CS 100: Bits and Computing

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Week 2-2

Logistics

Homeworks

- HW 1 due now
- HW 2 is up
  - Due next week Friday
  - Code.org plus a few additional exercises
- HW 3 Python programming
  - Will be Posted Next week
  - Make sure you have access to a computer
  - Install Python 3 over the weekend

Mini-Exam

- Next week Thursday
- Last 30 minutes of class
- 1 page, front and back
- Open notes, book, slides
- Stuff like HW 1 and Code.org exercises

Reading

- Pattern Ch 3: Programming
- Zyante Ch 3: Programs and Software
- Start "Think": Ch 1

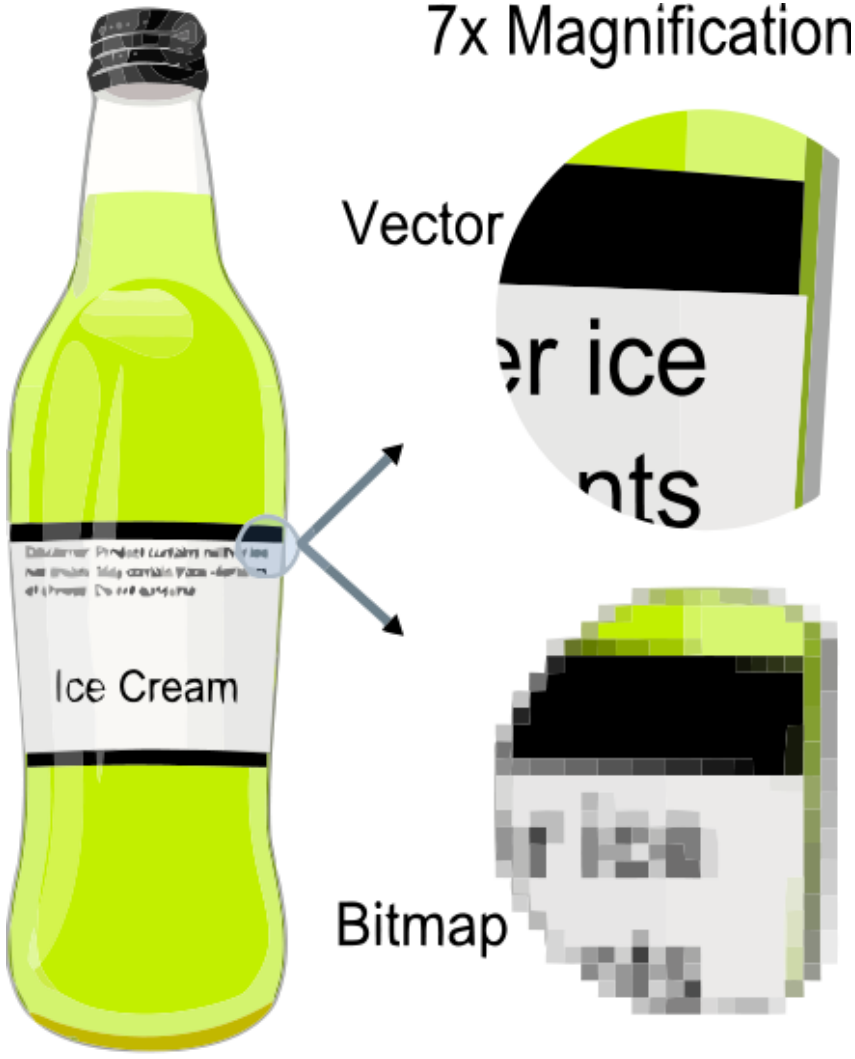
Last Time: Graphics Types

Bitmap/Raster Graphics

- Represent each pixel with some bits (usually color)
- Zooming in causes *pixelation*
- File Types: `gif`, `jpg/jpeg`, `png`, `bmp`, `exif`, `tiff`

Vector Graphics

- Represent drawing instructions for display program to perform
- Scale nicely
- File Types: `svg`, `pdf`, `ps`, `ai`



Source: Wikip "Vector Graphics"

Other Stuff To Represent with Bits

Spend a couple minutes discussing how the following can be represented as bits

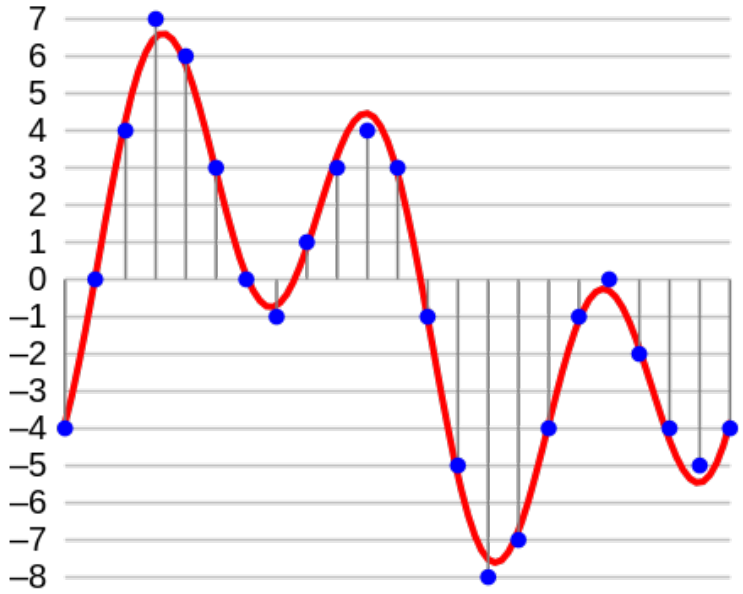
- Documents (Word Doc / PDF)
- Sound (music, audio recordings)
- Movies

Documents

- PDF and DOC/DOCX files are a combination of vector graphic instructions and raster graphic displays
- Contain bit instructions of what characters to put where
- Also contain bit instructions to place raster images at certain locations AND the bits for those images
- Be aware: `Myfile.docx` is a collection of bits usually interpreted by Microsoft Word but they could be interpreted by something else

Sound

- Changes in vibration level give rise to different sounds
- Record large number of samples per second
- Sample indicates the strength of vibration at that moment
- Encode vibration strength with fixed number of bits



Zyante Exercise 2.2.4

- Vibration level is encoded with 8 bits (1 byte)
- Sample 48,000 times per second (48 KHz)
- For 2 minutes of audio, how many bytes are required?
- How many levels of "loudness" are there for 1 byte?

Movies

- Show a series of pictures in rapid succession
  - Frames Per Second
- Add sound to changing pictures $\rightarrow$ Movies
- Combine techniques from Pictures and Sound
- Moves contain LOTS of data, compression is important to make the size managable
- Key observation: not everything changes from picture to picture nor from sound to sound

Some weeks from now...

- Discuss compression: make files smaller
- Algorithms for doing compression
- Effects on image, sound, text quality

Computing with Bits

- Humans often want a pretty way to see bits like characters or pictures on a screen
- Humans interpret those things readily
- Most of what computers do is modify bits internally
- How the modification happens depends on how the computer works
- All computers implement some sort of Boolean Logic which is an abstract way to talk about bit changes

Boolean Logic

- Deals with True and False values: Bits are True and False!
- Combine values of variables with boolean functions
- Usually AND OR NOT
- Describe function output using truth tables

NOT with Booleans

A	NOT A
True	False
False	True

NOT with Bits

A	NOT A
1	0
0	1

OR with Bits

A	B	A OR B
1	1	1
1	0	1
0	1	1
0	0	0

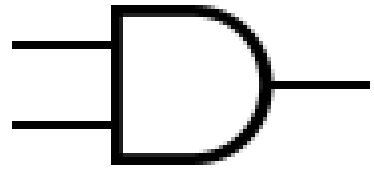
AND with Bits

A	B	A AND B
1	1	1
1	0	0
0	1	0
0	0	0

Logic Gates

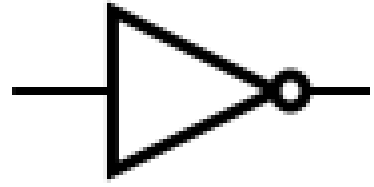
Abstract physical device that implements a boolean function

- AND Gate implements AND function (2 inputs, 1 output)



- OR Gate implements OR funtion (2 inputs, 1 output)

- NOT Gate implements NOT function (1 input, 1 output) Also called an INVERTER

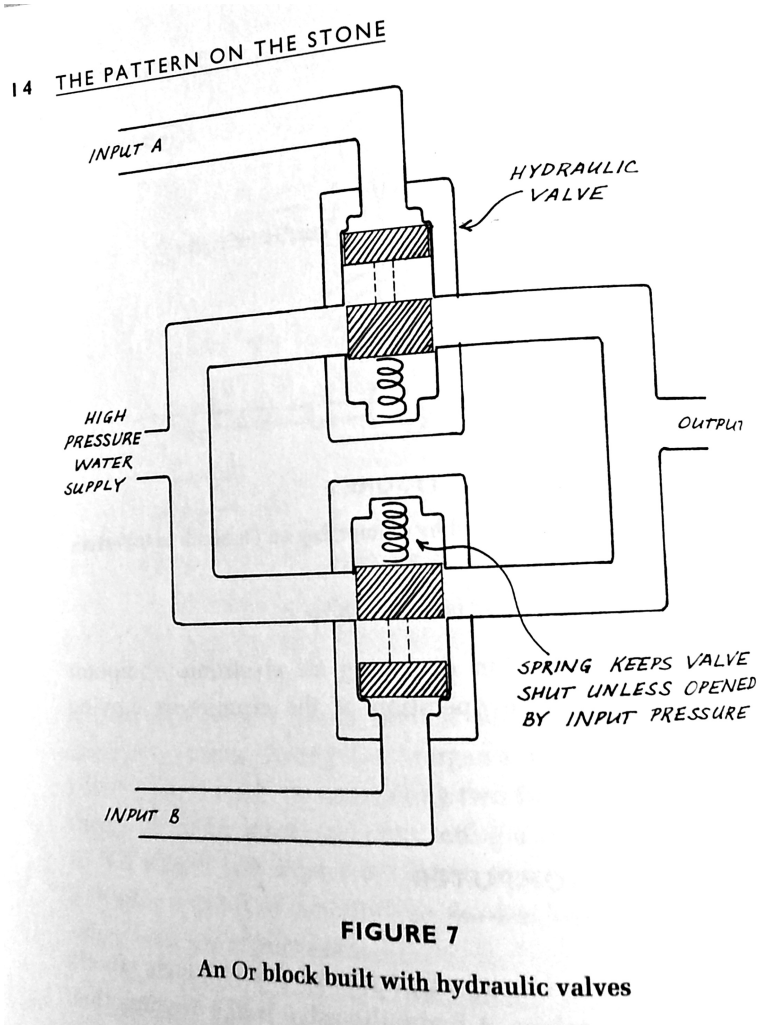


Different Means of Implementing Gates

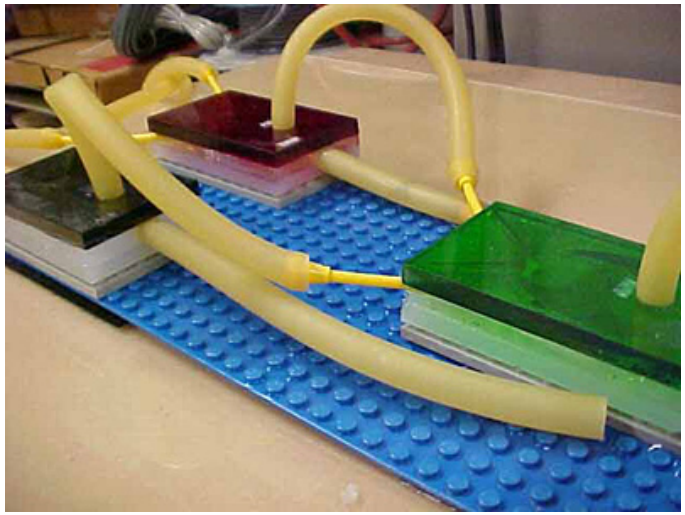
There are lots of ways to implement gates, some described in your textbook. What are some ways?

Water Gate

"Pattern" Water Gate



4-bit Adder Using Water



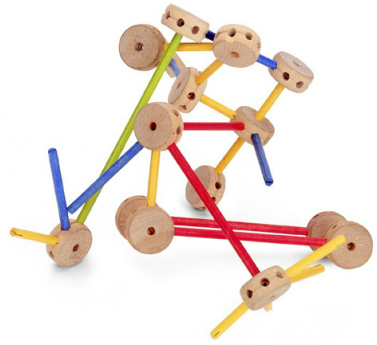
Source

This is how the 4-bit adder looked like, after many (I mean, many!) hours of wet work. If you think programming a computer is hard, just imagine what it would be if your bits were leaking all over the place.

- Paul Blikstein, MIT Media Lab, Programmable Water

Tinker Toy Gates

Logic implemented using Tinker Toys



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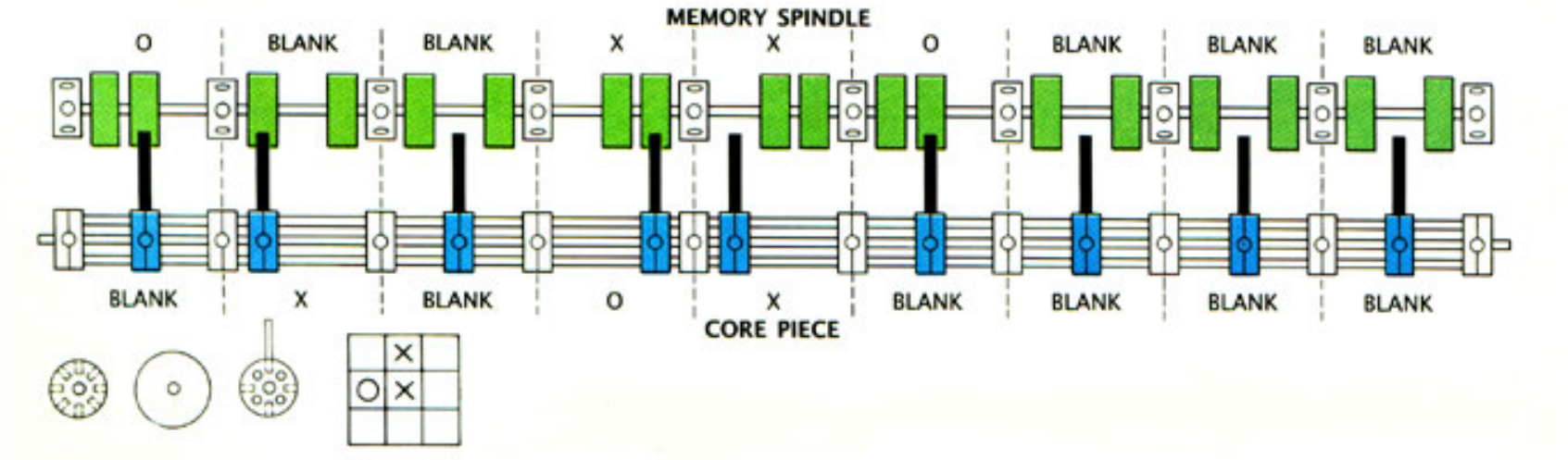

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Tinker Toy "Computer"

This thing plays TicTacToe

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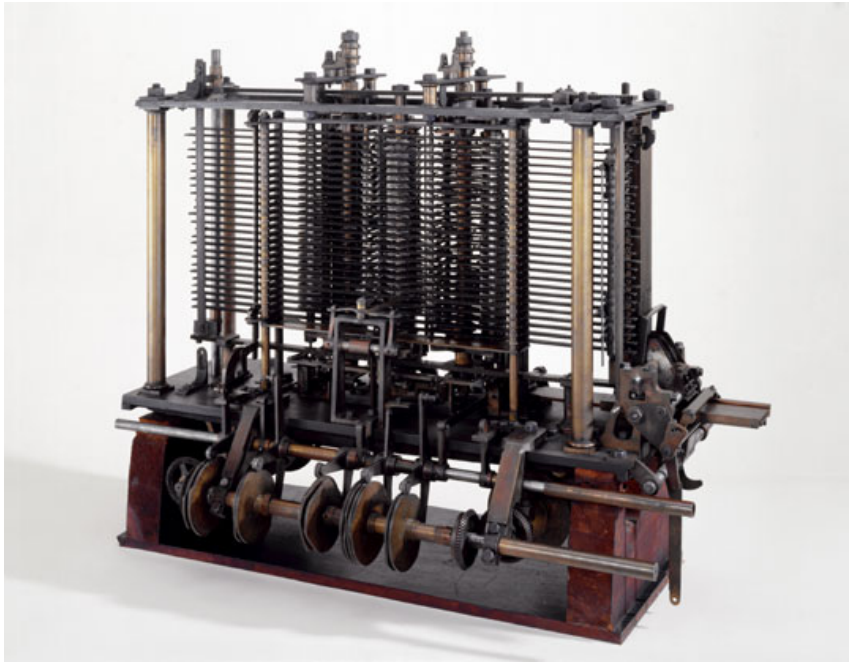
Gates of Yesterday and Today

Initially

Mechanical Gates, Clunky, Slow, but Impressive

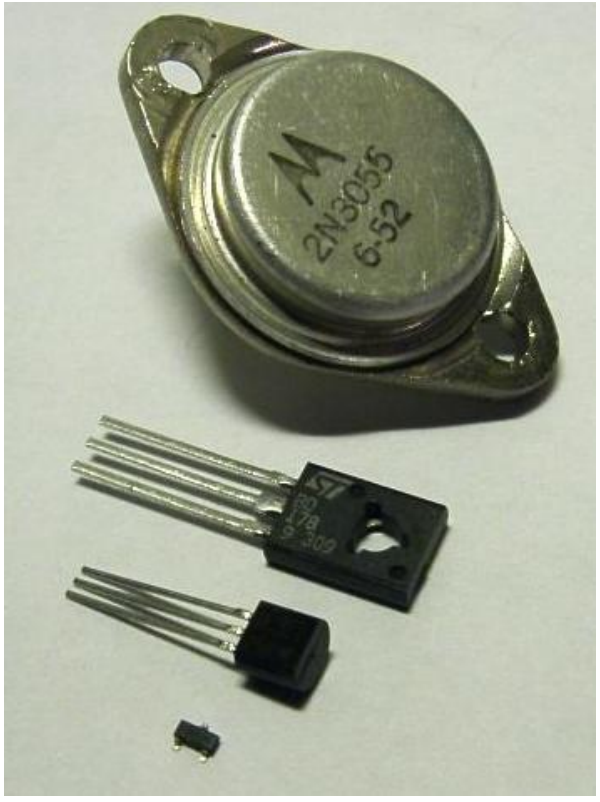
Babbage's Analytical Engine



Source: Science Museum, London

Nowadays

Gates are mainly implemented using electricity running through transistors. Fast, like speed of light fast...



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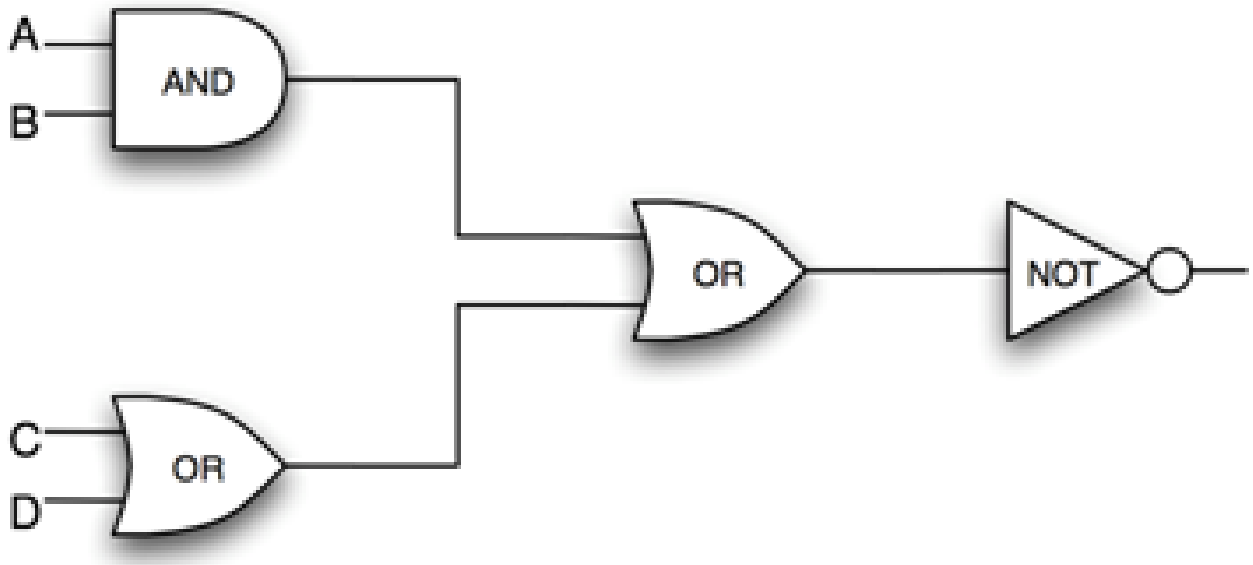
Example of Gates Strung together

A	B	C	D	A AND B	C OR D	AB OR CD	NOT
0	0	0	0	0	0	0	1
0	0	0	1	0	1	1	0
0	0	1	0	0	1	1	0
0	0	1	1	0	1	1	0
0	1	0	0	0	0	0	1
				....	...	...	...



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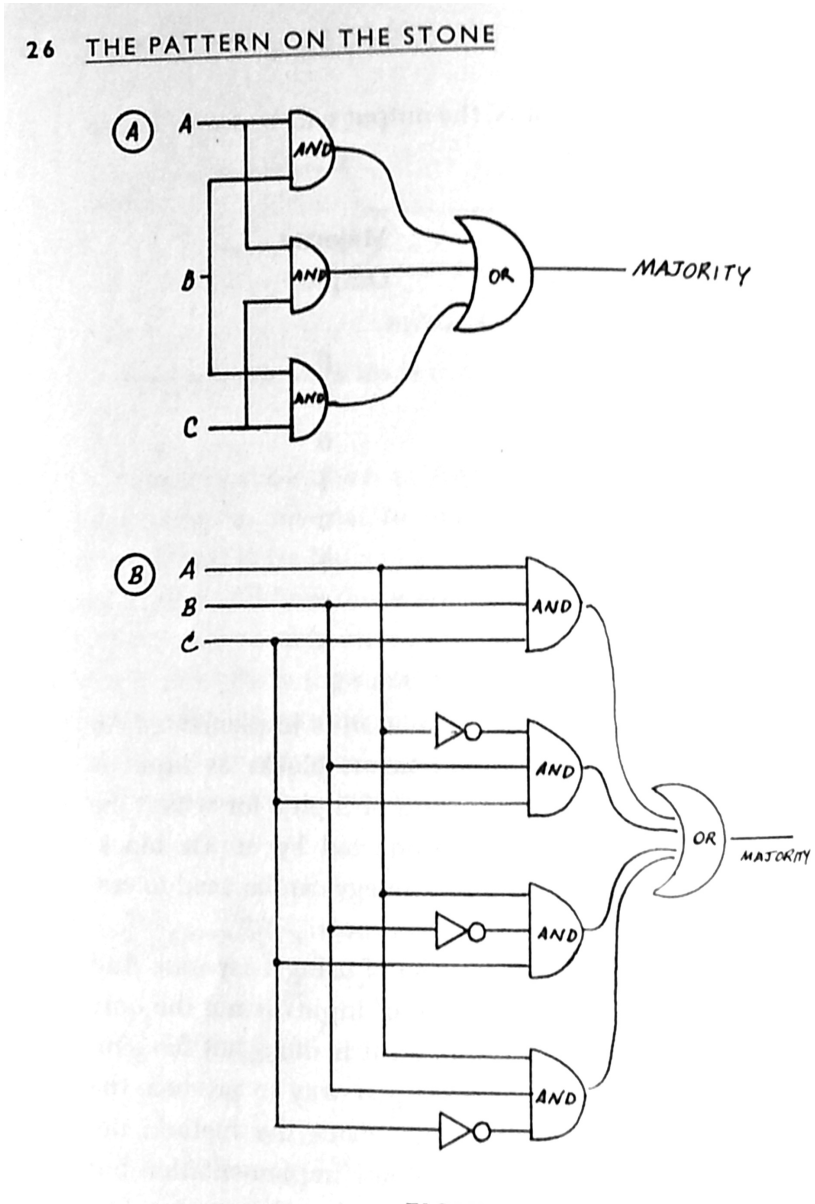
Gates That "Do" Stuff

Majority True

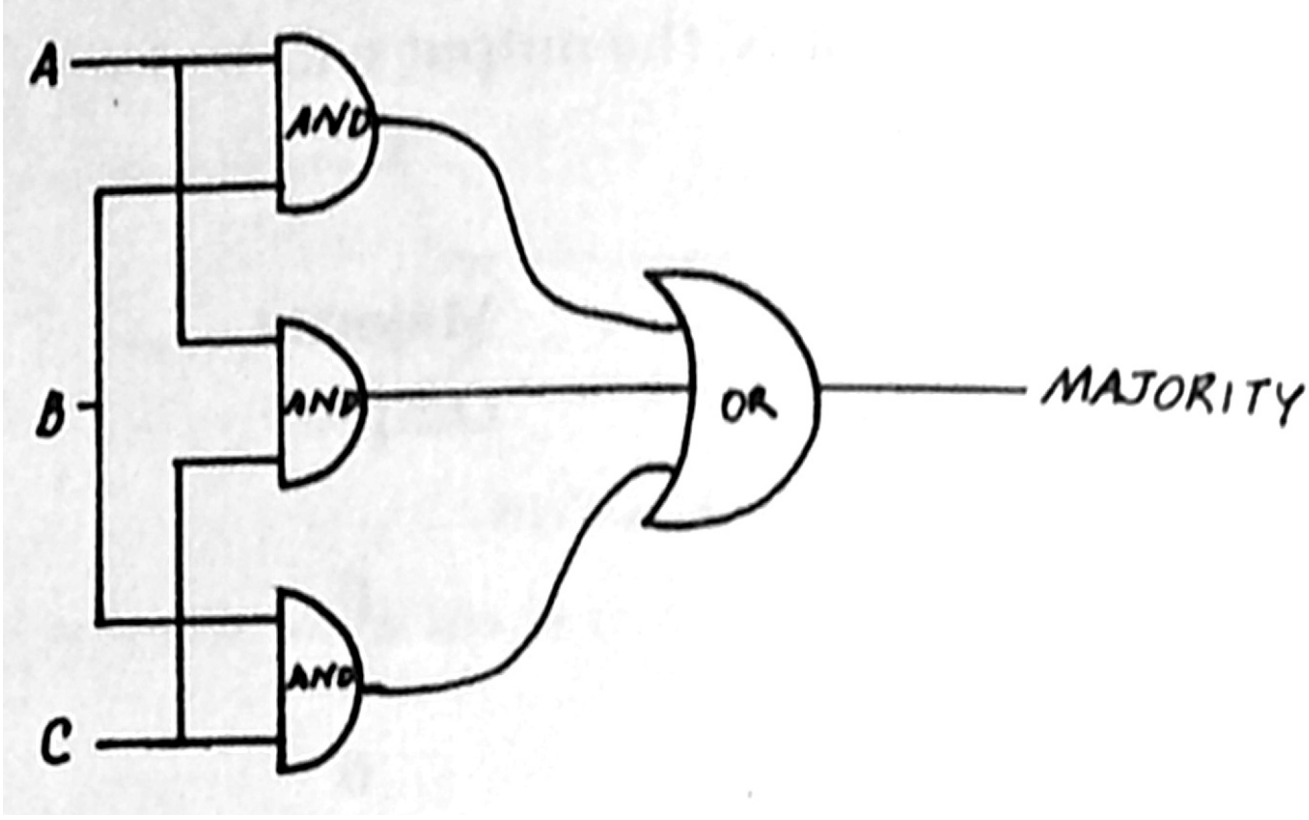
True when the majority of 3 inputs is true

- Inputs called A, B, C
- Two designs given in "Pattern"
- Upper design uses AND and OR gates
- Lower uses AND, OR, NOT gates
- Which is *better*?



Interpretting Majority

- Try all possible inputs for A, B, C
- Calculate the "Truth Table" for the circuit



Next time

- Python programming
- Turtle art
- Be working on HW2 Code.org exercises