



AI in Radiology – Getting Your Bearings



Disclosures

▷ Employed by vRad

Outline

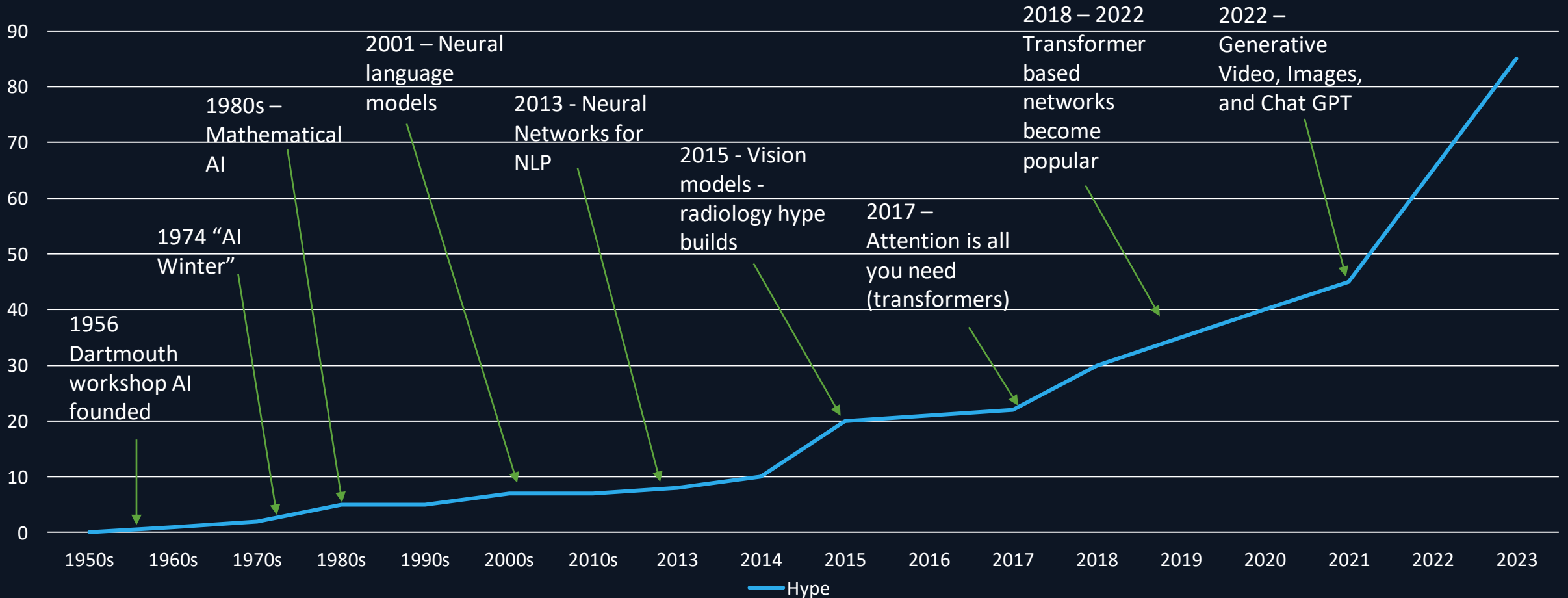
- ▷ What is AI?
- ▷ Let's Build AI
- ▷ Types of AI
- ▷ FDA – CADt/CADe/CADx
- ▷ Future

What is AI?

- ▷ “Artificial intelligence is a machine’s ability to perform the cognitive functions we usually associate with human minds.” – McKinsey & Co
- ▷ AI is a set of mathematical concepts that rely on massive parallel computing resources to guess at relationships in data until it forms a complex mathematical equation that represents those relationships

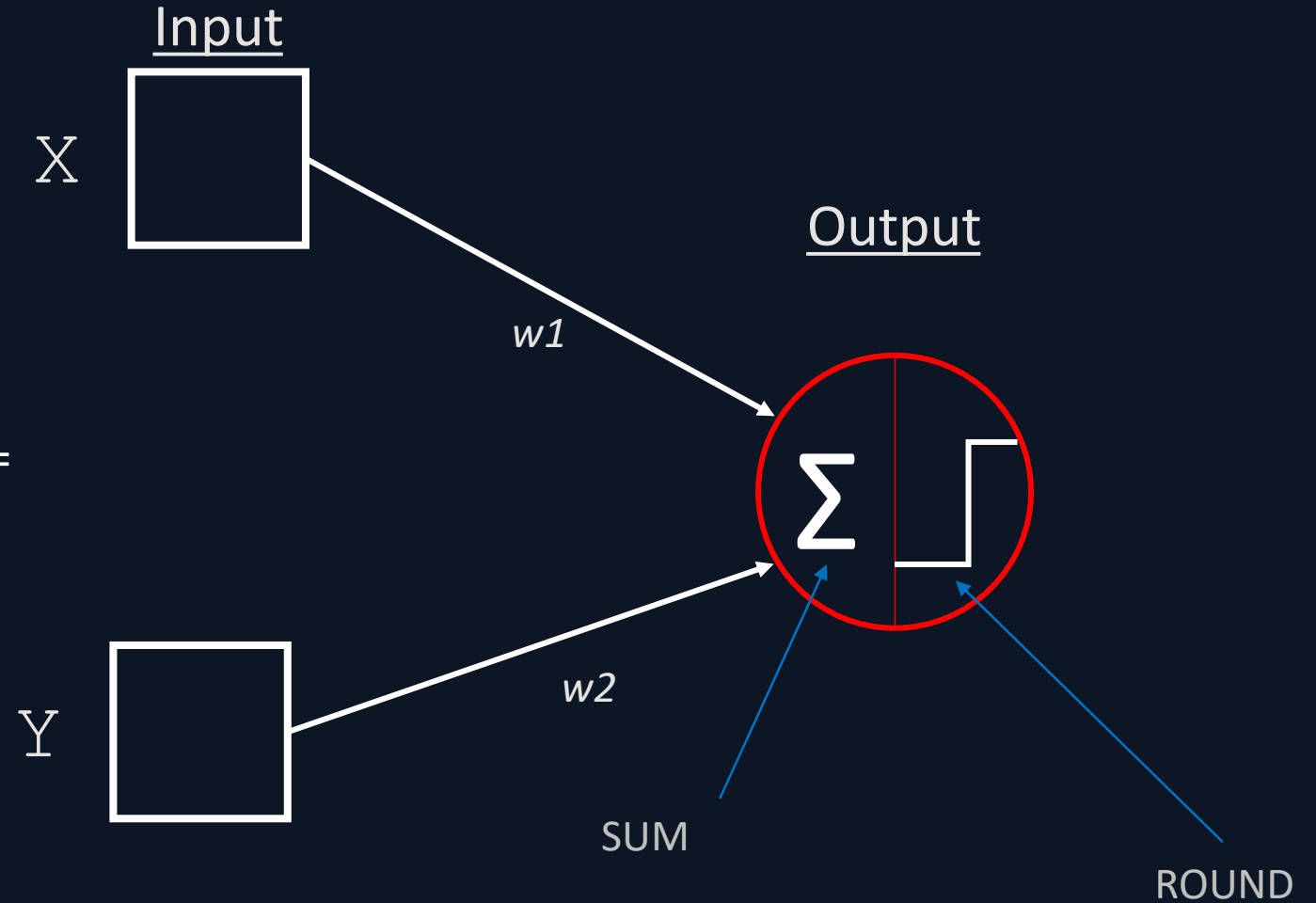
Brian Baker's AI Hype Chart

AI Hype



Basics of an AI/ML “Network”

- Goal: Tell if two things are true
 - X : Is a dog
 - Y : Is it black
- Our network should tell us if *both* conditions are true
- The manual heuristic version of this is if($X == \text{true}$ and $Y == \text{true}$)
- Preprocess data
 - Make everything numbers
 - $\text{bool} = 1$ (true), 0 (false)



Basics of an AI/ML “Network”

- Goal: Tell if two things are true

- X : Is a dog
- Y : Is it black

- This is a network

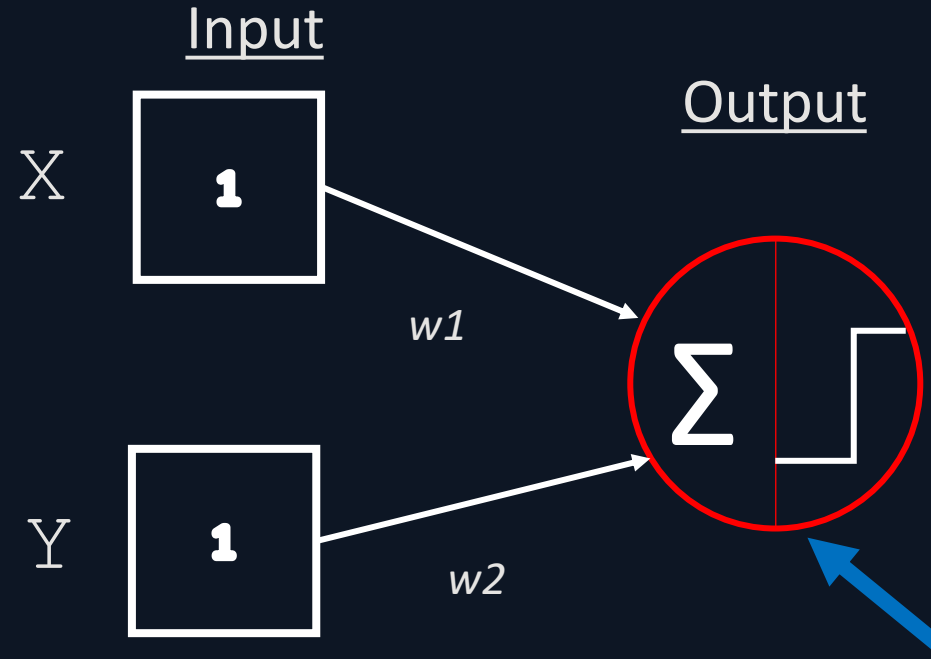
- Inputs in boxes
- Answer in circle

- Multiply inputs by w

- Add the numbers

- Round the answer

- $1 = \text{true}$, $0 = \text{false}$
- Also “squash” so that $>1 = 1$



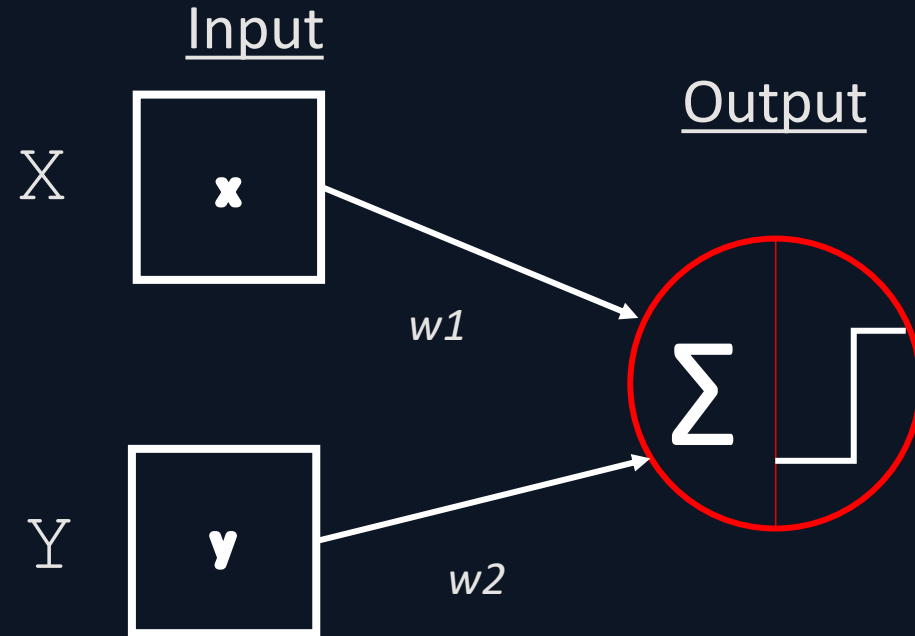
We want the answer to be 1 or “true” when both X and Y are true; the network produces an equation, based on weight value of W

X (Is a Dog) = 1 (true)

Y (Is it black) = 1 (true)

Basics of an AI/ML “Network”

The basic equation



$$\text{Round}((x * w1) + (y * w2))$$

Basics of an AI/ML “Network”

Test Case 1: X = 1; Y = 1

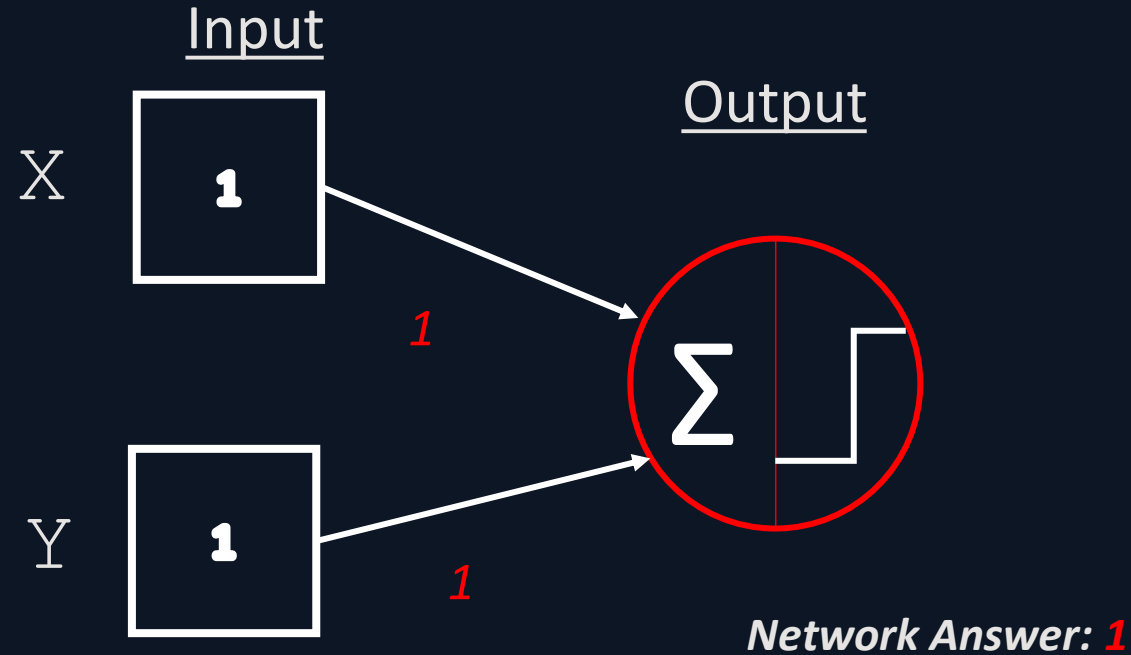
Try some weights

W1: 1

W2: 1

Test Case 1 Passes

Great, it works, right?



*Round((1 * 1) + (1 * 1)) = 1 (the network isn't exactly rounding, it's normalizing the value 0 - 1)*

Basics of an AI/ML “Network”

Test Case 2: X = 1; Y = 0

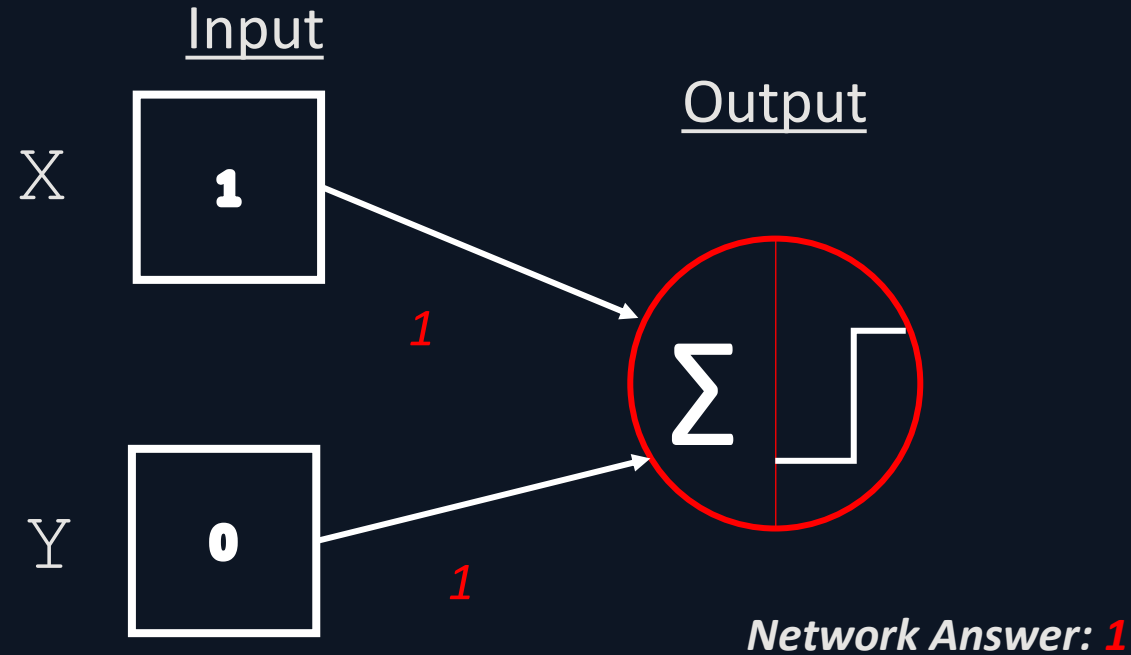
Try some weights

W1: 1

W2: 1

Test Case 2 Fails!

Wait, the network says they are both true, but we know Y is false (0), wrong answer!



*Round((1 * 1) + (1 * 0)) = 1 (the network isn't exactly rounding, it's normalizing the value 0 - 1)*

Basics of an AI/ML “Network”

Test Case 1: X = 1; Y = 1

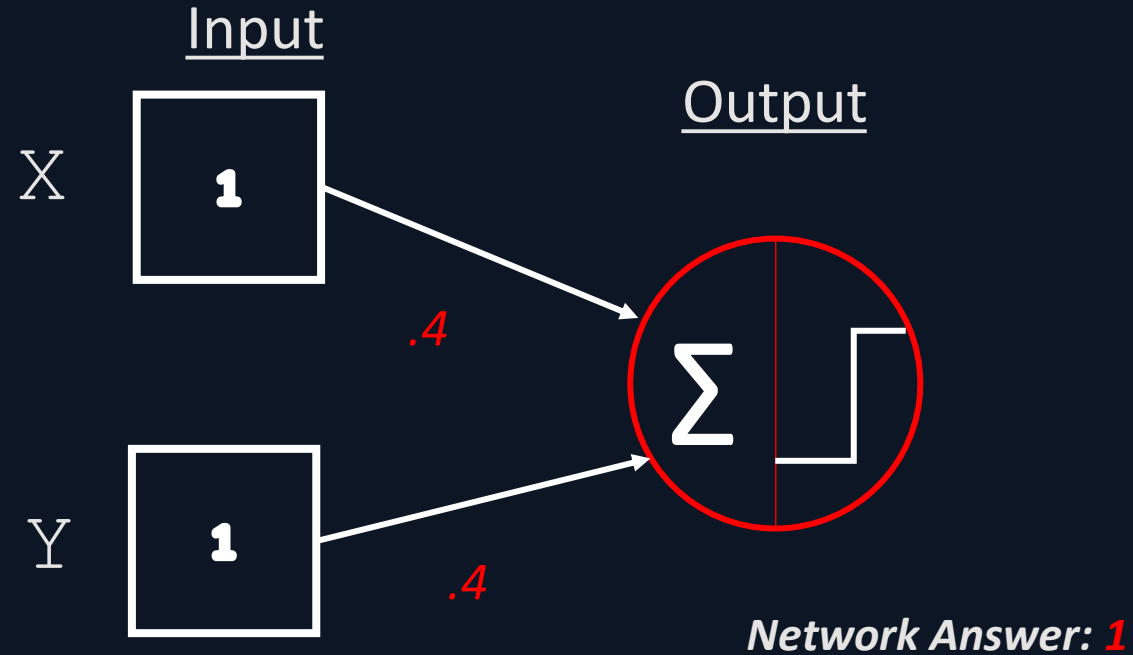
Try some weights

W1: .4

W2: .4

Test Case 1: Passes!

But, I don't trust it yet!



*Round((1 * .4) + (1 * .4)) = 1 (the network isn't exactly rounding, it's normalizing the value 0 - 1)*

Basics of an AI/ML “Network”

Test Case 2: X = 1; Y = 0

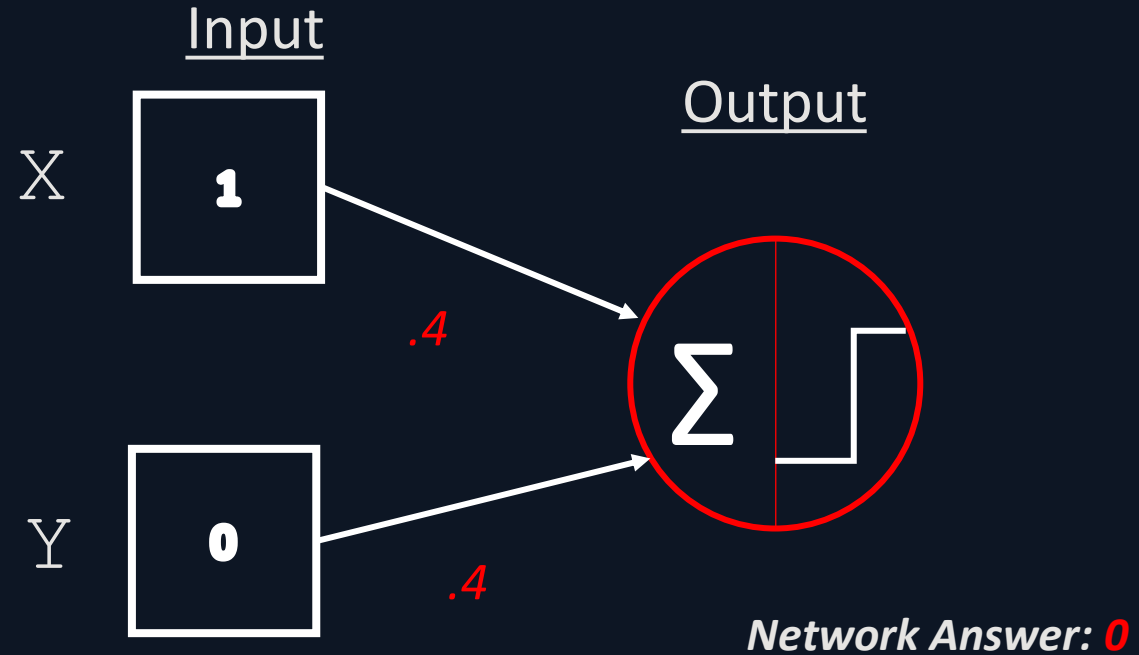
Try some weights

W1: .4

W2: .4

Test Case 2 Passes!

A working neural net!



*Round((1 * .4) + (0 * .4)) = 1 (the network isn't exactly rounding, it's normalizing the value 0 - 1)*

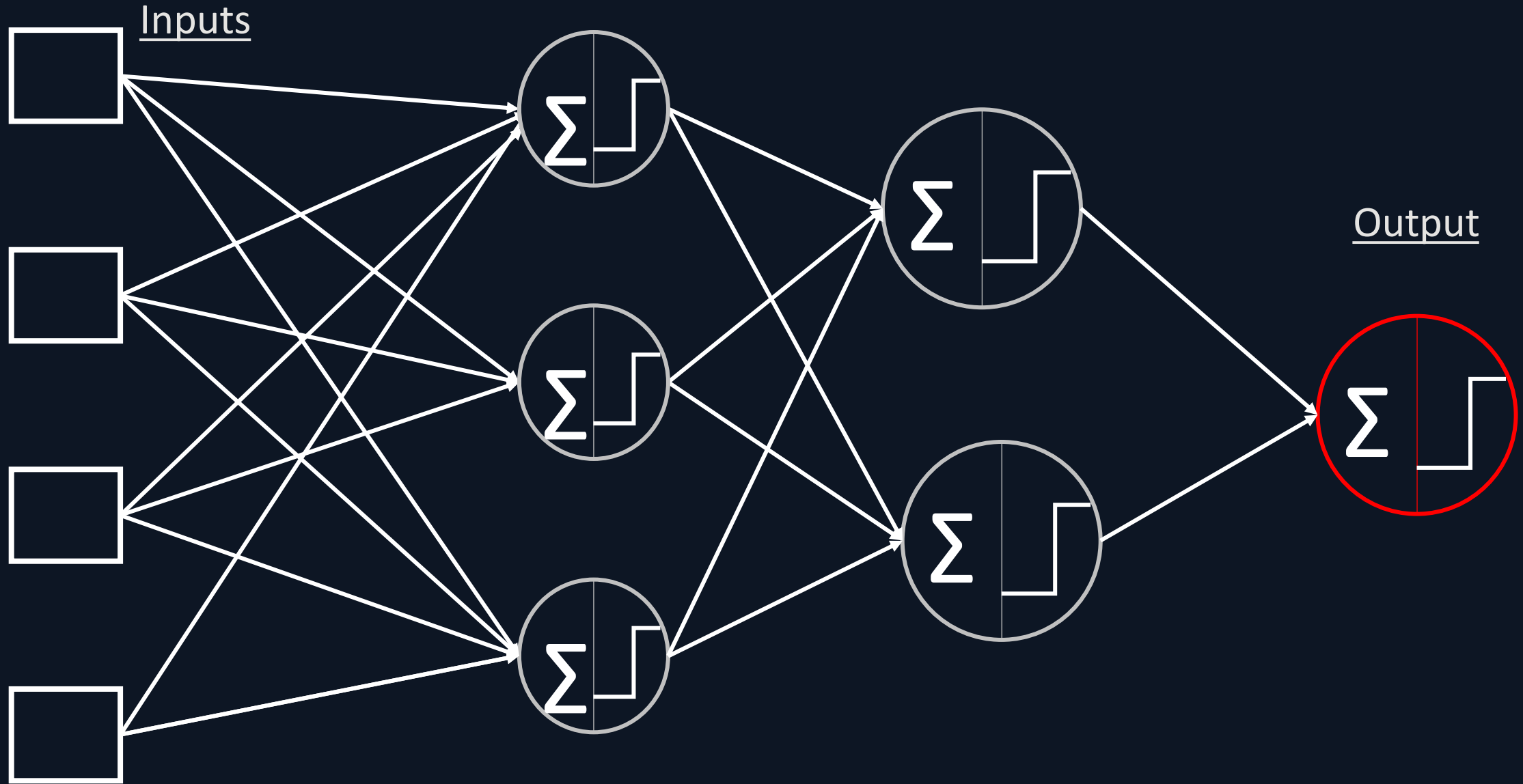
Congratulations

Congratulations!

You just made a working
neural network!



Times a Billion! And Connected Layers!



Types of AI

- ▷ Heuristic -> Ol' fashioned programming
- ▷ Statistics -> Regressions, Clustering, Vector Machines...
- ▷ NN -> Neural network
- ▷ Convolutional Neural Network -> NN w/ convolution kernel
- ▷ 3D NN -> NN/CNN w/ ability to analyze volumetric data
- ▷ Transformers -> Allow NNs to have "attention"
- ▷ Generative AI -> oriented at generating content
- ▷ Foundation model -> general purpose generation

FDA

- ▷ CADe -> assisted/aided detection for mammo, US breast lesions, lung nodules – not intended to highlight images; not intended for triage
- ▷ CADt -> triage use cases – not intended to highlight images
- ▷ CADx -> lesions suspicious of cancer
- ▷ QIH -> general bucket for using AI and showing results

Confused? I recommend taking away that CADt is specifically intended for triage use cases.

Read the labeling – labeling requirements continue to improve.

Future

- ▷ Today -> focused on single pathology use cases. Tomorrow? Most likely multi-pathology
- ▷ Should I be worried about my job?
 - I believe pressure will start on XR. Radiologist in the US are too few and overworked. XR is not where most radiologists make their money and is a far more tractable problem for AI and regulatory bodies
 - I believe CT/MR will ramp up as AI gets better at XR and that radiologists will read more CT and MR and need better tools based on AI to do so – automatic measurements, organ identification, QA workflows etc.
- ▷ Automation
 - In nearly every wave of ‘automation’, there ends up being more jobs, not fewer. However, jobs do change during these waves. I believe radiology will change – for the better for radiologists and patients. Radiologists will read more cases and more complex cases, faster, with better quality.

Thank you