How AI Works & Why You Are Important

(in 45 minutes)

Lisa Yan

(with slides from Chris Piech)

Announcements

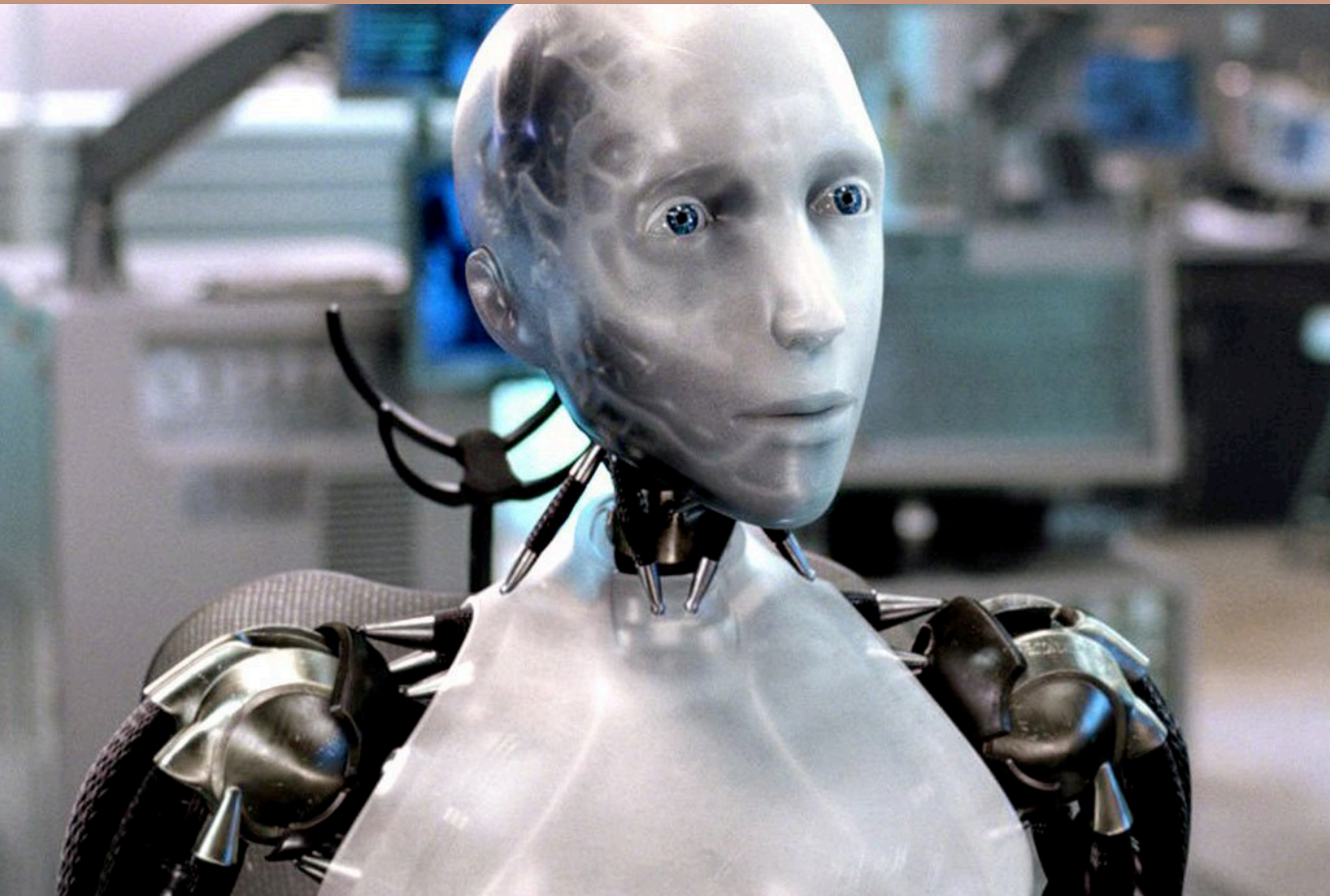
- Final Project due at 6pm!

- Ceren's user study:
  - Consent forms will be handed out Lab 3
  - Email to come soon (with instructions)
  - Do this AFTER you've submitted your project ☺

- CS Bridge exit survey: fill out during Lab 3

Where is my robot?

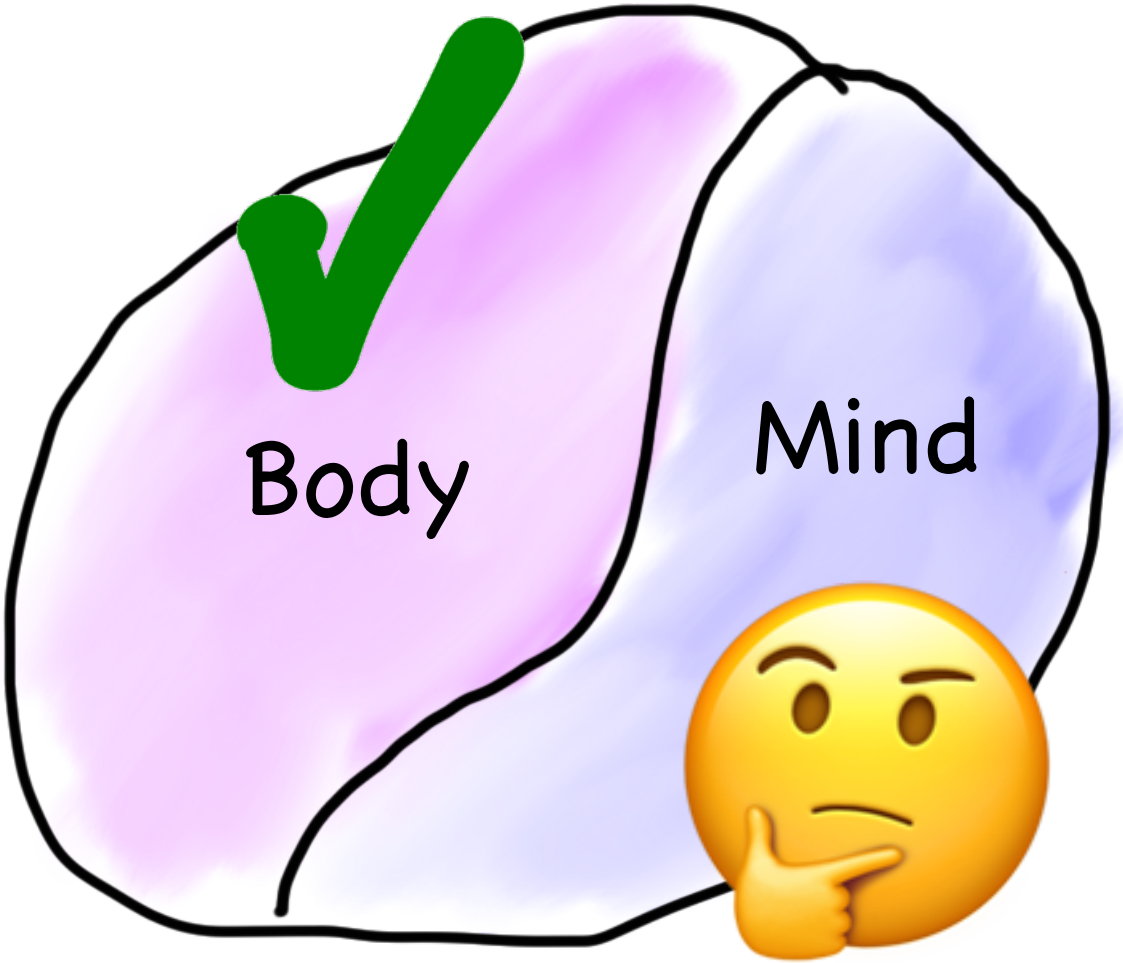
Sci-Fi Has Promised Me Robots



House Cleaning Robot

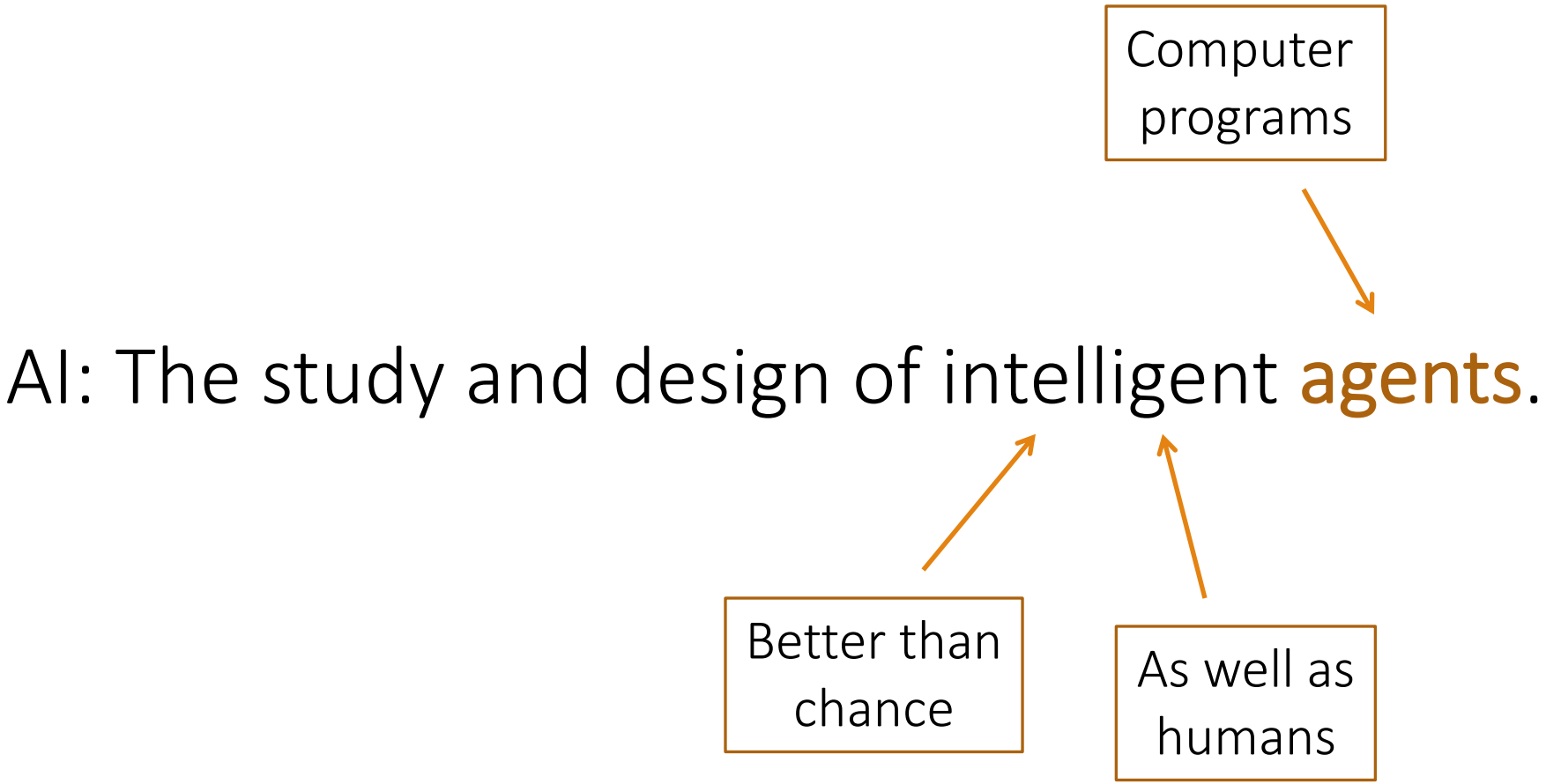
House Cleaning Robot

Robots?

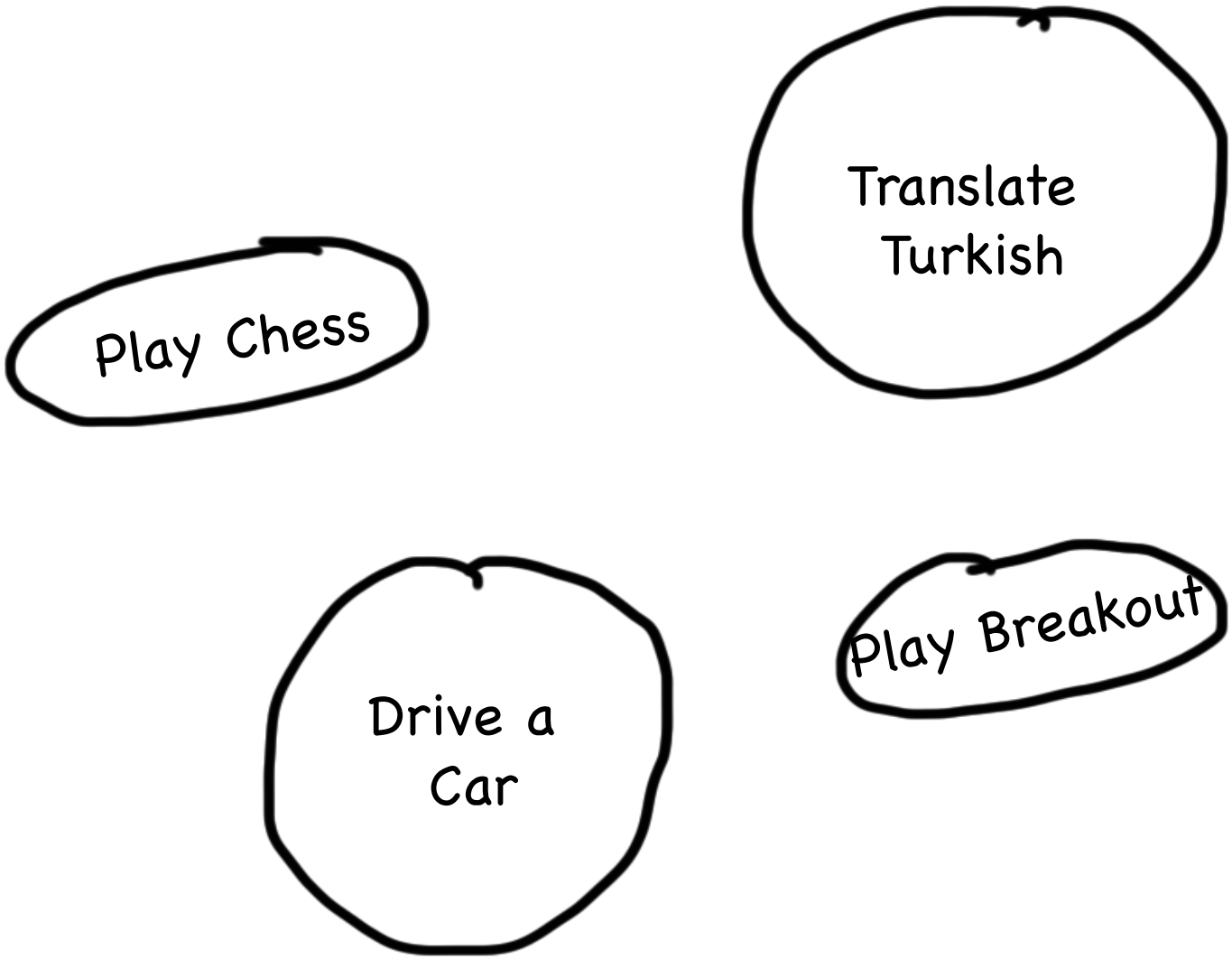


What is AI?

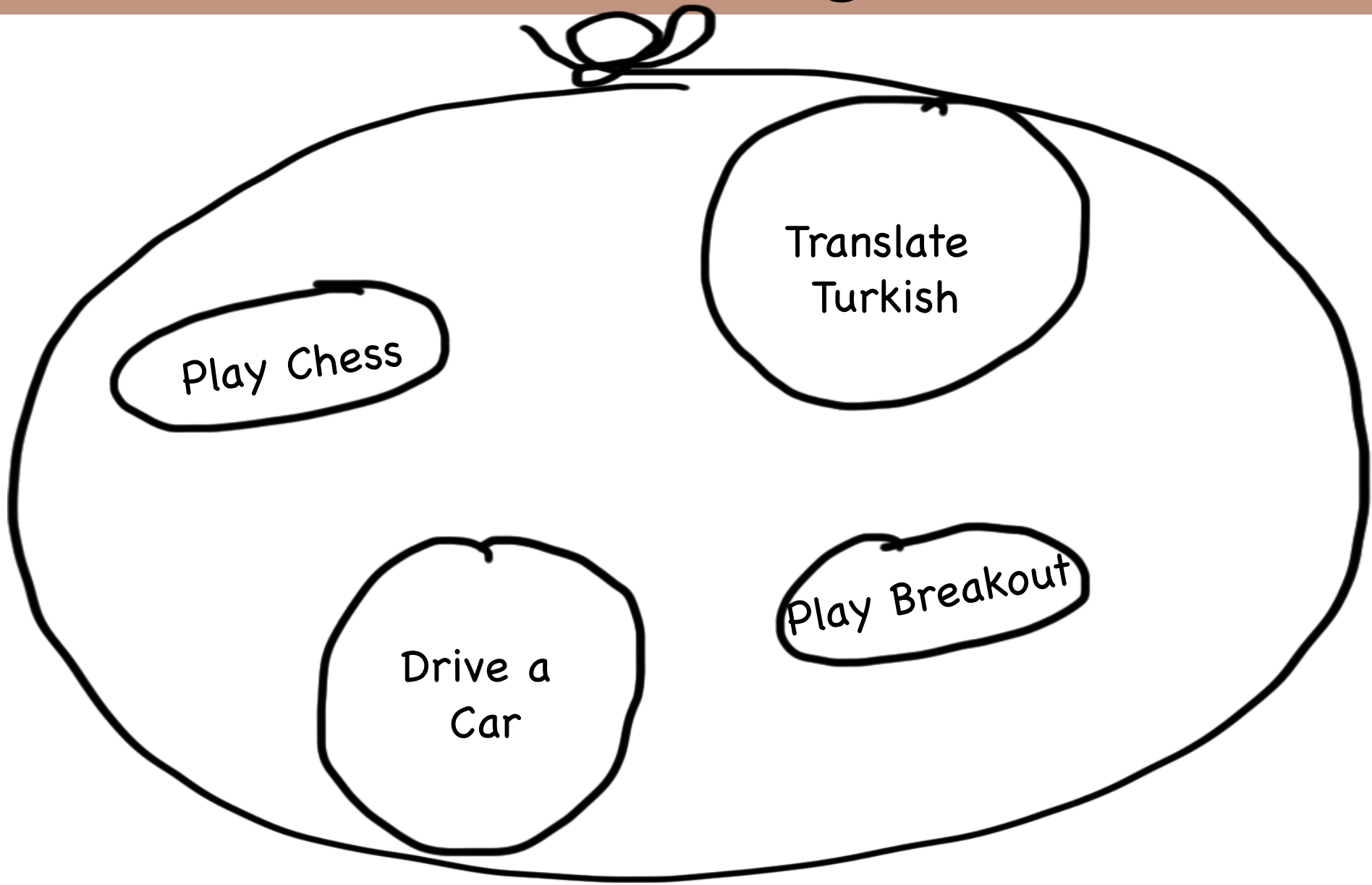
[suspense]


Computer programs
AI: The study and design of intelligent agents.
Better than chance
As well as humans

Narrow Intelligence



General Intelligence



Brief History

Early Optimism 1950s

1952

Early Optimism (1950s)

"Machines will be capable, within twenty years, of doing any work a man can do."

–Herbert Simon, 1952

Underwhelming Results (1950s–1980s)

The spirit is willing but the flesh is weak.

↓

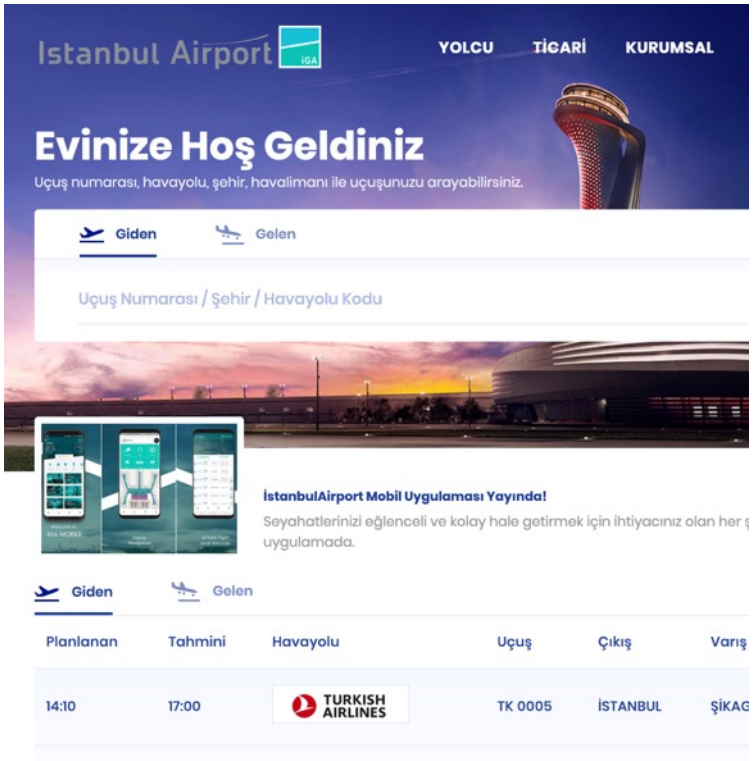
(Russian)

↓

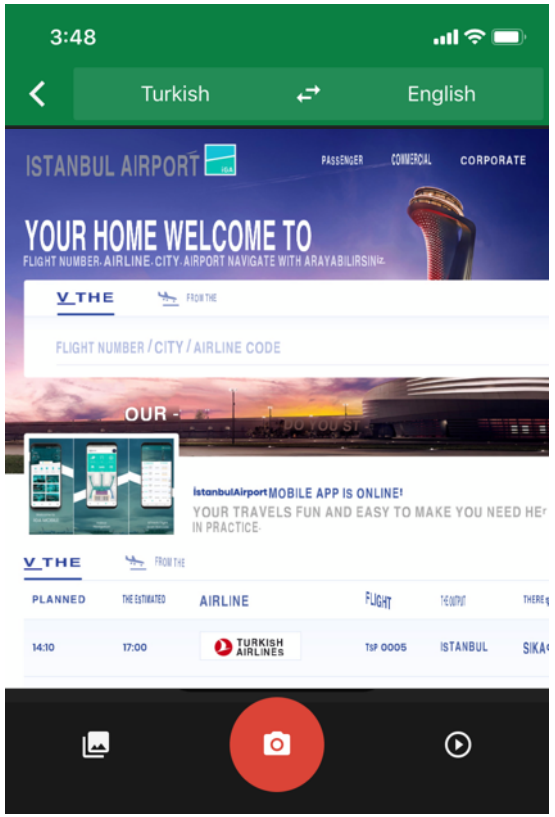
The vodka is good but the meat is rotten.

The world is too complex!

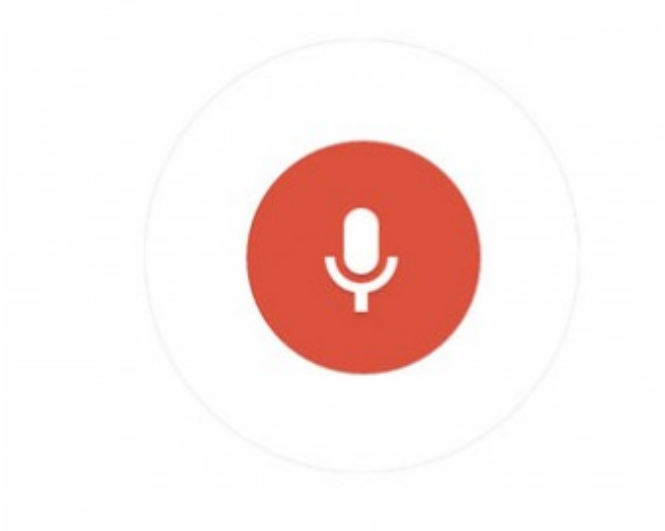
Modern Game of AI

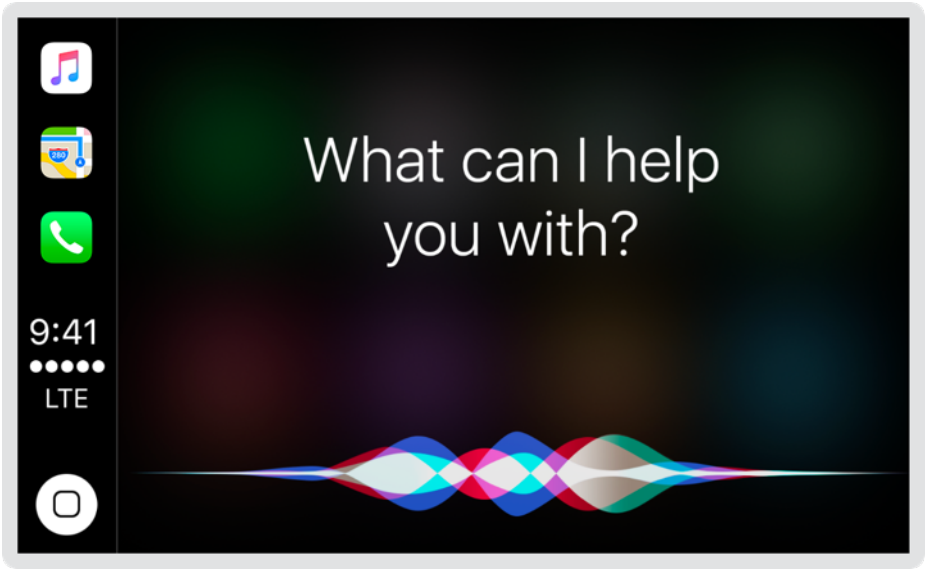


2014



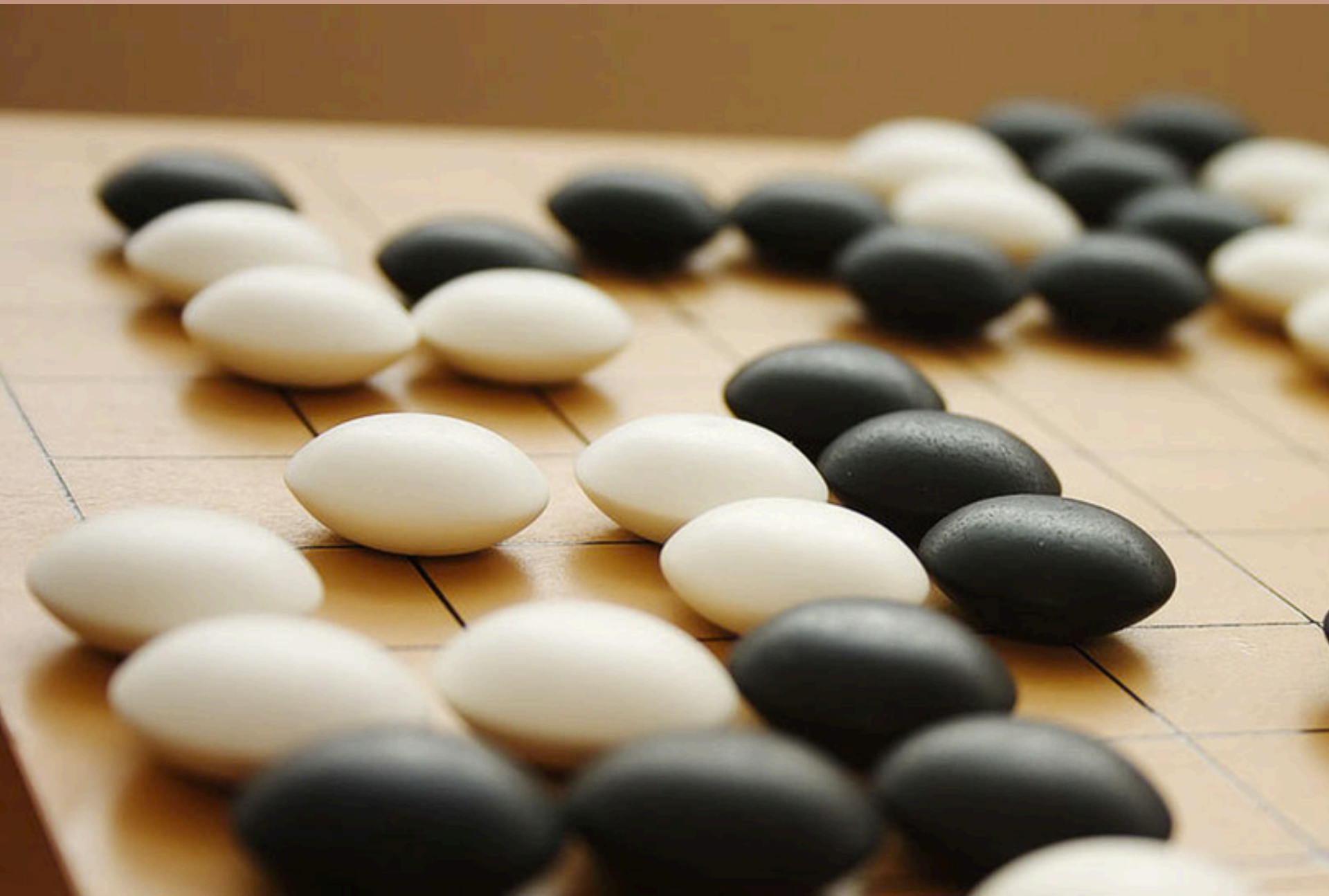
Told Speech Was 30 Years Out



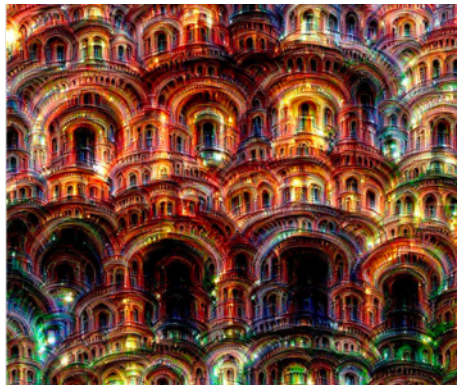


Almost perfect…

The Last Remaining Board Game



Computers Making Art



Self-driving Cars

What is going on?

[more suspense]

Story of Modern AI:

Focus on one problem

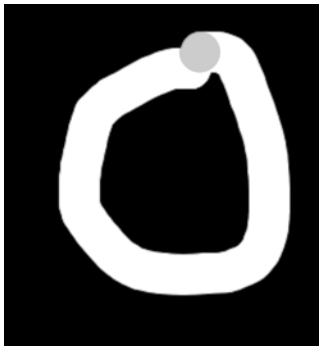
Make a Harry Potter Sorting Hat

Classification

That is a picture of a one

Classification

That is a picture of a zero



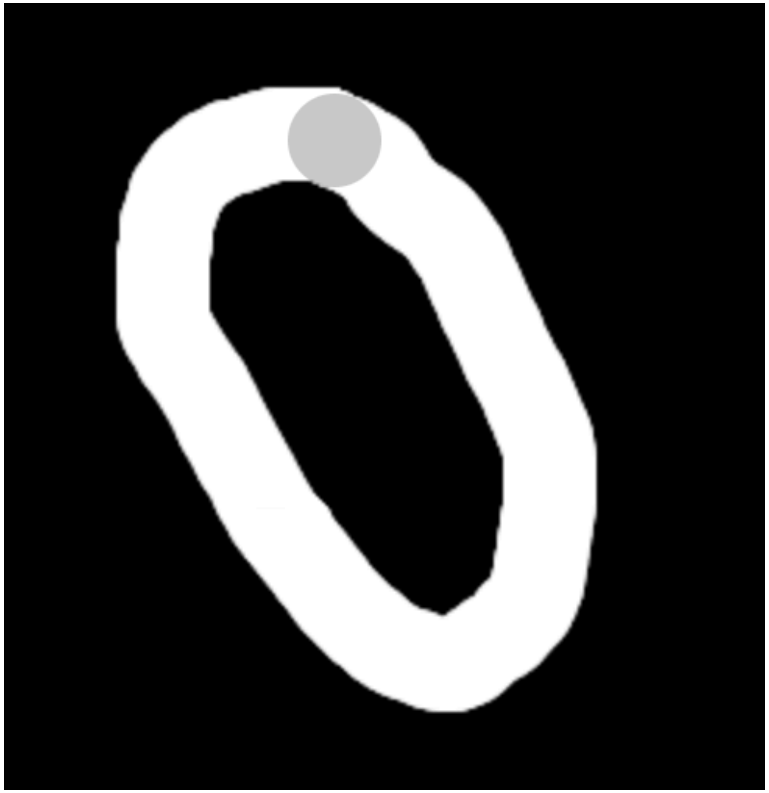
Classification

That is a picture of an **zero**

* It doesn't have to be correct all of the time

Can you do it?

What number is this?



What number is this?

How about now?

What a computer sees

0	0	1	0	1	0	1	0	0	0	1	1	1	0	1
1	0	0	1	0	1	1	1	0	1	0	0	0	0	0
1	1	1	0	1	0	0	1	1	0	0	1	0	1	0
1	1	1	1	1	0	0	0	0	0	1	1	0	1	1
0	0	0	1	1	0	0	1	0	0					
1	0	0	1	1	0	0	0	1	0					
1	1	0	1	1	0	0	1	1	0					
1	0	1	0	0	1	0	0	1	0					
0	0	0	0	1	0	1	0	1	1					
0	1	1	0	0	0	0	0	1	1					
0	0	1	0	1	1	1	0	0	0					
0	1	1	1	0	1	0	0	1	0					
1	1	0	0	0	0	0	0	0	0					
0	0	0	0	0	0	0	0	1	1					
0	0	1	1	1	0	1	0	1	1					

What a human sees

Why is it easy for Humans?

About 30% of your cortex is used from vision
3% is used to process hearing

Very hard to Program


```
public class HarryHat extends ConsoleProgram {

    public void run() {
        println("Todo: Write program");
    }

}
```

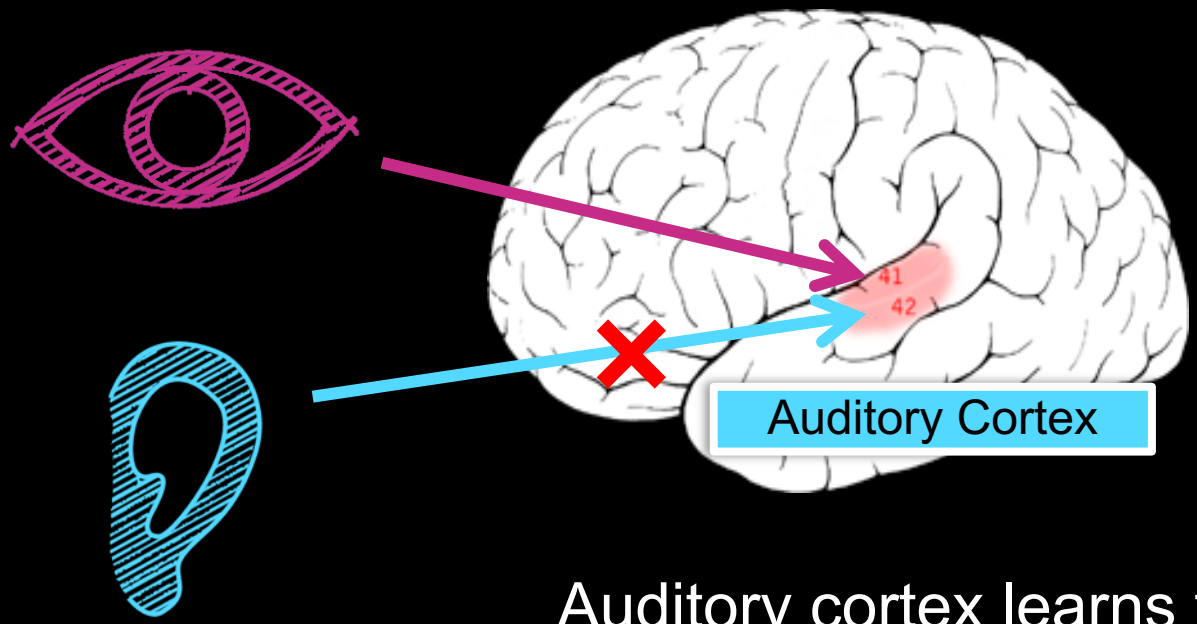
Perhaps there is an insight?

One Algorithm Hypothesis

Much of perception in the brain can be explained with a single learning algorithm.

[Andrew Ng]

One Algorithm Hypothesis

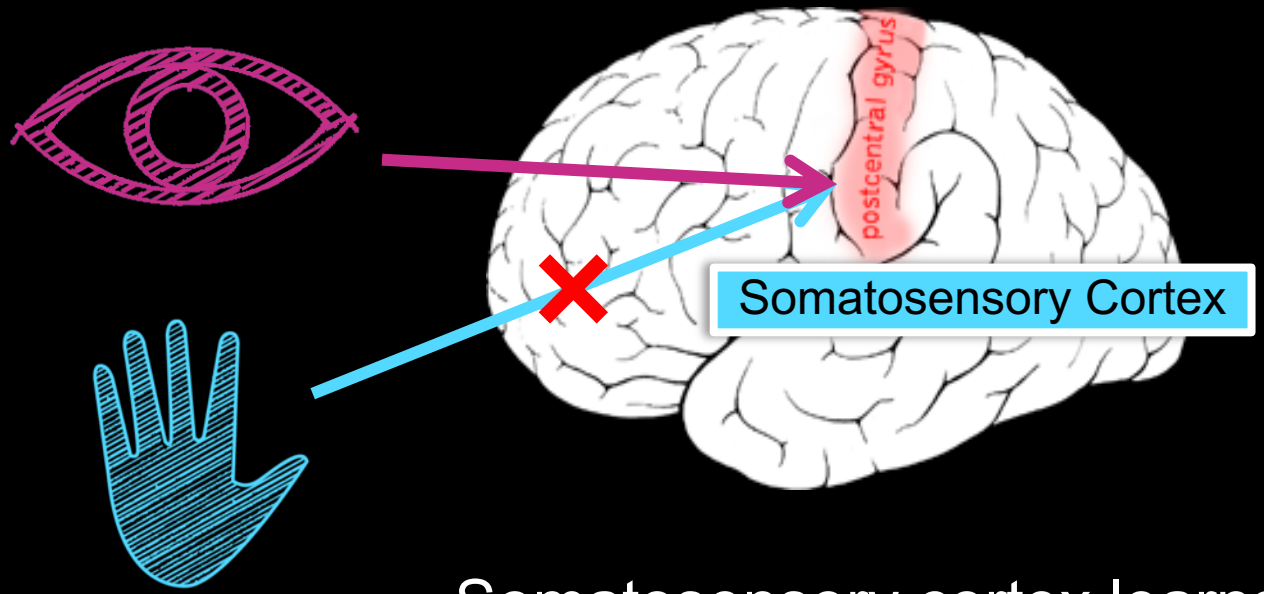


Auditory cortex learns to see

[Roe et al., 1992]

[Andrew Ng]

One Algorithm Hypothesis

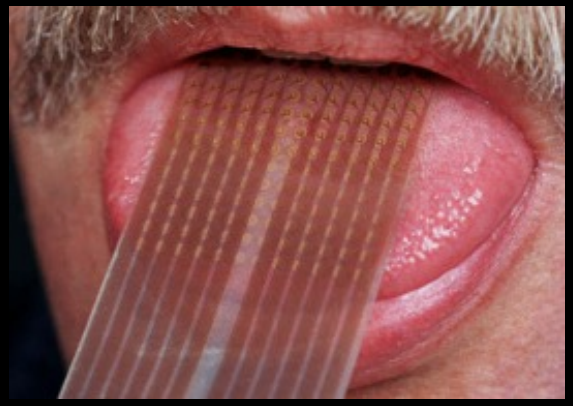


Somatosensory cortex learns to see

[Metin & Frost, 1989]

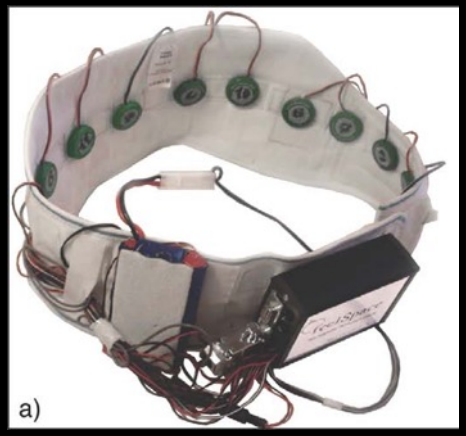
[Andrew Ng]

Sensor Representations

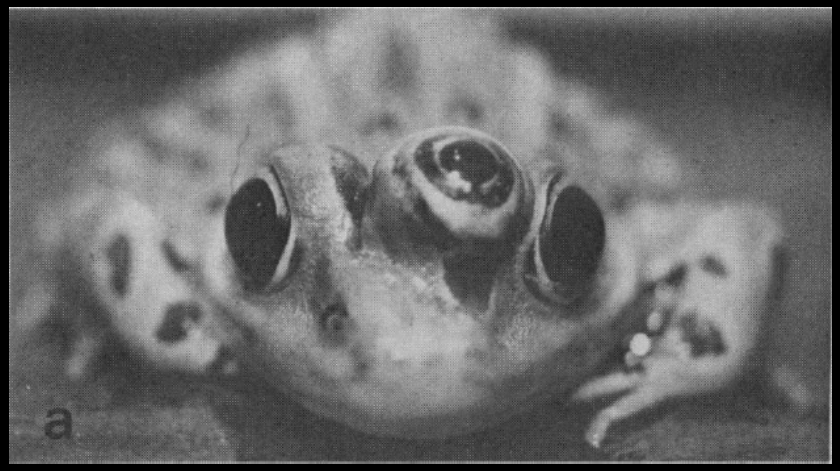


Seeing with your tongue

Human echolocation (sonar)



Haptic belt: Direction sense



Implanting a 3rd eye

[BrainPort; Welsh & Blasch, 1997; Nagel et al., 2005; Constantine-Paton & Law, 2009]

Two Great Ideas

Story of Modern AI:

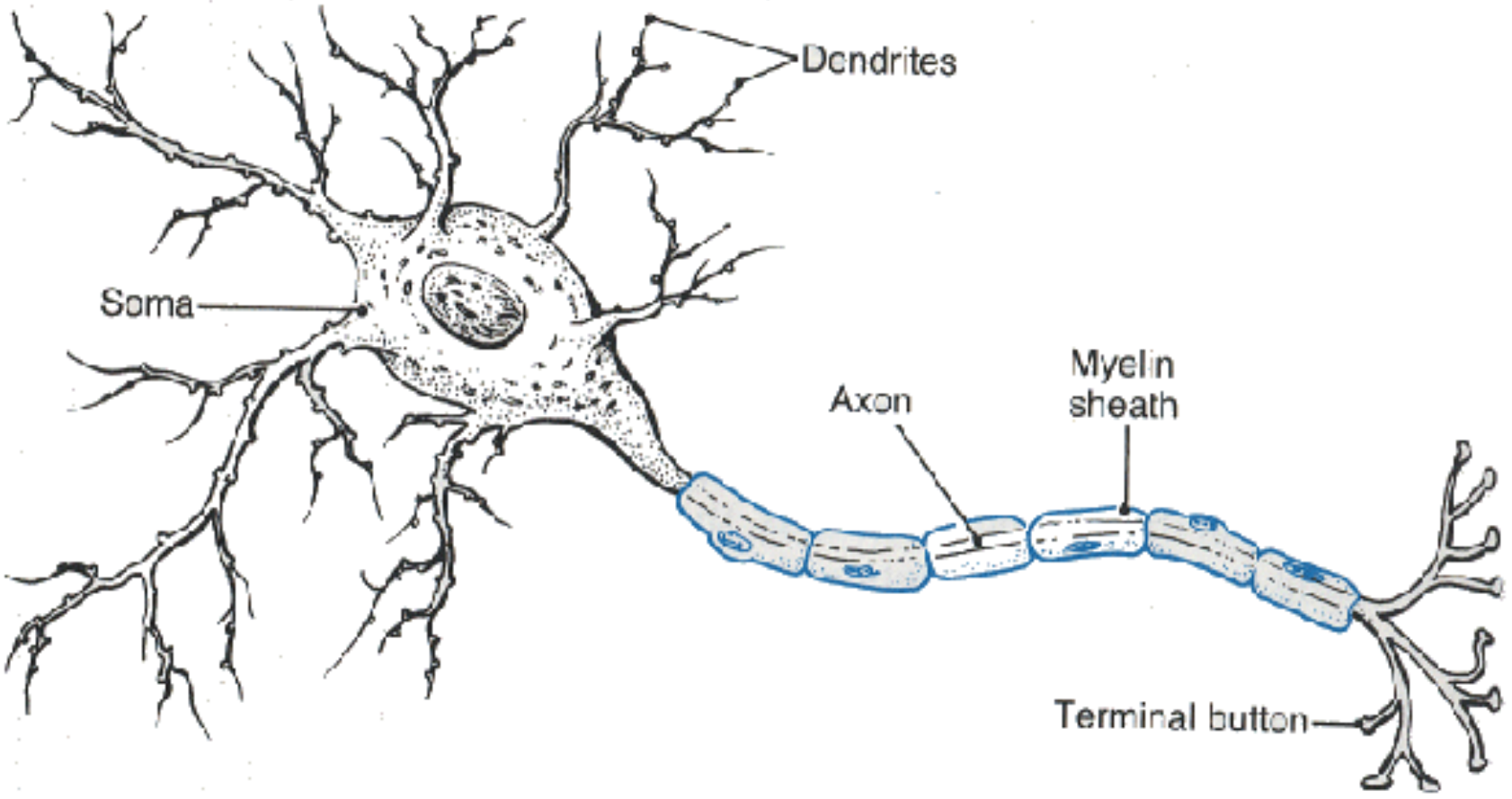
1. Artificial Neurons

2. Learn by Example

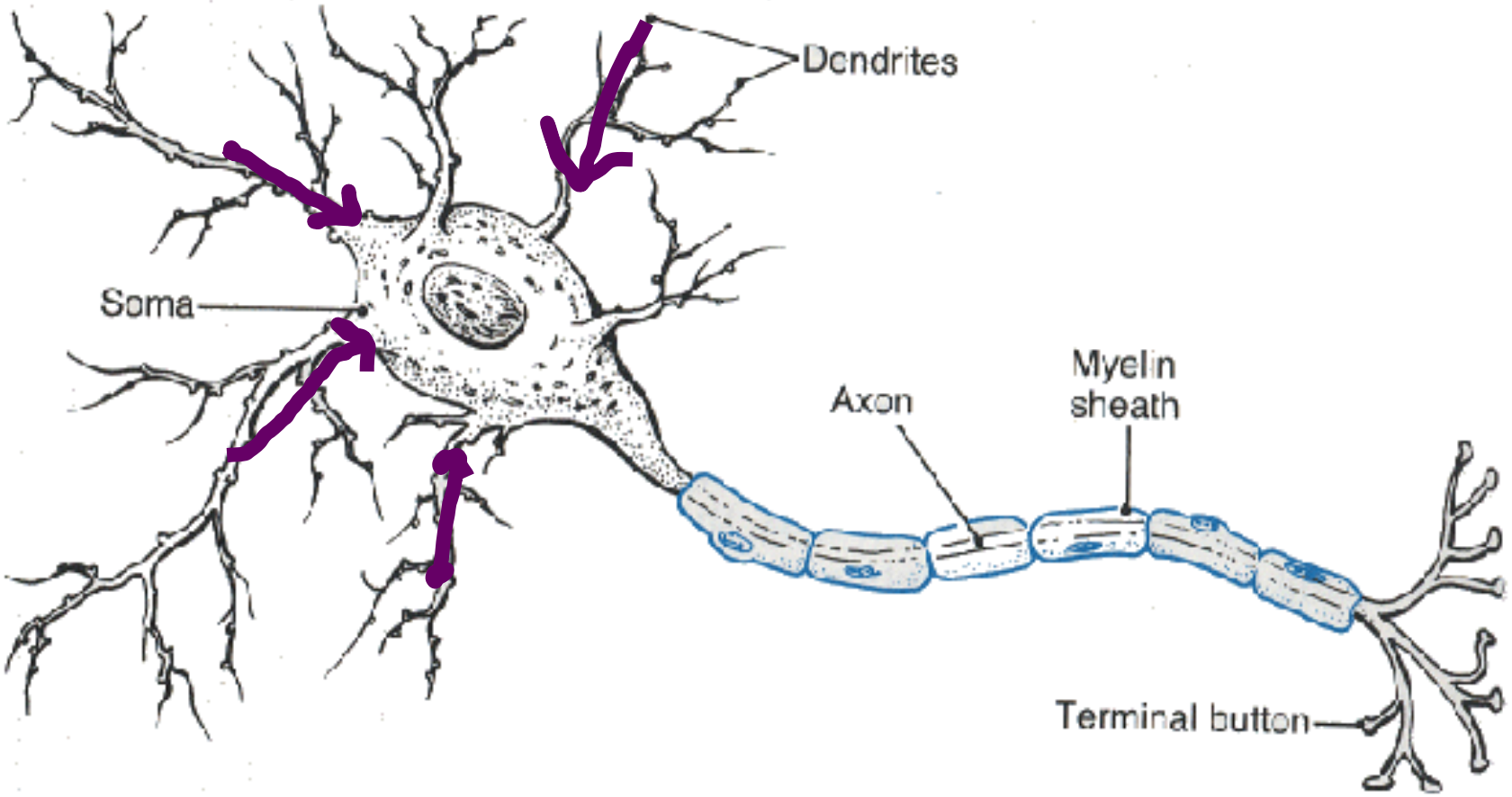
Machine Learning

1. Artificial Neurons

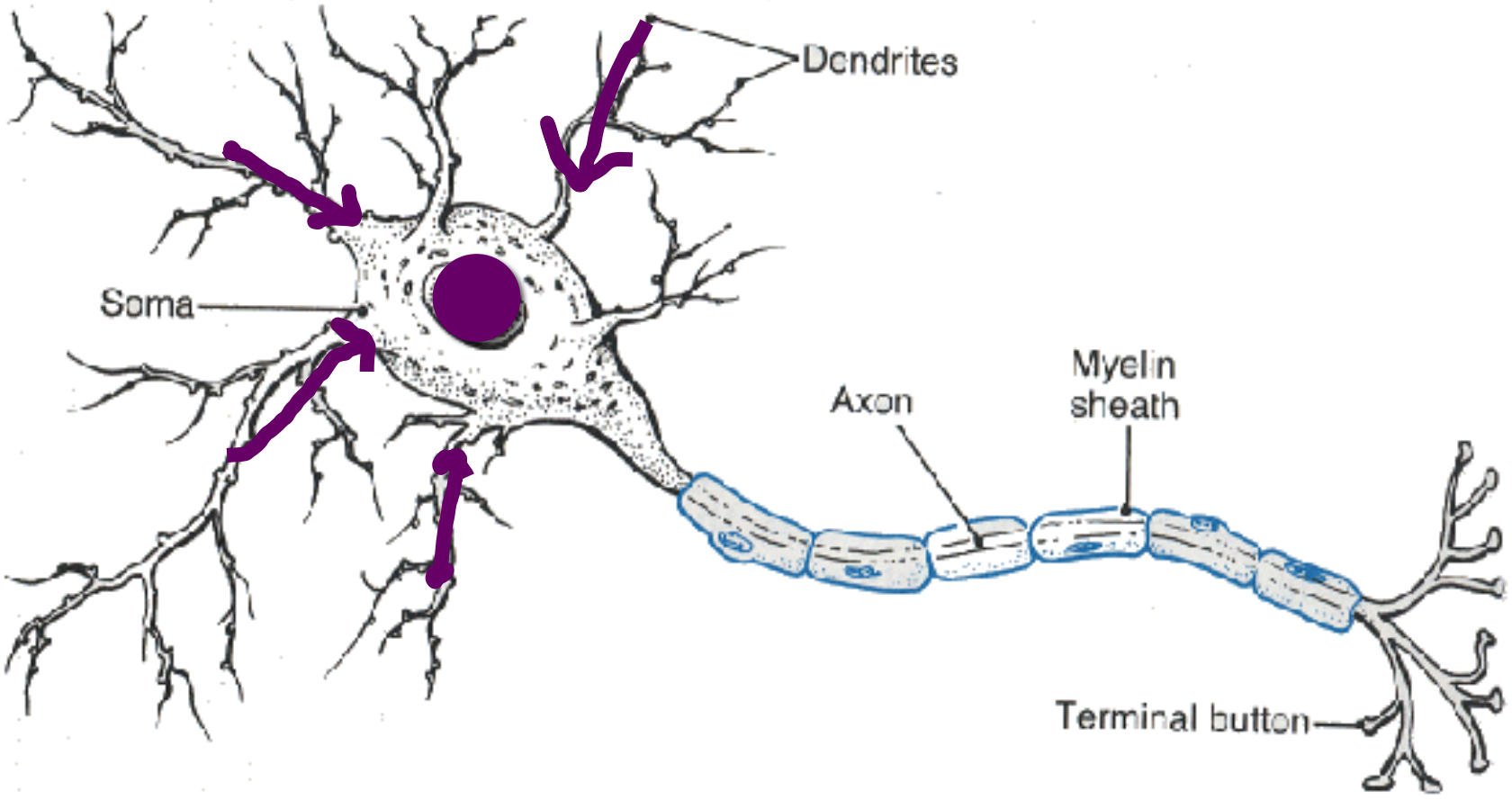
Neuron



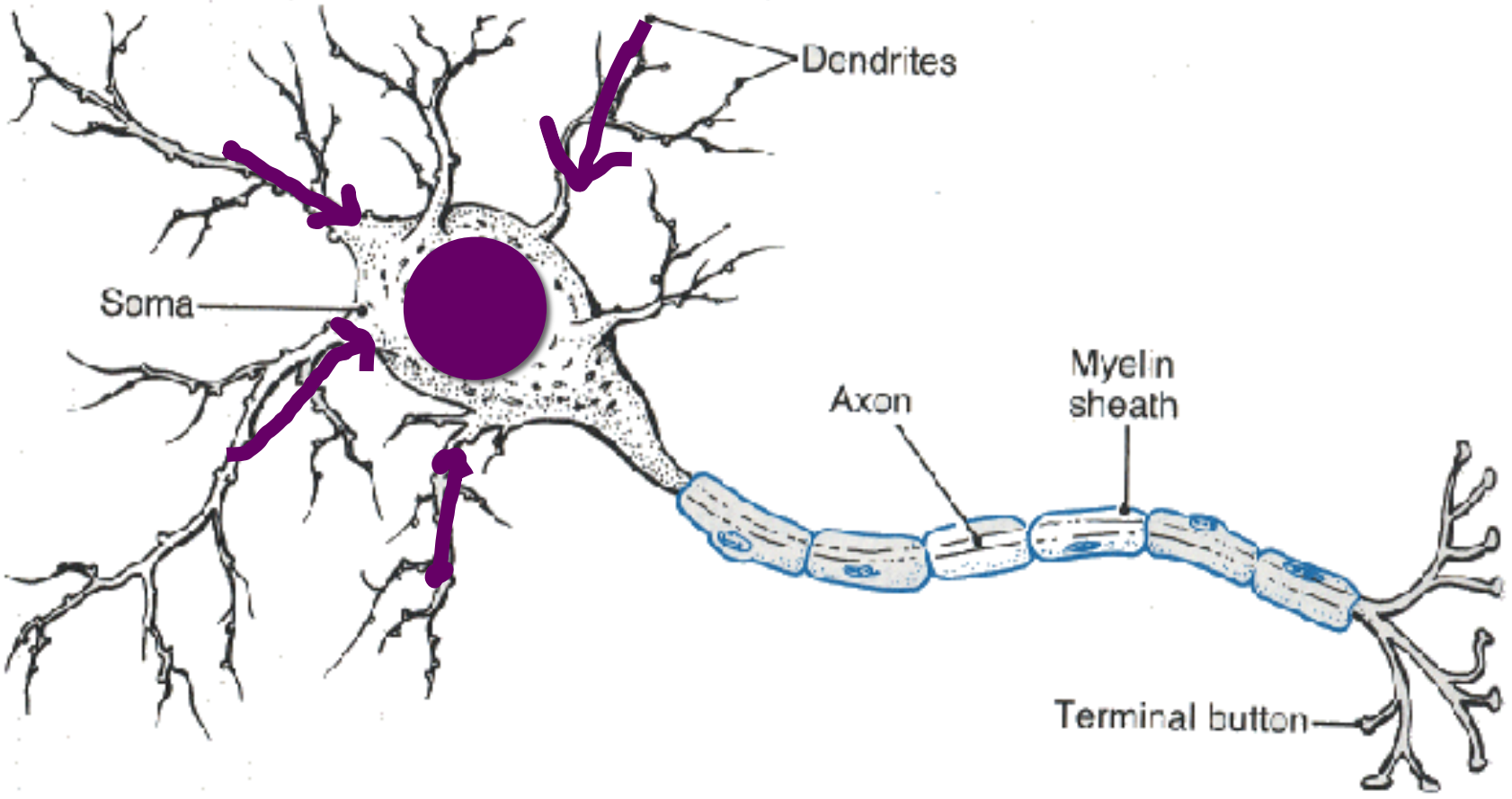
Neuron



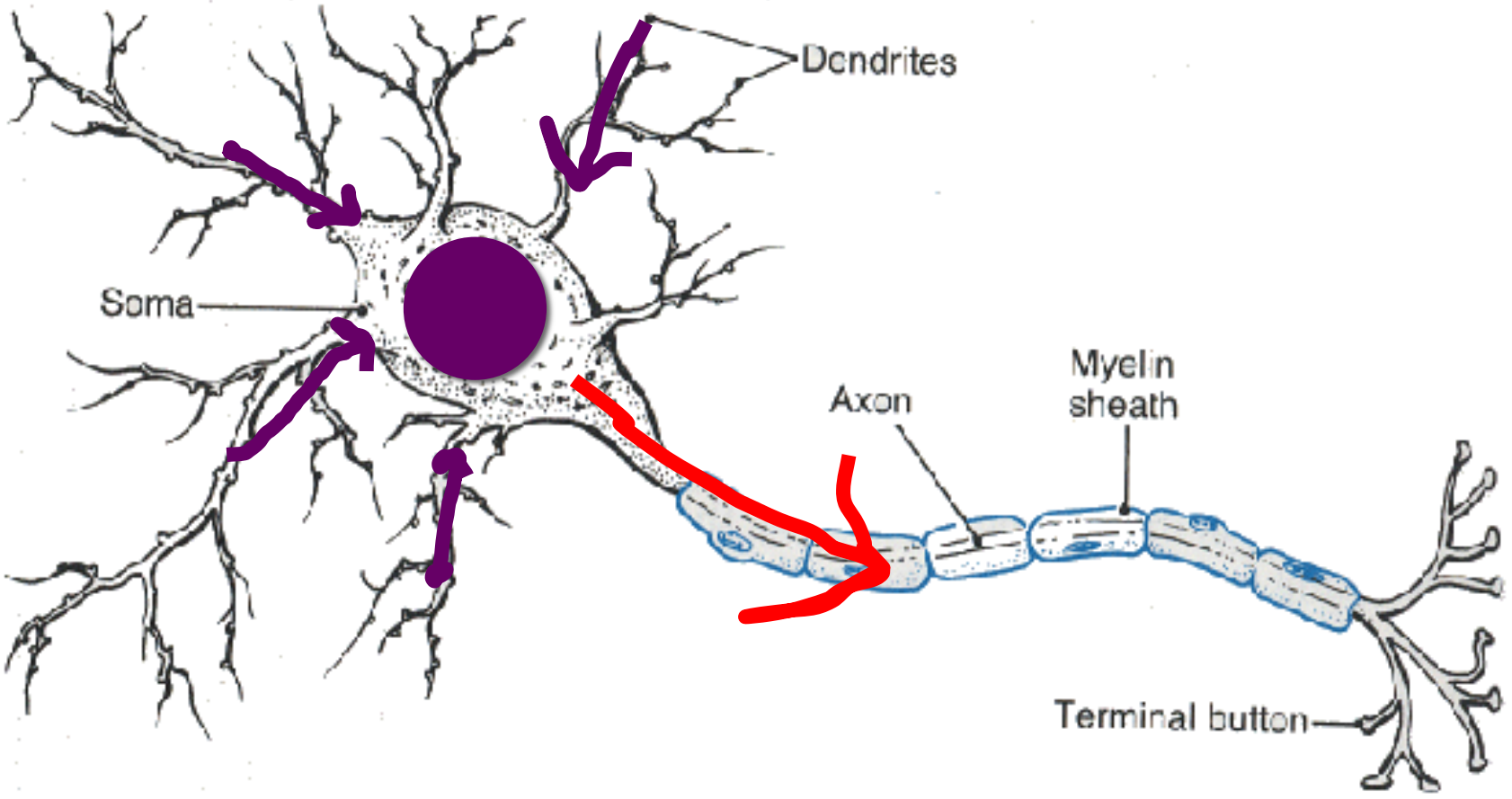
Neuron



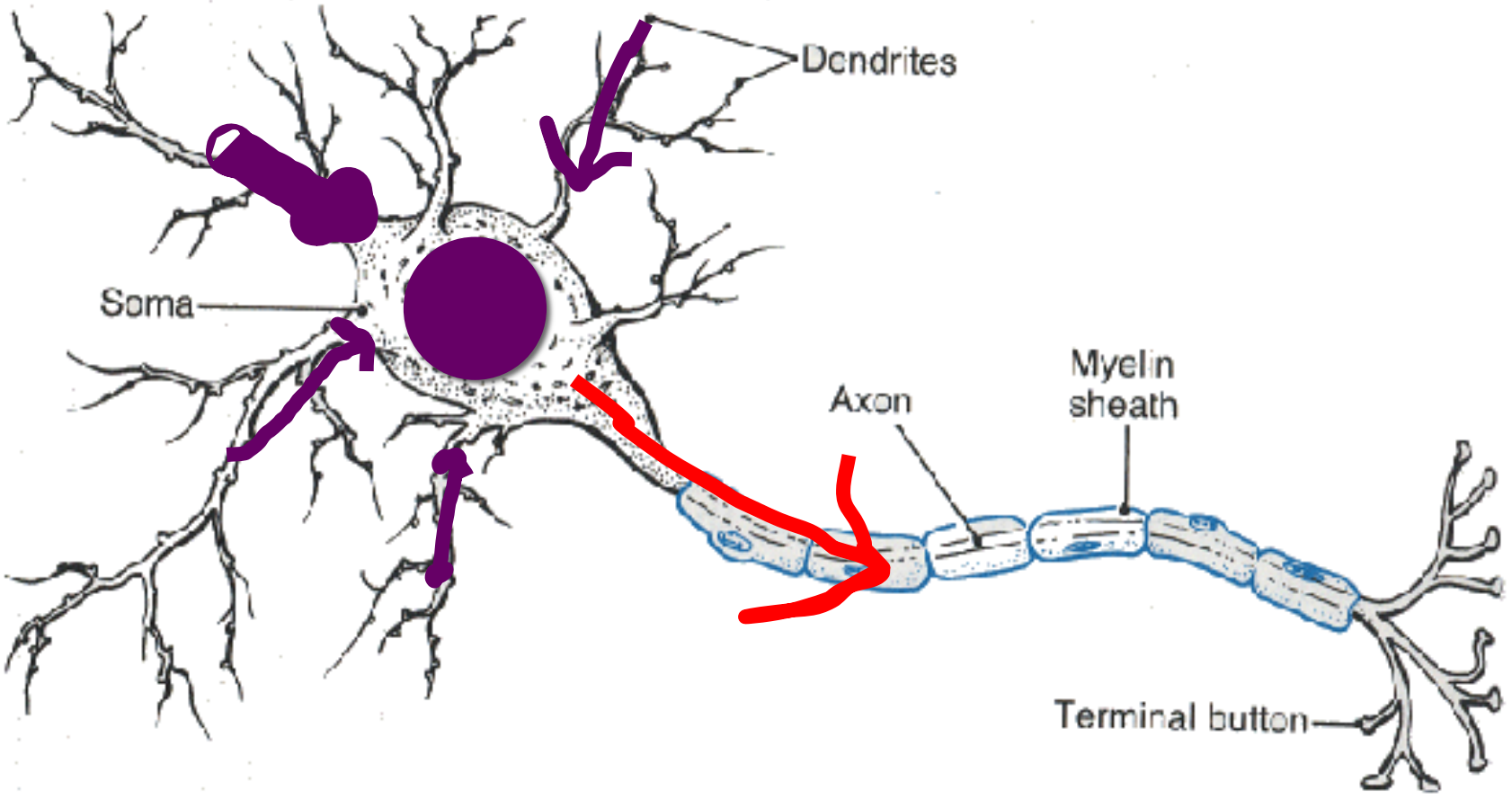
Neuron



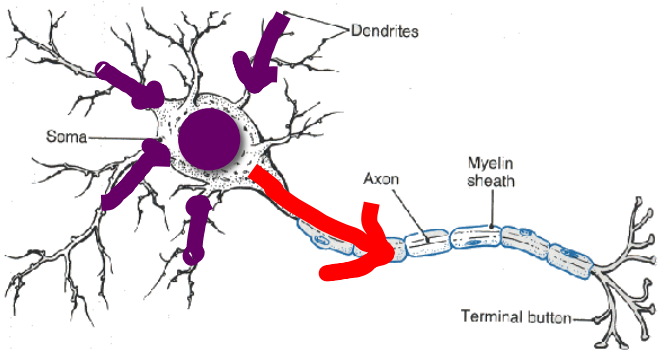
Neuron

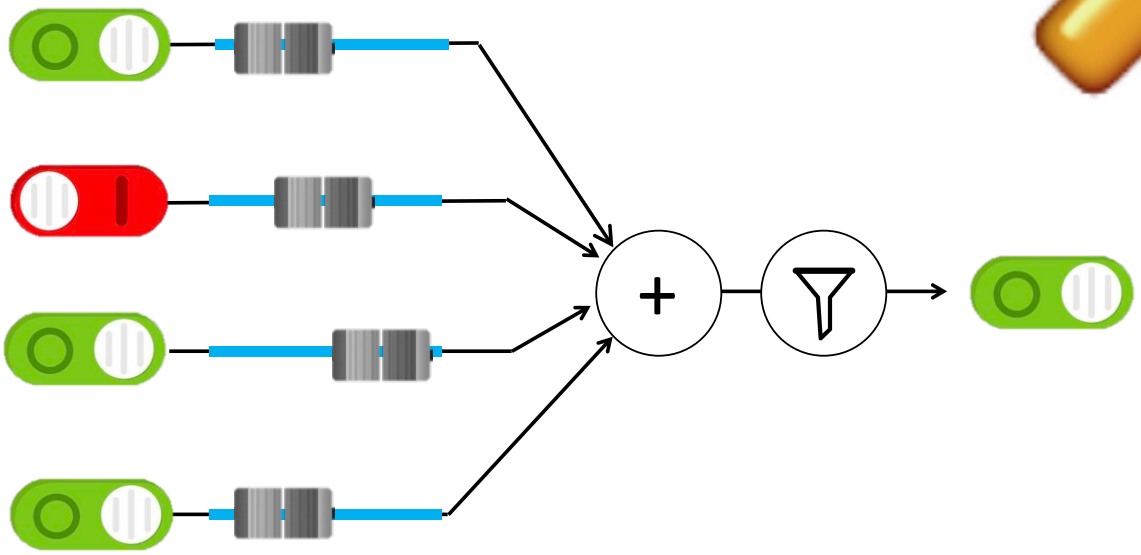


Some Inputs are More Important

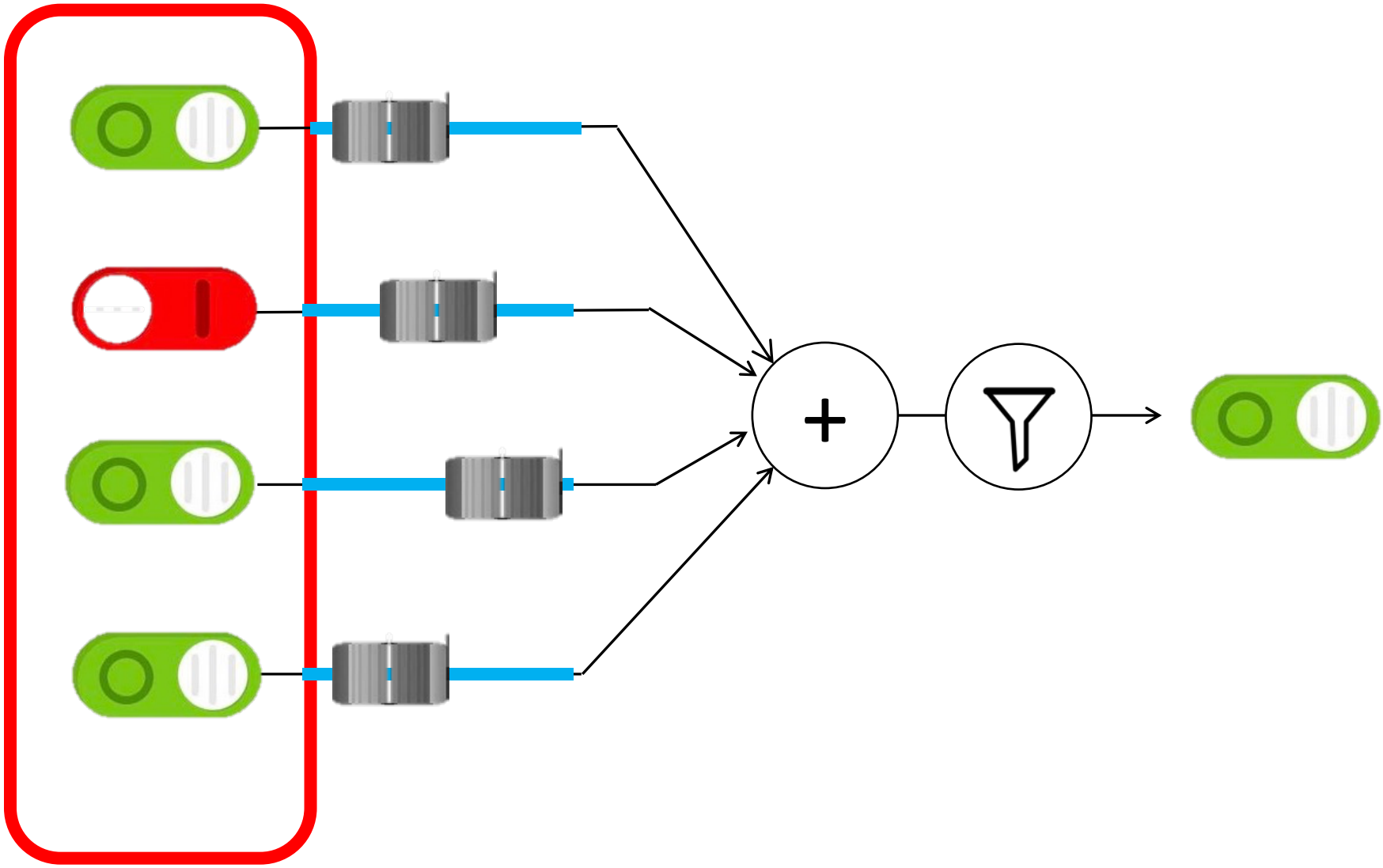


Artificial Neuron

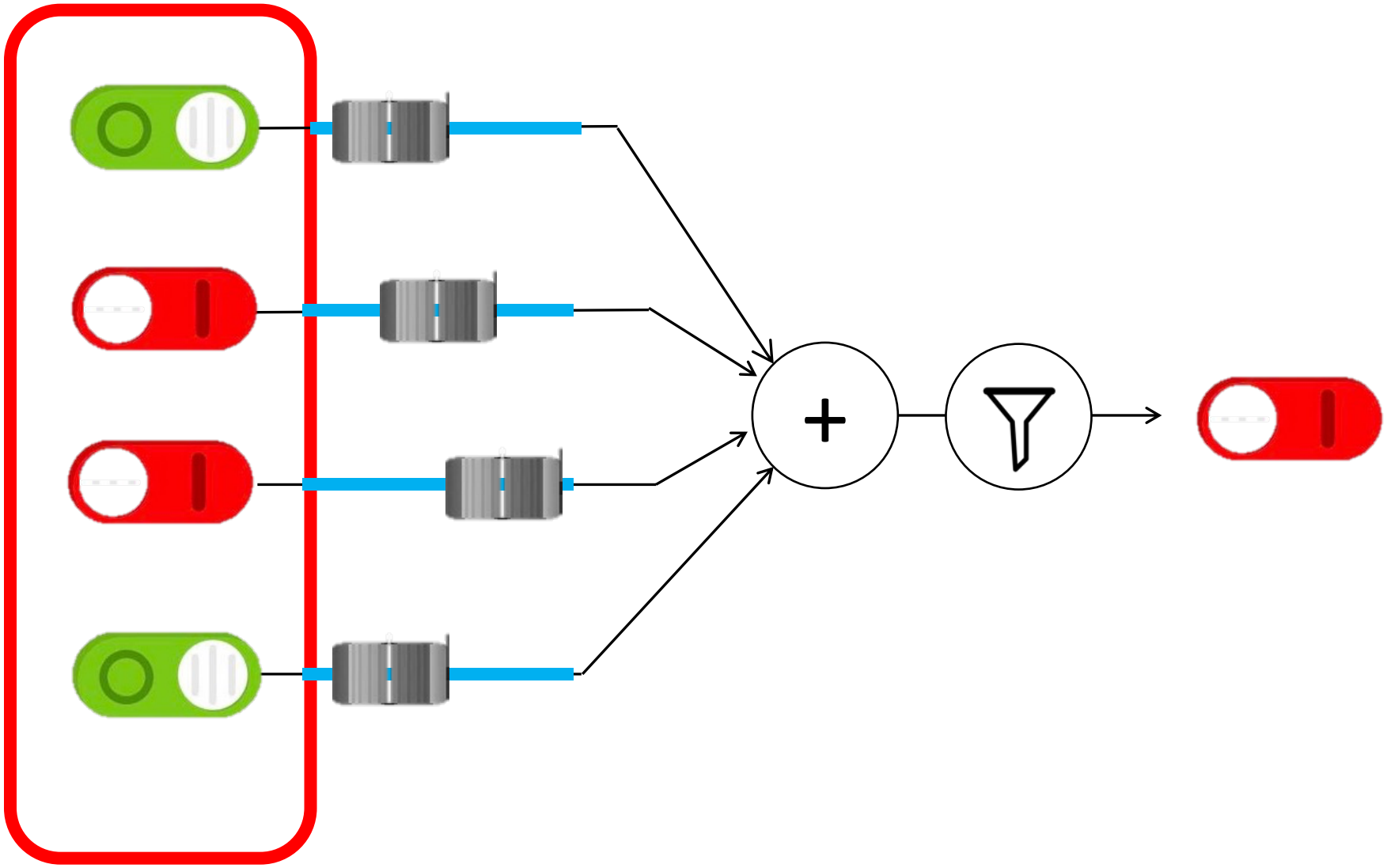




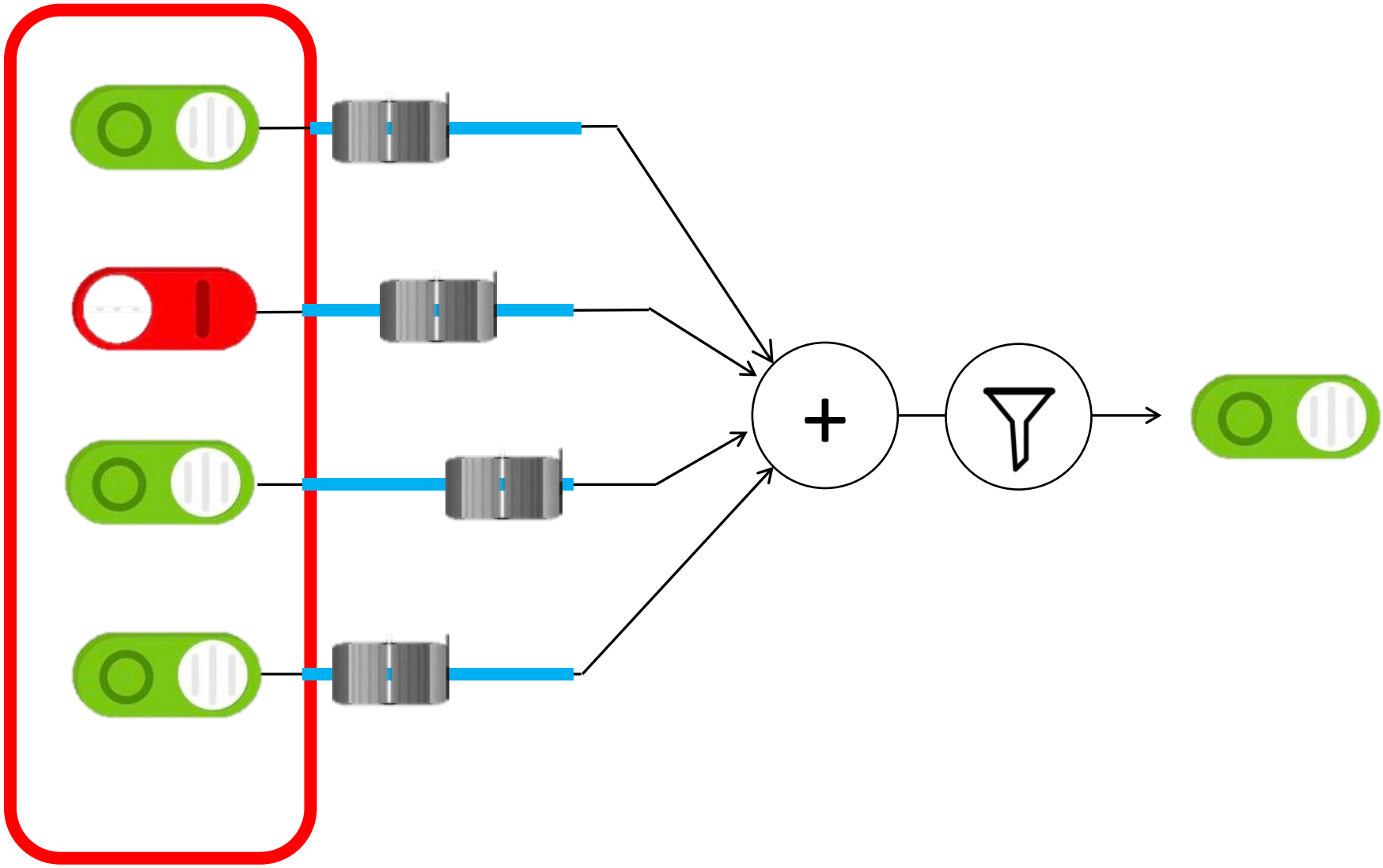
Inputs



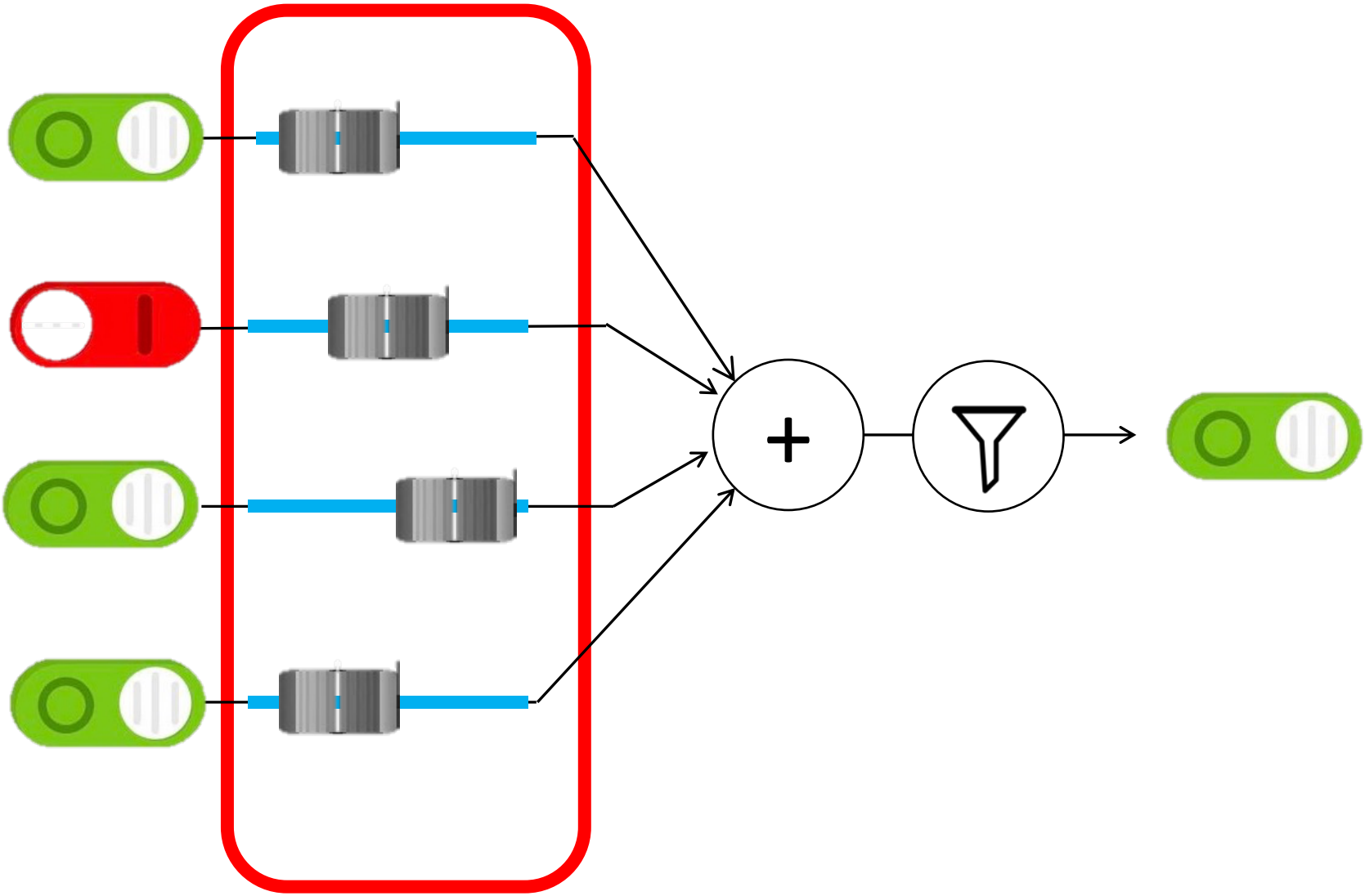
Inputs



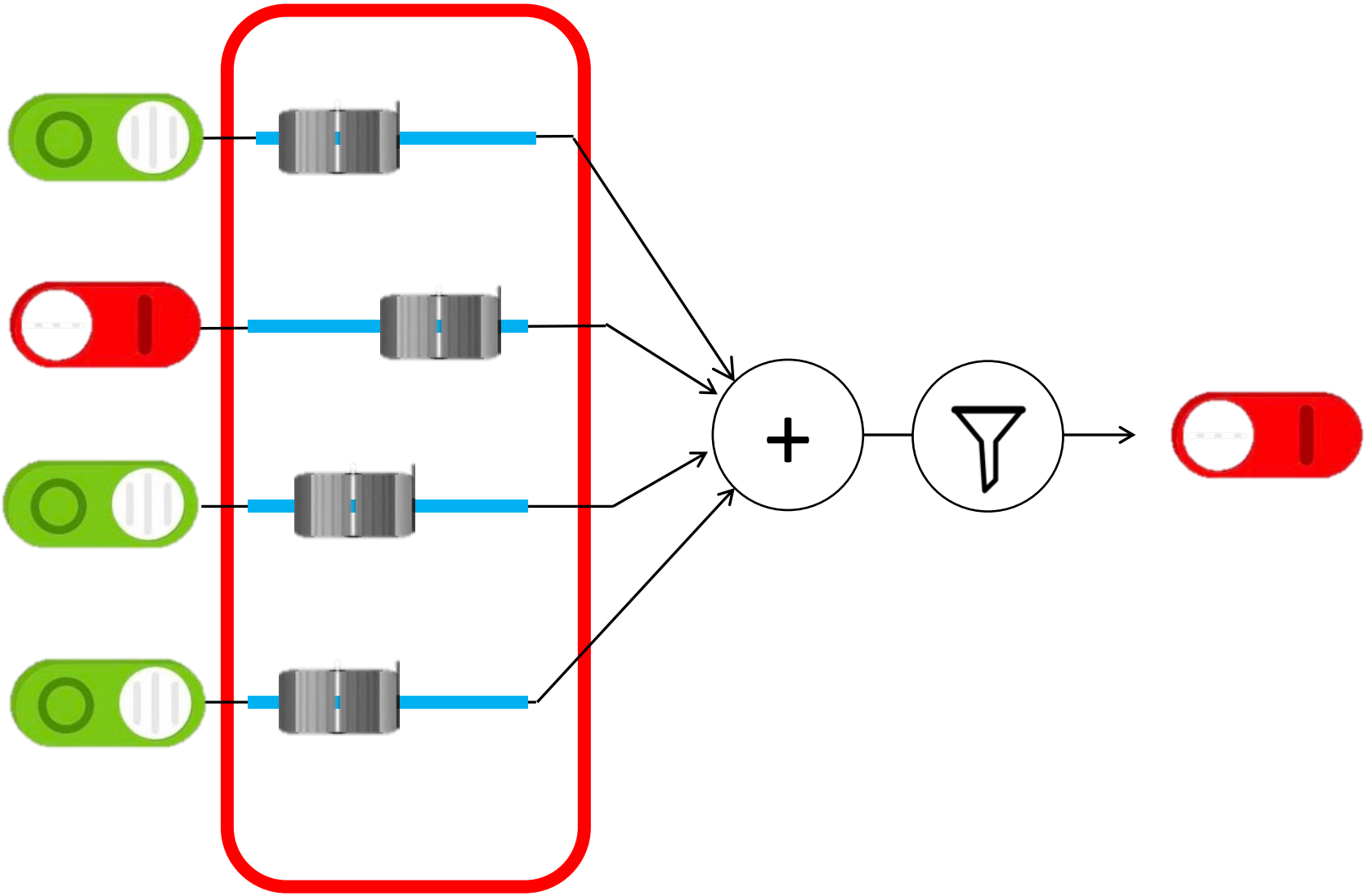
Inputs



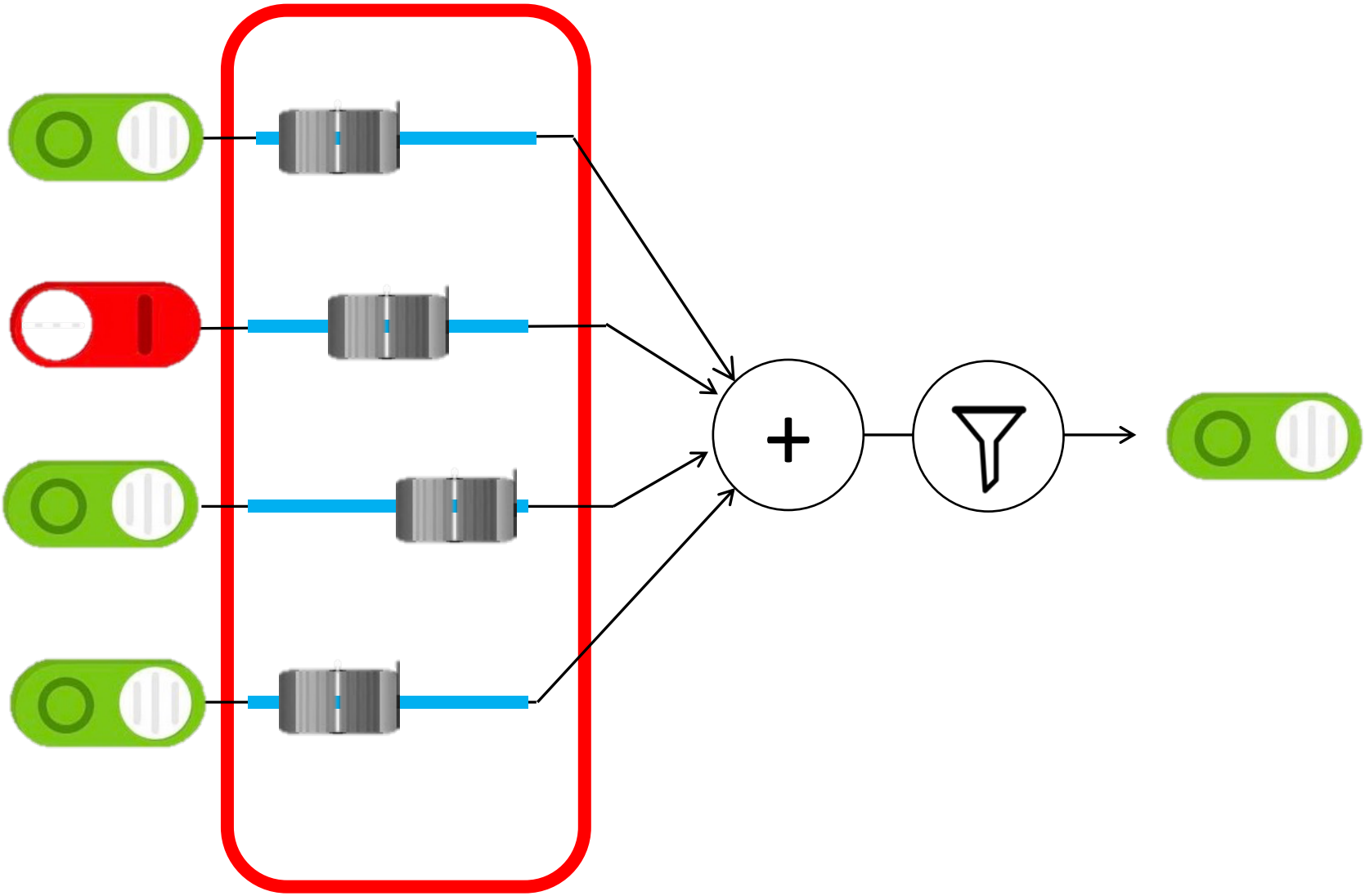
Weights



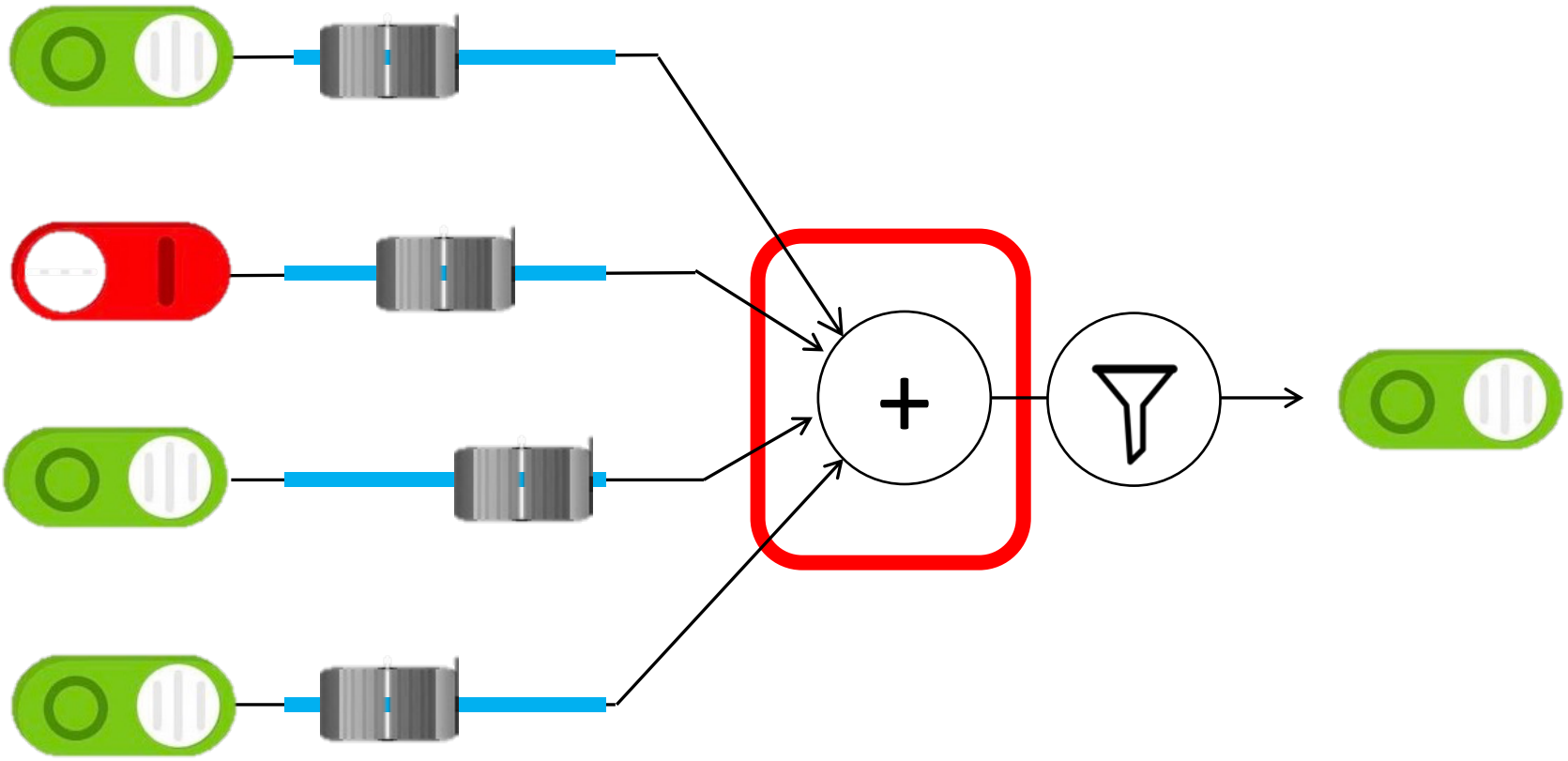
Weights



Weights

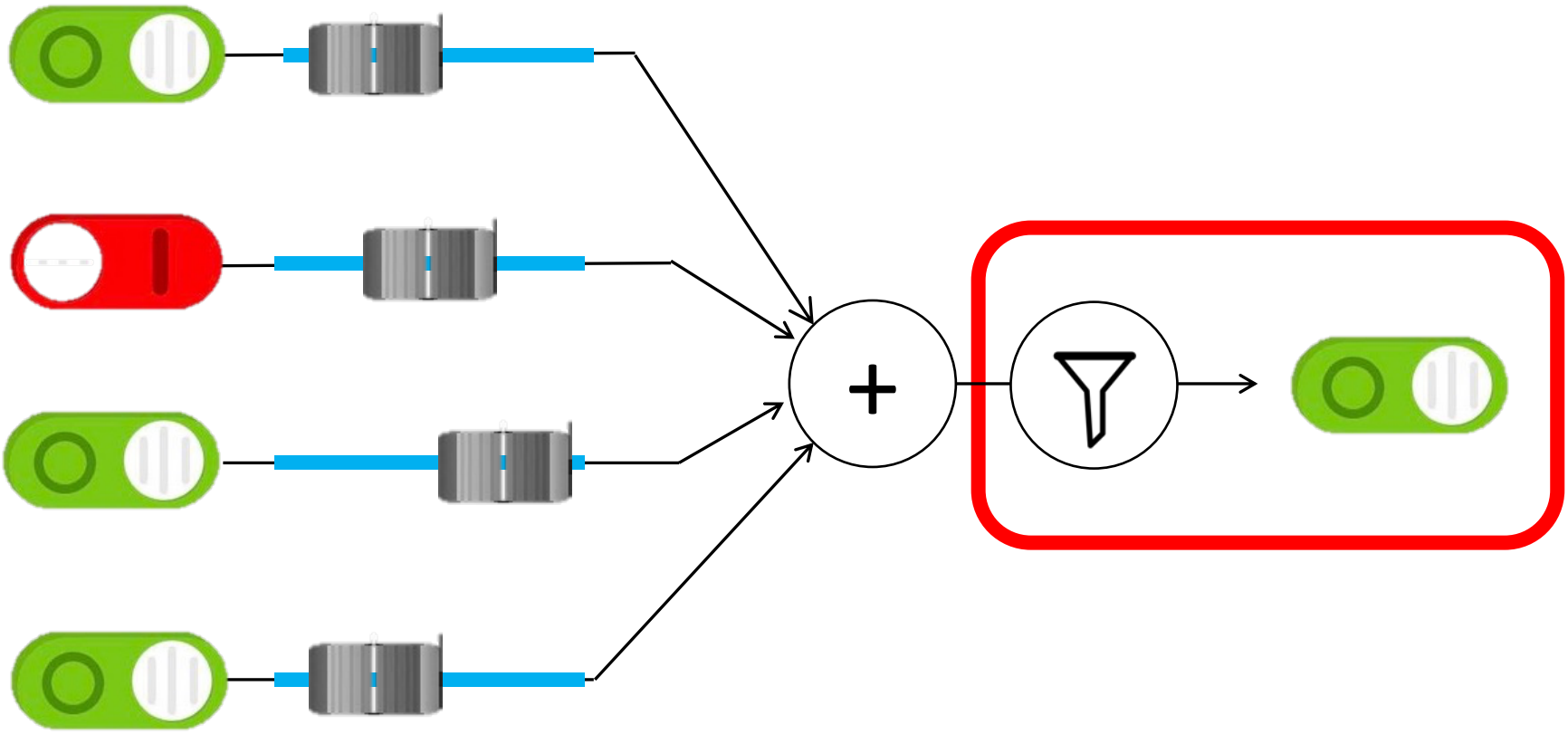


Weighted Sum



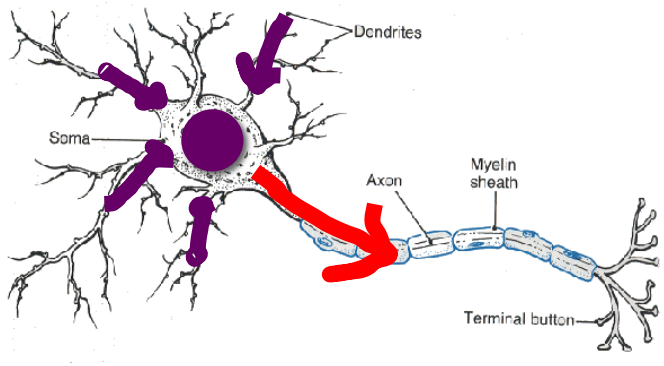
```
double weightedSum = 0;
weightedSum += input0 * weight0;
weightedSum += input1 * weight1;
weightedSum += input2 * weight2;
weightedSum += input3 * weight3;
```

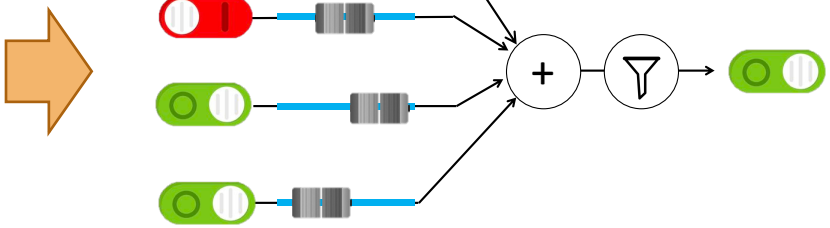
Filter and Output



Biological Basis

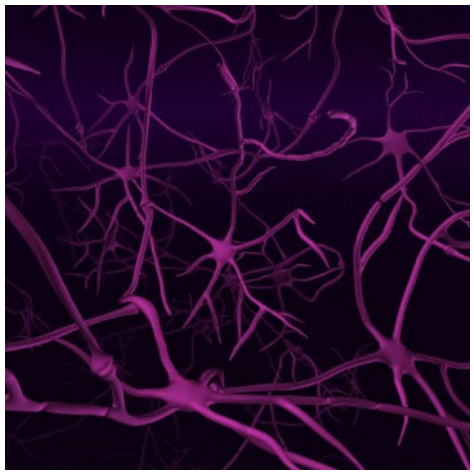
A neuron





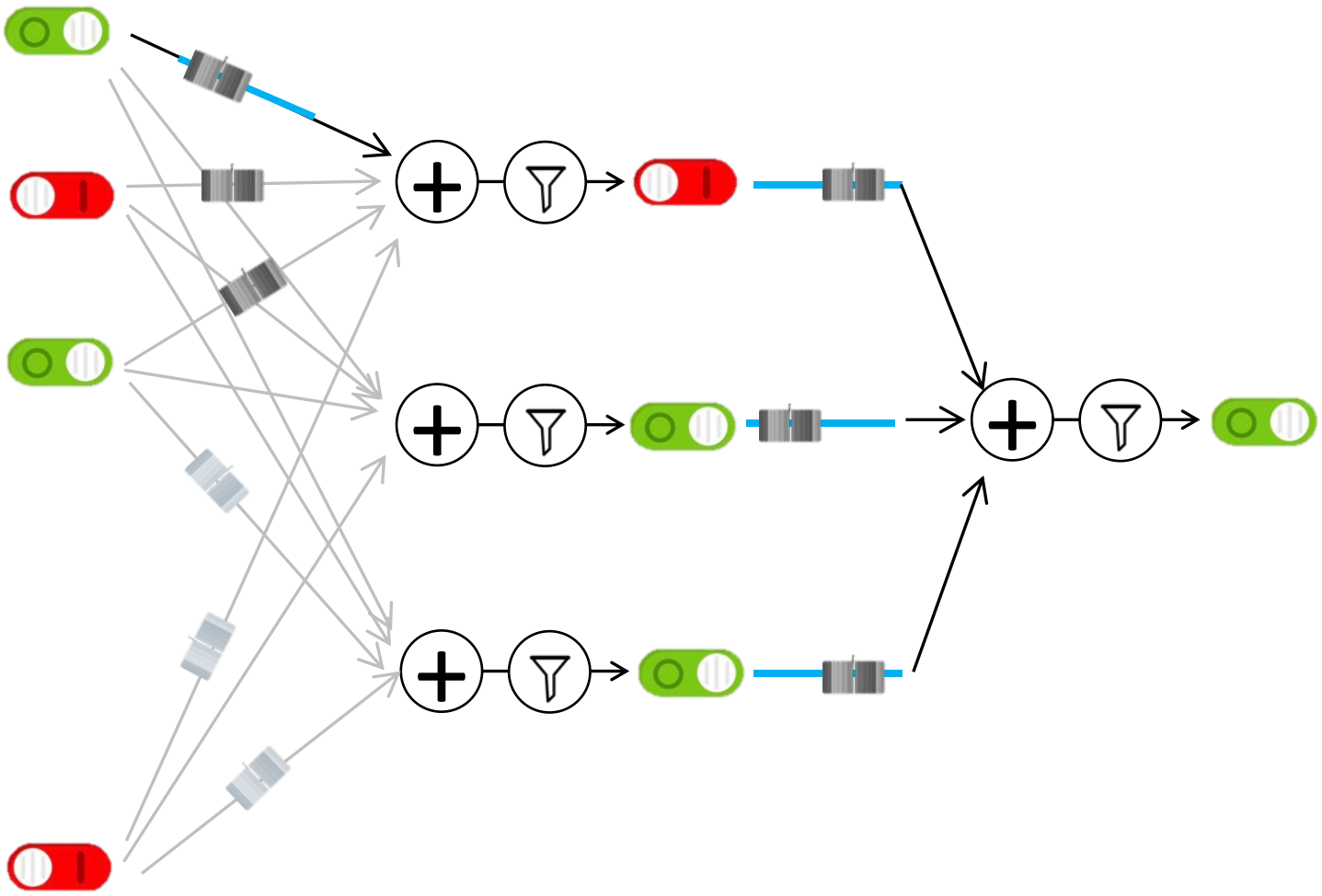
Your brain

(actually, probably someone else's brain)

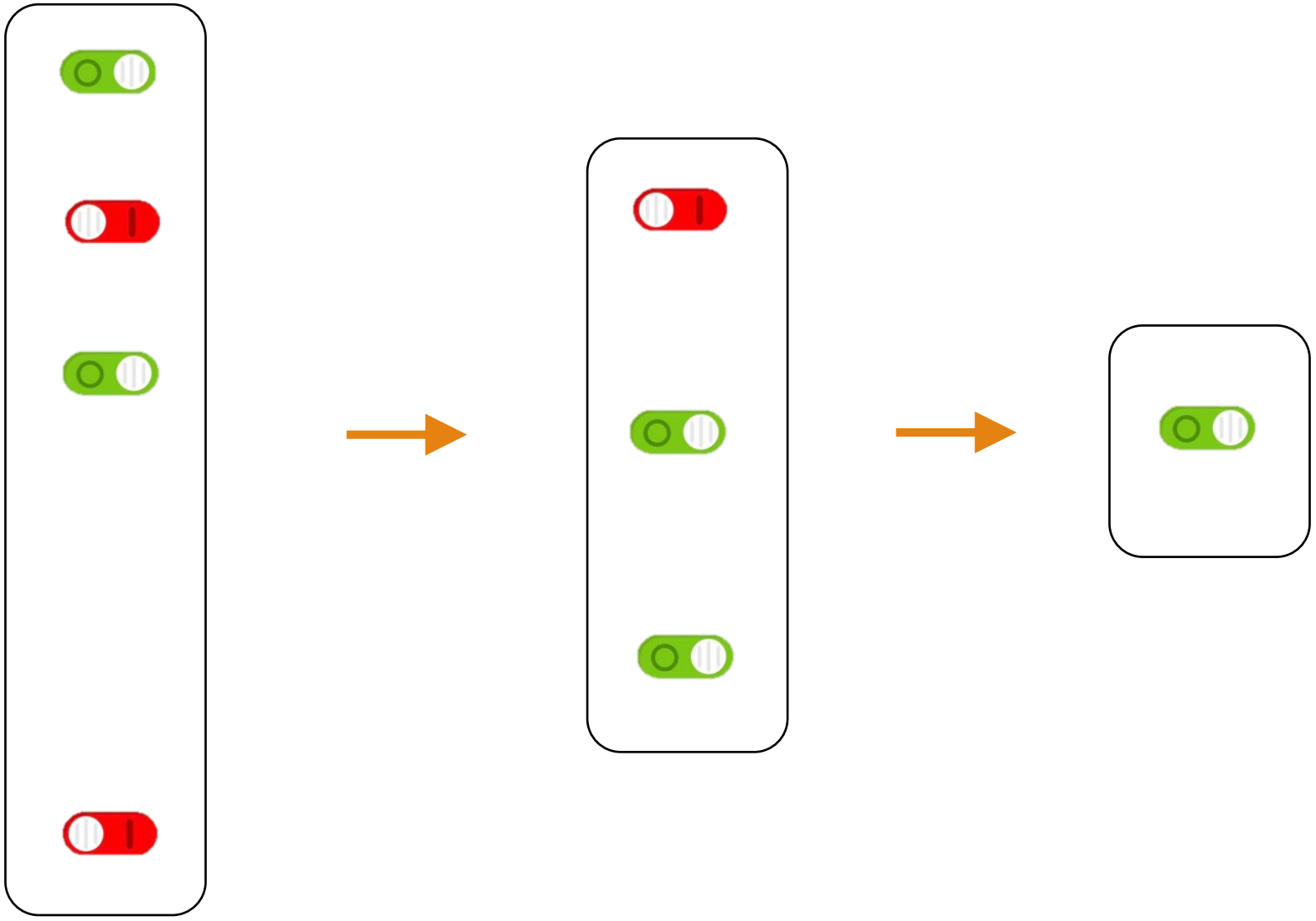


???

Put Many Together



Put Many Together

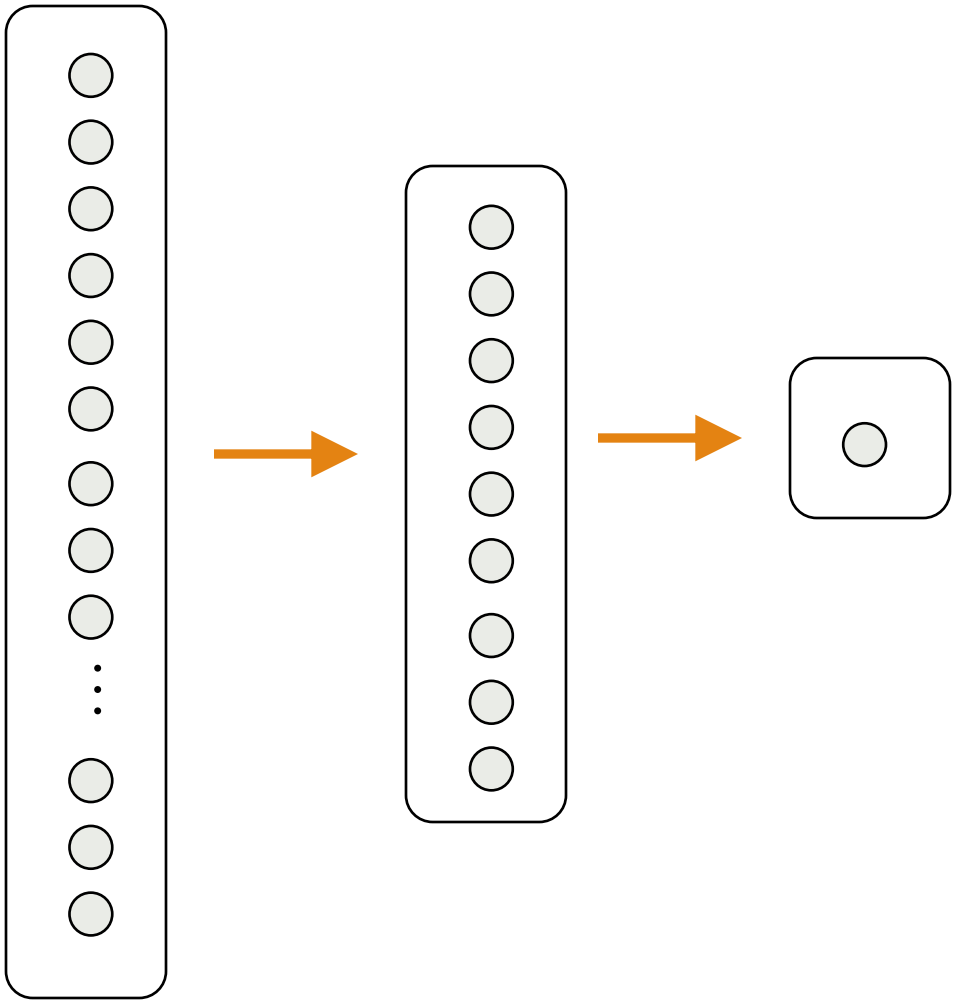


Input Neurons

Hidden Neurons

Output Neurons

Making a Prediction



Input Neurons

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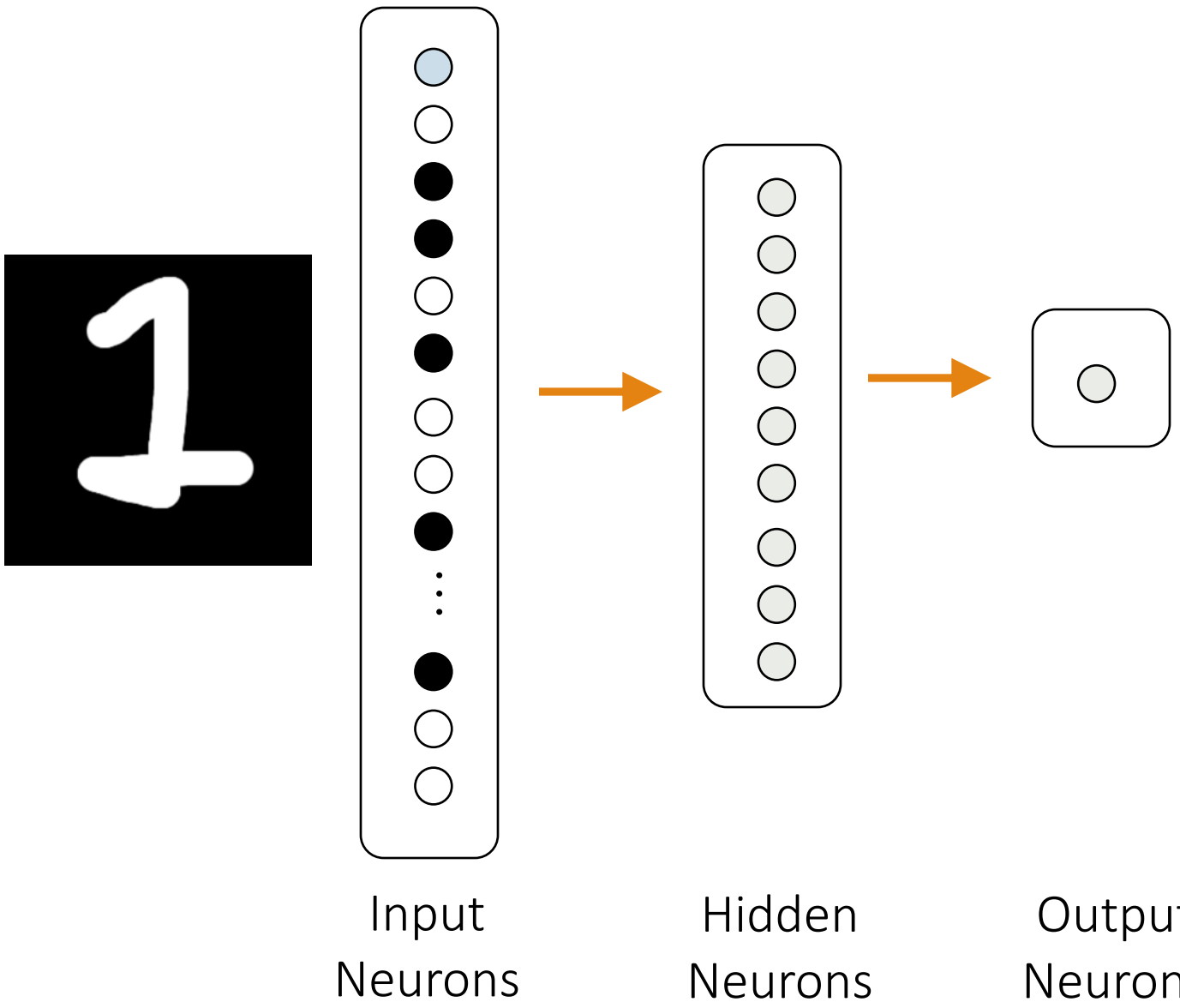
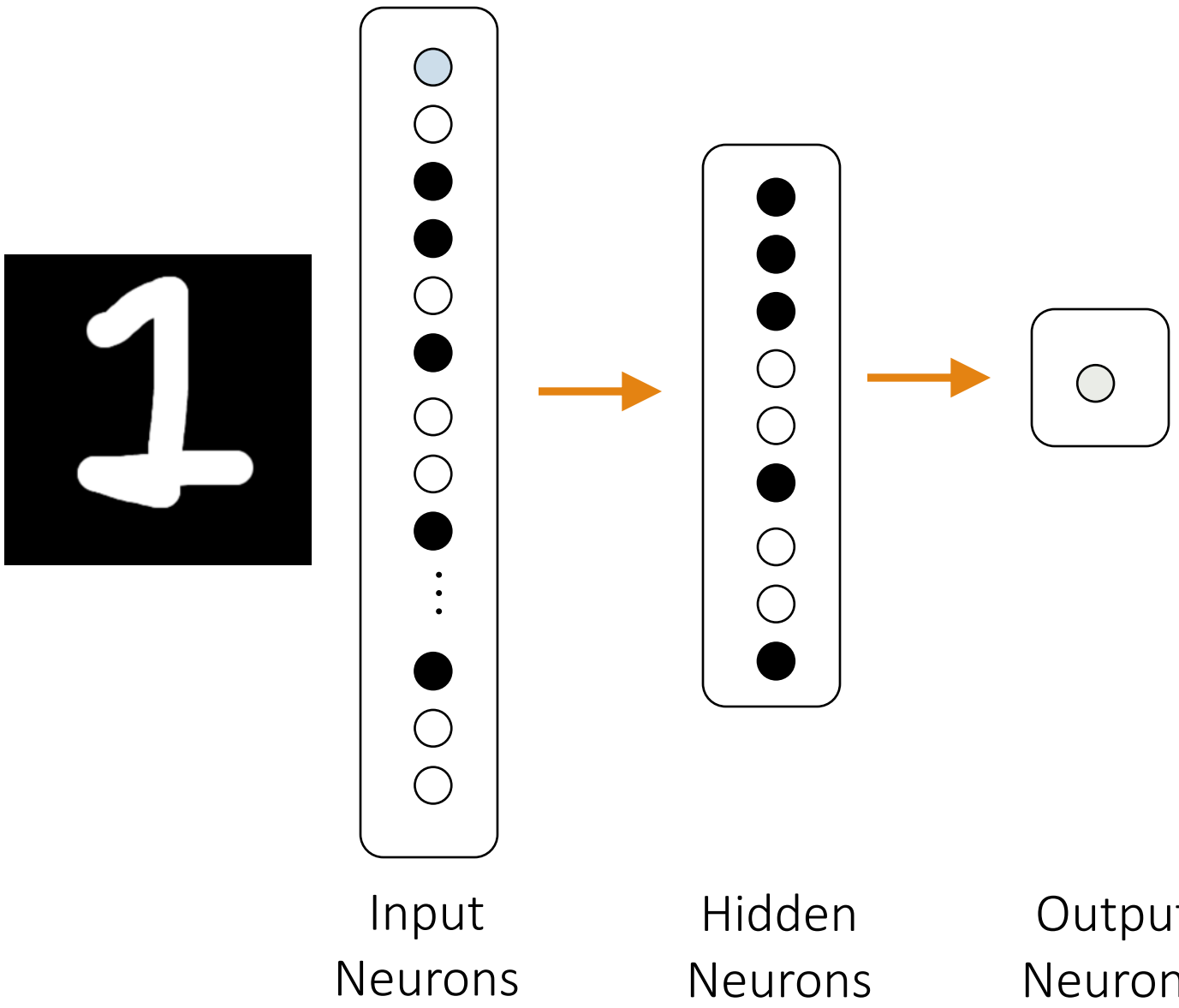
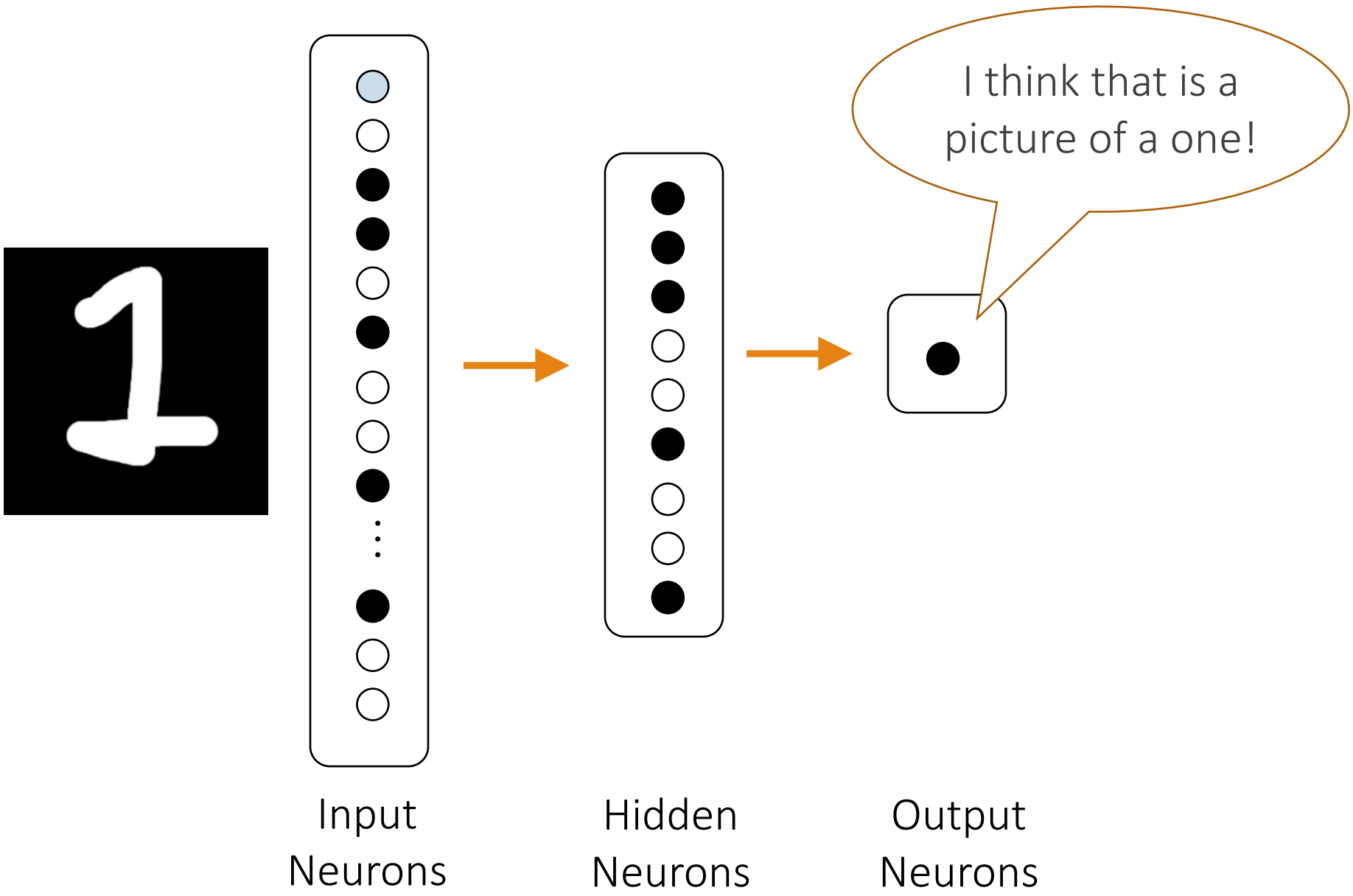
Making a Prediction



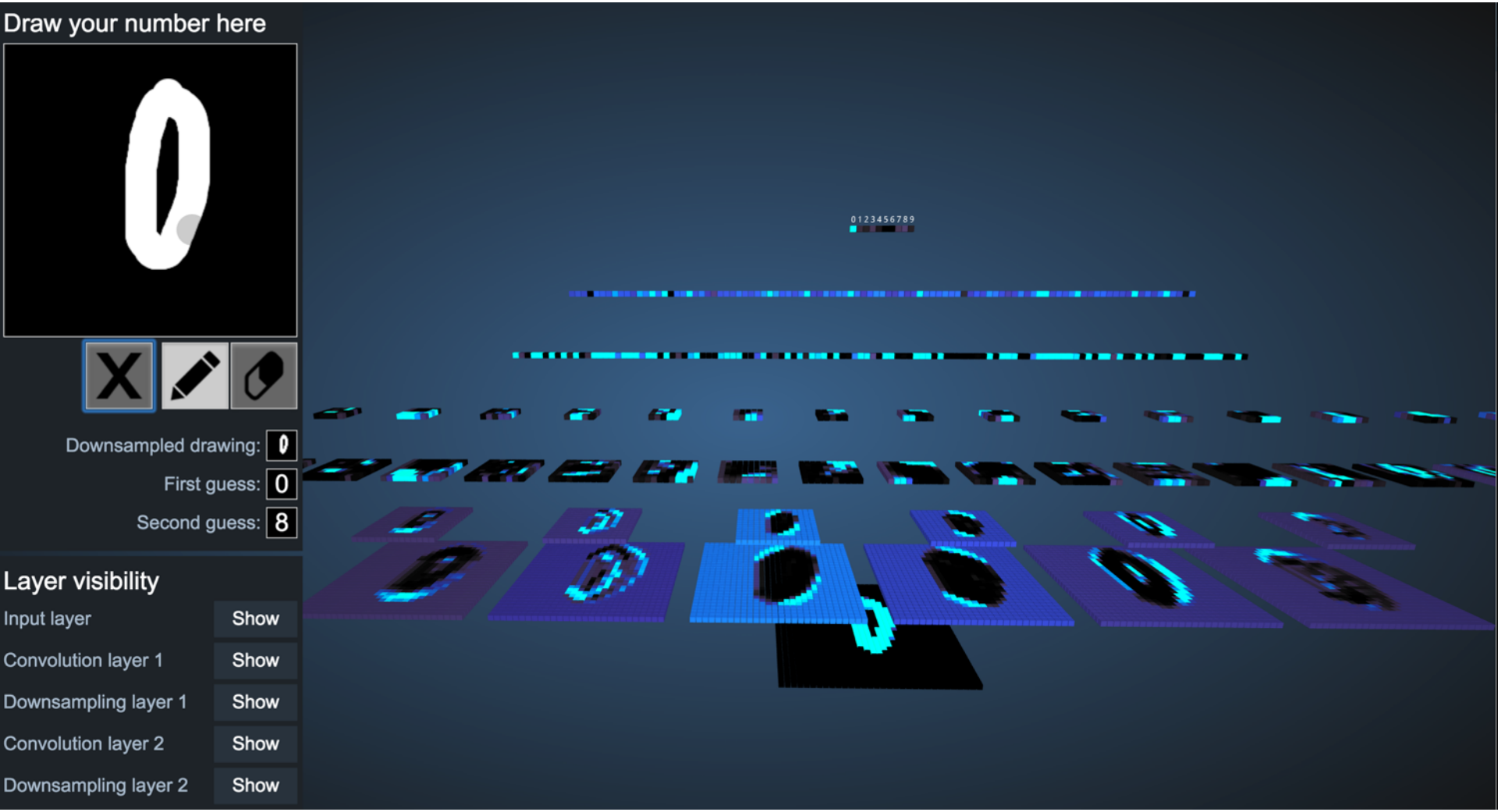
Making a Prediction



Making a Prediction

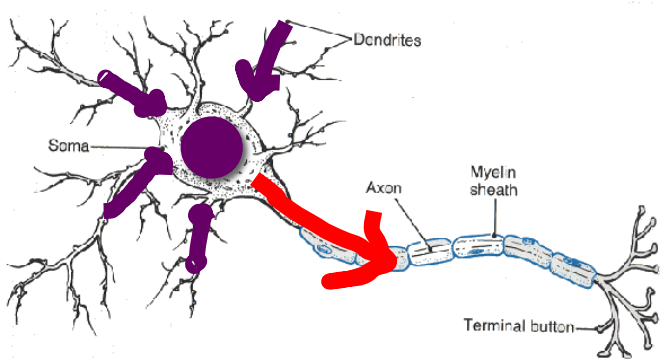


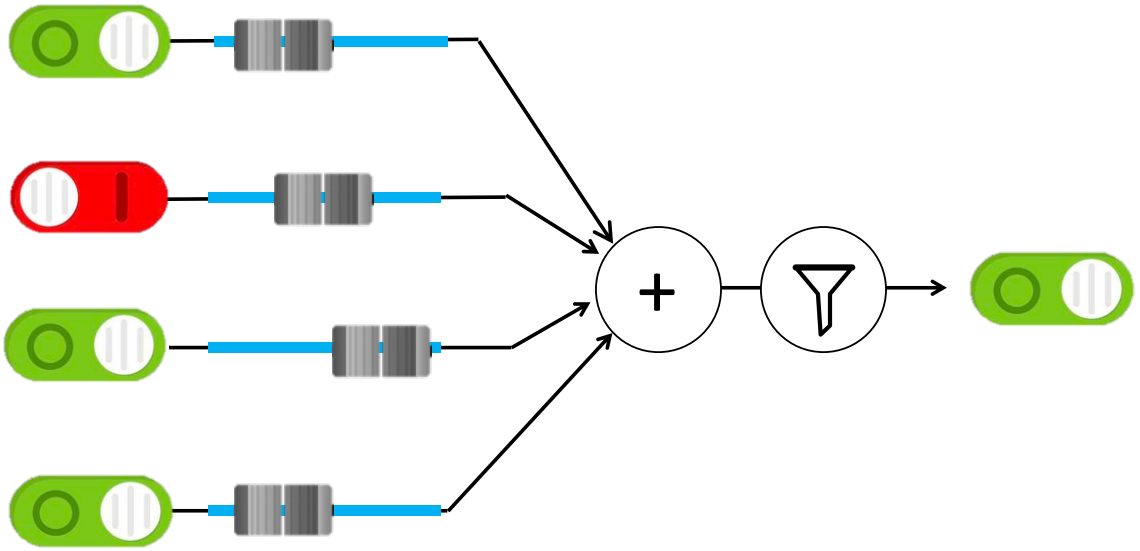
You Can Try It Yourself



http://scs.ryerson.ca/~aharley/vis/conv/

Great Idea: Artificial Neurons





Two Great Ideas

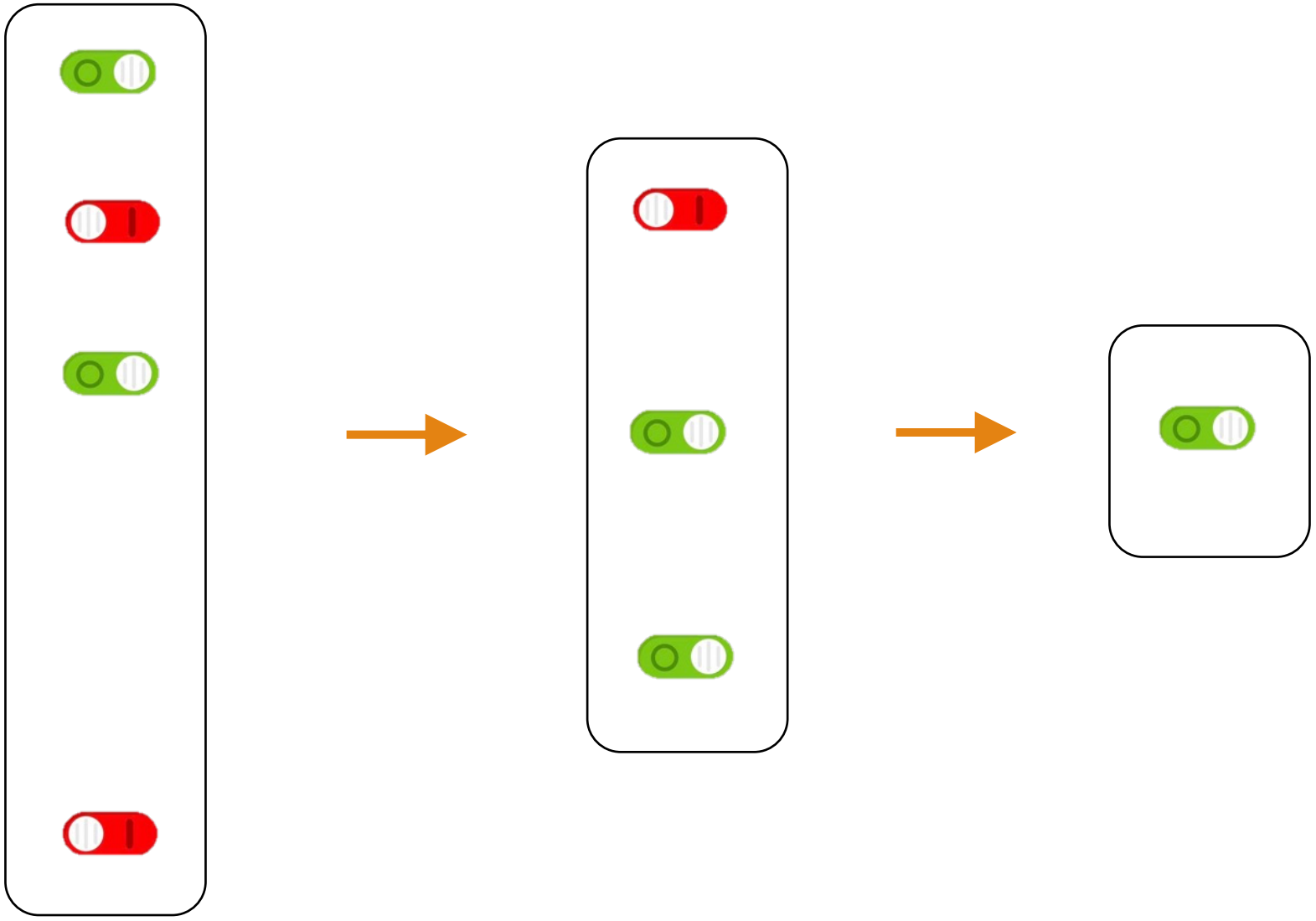
1. Artificial Neurons

2. Learn by Example

2. Learn From Experience

Neural Networks gets their *intelligence* from its sliders (aka its weights)

Neural Network

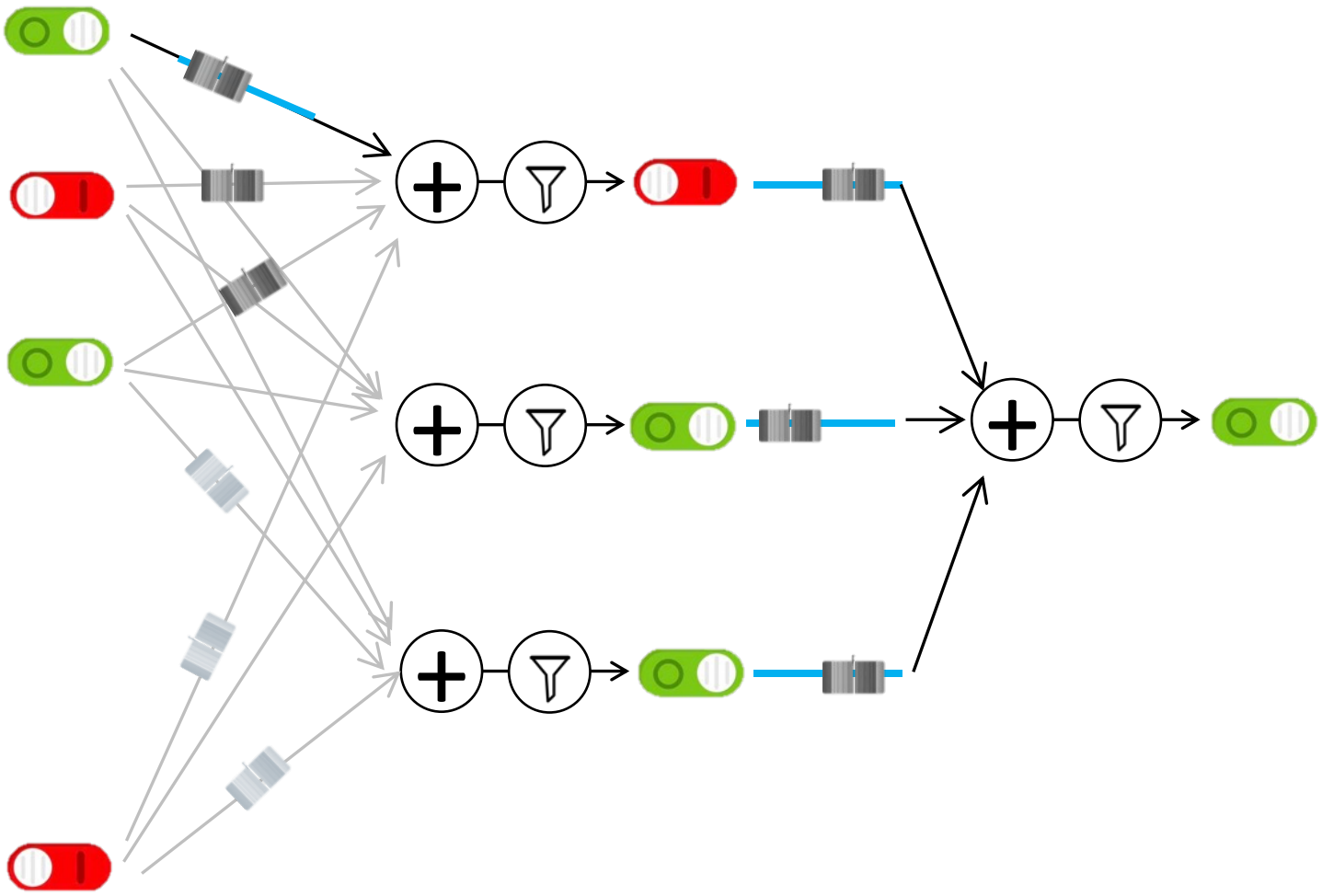


Input Neurons

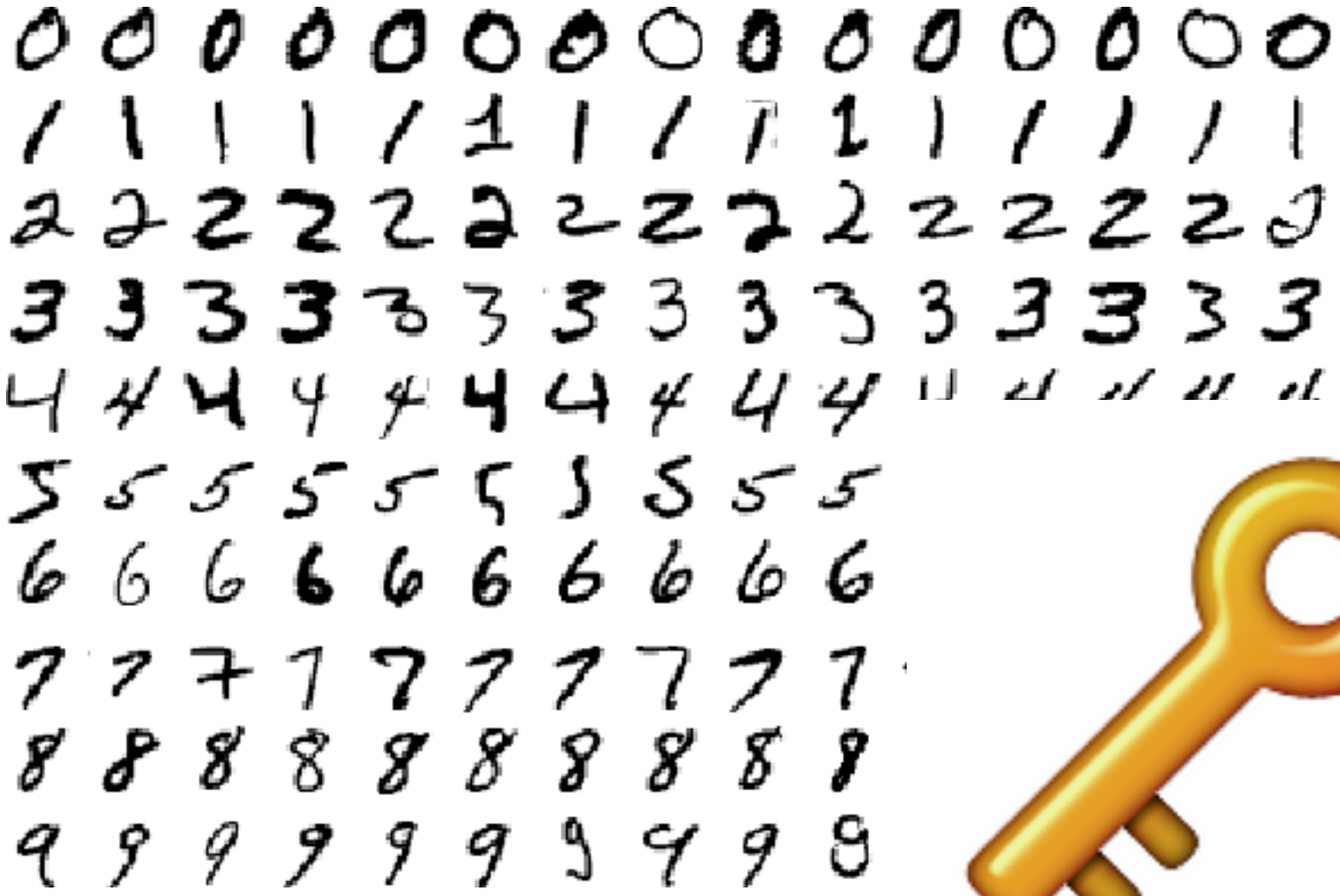
Hidden Neurons

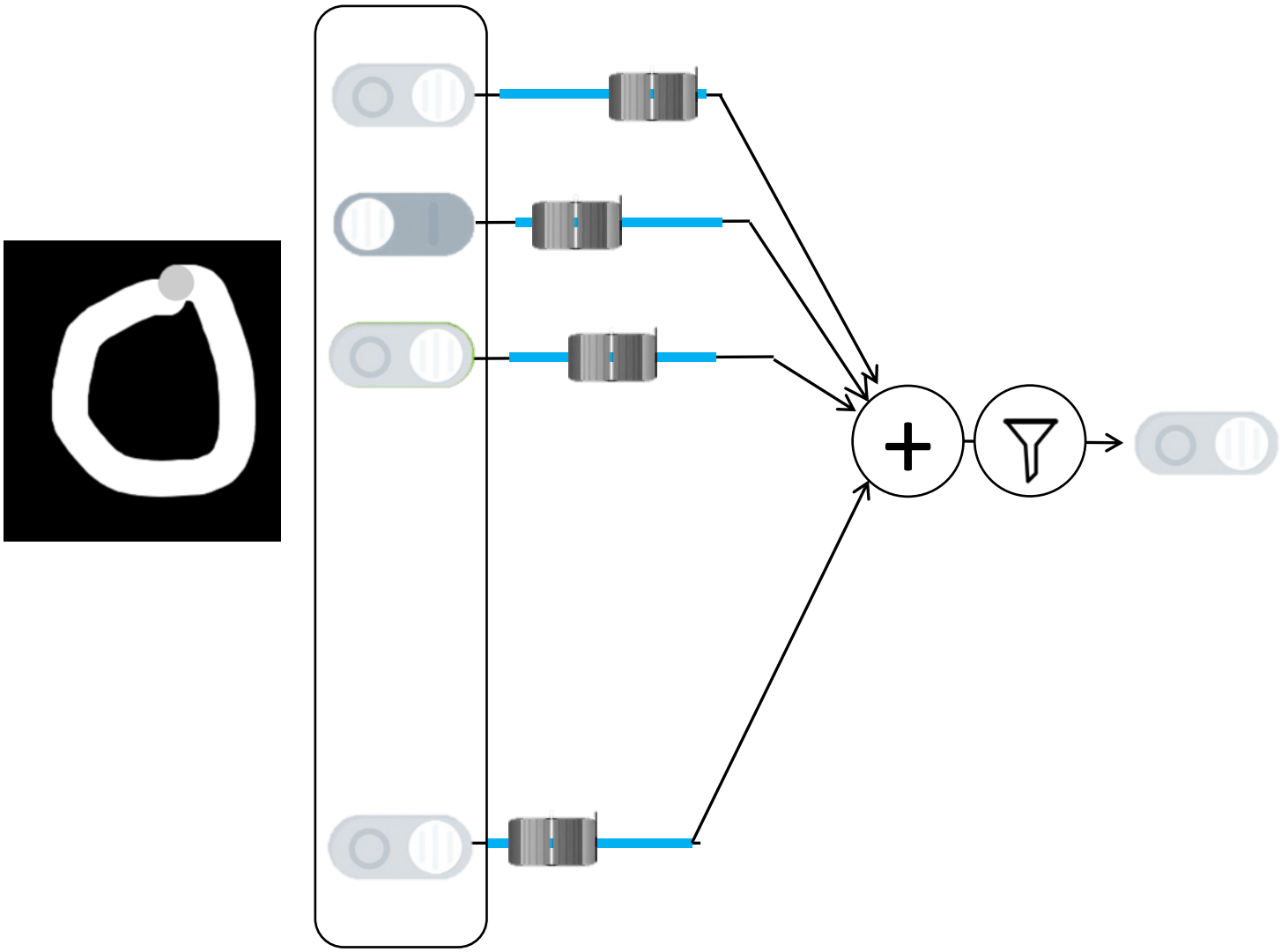
Output Neurons

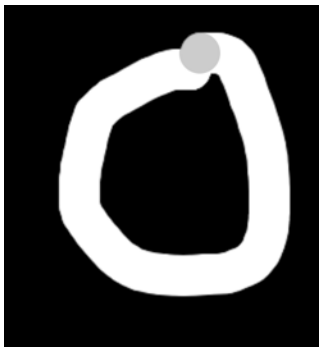
Neural Network

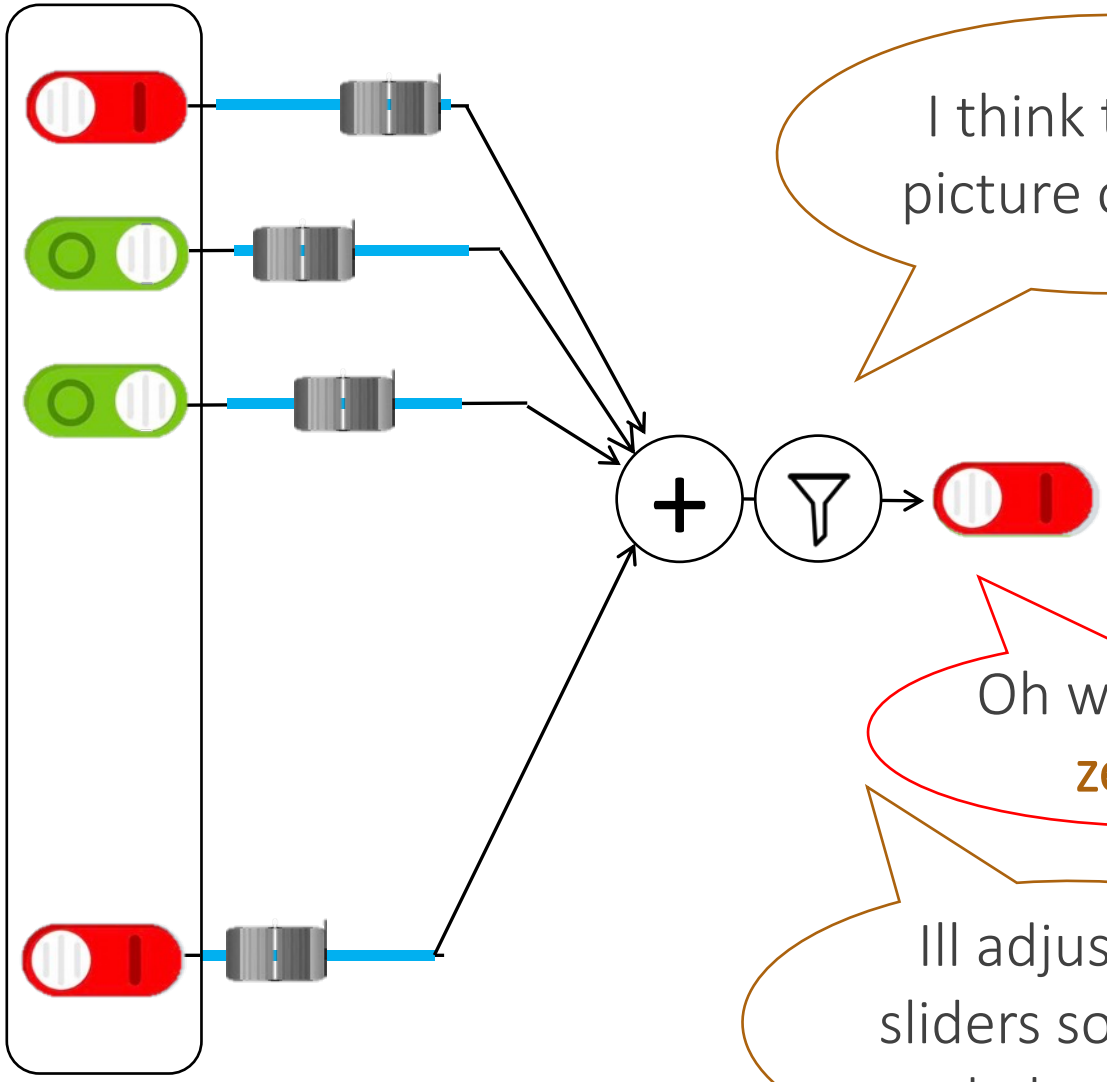


Learn by Example





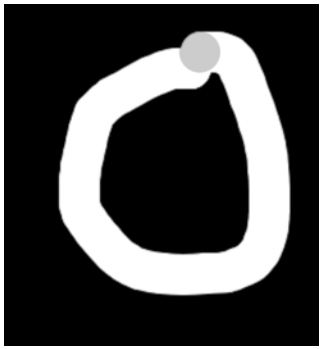


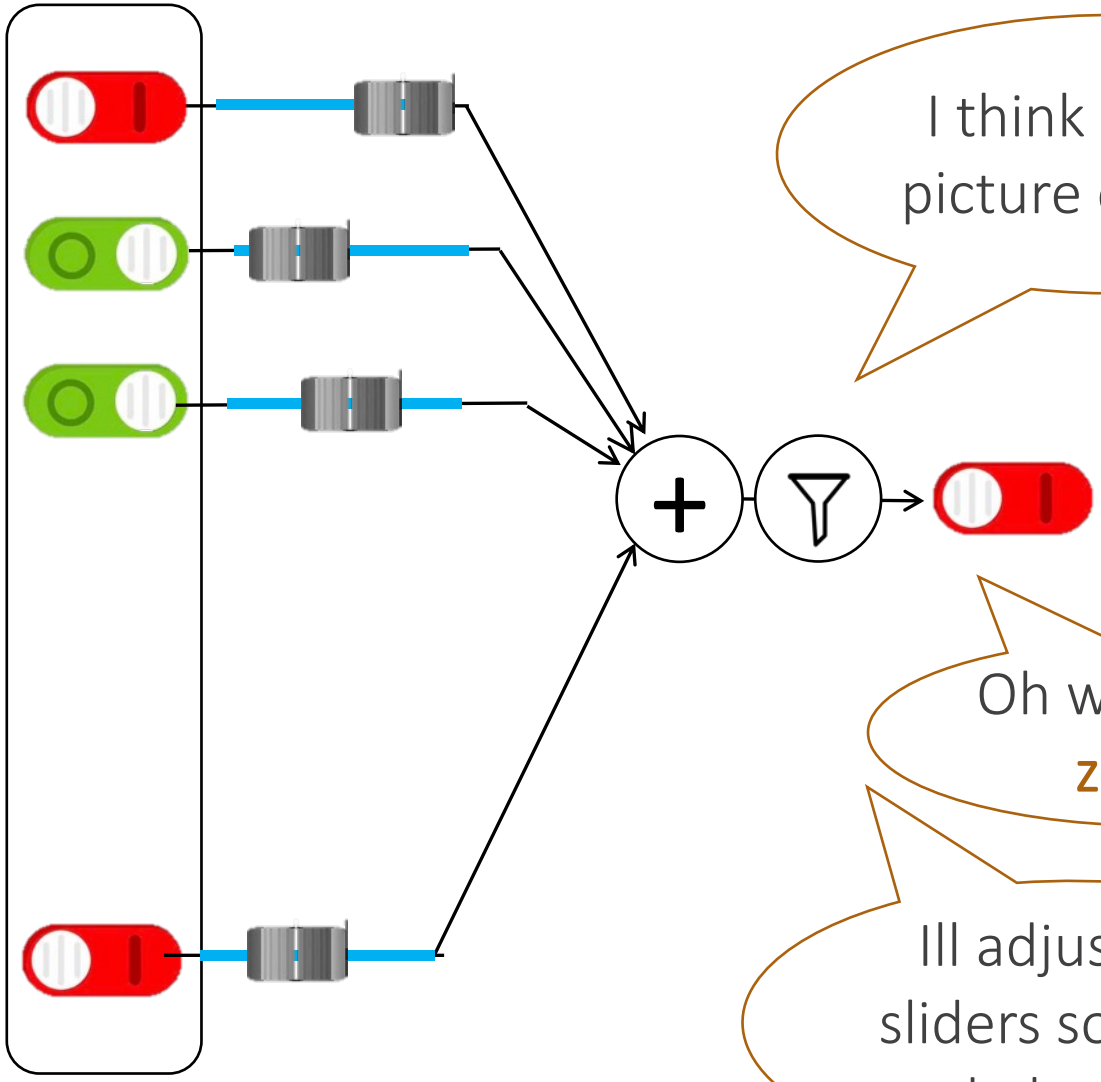


I think that is a picture of a **one**!

Oh what, it's a **zero**??

Ill adjust my sliders so that I do better.





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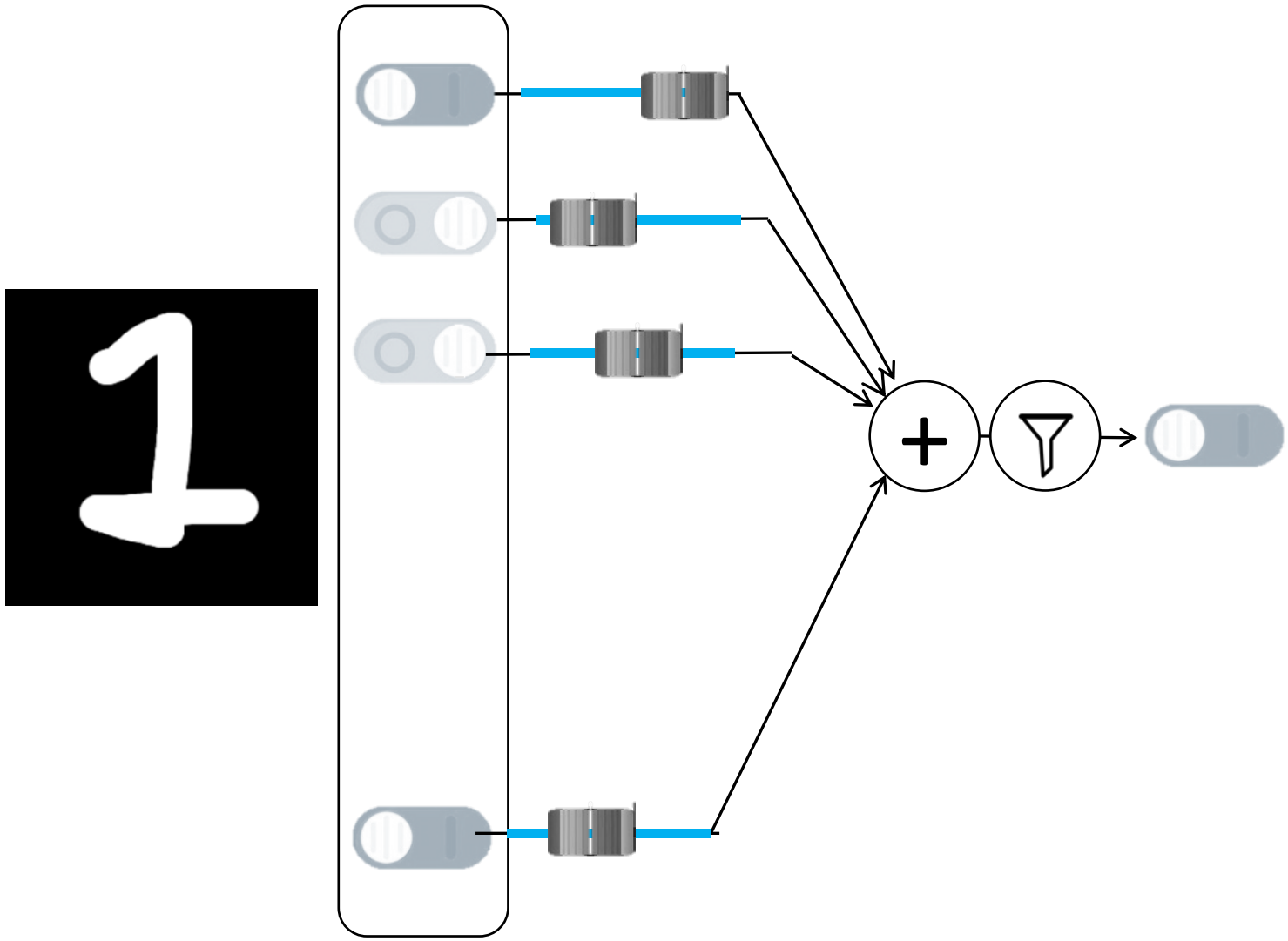
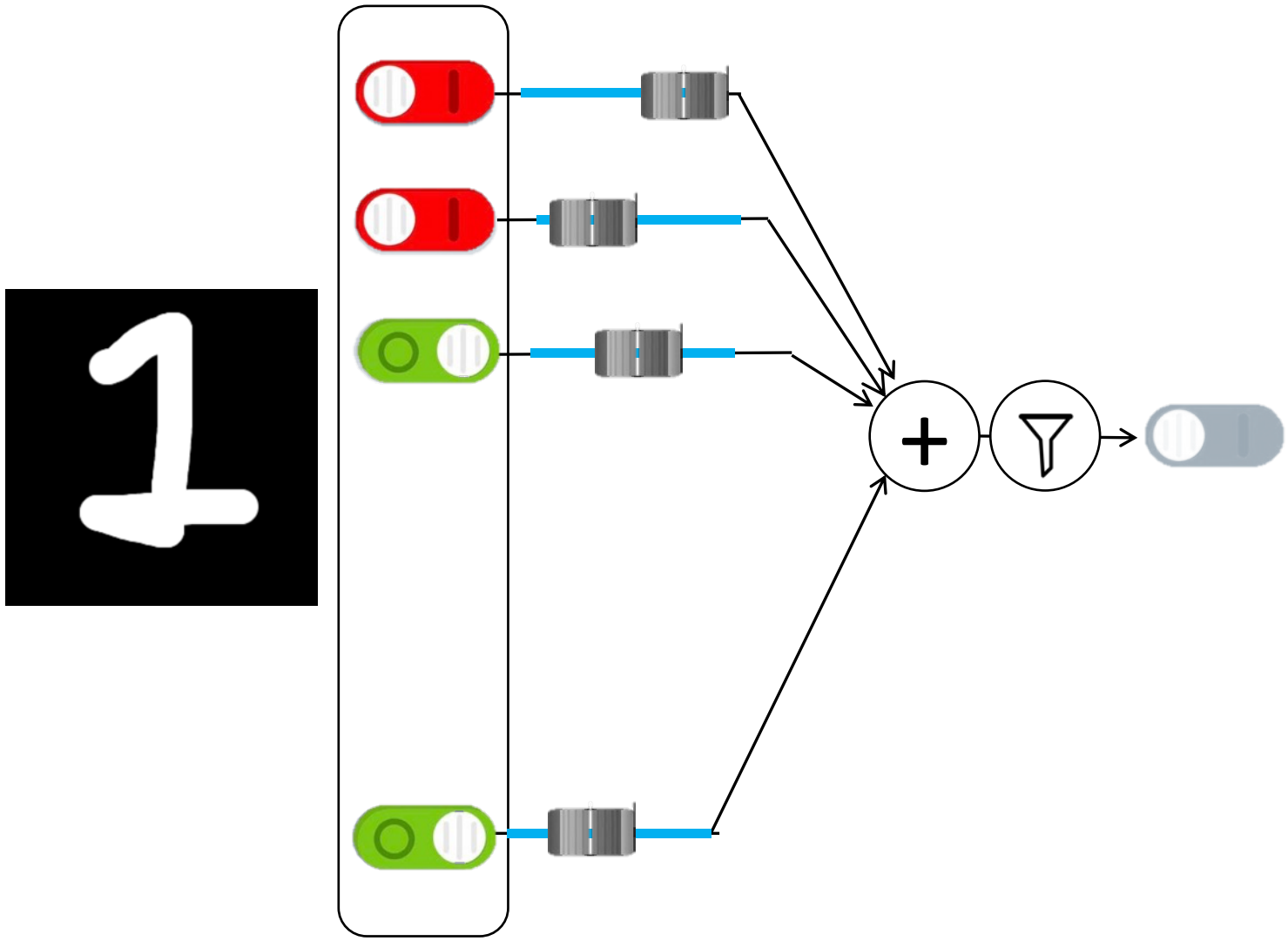
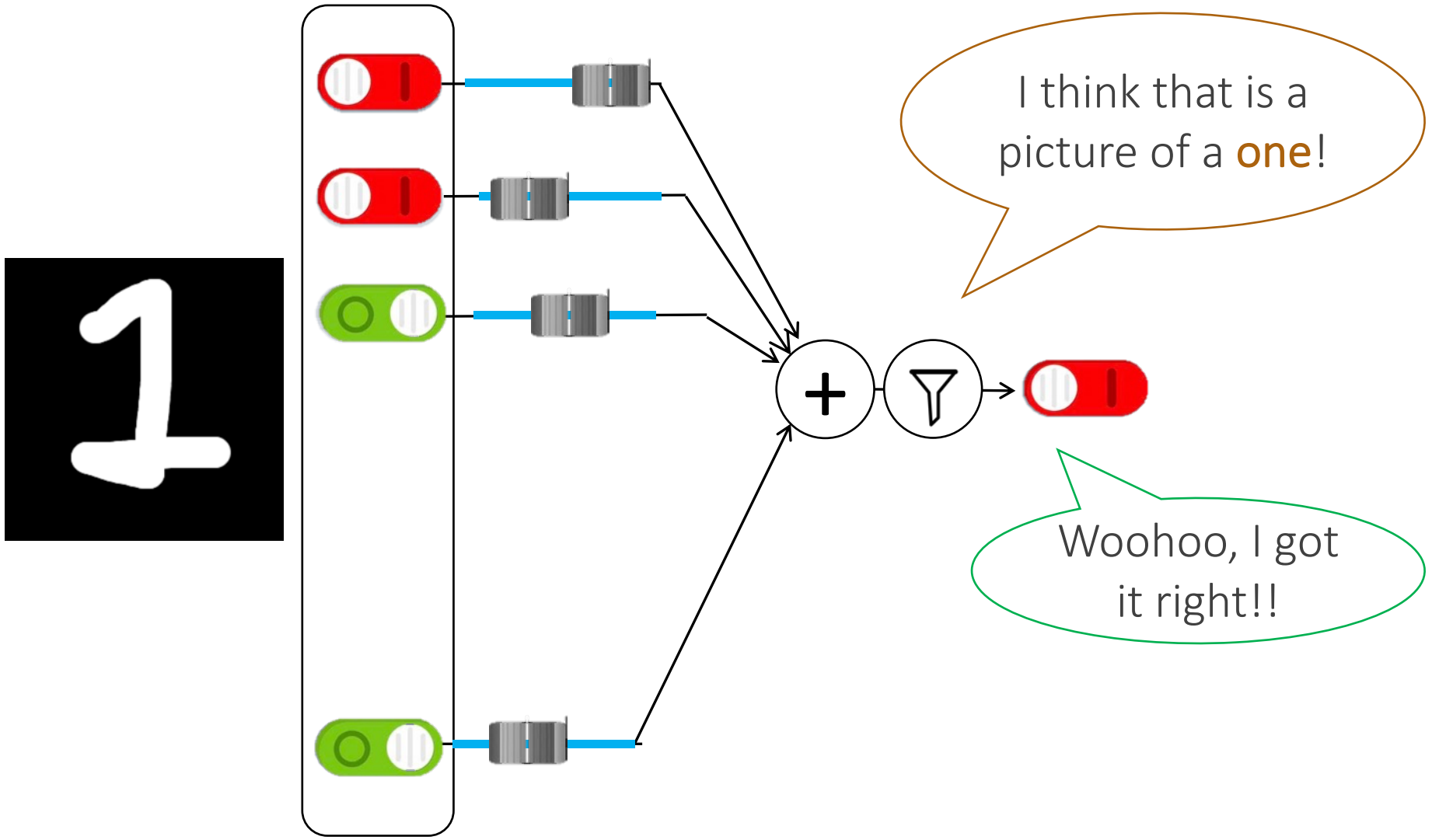
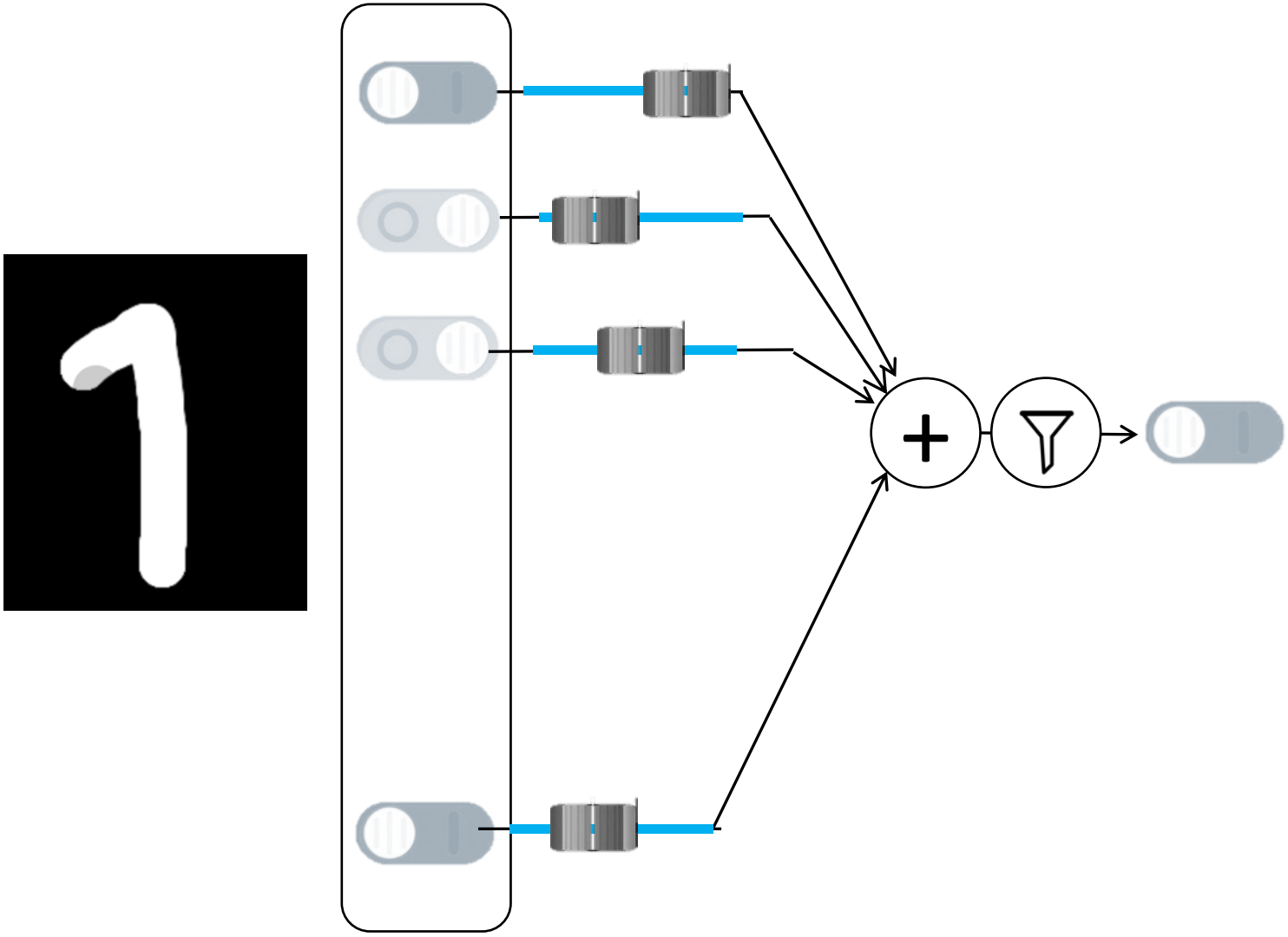
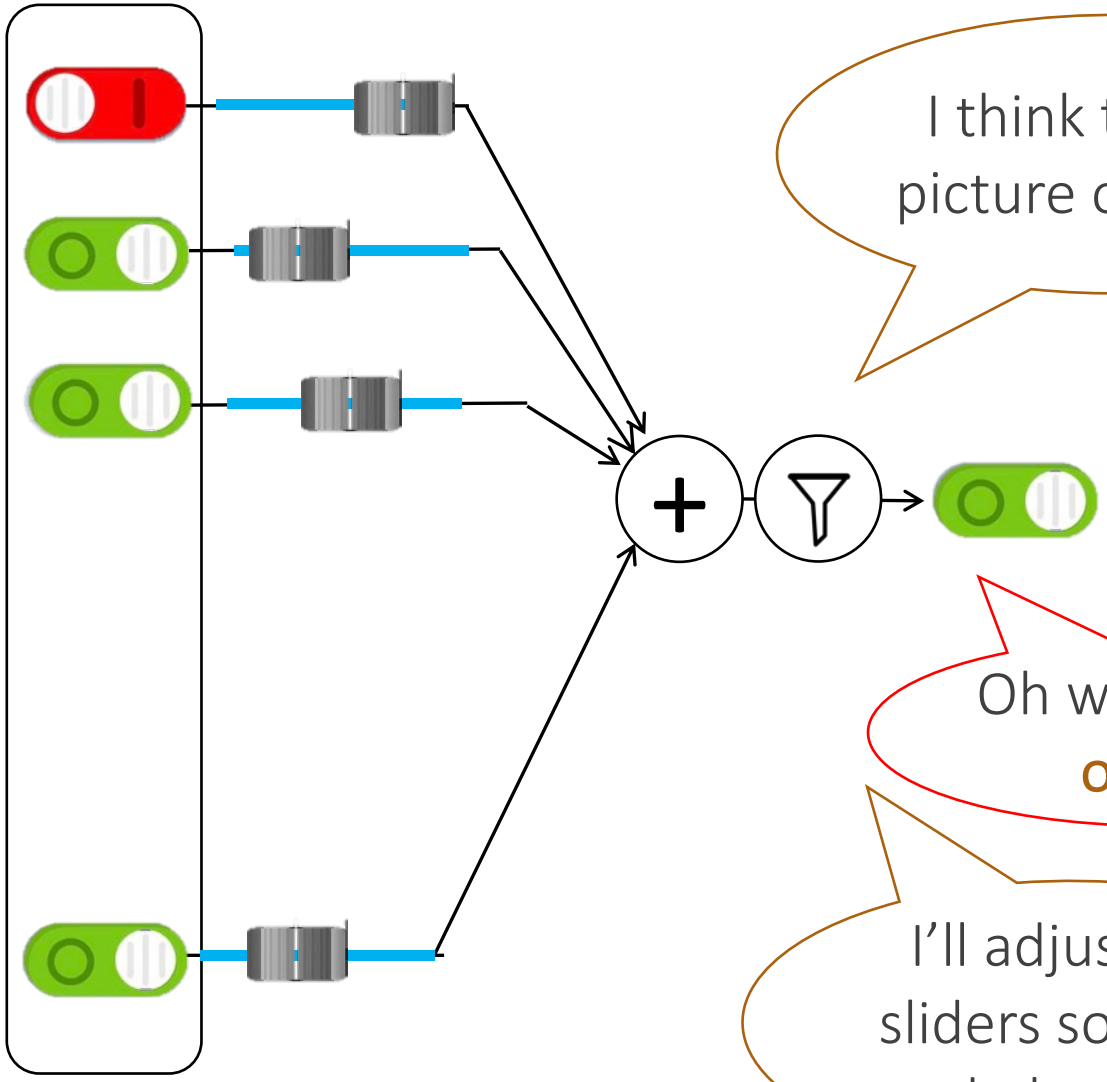





I think that is a picture of a one!
Woohoo, I got it right!!

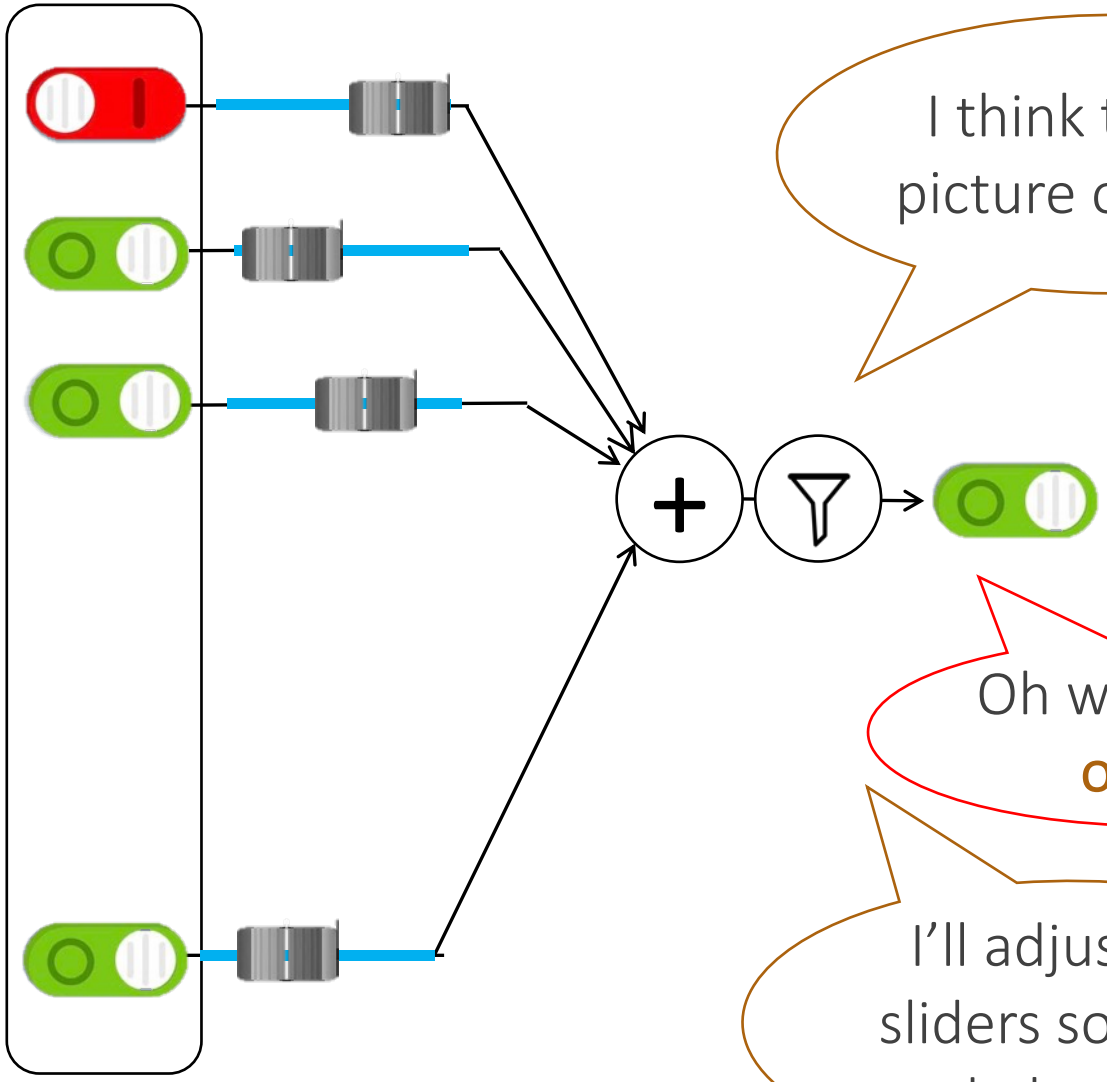




I think that is a picture of a **zero**!

Oh what, it's a **one**??

I'll adjust my sliders so that I do better.



I think that is a picture of a **zero**!

Oh what, it's a **one**??

I'll adjust my sliders so that I do better.

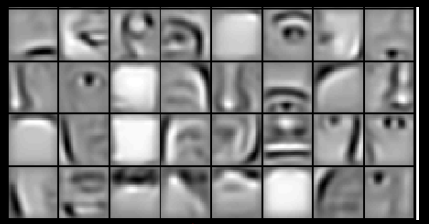
Study Hard!

Train on Faces

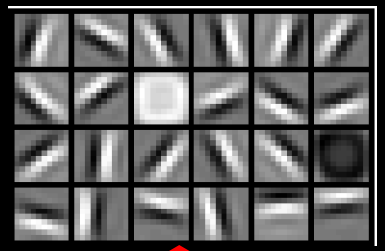
Visualize the Sliders

Training set: Aligned images of faces.

object models



object parts (combination of edges)



edges

pixels

[Honglak Lee]

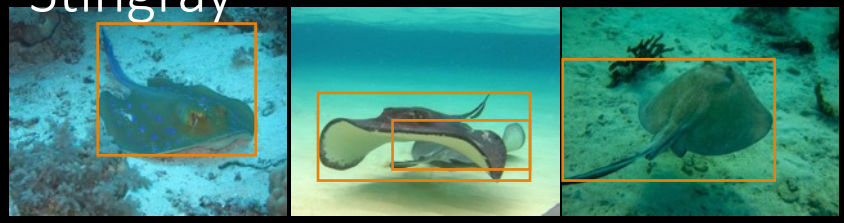
Woah… that’s like a brain…

True.

ImageNet Decomposition

…
smoothhound, smoothhound shark, Mustelus mustelus
American smooth dogfish, Mustelus canis
Florida smoothhound, Mustelus norrisi
whitetip shark, reef whitetip shark, Triaenodon obseus
Atlantic spiny dogfish, Squalus acanthias
Pacific spiny dogfish, Squalus suckleyi
hammerhead, hammerhead shark
smooth hammerhead, Sphyrna zygaena
smalleye hammerhead, Sphyrna tudes
shovelhead, bonnethead, bonnet shark, Sphyrna tiburo
angel shark, angelfish, Squatina squatina, monkfish
electric ray, crampfish, numbfish, torpedo
smalltooth sawfish, Pristis pectinatus
guitarfish
roughtail stingray, Dasyatis centroura
butterfly ray
eagle ray
spotted eagle ray, spotted ray, Aetobatus narinari
cownose ray, cow-nosed ray, Rhinoptera bonasus
manta, manta ray, devilfish
Atlantic manta, Manta birostris
devil ray, Mobula hypostoma
grey skate, gray skate, Raja batis
little skate, Raja erinacea
…

Stingray



Mantaray

0.005%

Random guess

1.5%

Pre Neural Networks (2012)

43.9%

GoogLeNet (2015)

73.1%

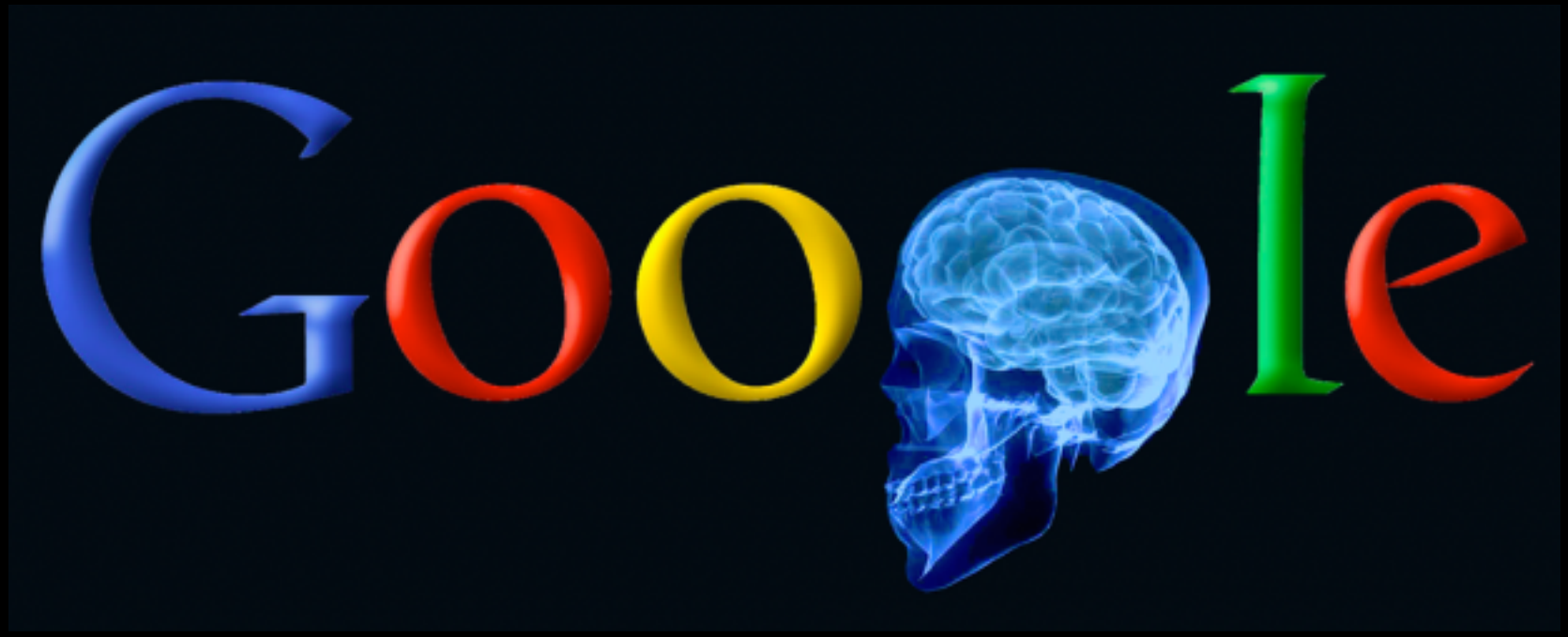
2017

Le, et al., *Building high-level features using large-scale unsupervised learning*. ICML 2012

Szegedy et al, Going Deeper With Convolutions, CVPR 2015

http://image-net.org/challenges/LSVRC/2017/results

Google Brain



1 Trillion Artificial Neurons

(btw, human brains have 1 billion neurons)

A Neuron That Fires When It Sees Cats

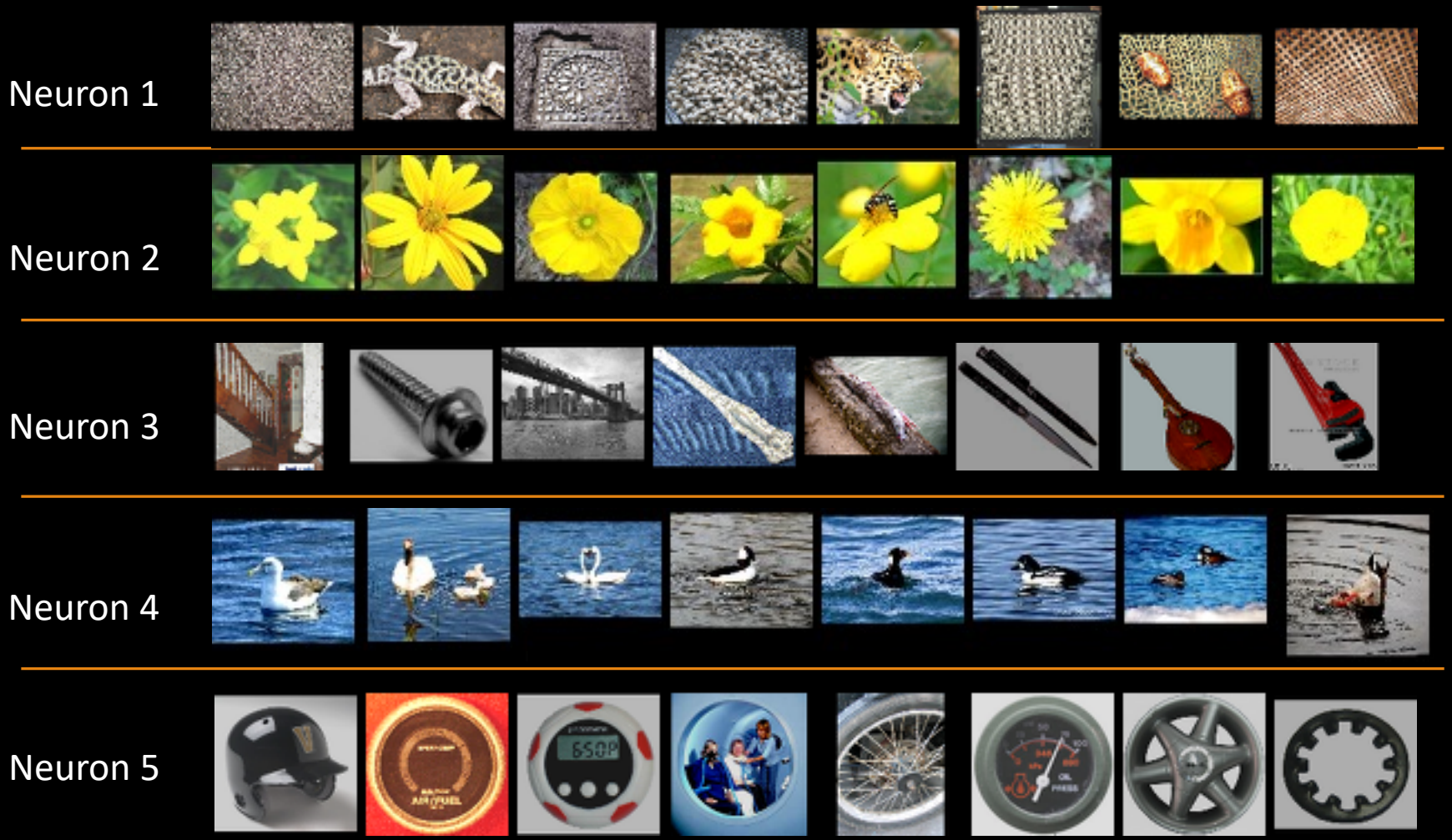
Top stimuli from the test set

Optimal stimulus
by numerical optimization

Le, et al., *Building high-level features using large-scale unsupervised learning*. ICML 2012

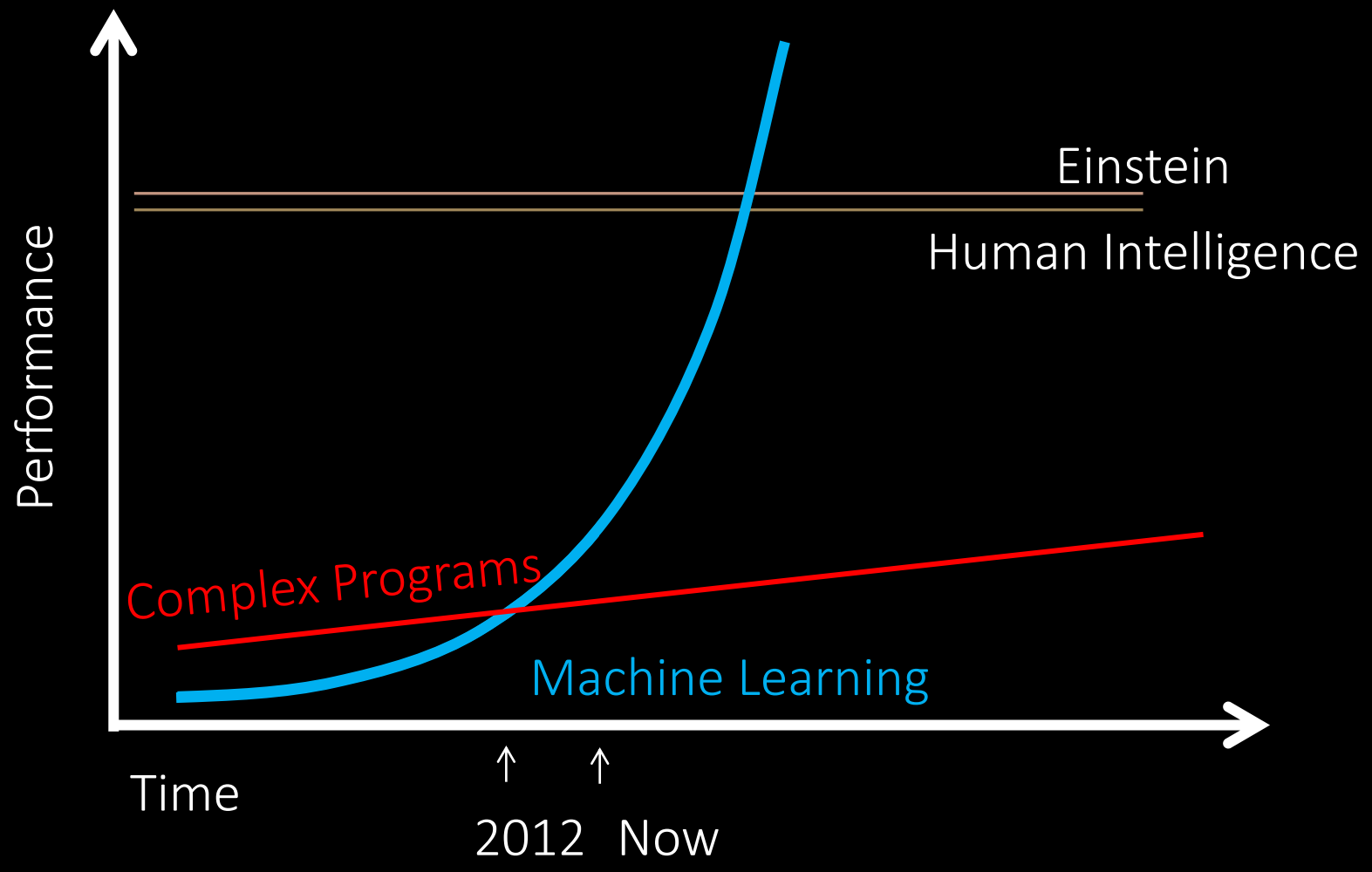

HIRE THE SMARTEST PEOPLE IN THE WORLD
INVENT CAT DETECTOR
memegenerator.net

Other Neurons



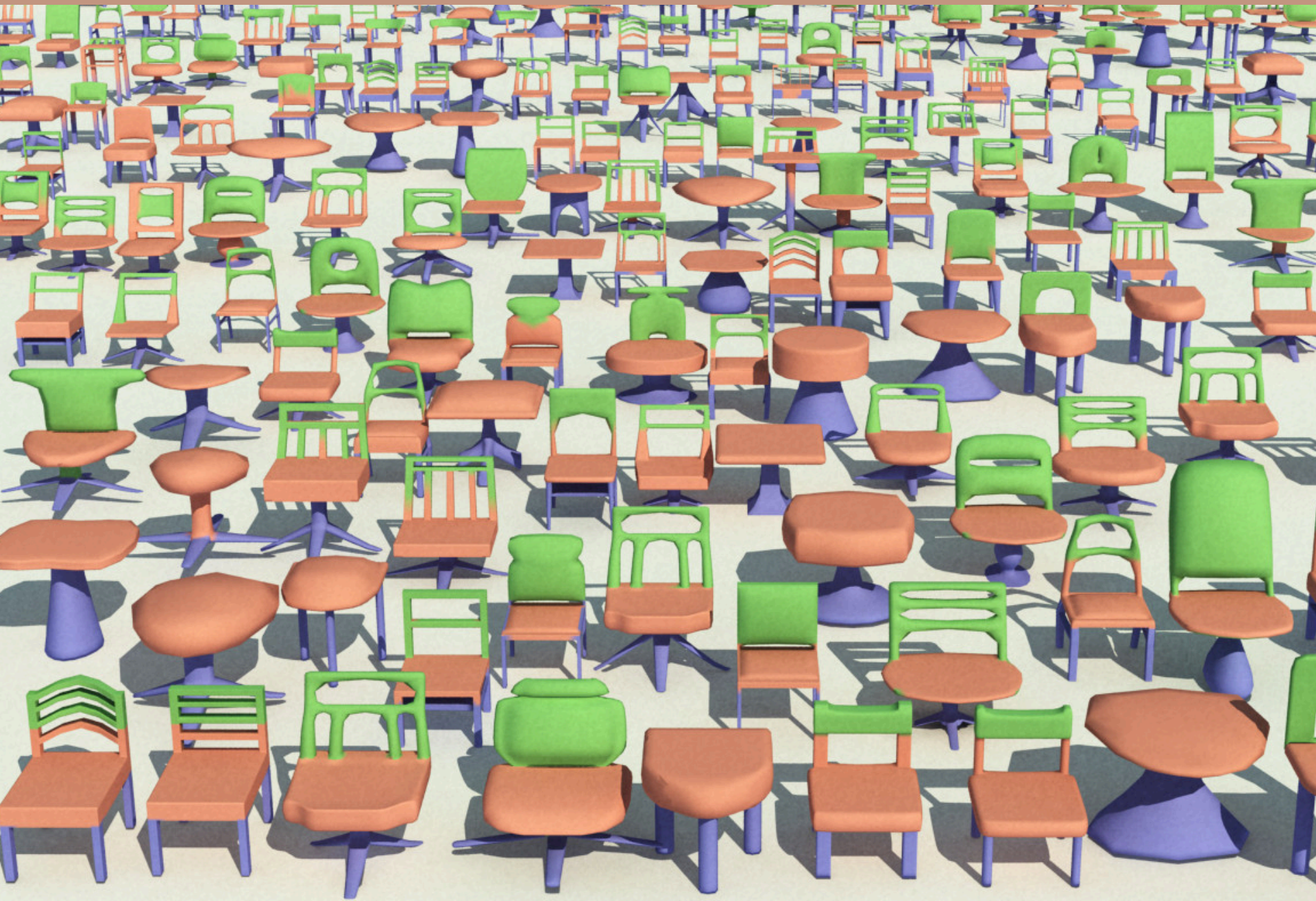
Le, et al., *Building high-level features using large-scale unsupervised learning*. ICML 2012

The Future of AI

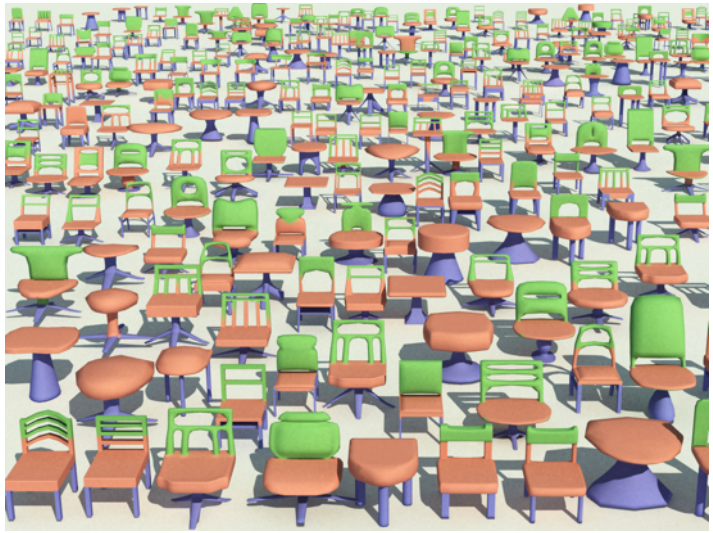


What’s the catch?

(1) Machine Learning Needs Data

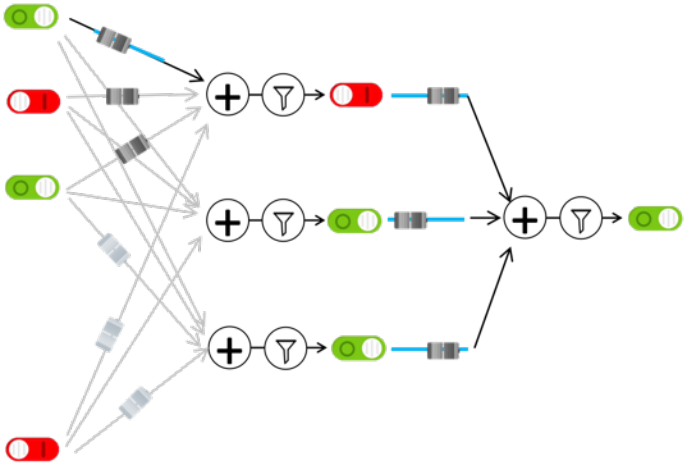


(1) Machine Learning Needs Data



(1) Get Data

Compiled by humans

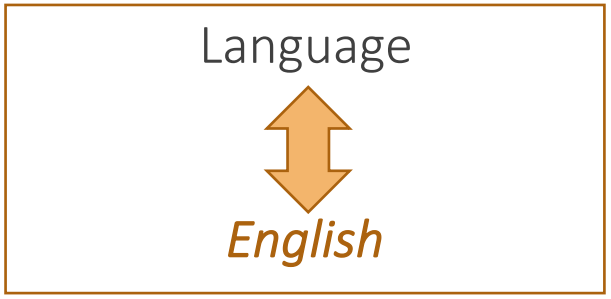


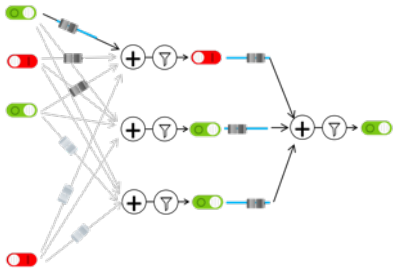
(2) Train computer

Math and logic

(1) Machine Learning Needs Data

Machine Translation





(1) Get Data

(2) Train computer

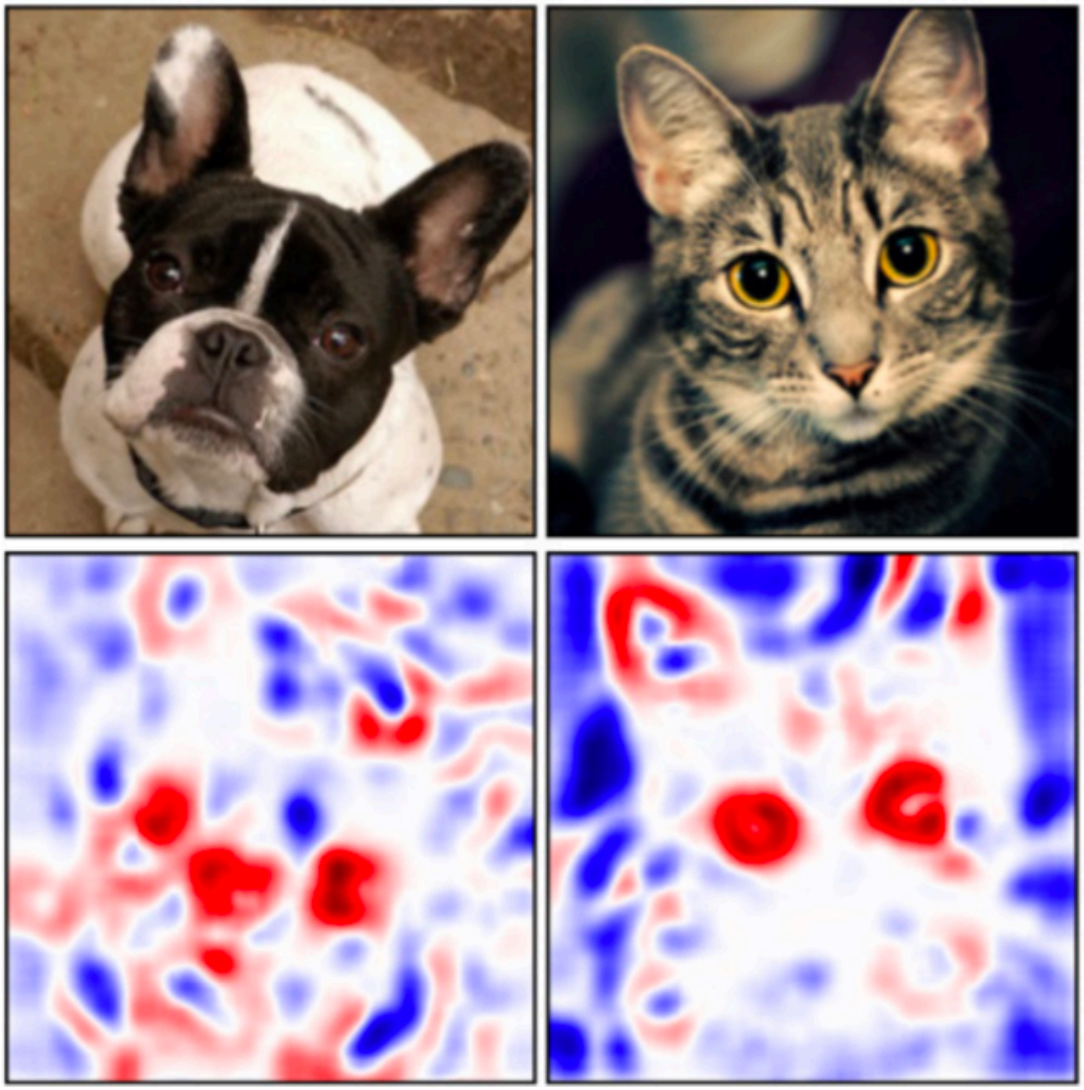
Language	# challenges
German	7
Czech	6.5
Russian	6
Finnish	5
French,Turkish,Chinese	3
German-Czech	1

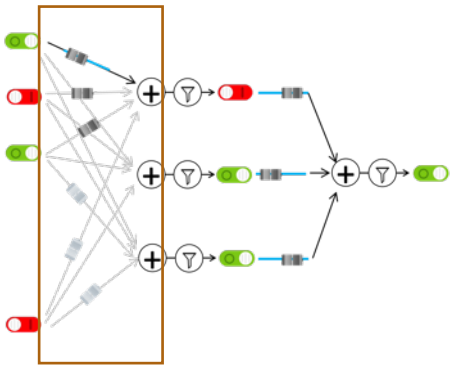
One-time appearances:
Hindi, Spanish, Lithuanian,
Romanian, Latvian, Estonian, Gujarati

Because the engineers all speak English!

Conference in Machine Translation (WMT), since 2013 http://www.statmt.org/wmt19/

(2) How can we explain decisions?





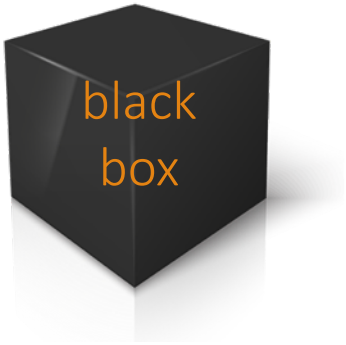
Visualize sliders

Zintgraf et al., *Visualizing Deep Neural Network Decisions: Prediction Difference Analysis,* ICLR 2017

(2) How can we explain decisions?

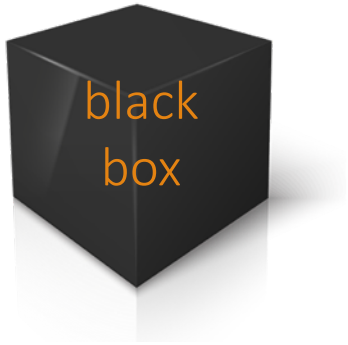
That is a picture of a one!

(probably fine)



(2) How can we explain decisions?

This person is dangerous!



(not fine)

(3) How can we make it fair?

$$\overrightarrow{\text{man}} - \overrightarrow{\text{woman}} \approx \overrightarrow{\text{king}} - \overrightarrow{\text{queen}}$$

$$\overrightarrow{\text{man}} - \overrightarrow{\text{woman}} \approx \overrightarrow{\text{computer programmer}} - \overrightarrow{\text{homemaker}}.$$

Should our data reflect society's systemic bias?

Bolukbasi et al., *Man is to Computer Programmer as Woman is to Homemaker? Debiasing Word Embeddings,* NIPS 2016

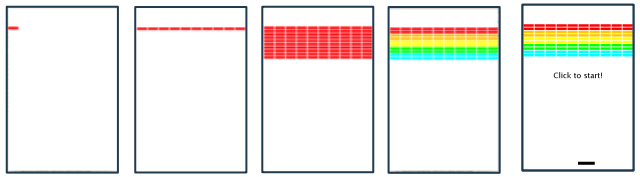
Dataset: Google News

The current challenge

Understand data.

Then train your model.

Then make your system usable for *real people*.



- Quickly set up the bricks
- Spent 2 hrs implementing mouse interactor

Tracy

I can help you better!

Instructor

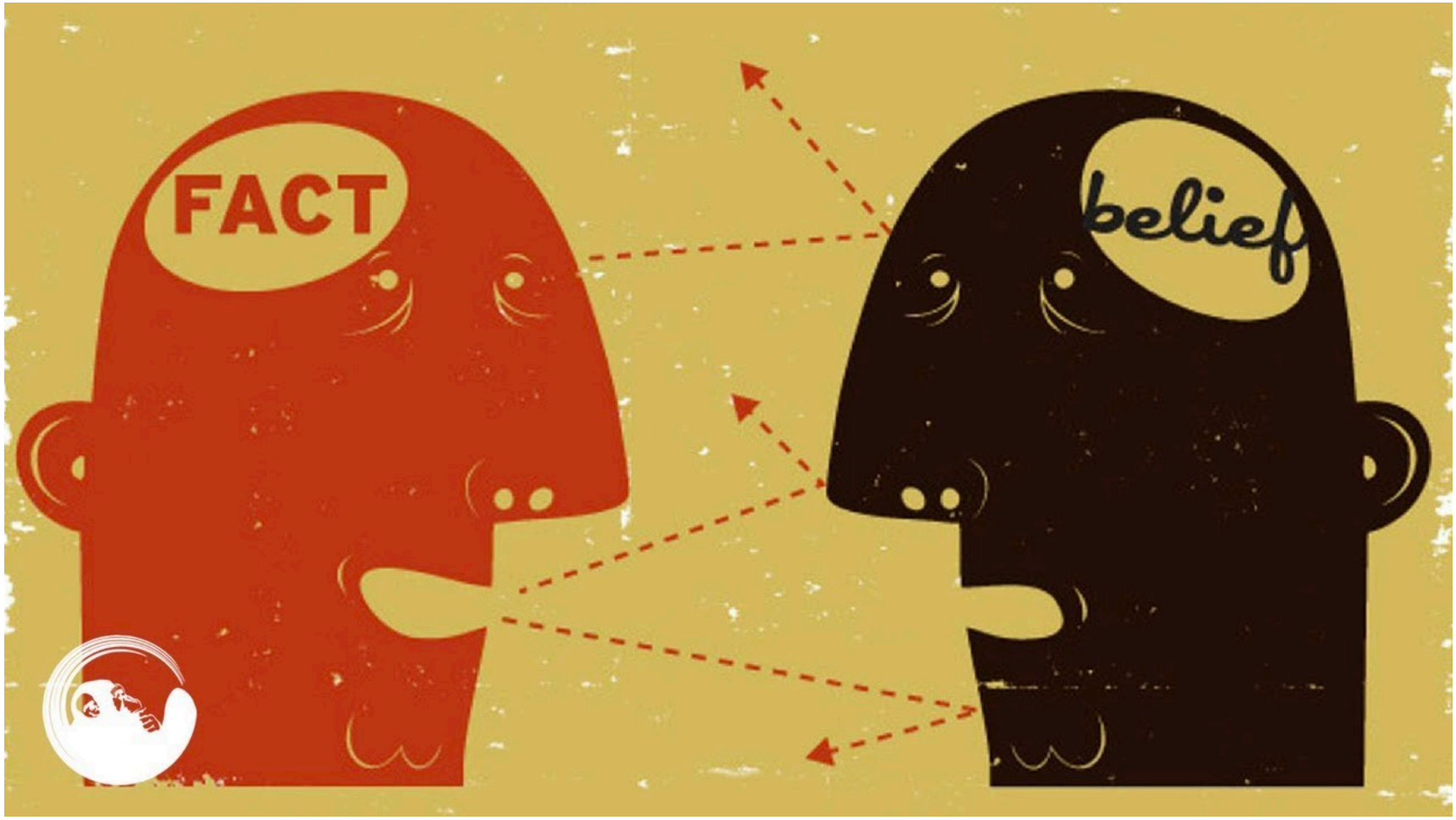
Where is my robot?

… coming soon

You can help

A little math

You can help



Understand; don’t assume

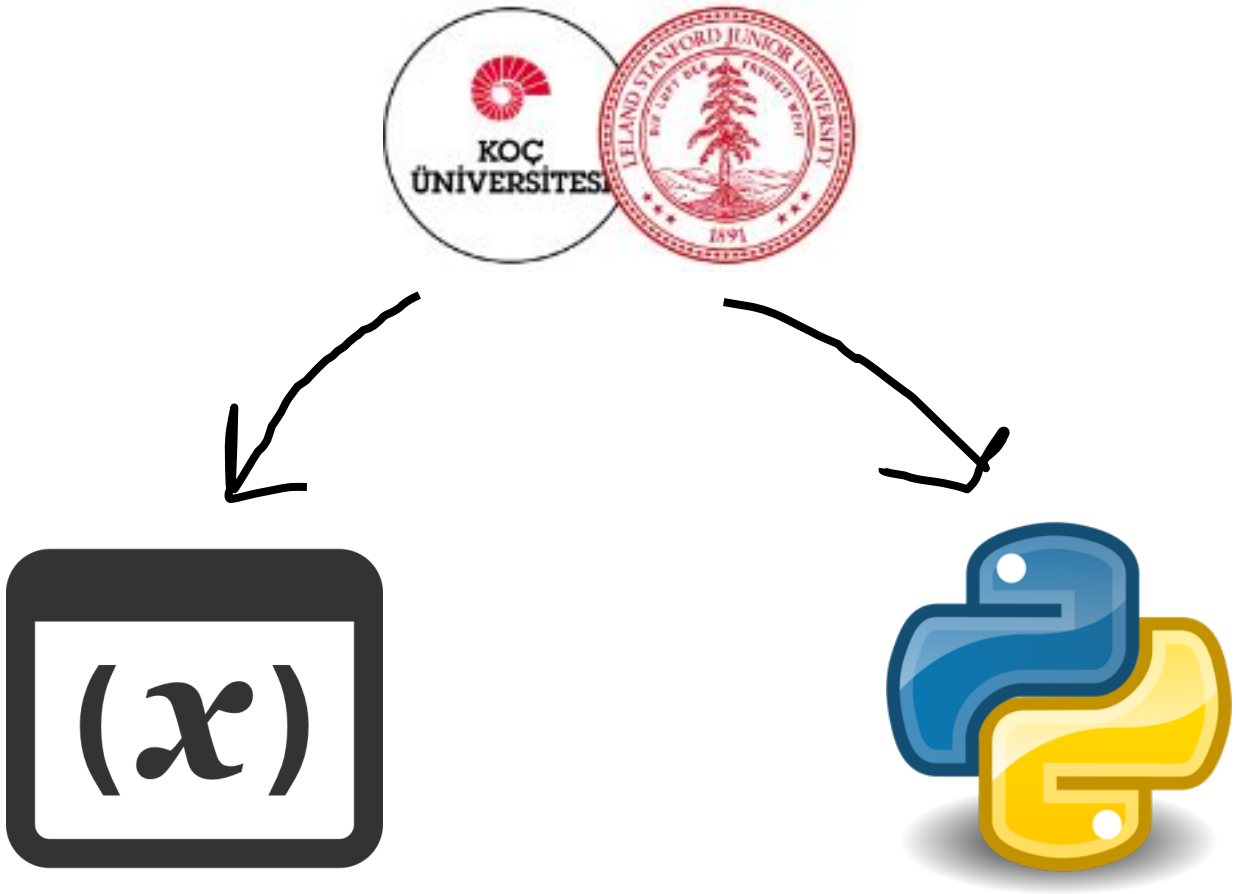
Can you do it?

(I explained to you the main components)

Not easy…

But yes. You can.

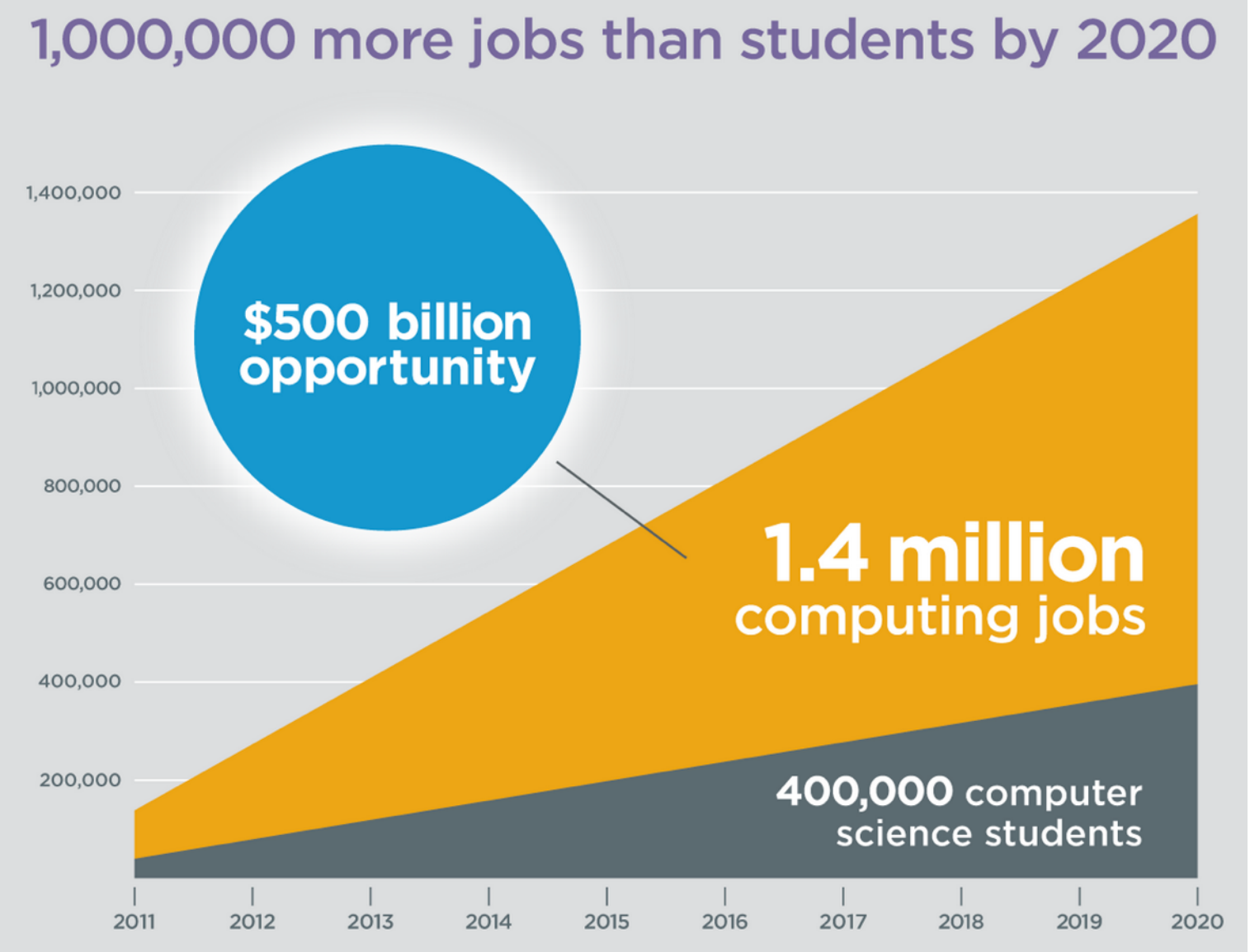
Path to AI


KOÇ
ÜNİVERSİTESİ
LELAND STANFORD JUNIOR UNIVERSITY
1891
(x)

Why?

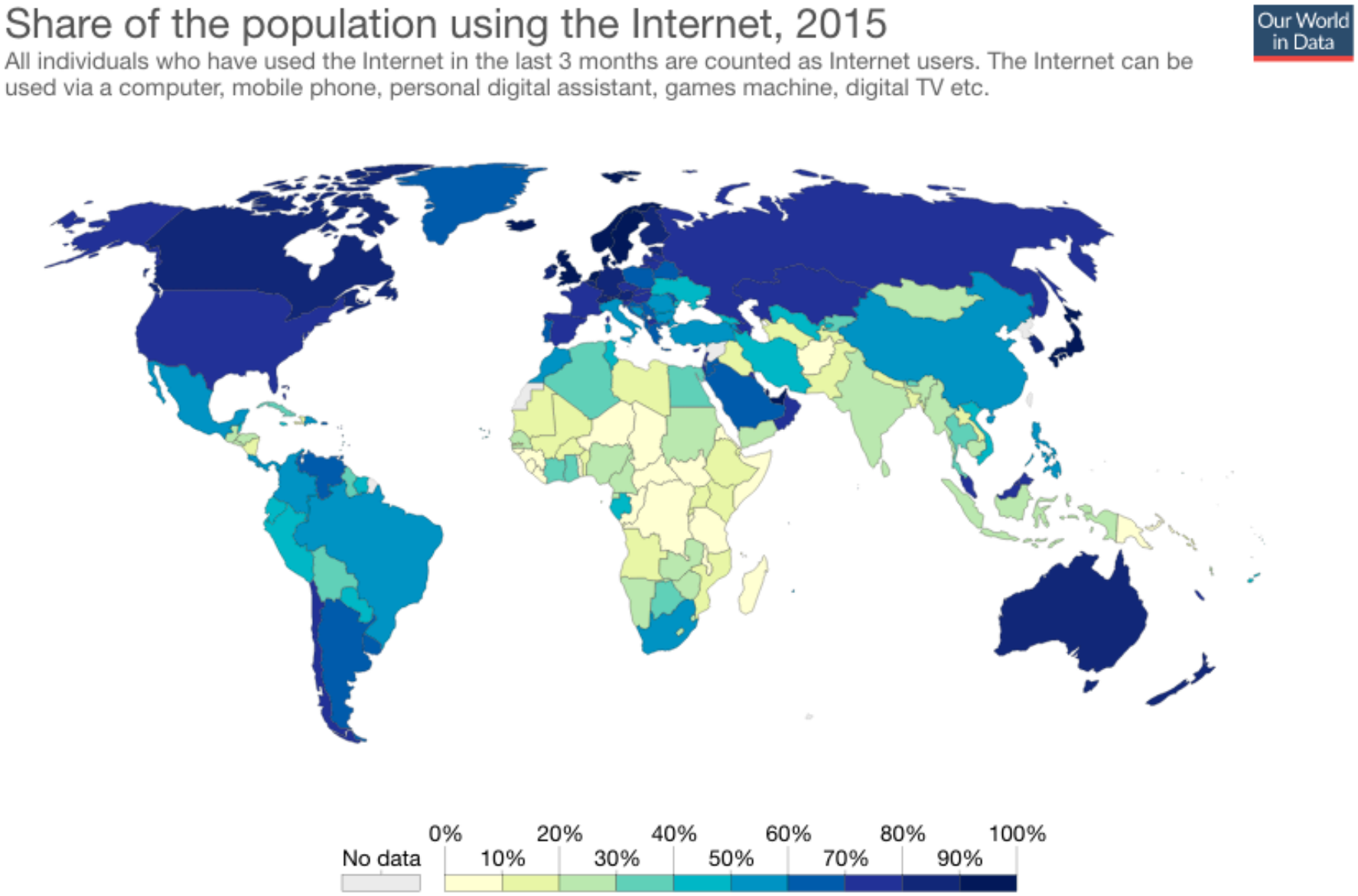
Closest Thing To Magic

It's Useful



Code.org

It should fit your culture



(make it so that) Everyone is Welcome


The End?
Submit your projects by 6pm!