Computer Science 210

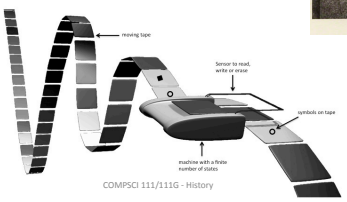
Computer Systems 1

Chapter 4:
The von Neumann Model

Credits: "McGraw-Hill" slides prepared by Gregory T. Byrd, North Carolina State University

The Turing Machine

- Alan Turing, 1936
- A simple (hypothetical) computing machine
- Could solve any problem for which a program could be written
- The basis of all modern computers



The Universal Machine

- An algorithm describes how to solve an individual decision problem
- At this time computers were people
- Turing imagined a hypothetical factory filled with floor upon floor, rows upon rows of hundreds upon hundreds of computers
- each using an algorithm to solve a particular decision problem
- Such a factory could in theory solve the decision problem for all conceivable problems
- This was the ***universal machine***

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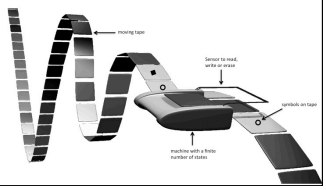
A Turing Machine

- A Turing Machine consists of:
  - an infinite input/output tape divided into cells containing symbols
  - a read / write head
  - an internal state
  - a set of rules



A Turing Machine - example

- Is a string a palindrome?

_	_	A	B	B	A	_

- Step right until you detect 1st character

_	_	**A**	B	B	A	_

- Erase the "A" and apply a rule looking for an "A" at the string's end

_	_	**_**	B	B	A	_

- Step right until you detect blank character then go back one cell to the left – is this an "A"?

_	_	_	B	B	**A**	_

A Turing Machine - example

- Step right until you detect blank character then go back one cell to the left – is this an "A"?

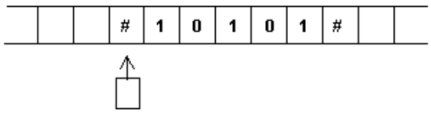
_	_	_	B	B	**A**	_

- If NOT(A) then STOP – it's not a palindrome
- Else erase A step left to first character of string

_	_	_	**B**	B	_	_

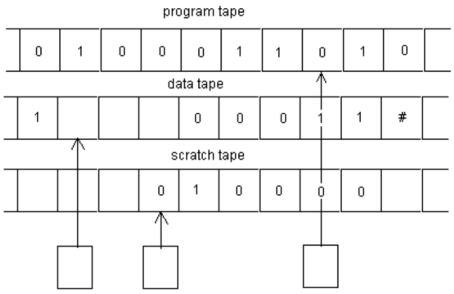
- Repeat steps above until either all characters erased (it's a palindrome) or program STOPs (it's not a palindrome

A Turing Machine - example



q0 start state, looking for the first input character
q1 remembering a 0, looking for an end marker
q2 remembering a 1, looking for an end marker
q3 remembering a 0 having found an end marker, looking for a match
q4 remembering a 1 having found an end marker, looking for a match
q5 returning to the front of the string after a successful match
q6 mismatch detected, final rejection state
q7 if input character at tape head is #, accept, else same as start state

A Universal Turing Machine



Colossus

- 1943 First programmable digital computer - Colossus
- 10 machines built for Bletchley Park, England to crack German High Command's Lorenz code
- Designed by Tommy Flowers
- 1,500 valves (vacuum tubes)
- TOP SECRET until 1970's
- ENIAC in 1945 was publicised as the "first computer"

Lorenz machine

The Stored Program Computer

•1943: Colossus Mark 1

The Stored Program Computer

1945: ENIAC
- Hard-wired program – settings of dials and switches.
- Presper Eckert and John Mauchly – first general-purpose electronic computer.
  (or was it John V. Atanasoff in 1942?)
  (or was it Konrad Zuse in 1941?)

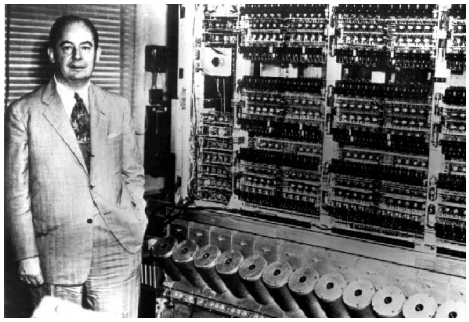
•1944: Beginnings of EDSAC
- Maurice Wilkes, inspired by conversations with Eckert & Mauchly
- Among other improvements, includes program stored in memory

•1944: Beginnings of EDVAC (working 1949)

The Stored Program Computer (continued)

1945: John von Neumann
- Wrote a report called, *First Draft of a Report on EDVAC,* on the stored program concept,

The basic structure proposed in the draft became known as the "von Neumann machine" (or model)
- a ***memory***, containing instructions and data
- a ***processing unit***, for performing arithmetic and logical operations
- **a *control unit***, for interpreting instructions
- **input/output** (I/O) devices



John von Neumann (1903-1957) with the ENIAC

Konrad Zuse, 1910-1995

Sir Maurice Vincent Wilkes/Konrad Zuse

Konrad Zuse (1910-1995) and Maurice Wilkes (1913-2011)

Maurice Wilkes (1913-2011), designer of the EDSAC, an early working stored-program computer (1949)

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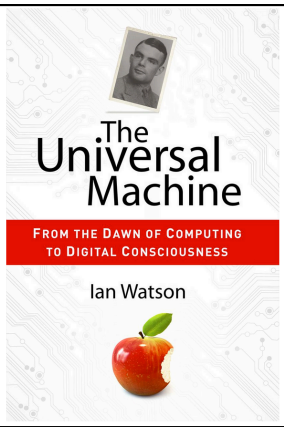
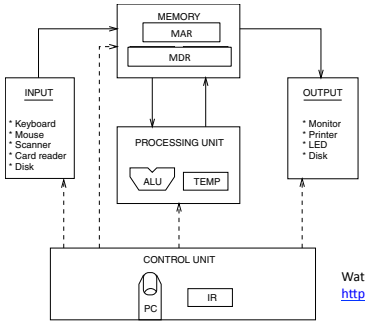


Von Neumann Model



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