

The von Neumann Model + Turing Machines

Modern Computers?!

By Micah Rubin and Riley Boucot

Turing Machine

Turing machines are theoretical concepts invented to explore the domain of computable problems mathematically.

The Turing machine model works by manipulating symbols on a tape with an infinite number of slots.

The slot currently being read (the head) can change the symbol being read and move on to other slots.

Turing machines do not get deep into implementation.

History of the von Neumann Model

- Early computers (e.g. ENIAC) ran fixed programs; creating a new program for the computer required rewiring the machine.
- John von Neumann had the idea of storing the program inside the memory of the computer.
- EDSAC was the first actual stored-program computer; the first programs it ran were in 1949 and calculated a table of squares and a list of prime numbers.
- Today, all but the simplest of computers are examples of stored-program computers.

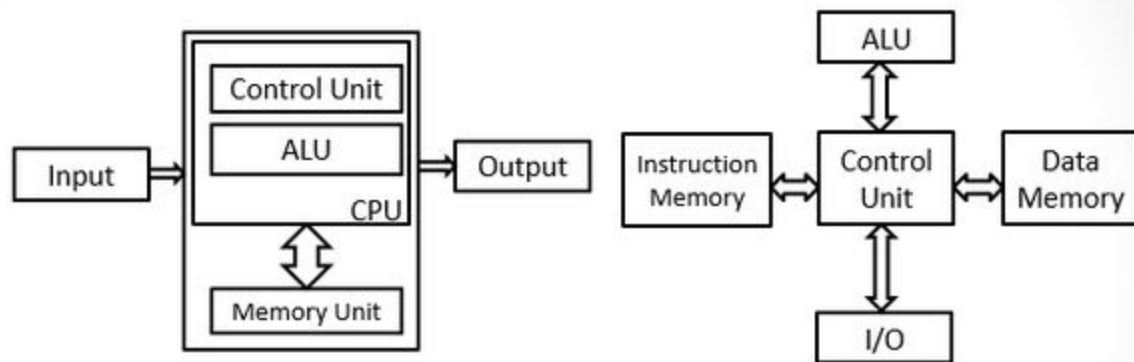
The von Neumann Model (Princeton Model)

The von Neumann Model is an architecture for the construction of actual computers.

This model does not say anything about the computational capabilities of the machines that implement it.

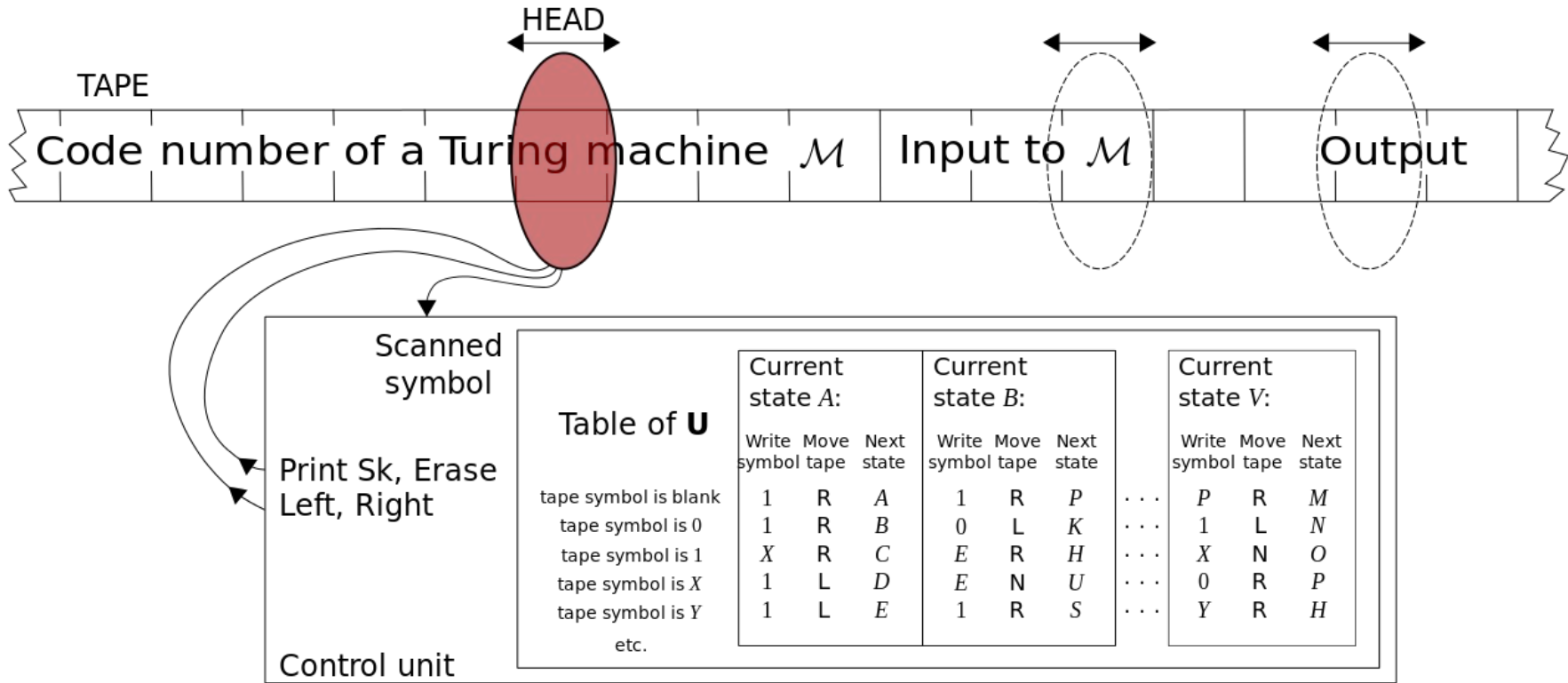
Most modern computers are random-access stored-program machines (RASPs) which are an example of von Neumann architecture; RASPs are, however, equivalent to Universal Turing Machines.

Von Neumann vs. Harvard architectures



Von Neumann Model

Harvard Model



Example of how a TM can be encoded onto the tape (storing of a program), the TM which puts 0.1.0.1... can be encoded by using a series of 5-tuples.

The only characters we actually need to use to encode these 5-tuples are:

D, A, C, R, L, N, ; (D, A, C are used to represent states and symbols; R, L, N represent movement on tape; ; is to separate)

Results, Theory, and Ongoing Research

The von Neumann model, and the Universal TM, are essentially describing the theoretical side of what happens in a modern computer.

To see current results of the von Neumann model and its pairing with Turing Machines, one can just look at essentially anything being done by computers today.

Most modern research seems to be in improving the hardware rather than the architecture of computers; it is highly unlikely that computers will cease to use the von Neumann model in the foreseeable future.

Works Cited

"On Computable Numbers, with an Application to the Entscheidungsproblem" by Alan Turing, 1936

<http://www4.ncsu.edu/~spbalik/java/history.html>

<http://www.computinghistory.org.uk/det/3665/john-von-neumann/>

<http://none.cs.umass.edu/~dganesan/courses/fall09/handouts/Chapter4.pdf>

<http://web.mit.edu/manoli/turing/www/turing.html>

https://www.maa.org/external_archive/devlin/devlin_12_03.html

<http://www.theinfolist.com/php/SummaryGet.php?FindGo=Von%20Neumann%20architecture>