DECO1005
History and Theory of Computing, Multimedia and Animation

LECTURE 2
COMPUTING

Pre-history

Ways and means of reasoning/ computing:

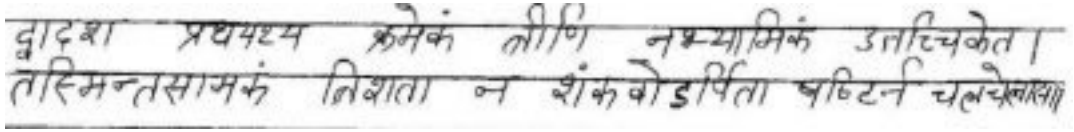
- Stones/ pebbles
- Beads
- Sticks
- Bones
- Fingers

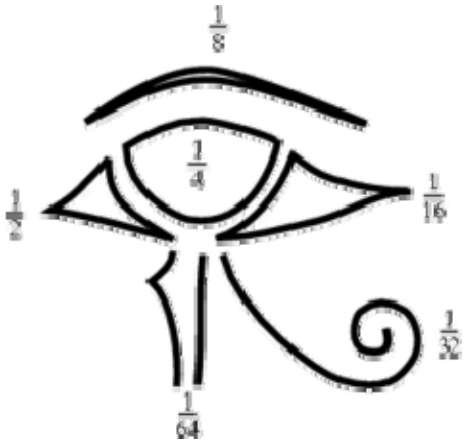
MAIN IDEA: **“NUMBERS” ARE PHYSICAL THINGS, NOT SYMBOLIC.**

Pre-history

Ways and means of reasoning/ computing:

- Symbols
- Numerals
- Letters
- Language
- Mathematics



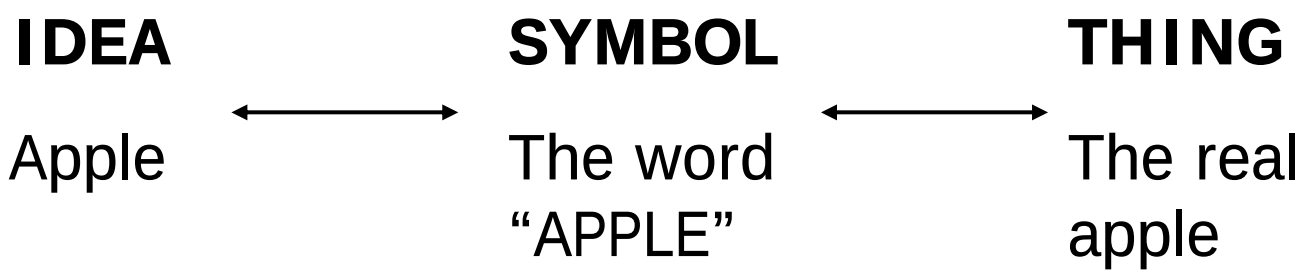


MAIN IDEA: **“NUMBERS” BECOME SYMBOLIC, DIFFERENT FROM PHYSICAL OBJECTS.**

Pre-history

This is a **HUGE** leap:

This idea of the SYMBOL being different from the IDEA that it represents from the REAL OBJECT in the world out there.

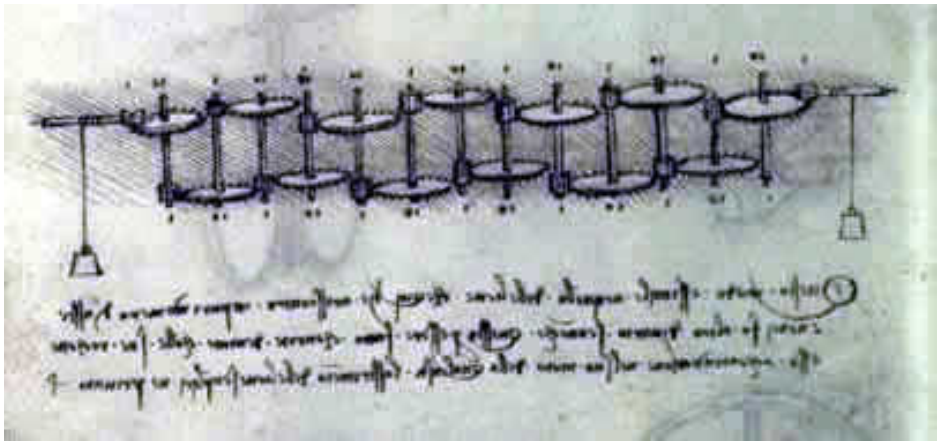


History, moving on...

Development of ideas and some examples:

- the separation of the physical and the symbolic
- the development of “hardware” and “software”

DaVinci



Mechanical calculator designed by him

History, moving on...

- John Napier
- Blaise Pascal
- Gottfried Wilhelm von Leibnitz
- Newton
- ...

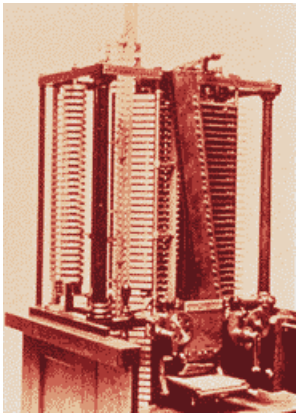
MAIN IDEA: "**CALCULATIONS" HAVE BECOME SYMBOLIC, "CALCULATORS" ARE MECHANICAL, MACHINES COMPUTE WITHOUT MEMORY.**

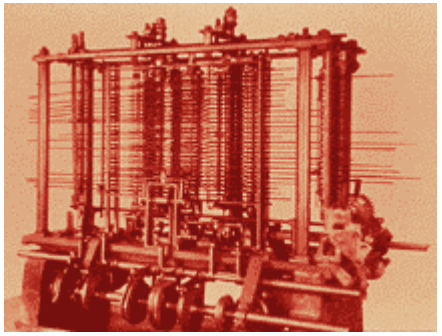
Beginning of Modern Era...

- 1821, Charles Babbage and the Difference Engine

- 1834, Charles Babbage and the Analytical Engine

- Lady Ada Lovelace and the beginning of ideas on programming





Although electricity has been discovered, Babbage plans his machines on mechanical principles and makes no use of the then latest technological innovations!!

This leads to the two machines never being completely built!!

Beginning of Modern Era...

- 1847, George Boole and binary logic
- 1867-68, Typewriters and the QWERTY keyboard
- 1876, Telephones
- onto 1900s...Devices, devices, more devices...

MAIN IDEA: INDUSTRIAL REVOLUTION, INCREASING COMPLEXITY IN ALL DISCIPLINES, NEED FOR FASTER COMPUTING PARALLED BY EXPLOSIVE GROWTH IN HARDWARE TECHNOLOGIES

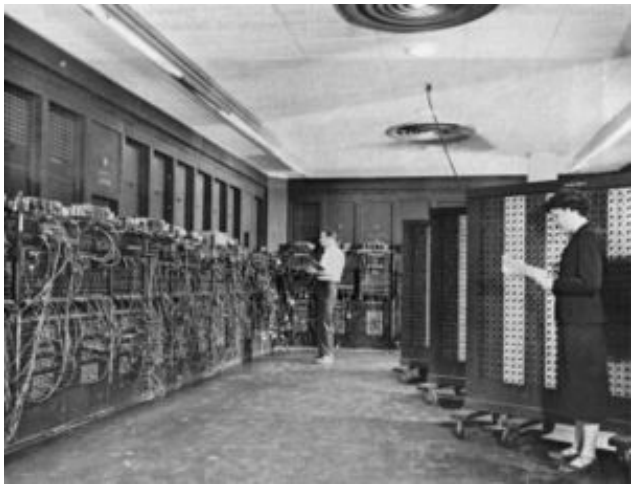
Modern computing commences...

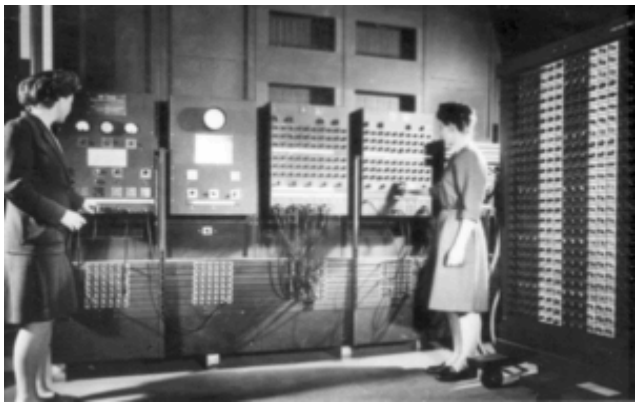
- Generations:

- Each generation marks a major technological innovation and changes the way computing happens.
  - 0, 1920s – 1940s, “Electromechanical contraptions”
  - 1, 1940 – 1956, Vacuum tube based computers
  - 2, 1956 – 1963, Transistor based computers
  - 3, 1964 – 1971, Integrated circuits
  - 4, 1971 – present, microprocessor, LSI, VLSI
  - 5, and beyond...

Modern computing...

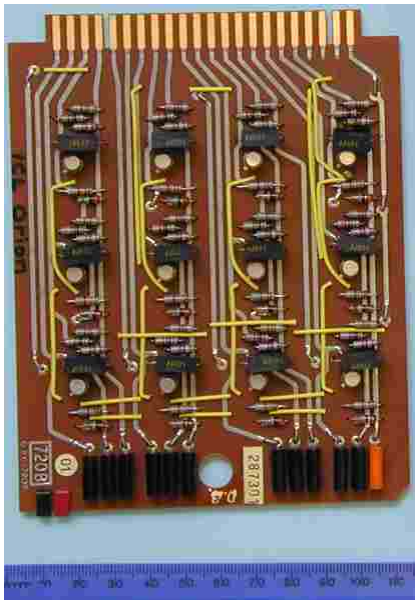
- First generation:
  - Vacuum tubes for circuitry
  - Magnetic drums for memory
  - Room big, enormous heat production
  - Machine language
  - Input mechanisms like punch cards
  - Examples: UNIVAC, ENIAC





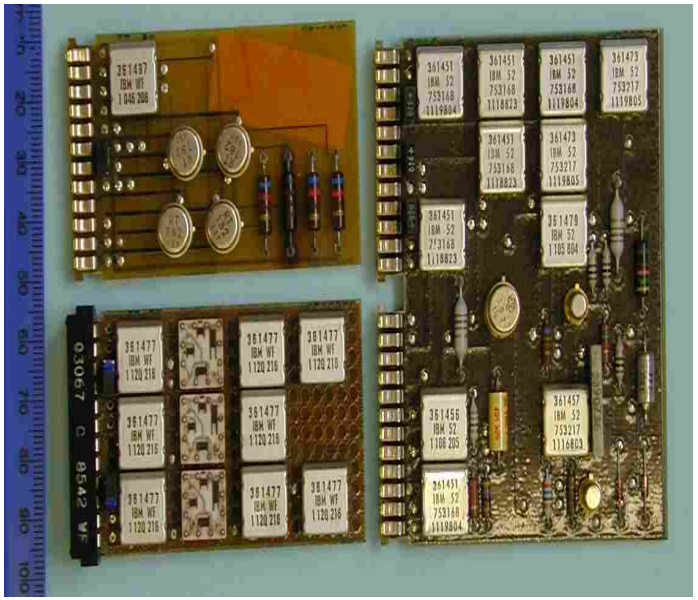
Modern computing...

- Second generation:
  - Transistors replace tubes
  - Magnetic drum to magnetic core memory
  - Major improvement over tubes
  - Assembly language
  - Input mechanisms like punch cards
  - Examples: Bell Labs and IBM computers



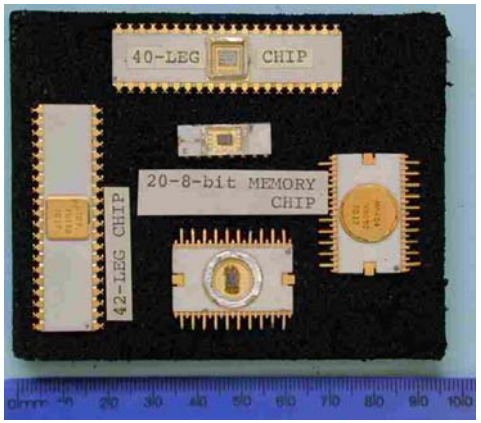
Modern computing...

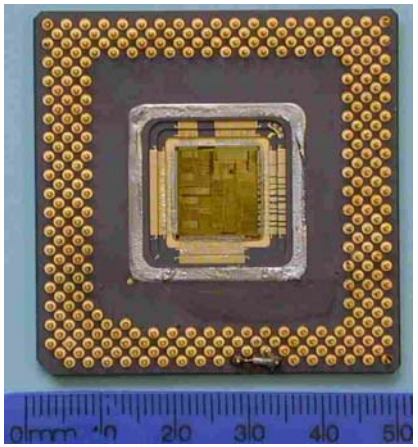
- Third generation:
  - Integrated circuits replace transistors
  - 100s of transistors on a small silicon chip
  - Major improvement over transistors
  - High level language
  - I/O mechanisms: keyboards, monitors
  - Operating systems
  - Examples: Bell Labs and IBM computers



Modern computing...

- Fourth generation:
  - Microprocessor replaces ICs
  - 1000s of ICs on a single silicon chip
  - From one room, to the palm of a hand
  - CPU, memory, I/O – on a single chip
  - Starting of GUIs, mouse, hand held devices
  - Examples: INTEL 4004, IBM, Apple





Modern computing...

- Fifth generation:
  - Parallel computing
  - Molecular and Nanotechnology
  - Quantum computing
  - Artificial intelligence and machine learning
  - Self organization and self-learning

Modern computing...

1935, Alan Turing and Universal Turing Machines

An infinite tape, a limitless memory, a scanner, preliminary operations...

Lead to...

CONCEPTS OF A STORED PROGRAM, A MACHINE THAT CAN PERFORM ANY CALCULATION and THE MACHINE ALTERING ITS OWN PROGRAM

"What we want is a machine that can learn from experience...the possibility of letting the machine alter its own instructions provides the mechanism for this..."

Modern computing...

Programming languages:

- Machine language
- Assembly language
- High level language

MAIN IDEA: Move from the symbolic being based in the mechanical to the mechanical being separate from the symbolic.

Modern computing...

- The earliest computer programs were mechanical. Programs hard coded into machine; machine reset when another program to be executed.

- 1945, Von Neuman's introduction of the "shared program technique" and "conditional control transfer"

- 1949, Grace Hopper and the first compiler

- FORTRAN, COBOL, PASCAL, C, C++, ...

- The rise of object-oriented programming

- The rise of agent-oriented programming

Modern computing...

Transition patterns:

- The mechanical age
- The electrical age
- The electronic age
- The quantum age

INCREASING LEVELS OF "ZOOM" THROUGH TIME...

Discovering the universe at finer scales...

MAIN IDEA: AS THE STRUCTURE OF MATTER IS DISCOVERED AT SMALLER AND SMALLER SCALES, HARDWARE BECOMES SMALLER, SOFTWARE MORE COMPLEX.

Modern computing...

-NANOTECHNOLOGY

- Control individual atoms and molecules to create computer chips; Thousands of times smaller than current technologies

- Current processes use lithography to imprint circuits on semiconductor materials.

- Some manufacturing plants can produce circuits smaller than one micron (1,000 nanometers)

- This still means aggregates of millions of atoms. It is widely believed that lithography is quickly approaching its physical limits.

- To continue reducing the size of semiconductors, new technologies that juggle individual atoms will be necessary. This is the realm of nanotechnology.

Modern computing...

- QUANTUM COMPUTATION

- Relies on quantum physics properties of atoms or nuclei that allow them to work together as quantum bits, or **qubits**, to be the computer's processor and memory; Leads to exponentially faster computations.

- Binary nature of computing : 0 or 1 representation

- Qubits encode information as a series of quantum mechanical states such as spin directions, polarization states etc.
    - might represent 1 or 0
    - might represent somewhere between 1 and 0
    - might represent superposition of many numbers at once

- Quantum computers will be able to perform many operations at once in parallel

Modern computing...

ARTIFICIAL INTELLIGENCE

-What is “Intelligence” ?

- The Herbert Simon – Allan Newell view: “Intelligence” may be captured, understood and represented symbolically, and so machines can be “intelligent”.

- The Clancey or Penrose view: “Intelligence” is sub-symbolic and all of it may not be represented explicitly. Even if a machine performs EXACTLY as a human, does it “know” what it is doing? NO.

The exploration of various ways of representing “intelligence” and “intelligent computation”.

Modern computing...

MACHINE LEARNING

- Mitchell's definition: A computer program "learns" if its performance on a class of tasks improves (as measured by some performance measure) with experience.

- Different paradigms: Supervised learning, unsupervised learning, reinforcement learning etc.

- Examples: domains – vision, sound, speech etc.; ways – classification, clustering, decision making, ...

Modern computing...

MAIN IDEAS:

- Modern computing uses findings from cognitive science and neuroscience to design explicit mathematical representations of “intelligent processes” bringing about “intelligent behavior”.

AND

- Modern computing brings to light, by mathematical/ symbolic enquiry, some aspects of “real” intelligence: better biological understanding through computational modeling.

References...

Some material and all images in this presentation use information from the following websites:

- http://en.wikipedia.org/wiki/History_of_computing_hardware
- http://www.webopedia.com/
- http://www.thocp.net/
- http://www.cs.sun.ac.za/~museum/

Assignment 1 and Presentation 1

Presentation 1 Date: 21 August, 2007

- First group presents on Computing History and Theory

- The other two groups ask questions

ASSIGNMENT 1 OUT: 31 July, 2007

ASSIGNMENT 1 IN: 14 August, 2007, no later than 5:00 pm.