

History of Computers: Part 1. Ancient Computers

Damian Gordon



~20,000BC

Ishango bone

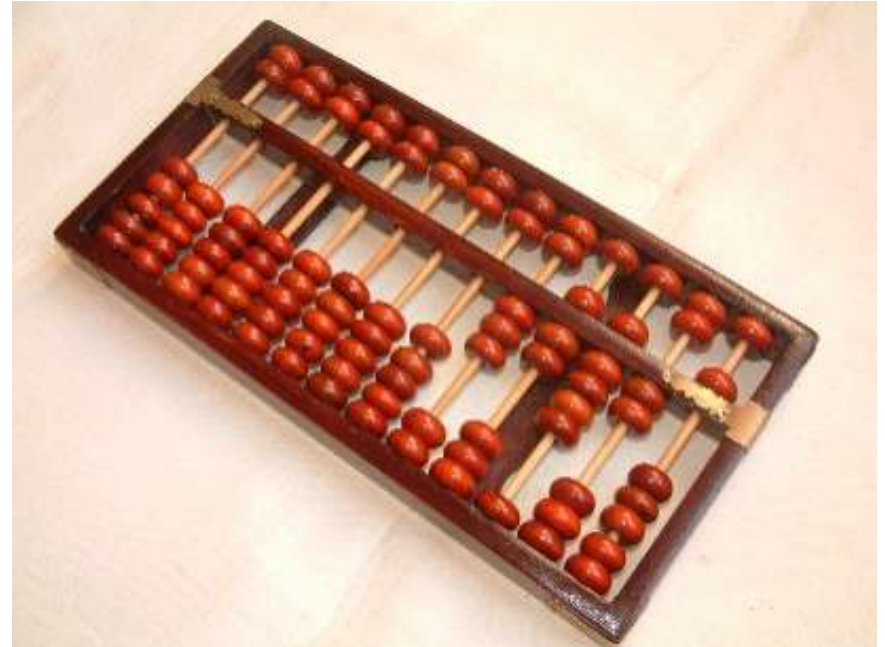
- ▶ Might be an early example of a **Tally Stick**.
- ▶ An ancient memory aid device to record and document numbers, quantities, or even messages.
- ▶ Historical reference is made by
 - ▶ Pliny the Elder (23–79AD) about the best wood to use for tallies
 - ▶ Marco Polo (1254–1324) who mentions the use of the tally in China.



~2500BC

Abacus

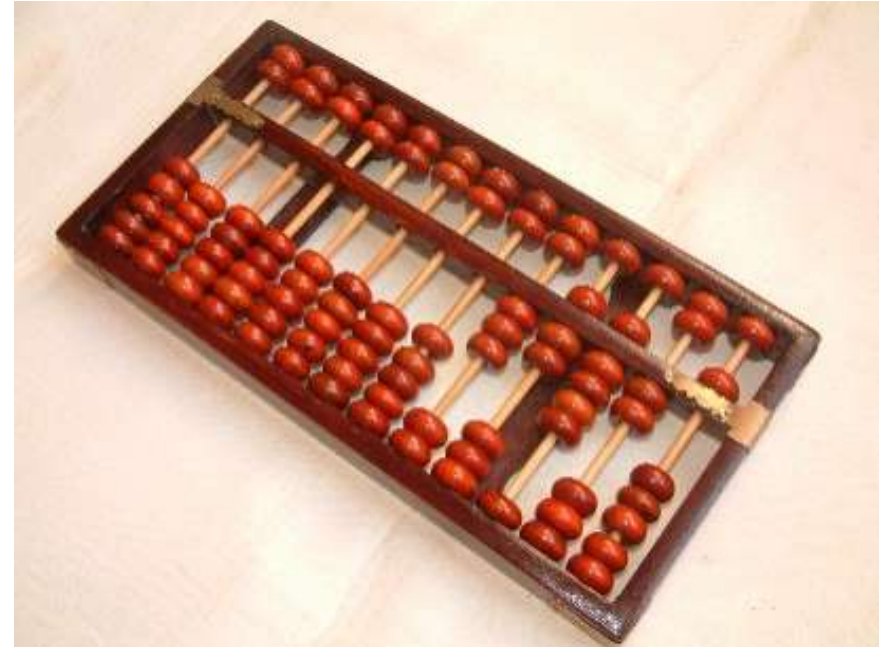
- ▶ Also called a **counting frame**
- ▶ A calculating tool for performing arithmetic processes.
- ▶ The user of an abacus is called an abacist.



~2500BC

Abacus

Country	Era
Mesopotamia	2700-2300 BC
Persia	~600 BC
Greece	~500 BC
Romans	1 BC
China	~200 BC
India	~ 500 AD
Japan	~ 1600 AD
Korea	~ 1400 AD



~150–100BC

Antikythera Mechanism

- ▶ An ancient mechanical computer designed to calculate astronomical positions.
- ▶ It was recovered in 1900–01 from the Antikythera wreck, but its complexity and significance were not understood until decades later.





~150–100BC

Astrolabe

- ▶ An astronomical instrument used by astronomers, navigators, and astrologers.
- ▶ Its many uses include locating and predicting the positions of the Sun, Moon, planets, and stars;
- ▶ determining local time given local latitude and vice-versa;
- ▶ surveying;
- ▶ triangulation;
- ▶ and to cast horoscopes.



Al-Jazari

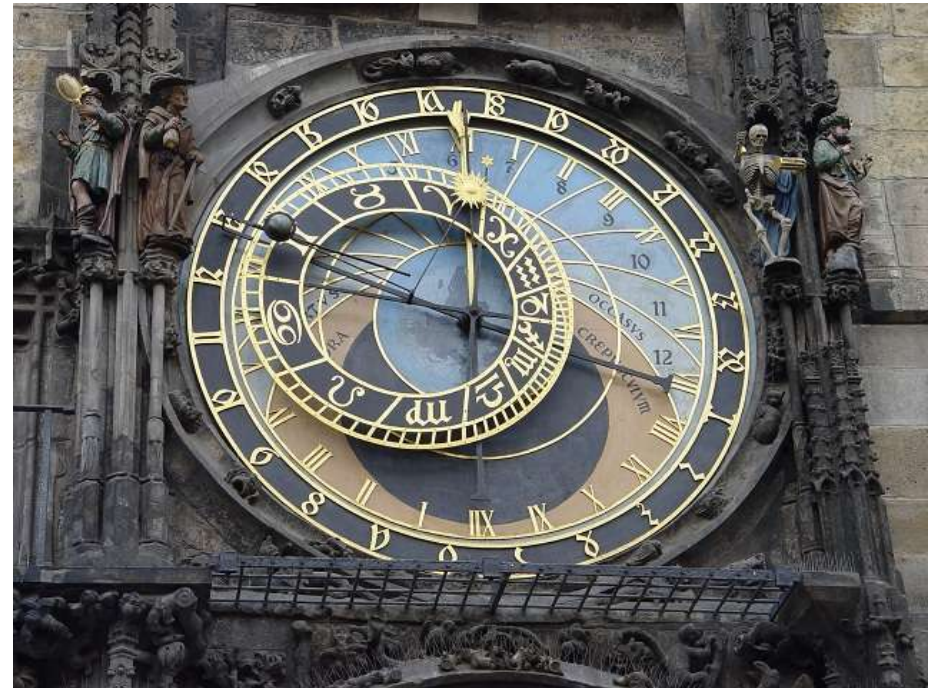
- ▶ Born 1136
- ▶ Died 1206
- ▶ Born in northwestern Iraq
- ▶ A polymath: a scholar, inventor, mechanical engineer, craftsman, artist, mathematician and astronomer
- ▶ He is best known for writing the *Book of Knowledge of Ingenious Mechanical Devices* in 1206, where he described fifty mechanical devices.



~1200AD

Astronomical clock

- ▶ A clock with special mechanisms and dials to display astronomical information, such as the relative positions of the sun, moon, zodiacal constellations, and sometimes major planets.
- ▶ The “castle clock” is an astronomical clock invented by Al-Jazari in 1206, is thought to be the earliest programmable analog computer.



John Napier

- ▶ **John Napier of Merchiston**
- ▶ Born 1550
- ▶ Died 4 April 1617
- ▶ Born in Merchiston Tower, Edinburgh
- ▶ A Scottish mathematician, physicist, astronomer & astrologer, and also the 8th Laird of Merchistoun.



~1617AD

Napier's Bones

- ▶ An abacus created by John Napier for calculation of products and quotients of numbers
- ▶ A rod's surface comprises 9 squares, and each square, except for the top one, comprises two halves divided by a diagonal line.
- ▶ The first square of each rod holds a single-digit, and the other squares hold this number's double, triple, quadruple and so on until the last square contains nine times the number in the top square.
- ▶ The digits of each product are written one to each side of the diagonal; numbers less than 10 occupy the lower triangle, with a zero in the top half.



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SET OF RODS

SET OF RODS

~1620AD

Slide Ruler

- ▶ The slide rule is a mechanical analog computer.
- ▶ The slide rule is used primarily for multiplication and division, and also for functions such as roots, logarithms and trigonometry.
- ▶ William Oughtred and others developed the slide rule in the 17th century based on the emerging work on logarithms by John Napier.



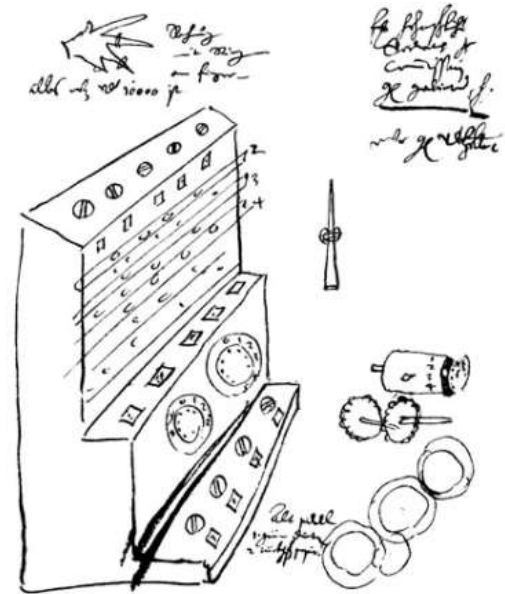
Wilhelm Schickard

- ▶ Born 22 April 1592
- ▶ Died 24 October 1635
- ▶ Born in Herrenberg, Germany
- ▶ a German polymath who designed a calculating machine in 1623



Schickard Clock

- ▶ Schickard's letters to Johannes Kepler show how to use the machine for calculating astronomical tables.
- ▶ The machine could add and subtract six-digit numbers, and indicated an overflow of this capacity by ringing a bell; to add more complex calculations
- ▶ His letters mention that the original machine was destroyed in a fire while still incomplete.
- ▶ This machine was not programmable



Blaise Pascal

- ▶ Born June 19, 1623
- ▶ Died August 19, 1662
- ▶ Born in Clermont-Ferrand, France
- ▶ A French mathematician, physicist, inventor, writer and Catholic philosopher.



Blaise Pascal

- ▶ He invented the mechanical calculator.
- ▶ Pascal also was a mathematician who helped create two major new areas of research.
 - He wrote a significant treatise on the subject of **projective geometry** at the age of sixteen,
 - He corresponded with Pierre de Fermat on **probability theory**, strongly influencing the development of modern economics and social science.



Pascaline

- ▶ A mechanical calculator that could add and subtract directly.
- ▶ The calculator had spoked metal wheel dials, with the digit 0 through 9 displayed around the circumference of each wheel. To input a digit, the user placed a stylus in the corresponding space between the spokes, and turned the dial until a metal stop at the bottom was reached, similar to the way a rotary telephone dial is used. This would display the number in the boxes at the top of the calculator. Then, one would simply redial the second number to be added, causing the sum of both numbers to appear in boxes at the top.
- ▶ Pascal began to work on his calculator when he was only 19 years old. He received a Royal Privilege in 1649 that granted him exclusive rights to make and sell calculating machines in France. By 1652 Pascal claimed to have produced some fifty prototypes and sold just over a dozen machines, but the cost and complexity of the Pascaline—combined with the fact that it could only add and subtract—was a barrier to further sales, and production ceased in that year.



Gottfried Leibniz

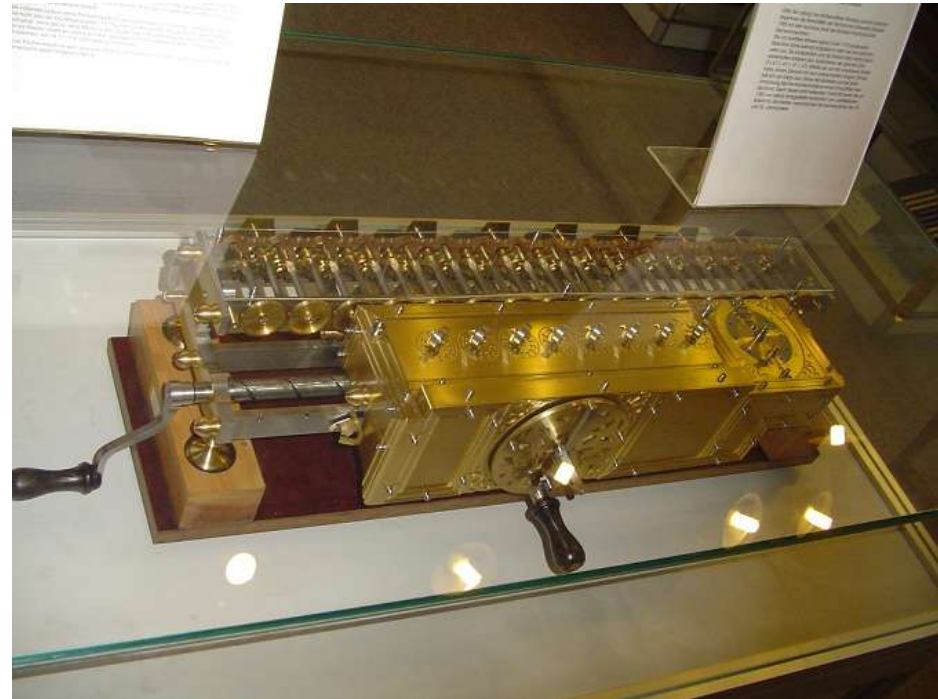
- ▶ Born July 1, 1646
- ▶ Died November 14, 1716
- ▶ Born in Leipzig, Electorate of Saxony
- ▶ A very important German mathematician and philosopher



1672AD

Stepped Reckoner

- ▶ A digital mechanical calculator invented by German mathematician Gottfried Wilhelm Leibniz around 1672 and completed 1694.
- ▶ It was the first calculator that could perform all four arithmetic operations: addition, subtraction, multiplication and division.
- ▶ Its intricate precision gearwork, however, was somewhat beyond the fabrication technology of the time; mechanical problems, in addition to a design flaw in the carry mechanism, prevented the machines from working reliably
- ▶ Despite the mechanical flaws of the Stepped Reckoner, it gave future calculator builders new possibilities.
- ▶ Leibniz once said *"It is unworthy of excellent men to lose hours like slaves in the labour of calculation which could safely be relegated to anyone else if machines were used."*



1703AD

The Binary Number System

- ▶ The modern binary number system was developed by Gottfried Leibniz in his article *Explication de l'Arithmétique Binaire* (1703).
- ▶ Leibniz's system uses 0 and 1, like the modern binary numeral system.
- ▶ As a Sinophile (fan of China), Leibniz was aware of the *I Ching* and noted with fascination how its hexagrams correspond to the binary numbers from 0 to 111111, and concluded that this mapping was evidence of major Chinese accomplishments in the sort of philosophical mathematics he admired.

TABLE 86 MEMOIRES DE L'ACADEMIE ROYALE

DES NOMBRES. bres entiers au-dessous du double du plus haut degré. Car icy, c'est com- me si on disoit, par exemple, que 111 ou 7 est la somme de quatre, de deux & d'un. Et que 1101 ou 13 est la somme de huit, quatre & un. Cette propriété sert aux Effayeurs pour peser toutes sortes de masses avec peu de poids, & pourroit servir dans les monnoyes pour donner plusieurs valeurs avec peu de pieces.

Cette expression des Nombres étant établie, sert à faire tres-facilement toutes sortes d'operations.

Pour l'Addition par exemple.

Pour la Soustraction.

Pour la Multiplication.

Pour la Division.

Et toutes ces operations sont si aisées, qu'on n'a jamais besoin de rien essayer ni deviner, comme il faut faire dans la division ordinaire. On n'a point besoin non-plus de rien apprendre par cœur icy, comme il faut faire dans le calcul ordinaire, où il faut sçavoir, par exemple, que 6 & 7 pris ensemble font 13; & que 5 multiplié par 3 donne 15, suivant la Table d'une fois un est un, qu'on appelle Pythagorique. Mais icy tout cela se trouve & se prouve de source, comme l'on voit dans les exemples précédens sous les signes \oplus & \odot .

Joseph Marie Jacquard

- ▶ **Joseph Marie Charles *dit* Jacquard**
- ▶ Born 7 July 1752
- ▶ Died 7 August 1834
- ▶ Born in Lyon, France
- ▶ He played an important role in the development of the earliest programmable loom, which in turn played an important role in the development of computers.



Jacquard Loom

- ▶ A mechanical loom that simplifies the process of manufacturing textiles with complex patterns.
- ▶ The loom is controlled by punched cards with punched holes, each row of which corresponds to one row of the design.
- ▶ Multiple rows of holes are punched on each card and the many cards that compose the design of the textile are strung together in order.



Charles Xavier Thomas

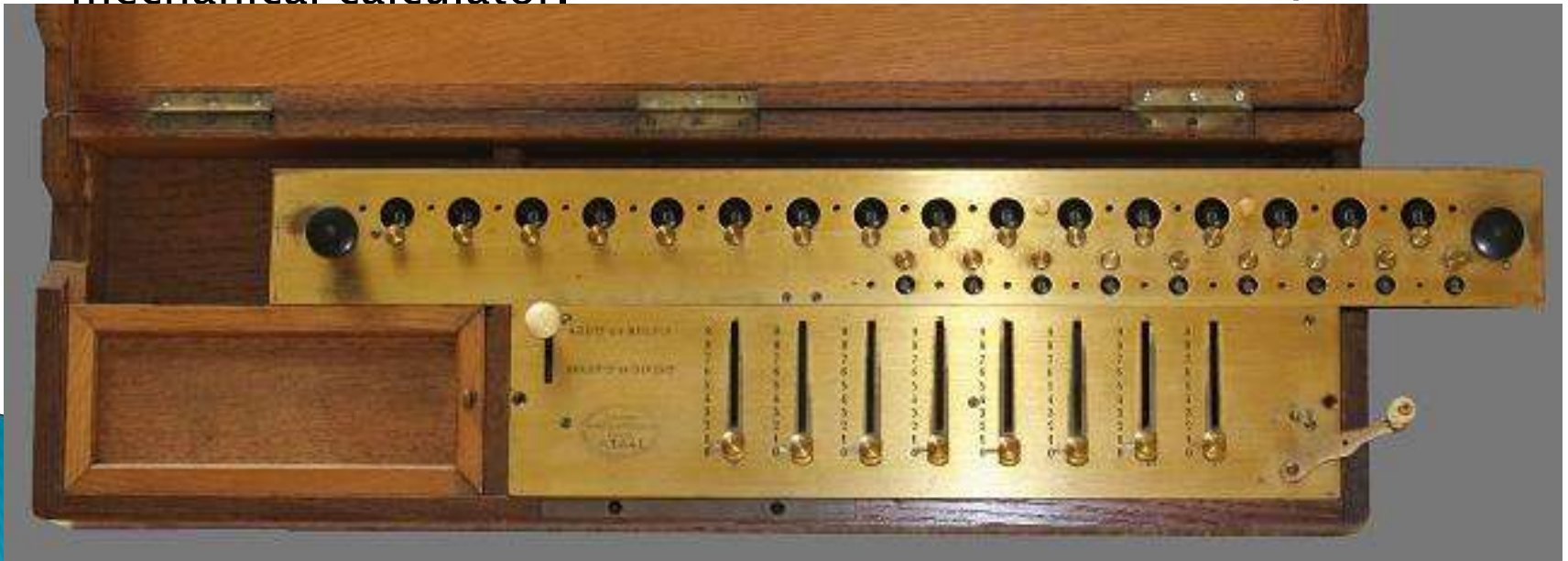
- ▶ **Charles Xavier Thomas de Colmar**
- ▶ Born May 5, 1785
- ▶ Died March 12, 1870
- ▶ Born in Colmar, France
- ▶ A French inventor and entrepreneur best known for designing, patenting and manufacturing the first commercially successful mechanical calculator,



1820AD

Arithmometer

- ▶ A mechanical calculator that could add and subtract directly and could perform long multiplications and divisions effectively by using a movable accumulator for the result.
- ▶ it became the first commercially successful mechanical calculator.
- ▶ Its sturdy design gave it a strong reputation of reliability and accuracy and made it a key player in the move from *human computers* to calculating machines that took place during the second half of the 19th century



Human Computers

- ▶ The term "**computer**" was in use from the mid-17th century, literally meant "*one who computes*": a person performing mathematical calculations.
- ▶ Teams of people were frequently used to undertake long and often tedious calculations; the work was divided so that this could be done in parallel.
- ▶ The approach was taken for astronomical and other complex calculations. Perhaps the first example of organized human computing was by the Frenchman Alexis Claude Clairaut in 1759 when he divided the computation to determine timing of the return of Halley's Comet with two colleagues, Joseph Lalande and Nicole-Reine Lepaute.
- ▶ The Indian mathematician Radhanath Sikdar was employed as a "computer" for the Great Trigonometric Survey of India in 1840. It was he who first identified and calculated the height of the world's highest mountain, later called Mount Everest.



Radhanath Sikdar

Charles Babbage

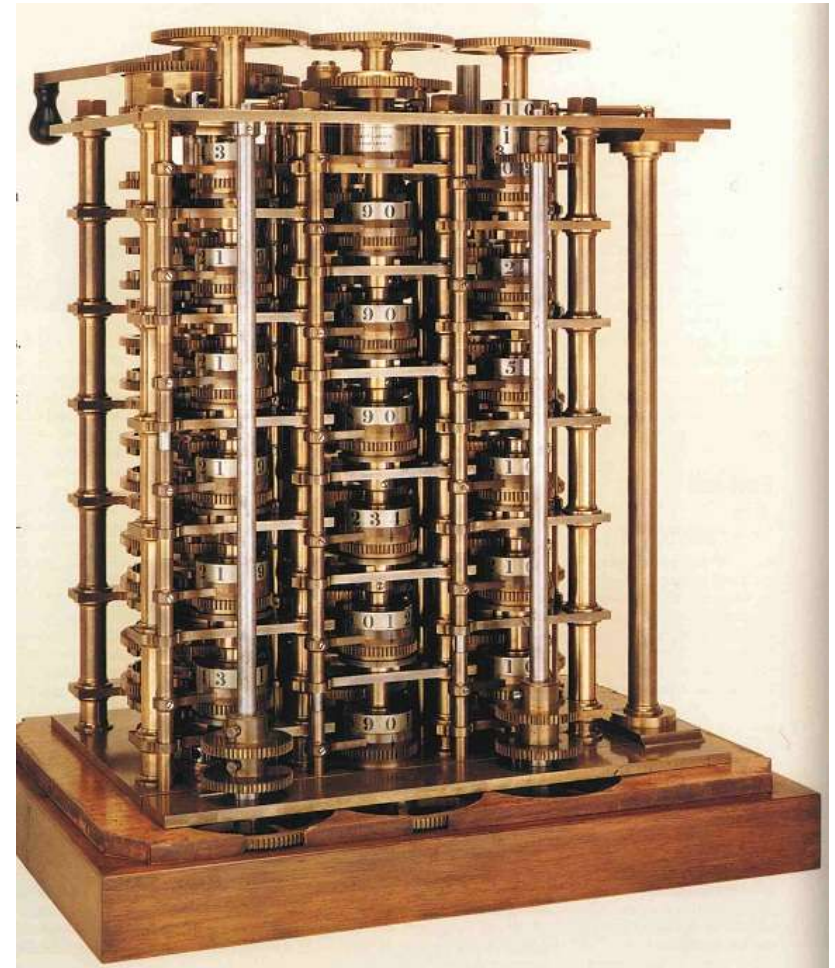
- ▶ Born 26 December 1791
- ▶ Died 18 October 1871
- ▶ Born in London
- ▶ Considered the “*father of computers*” since he designed the first computer system the “**Difference engine**” followed by the “**Analytical engine**”

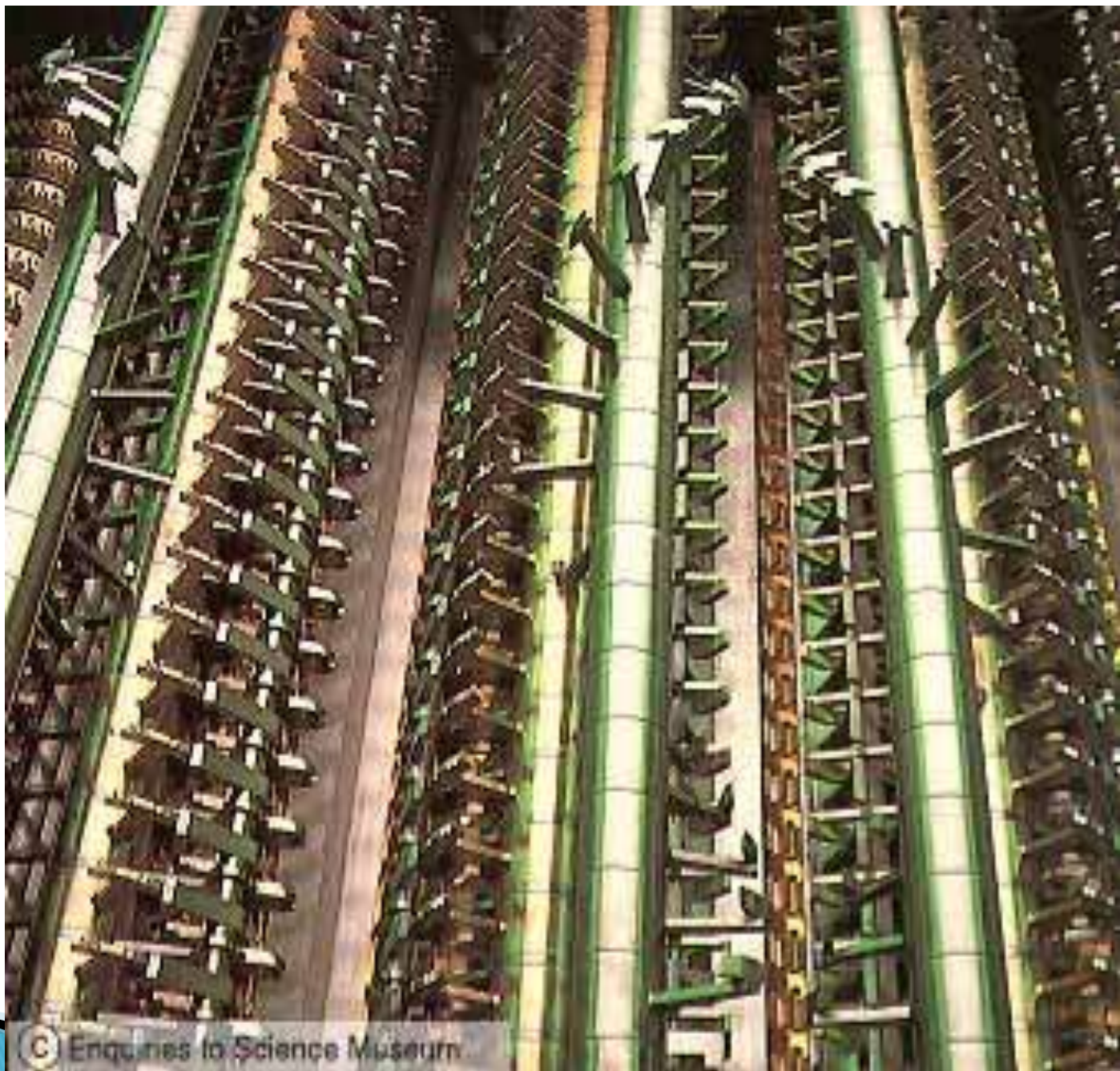


1822AD

Difference Engine

- ▶ an automatic, mechanical calculator designed to tabulate polynomial functions.
- ▶ Both logarithmic and trigonometric functions can be approximated by polynomials, so a difference engine can compute many useful sets of numbers.



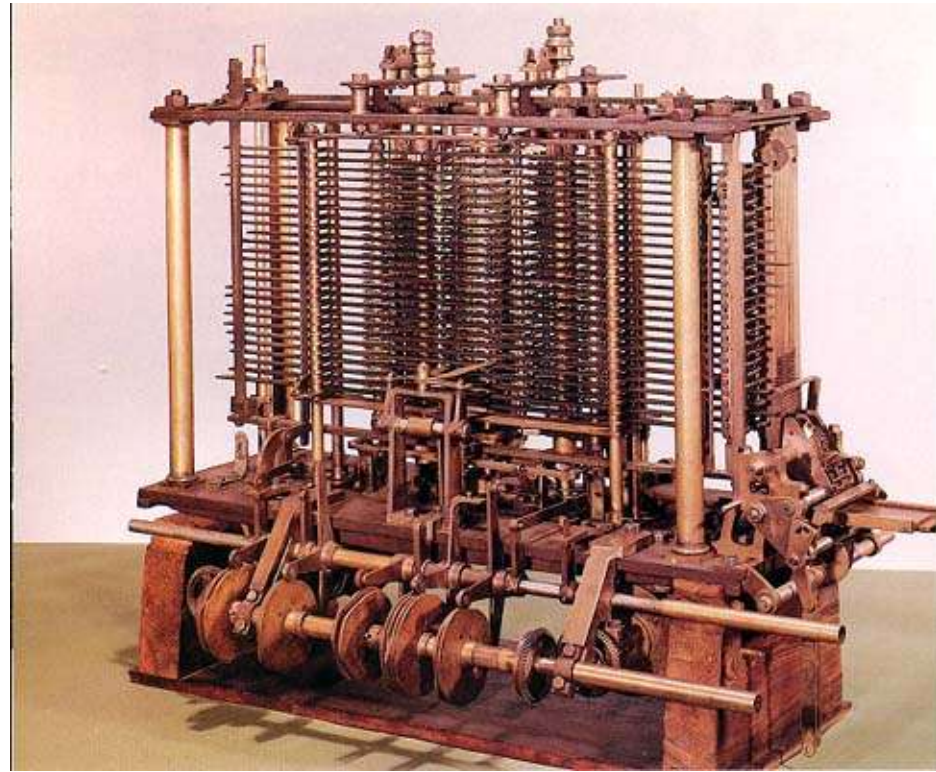


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1837AD

Analytical Engine

- ▶ A mechanical general-purpose computer.
- ▶ In its logical design the machine was essentially modern, anticipating the first completed general-purpose computers by about 100 years.
- ▶ Babbage continued to refine the design until his death in 1871. Because of the complexity of the machine, the lack of project management science, the expense of its construction, and the difficulty of assessing its value by Parliament relative to other projects being lobbied for, the engine was never built.



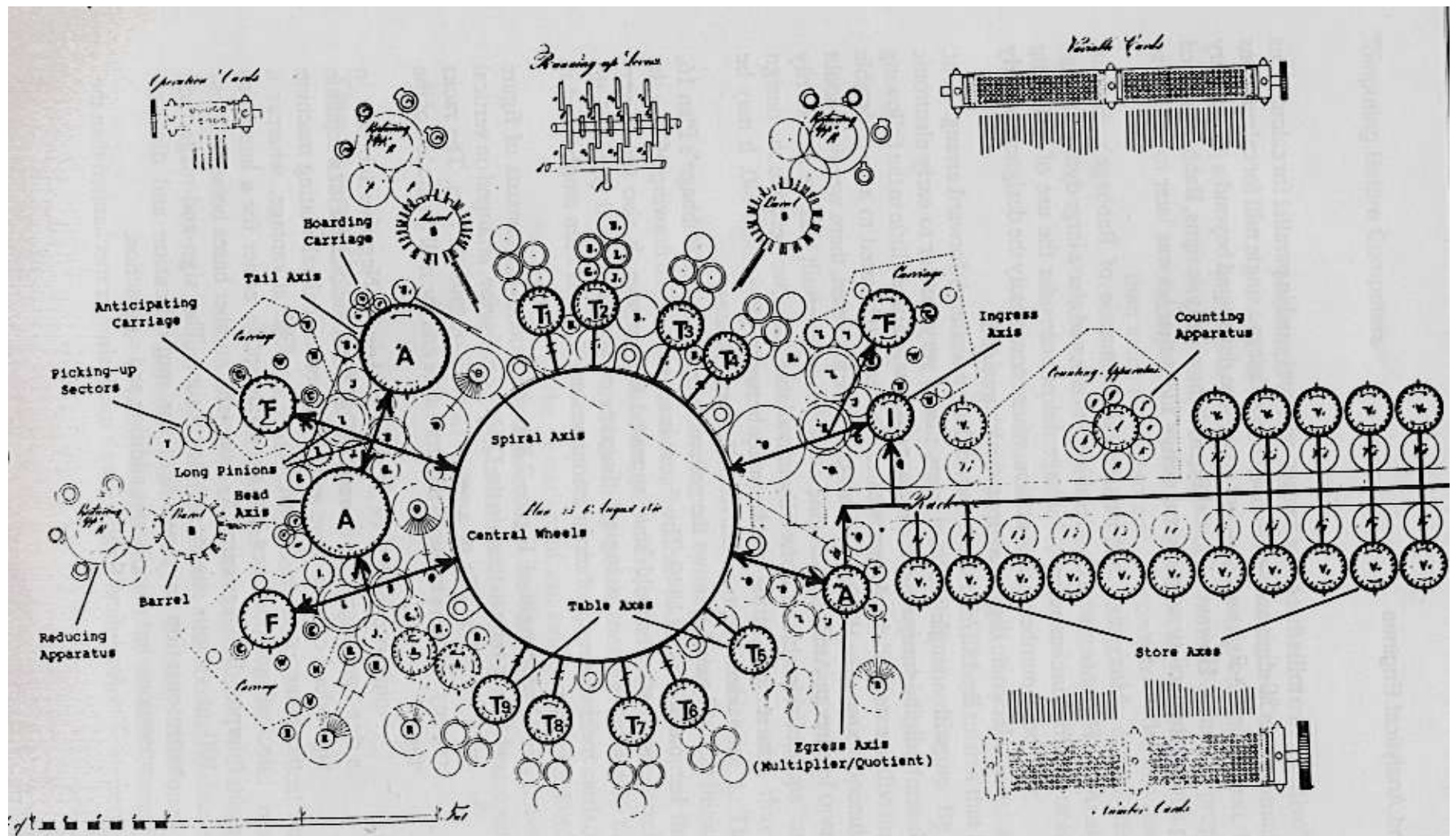


Figure 2.8. Babbage's Plan 16 for the Analytical Engine in August 1840. The original plan drawing of the mechanism has been annotated to show the functional relationships of the principal

Ada Byron

- ▶ **Augusta Ada Byron, Countess of Lovelace**
- ▶ Born 10 December 1815
- ▶ Died 27 November 1852
- ▶ Born in London
- ▶ Considered “*the world’s first computer programmer*” since she created the first algorithm.



Ada Byron



- ▶ The only child of the poet George Gordon, 6th Lord Byron and his wife, Anne Milbanke, Baroness Wentworth
- ▶ Her parents were separated since she was born
- ▶ Her mother developed a deep dislike for poetry, and insisted that her daughter would only be tutored in the sciences and mathematics

Analytical Engine

- ▶ When Ada was 17 (1832), she met the inventor of the Differential Engine, Charles Babbage.
- ▶ He was a professor of mathematics at Cambridge, and elected as a Fellow of Royal Society, and recognized as a talented mathematician.
- ▶ Ada and Babbage met in high London society, becoming lifelong friends, and spoke frequently upon the developing subjects of mathematics, logic, and science.
- ▶ Ada's interests were wide and varied, not just math, but also including horses, and music. Her education and nobility, as Babbage's newfound fame, uniquely put the duo together, and allowed her to participate in a largely male dominated field.



- ▶ In 1842, the Italian mathematician Luigi Menabrea, whom Babbage had met while travelling in Italy, wrote a description of the engine in French.
- ▶ In 1843, the description was translated into English and extensively annotated by Ada, who had become interested in the engine ten years earlier. In recognition of her additions to Menabrea's paper, which included a way to calculate Bernoulli numbers using the machine, she has been described as the first computer programmer.
- ▶ The modern computer programming language Ada is named in her honour.

Check Out:
<http://sydneypadua.com/2dgoggles/the-complete-lovelace-and-babbage/>



ADA LOVELACE THE ORIGIN!

BY SYDNEY PADUA

ADA LOVELACE WAS THE ONLY LEGITIMATE CHILD OF MAD, BAD, AND DANGEROUS TO KNOW POET AND NUTCASE LORD BYRON...

HER MOTHER ANABEL FLED THE EXPLODING PLANET HER HUSBAND YET WORRIED THAT ADA HAD INHERITED HIS WILD BLOOD.



ADA MUST BE SAVED FROM BECOMING POETICAL!

...MATHEMATICS!!

ONLY ONE THING CAN SUBDUCE POETRY...



ADA'S MOTHER HIRED THE FINEST MATHEMATICIANS AND SCIENTISTS OF THE AGE TO TURN HER INTO A HUMAN CALCULATING MACHINE!!

MEANWHILE, IN HIS SECRET LABORATORY, CHARLES BABBAGE IS WORKING ON THE RADICAL NON-HUMAN CALCULATING MACHINE...

NO ONE HAS THE INTELLECT TO GRASP THE GENIUS OF MY DIFFERENCE ENGINE!!!



SHORT-SIGHTED FOOLS!!!

DIDN'T THEY GIVE YOU THAT HUGE GRANT THAT YOU THEN USED FOR A TOTALLY DIFFERENT MACHINE THAT YOU ALSO DIDN'T BUILD?

SILENCE, MINION!



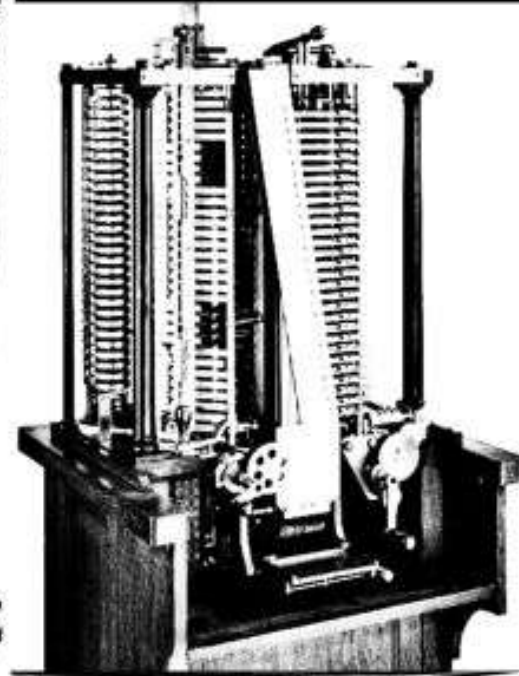
THEN, AT A PARTY IN 1833, FATE INTERVENED...



IN COLLABORATION WITH BABBAGE, ADA PRODUCED, IN THEORY, THE FIRST COMPUTER PROGRAMME...



SOME SORT OF MATH THING FOR THE NEXT-GEN ANALYTICAL ENGINE WHICH I DON'T UNDERSTAND.



UNFORTUNATELY, ADA DIED AT ONLY AGE 36, AND BABBAGE NEVER DID BUILD ANY OF HIS CALCULATING ENGINES..

THE NEXT STEPS IN COMPUTING WERE NOT TAKEN UNTIL THE 1930'S. BABBAGE'S ENGINE WAS FINALLY BUILT IN 1991, YOU CAN SEE IT AT THE SCIENCE MUSEUM IN LONDON.

OMG THAT'S SO BORING! WHAT ACTUALLY HAPPENED WAS, BABBAGE AND LOVELACE SUCCESSFULLY DEVELOPED THE COMPUTER IN THE MID 1830'S (GIVING HUMANITY THE NECESSARY TECHNOLOGICAL ADVANTAGE TO REPEL THE ALIEN INVASION OF 1898), AND USED THEIR COMBINED POWERS TO FIGHT CRIME AND HAVE ADVENTURES!!



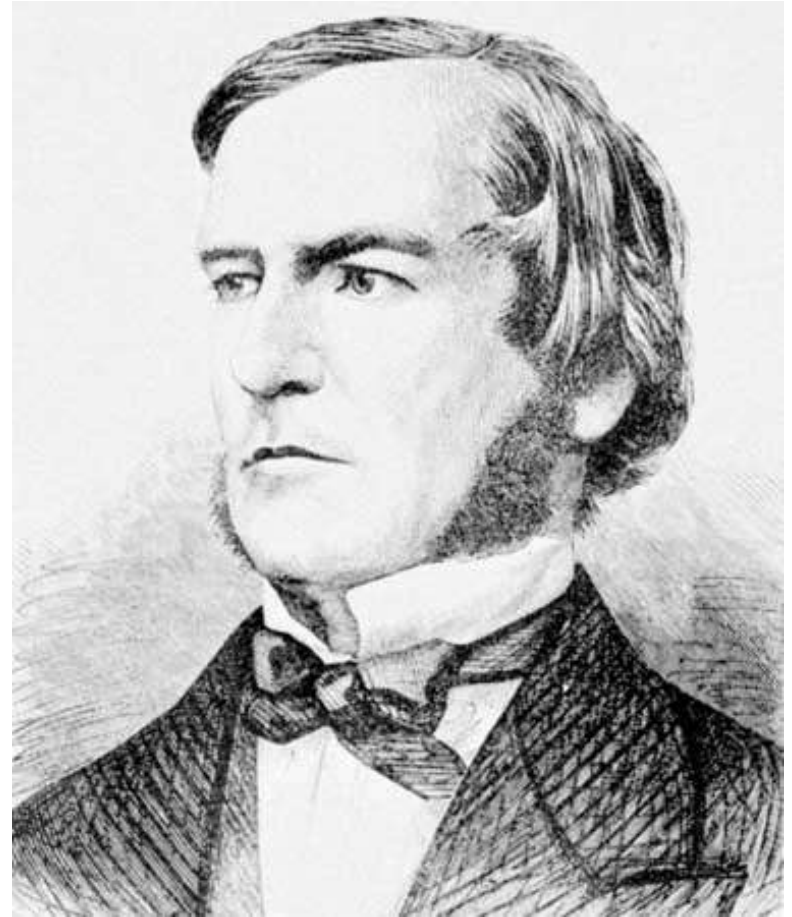
ALTHOUGH THEY DID HAVE A SOMEWHAT IDIOSYNCRATIC VIEW OF WHAT CONSTITUTES 'CRIME'.



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George Boole

- ▶ Born 2 November 1815
- ▶ Died 8 December 1864
- ▶ Born in Lincoln, Lincolnshire, England
- ▶ A mathematician and philosopher, who invented Boolean logic – the basis of modern digital computer logic



- | | | y | |
|-----|---|-----|---|
| | | 0 | 1 |
| x | 0 | 0 | 0 |
| | 1 | 0 | 1 |

		y	
	x	0	1
v	0	0	1
	1	1	1

		y	
	→	0	1
x	0	1	1
	1	0	1

		y	
	⊕	0	1
x	0	0	1
	1	1	0

A diagram of an AND gate. It has two input lines on the left labeled x and y . The output line on the right is labeled $x \text{ AND } y$.



A logic diagram of an AND gate. It has two inputs, labeled x and y , on the left. The gate is represented by a D-shaped symbol. The output, labeled $x \text{ AND } y$, is on the right.



A Venn diagram with two overlapping circles, X and Y, inside a rectangular frame. The intersection of the two circles is shaded gray. Below the circles, the text $X \cap Y$ is written.

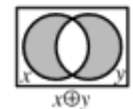
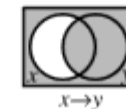
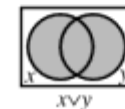
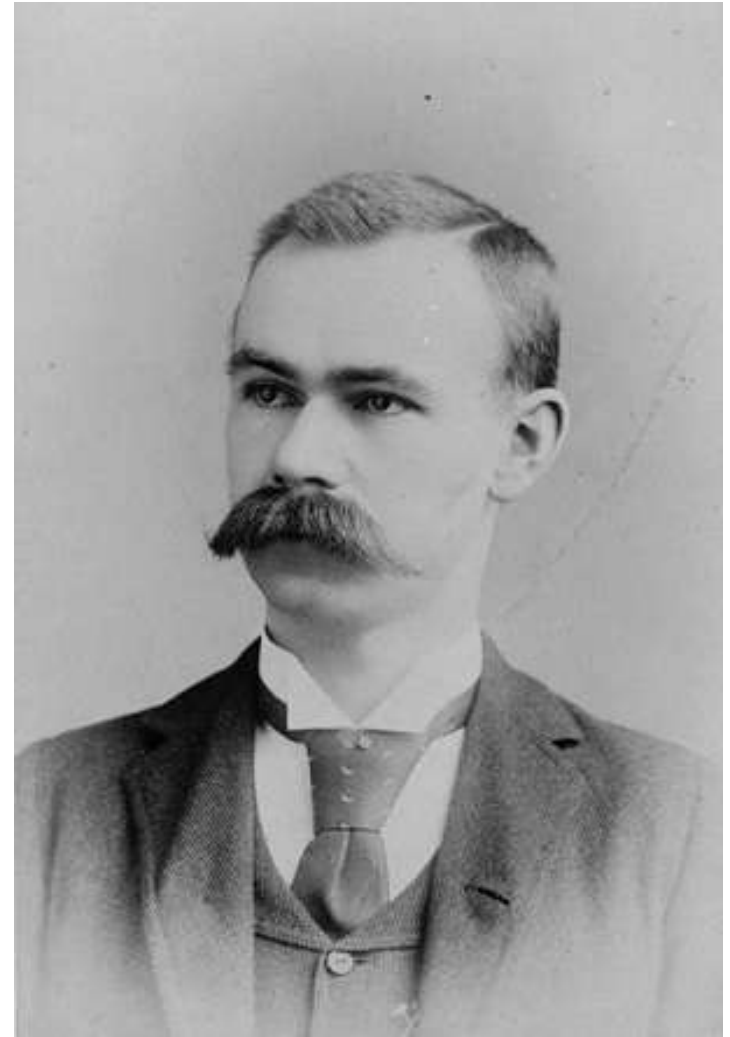


Figure 4. Venn diagrams

Herman Hollerith

- ▶ Born February 29, 1860
- ▶ Died November 17, 1929
- ▶ Born in Buffalo, New York
- ▶ An American statistician who developed a mechanical tabulator based on punched cards to rapidly tabulate statistics from millions of pieces of data.
- ▶ He was the founder of the company that

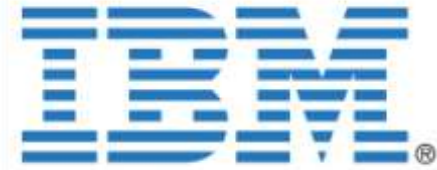


Punch Cards

-
- A large, ornate wooden desk with a high back featuring a grid of small drawers, a swivel chair, and a small side table. The desk is made of dark wood and has a classic, formal design. The high back of the desk is covered in a grid of small, round drawers, each with a decorative knob. The desk surface is smooth and polished, with a few books and papers resting on it. A swivel chair with a wooden frame and a cushioned seat is positioned in front of the desk. To the right of the desk is a small, matching side table with a single drawer. The entire set is set against a plain, light-colored wall.

[illegible]

Punch Cards

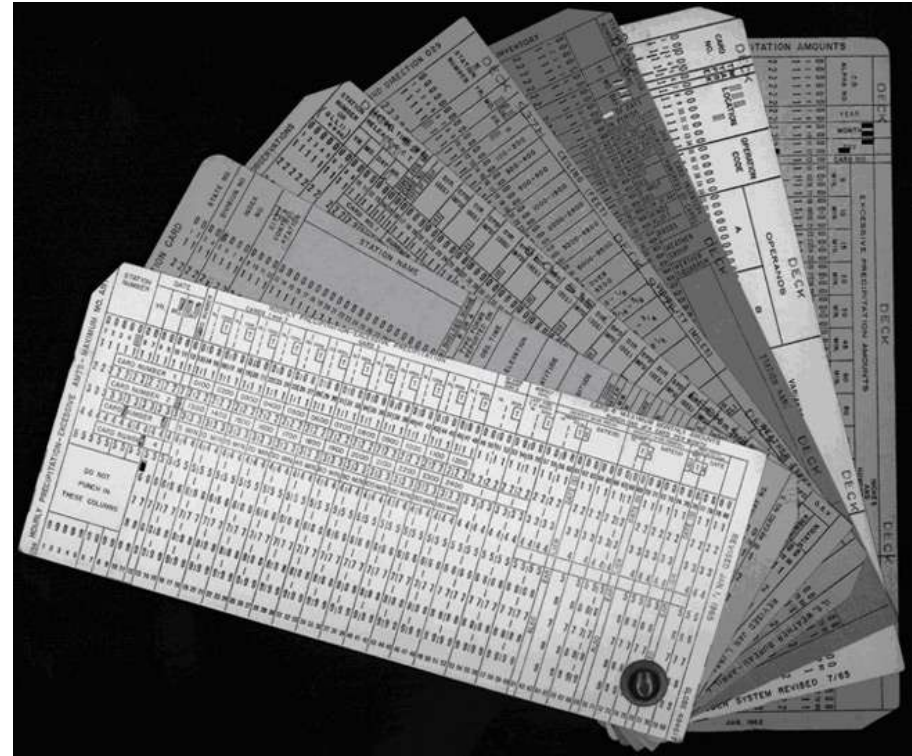


- ▶ The 1880 census had taken eight years to process.
- ▶ Hollerith built machines under contract for the Census Office, which used them to tabulate the 1890 census in only one year.
- ▶ Hollerith then started his own business in 1896, founding the *Tabulating Machine Company*.
- ▶ In 1911 the *Tabulating Machine Company* merged with the Computing Scale Corporation, the International Time Recording Company, and the Bundy Manufacturing Company to form the *Computing Tabulating Recording Corporation*.
- ▶ This company was renamed to International Business Machines, IBM in 1924.

1884AD

Punch Cards

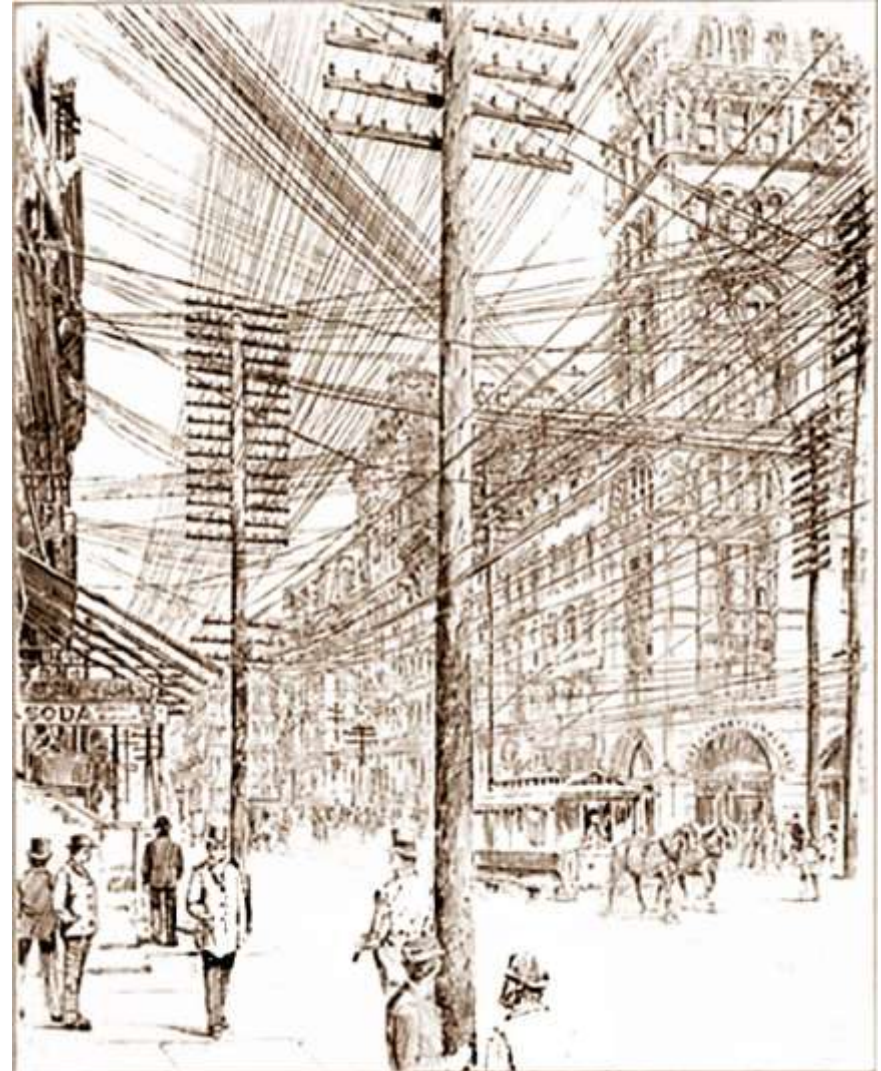
- ▶ The warning printed on most cards intended for circulation as documents (checks, for example), "*Do not fold, spindle or mutilate*," became a catch phrase for the post-World War II era.



1880s

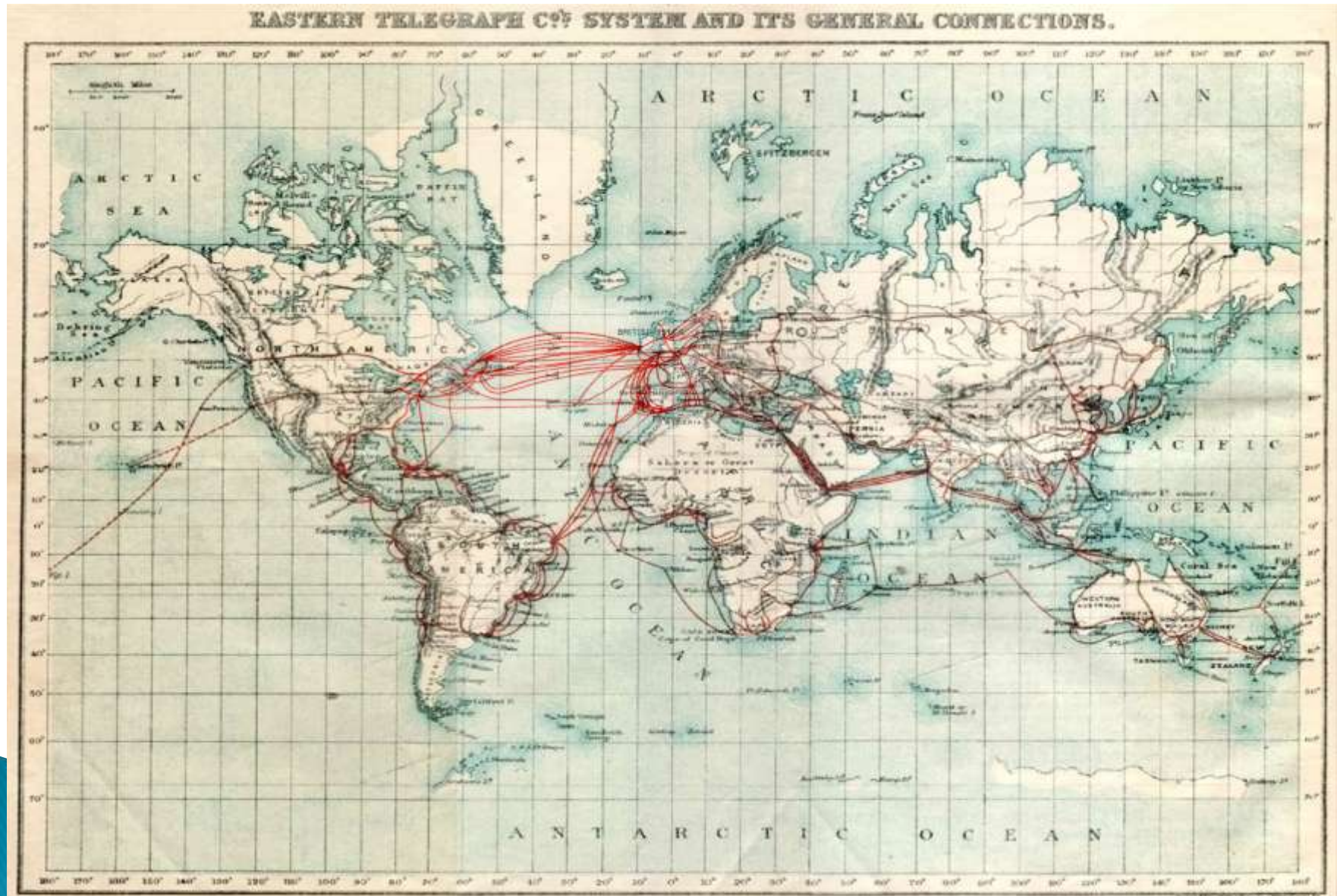
Victorian Internet

- ▶ The **Victorian Internet** is a term coined in the late 20th century to describe advanced 19th century telecommunications technologies such as the telegraph and pneumatic tubes.
- ▶ According to Tom Standage's *The Victorian Internet* (1998), besides news reporting, telegraphy, as the first true global network, permitted applications such as message routing, social networks (between Morse operators -- with gossip and even marriages among operators via telegraph), cryptography and text coding, abbreviated slang, network security experts, hackers, wire fraud, spamming, e-commerce, stock exchange minute-by-minute reports via ticker tape machines, and many others.



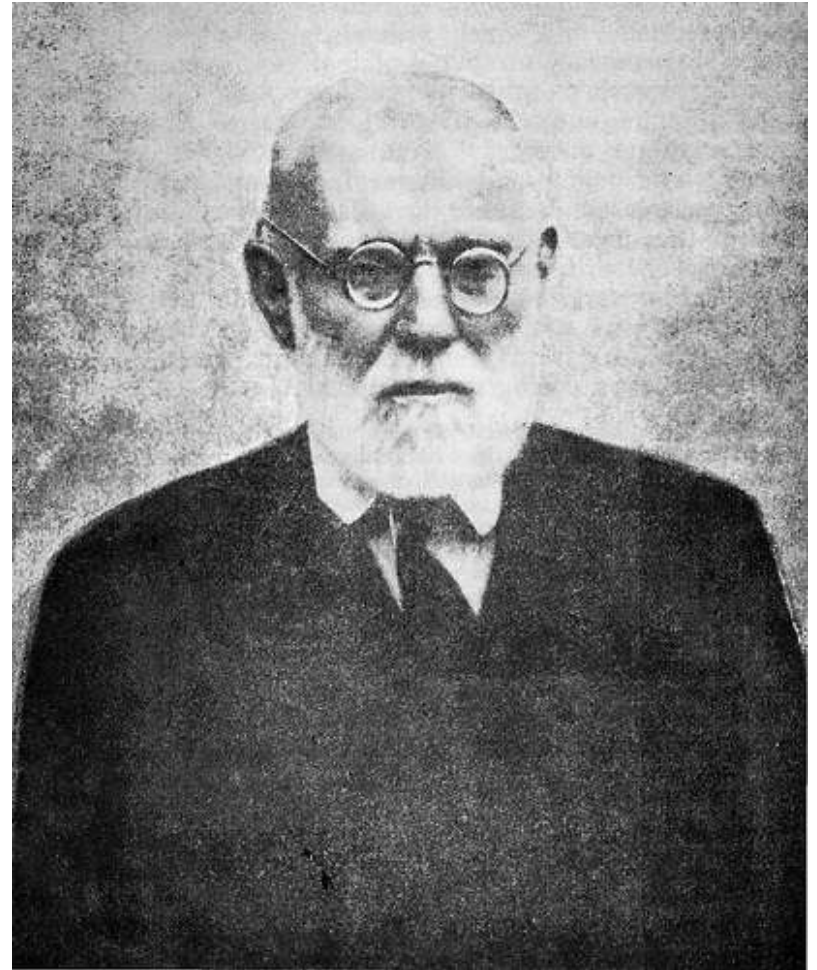
1901

Victorian Internet



Paul Otlet

- ▶ Born 23 August 1868
- ▶ Died 10 December 1944
- ▶ Born in Brussels, Belgium
- ▶ An author, entrepreneur, visionary, lawyer and peace activist.
- ▶ He created the Universal Decimal Classification
- ▶ He was responsible for the widespread adoption in Europe of the standard American 3x5 inch index card used until recently in most library catalogues around the world.



1895AD

The Universal Bibliographic Repertory

- ▶ In 1895, Otlet and La Fontaine also began the creation of a collection of index cards, meant to catalogue facts, that came to be known as the "Repertoire Bibliographique Universel" (RBU), or the "Universal Bibliographic Repertory".
- ▶ By the end of 1895 it had grown to 400,000 entries; later it would reach a height of over 15 million.



The Mundaneum

- ▶ In 1910, Otlet first envisioned a "city of knowledge", which Otlet originally named the "Palais Mondial" ("World Palace"), that would serve as a central repository for the world's information.
- ▶ In 1919, soon after the end of World War I, he convinced the government of Belgium to give him the space and funding for this project, arguing that it would help Belgium bolster its bid to house the League of Nations headquarters.
- ▶ They were given space in the left wing of the Palais du Cinquantaire, a government building in Brussels.



- ▶ Index cards were stored in custom-designed cabinets, and indexed according to the Universal Decimal Classification. The collection also grew to include files (including letters, reports, newspaper articles, etc.) and images, contained in separate rooms; the index cards were meant to catalogue all of these as well. The Mundaneum eventually contained 100,000 files and millions of images.

