

# Computer Science 1400: Part #1

How We Got Here:  
In the Beginning (pre-1940)

WHAT IS A COMPUTER (REALLY)?

WHAT WERE THE FIRST COMPUTERS?

# Ancient Computing Devices



Quipu  
(Peru; 1000  
AD)



Abacus  
(Mesopotamia;  
2500 BC)



Antikythera  
Computer  
(Greece;  
200 BC)

## What *is* a Computer? (Take I)

**numbers → calculator → results**

## The First (and Last) Computers



Nicole-Reine Lepaute  
(1723–1788)



Gertrude Blanch  
(1896–1996)

## Organization of Human Computing

- From the early 1600's until the 1940's, a computer was a person who performs calculations, *i.e.*, computes.
- Early human computing was done for problems in astronomy, *e.g.*, the 1758 return of Halley's comet (Alexis-Claude Clairaut, Joseph-Jerome Lelande, and Nicole-Reine Lepaute (1757)).
- Computing subsequently used to create various mathematical tables used in navigation (Nevil Maskelyne: *Nautical Almanac* (1766–now)) and surveying (Gaspard de Prony: *Tables du Cadastre* (1790–1801)).

## Organization of Human Computing (Cont'd)



Nevil Maskelyne  
(1732–1811)



Gaspard de Prony  
(1735–1839)

## Organization of Human Computing (Cont'd)

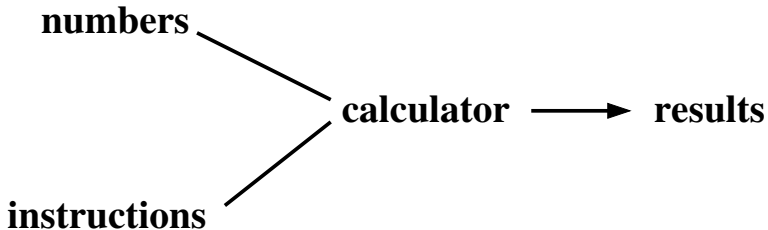
- With the computing groups of Maskelyne and de Prony, for the first time, computers are paid employees.
- Human computing groups varied along several dimensions:
  - Size
  - Geographical centralization
  - Number of organizational levels
  - Education of lowest-level computers
- Regardless of size, all groups incorporated checking mechanisms, *e.g.*, repeat calculation + comparison, differencing, and, until the late 1800's, were staffed by men.

## Organization of Human Computing (Cont'd)

	Size	Central?	Levels	Education
Lepaute	3	total	1	high
Maskelyne	15	partial	2	medium
de Prony	100	partial	3	low



## What *is* a Computer? (Take II)



Overall speed of calculation can only increase if input, calculation, and output operations **all** undergo **same** increase in speed.

# What *is* a Computer? (Take II) (Cont'd)



*"Can you step up here just a moment, Mr. Hodgini? I think I've found your bottleneck."*

## The First Mechanical Computers

- True mechanical computers emerged in the 17th century, *e.g.*, the 1642 addition machine of Blaise Pascal (1623–1662).

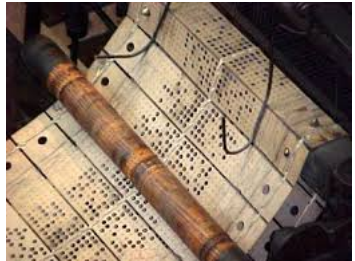


- Were expensive, fragile, and had restricted functionality.

## The First Mechanical Computers (Cont'd)



Jaquard Loom (1802)



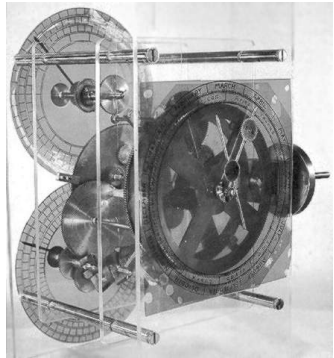
Jaquard Cards (detail)

## Interlude: Analog vs. Digital Computers

- Analog computers encode entities using continuously changeable physical phenomena (mechanical / electrical).



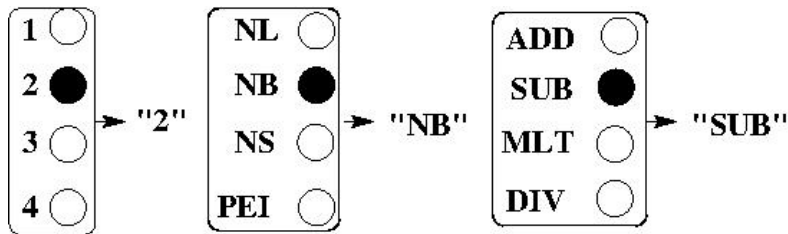
Antikythera Computer  
(Greece: 200 BC)



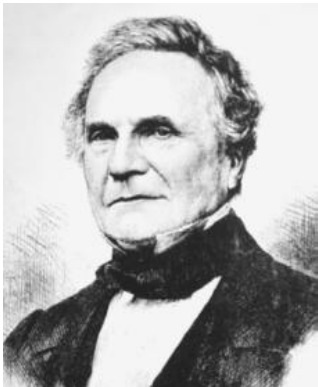
Antikythera Computer  
(Reconstruction)

## Interlude: Analog vs. Digital Computers (Cont'd)

- Digital computers encode entities using discretely changeable physical phenomena (mechanical / electrical).
- Basic digital scheme encodes an entity by using punched hole to select one of a set of possible entities.



## The First Mechanical Computers (Cont'd)



Charles Babbage  
(1791–1871)



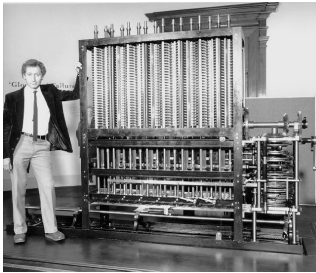
Ada Lovelace  
(1815–1852)

## The First Mechanical Computers (Cont'd)

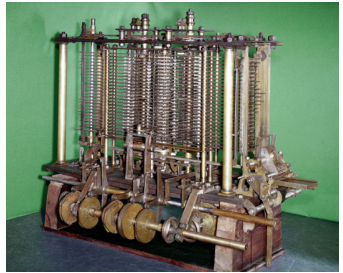
- Babbage designed two mechanical computers.
- The Difference Engine could compute fixed mathematical functions using only repeated additions.
  - Design inspired by visit to de Prony in 1819.
  - Could also typeset and print computed tables.
- The Analytical Engine could perform arbitrary specified mathematical computations.
  - Contained memory and programming mechanism based on Jacquard-style punched cards.
  - Mechanisms of and elementary programming techniques for AE described by Ada Lovelace.



# The First Mechanical Computers (Cont'd)



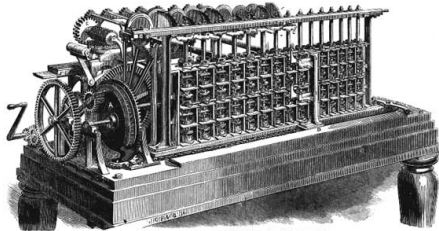
Difference Engine  
(1822 [1991])



Analytical Engine  
(1834)

## The First Mechanical Computers (Cont'd)

- Neither of Babbage's Engines were fully implemented in his lifetime, but versions did appear (Scheutz DE (1843)).



- Were expensive fragile, and had restricted functionality.

*... But ...*

## Commercial Computing

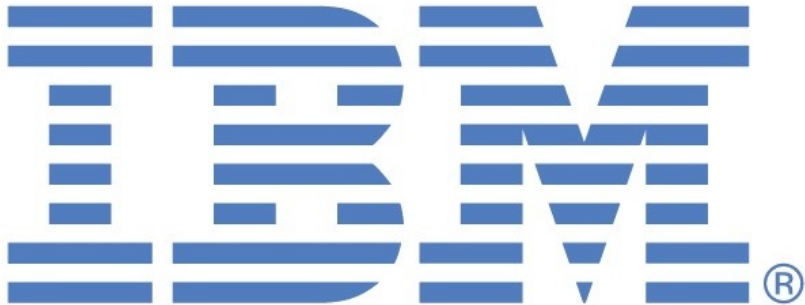


Banker's Clearing House (London, 1830)

## Commercial Computing (Cont'd)

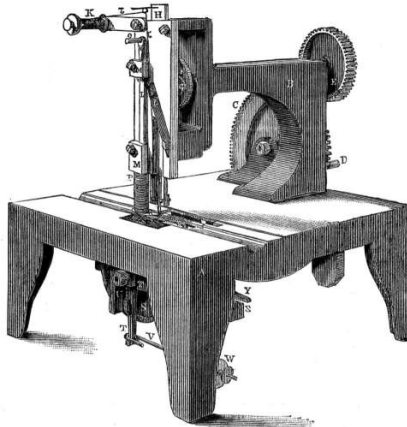
- Large scale-commercial activity arose in Europe in the early 1800's, involving both computing and the filing, bookkeeping, and document preparation handled by clerks.
- Clerks and computers organized into increasingly complex centralized offices to handle business associated with the financial, communications, and transportation industries, *e.g.*, the Banker's Clearing House (est. 1830) to handle the processing of inter-bank cheques.
- American commercial activity, starting up several decades after their European counterparts, was able to exploit newly-available office machinery; for legacy / cost reasons, European businesses remained purely human-based until the early 1900's.

## Commercial Computing: Creating IBM



i.e., International Business Machines (1924)

# Commercial Computing: Creating IBM (Cont'd)



**THE SINGER MACHINE, AUGUST 12, 1851.**

Earliest model filed in Patent Office. Reproduced from the SCIENTIFIC AMERICAN of November 1, 1851.

Sewing Machine (Singer, 1851)

# Commercial Computing: Creating IBM (Cont'd)



Typewriter  
(Remington,  
1874)



Adding  
Machine  
(Burroughs;  
1885)



Cash Register  
(NCR, 1884)

## Commercial Computing: Creating IBM (Cont'd)

- Office machine industry built on large-scale precision manufacturing techniques used for sewing machines and retail sales and repair branch outlets pioneered by Singer.
- Remington introduced user training schools for their typewriters.
- National Cash Register under John Patterson further added a research and development division, mailed systems-oriented product literature for existing and potential customers, and, perhaps more importantly, a standardized dress code, training schools, sales scripts, and generous financial incentives (base pay + commissions) for salesman.
- Hired as a salesman in 1896, Thomas Watson Sr. was by 1911 NCR General Manager.



## Commercial Computing: Creating IBM (Cont'd)



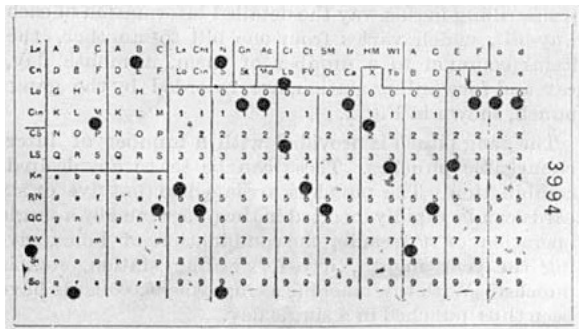
John Patterson  
(1844–1922)



Thomas Watson Sr.  
(1874–1956)

## Commercial Computing: Creating IBM (Cont'd)

- Manual methods too slow and expensive as of 1880 US Census; mechanical technology used in 1890 census.



Hollerith Punchcard

## Commercial Computing: Creating IBM (Cont'd)



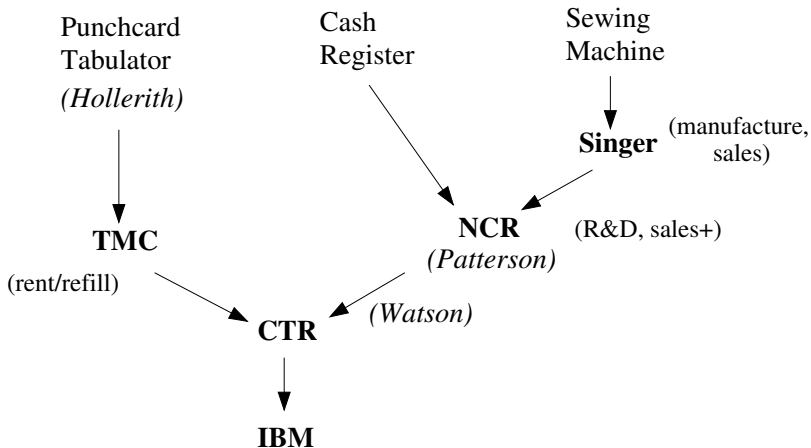
Herman Hollerith  
(1860–1929)



Tabulator Machine  
(1890)

- Hollerith pioneered (machine) rental / (punchcard) refill business model.

## Commercial Computing: Creating IBM (Cont'd)



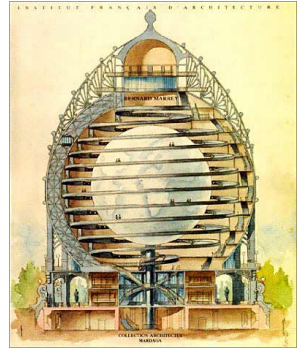
## Human Computing: 1870-1940

- Existing office machinery sufficient for booming commercial computing needs; however, scientific and statistically-oriented government computing still required human computers (assisted where possible by adding and tabulator machines).
- Boom in Maskelyne-style human computing for creating ballistics tables during World War I.
- Though men preferred, women and minorities increasingly hired as computers (particularly during World War I), cf. Harvard Observatory 1875+.
- During the Great Depression of the 1930's, de Prony-style computing resurrected in the Mathematical Tables Project; under WPA regulations, human computing becomes "job of the dispossessed" (Gries (2005), p. 276).

## Human Computing: 1870-1940 (Cont'd)



## Human Computing: 1870-1940 (Cont'd)



Lewis Richardson's "Weather-Forecast Factory" (1922)

## New Frontiers in Mechanical Computing



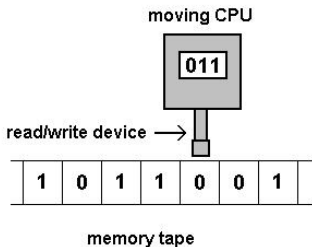
Differential Analyzer (Vannevar Bush, 1931)  
(solves Ordinary Differential Equations (ODE))



## ... Meanwhile, Back in Academia ...



Alan Turing  
(1912–1954)



Turing Machine (TM)  
(1936)

- TM mathematical model of general-purpose computation.