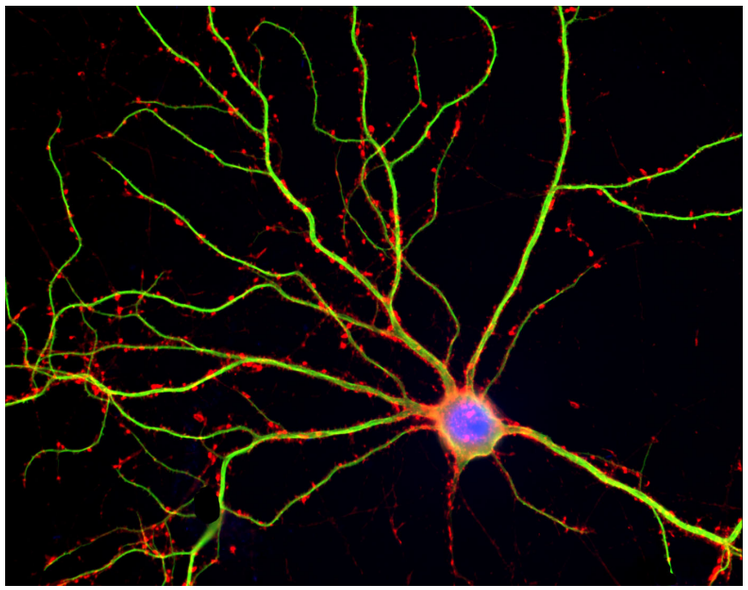
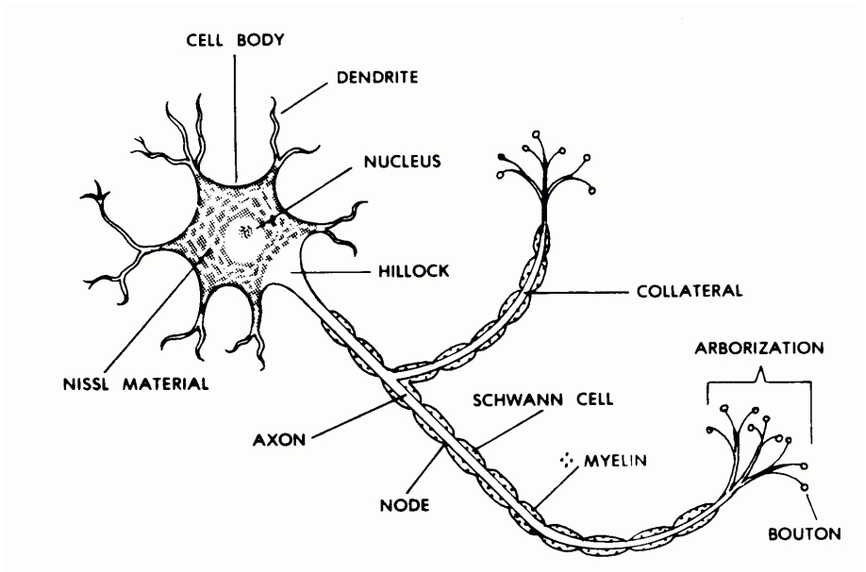
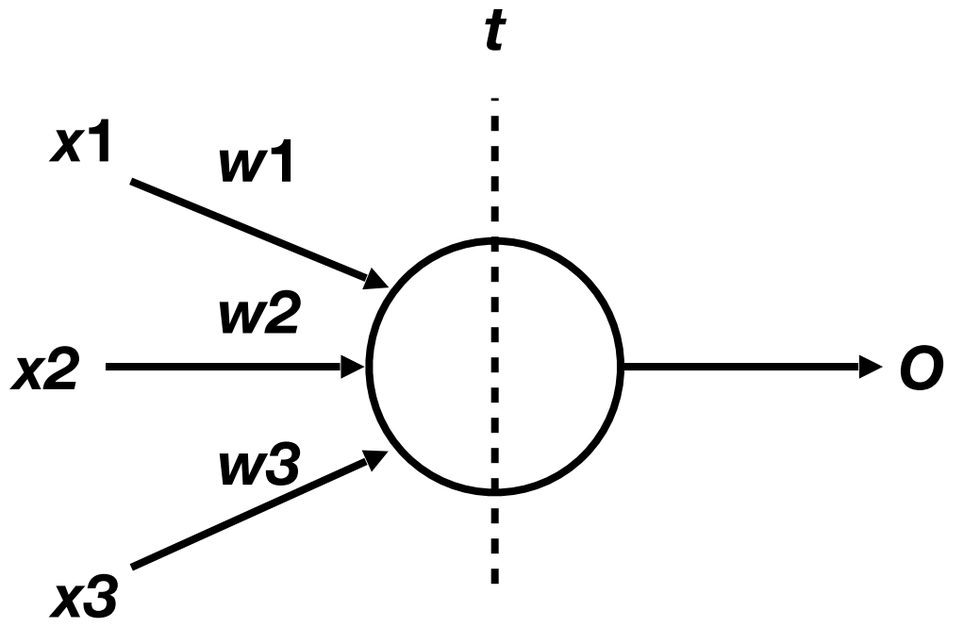
# Perceptron

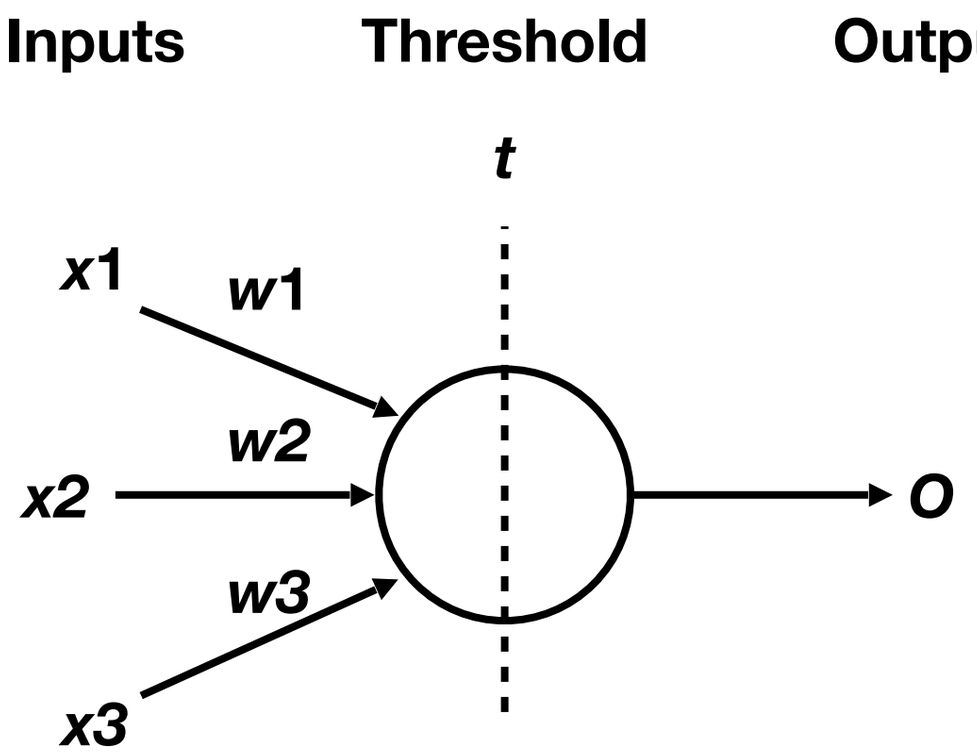




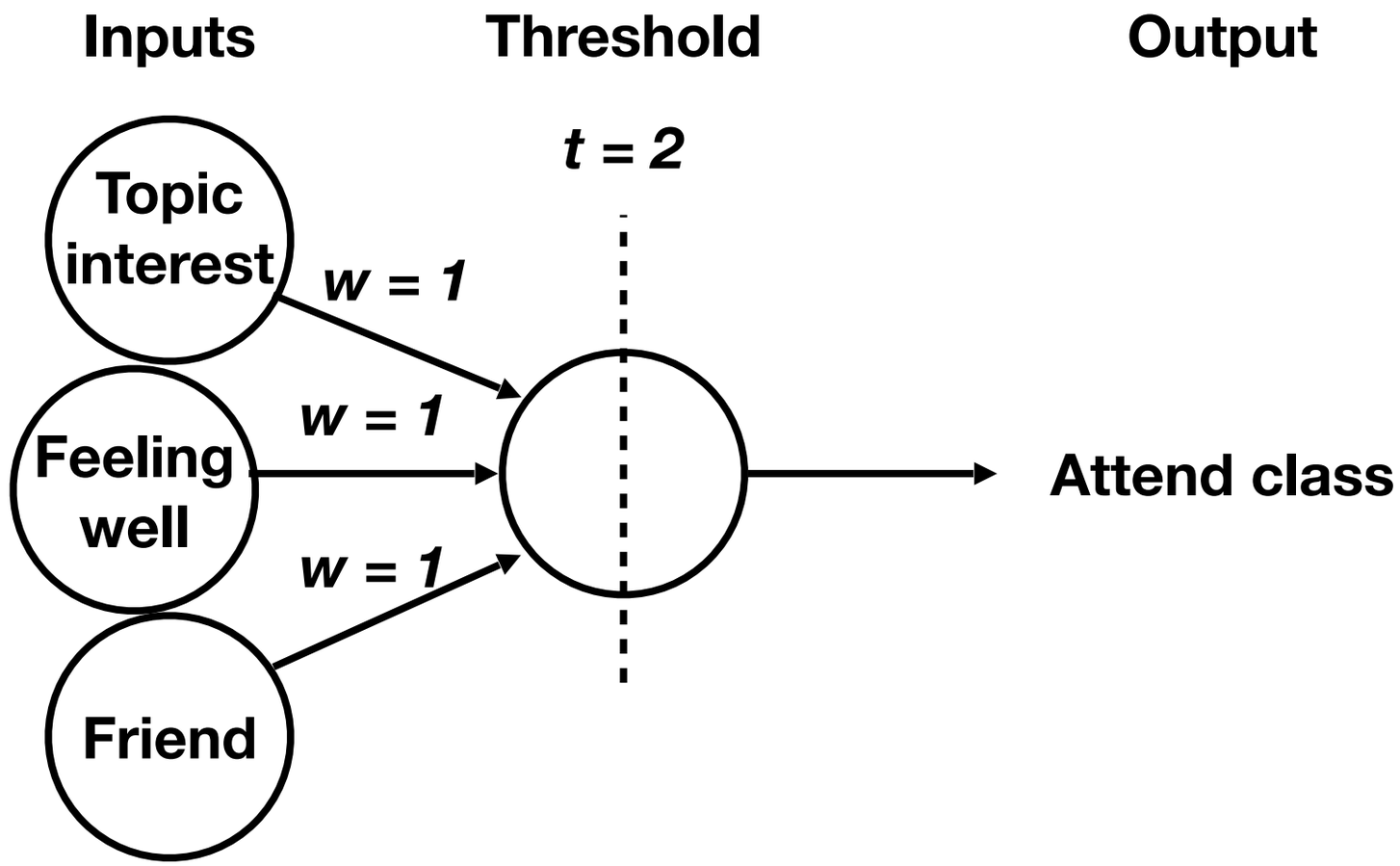




Frank Rosenblatt, 1957

# Perceptron



# Perceptron


Inputs
Threshold
Output
t = 2
Topic interest
Feeling well
Friend
w = 1
w = 1
w = 1
Attend class

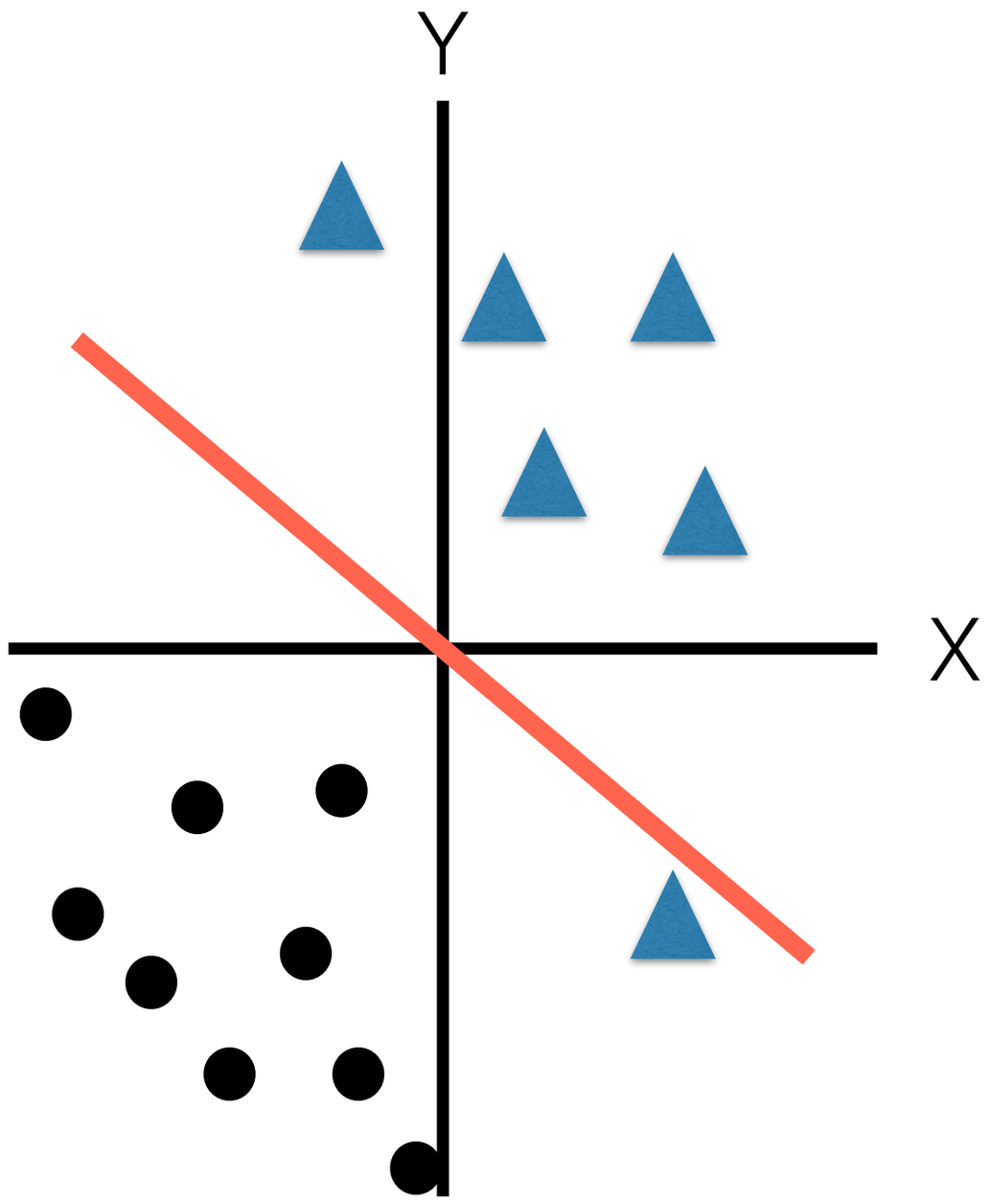
# Bias (Threshold)

- Another way to describe the threshold
- Negative threshold
- More convenient for notation
- Describes how easy it is to make the perceptron “fire”

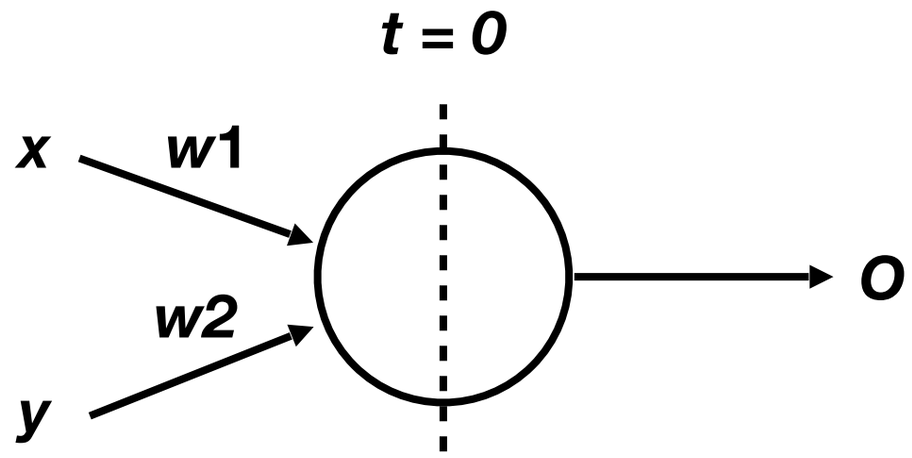
# Logic

- From the perceptron we can create a NAND gate
- From a NAND gate can create all other logic units (AND, NOR, etc.)
- See Nielson 2016*

# Notation Example




*linearly separable



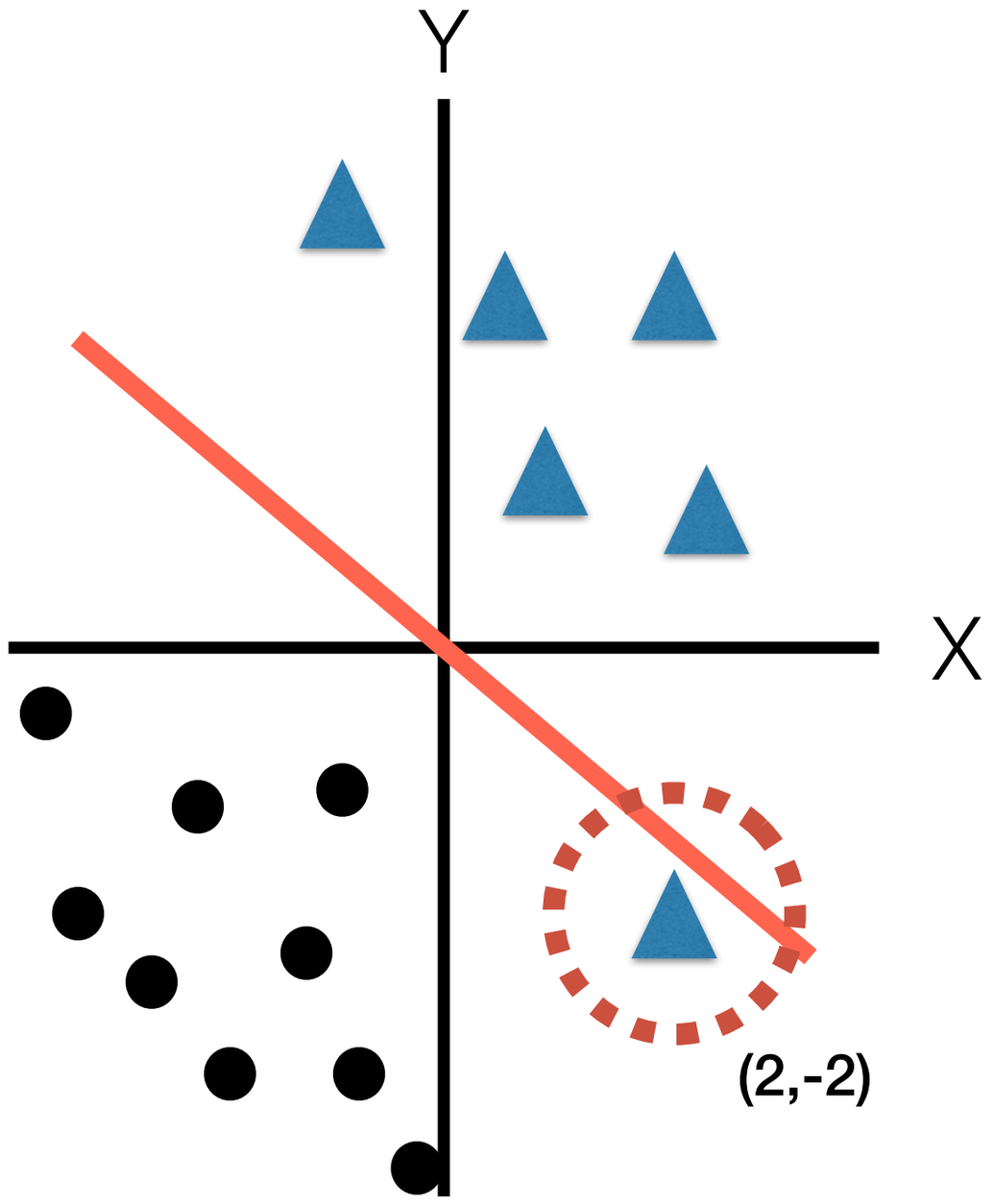

| inputs | weights |
|---|---|
| 1 | 0 |
| $x$ | 1 |
| $y$ | 0.5 |

**= 1 x 0 + 1 x $x$ + 0.5 x $y$**

$= x + 0.5y$

$y = -2x$

# Updating




| inputs | weights |
|---|---|
| 1 | 0 |
| $x$ | 1 |
| $y$ | 0.5 |

**= 1 x 0 + 1 x $x$ + 0.5 x $y$**

$= x + 0.5y$

$y = -2x$

**For each misclassified point update w:**

$$w_{NEW} = w_{OLD} + ndx$$

Learning Rate

Re-classification +1 or -1

inputs

# Updating

**For each misclassified point update w:**

$$w_{NEW} = w_{OLD} + ndx$$

Learning Rate

Re-classification (1 or -1)

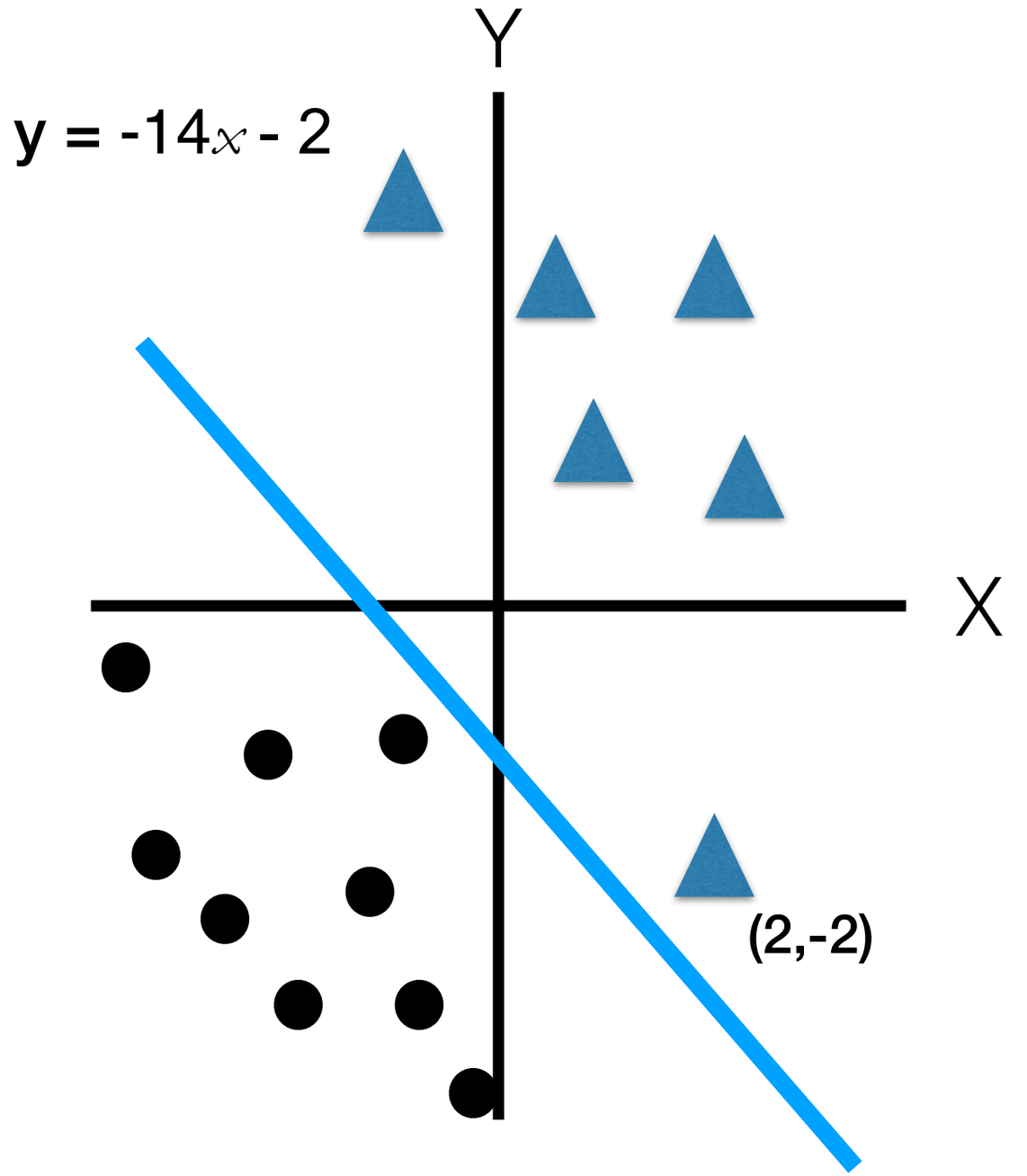
inputs

$$w_{NEW\text{-}1} = 0 + 0.2 \times 1 \times 1 = 0.2$$

$$w_{NEW\text{-}x} = 1 + 0.2 \times 1 \times 2 = 1.4$$

$$w_{NEW\text{-}y} = 0.5 + 0.2 \times 1 \times -2 = 0.1$$

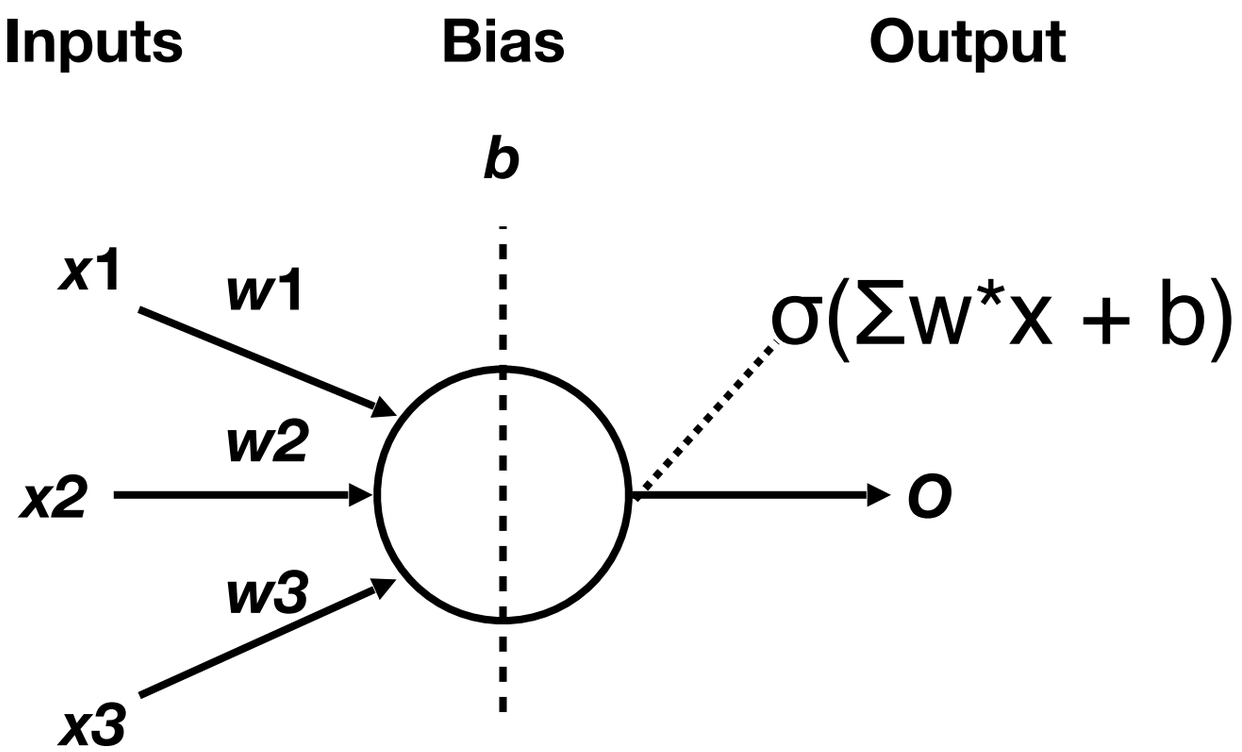
| inputs | old w | new w |
|---|---|---|
| 1 | 0 | 0.2 |
| $x$ | 1 | 1.4 |
| $y$ | 0.5 | 0.1 |



# Sigmoid Neurons

- Want to build a learning algorithm
- Could change b or w
- BUT that will cause very large changes
- Network will never “fix”
- Solution: “smooth” the output

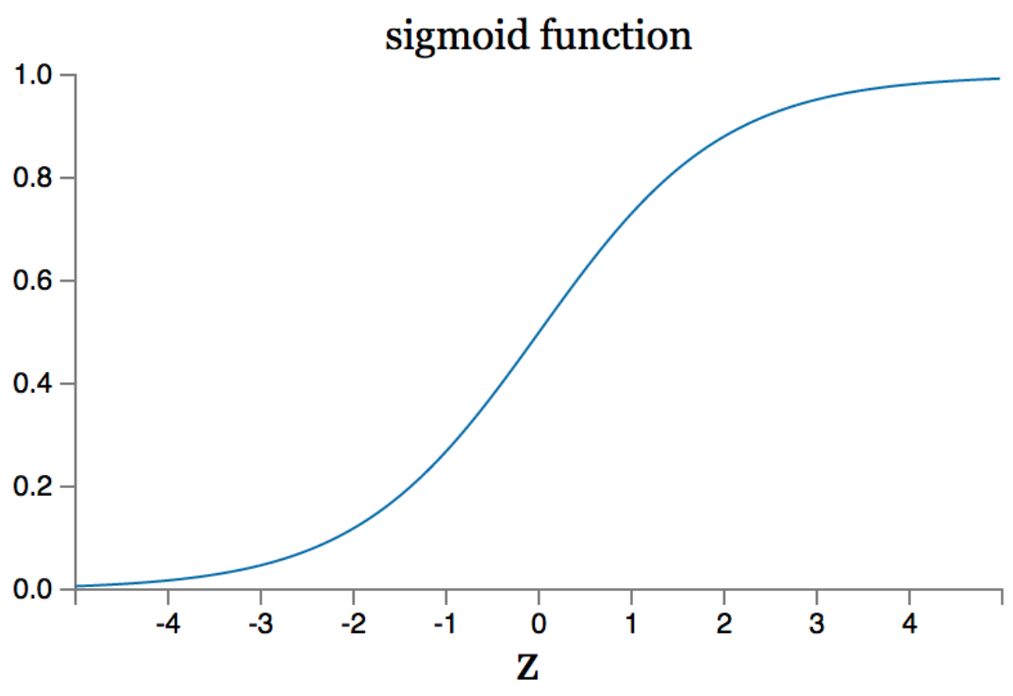
# Sigmoid Neurons



# Sigmoid Neurons

- Sigmoid function "smooths" the output
- Makes changing w *and* b less sudden and more predictable
- Could use lots of other functions…

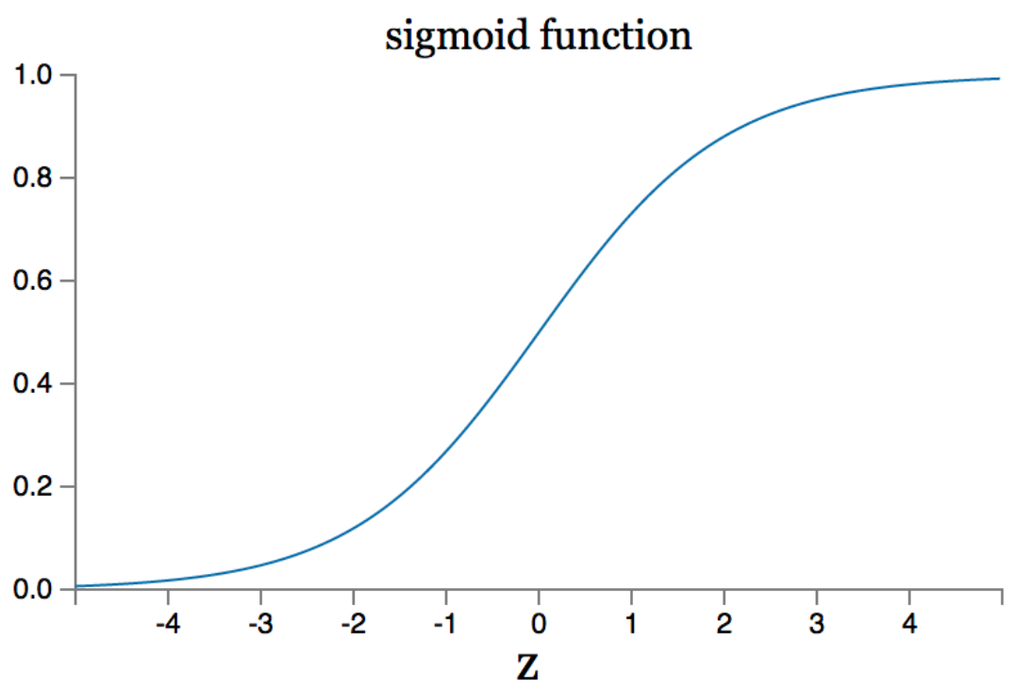
$$\sigma(z) \equiv \frac{1}{1+e^{-z}}.$$



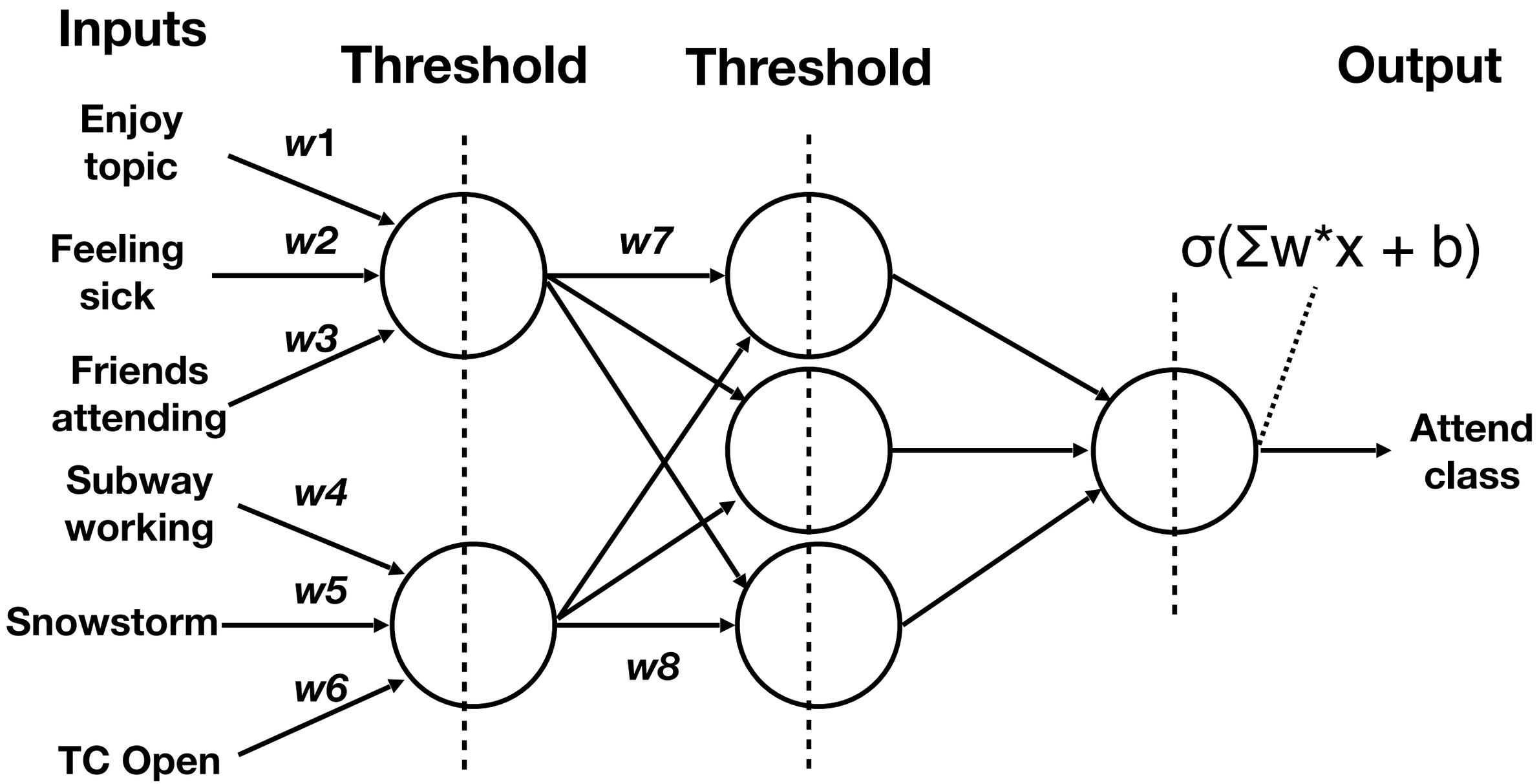
# Sigmoid Neurons

- Perceptrons have 0/1 output
- Sigmoid neurons have 0 - 1 output (eg. 0.1, 0.6778, etc.)
- How to interpret sigmoid neuron output?

$$\sigma(z) \equiv \frac{1}{1+e^{-z}}.$$



# Perceptron


Inputs
Threshold
Threshold
Output
Enjoy topic
Feeling sick
Friends attending
Subway working
Snowstorm
TC Open
w1
w2
w3
w4
w5
w6
w7
w8
σ(Σw*x + b)
Attend class
Hidden Layer

# Project

Build a neural network that predicts whether a student is paying attention from their webcam footage.