CS101 Introduction to Computing
Lecture 2
Evolution of Computing
Today’s Goal

- To learn about the evolution of computing
- To recount the important and key events
- To identify some of the milestones in computer development
  Babbage’s Analytical Engine - 1833
- Mechanical, digital, general-purpose
- Was crank-driven
- Could store instructions
- Could perform mathematical calculations
- Had the ability to print
- Could punched cards as permanent memory
- Invented by Joseph-Marie Jacquard

**Turing Machine – 1936**

Introduced by Alan Turing in 1936, Turing machines are one of the key abstractions used in modern computability theory, the study of what computers can and cannot do. A Turing machine is a particularly simple kind of computer, one whose operations are limited to reading and writing symbols on a tape, or moving along the tape to the left or right. The tape is marked off into squares, each of which can be filled with at most one symbol. At any given point in its operation, the Turing machine can only read or write on one of these squares, the square located directly below its "read/write" head.

**The “Turing test”**

A test proposed to determine if a computer has the ability to think. In 1950, Alan Turing (Turing, 1950) proposed a method for determining if machines can think. This method is known as The Turing Test.

The test is conducted with two people and a machine. One person plays the role of an interrogator and is in a separate room from the machine and the other person. The interrogator only knows the person and machine as A and B. The interrogator does not know which is the person and which is the machine. Using a teletype, the interrogator, can ask A and B any question he/she wishes. The aim of the interrogator is to determine which is the person and which is the machine. The aim of the machine is to fool the interrogator into thinking that it is a person. If the machine succeeds then we can conclude that machines can think.
Vacuum Tube – 1904:
A vacuum tube is just that: a glass tube surrounding a vacuum (an area from which all gases has been removed). What makes it interesting is that when electrical contacts are put on the ends, you can get a current to flow though that vacuum.
A British scientist named John A. Fleming made a vacuum tube known today as a diode. Then the diode was known as a "valve."

ABC – 1939
The Atanasoff-Berry Computer was the world's first electronic digital computer. It was built by John Vincent Atanasoff and Clifford Berry at Iowa State University during 1937-42. It incorporated several major innovations in computing including the use of binary arithmetic, regenerative memory, parallel processing, and separation of memory and computing functions.

Harvard Mark 1 – 1943:
Howard Aiken and Grace Hopper designed the MARK series of computers at Harvard University. The MARK series of computers began with the Mark I in 1944. Imagine a giant roomful of noisy, clicking metal parts, 55 feet long and 8 feet high. The 5-ton device contained almost 760,000 separate pieces. Used by the US Navy for gunnery and ballistic calculations, the Mark I was in operation until 1959.

The computer, controlled by pre-punched paper tape, could carry out addition, subtraction, multiplication, division and reference to previous results. It had special subroutines for logarithms and trigonometric functions and used 23 decimal place numbers. Data was stored and counted mechanically using 3000 decimal storage wheels, 1400 rotary dial switches, and 500 miles of wire. Its electromagnetic relays classified the machine as a relay computer. All output was displayed on an electric typewriter. By today's standards, the Mark I was slow, requiring 3-5 seconds for a multiplication operation.

ENIAC – 1946:
ENIAC I (Electrical Numerical Integrator And Calculator). The U.S. military sponsored their research; they needed a calculating device for writing artillery-firing tables (the settings used for different weapons under varied conditions for target accuracy).
John Mauchly was the chief consultant and J Presper Eckert was the chief engineer. Eckert was a graduate student studying at the Moore School when he met John Mauchly in 1943. It took the team about one year to design the ENIAC and 18 months and 500,000 tax dollars to build it.
The ENIAC contained 17,468 vacuum tubes, along with 70,000 resistors and 10,000 capacitors.

Transistor – 1947
The first transistor was invented at Bell Laboratories on December 16, 1947 by William Shockley. This was perhaps the most important electronics event of the 20th century, as it later made possible the integrated circuit and microprocessor that are the basis of modern electronics. Prior to the transistor the only alternative to its current regulation and switching functions (TRANSfer
resISTOR) was the vacuum tubes, which could only be miniaturized to a certain extent, and wasted a lot of energy in the form of heat.

- Compared to vacuum tubes, it offered:
  - smaller size
  - better reliability
  - lower power consumption
  - lower cost

**Floppy Disk – 1950**

- Invented at the Imperial University in Tokyo by Yoshiro Nakamats

**UNIVAC 1 – 1951**

UNIVAC-1. The first commercially successful electronic computer, UNIVAC I, was also the first general purpose computer - designed to handle both numeric and textual information. It was designed by J. Presper Eckert and John Mauchly. The implementation of this machine marked the real beginning of the computer era. Remington Rand delivered the first UNIVAC machine to the U.S. Bureau of Census in 1951. This machine used magnetic tape for input.

- first successful commercial computer
- design was derived from the ENIAC (same developers)
- first client = U.S. Bureau of the Census
- $1 million
- 48 systems built

**Compiler - 1952**

Grace Murray Hopper an employee of Remington-Rand worked on the NUIVAC. She took up the concept of reusable software in her 1952 paper entitled "The Education of a Computer" and developed the first software that could translate symbols of higher computer languages into machine language. (Compiler)

**ARPANET – 1969**

The Advanced Research Projects Agency was formed with an emphasis towards research, and thus was not oriented only to a military product. The formation of this agency was part of the U.S. reaction to the then Soviet Union's launch of Sputnik in 1957. (ARPA draft, III-6). ARPA was assigned to research how to utilize their investment in computers via Command and Control Research (CCR). Dr. J.C.R. Licklider was chosen to head this effort.

- Developed for the US DoD Advanced Research Projects Agency
- 60,000 computers connected for communication among research organizations and universities

**Intel 4004 – 1971**

The 4004 was the world's first universal microprocessor. In the late 1960s, many scientists had discussed the possibility of a computer on a chip, but nearly everyone felt that integrated circuit technology was not yet ready to support such a chip. Intel's Ted Hoff felt differently; he was the first person to recognize that the new silicon-gated MOS technology might make a single-chip CPU (central processing unit) possible.

Hoff and the Intel team developed such architecture with just over 2,300 transistors in an area of only 3 by 4 millimeters. With its 4-bit CPU, command register, decoder, decoding control, control monitoring of machine commands and interim register, the 4004 was one heck of a little invention. Today's 64-bit microprocessors are still based on similar designs, and the microprocessor is still the most complex mass-produced product ever with more than 5.5 million transistors performing hundreds of millions of calculations each second - numbers that are sure to be outdated fast.
Altair 8800 – 1975
By 1975 the market for the personal computer was demanding a product that did not require an electrical engineering background and thus the first mass produced and marketed personal computer (available both as a kit or assembled) was welcomed with open arms. Developers Edward Roberts, William Yates and Jim Bybee spent 1973-1974 to develop the MITS (Micro Instruments Telemetry Systems) Altair 8800. The price was $375, contained 256 bytes of memory (not 256k), but had no keyboard, no display, and no auxiliary storage device. Later, Bill Gates and Paul Allen wrote their first product for the Altair -- a BASIC compiler (named after a planet on a Star Trek episode).

Cray 1 – 1976
It looked like no other computer before, or for that matter, since. The Cray 1 was the world's first “supercomputer,” a machine that leapfrogged existing technology when it was introduced in 1971. And back then, you couldn't just order up fast processors from Intel. “There weren't any microprocessors,” says Gwen Bell of The Computer Museum History Center. “These individual integrated circuits that are on the board performed different functions.” Each Cray 1, like this one at The Computer Museum History Center, took months to build. The hundreds of boards and thousands of wires had to fit just right. “It was really a hand-crafted machine,” adds Bell. “You think of all these wires as a kind of mess, but each one has a precise length.”

IBM PC – 1981
On August 12, 1981, IBM released their new computer, re-named the IBM PC. The “PC” stood for “personal computer” making IBM responsible for popularizing the term “PC”. The first IBM PC ran on a 4.77 MHz Intel 8088 microprocessor. The PC came equipped with 16 kilobytes of memory, expandable to 256k. The PC came with one or two 160k Floppy Disks Drives and an optional color monitor. The price tag started at $1,565, which would be nearly $4,000 today.

Apple Macintosh – 1984
Apple introduced the Macintosh to the nation on January 22, 1984. The original Macintosh had 128 kilobytes of RAM, although this first model was simply called "Macintosh" until the 512K model came out in September 1984. The Macintosh retailed for $2495. It wasn't until the
Macintosh that the general population really became aware of the mouse-driven graphical user interface.

**World Wide Web -1989**

"CERN is a meeting place for physicists from all over the world, who collaborate on complex physics, engineering and information handling projects. Thus, the need for the WWW system arose "from the geographical dispersion of large collaborations, and the fast turnover of fellows, students, and visiting scientists," who had to get "up to speed on projects and leave a lasting contribution before leaving."

CERN possessed both the financial and computing resources necessary to start the project. In the original proposal, Berners-Lee outlined two phases of the project:

- First, CERN would "make use of existing software and hardware as well as implementing simple browsers for the user's workstations, based on an analysis of the requirements for information access needs by experiments."
- Second, they would "extend the application area by also allowing the users to add new material."

Berners-Lee expected each phase to take three months "with the full manpower complement": he was asking for four software engineers and a programmer. The proposal talked about "a simple scheme to incorporate several different servers of machine-stored information already available at CERN."

Set off in 1989, the WWW quickly gained great popularity among Internet users. For instance, at 11:22 am of April 12, 1995, the WWW server at the SEAS of the University of Pennsylvania "responded to 128 requests in one minute. Between 10:00 and 11:00

**Quantum Computing with Molecules**

by Neil Gershenfeld and Isaac L. Chuang

Factoring a number with 400 digits--a numerical feat needed to break some security codes--would take even the fastest supercomputer in existence billions of years. But a newly conceived type of computer, one that exploits quantum-mechanical interactions, might complete the task in a year or so, thereby defeating many of the most sophisticated encryption schemes in use. Sensitive data are safe for the time being, because no one has been able to build a practical quantum computer. But researchers have now demonstrated the feasibility of this approach. Such a computer would look nothing like the machine that sits on your desk; surprisingly, it might resemble the cup of coffee at its side.

Several research groups believe quantum computers based on the molecules in a liquid might one day overcome many of the limits facing conventional computers. Roadblocks to improving conventional computers will ultimately arise from the fundamental physical bounds to miniaturization (for example, because transistors and electrical wiring cannot be made slimmer than the width of an atom). Or they may come about for practical reasons--most likely because the facilities for fabricating still more powerful microchips will become prohibitively expensive. Yet the magic of quantum mechanics might solve both these problems.