Beyond CS106A

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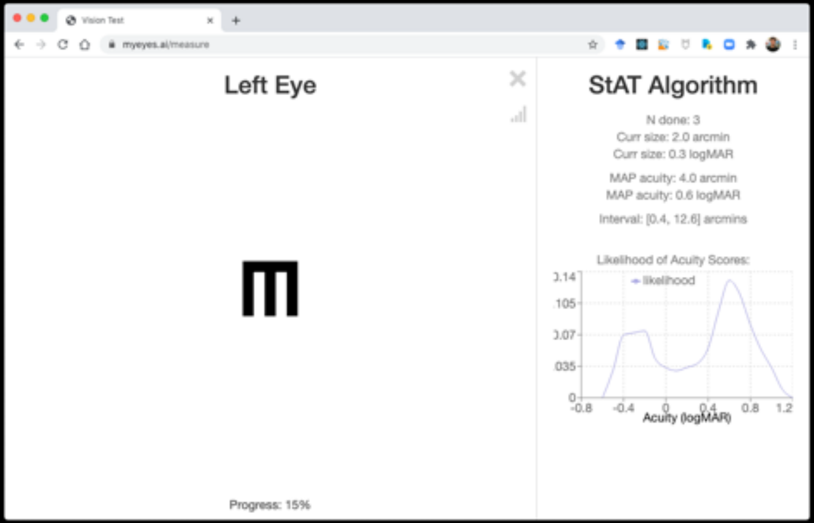
CS106A, Stanford University

You all have your own **identity**
and goals.

CS is a versatile tool.

Life beyond CS106A?
Learn more so you can
express yourself.

I should be blind!



Left Eye

Progress: 15%

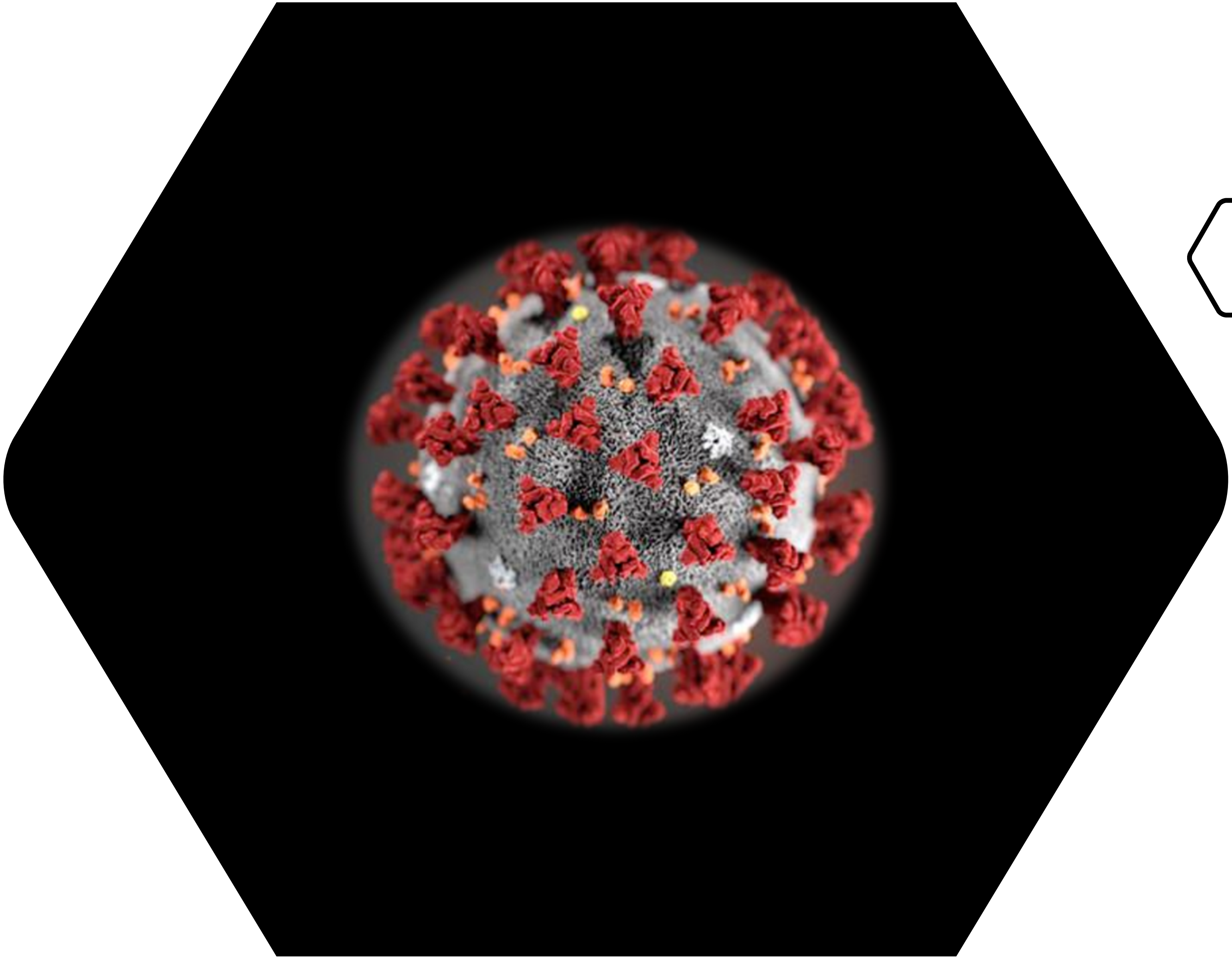
StAT Algorithm

N done: 3
Curr size: 2.0 arcmin
Curr size: 0.3 logMAR

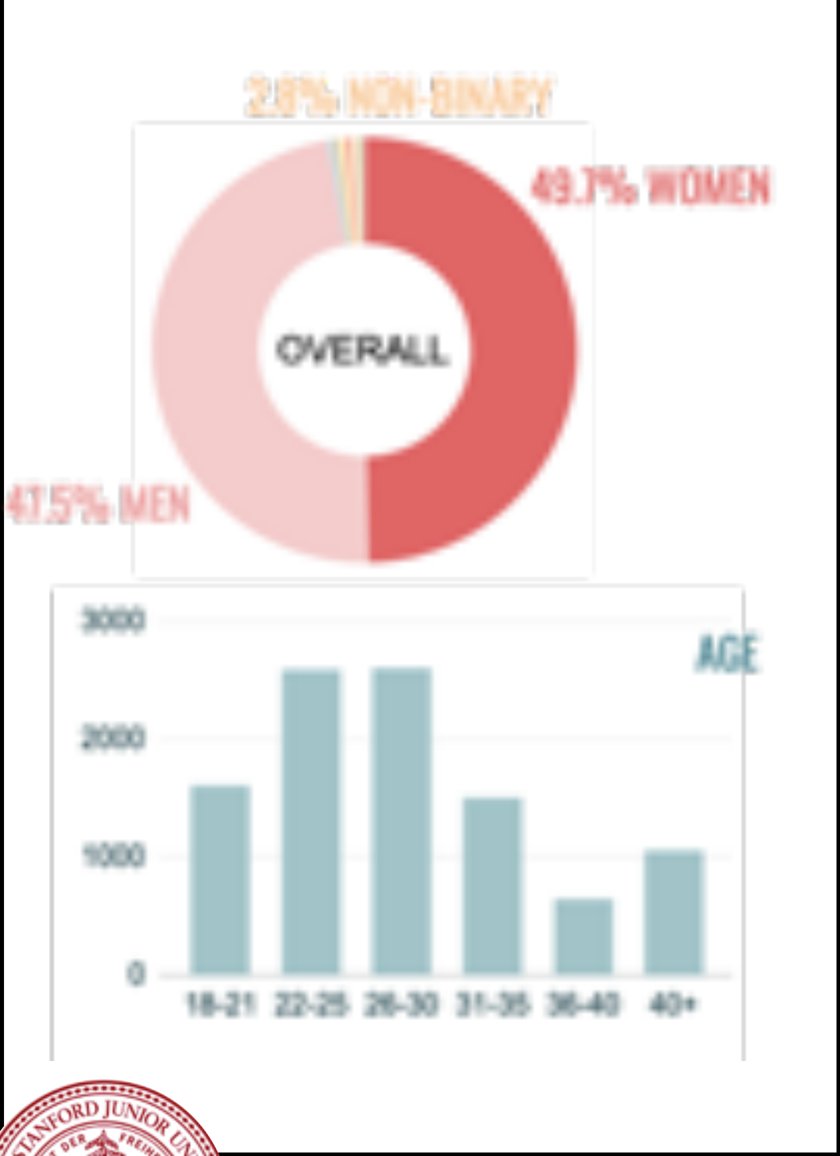
MAP acuity: 4.0 arcmin
MAP acuity: 0.6 logMAR

Interval: [0.4, 12.6] arcmins

Likelihood of Acuity Scores:



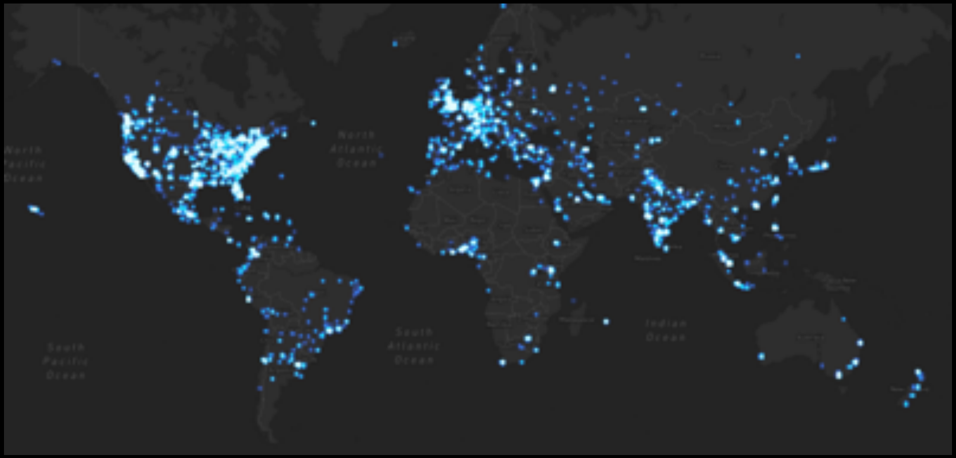
Code in Place : Course with the most section leaders?



1,000 volunteer section leaders teach

10,000 students

First half of Stanford CS106A



20% experienced job loss or home loss

10x retention vs baseline MOOC

6k hours of live teaching

60k hours of lecture watched

Better CS106A for Stanford students

The magnitude of people who **want to teach** is roughly proportional to the magnitude of people who **want to learn**.

Teaching is **learning**

Teaching is **joyful**

The education community has barely scratched the surface of the **potential** in this claim.

Some of our best teachers were students who had only taken CS106A

Have you thought about teaching?

Great way to learn
Great way to give back

1. How to make your own project
2. What other languages look like
3. Deep Learning in Python

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Programming Languages

Python

```
evens = []
for i in range(100):
    if i % 2 == 0:
        evens.append(i)
print(evens)
```

prints [2, 4, 6, 8, 10, 12, …]

C++

```
Vector<double> evens;
for(int i = 0; i < 100; i++) {
    if(i % 2 == 0) {
        evens.add(i);
    }
}
cout << evens << endl;
```

prints [2, 4, 6, 8, 10, 12, …]

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        evens.add(i);
    }
}
cout << evens << endl;
```

```
prints [2, 4, 6, 8, 10, 12, … ]
```

Java

```
ArrayList<Double> evens = new ArrayList<Double>();
for(int i = 0; i < 100; i++) {
    if(i % 2 == 0) {
        evens.add(i);
    }
}
println(evens);
```

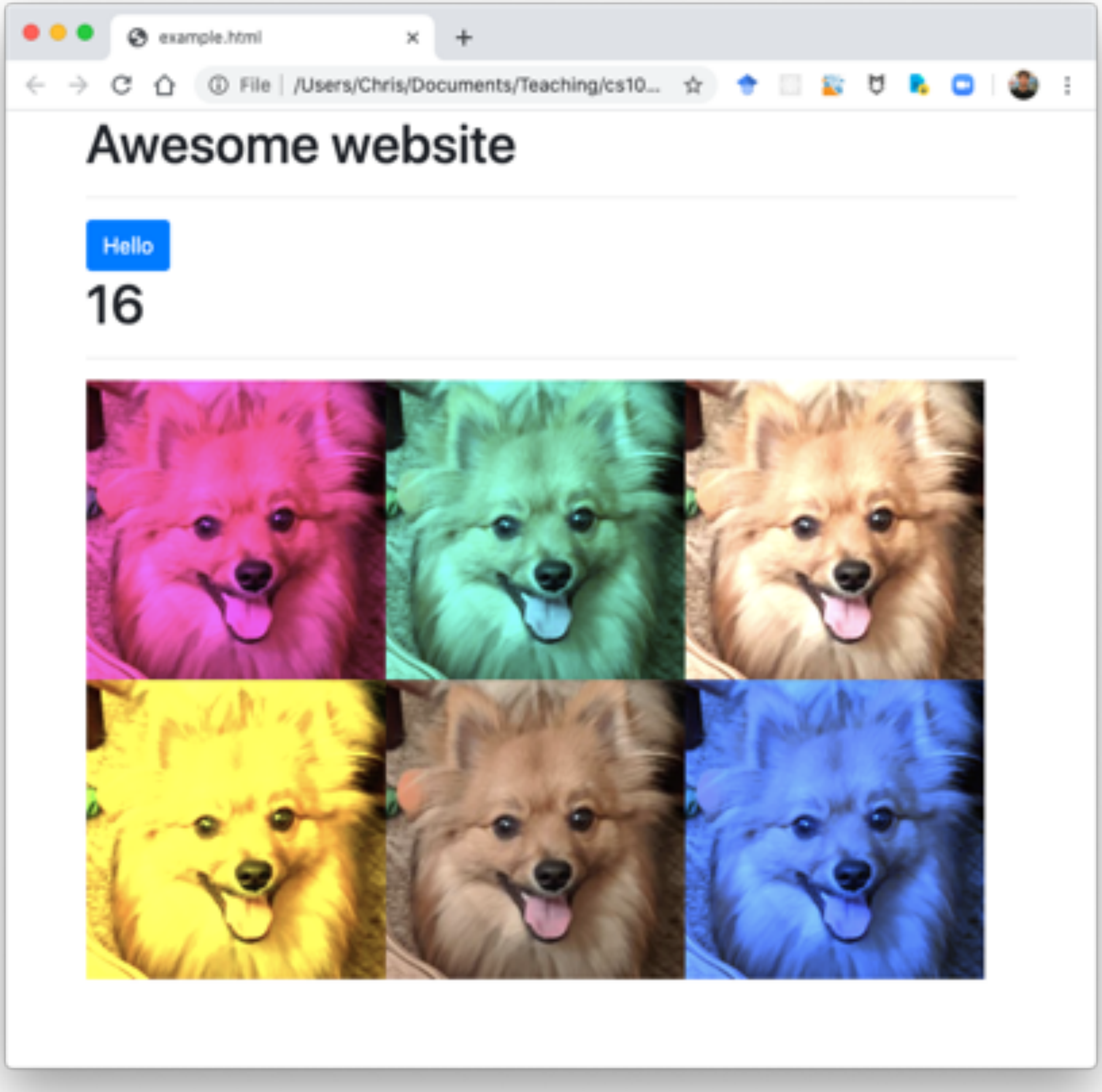
```
prints [2, 4, 6, 8, 10, 12, … ]
```

Javascript

```
var evens = []
for(var i = 0; i < 100; i++) {
    if(i % 2 == 0) {
        evens.push(i)
    }
}
console.log(evens)
```

prints [2, 4, 6, 8, 10, 12, …]

Lets Play



Awesome website

16

There is something going on
in the world of AI

[suspense]

Self Driving Cars

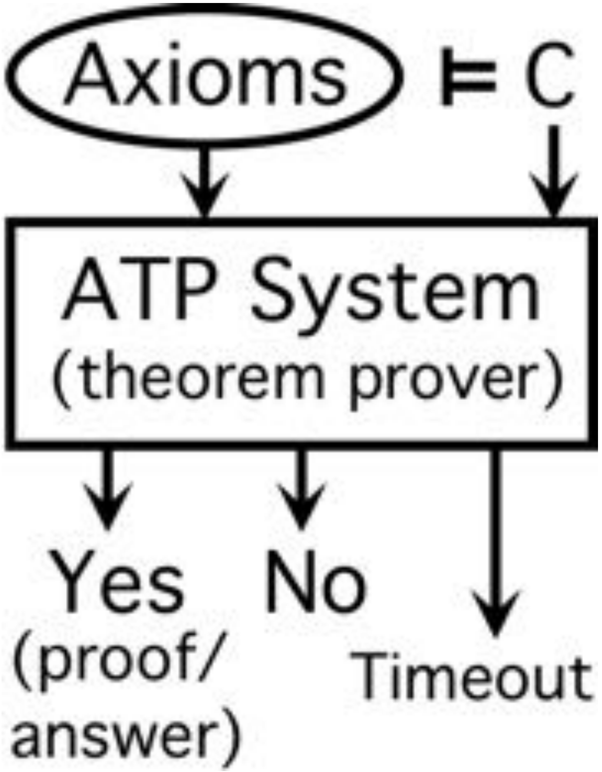
Computers Making Art

The Last Remaining Board Game

Early Optimism 1950

1952

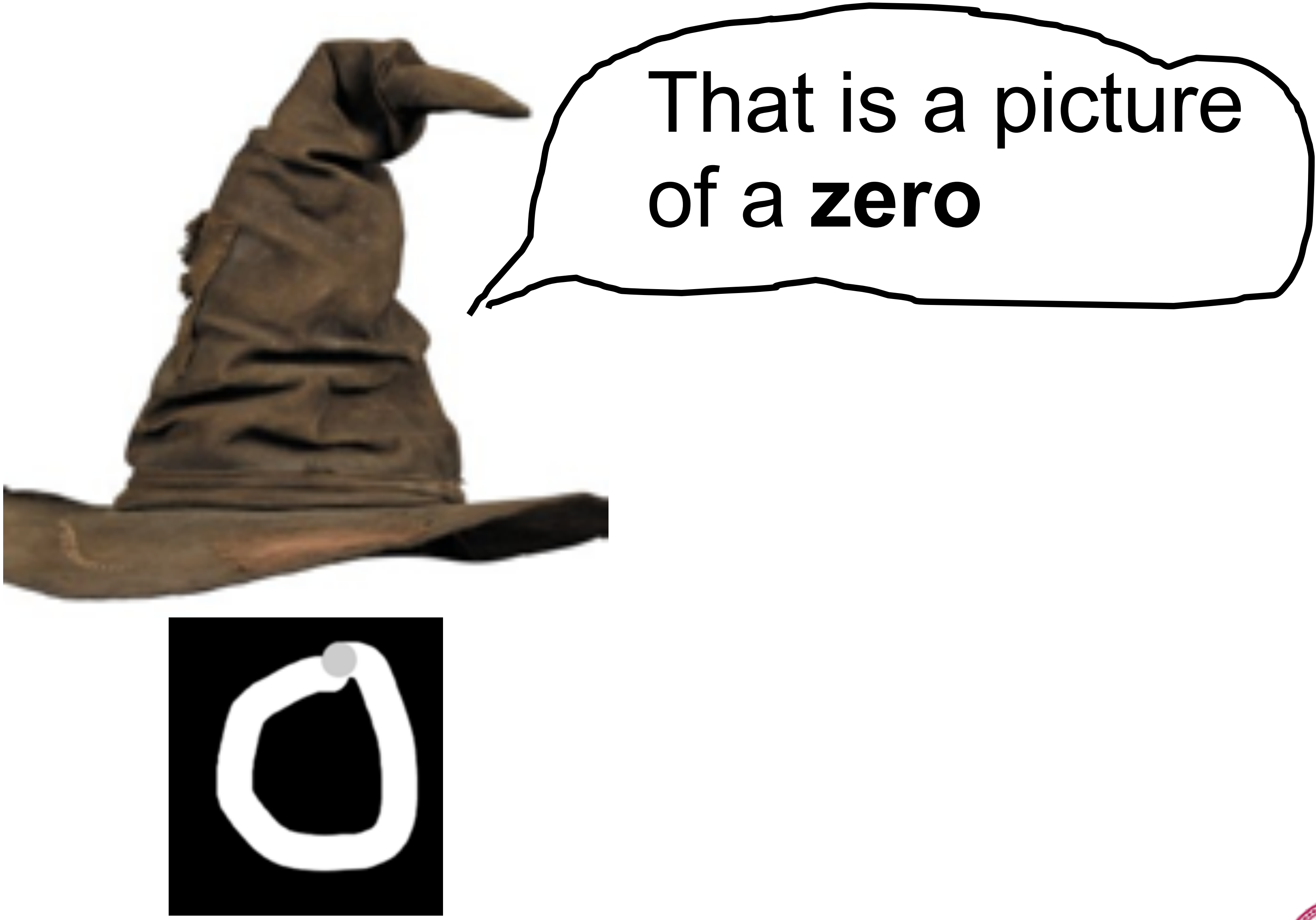
1955



Computer Vision

Classification

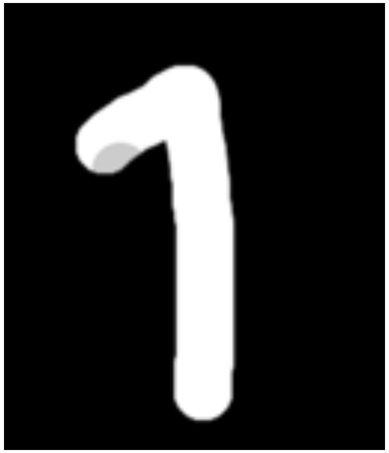
Classification



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

Identifying Cats

Here's one way you might code this…

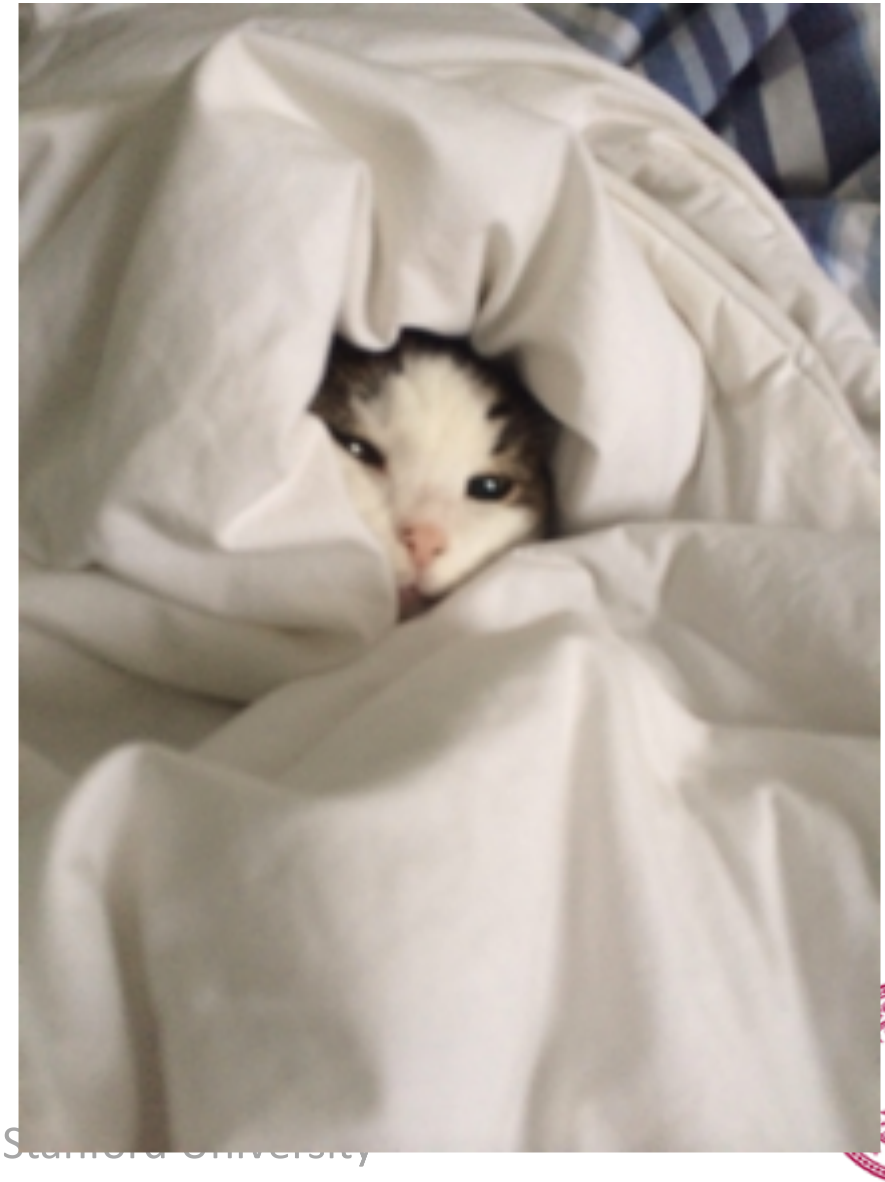
```
def is_cat(image):
   if contains_two_eyes(image):
      if has_whiskers(image):
         if has_pointy_ears(image):
            return True
   return False
```

Identifying Cats

Here's one way you might code this…

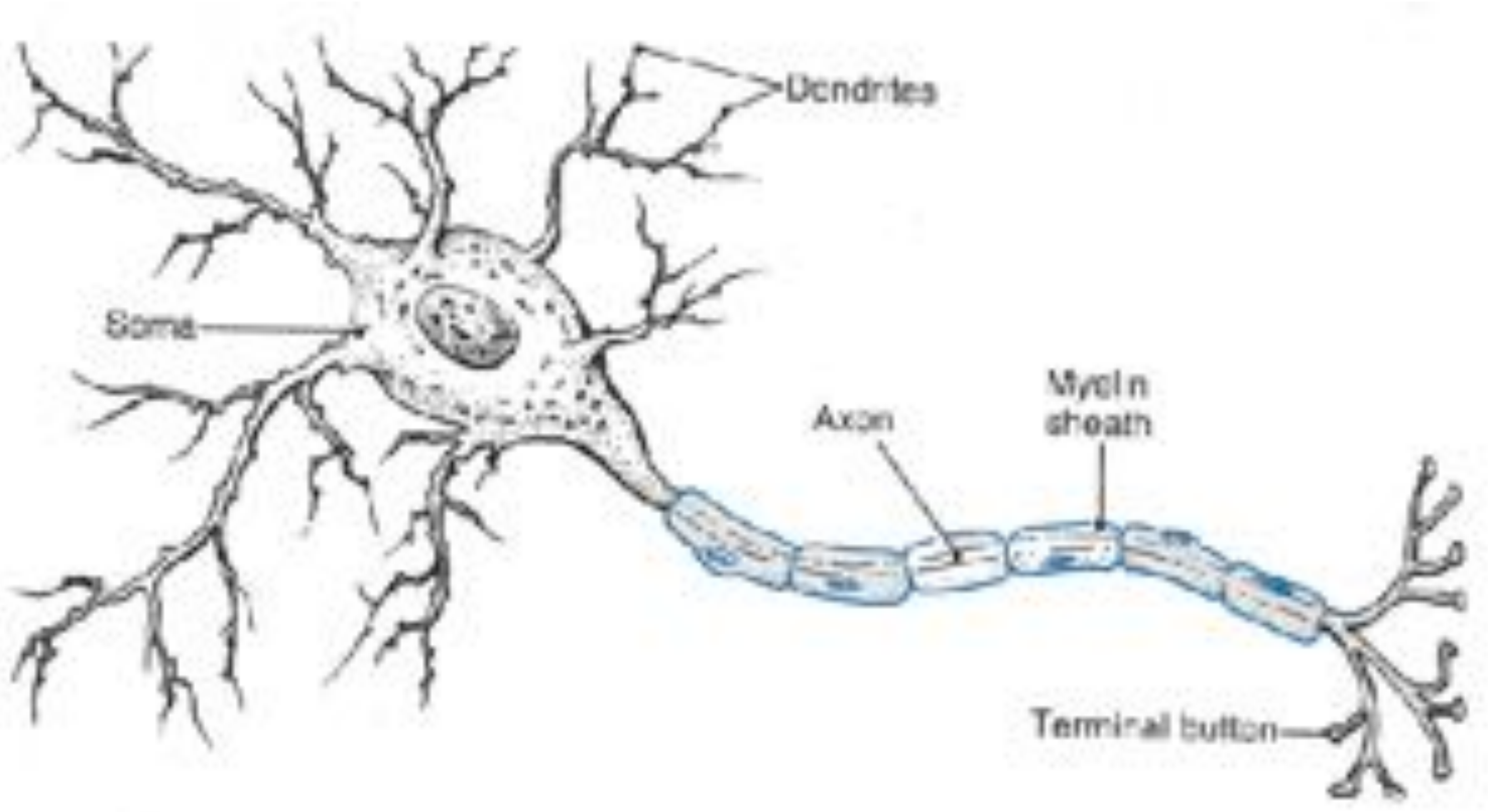
```python
def is_cat(image):
  if not contains_two_eyes(image):
    return False
  if not has_whiskers(image):
    return False
  if not has_pointy_ears(image):
    return False
  return True
```

Some Tricky Cases

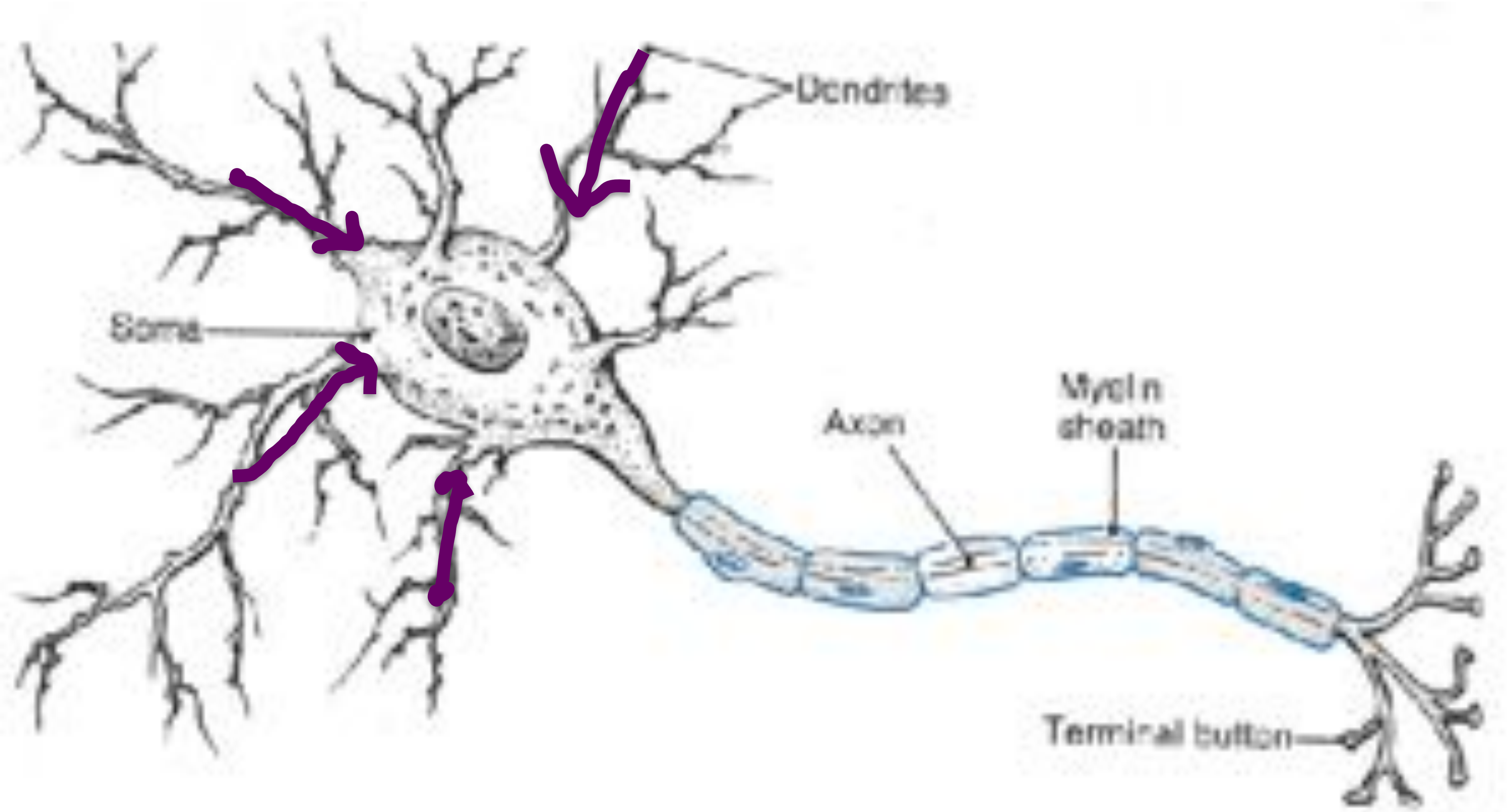


Great idea inspired by biology

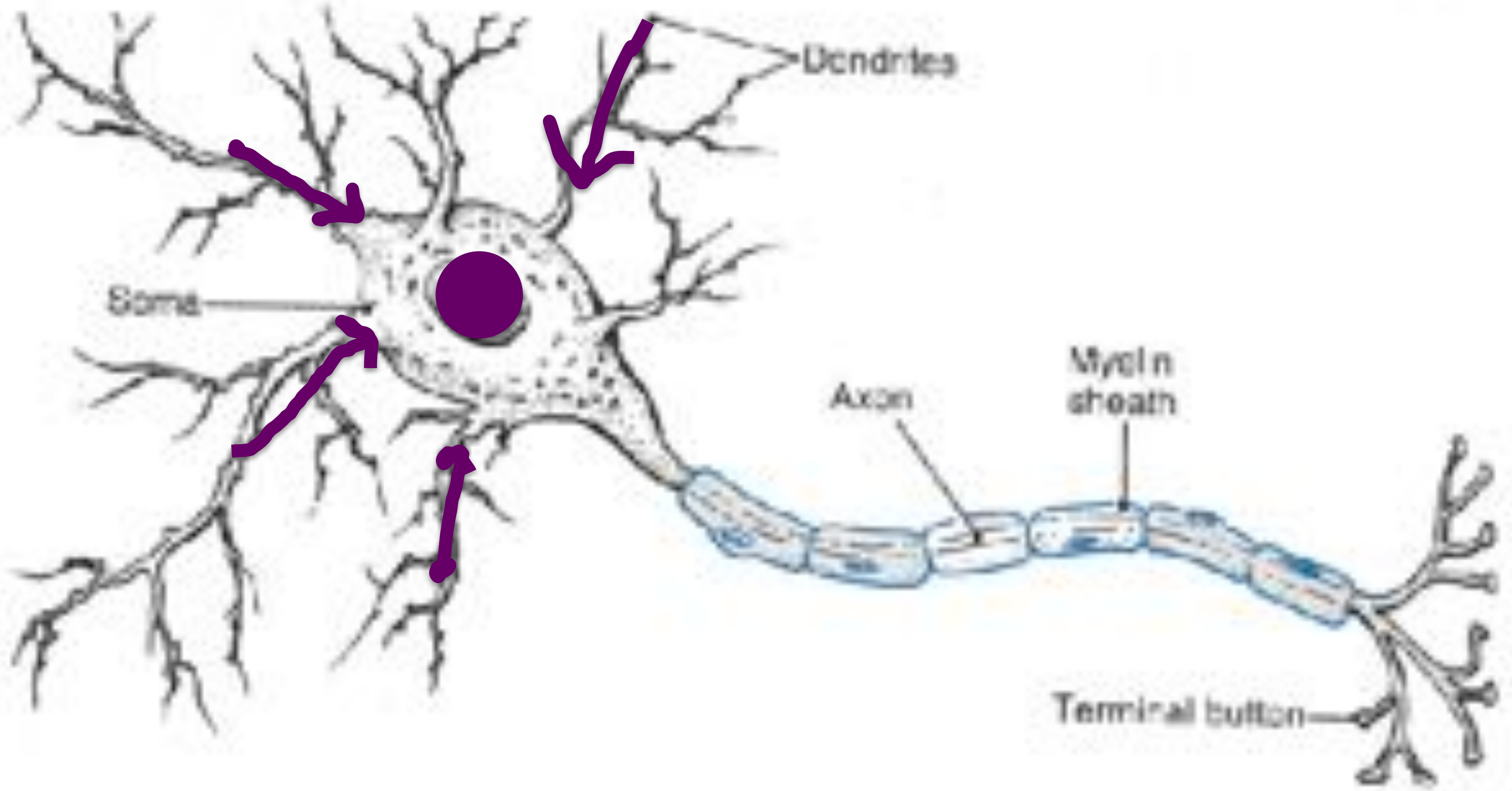
Neuron



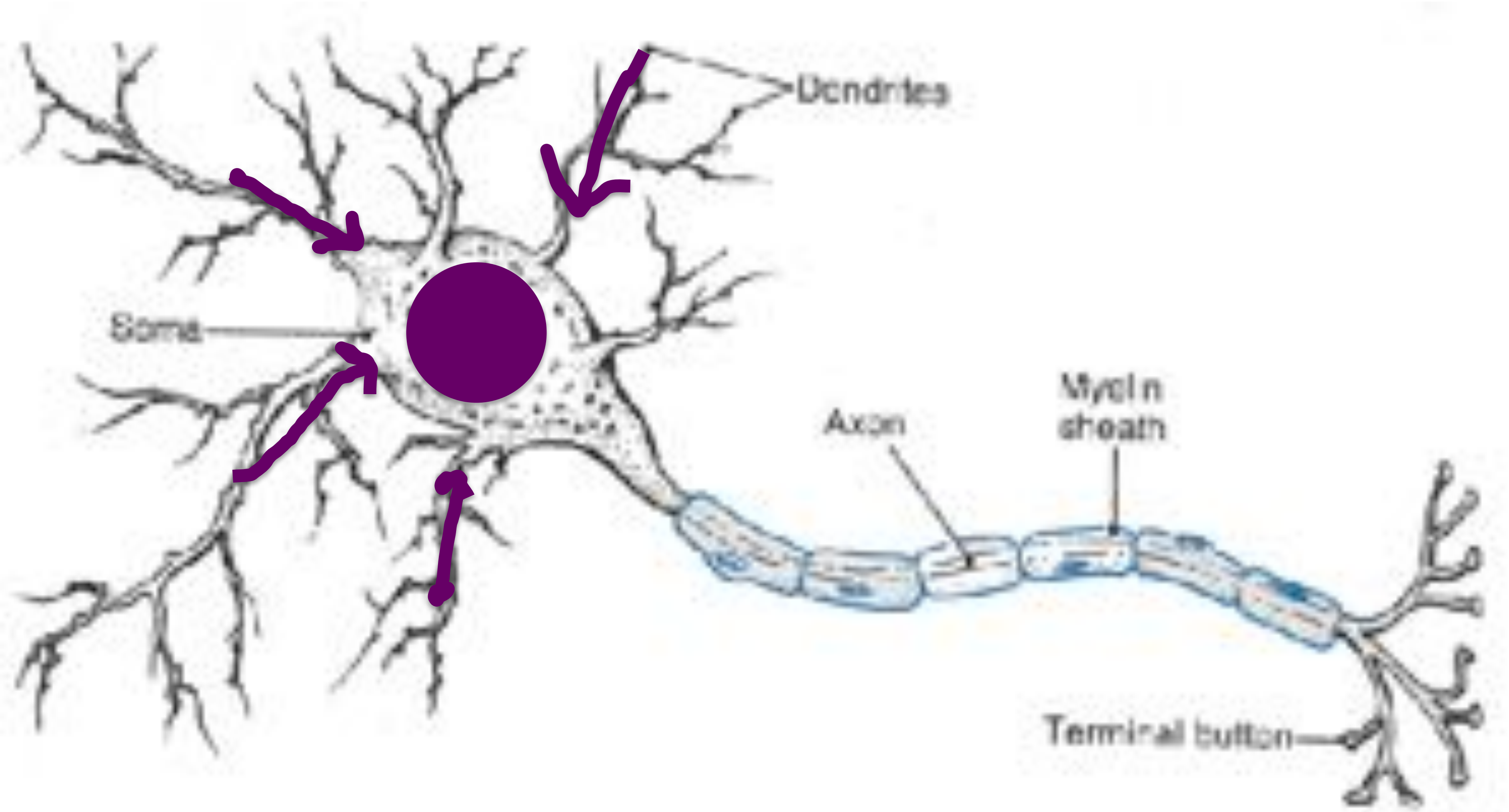
Neuron



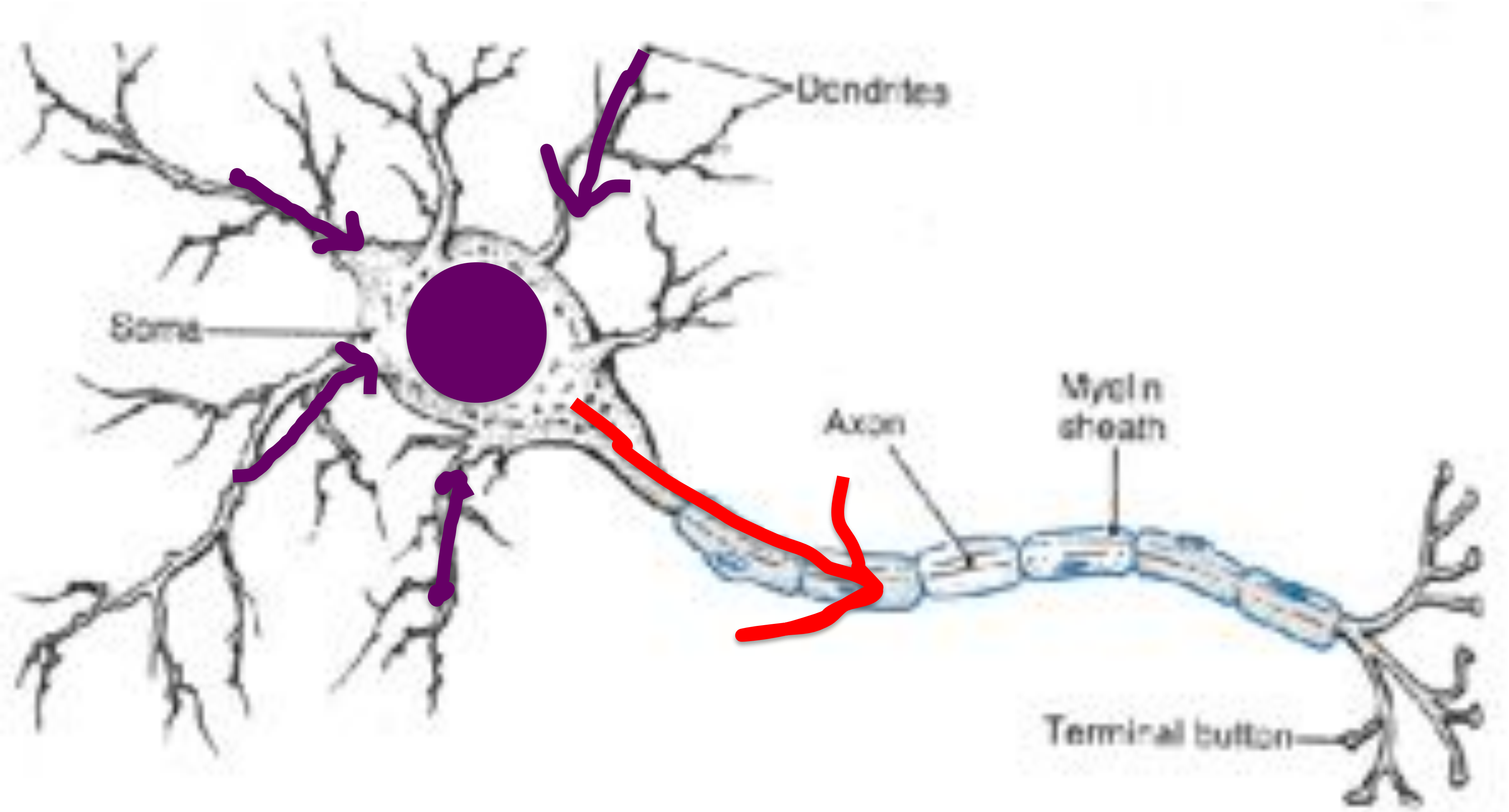
Neuron



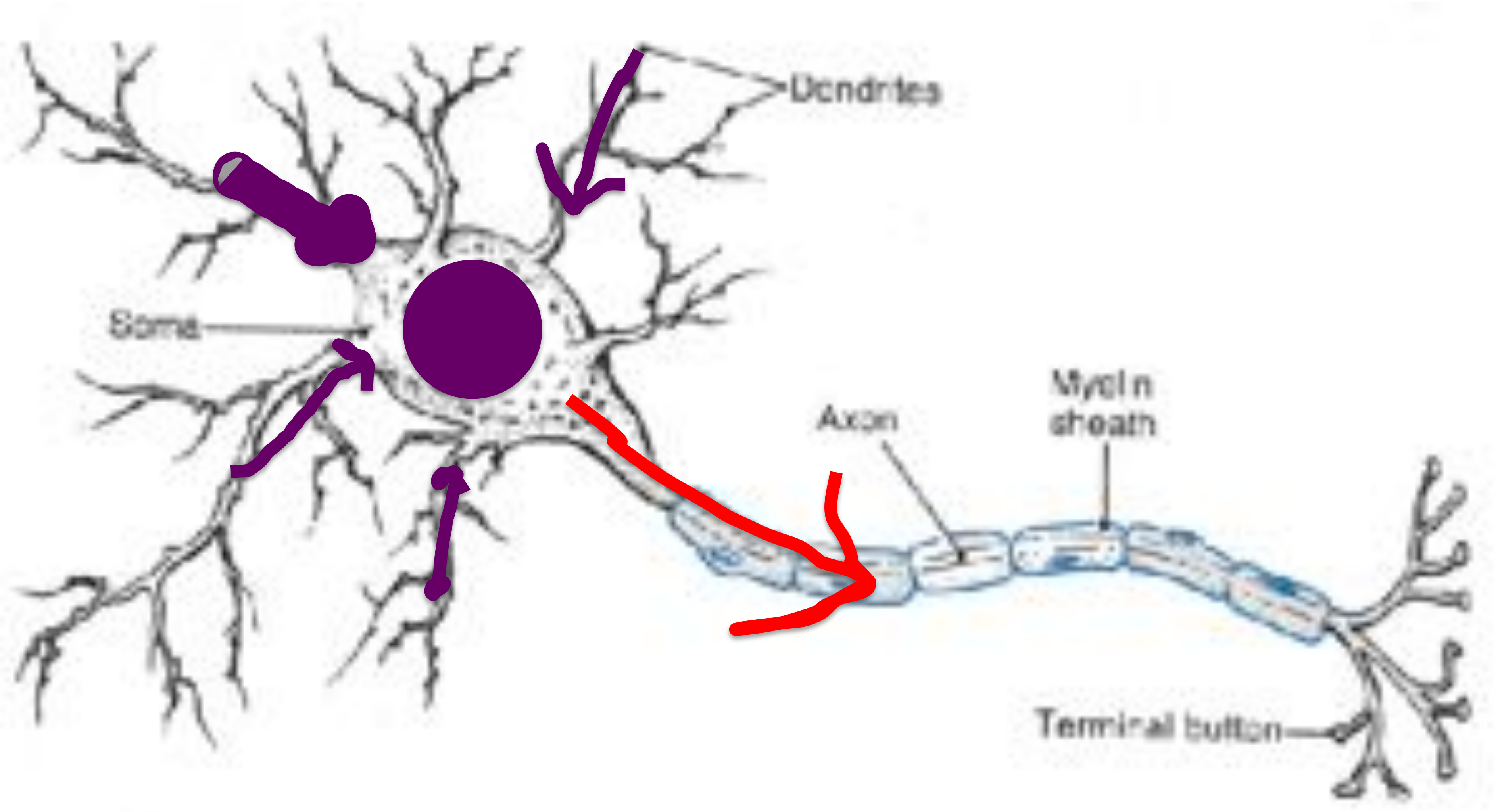
Neuron



Neuron

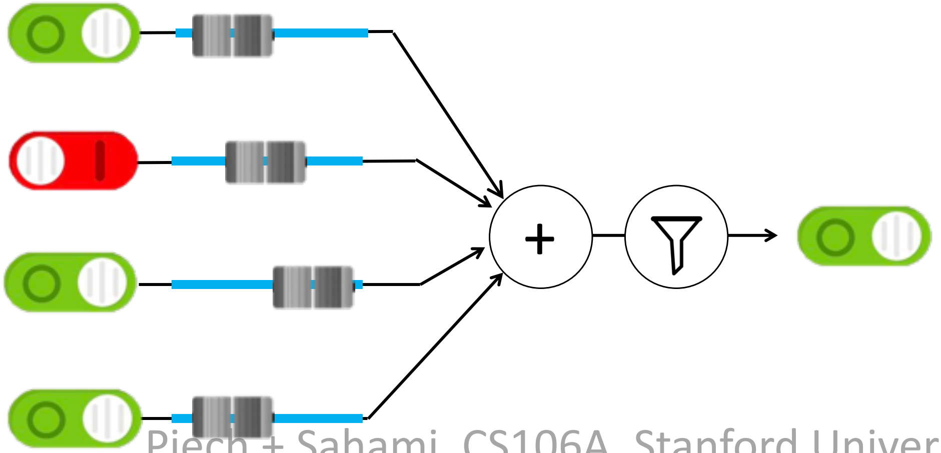


Some Inputs are More Important



Artificial Neuron

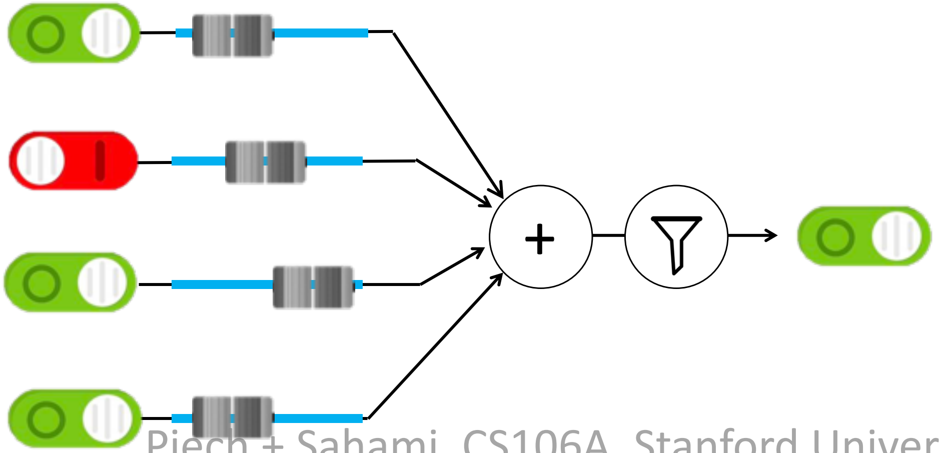
```
# calculate the activation of a neuron
def activate(weights_list, inputs_list):
    n = len(inputs_list)
    weighted_sum = 0
    for i in range(n):
       weighted_sum += weights_list[i] * inputs_list[i]

    return squash(weighted_sum)



# the sigmoid function forces a value to be between 0 and 1
def squash(value):
    return 1 / (1 + math.exp(-value));
```



Artificial Neuron

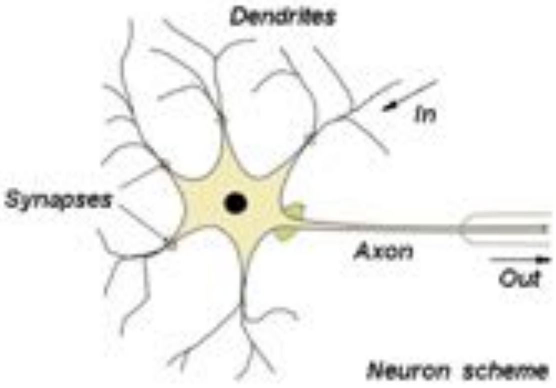
```
# calculate the activation of a neuron
def activate(weights_list, inputs_list):
    n = len(inputs_list)
    # using list comprehensions like Juliette showed us
    weighted = [weights_list[i] * inputs_list[i] for i in range(n)]
    weighted_sum = sum(weighted)
    return squash(weighted_sum)
```

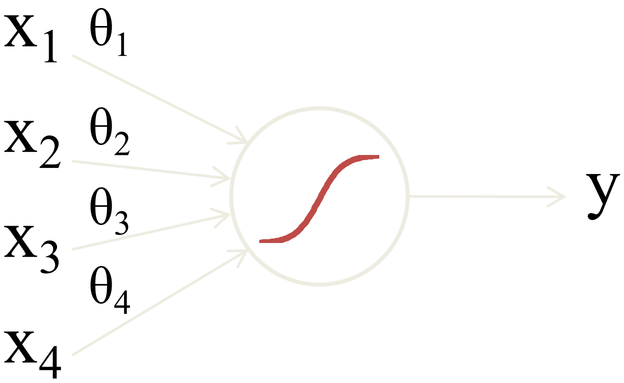
```
# the sigmoid function forces a value to be between 0 and 1
def squash(value):
    return 1 / (1 + math.exp(-value));
```



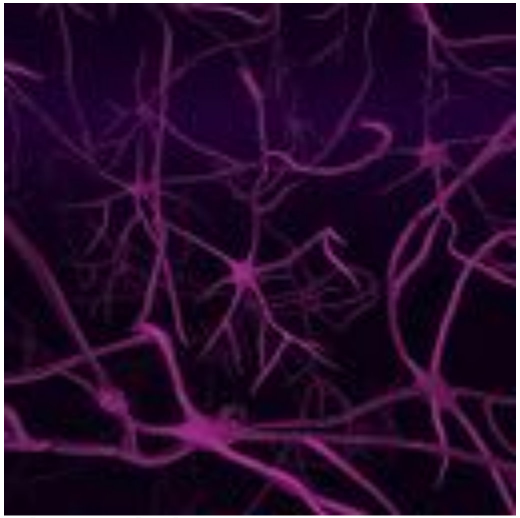
Biological Basis for Neural Networks

- A neuron

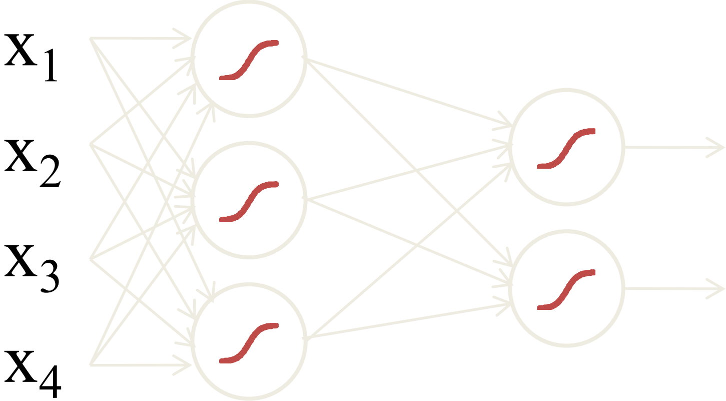




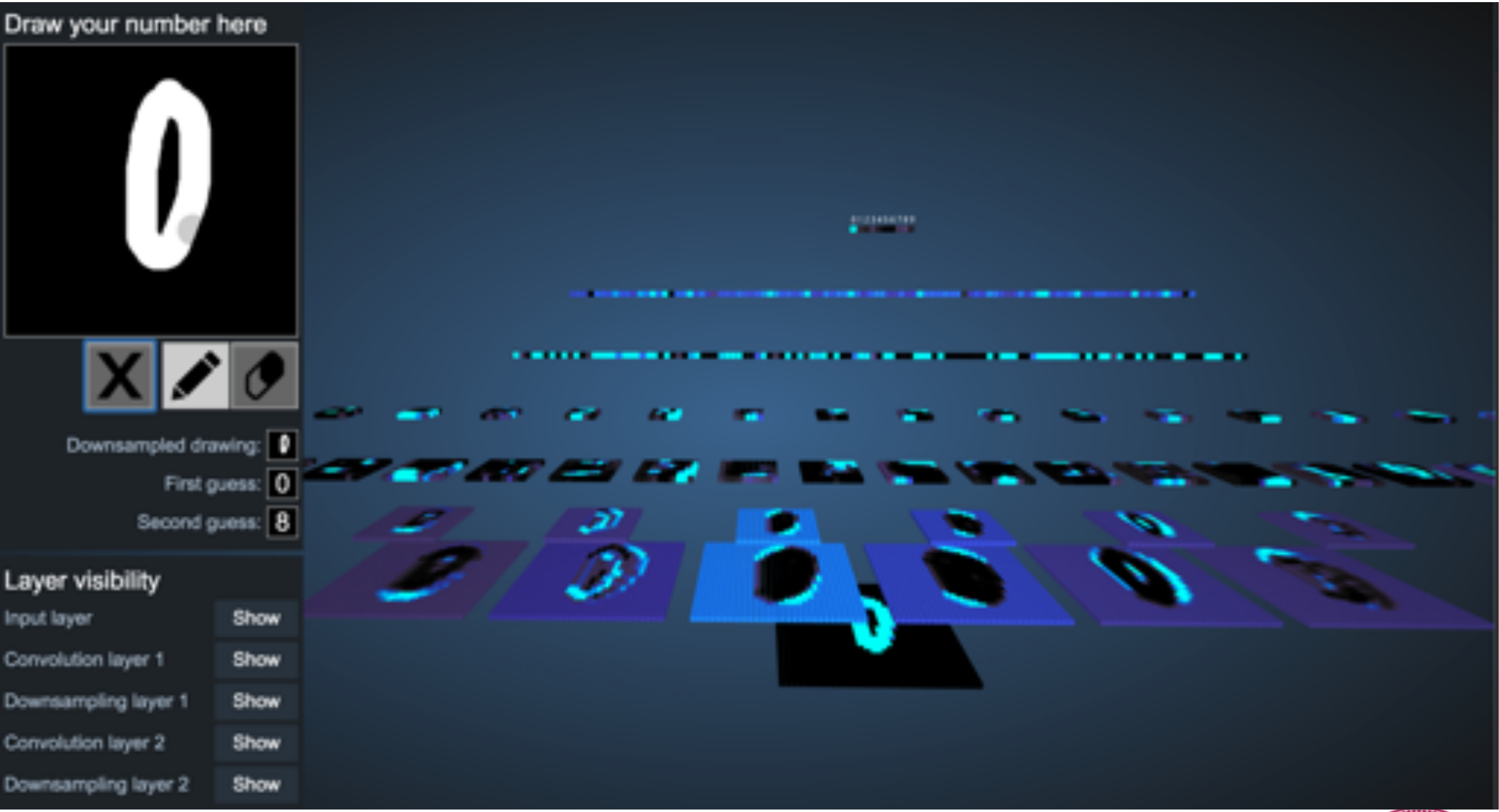
- Your brain



Actually, it's probably someone else's brain



Demonstration



Downsampled drawing: 0

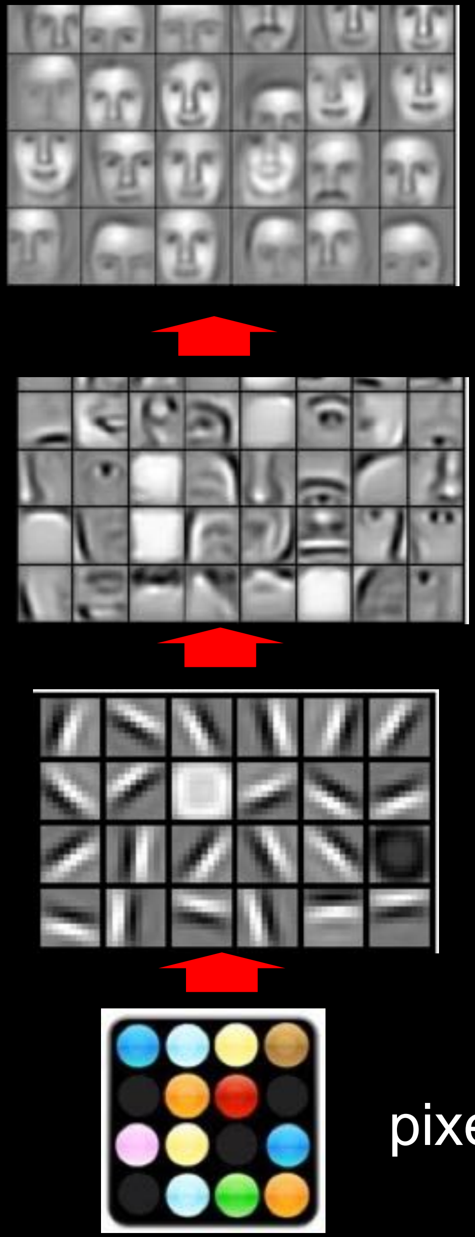
First guess: 0

Second guess: 8

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

Visualize the Weights

Training set: Aligned images of faces.



object models

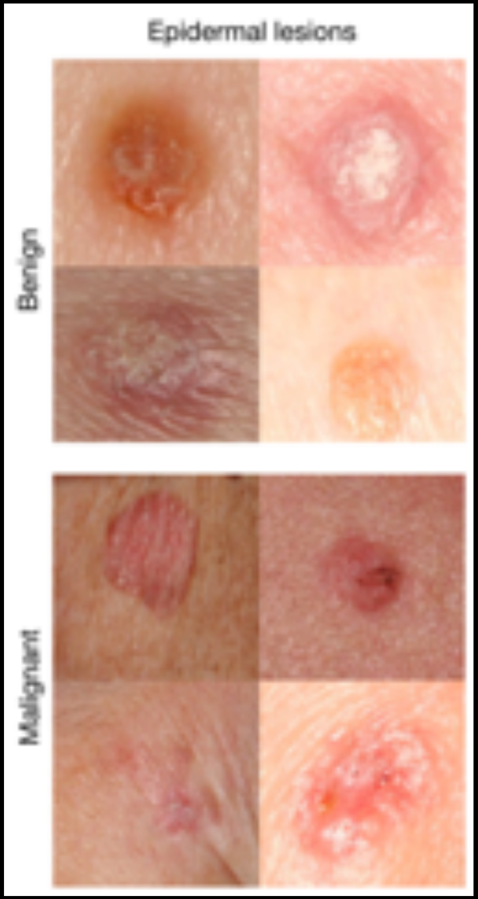
object parts (combination of edges)

edges

pixels

[Honglak Lee]

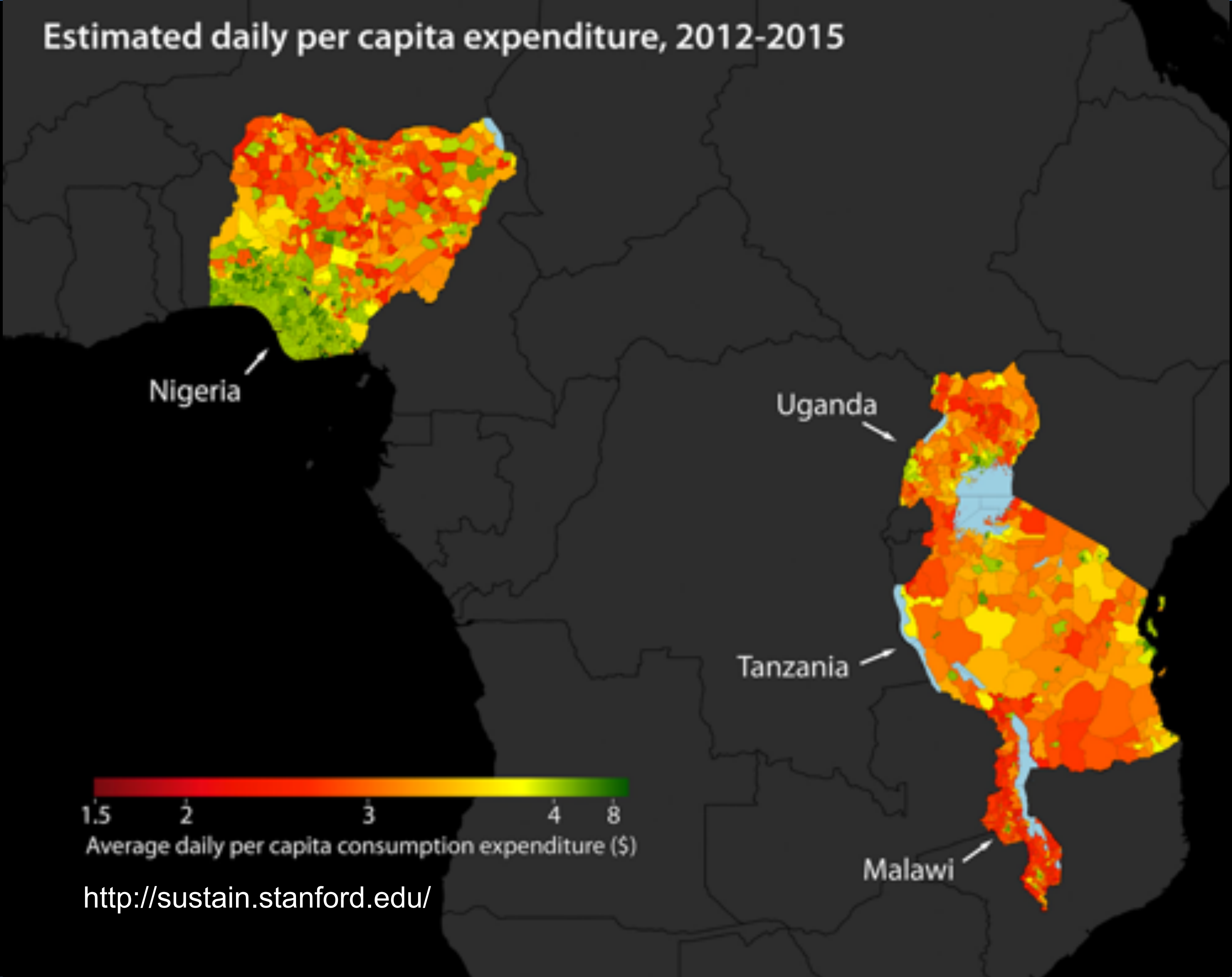
Where is this useful?



A machine learning algorithm performs **better than** the best dermatologists.

Developed this year, at Stanford.

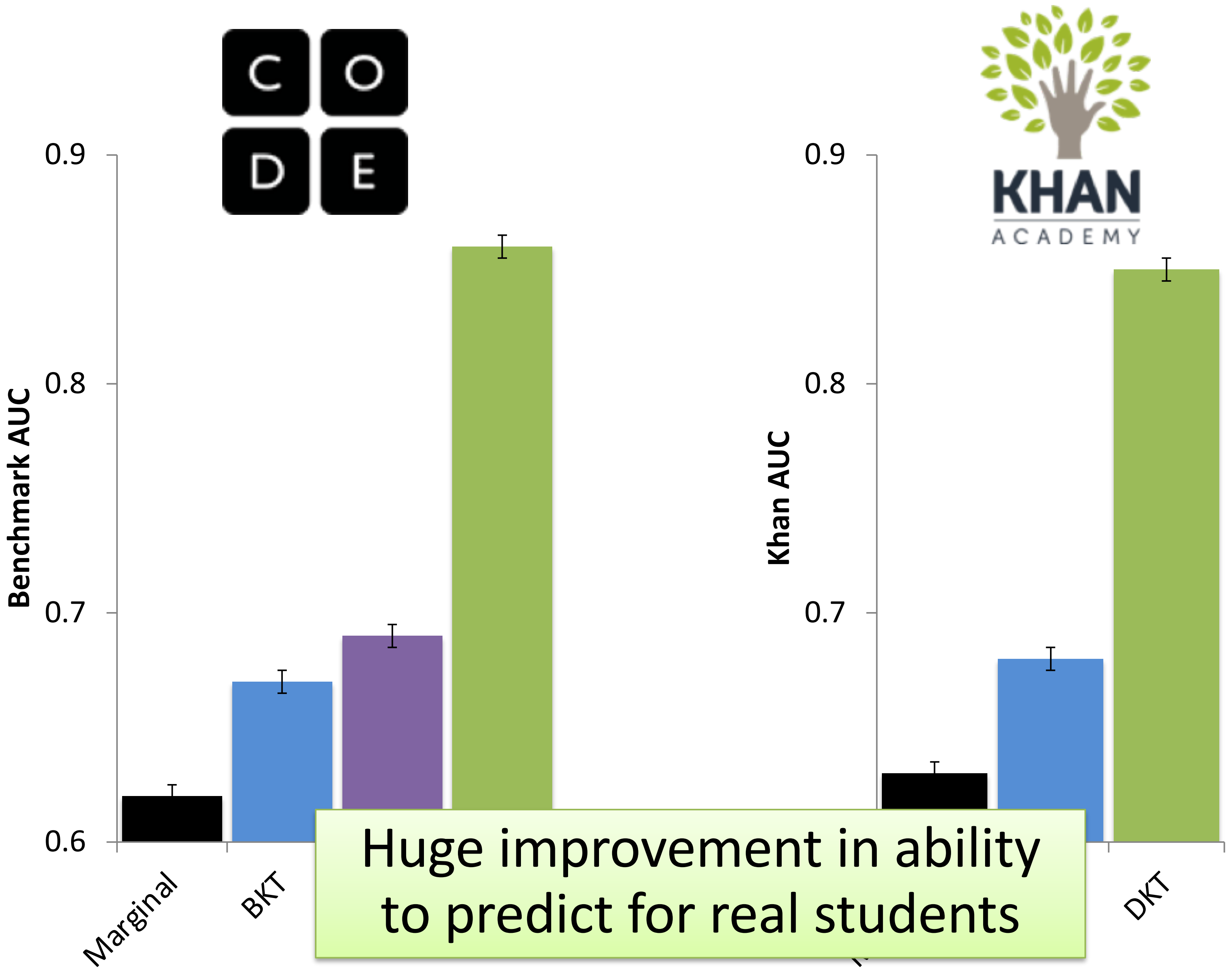
Esteva, Andre, et al. "Dermatologist-level classification of skin cancer with deep neural networks." *Nature* 542.7639 (2017): 115-118.



Estimated daily per capita expenditure, 2012-2015

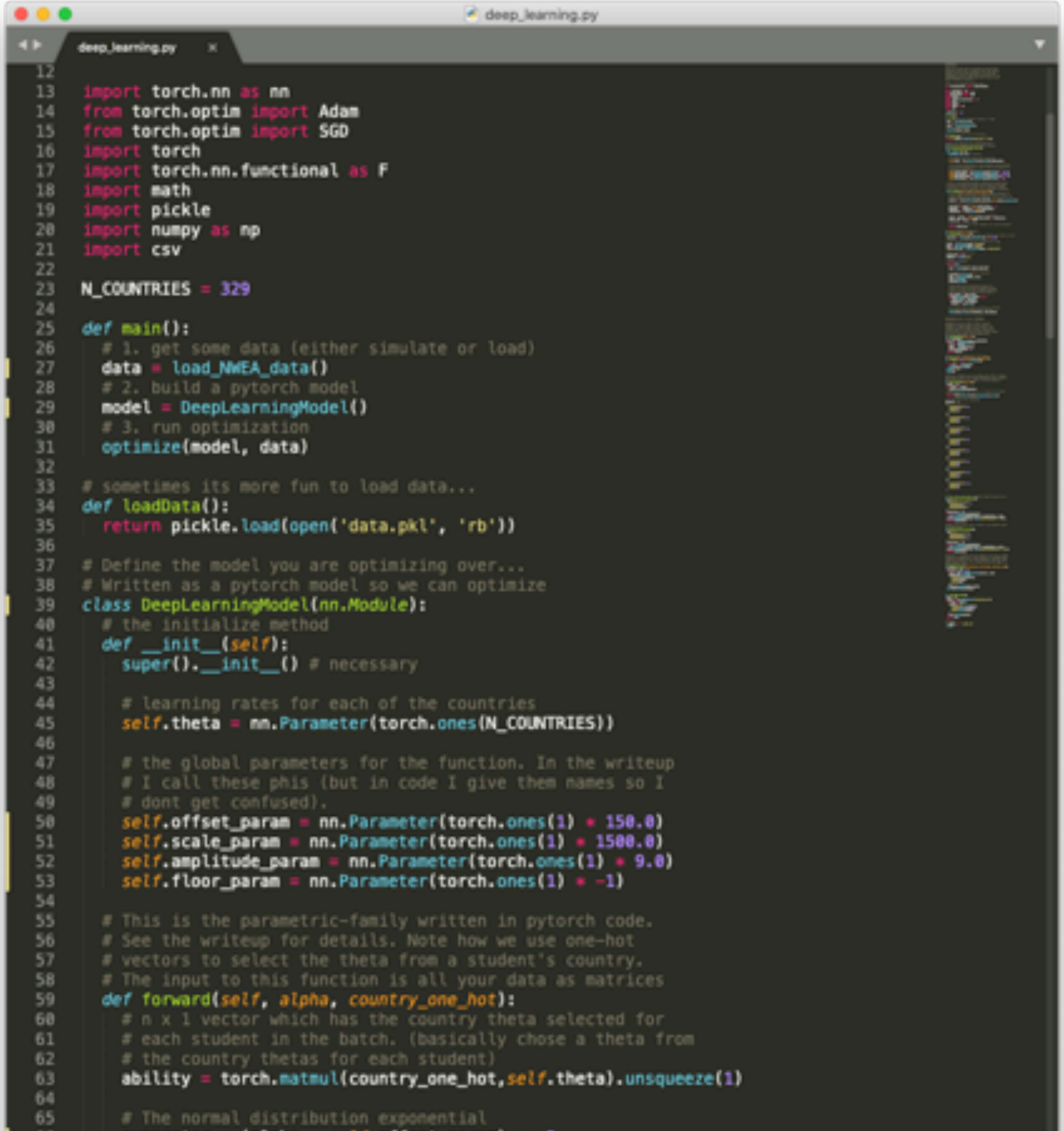
http://sustain.stanford.edu/

Understanding Students



Huge improvement in ability to predict for real students

What does it look like?



```python

import torch.nn as nn
from torch.optim import Adam
from torch.optim import SGD
import torch
import torch.nn.functional as F
import math
import pickle
import numpy as np
import csv

N_COUNTRIES = 329

def main():
  # 1. get some data (either simulate or load)
  data = load_NWEA_data()
  # 2. build a pytorch model
  model = DeepLearningModel()
  # 3. run optimization
  optimize(model, data)

# sometimes its more fun to load data...
def loadData():
  return pickle.load(open('data.pkl', 'rb'))

# Define the model you are optimizing over...
# Written as a pytorch model so we can optimize
class DeepLearningModel(nn.Module):
  # the initialize method
  def __init__(self):
    super().__init__() # necessary

    # learning rates for each of the countries
    self.theta = nn.Parameter(torch.ones(N_COUNTRIES))

    # the global parameters for the function. In the writeup
    # I call these phis (but in code I give them names so I
    # dont get confused).
    self.offset_param = nn.Parameter(torch.ones(1) * 150.0)
    self.scale_param = nn.Parameter(torch.ones(1) * 1500.0)
    self.amplitude_param = nn.Parameter(torch.ones(1) * 9.0)
    self.floor_param = nn.Parameter(torch.ones(1) * -1)

  # This is the parametric-family written in pytorch code.
  # See the writeup for details. Note how we use one-hot
  # vectors to select the theta from a student's country.
  # The input to this function is all your data as matrices
  def forward(self, alpha, country_one_hot):
    # n x 1 vector which has the country theta selected for
    # each student in the batch. (basically chose a theta from
    # the country thetas for each student)
    ability = torch.matmul(country_one_hot,self.theta).unsqueeze(1)

    # The normal distribution exponential
```

1. How to make your own project
2. What other languages look like
3. Deep Learning in Python

Chris:
CS109

Mehran:
CS182

What's life after CS106A going to be like for you and Mehran?