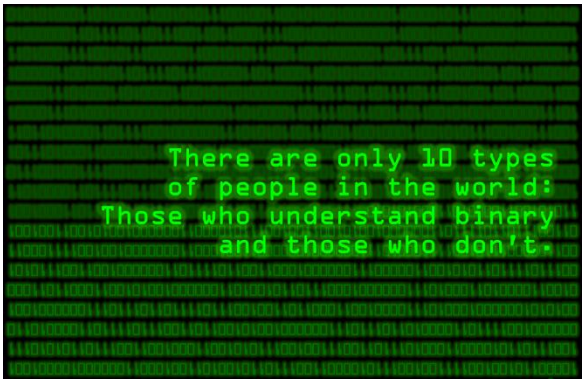

Without formal language, without the computable sets of sequences, computers would've never existed

## 100 BC – Binary System – to 1689

A **binary code** is a way of representing text or computer processor instructions by the use of the binary number system's two-binary digits **0** and **1**

Binary can **correspond to a variety of different** symbols, letters or instructions.

A bit string is assigned to each particular symbol or instruction.




Why can a binary string of eight binary digits (bits) be represented as 256 possible values??

**Because**? There are 8 positions where either a value or 0 or 1 can be entered for an 8 bit representation. What is $2^8$ =

Documents show Binary numbers first described in Chandashutram written by Indian scholar Pingala in 100 BC!!!

## 1689 - Gottfried Leibniz

The modern binary number system, the basis for binary code, was refined by Gottfried Leibniz in 1689

Leibniz: completed his bachelor's degree in philosophy aged 15, gained a master's degree a year later and then an undergraduate degree in law a year after that!!

Also, Gottfried Leibniz's 1673 "Step Reckoner" introduced a design innovation that enabled a single gear to represent any digit from 0 to 9 in just one revolution.

It could multiply numbers of up to 5 and 12 digits to give a 16 digit result

This stepped-drum approach dominated calculator design for the next two centuries.

## 1642 – Pascal's first mechanical calculator

Blaise Pascal is usually credited for building the first mechanical adding (& subtraction) machine (when he was age 18)

Pascal's took our civilisation one step closer to the invention of computers.

He was educated by his father, his father being supervisor of taxes in their home town in France.

Pascal's calculator was designed to help his father with the laborious arithmetic calculations that tax collecting involved.

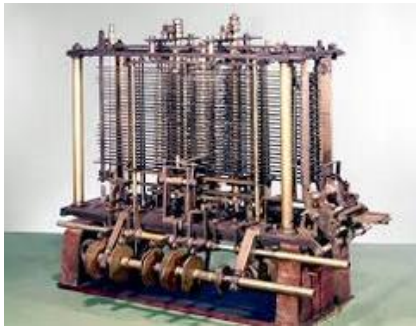
His calculator could add, subtract, multiply and divide (bearing in mind that multiplication is repetition of addition and division is repetition of subtraction!)

The calculator, called **Pascaline**, also called Arithmetic Machine, was the first calculator or adding machine to be produced in any quantity and actually used (Pascal built 50 prototypes before releasing his first machine, eventually twenty machines were built)

- *Pascal versus Schickard*: There are claims that there are  Schickards drawings of a calculating clock that predating the public release of Pascal's calculator by 20yrs.
- Schickard built two calculators around 1623. One, for his astronomer friend Johannes Kepler, was destroyed by fire. The other is, as far as we know, lost. We know about them only from Schickard's handwritten letters, which contain sketches of what he had built.

| | |
|---|---|
| 1493 | Leonardo da Vinci produced drawings of a device consisting of interlocking cog wheels which can be interpreted as a mechanical calculator capable of addition and subtraction.<br><br>A working model inspired by this plan was built in 1968 but it remains controversial whether Leonardo really had a calculator in mind.<br><br>Da Vinci also made plans for a mechanical man: an early design for a robot. |

## 1842 – Babbage's Analytical Engine



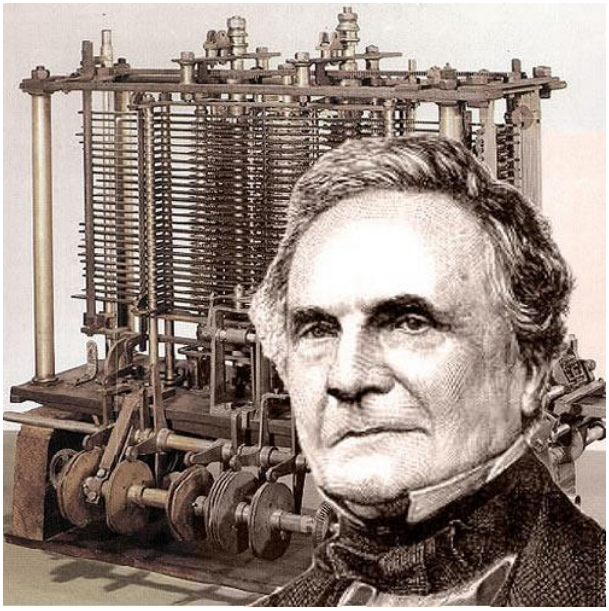
Charles Babbage, an English mechanical engineer originated the concept of a programmable **computer**.

Babbage conceptualised and invented the first mechanical **computer** that could organise calculations (the first prototype was designed in 1822).

Fixated by the idea that the common laborers' jobs could be taken over completely by machinery, he envisioned that mechanising calculations would make the processes quicker and more reliable

Babbage's Analytical Engine was repeatable/programmable, error free and of course automatic – it could calculate 60 additions/minute!

It had programs, memory, cycles, loops, and all sorts of what we might consider as modern day capabilities despite being **constructed entirely out of brass gears** and **powered by a steam engine**



Babbage's **Analytical Engine** was a proposed mechanical general-purpose computer and, as such, the first design for a real computer

A major component if this Engine was that a program for it was to be stored on read-only memory, in the form of punched cards.

In the end, no more than a few parts were actually built. The cost overruns had been considerable (£17,470 was already spent)

## Ada Lovelace the 19th century Programmer

| Read & watch: some background info etc. on Ada Lovelace?<br><br>https://goo.gl/HQ9pTf |
|---|

A century before the computer age, Ada Lovelace imagined a world where technology went far beyond mere calculations to become a collaborative tool for everything from science to music.

Her work led to a close friendship and working relationship with Charles Babbage

She is chiefly known for her work on Charles Babbage's proposed mechanical general-purpose computer, the Analytical Engine.

Lovelace wrote a paper in the 1840s imagining the potential of Babbage's machines, including the idea that they could compose music and the original computer algorithm, now widely considered to be the world's first computer program.

It is this fundamental transition from a machine which is a number cruncher to a machine for manipulating symbols according to rules that is the fundamental transition from calculation to computation—to general-purpose computation

In her notes, Lovelace emphasised the difference between the Analytical Engine and previous calculating machines, particularly its ability to be programmed to solve problems of any complexity

- Ever hear of the 1980's programming language "Ada"?
- As of 2015, inventor Charles Babbage and mathematician Ada Lovelace (known for her work on Babbage's early mechanical general-purpose computer appear in all British Passports.

- At the young age of 12, this future "Lady Fairy", as Charles Babbage affectionately called her, decided she wanted to fly...

Sadly, Lovelace never got to try out her ideas after falling out with Babbage and dying young, but she went on to inspire early computer pioneers including a certain Alan Turing (who found her paper during his research).

Turing is the mathematician whose codebreaking computer helped end the Second World War, and is widely considered to be the father of computer science and artificial intelligence.

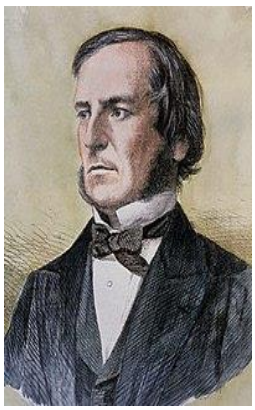
## 1847 – Boolean Algebra: George Boole

George Boole was first professor of mathematics at Queen's College (UCC)

Boole described an algebraic system of logic, now known as **Boolean algebra**.

Boole's system was based on binary that consisted the 3 most basic operations:

**AND**, **OR**, and **NOT**



With Binary being the system of a yes-no, on-off approach

Boole developed his algebra of logic not for machinery but as a theory of **how the human mind worked**

Boole meet with Babbage in 1862 at a London Exposition

A century later, boolean algebra would provide an ideal foundation for designing the electronic structure of computers, and for manipulating information within computers!!!

## 1888 - Hollerith's Tabulating Machine

1880 population size meant it took >7years to tabulate the Census

The U.S. Census Bureau ran a competition to find a more efficient method to process and tabulate data for the 1890 Census

Herman Hollerith's (1860-1929) machine was designed:

> He won the Census Bureau's Competition & for the competition, his machine completed the task of preparing data from 4 areas in US in just 5.5 hours

He invented the recording of data on a medium that could then be read by a machine

Hollerith chose the punched card as the basis for storing and processing information and he built the first punched-card tabulating and sorting machines as well as the first key punch

Modified versions of his technology would continue to be used at the Census Bureau until replaced by computers in the 1950s

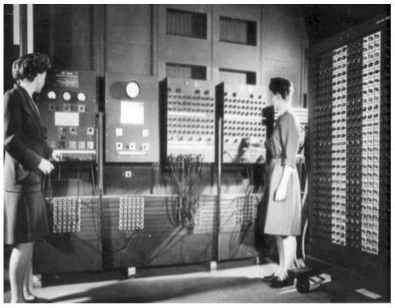
His machines used mechanical relays to increment mechanical counters

Hollerith's designs dominated the computing landscape for almost 100 years

He founded the company that was to become IBM

## 1946 – ENIAC

- The first all electronic computer was the Electrical Numerical Integrator and Calculator, known as ENIAC
- ENIAC was the first multipurpose electronic computer, though very difficult to re-program.
- It was primarily used to computer aircraft courses, shell trajectories, and to break codes during World War II.



Programmers Betty Jean Jennings (left) and Fran Bilas (right) operate ENIAC's main control panel at the Moore School of Electrical Engineering. (U.S. Army photo from the archives of the ARL Technical Library)

The machine was built out of:

- nearly 17,500 vacuum tubes,
- 7,200 diodes and
- many miles of wire

It took up 1,800 square feet (170 m2) of space.

ENIAC was never turned off because it blew too many vacuum tubes when turned back on!

- It was programmable by pulling wires from one place to another which could take days/weeks ... Method used until 1948 with intro of ROM

## 1948 – The Transistor

In 1948 an event occurred that was to forever change the course of computers and electronics.

Working at Bell Labs three scientists, Bordeen, Brattain and Shockly invented the transistor.

The change over from vacuum tube circuits to transistor circuits occurred between 1956 and 1959.

This brought in the second generation of computers, those based on transistors.

## 1965 - Moore's Law

For over 50 years, the electronics industry has been driven by what is called "Moore's Law," that every two years, the number of transistors that could fit on a microchip would double

In Moore's original paper that was published in Electronics magazine, his prediction was actually that transistor count would double approximately every year for the 10-year period from 1965 to 1975.

Tech companies come up with new, faster, smarter and better gadgets constantly

Moore's Law, as articulated by Intel cofounder Gordon Moore, is that "The number of transistors incorporated in a chip will approximately double every 24 months."

Transistors are tiny electrical switches and are the fundamental unit that drives all the electronic gadgets we can think of. As they get smaller, they also get faster and consume less electricity to operate.

We're getting very close to the limit of how small we can make a transistor.

Transistors have become so small (Intel is currently working on readying its 10nm architecture, which is an atomically small size)

Maybe there are a variety of solutions to this —innovating new types of transistors? use new materials?

## 1950 - The Turing Test

In London in 1947, in the course of what was, so far as is known, the earliest public lecture to mention computer intelligence, Turing said, 'What we want is a machine that can learn from experience', adding that the 'possibility of letting the machine alter its own instructions provides the mechanism for this'

The Turing test, is a test of a machine's ability to exhibit intelligent behavior equivalent to, or indistinguishable from, that of a human