

S107e

Computer Systems from the Ground Up

Winter 2021

<https://cs107e.github.io>

Who?

Pat

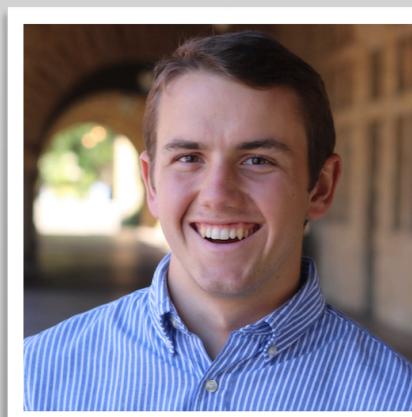


Peter

Julie



Liana



Sean



Anna

Weekly Cadence

Each week has a focus **topic**

Pair of coordinated **lectures** on Fri and Mon

Lab on Wed, open 10am-2pm, plan on 2 hours

Assignment handed out Wed (after lab), YEAH session Thu, due at end of day Tue

Staying on pace leads to best outcomes!

Lectures

Attendance is **necessary**

Content is unique to the course, no textbook, readings/slides are not a standalone resource

Although zoom recorded, **live** is best (participate, ask questions, stay on schedule)

Pose questions verbally or type in chat, but **do ask!!**

We would love your **video on** during lecture if possible

Labs

Attendance is **mandatory**

Guided exercises, work with peers, **check in** with staff

Finish lab **ready** for assignment, esp. experience with
tricky parts (hardware/software interface)

Philosophy: lots-of-help, hands-on, collaborative

Lab room: we are making a cool interactive video
space -- should be fun place to hang out!

Assignments

7 weekly assignments

Build on each other, complete full system

Assignment specifications

Core (required, tight spec, guided steps)

Extension (optional, opportunity for your exploration/
creativity)

Revise and **resubmit** to address issues in core functionality

Project

Design and build **your own system**

Learning community

Stay **connected**

Participate in lecture

Collaborate in lab

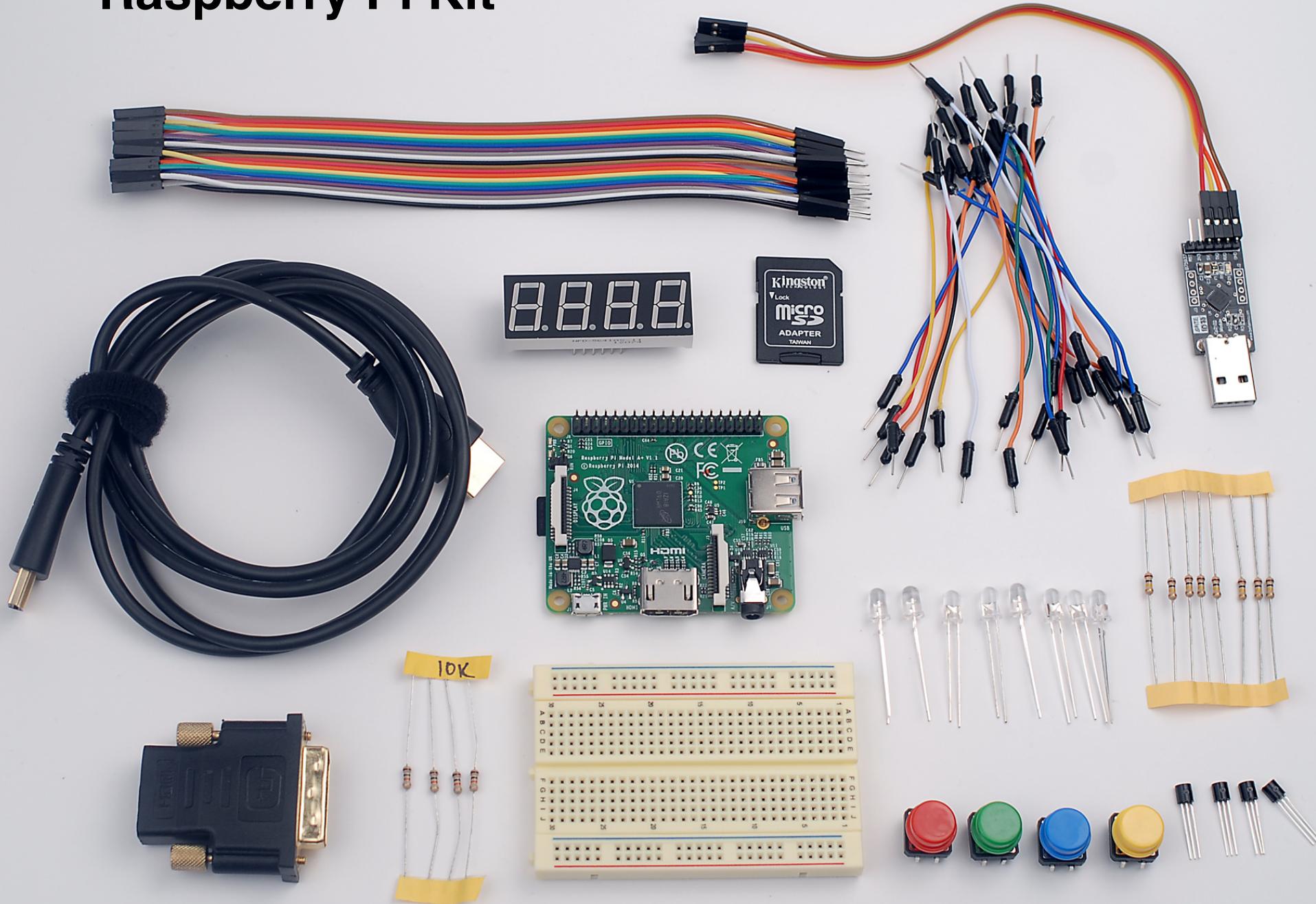
Discuss on Ed forum

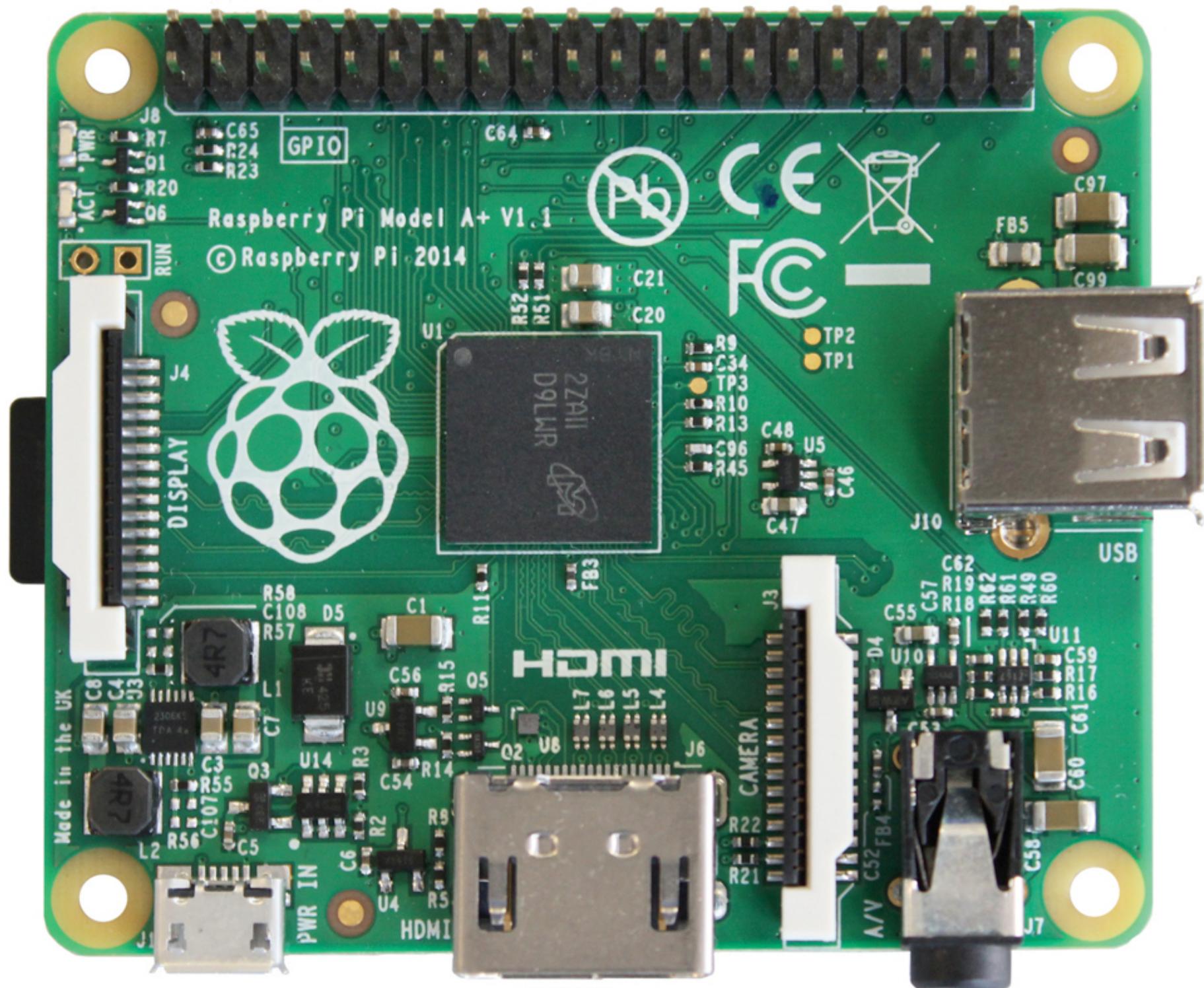
Come to office hours

Work in our shared OhYay space

Be **curious**. Learn by **doing**. Ask for and offer **help**.

Raspberry Pi Kit





ARUKCE MC1
V-OF3
1439 1-6



MICRO SD CARD



J9

C66

R12	C10	C17	C36	C69	C37	R25
C50	C9	F8	C49	C18	C12	C35
C51	C9	F8	C49	C14	C12	C30
C52	C9	F8	C49	C13	C12	C31
C45	C29					

PP21 C23 C28 L3
R31 C26 C42 C3
C19 C41 C43 C67
C44 C16 C10 C32
C25 C27 C37 X1
C10 C11 C38 C24
C15 PP15 PP10
PP14 PP19 PP16
PP17 PP5

J551 N
PP31 TDI
PP32 TDO
PP29 THS
PP34 TCK
PP33 GND
PP31



C24
R1m
PP8 PP4
PP7 PP1
PP2
PP3

PP22

PP35

PP23

PP27

PP26

PP12

PP25

PP24

PP40

PP39

PP38

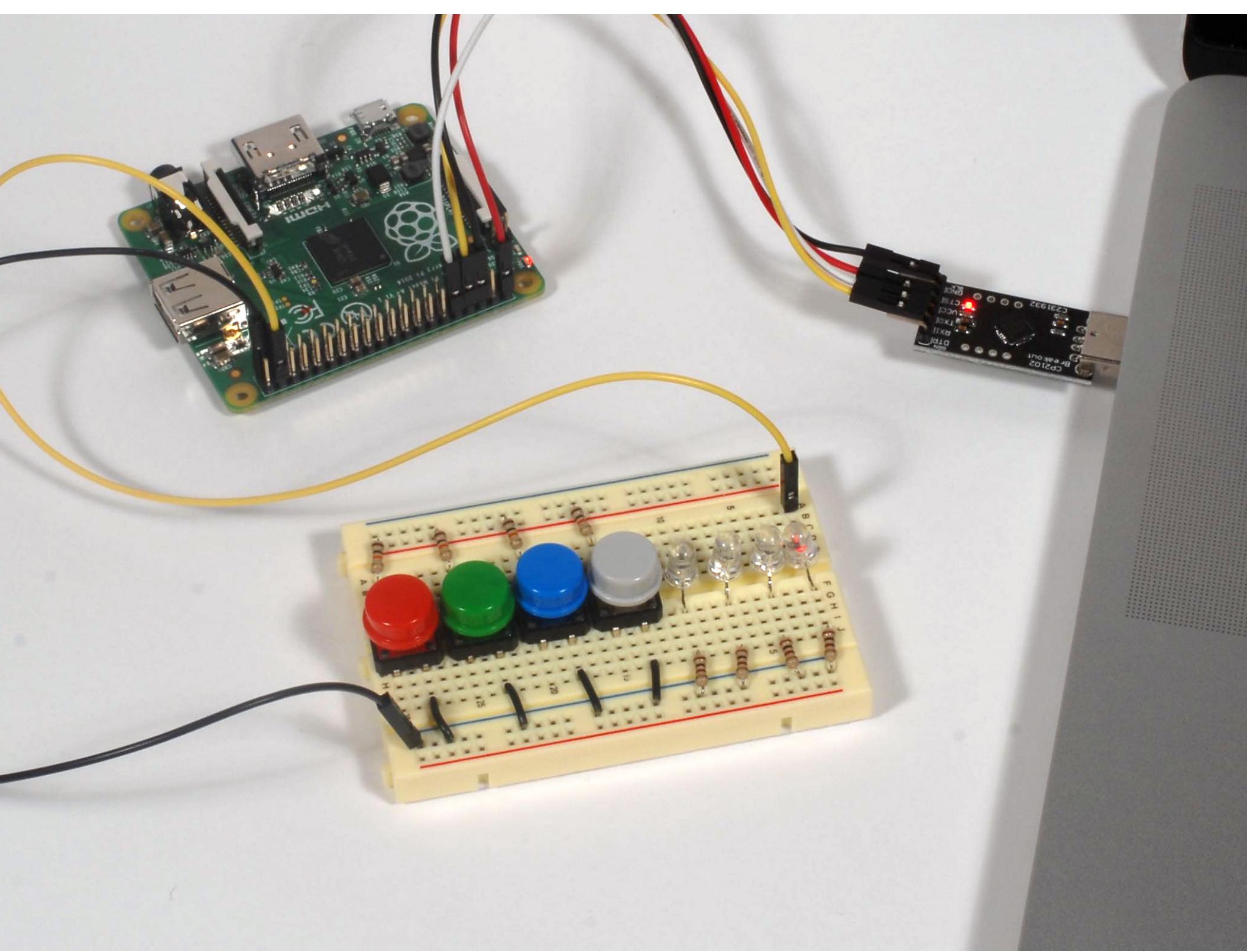
PP37

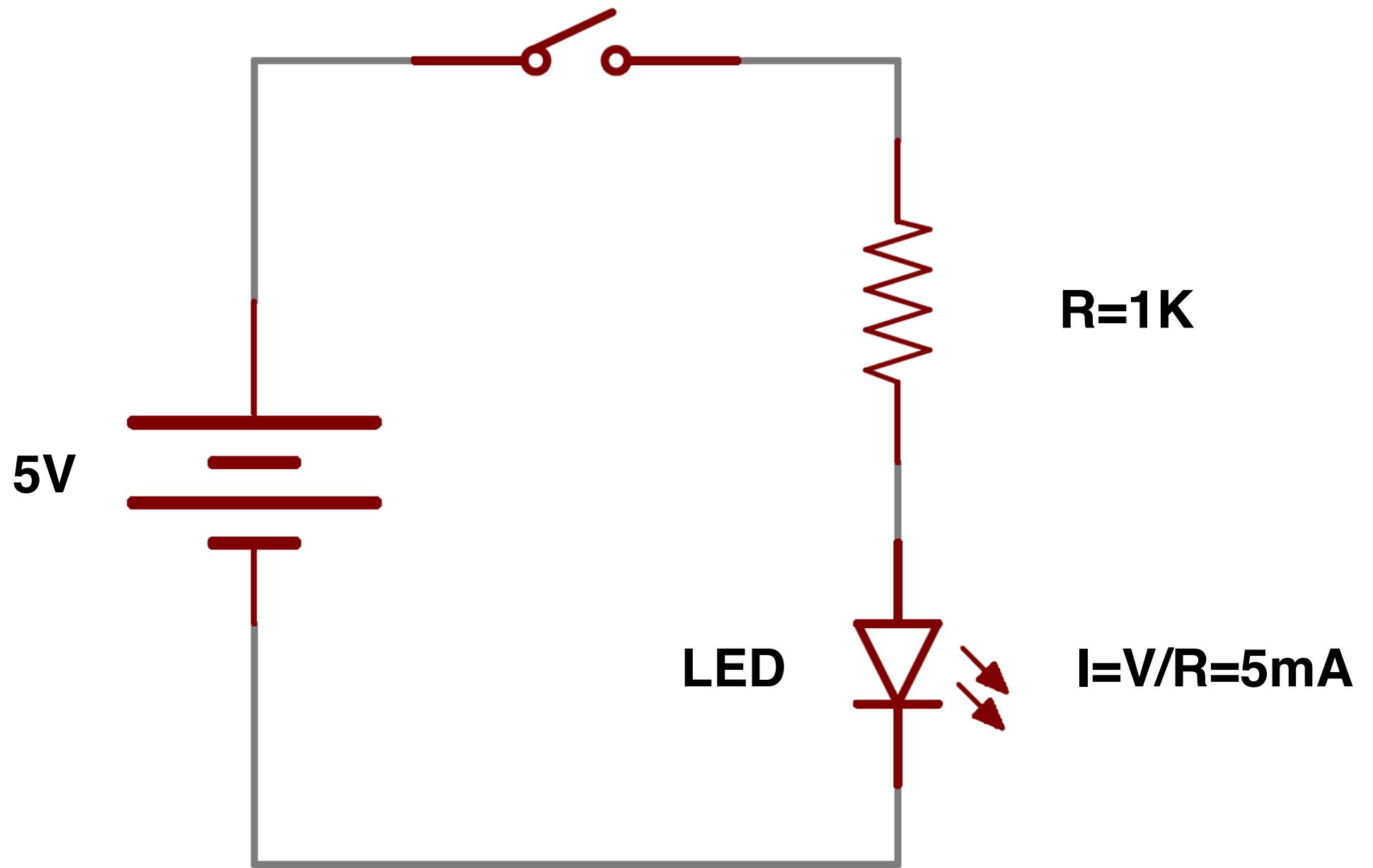
PP30

PP31

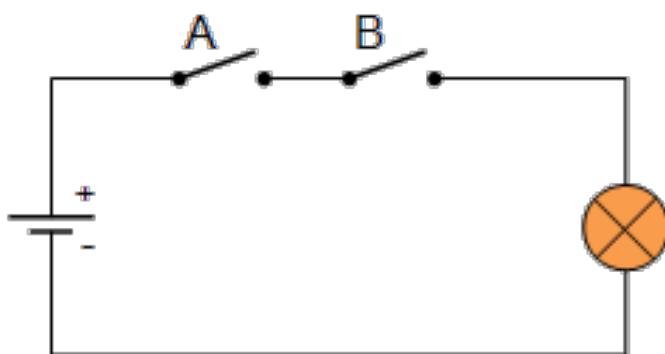
J5

PP10
PP13





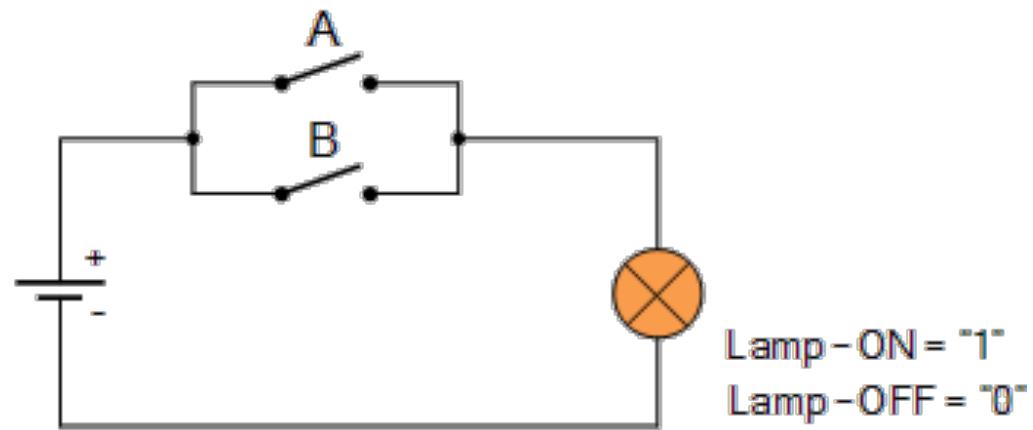
Switching Logic



Switch A - Open = "0". Closed = "1"

Switch B - Open = "0". Closed = "1"

Lamp - ON = "1"
Lamp - OFF = "0"



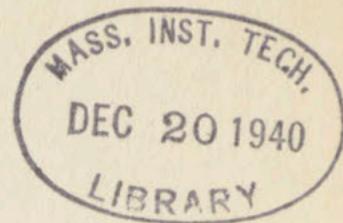
Switch A - Open = "0". Closed = "1"

Switch B - Open = "0". Closed = "1"

Lamp - ON = "1"
Lamp - OFF = "0"

AND

OR



A SYMBOLIC ANALYSIS
OF
RELAY AND SWITCHING CIRCUITS

by

Claude Elwood Shannon

B.S., University of Michigan

1936

Submitted in Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

from the

Massachusetts Institute of Technology

1940

Logic / Boolean Algebra

Name	NOT	AND	NAND	OR																																																			
Alg. Expr.	\bar{A}	AB	\overline{AB}	$A + B$																																																			
Symbol																																																							
Truth Table	<table border="1"> <thead> <tr> <th>A</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> </tr> </tbody> </table>	A	X	0	1	1	0	<table border="1"> <thead> <tr> <th>B</th> <th>A</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> </tr> </tbody> </table>	B	A	X	0	0	0	0	1	0	1	0	0	1	1	1	<table border="1"> <thead> <tr> <th>B</th> <th>A</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> </tr> </tbody> </table>	B	A	X	0	0	1	0	1	1	1	0	1	1	1	0	<table border="1"> <thead> <tr> <th>B</th> <th>A</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> </tr> </tbody> </table>	B	A	X	0	0	0	0	1	1	1	0	1	1	1	1
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C syntax

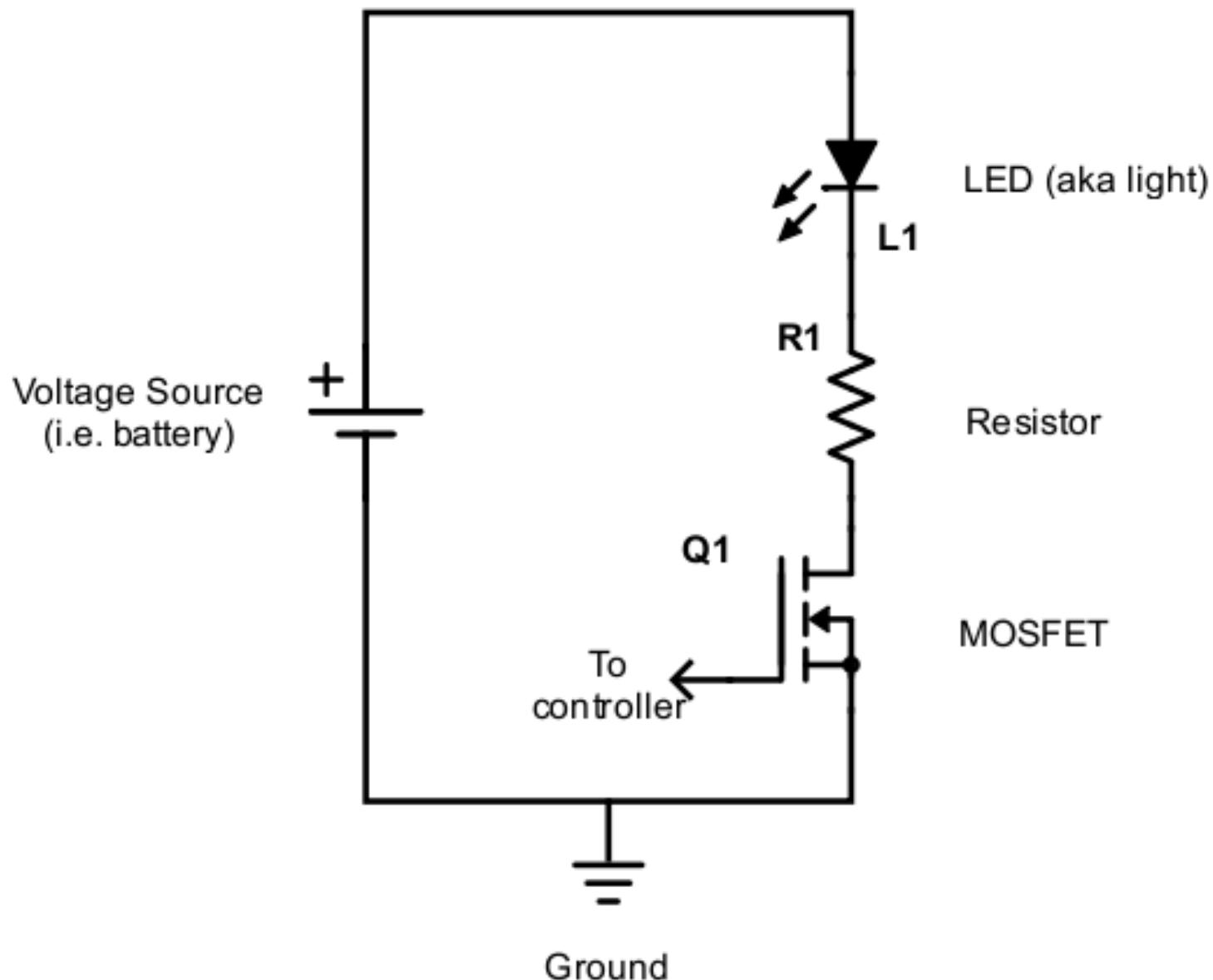
$\sim A$

$A \& B$

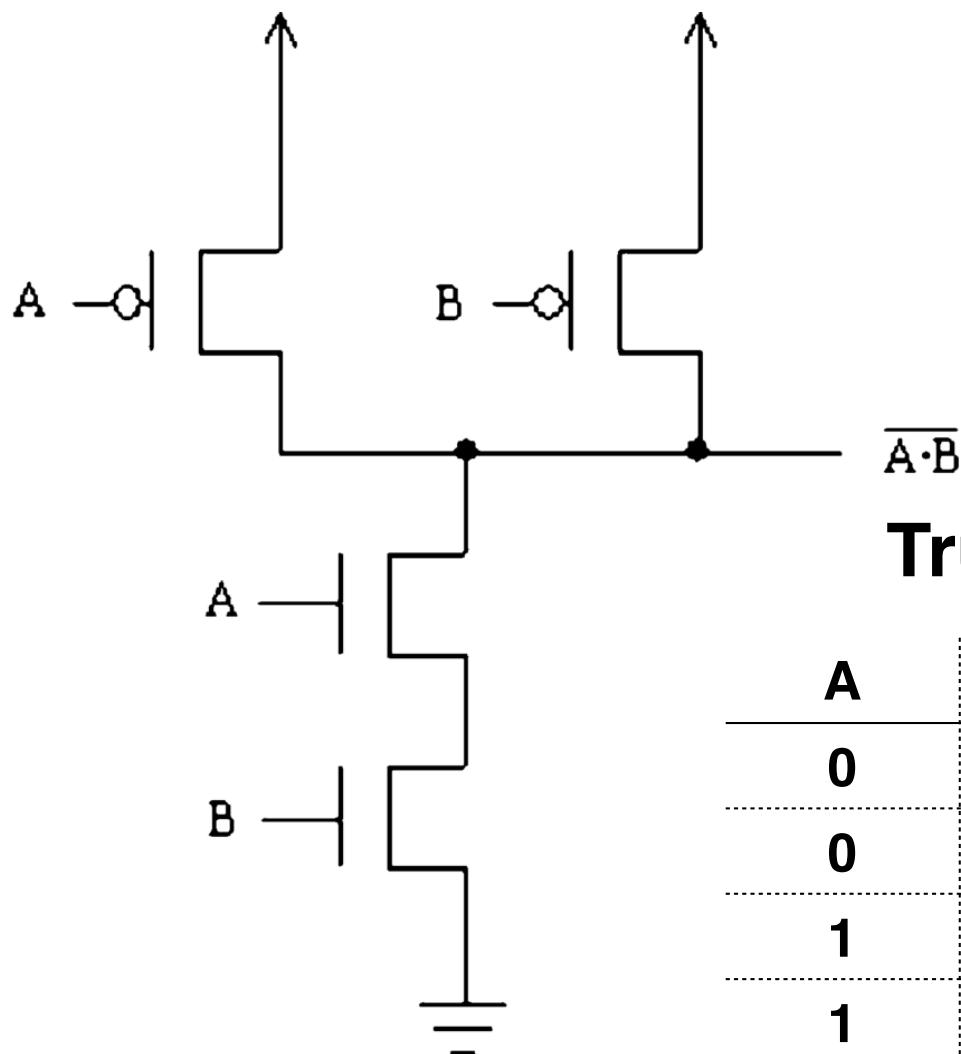
$\sim(A \& B)$

$A | B$

Transistor as a Switch



CMOS NAND Gate

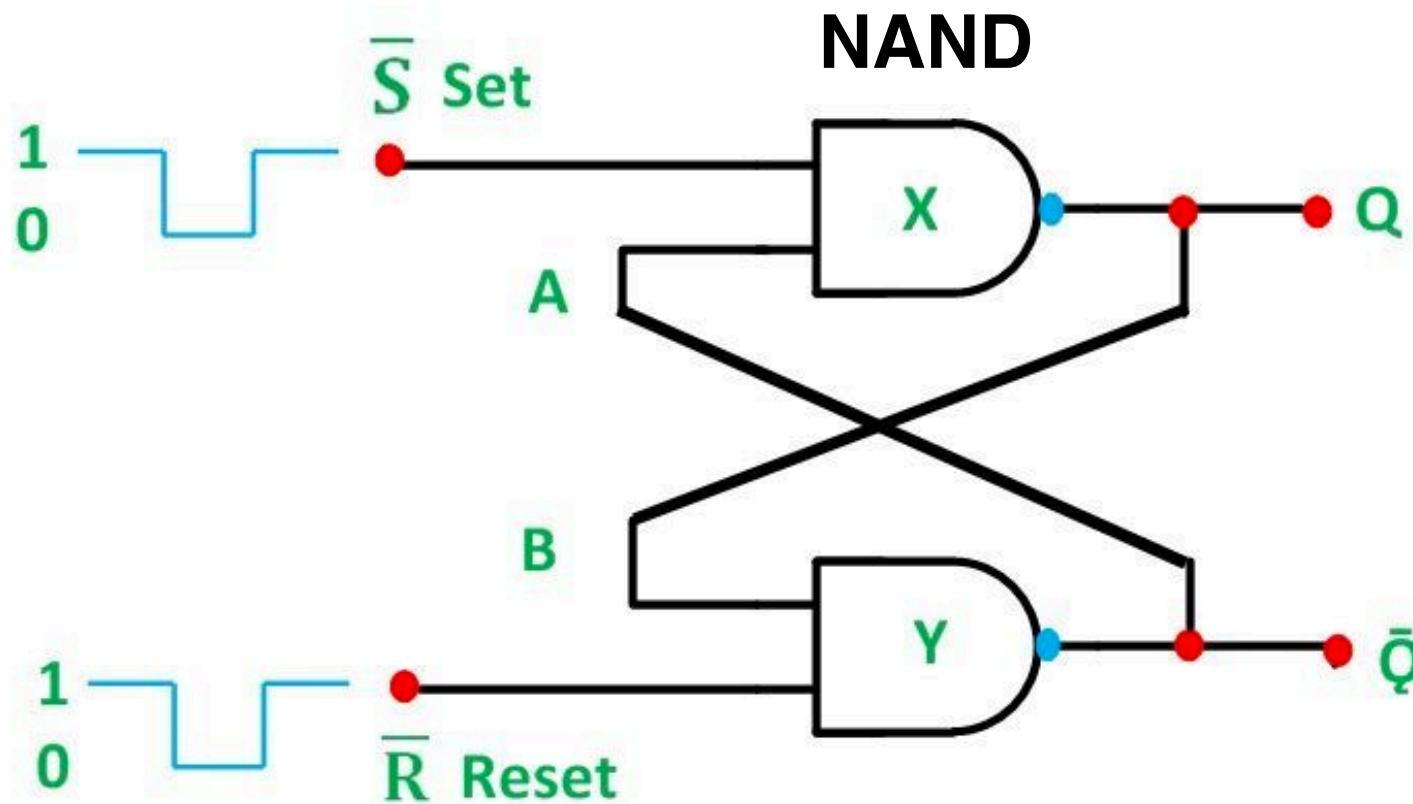


Truth Table

A	B	$\sim(A \cdot B)$
0	0	1
0	1	1
1	0	1
1	1	0

AND, OR, NOT can be built from NAND

RS Flip Flop



Circuit Globe

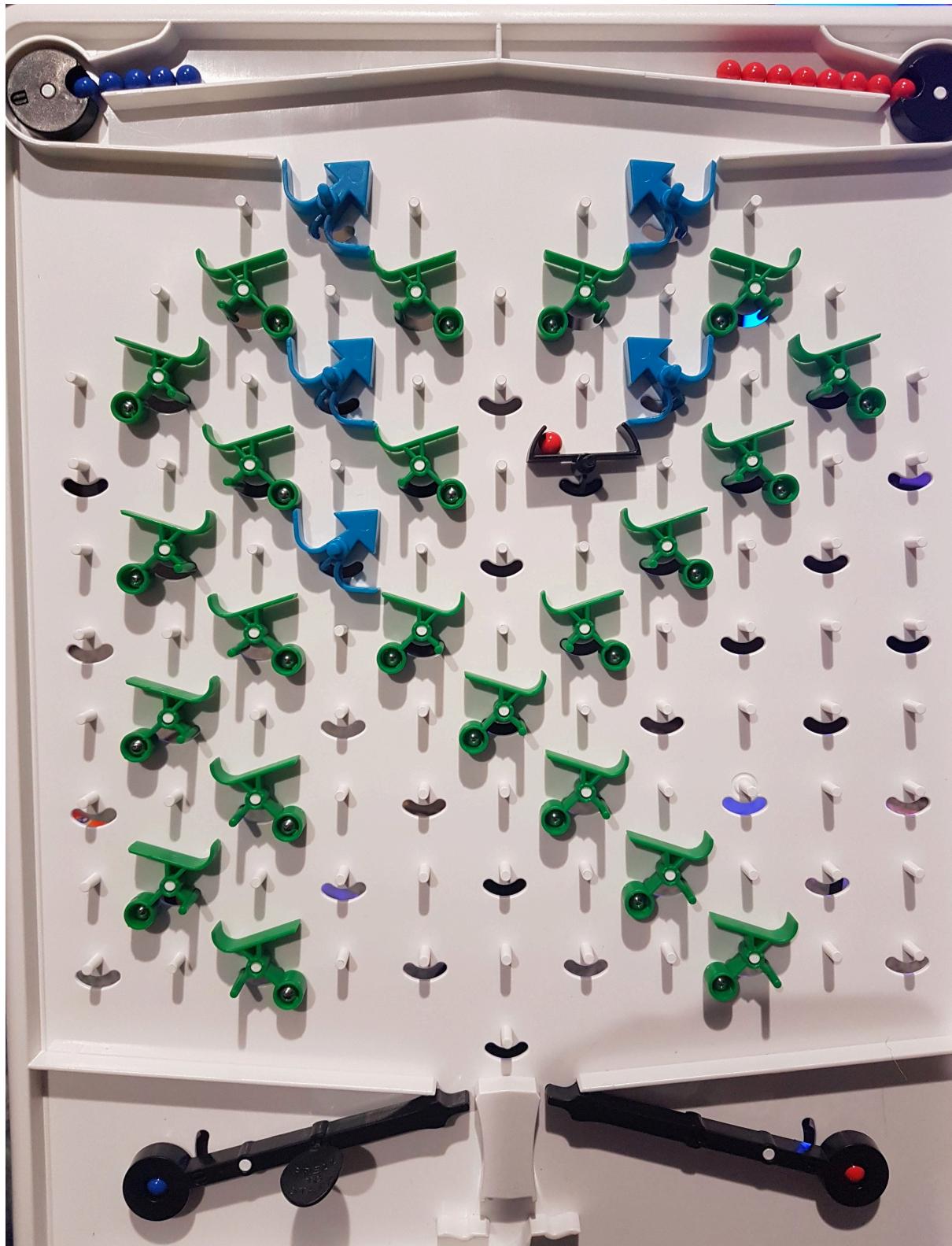
1-Bit Register/Memory

NAND and Register/Memory

are all

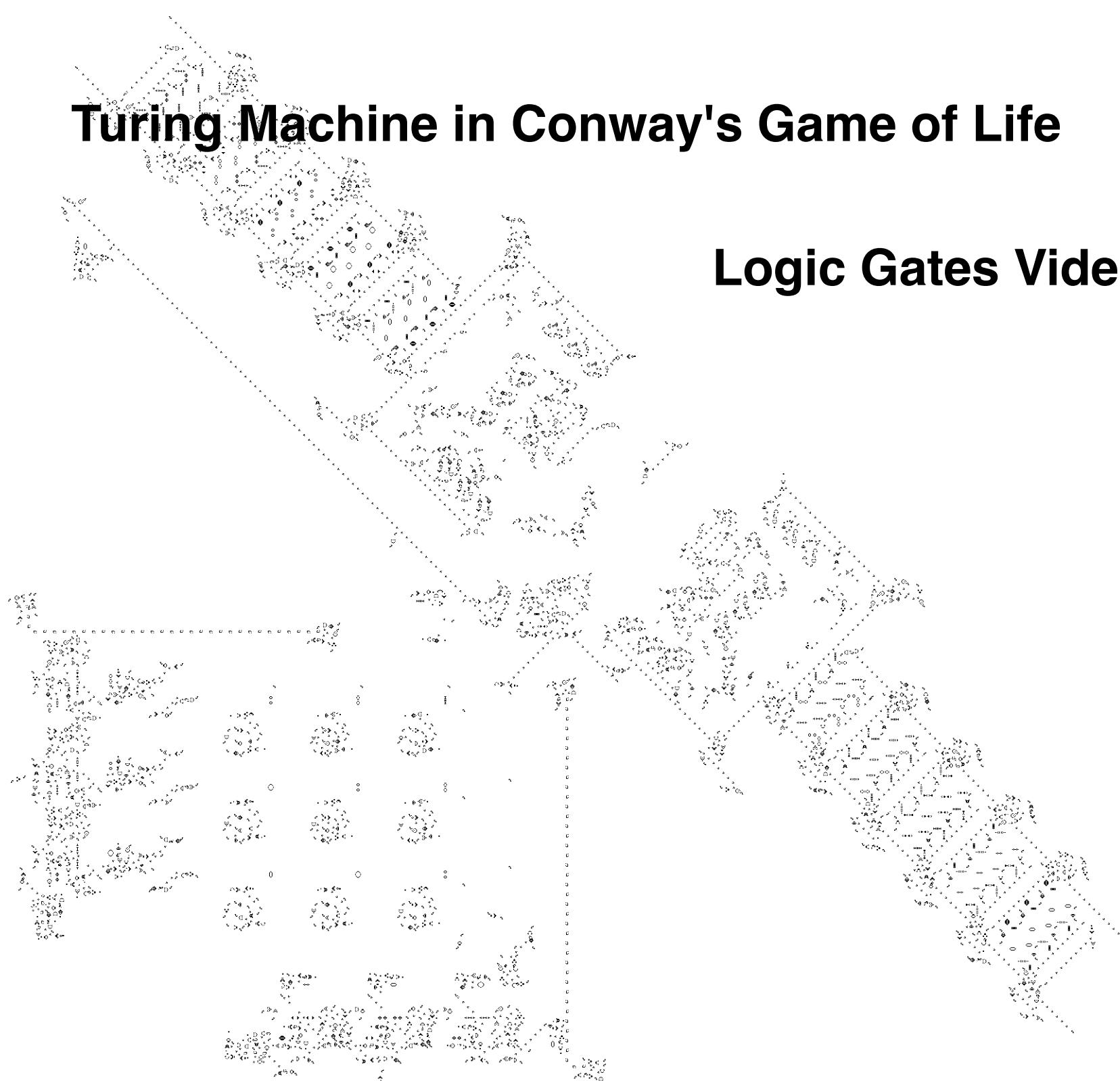
you need to build a computer

Turing Tumble

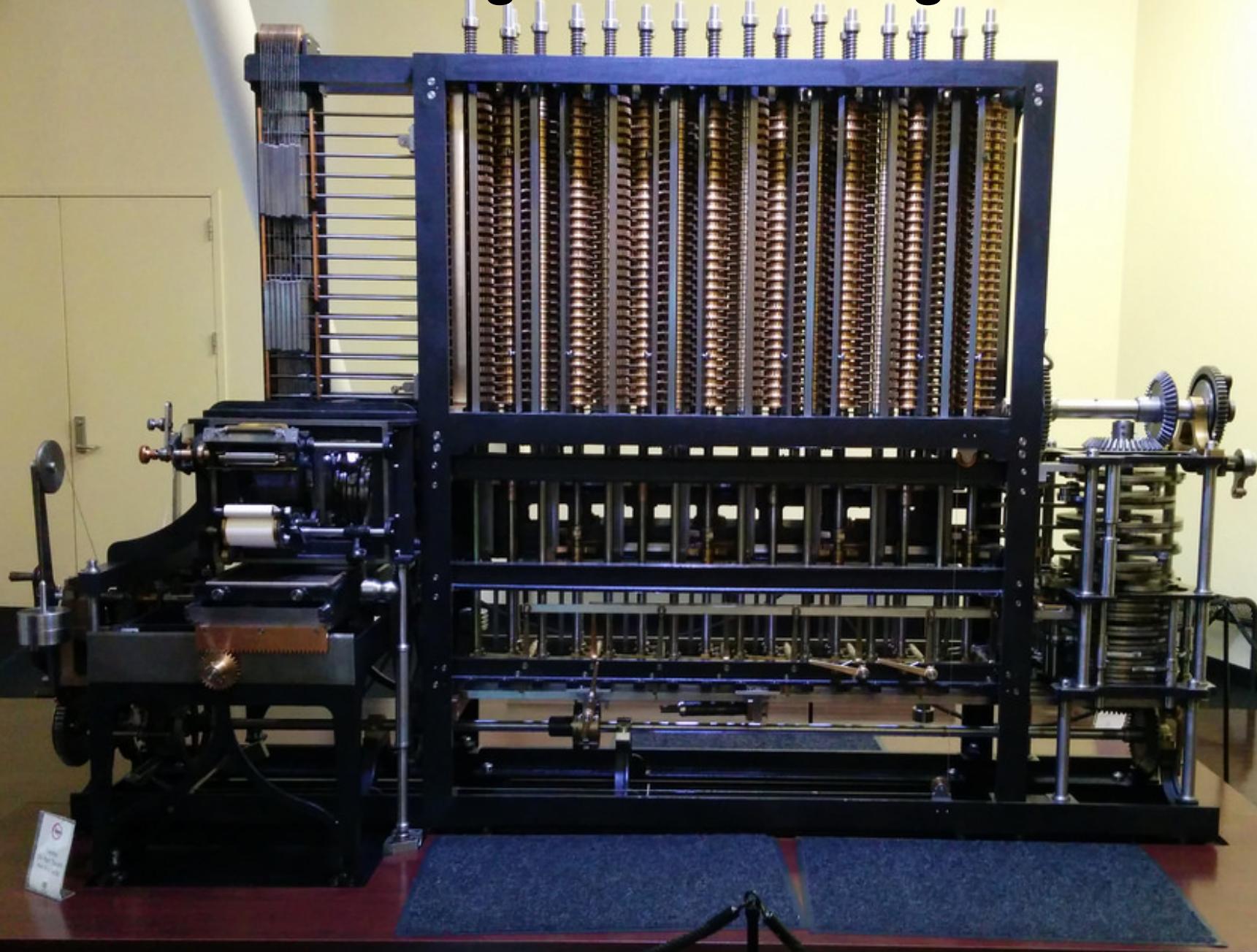


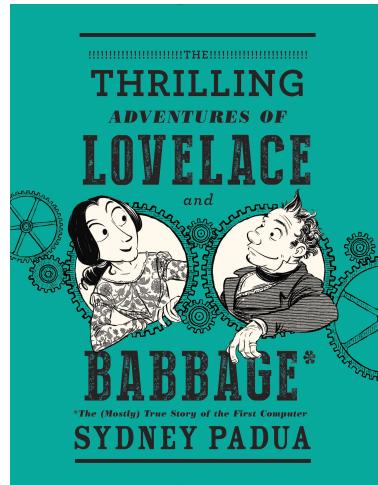
Turing Machine in Conway's Game of Life

Logic Gates Video

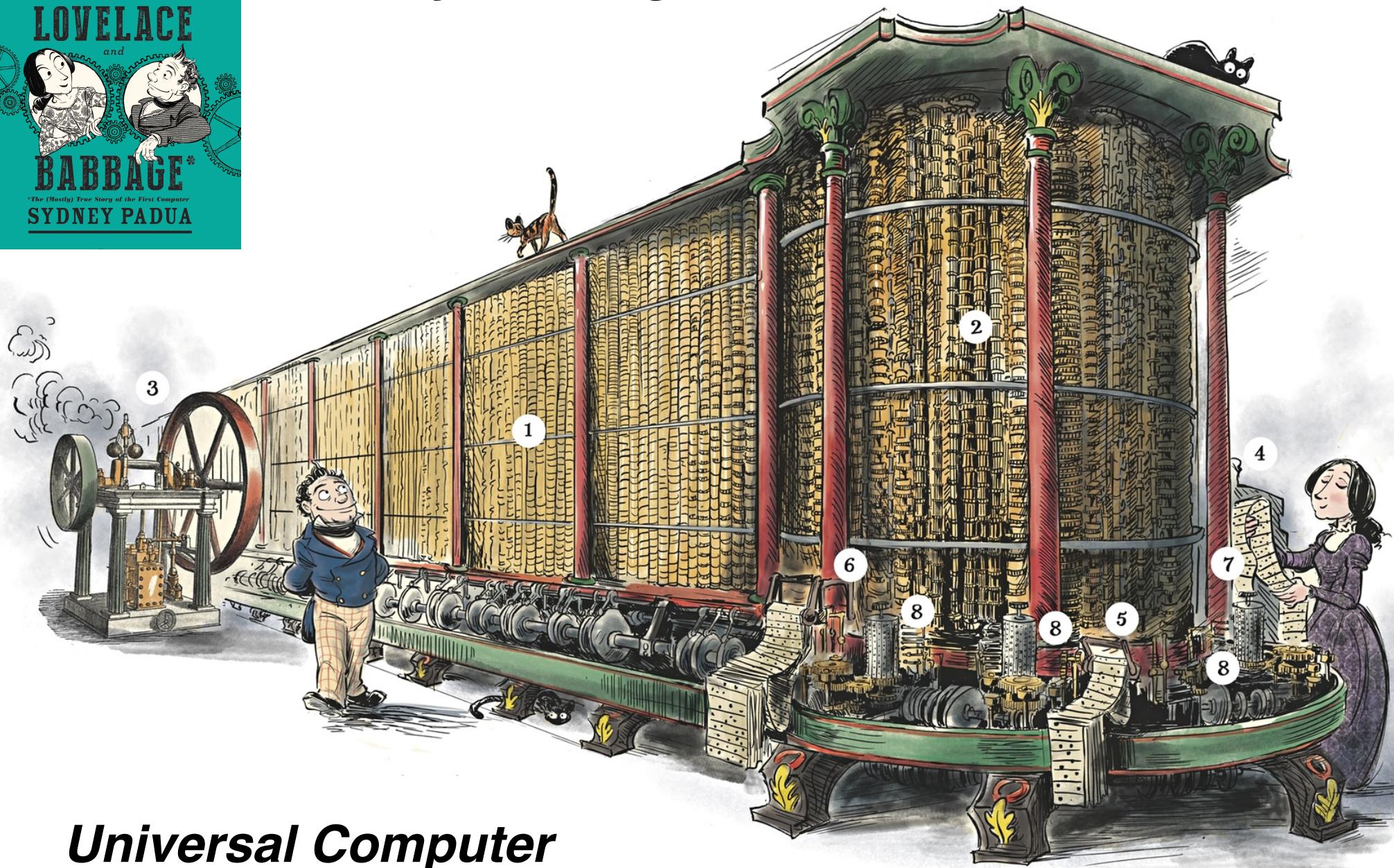


Babbage Difference Engine



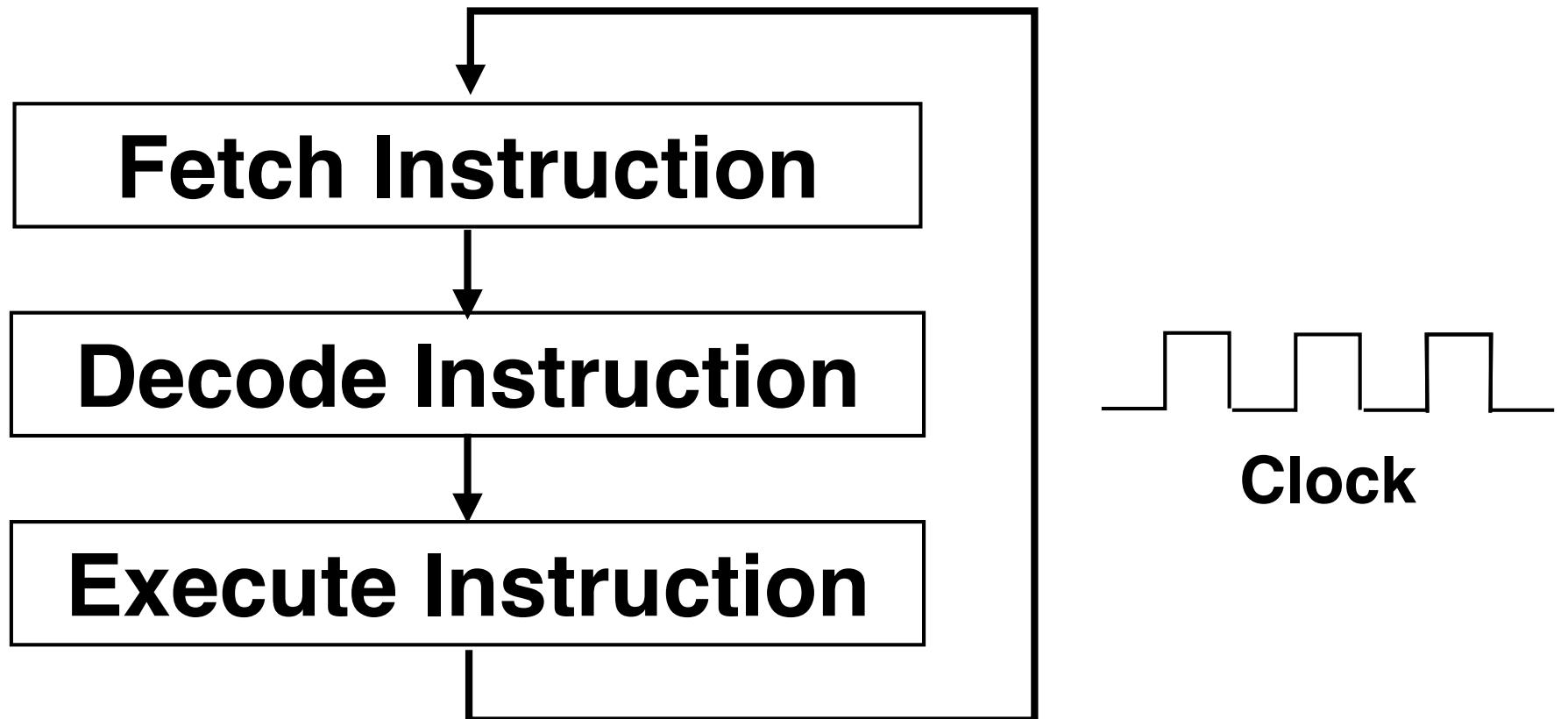


Analytical Engine



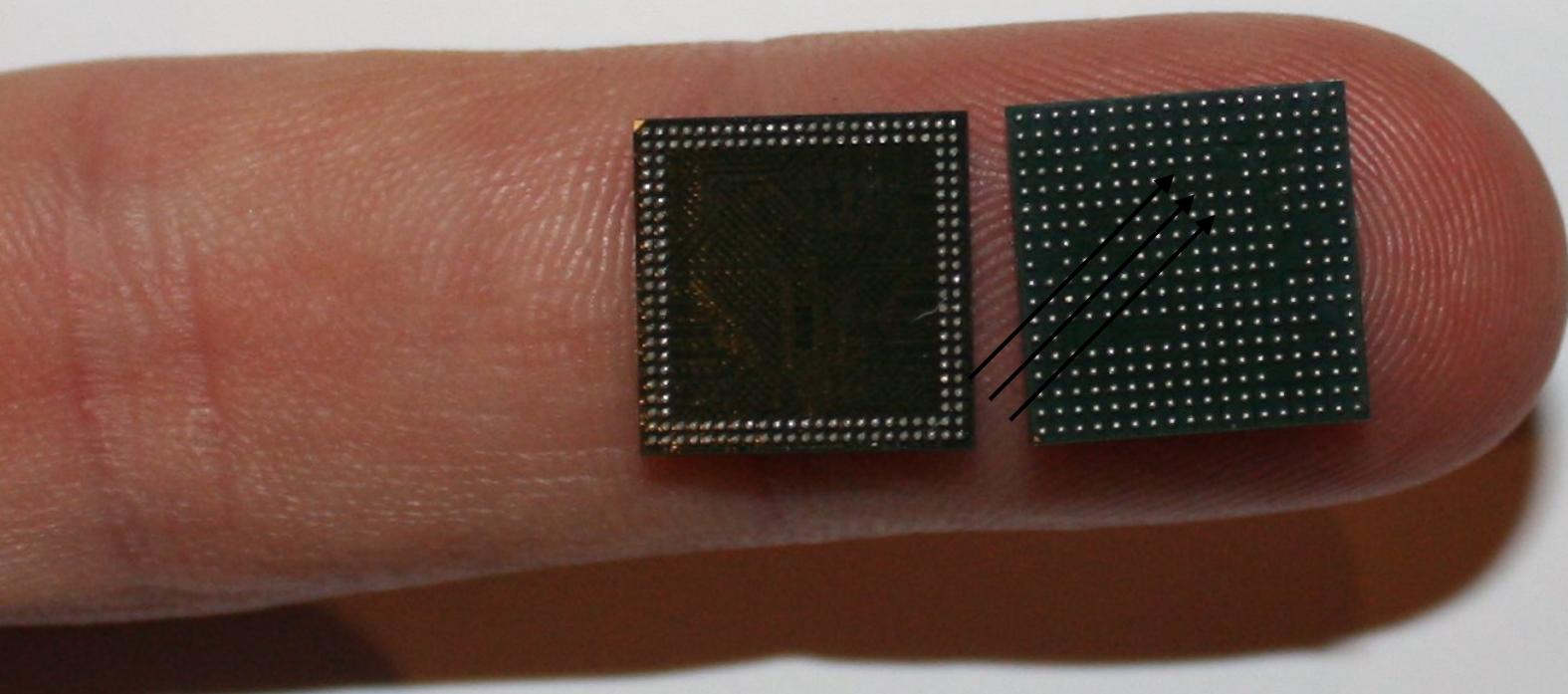
Universal Computer

Running a Program



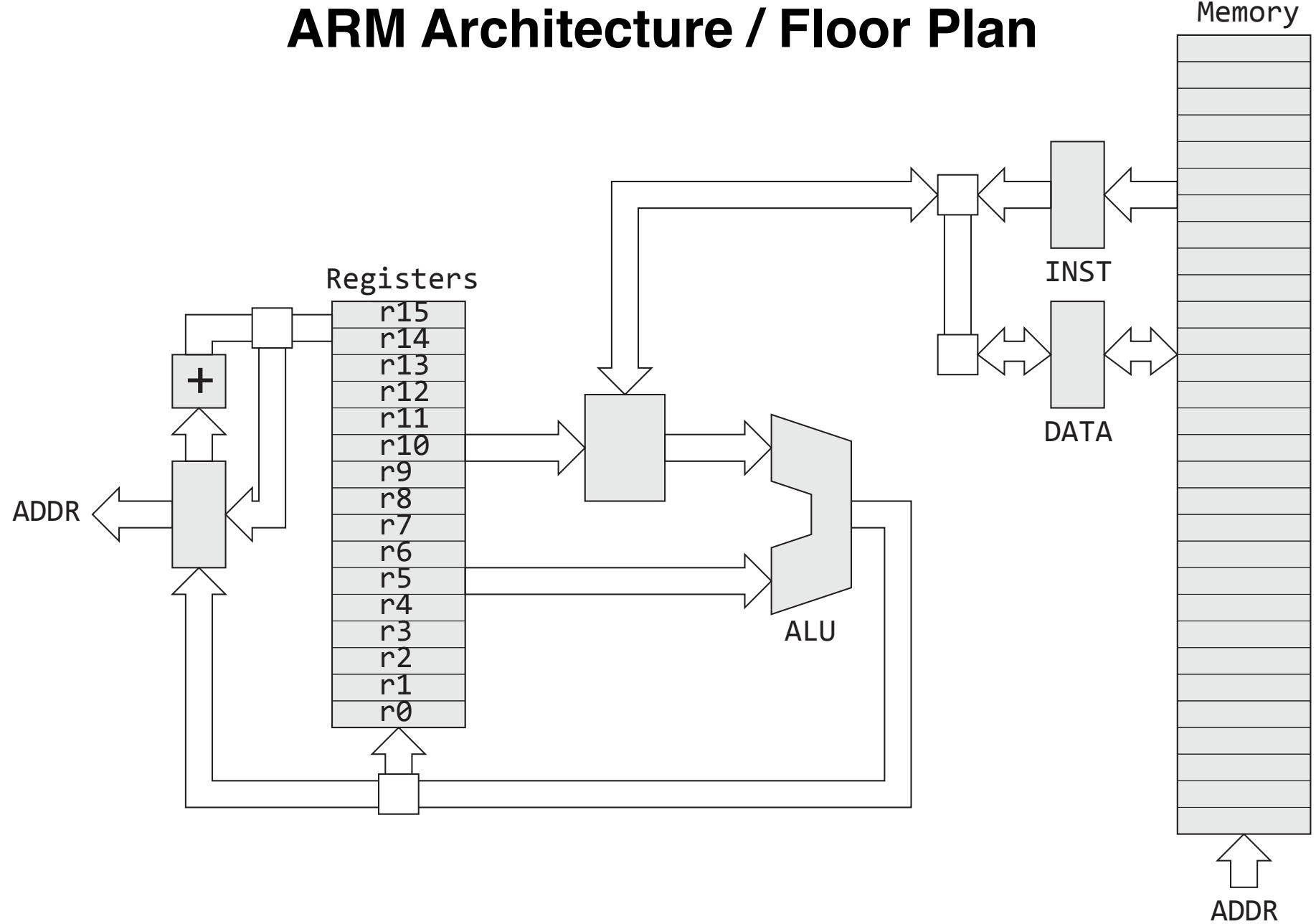
Package on Package

Broadcom 2865 ARM Processor



Samsung 4Gb (gigabit) SDRAM

ARM Architecture / Floor Plan



First Week

Lab 0 on Wed

Pre-lab:

- Install your development environment (follow steps in install guide <http://cs107e.github.io/guides/install>)
- Read and understand our guides on background topics (electricity, numbers, unix)

During lab:

- Establish comfort with background topics
- Practice with environment/tools, habits for productivity
- Meet one another!

Number Representations

Binary representation

Hexadecimal

Bit operators

Guide: <https://cs107e.github.io/guides/numbers/>

Basic Electricity

Voltage and current

Ohms Law : $V = I R$

Power : $P = I V$

Driving an LED

Transistor switches

Breadboarding

Guide: <https://cs107e.github.io/guides/electricity/>

Unix Command Line

Moving around the file system

Creating, moving, and deleting files

Compiling and running programs

Profiles and paths

Guide: <https://cs107e.github.io/guides/unix/>

Note: Watch cs107 UNIX videos!

Essential Tools

git

- **git add/commit/push/pull**

editor

- **vim, emacs, sublime, ...**