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
The Abacus

- Earliest archaeological evidence of a Greek abacus used around the 5th century BC.
- Earliest documents illustrating the use of the Chinese abacus (suan pan) from the 13th 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 \( \Delta f(x) \)
  \[
  \Delta f(x) = f(x+1) - f(x) = (x+1)^2 + (x+1) + 1 - (x^2 + x + 1) = 2x + 2
  \]
• Second order difference \( \Delta^2 f(x) \)
  \[
  \Delta^2 f(x) = \Delta f(x+1) - \Delta f(x) = 2(x+1) + 2 - (2x + 2) = 2
  \]
• Given: \( f(0) = 1, \Delta f(0) = 2, \Delta^2 f(0) = 2 \) (note: all \( \Delta^2 f(x) = 2 \))
  - \( \Delta f(1) = \Delta f(0) + \Delta^2 f(0) = 2 + 2 = 4 \)
    \[
    f(1) = f(0) + \Delta f(0) = 1 + 2 = 3 \quad (f(1) = 1^2 + 1 + 1 = 3)
    \]
  - \( \Delta f(2) = \Delta f(1) + \Delta^2 f(1) = 4 + 2 = 6 \)
    \[
    f(2) = f(1) + \Delta f(1) = 3 + 4 = 7 \quad (f(2) = 2^2 + 2 + 1 = 7)
    \]
Method of Finite Differences

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

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15110 Principles of Computing, Carnegie Mellon University
Method of Finite Differences

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

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Babbage’s Difference Engine

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

Hollerith’s Census Machine

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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

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

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

```
Address  Contents
200      1000 0001  (ADD to R1)
201      0110 0110  (data value 100)
202      1001 0001  (ADD to R1)
203      0110 0110  (data at address 100)
204      1111 0111  (JUMP 7 bytes)
```

“fetch-decode-execute”
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
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

• 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.
The Integrated Circuit

• Robert Noyce and Jack Kilby are credited with the invention of the integrated circuit (IC) or microchip.
• 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 ≈ $10^3$ bytes
- **Megabyte** (MB) 1024 KB = $2^{20}$ bytes ≈ $10^6$ bytes
- **Gigabyte** (GB) 1024 MB = $2^{30}$ bytes ≈ $10^9$ bytes
- **Terabyte** (TB) 1024 GB = $2^{40}$ bytes ≈ $10^{12}$ bytes
- **Petabyte** (PB) 1024 TB = $2^{50}$ bytes ≈ $10^{15}$ 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
  – 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

source: Intel
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
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)
Really?

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