

## UNIT 1A

# A Brief History Of Computing

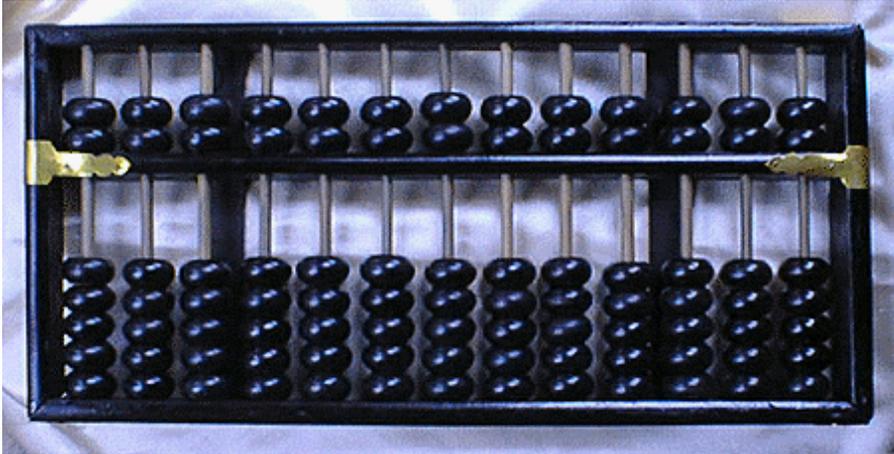
Pre-Electronic Computing (up to the 1940's)

# What is computation?

- Computation (n.) - The act or process of computing.
- Computing (n.) - the procedure of calculating; determining something by mathematical or logical methods.
- Computer science (n.) - the branch of engineering science that studies (with the aid of computers) computable processes and structures

Source: [www.thefreedictionary.com](http://www.thefreedictionary.com)

# The Abacus



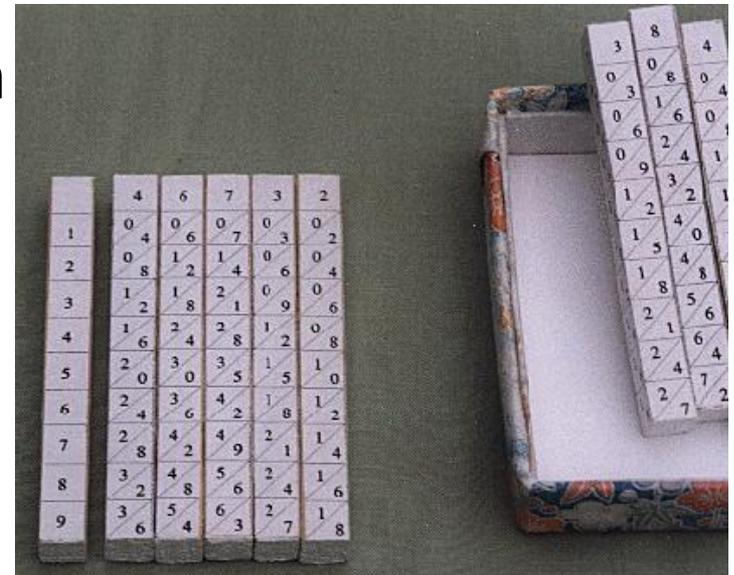
Chinese abacus

- Earliest archaeological evidence of a Greek abacus used around the 5<sup>th</sup> century BC.
- Earliest documents illustrating the use of the Chinese abacus (suan pan) from the 13<sup>th</sup> century AD.
- Other abacus forms: Soroban (Japan), Choreb (Afghanistan), Schoty (or stchoty) (Russia)

# John Napier



- Scottish mathematician (1550-1617)
- Invented Napier's Bones, used to perform multiplication using only addition.
- Napier is also the inventor of logarithms.
- Napier's bones were very successful and were widely used in Europe until mid 1960's.



# Mechanical Arithmetic Machines

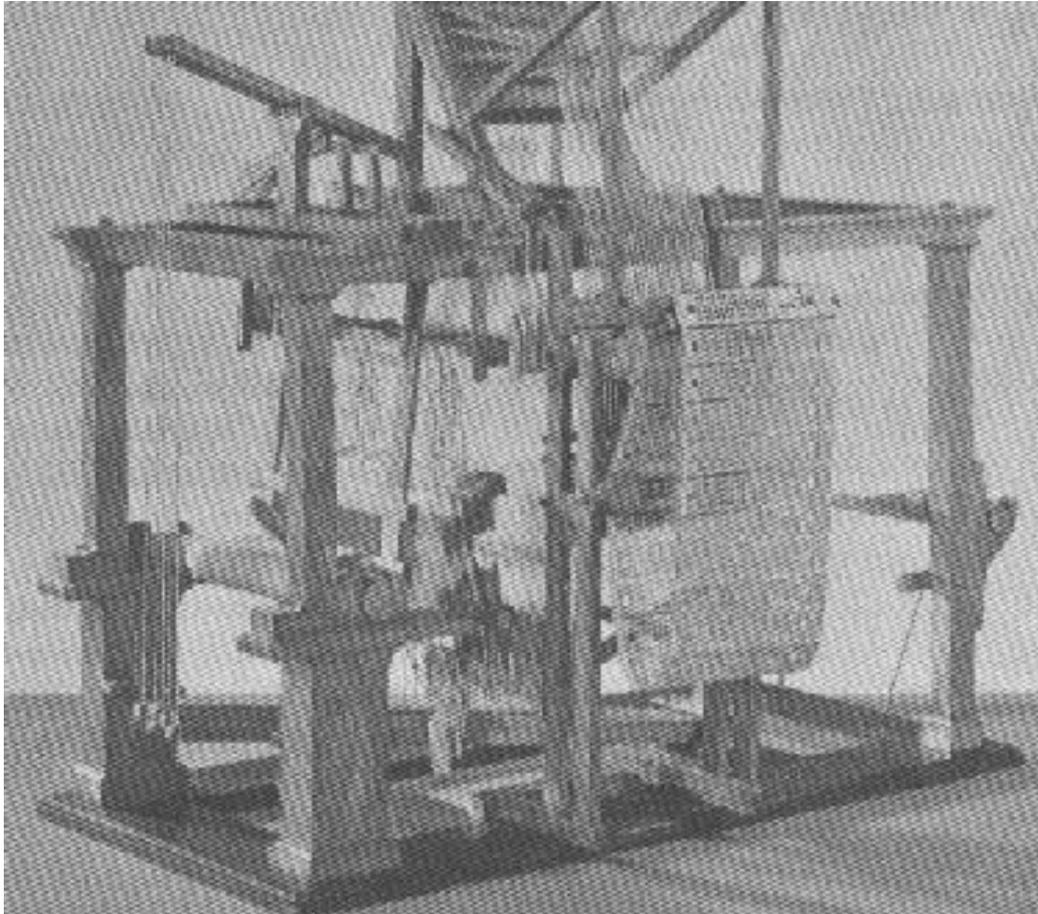


Pascaline (1643)

Leibniz' machine (1674)



# Jacquard's Loom (1805)



Developed by Joseph-Marie Jacquard. The loom was controlled by a loop of punched cards. Holes in the punched cards determined how the knitting proceeded, yielding very complex weaves at a much faster rate.

from  
Columbia University  
Computing History  
<http://www.columbia.edu/acis/history/jacquard.html>

# Charles Babbage



- Mathematician, industrialist, philosopher, politician
- Difference Engine (1822)
  - Babbage’s first computational machine was based on the method of finite differences.
- Analytical Engine (1834-1836)
  - Babbage’s more general “computer”
  - Never built, but its design is considered to be the foundation of modern computing

# Method of Finite Differences

- $f(x) = x^2 + x + 1$
- First order difference  $\Delta f(x)$   
 $= f(x+1) - f(x) = (x+1)^2 + (x+1) + 1 - (x^2 + x + 1) = 2x + 2$
- Second order difference  $\Delta^2 f(x)$   
 $= \Delta f(x+1) - \Delta f(x) = 2(x+1) + 2 - (2x + 2) = 2$
- Given:  $f(0) = 1$ ,  $\Delta f(0) = 2$ ,  $\Delta^2 f(0) = 2$  (note: all  $\Delta^2 f(x) = 2$ )
  - $\Delta f(1) = \Delta f(0) + \Delta^2 f(0) = 2 + 2 = 4$   
 $f(1) = f(0) + \Delta f(0) = 1 + 2 = 3$       ( $f(1) = 1^2 + 1 + 1 = 3$ )
  - $\Delta f(2) = \Delta f(1) + \Delta^2 f(1) = 4 + 2 = 6$   
 $f(2) = f(1) + \Delta f(1) = 3 + 4 = 7$       ( $f(2) = 2^2 + 2 + 1 = 7$ )

# Method of Finite Differences

- $f(x) = x^2 + x + 1$
- $\Delta f(x) = 2x + 2$
- $\Delta^2 f(x) = 2$

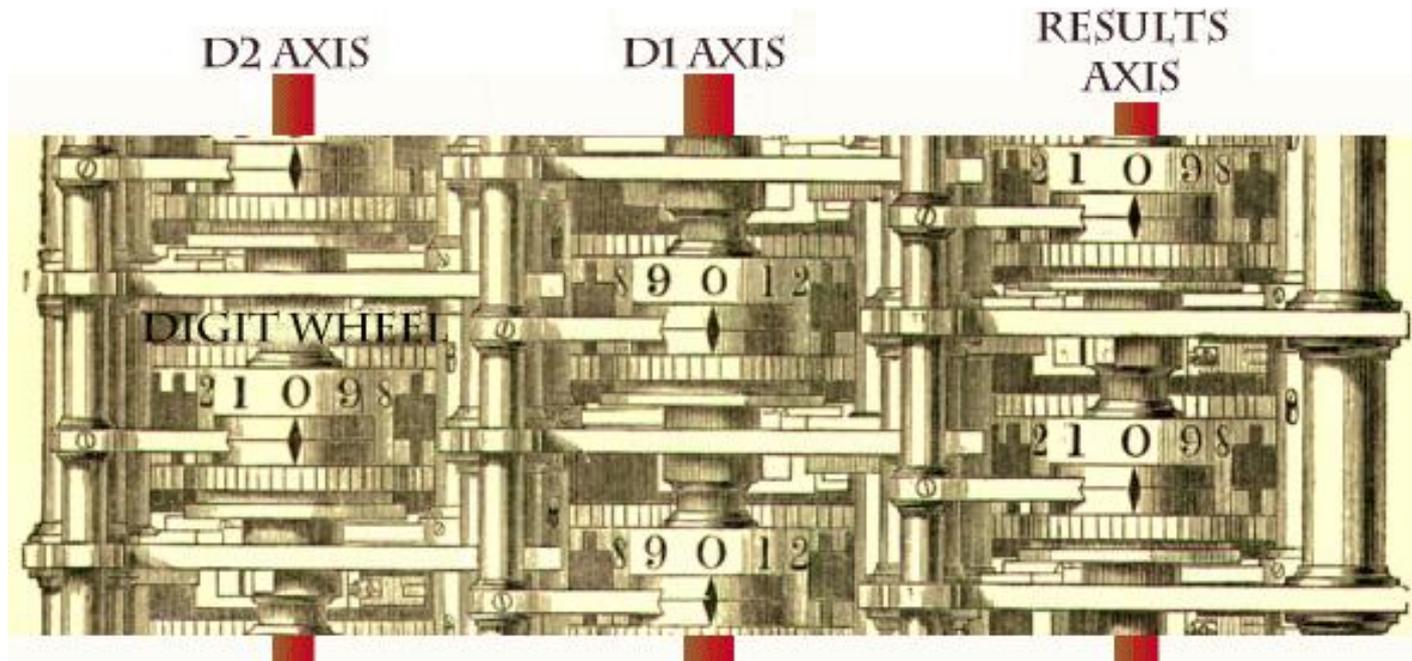
$x$	$\Delta^2 f(x)$	$\Delta f(x)$	$f(x)$
0	2	2	1
1	2	4	3
2	2	6	7
3	2	8	13

# Method of Finite Differences

- $f(x) = 15x^2 + 110$
- $\Delta f(x) = f(x+1) - f(x) =$
- $\Delta^2 f(x) = \Delta f(x+1) - \Delta f(x) =$

$x$	$\Delta^2 f(x)$	$\Delta f(x)$	$f(x)$
0			
1			
2			
3			

# Babbage's Difference Engine



[http://www.culture.com.au/brain\\_proj/CONTENT/BABBAGE.HTM](http://www.culture.com.au/brain_proj/CONTENT/BABBAGE.HTM)

# Babbage's Difference Engine

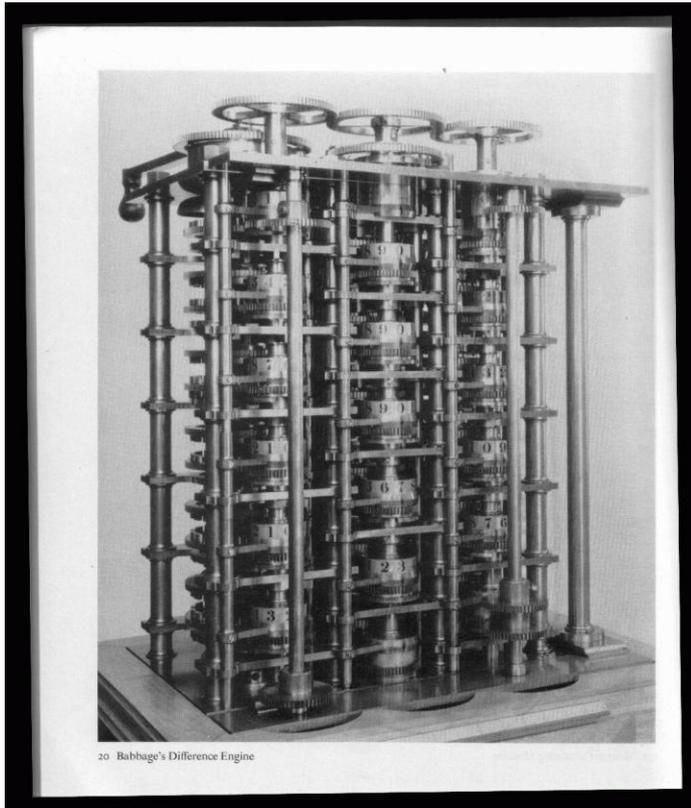


Photo of the  
1832 Fragment  
of a Difference Engine

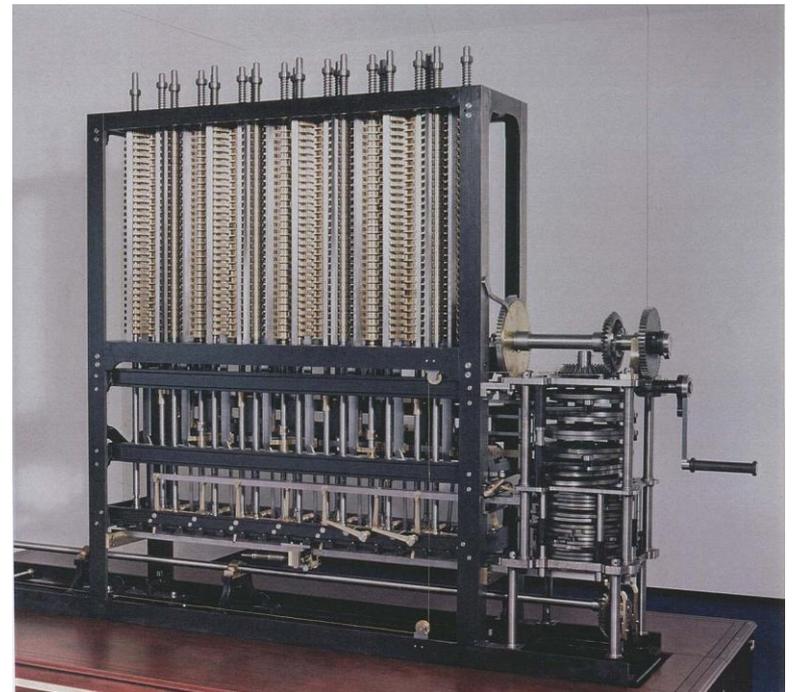


photo of Babbage Difference Engine No. 2  
constructed in 1991

# Ada Lovelace



- 1815-1852
- Daughter of poet Lord Byron
- Translated Menabrea's *Sketch of the Analytical Engine* to English
  - Quadrupled its length by adding lengthy notes and detailed mathematical explanations
- Referred to as the world's first programmer
  - Described how the machine might be configured (programmed) to solve a variety of problems.

# Herman Hollerith

## & The Hollerith Census Machine



- 1880 U.S. Census
  - The amount of data that needed to be analyzed was growing so quickly due to immigration
  - Required almost a decade to compute 1880 Census
- In 1882, Hollerith investigated a suggestion by Dr. John Shaw Billings, head of the division of Vital Statistics for the Census Bureau
  - “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.”

# Hollerith's Census Machine



Photo: IBM

# Hollerith's Census Machine

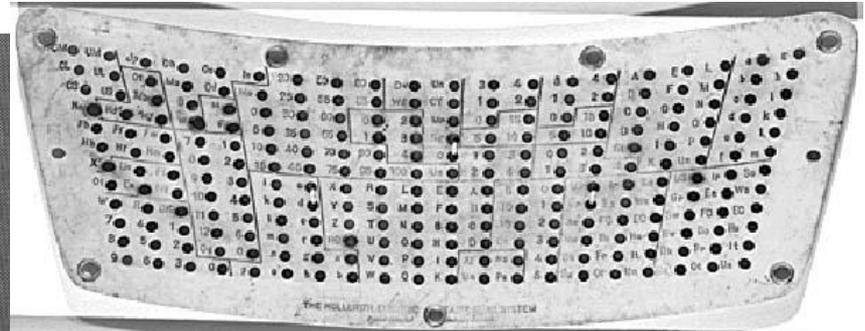
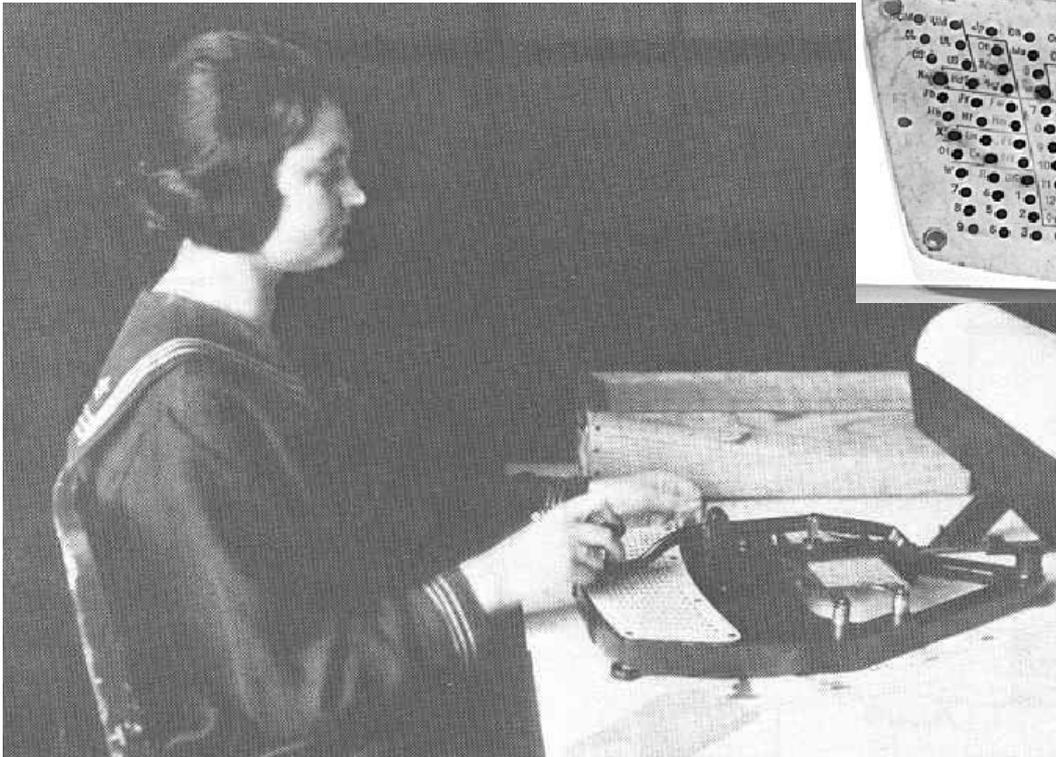


Photo of Pantographic Card Punch plate: from US Library of Congress

Photo from 1920 Census: Austrian, Geoffrey, *Herman Hollerith: Forgotten Giant of Information Processing*, Columbia University Press (1982).

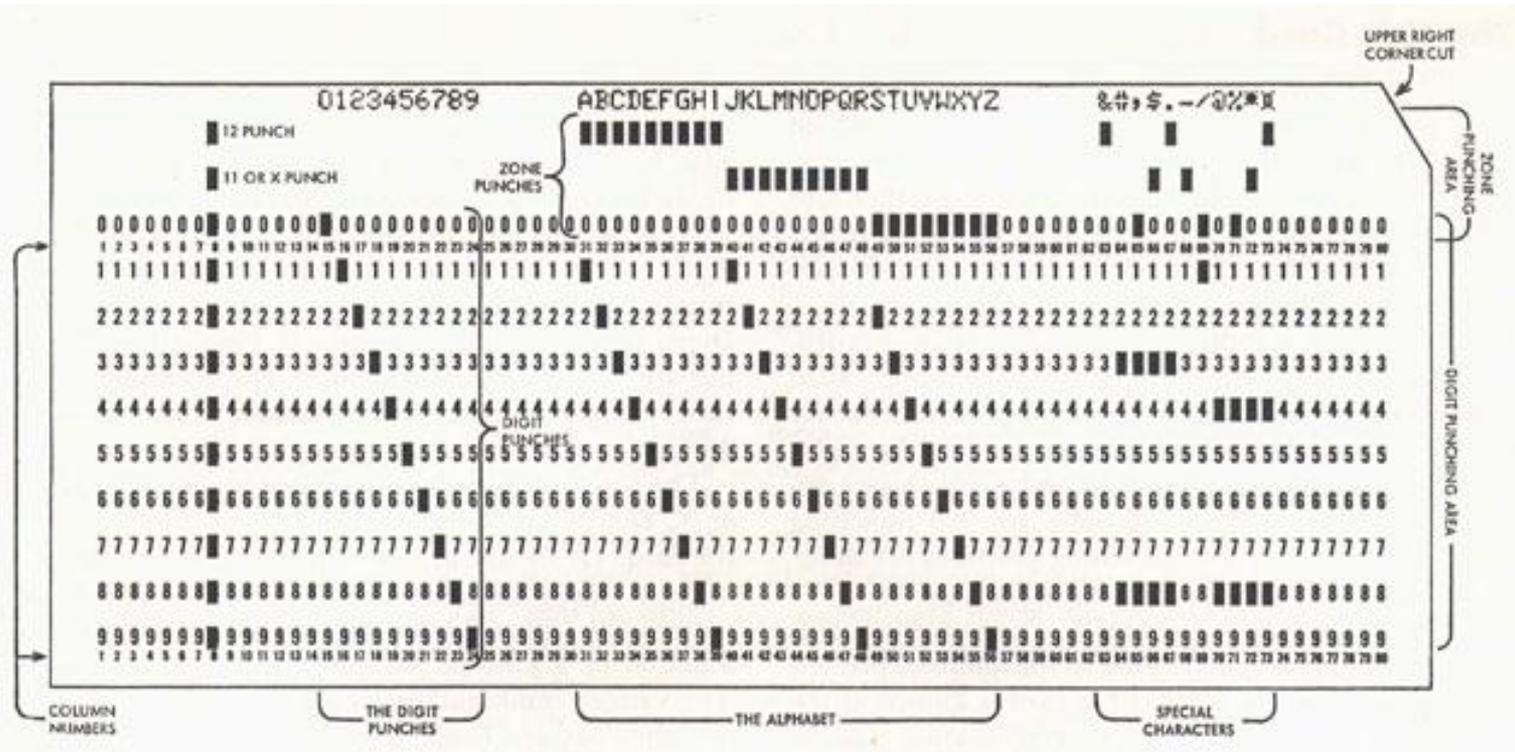
# Hollerith's Census Machine

1	2	3	4	CM	UM	Jp	Ch	Oc	In	20	50	80	Dv	Un	3	4	3	4	A	E	L	a	g
5	6	7	8	CL	UL	O	Mi	Qd	Mo	25	55	85	Wd	CY	1	2	1	2	B	F	M	b	h
1	2	3	4	CS	US	Mb	B	M	0	30	60	0	2	Mr	0	15	0	15	C	G	N	c	i
5	6	7	8	No	Hd	Wf	W	F	5	35	65	1	3	Sg	5	10	5	10	D	H	O	d	k
1	2	3	4	Fh	Ff	Fm	7	1	10	40	70	90	4	0	1	3	0	2	St	I	P	e	l
5	6	7	8	Hh	Hf	Hm	8	2	15	45	75	95	100	Un	2	4	1	3	4	K	Un	f	m
1	2	3	4	X	Un	Ft	9	3	i	c	X	R	L	E	A	6	0	US	Ir	Sc	US	Ir	Sc
5	6	7	8	Ot	En	Mt	10	4	k	d	Y	S	M	F	B	10	1	Gr	En	Wa	Gr	En	Wa
1	2	3	4	W	R	CK	11	5	l	e	Z	T	N	G	C	15	2	Sw	FC	EC	Sw	FC	EC
5	6	7	8	7	4	1	12	6	m	f	NG	U	O	H	D	Un	3	Nw	Bo	Hu	Nw	Bo	Hu
1	2	3	4	8	5	2	Oc	0	n	g	a	V	P	I	Al	Na	4	Dk	Fr	It	Dk	Fr	It
5	6	7	8	9	6	3	0	p	o	h	b	W	Q	K	Un	Pa	5	Ru	Ot	Un	Ru	Ot	Un

Photo of a punch card for the Hollerith machine, from *John McPherson, Computer Engineer*, an oral history conducted in 1992 by William Aspray, IEEE History Center, Rutgers University, New Brunswick, NJ, USA.

- The entire 1890 census data was processed in 3 months and complete 1890 data was published in 1892.
- Total population of the U.S.: 62,622,250

# The Birth of IBM



An IBM punch card used from 1928 until the 1970s.

- Hollerith forms the Tabulating Machine Company in 1896 which eventually becomes IBM in 1924 through a merger and several name changes.

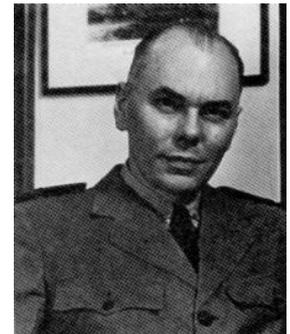
# Harvard Mark I

## IBM Automatic Sequence Controlled Calculator



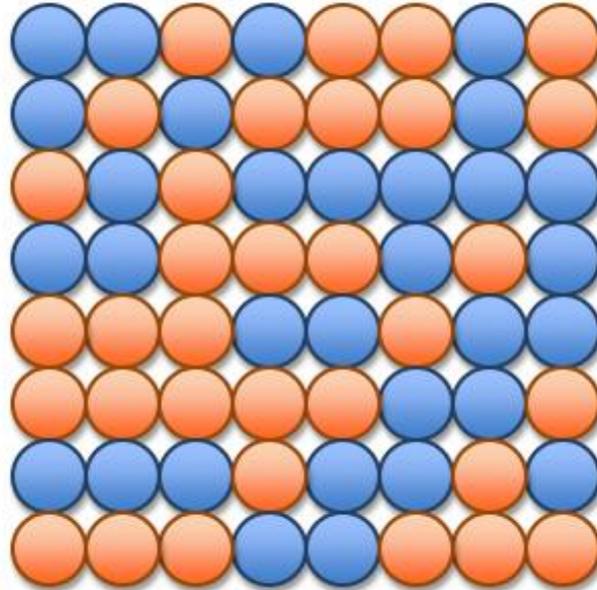
- Developed by Howard Aiken
- Contained more than 750,000 components
  - over 50 feet long
  - 8 feet tall
  - weighed ~5 tons
- Sounded like a “roomful of ladies knitting”

Harvard Mark I  
(IBM Archives)



Aiken

In 1947, how many electronic digital computers did Aiken predict would be required to satisfy the computing needs of the entire U.S.?

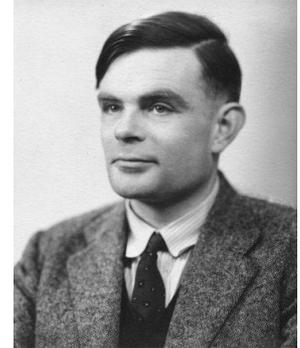


## UNIT 1B

# A Brief History Of Computing

Electronic Computing (1940's to the Present)

# Alan Turing



- Considered the “father” of modern computer science.
- Presented formalisms for the notions of computation and computability in the 1930’s.
- Worked at Bletchley Park in Great Britain during WWII to develop Colossus to help break the German Enigma Code.
- Developed the notion in 1950 of a test for machine intelligence now called the Turing Test.
- The Turing Award, the highest award in computing, is named in honor of Alan Turing.

# ENIAC

## Electronic Numerical Integrator and Computer

- Collaboration between Moore School of Electrical Engineering at the University of Pennsylvania and the Ballistic Research Laboratory in Aberdeen, MD
  - Designed by John W. Mauchley and J. Presper Eckert
- In 1943, the Ordnance Dept. signs a contract for UPenn to develop an electronic computer to solve differential equations for ballistic trajectories
- Constructed completed in the fall of 1945 after WWII ends, and dedicated in February 1946.



from [www.computer.org](http://www.computer.org)

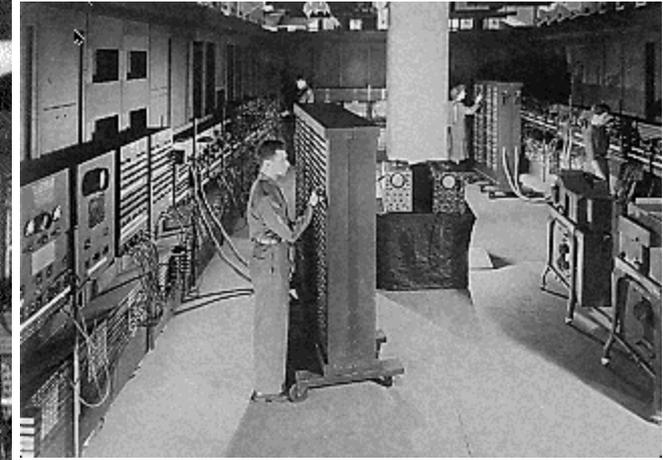
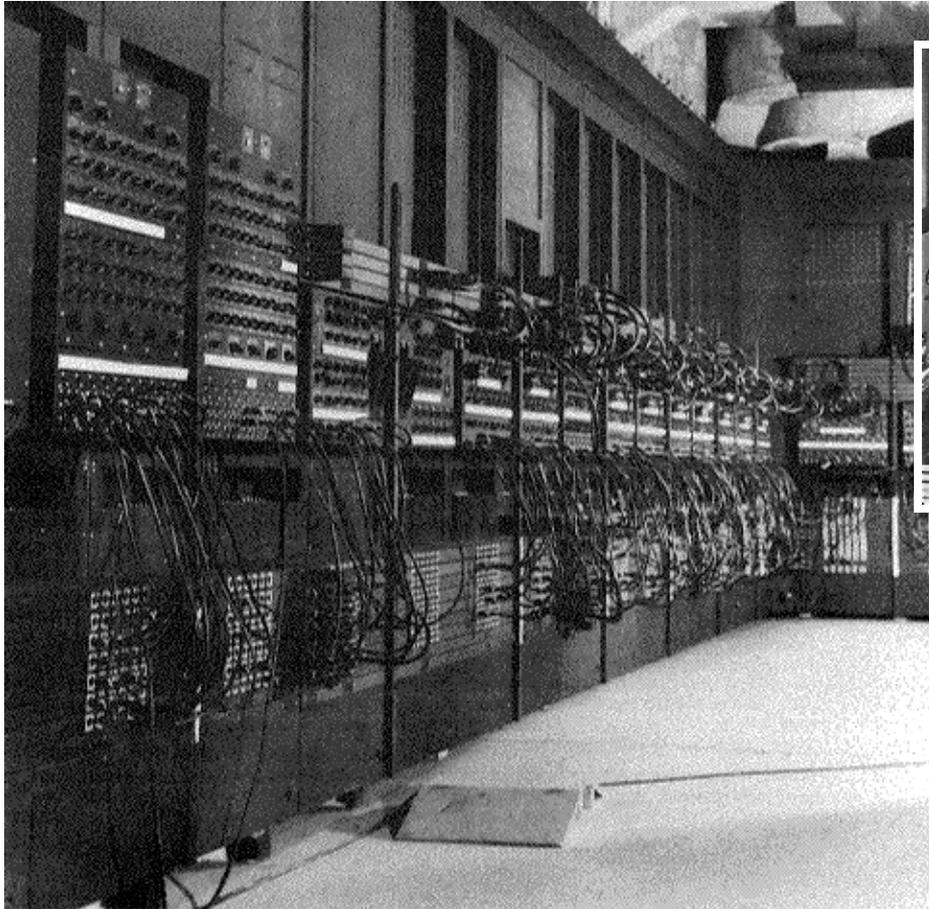
# ENIAC

## Electronic Numerical Integrator and Computer

- Filled an entire room
  - 42 panels, each 9' X 2' X 1', three on wheels
  - organized in a U shaped around the perimeter of a room with forced air cooling
- Weighed 30 tons
- Reportedly consumed 150-200 kW of power
- Contained a huge amount of parts:
  - approx. 19,000 vacuum tubes and 1,500 relays
  - over 100,000 resistors, capacitors and inductors
- Input and output via an IBM card reader and card punch

# ENIAC

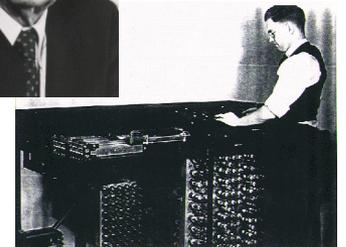
## Electronic Numerical Integrator and Computer



(Virginia Tech –  
History of Computing)

# The first electronic computer?

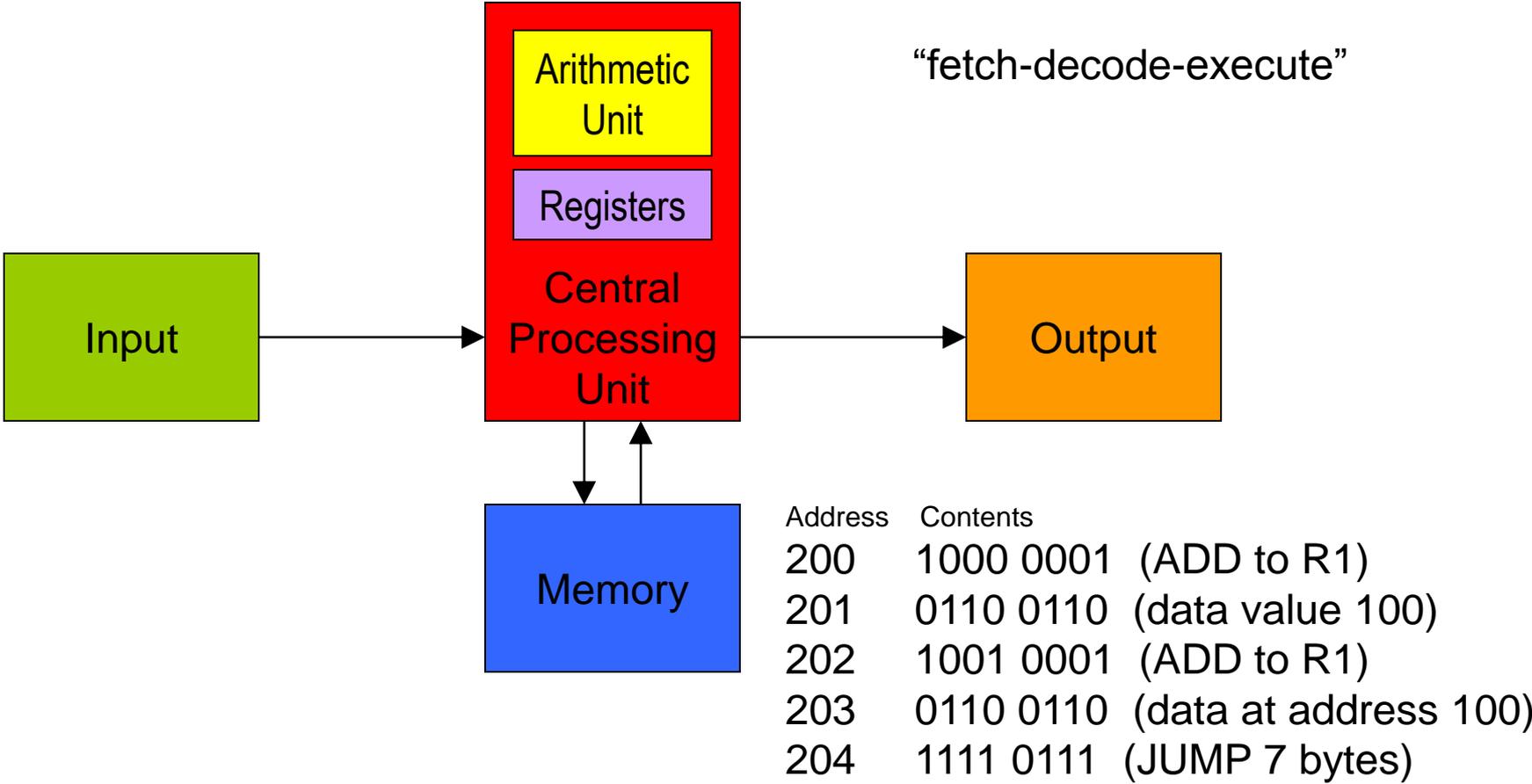
- Patent filed for ENIAC in 1947 as first electronic computer
- In 1973, patent is ruled invalid
  - The inventor of the first electronic computer is John Atanasoff for the Atanasoff-Berry Computer
  - Outside of the U.S., Konrad Zuse of Germany is considered the inventor of the modern-day computer
    - Also designed the first programming language, Plankalkül (Plan Calculus) in 1945



# Stored Program Concept

- Stored-program concept is the fundamental principle of the ENIAC's successor, the EDVAC (Electronic Discrete Variable Automatic Computer)
- Instructions were stored in memory sequentially with their data
- Instructions were executed sequentially except where a conditional instruction would cause a jump to an instruction someplace other than the next instruction.

# Stored Program Concept



# Stored Program Concept

- Mauchly and Eckert are generally credited with the idea of the stored-program
- BUT: John von Neumann publishes a draft report that describes the concept and earns the recognition as the inventor of the concept
  - “von Neumann architecture”
  - *A First Draft of a Report of the EDVAC* published in 1945
  - <http://www.wps.com/projects/EDVAC/>



von Neumann,  
Member of the Navy  
Bureau of Ordinance  
1941-1955

# UNIVAC and the First Compiled Programming Language

- UNIVAC I

- Built by Remington Rand to compute 1950 U.S. census but completed in 1951
- Used to predict the winner of the 1952 U.S. Presidential Election based on ~3.4M votes



J. Presper Eckert and Walter Cronkite next to the UNIVAC in 1952  
(Center for the Study of Technology and Society)

- A-0 is a programming language for the UNIVAC I or II, using three-address code instructions for solving mathematical problems.
  - Example: ADD R1, R2, R3  
(Add the contents of R2 and R3 and put result in R1.)
- A-0 was the first language for which a compiler was developed, produced by a team led by Admiral Grace Hopper.



Admiral Grace Hopper

# The Integrated Circuit



- Robert Noyce and Jack Kilby are credited with the invention of the integrated circuit (IC) or microchip.
  - Kilby wins Nobel Prize in Physics in 2000.
  - Robert Noyce co-founded Intel in 1968.
- By the mid 1970s, ICs contained tens of thousands of transistors per chip.
  - In 1970, Intel created the 1103--the first generally available DRAM chip.
  - Today, you would need more than 65,000 of them to put 8 MB of memory into a PC.

# Units of Memory

- Byte      B      8 bits (8b)
- Kilobyte    KB      1024 B      =  $2^{10}$  bytes       $\approx 10^3$  bytes
- Megabyte    MB      1024 KB      =  $2^{20}$  bytes       $\approx 10^6$  bytes
- Gigabyte    GB      1024 MB      =  $2^{30}$  bytes       $\approx 10^9$  bytes
- Terabyte    TB      1024 GB      =  $2^{40}$  bytes       $\approx 10^{12}$  bytes
- Petabyte    PB      1024 TB      =  $2^{50}$  bytes       $\approx 10^{15}$  bytes
- How many bytes can be stored in a 4GB flash drive?
- How many bytes/second is a 16Mbps cable modem connection?

# How Time Flies...

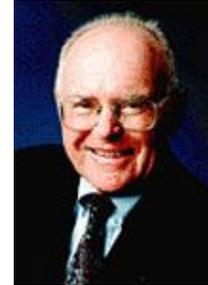


Commodore 64 (1982)  
40cm X 22 cm X 8 cm  
64KB of IC memory  
\$595



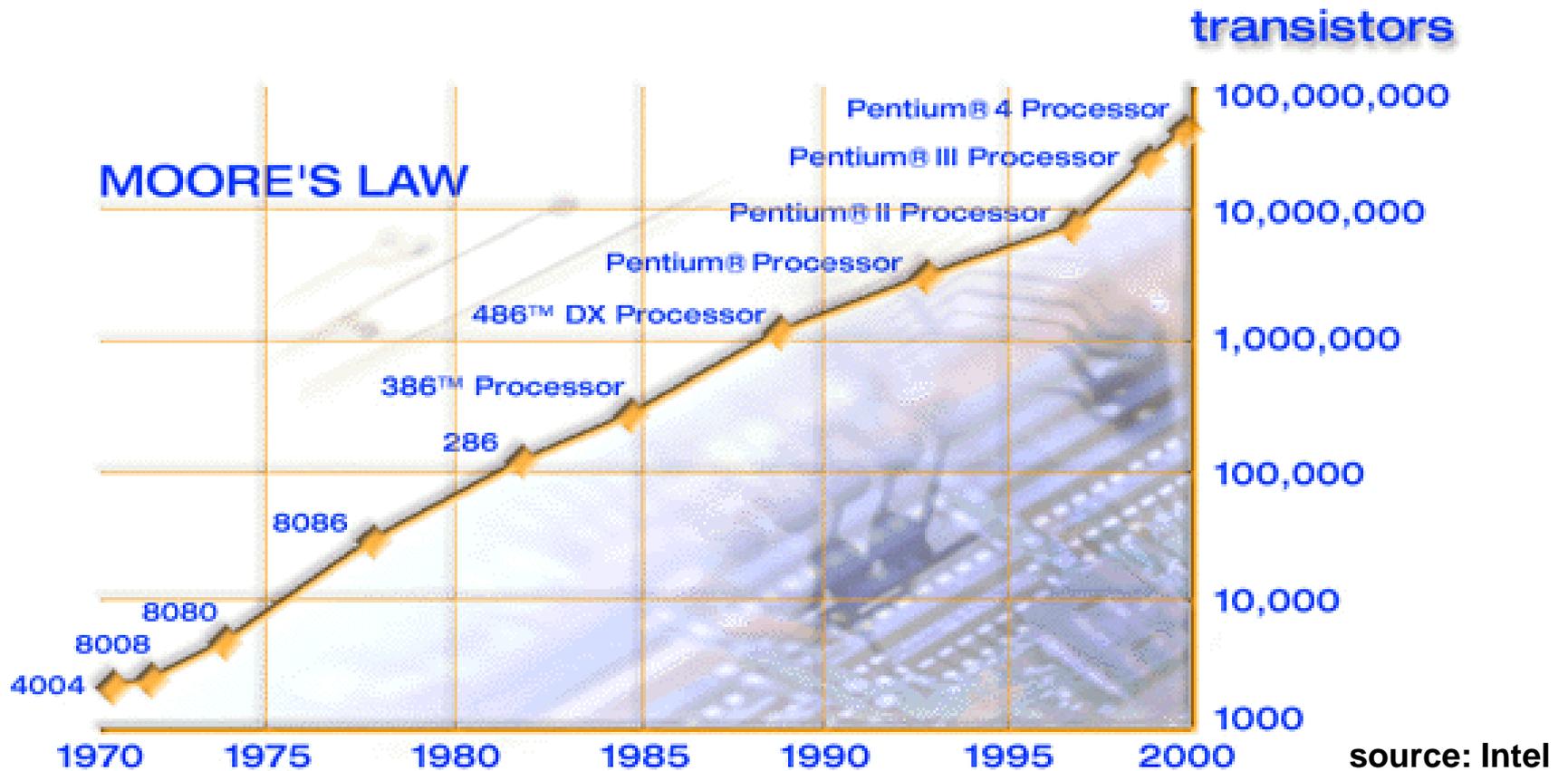
Apple iShuffle (2008)  
3cm X 3cm X 1cm  
2GB of flash memory  
\$49

# Moore's Law



- Gordon Moore co-founded Intel Corporation in 1968.
- Famous for his prediction on the growth of the semiconductor industry: Moore's Law
  - `ftp://download.intel.com/research/silicon/moorespaper.pdf`
  - An empirical observation stating in effect that the complexity of integrated circuits doubles every 18 months. (“complexity” generally means number of transistors on a chip)

# Moore's Law



# The GUI

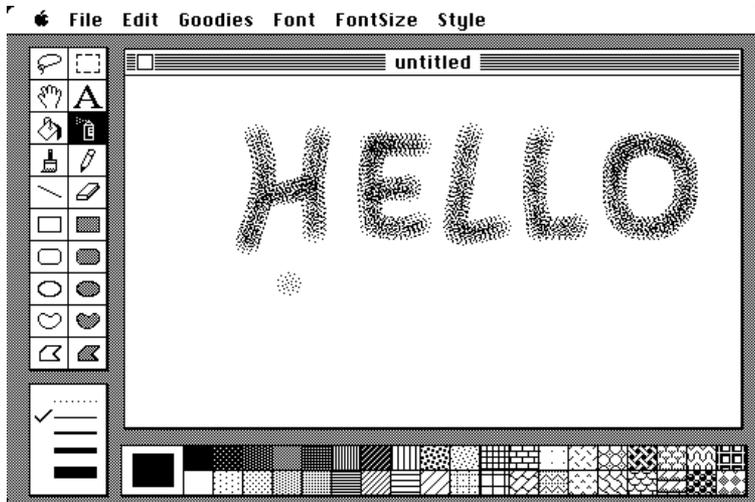
## Graphical User Interface

- Concept born at SRI in the early 1960s
- Major development at Xerox PARC in late 70s
- Apple Macintosh, founded by Steve Jobs and his friend Steve Wozniak, introduced in 1984 with full GUI operating system
- Microsoft is founded by Bill Gates and Paul G. Allen with sales of Microsoft BASIC
  - develops its own window-based operating system soon afterwards based on Apple's design... many lawsuits follow
- Even IBM jumps into the fray with OS/2

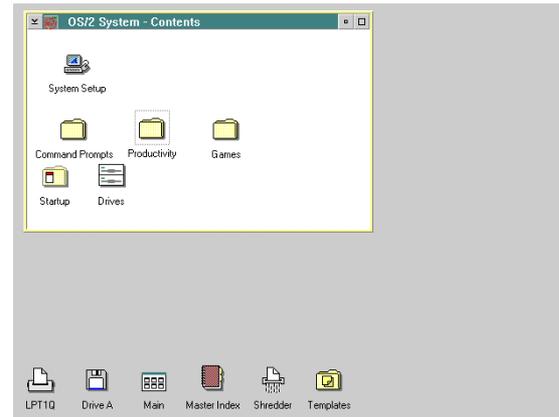


# The GUI

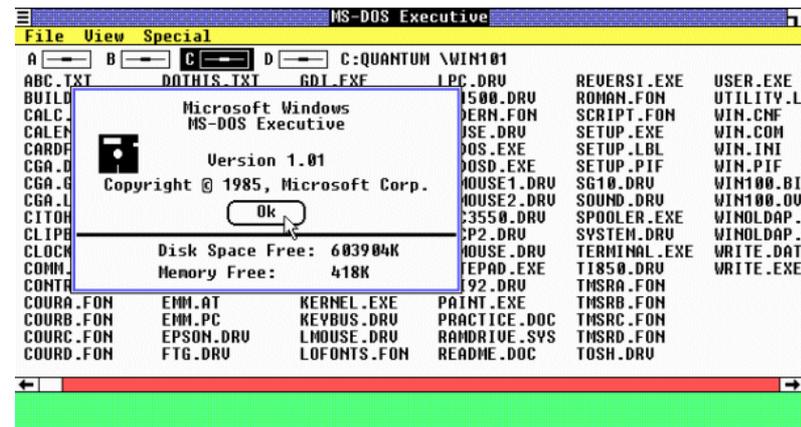
## Graphical User Interface



Macintosh OS



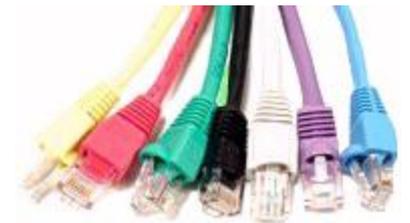
IBM  
OS/2



Microsoft Windows 1.0

# Input Devices

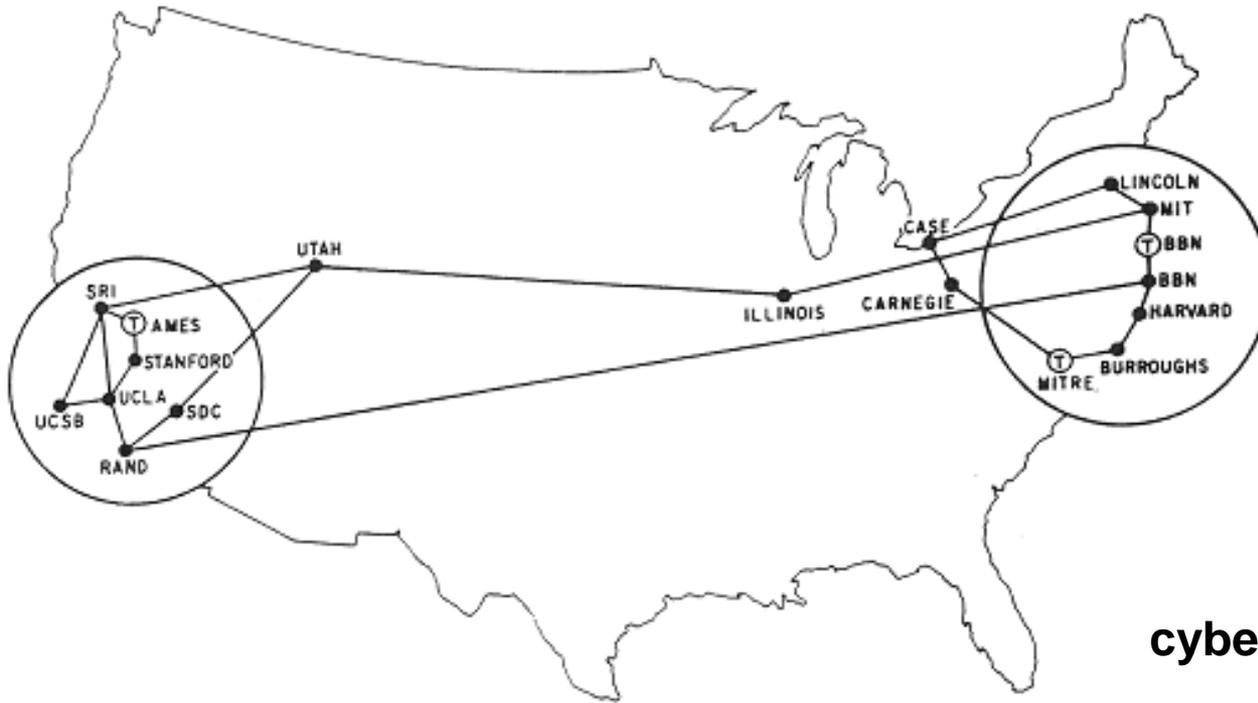
- The mouse was invented by Douglas Engelbart of Stanford Research Institute in 1963 after extensive usability testing.
  - He received a patent in Nov. 1970 for the "X-Y Position Indicator For A Display System".
  - He was the recipient of the 1997 ACM Turing Award. (<http://www.acm.org/awards/taward.html>)
- Ethernet was originally developed as one of the many pioneering projects at Xerox PARC.
  - Invented between 1973-1976 by Robert Metcalfe and David Boggs



# The Birth of the Internet

- The earliest ideas of a global computer network were formulated by J.C.R. Licklider at MIT in 1962 in a series of memos discussing the "Galactic Network" concept.
- The Advanced Research Projects Agency Network (ARPANET) of the U.S. DoD was the world's first operational packet switching network.
  - Much of the work in computer development in the 1960s was spurred by the Space Race and the Cold War.
- In 1971, Ray Tomlinson of Bolt, Beranek, and Newman (BBN) wrote the first email program
- By the late 1980s, the DoD transferred operation of the network to NSF, and what is known as the "Internet" emerges.

# ARPANET 1971

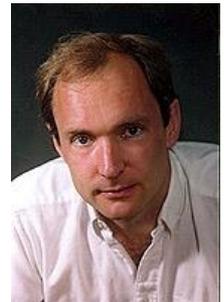


[cybergeography.org](http://cybergeography.org)

MAP 4 September 1971

# The World Wide Web

- Developed by Tim Berners-Lee of CERN (European Organization for Nuclear Research) - 1990
  - Used hypertext to mark up text documents so they could be searched and displayed by other users on the Internet
- Mosaic (1993): First Internet browser developed by a team at the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign (NCSA-UIUC)
- Google (1998): World's most popular search engine company on the web launches from a pair of graduate students at Stanford University (Larry Page and Sergey Brin)
- Wikipedia (2001), Facebook (2004), YouTube (2005), Twitter (2006)



# Really?

- In 1981, Bill Gates is supposedly quoted as saying that how much computer memory “ought to be enough for anyone”?

