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Learning to Learn

The Art of Doing Science and Engineering

Session 3:
History of Computers - Hardware

Historical Computing

Early Man counted numbers:

- Had a need to communicate numbers
- Astronomical awareness required computation

Arabic Numerals

- Opposed for centuries, but eventually adopted due to their greater practicality

Logarithms

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- Invented by Napier (1550-1617)
- Emergence of the Slide Rule / Analog Computing

Differential Analyzer (Analog Computing)

- Originally mechanical integrators (late 1940s)
- WWII saw advent of electronic analog computers
  - Useful, but only for low-accuracy problems

Digitization

Napier's Bones

- Inscribed Ivory Rods, tools for multiplication
- Likely the origin of digital calculators (Schickert/Pascal/Leibnitz)

Charles Babbage

- Difference Engine
  - Representing polynomials by sequences of additions, subtractions
  - Never built by Babbage, though a Norwegian family built several
- Analytical Engine
  - An approximate von Neumann computer design
  - Never properly constructed until 1992, but functioned as designed

Mechanical Calculators

Comptometers

Named Calculators

- The Millionaire
- The Monroe
- The Friden
- The Marchant

Punched Card Computing (1890s)

- Motivation to support the U.S. census efforts
- Spawned International Business Machines (IBM)
  - The 601 mechanical punch
    - Used to build the atomic bomb, performed operations at 1 Hz

Relay Computing

George Stibitz

- Demonstrated at Dartmouth
- Main Frame in New York
- Remote terminal / "time share"

Zuse / Aitken

- Similar contributions in relay technology

Computing Speed

Hand Calculators: 1/20 operations/sec

Relay Machines: 1 operations/sec/sec

Magnetic drum machines: 15 – 1000 operations/sec

IBM 701 type: 1000 operations/sec

Current (1990) computers can perform at giga (10^9) speeds and would take 3 seconds to perform more operations than there are seconds in a human lifetime.

A human lifetime will contain 3.1 x 10^9 seconds.

Natural Limits to Computing Speed

Light travels:

- nanosecond – 1 foot
- picosecond – 1/100 inch
- femtosecond – 300 atoms

Components must be very small and very close together to allow for fast computing.

Heat Dissipation – lower voltage, emerging heat conducting materials (diamond)

Computing Speeds

Adding arithmetic units does not efficiently increase total processing speed

Los Alamos National Lab charted the computing speed from 1943 to its natural asymptote (3.576 x 10^9)

Computing speeds have observed the 'S' curve

"The purpose of computing is insight, not numbers."

Man and Computers

Computers are gates and registers. They have no awareness of the purpose or meaning of the bits, that is applied by humans.

The viewpoint on difference between computers and humans will greatly effect how computers are used and how we attempt to use them.

"I am not interested in the competition of man vs. machine, I am interested solely in what man and machine can do together."