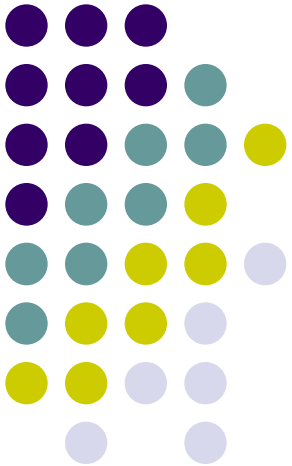
CSE 301
History of Computing

Computing in the 1800s:
Charles Babbage
and Herman Hollerith



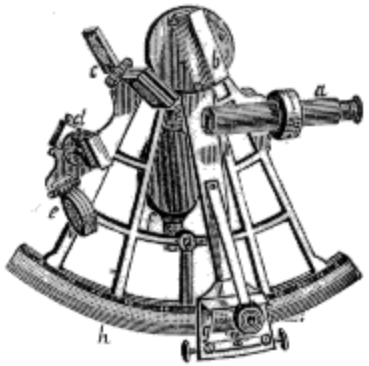
The Table-Making Industry

- France in 1790
  - midst of French Revolution
  - storming of Bastille was in 1789
  - change from monarchy to republic
  - led by Napoleon Bonaparte

- Gaspard De Prony
  - Hired to calculate the Tables du Cadastre
    - tables to help reassess taxes
  - used the principles of mass production

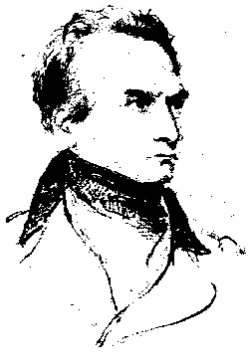
What's a nautical almanac?

- Describes the positions and movements of celestial bodies
  - sun, moon, planets, 57 stars
- Using a sextant and the Nautical Almanac, one can determine where one's ship is
- Requires lots of calculations
- Enter Charles Babbage



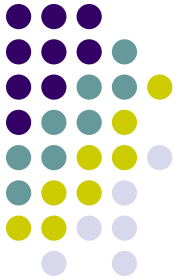
Sextant, p. 1932.

Charles Babbage



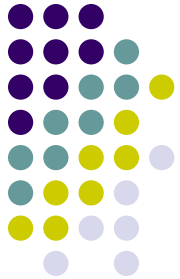
- 1792-1871
- The “(grand)father of computing”
- Mathematician, industrialist, philosopher, politician
- Wrote On the Economy of Manufactures (1832)
- Eccentric
- Loved fire, hated music
- Little known when he died
- Brain dissected years later

Babbage and Nautical Tables



- Worked on table-making project for the Nautical Almanac
  - for astronomers & navigators
- How did he like the work?
  - found the work tedious & error-prone
  - key step in calculations: the method of differences
- What was his proposal?
  - a machine to calculate & print tables

Difference Engine



- Machine proposed by Babbage
  - 1822 – demonstrated the concept was feasible and could be built with enough funds
  - 1823 – secured £1500 to build
  - 1833 – a prototype was built in 1833
  - 1842 – Babbage loses government funding
    - after £17000 total
- Babbage did not live to see a complete functioning Difference Engine

Babbage Difference Engine

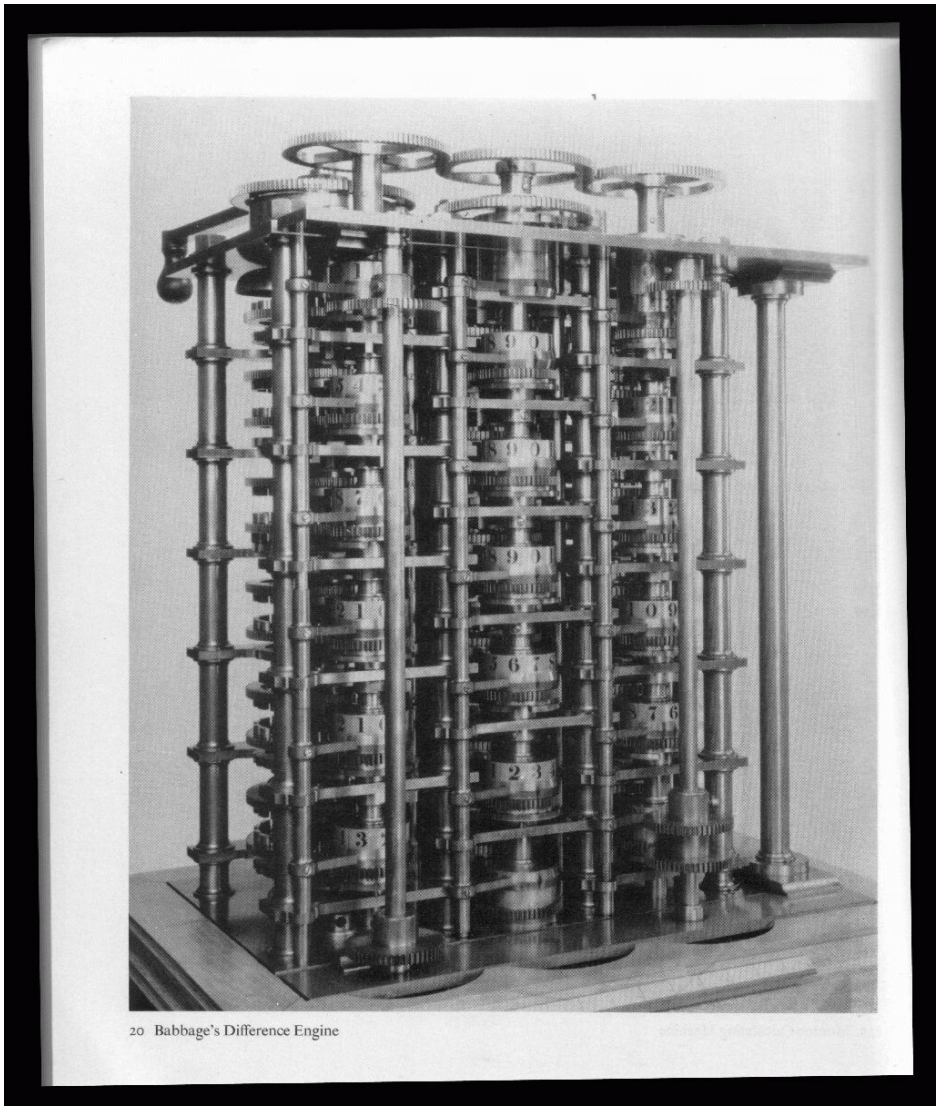
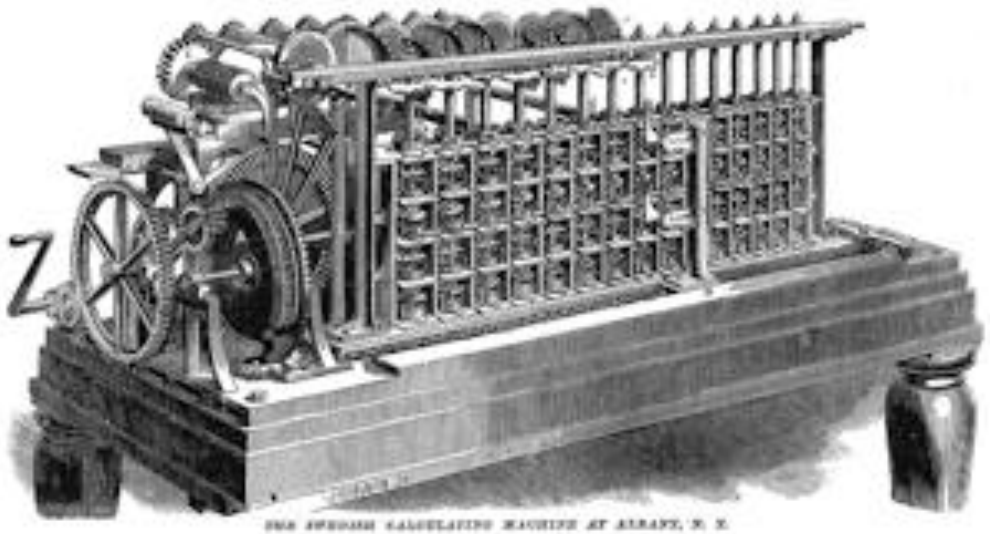


Photo of the
1832 Fragment
of a Difference Engine

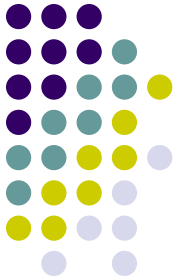
fragment made by
H.P.Babbage
from parts of
Difference Engine No.1

A Swedish Difference Engine

- 1853 – Father and son Georg and Edvard Scheutz of Sweden create the first complete difference engine
  - also the first calculator in history to be able to print out its results.

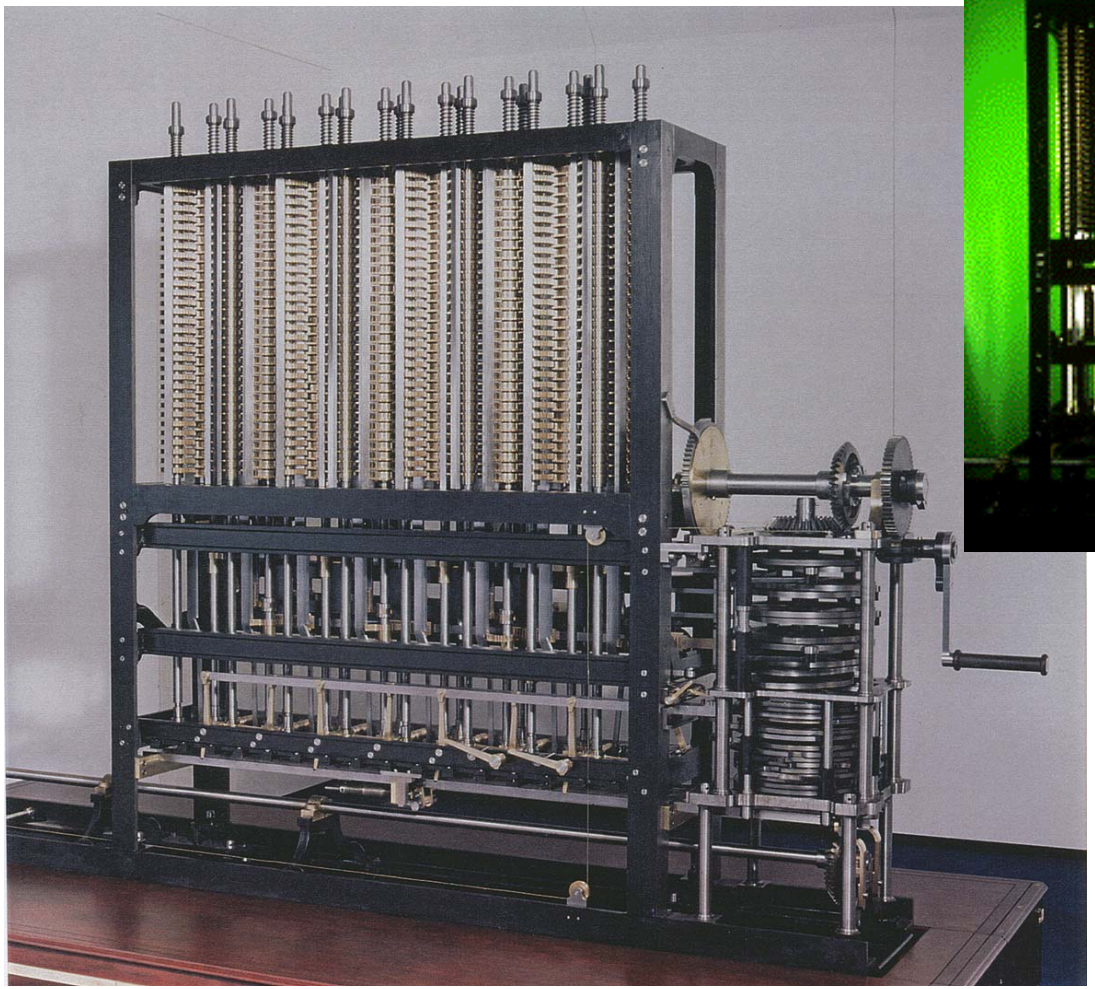


Why did Babbage's Difference Engine fail?



- The engineering was more difficult than the conceptualization
- Two tasks were necessary:
  1. design the Difference Engine
  2. develop the technology to manufacture it
- Other reasons:
  - Babbage was a perfectionist
  - Babbage lost interest
  - money, Babbage's degrading reputation, heartbreak

Babbage Difference Engine



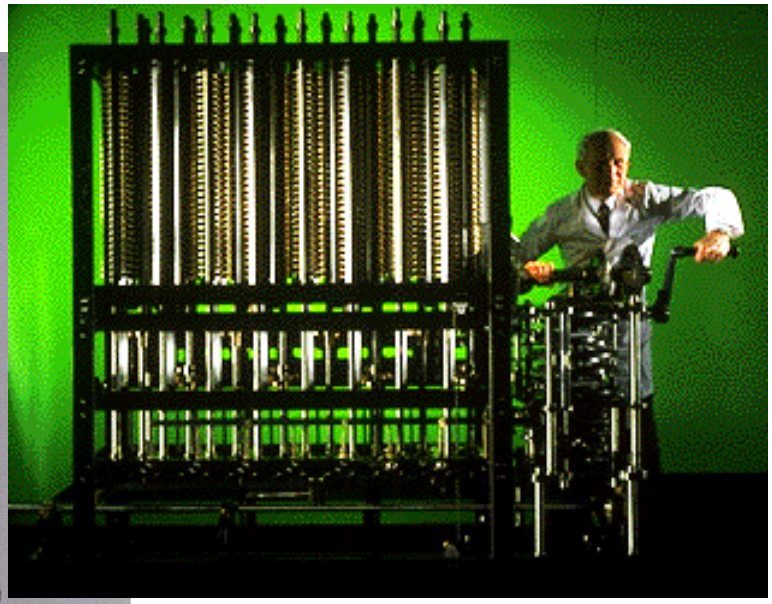
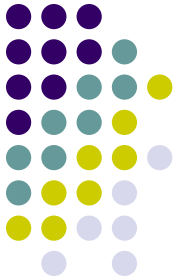


Photo of Babbage Difference Engine No. 2 constructed in 1991

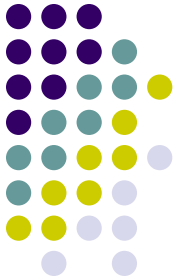
On display at London's Science Museum

Analytical Engine



- Designed around 1834 to 1836
  - to be a universal machine
  - capable of any mathematical computation
  - embodies many elements of today's digital computer
- Key ideas:
  - a control unit
  - mill – performed arithmetic operations (like an ALU)
  - store – stored numbers (like registers)
    - store had 1000 registers of 50 digits each
  - Incorporated using punched cards for input
    - idea came from Jacquard loom
- Never built by Babbage due to lack of funds and his eventual death in 1871

Analytical Engine



- Design included conditional branching (decision making capabilities)
  - based on whether the difference between two values was positive or negative.
- Example: Repeat calculation if 423 < 511.

  This means check if 423 – 511 < 0 (negative)

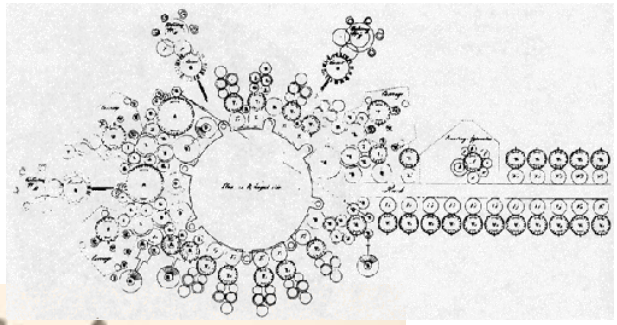
  00000 00423

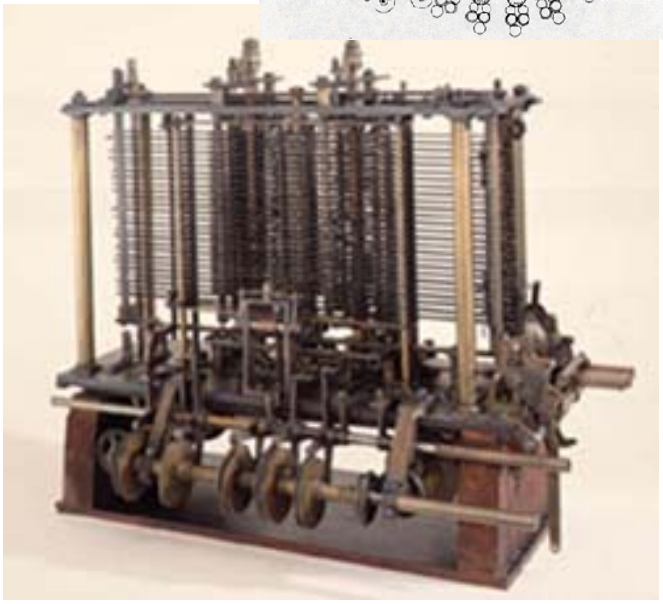
  – 00000 00511

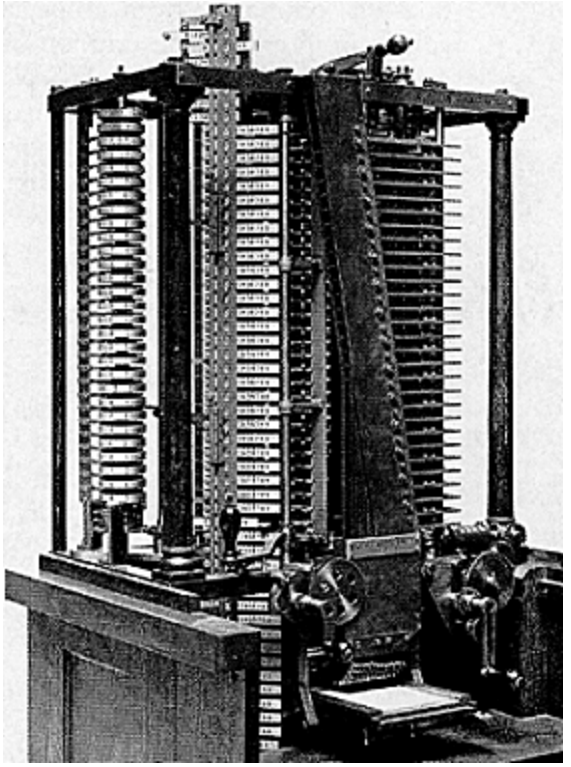
  999999 99912
- Engine Instructions stored on punch cards strung together with loops of string to form a continuous chain

Analytical Engine

lithograph by Babbage



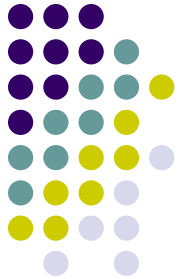




Analytic Engine completed by Babbage's son, Henry

Portion of the mill of the Analytical Engine with printing mechanism, under construction at the time of Babbage's death.

Going to London? Go to the Science Museum

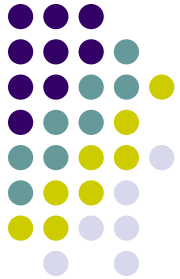


- Portion of Difference Engine (1832)
- Scheutz Difference Engine (1843)
- Experimental models and moulds from Charles Babbage's work on calculating machines (1870)
- Portion of Analytical Engine, under construction at the time of Babbage's death (1871)
- Difference Engine No. 2, trial piece made in the Science Museum Workshop (1989)
- Difference Engine No. 2, built by the Science Museum (1991)

Ada Augusta Byron, Countess Lovelace

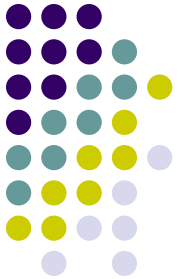
- 1815-1852
- Daughter of poet Lord Byron
- Mathematician who assisted Babbage
  - much admired by Babbage
  - she understood the significance of his work, which others did not
- Translated Menabrea's *Sketch of the Analytical Engine* to English (described Babbage's machine)
  - quadrupled its length by adding lengthy notes and detailed mathematical explanations
  - fact checked Babbage's work & programs

Ada – the first programmer?



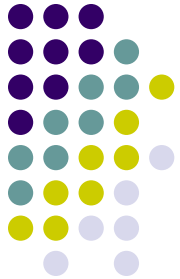
- Ada provided detailed instructions for how the analytical engine would work
- Some refer to as the world's first programmer
  - Some historians dispute this moniker, including our authors
    - say most of the technical content & all of the programs were Babbage's
  - Ada programming language named for her
  - Weaved coded instructions on punched cards
    - based on a language that was compatible with the Analytical Engine

Carrying on the Vision



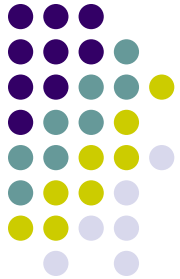
- Others made their own analytical engines, updating Charles Babbage's design
  - Henry P. Babbage (son)
    - created an assemblage of part of the Engine in 1910 (the mill and the printer)
  - Percy Ludgate, accountant (1883-1922)
    - replaced punched cards with perforated paper roll
    - electric motor used to drive main cyclinder
  - Torres y Quevedo
    - used electromagnetic relays to create an elementary analytical engine exhibited in Paris in 1914.

Information Processing



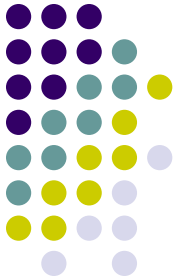
- Industry demands for high-volume information processing grew greatly in 1800s
  - Census tabulations (nothing new)
  - Industrial revolution & mass production
  - Centralized financial institutions
  - Railway management
  - Telegram management
  - Insurance industry
    - The “thrift movement” & shift from agricultural to industrial societies were contributing factors

The U.S. in the 1800s



- 20-30 years behind Europe in economic development
  - Europe industrialized in early 1800s
  - the U.S. was still mainly agricultural
- What helped changed this?
  - Territorial growth
  - U. S. Civil War (1860s)
  - U. S. Industrial Revolution
  - Population growth
- Industrial Revolution in Europe & North America greatly affected world politics
  - the West vs. China

America Emerges in the Office



- Post U.S. Civil War
  - American companies began to develop big offices
  - turned swords into ploughshares
- U. S. delay in industrializing (compared to Europe)
  - allowed American companies to take full advantage of emerging office technologies
  - timing is everything
- Another important factor:
  - “love affair with office machinery”
  - America was “gadget crazy”
  - more likely to buy useful or useless machinery than their European counterparts
- America soon became the leading producer of information technology goods
  - soon dominated type-writer, record keeping, & adding machine industries

U.S. Census

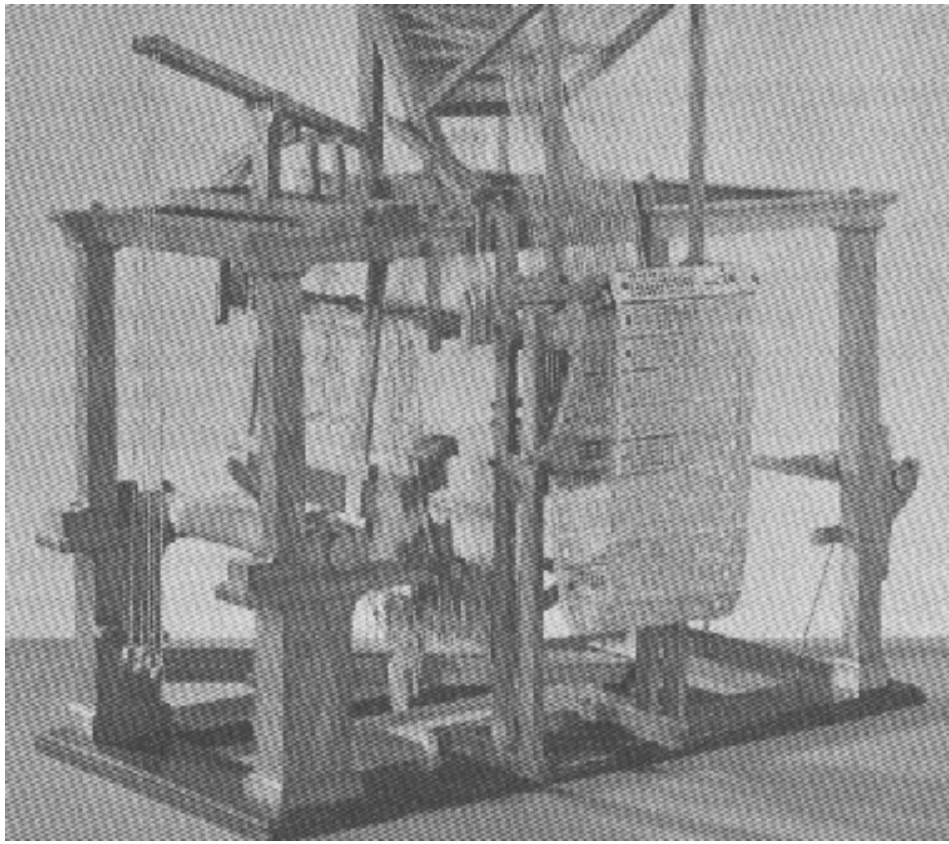
- Steadily increasing population
  - Early census had little info collected concerning demographics
- 1790 – 3.9 million
- 1840 – 17.1 million
  - 28 clerks in the Bureau of the Census
- 1860 – 31.4 million
  - 184 clerks
- 1870 – 38.6 million
  - 438 clerks
  - census report 3473 pages
- 1880 – 50.1 million
  - 1495 clerks
  - census report 21,000 pages
  - took 7 years to compile

Herman Hollerith

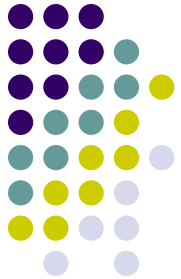
- Born Feb. 29, 1860 in Buffalo, NY
- Son of immigrant parents from Germany
- Schooled at home privately
- Worked at the US Census Bureau as in 1880
- Joined MIT as a mechanical engineering lecturer in 1882.
- Joined the U.S. Patent Office in Washington DC in 1884.

The 1880 U.S. Census

- Required seven years to process
  - grew as population grew
- In 1882, Hollerith investigated a suggestion by Dr. John Shaw Billings
  - “There ought to be some mechanical way of [tabulating Census data], something on the principle of the Jacquard loom, whereby holes in a card regulate the pattern to be woven.”



The Hollerith Electric Tabulating System



- Initially tried to store data as holes punched on paper tape.
  - inspired by train ticket
  - switched to the punched card as a better solution.
  - one card for each citizen
- A pin would push through holes in a card into mercury placed below the card to complete an electrical connection, causing a counter to advance.
- First tested on tabulating mortality statistics in 1887
- U.S. Census Bureau held a contest for a mechanical device to be used to count 1890 census
  - 3 entries
  - Hollerith's device won contest and so was used

The Hollerith Electric Tabulating System

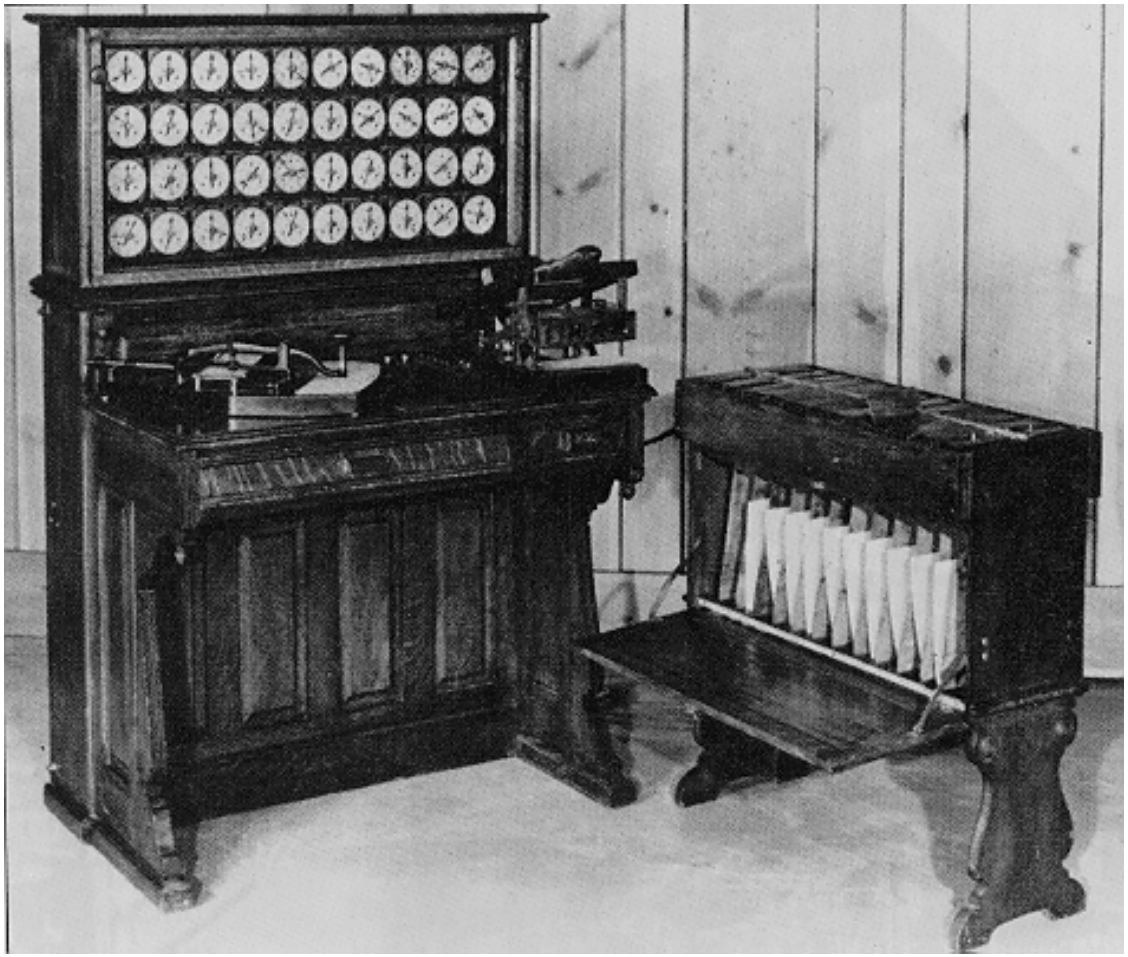
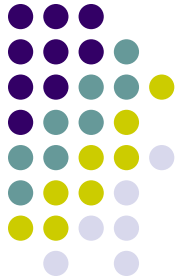


Photo: IBM

1890 U.S. Census

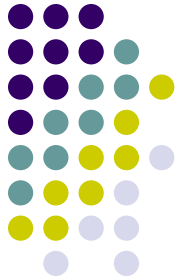
- The Hollerith machine saved the U.S. Government $5 Million
  - 2000 clerks
- The entire census data was tallied in 3 months (vs. 2 years)
- Data was processed in 2 ½ years (vs. 7 years)
  - Total population of the U.S.: 62,622,250
  - System was also used for census work in Canada, Norway, Austria and the UK
- Awards:
  - Elliot Cresson Medal by the Franklin Institute
  - Gold Medal of the Paris Exposition
  - Bronze Medal of the World's Fair in 1893

The Press wasn't so enthused



- The public (and local politicians wanting more federal money) thought the 1890 count was inaccurate
- The press echoed these concerns
- "Useless Machines"
  - The Boston Herald
- "Slip Shod Work Has Spoiled the Census"
  - The New York Herald

The Birth of “Big Blue”

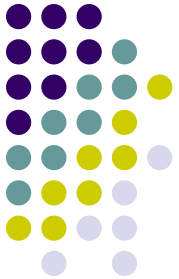


- Hollerith founded the Tabulating Machine Company in 1896.
- Machines used again in the 1900 U.S. Census
- Advanced machines made by rival James Powers used in 1910 U.S. Census
  - Powers forms Powers Tabulating Machine Company in 1911
- Hollerith’s company merged into Computer Tabulating Recording Company (CTRC)
  - Hollerith serves as consulting engineer with CTRC until retirement in 1921.
- CTRC was renamed International Business Machines Corporation (IBM) in 1924.

Modern Punch Cards

- Used from 1928 until the mid 1970s.
- Still used up to 2000 in voting machines in the U.S. Presidential election
  - leads to the “Hanging Chad” controversy

References



- http://tergestesoft.com/~eddysworld/babbage.htm