Machine Called Computer

Part 6: In Search of Computer until 1950

학습요령:

- 소제목 슬라이드(1번부터 7번까지)의 내용과 흐름을 이해하실 것
- 기타 상세한 내용은 기억할 필요 없음

References:

1. B. Randell, M. V. Wilkes, P. E. Ceruzzi, "Digital Computers, History of: Origins, Early, Since 1950," Encyclopedia of Computer Science, pp. 545-570, 2003

1. Mechanical Calculator (17C – 1970s)

Goal: automatic arithmetic
- Inputs: two numbers
- Output: their +, -, ×, ÷

Mechanical Aids to Calculation

❑ Adding machines in 17C

- W. Schickard

- B. Pascal's machine (1642) still exist

❑ Numerous attempts to practical calculating machines

❑ Commercially successful machine only in 19C

- Arithmometer by T. de Colmar in 1820

  – Use stepped-wheel mechanism by Leibniz

Schickard's Machine

❑ Add and subtract six-digit numbers - incomplete

Image of original drawing of Schickard's machine:
http://en.wikipedia.org/wiki/File:Rechenmaschine_wilhelm_schickard.png
Image of Schickard's calculating machine:
http://en.wikipedia.org/wiki/File:Schickardmaschine.jpg

Pascal's Calculator (Pascaline)

❑ Invented mechanical calculator (1642)

❑ Add and subtract two numbers directly

- Multiply and divide by repetition

Image of Pascal's calculator:

http://en.wikipedia.org/wiki/File:Arts_et_Metiers_Pascaline_dsc03869.jpg

Leibniz

❑ Invented Leibniz wheel (or stepped drum) in 1673
- To add automatic multiplication/division to Pascaline
❑ Built Stepped Reckoner (1694)

Image of Stepped Reckoner:
http://en.wikipedia.org/wiki/File:Leibnitzrechenmaschine.jpg
Image of Leibniz wheel:
http://en.wikipedia.org/wiki/File:Cylindre_de_Leibniz_anim%C3%A9.gif

Arithmometer

❑ T. de Colmar in 1820
- Add/subtract directly, mult/div effectively
- First commercially successful mechanical calculator
  – Millions of machines built from 1851 into 1970s

Image of Arithmometre built around 1887:
http://en.wikipedia.org/wiki/File:Arithmometre.jpg

Curta Calculator

❑ Small, hand-cranked calculator in 1948

- Add/subtract/mult/div, and more with difficulty
- Best portable calculator until displaced by electronic ones in 1970s

Image of Curta calculator:

http://en.wikipedia.org/wiki/File:Curta_calculator.jpg

Image of Curta calculator:

http://en.wikipedia.org/wiki/File:Curta_-_National_Museum_of_Computing.jpg

2. Operation Sequencing (? – 18C)

Contribution: idea of sequencing

- Complex task as sequence of simple operations
- Precursor to programming

Mechanical Automata

❑ Mechanical devices for sequencing a set of operations

❑ Pins on rotating cylinders (9C)

- Music box, play organ, movement of model figures

❑ Jacquard loom in 18C

- Woven pattern controlled by perforated cards

Read about mechanical automata (for example, letter writing and Cuckoo clock):

http://en.wikipedia.org/wiki/File:Baud_museum_mg_8521.jpg

Punched Card

❑ First used in 1725 for "control"

❑ Improved by Jacquard in 1801

- Jacquard loom

Image of Jacquard loom:
http://en.wikipedia.org/wiki/File:Hand-driven-jacquard-loom.jpg

3. Charles Babbage (19C)

Contribution: All ideas of modern computer
- Ultimate visionary (100 years ahead)
- Unable to build it with mechanical parts

Charles Babbage in 19C

- ❑ Difference Engine in 1822
  - Automatically generate values of algebraic functions
  - Method of finite difference
- ❑ Concept of Analytical Engine in 1834
  - Digital computer
  - Program-controlled
    - Conditional jump and iteration loop
  - Mechanical
    - Micro-programmed by rotating pegged cylinders
  - Arithmetic unit, store
  - Punched-card input and output, printing mechanism
- ❑ Lady Ada Lovelace

Difference Engine

Image of Babbage Difference Engine at Computer History Museum:

http://en.wikipedia.org/wiki/File:Babbage_Difference_Engine.jpg

4. Tabulating Machines (1890 – 1950s)

Contribution: idea of data processing
- Successful business computers
- Sorting, tabulating (not calculators)

Punched-Card Data Processing System

❑ Hollerith's idea (perhaps inspired by Jacquard loom)

- 1890 US National Census

- Use punched cards to represent logical/numerical data

- Tabulating machines and sorters

  – Successful and spread to business accounting

❑ Hollerith's company

- Merged to form Computing Tabulating Recording Co.

- Under presidency of T. J. Watson, renamed International Business Machines Corp. (IBM) in 1924

Tabulating Machine

❑ Hollerith's card and machine in 1890

- Electro-mechanical device

- Tabulation and sorting for US census

- 40 counters, max. 10000 counts each, relay logic

Image of Hollerith 1890 tabulating machine and sorter:
http://en.wikipedia.org/wiki/File:HollerithMachine.CHM.jpg
Image of Hollerith punched card:
http://en.wikipedia.org/wiki/File:Hollerith_punched_card.jpg

Early IBM Tabulating Machine

Image of early IBM tabulating machine:
http://en.wikipedia.org/wiki/File:Lochkarte_1.jpg

Punched Card

❑ Primary medium for data entry, storage, processing from 1890s to 1950s

Image of an 80-column punched card:
http://en.wikipedia.org/wiki/File:Blue-punch-card-front-horiz.png

Tabulating Machine

❑ Computing Tabulating Recording Company (CTR) in 1896
  - Can add numbers on cards (1896)
  - Automatic feeding tabulator (1906)
  - Printing tabulator (1920)

❑ IBM 301 in 1928 (c.f., term "super computing" in 1931)
  - Subtraction, class selection, print net balance
  - Transition from tabulating to accounting machine
  - IBM series continued until 1976

Image of tabulating machine:
http://en.wikipedia.org/wiki/File:Lochkarte_1.jpg
Image of control panel of IBM accounting machine:
http://en.wikipedia.org/wiki/File:IBM402plugboard.Shrigley.wireside.jpg

5. Electro-Mechanical Calculators (1930s and 1940s)

Contribution:

- Complex mathematical calculations
- Limited programmability
- Mechanical parts, relays, vacuum tubes

Electro-Mechanical Calculators in 1940s (Program-Controlled)

❑ Harvard Mark I in 1944

- (First) calculator that can execute long computation
- 72 accumulators, each 23 decimal digits
  – Add: 0.3 second, Mult. 6 seconds, div. 15.3 seconds
  – Log & trigonometric function took over one minute
- Instructions in paper tape – no branch instruction
- Rotating shafts, electromagnetic clutches, wheels
  – 76,500 components, hundreds of miles of wire
  – 16m long, 2.4m high, 0.6m deep (4,500 Kg)
- Later version use electromagnetic relays

❑ Zuse's Z3 in 1941, Germany (also program-controlled)

- Relays (later series use vacuum tubes)

Electro-Mechanical Calculators in 1940s Program-Controlled

❑ Harvard Mark 1 in 1944

Image of Harvard Mark I (left side):
http://en.wikipedia.org/wiki/File:Harvard_Mark_I_Computer_-_Left_Segment.jpg

Image of Harvard Mark I (right side):
http://en.wikipedia.org/wiki/File:Harvard_Mark_I_Computer_-_Right_Segment.JPG

Electronic Digital Calculator

❑ Earliest effort (ABC)

- Atanasoff and Berry, Iowa State College in 1938-1942

- To solve 30 simultaneous linear equations

- Only arithmetic unit completed

❑ IBM's electronic calculating devices

- Electronic version of punch-card machine in 1949

    – Actively used until stored-program computer arrive

6. Fully-Electronic General-Purpose Modern Digital Computer (1945-1950)

Contribution:

- Completion of the machine called computer
- Beginning of IT revolution

Electronic General-Purpose Program-Controlled Computer

† Earliest proposal by Schreyer and Zuse in 1939, Germany

† Britain's Colossus in 1943

- Special-purpose for code-breaking (2,000 tubes)

❑ ENIAC in 1943-46

- Mauchly and Eckert, U. of Pennsylvania
- Start with ballistic comp., end with general-purpose
- Internal electronic memory: 20 ACs (10 decimal digits)
- Add: 0.2 msec, Mult: 2.6 msec
- 19,000 tubes, 200KW of power
- Programmed by plugs, sockets, switches
  – Other computers read instructions from paper tape

ENIAC (1943-1946)

Image of ENIAC:

http://en.wikipedia.org/wiki/File:Classic_shot_of_the_ENIAC.jpg

Image of ENIAC:

http://en.wikipedia.org/wiki/File:Eniac.jpg

Large-Scale Modern Digital Computer

❑ EDVAC by John von Neumann, Eckert and Mauchly
- Proposal in 1945, before completion of ENIAC
- Stored-program concept by von Neumann
  - Avoid length setup time

❑ With EDVAC, modern digital computer is complete
- Design widely published and influential

❑ EDVAC
- One-tenth of equipment in ENIAC
  - Smaller but more powerful than ENIAC
- 100 times larger memory – Williams tube memory
- Serial binary machine (ENIAC is decimal)
- First bit-parallel computer, 44-bit word, 1 KHz clock

Large-Scale Modern Digital Computer

❑ EDVAC by von Neumann, Eckert and Mauchly

- Eckert-Mauchly Computer Corporation in 1947
  - UNIVAC I for business data processing in 1951
  - Remington Rand -> Sperry Rand -> Unisys
- Institute for Advanced Study, Princeton
  - EDVAC completed in 1952

† Less ambitious EDSAC in 1949, UK

† First US machine: SEAC in 1950

  - Dozen of computers have been built in these years

UNIVAC I (1947-1951)

Image of UNIVAC I:

http://en.wikipedia.org/wiki/File:UNIVAC-I-BRL61-0977.jpg

Image of UNIVAC I:

http://en.wikipedia.org/wiki/File:Museum_of_Science,_Boston,_MA_-_IMG_3163.JPG

EDVAC (1945-1952)

Image of EDVAC:

http://en.wikipedia.org/wiki/File:Edvac.jpg

7. IT Revolution

- 1950 – 1970
    - Built many computers
    - Semiconductor technology, software industry
- 1970s
    - From big and expensive computers
    - Personal computers (Silicon Valley)
- 1990s
    - From islands of computers
    - WWW (Internet, electronic commerce)
- 2000s
    - Smartphones (mobile commerce)

Summary

- ❑ Mechanical calculators (17C – 1970s)
- ❑ Complex task as sequence of simple operations (16C)
- ❑ C. Babbage, computer visionary in 19C
- ❑ Tabulating machines (1890 – 1950s)
- ❑ Various attempts in 1930s and 1940s (USA, Europe)
  - • Electromechanical, rather special-purpose computers
- ❑ ENIAC (1945/1946), UNIVAC1 (1951), EDVAC(1952)
  - • Fully-electronic general-purpose modern digital computer
- ❑ IT gold rush in USA (1950 to present)