Connecting Neuroscience and Machine Learning

Don't get Eaten by the Tiger

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Neuroscience

The study of the Brain

Visual System

- Object Classification
  Tiger or Tree

- Motion Detection
  Am I moving
  Is the tiger moving

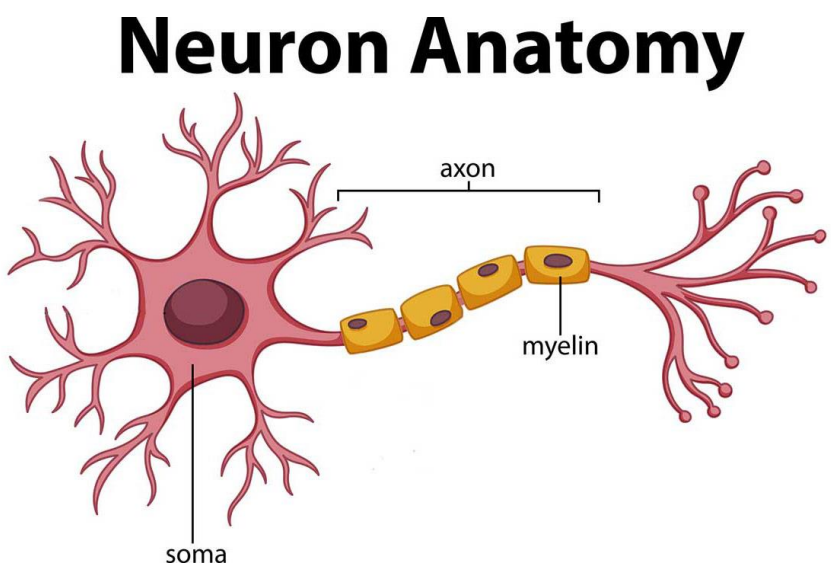
- Motion Discrimination
  Which Direction am I moving
  Which Direction is the tiger

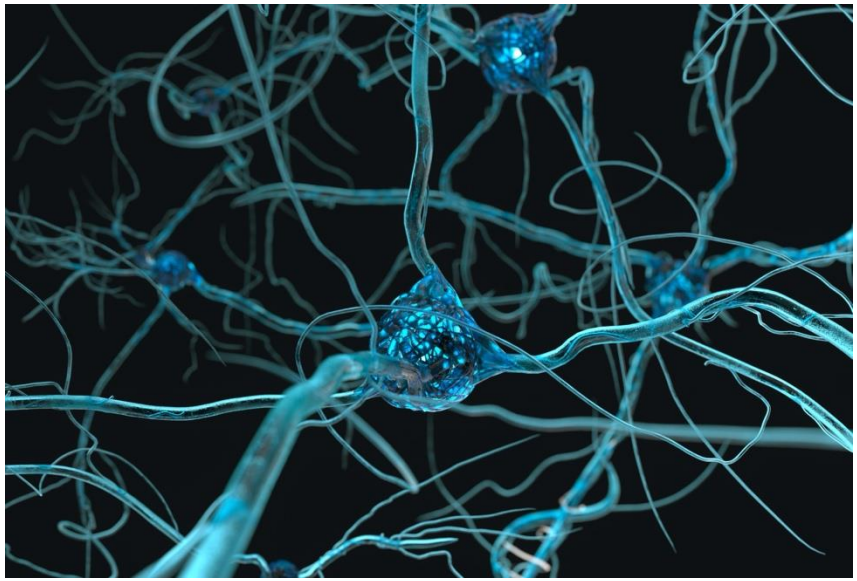
Questions for You

What is the brain made of?

1. Water
2. Protein
3. Fat
4. Veins
5. Glial Cells
6. Neurons

What Does a Neurons Look Like



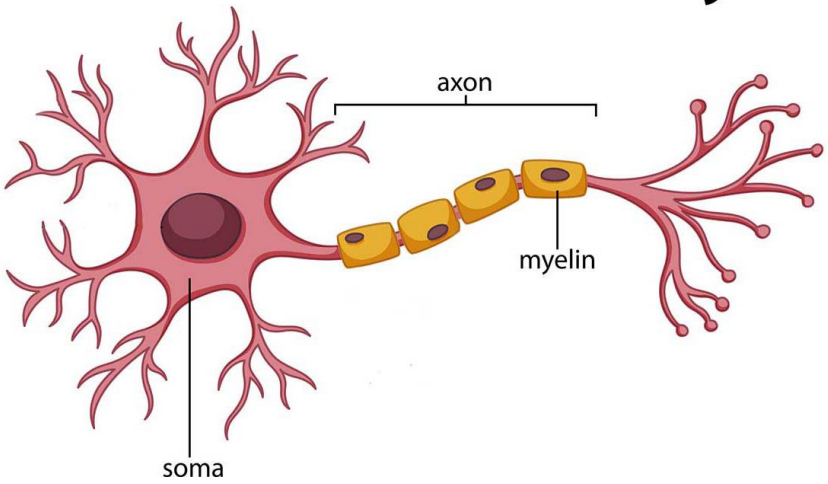


How Many Neurons?

100,000,000,000

How Does a Neurons Work

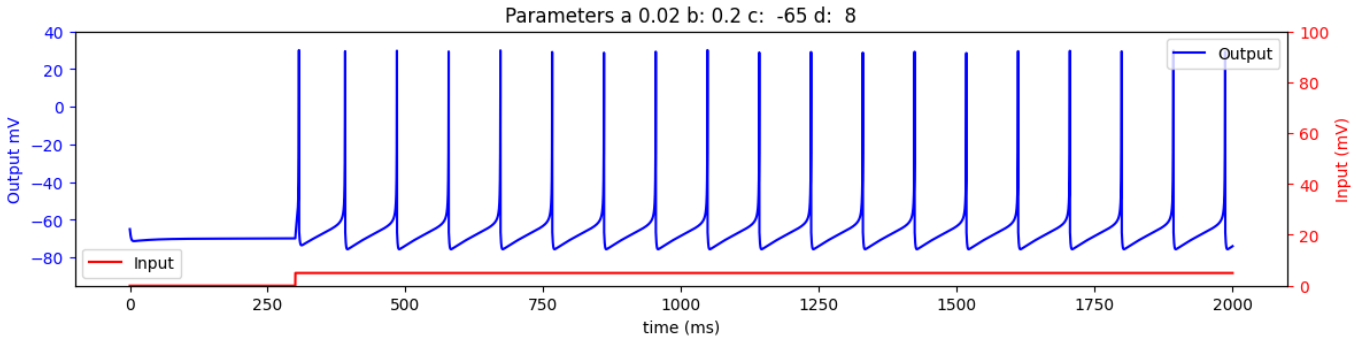
Neuron Anatomy



Spike

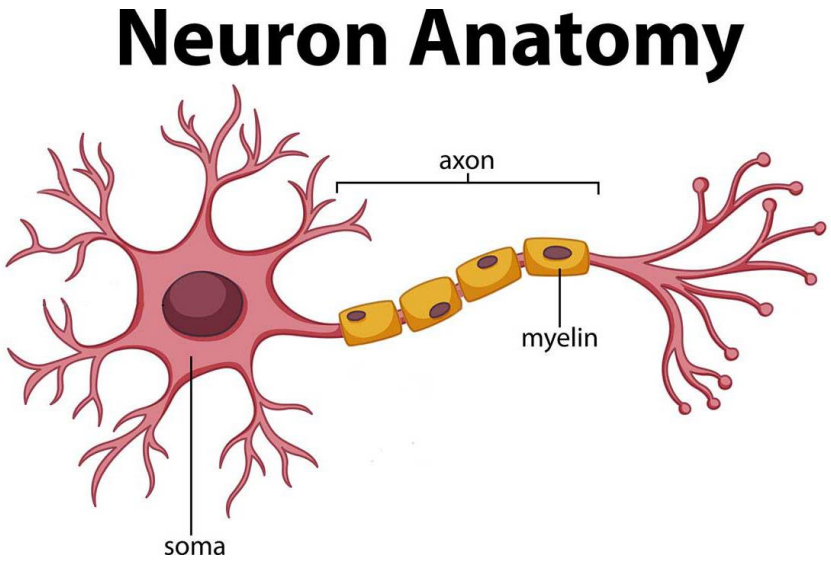
0

1

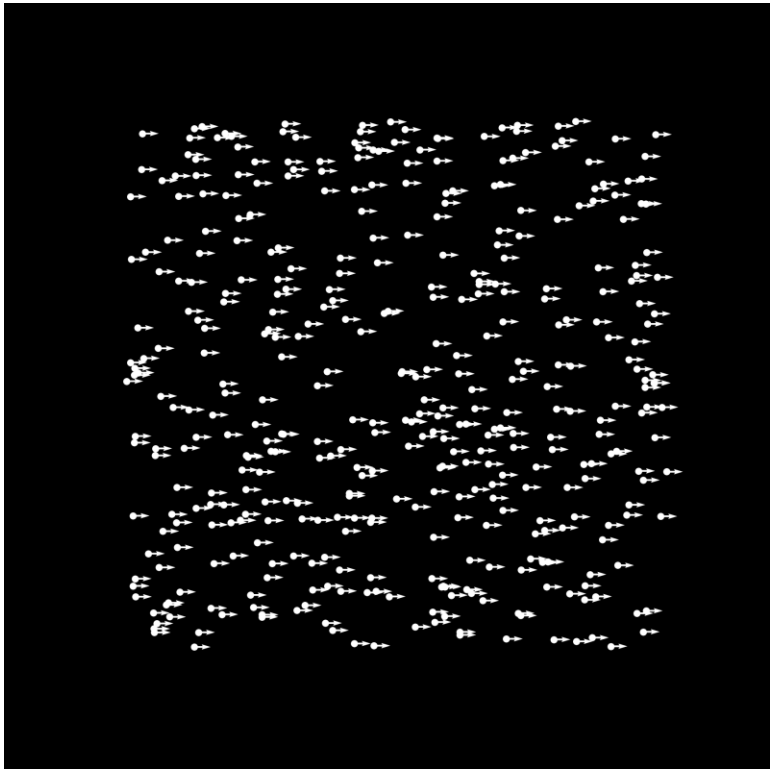


TU DUBLIN
OLLSCOIL TEICNEOL BHAILE ÁTHA CLIATH
TECHNOLOGICAL UNIVERSITY DUBLIN

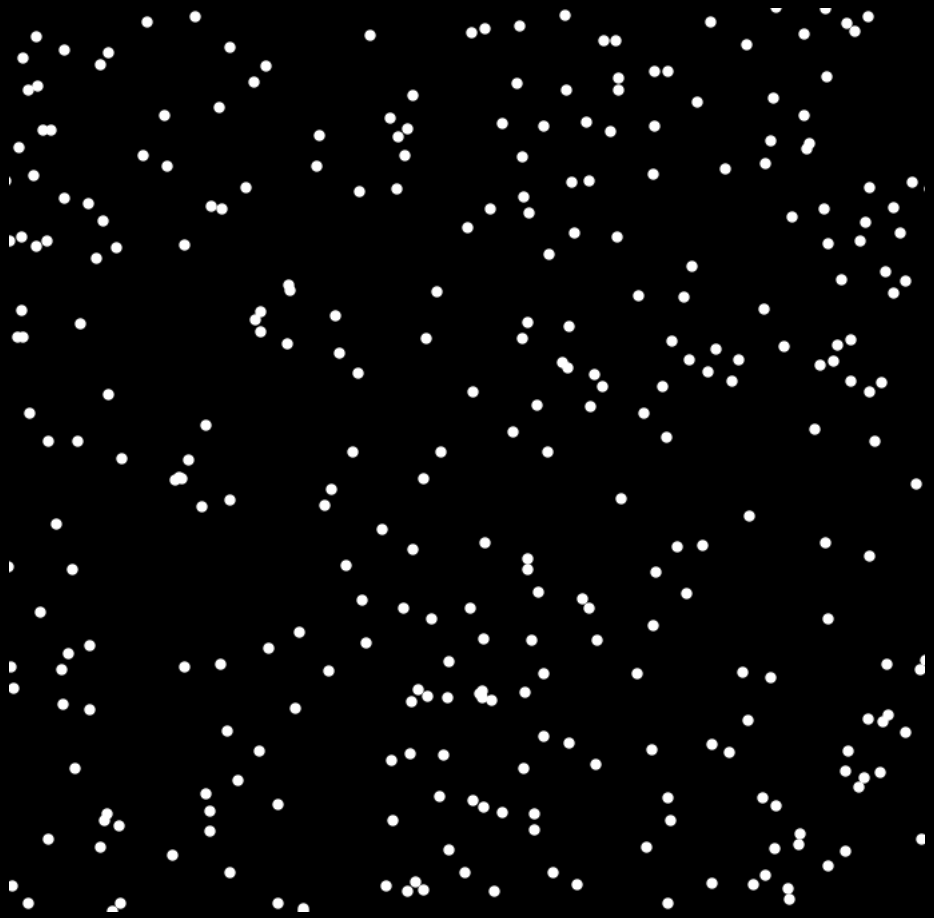
Volunteer A Neuron



Is the Tiger Coming for Me

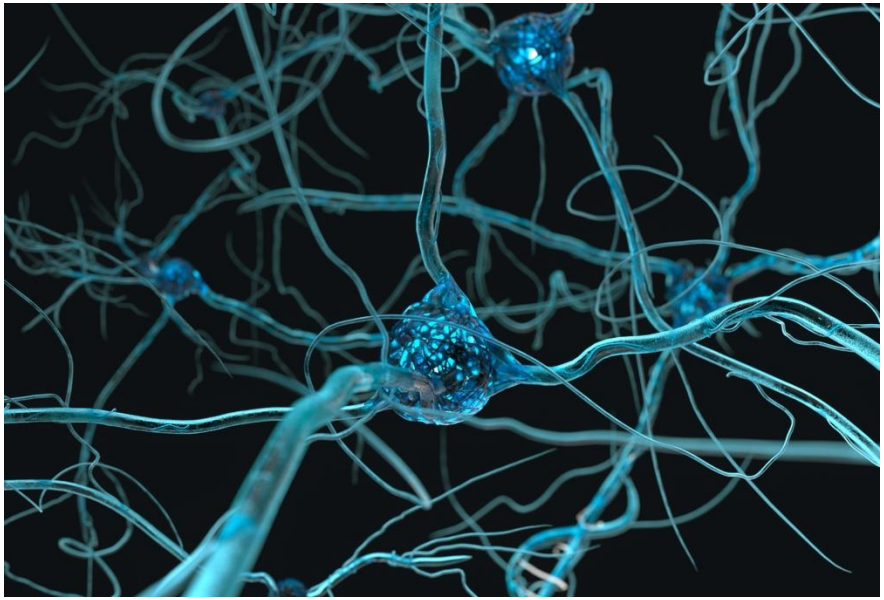


Left Or Right?



No Noise

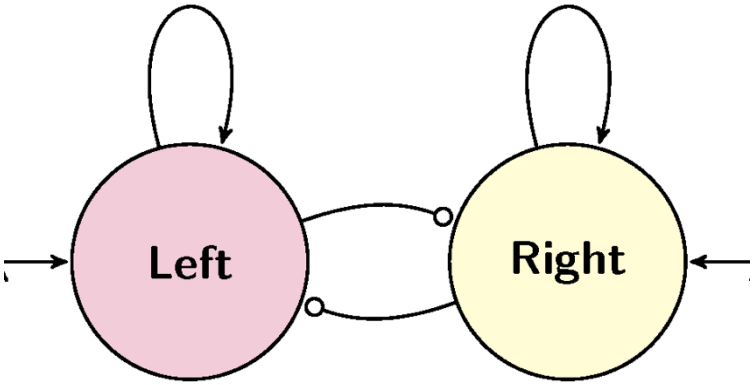
How do Neurons Work Together?



100,000,000,000 Neurons
each with
10,000 connections
1,000,000,000,000,000 connections

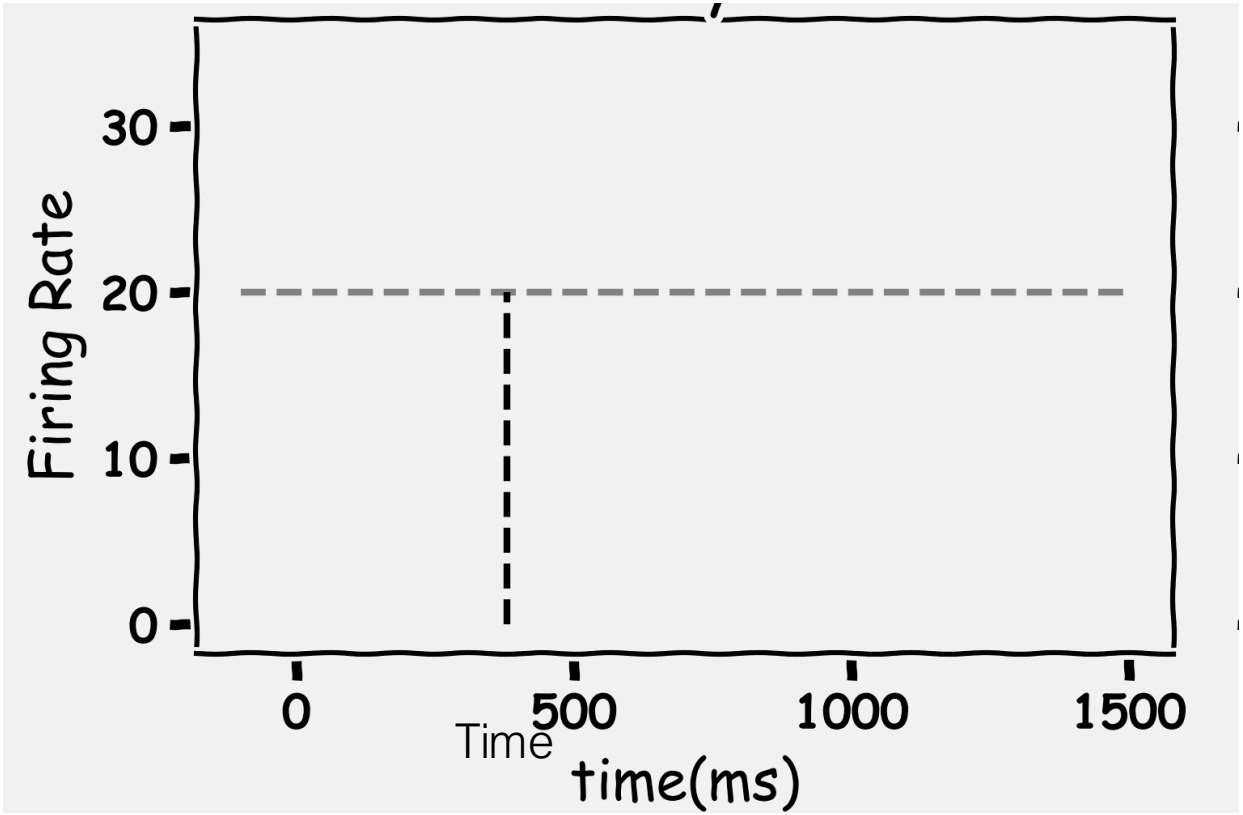
Two Areas

- Let's get a everyone to be two groups of Neurons
- A Left side and a Right side

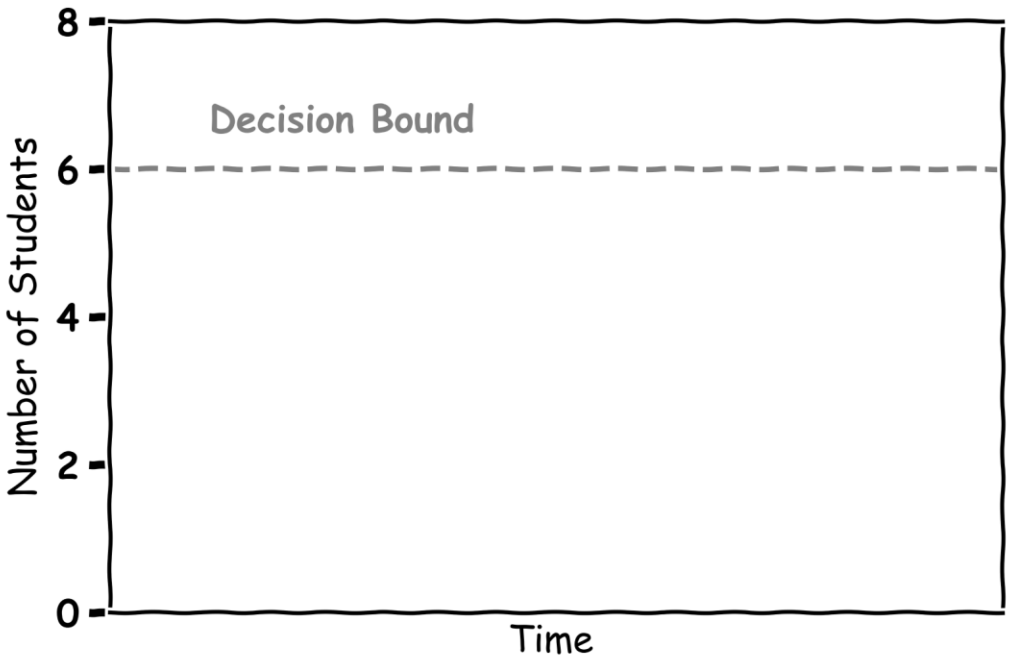


- The most votes is the decision
- But is it the correct decision

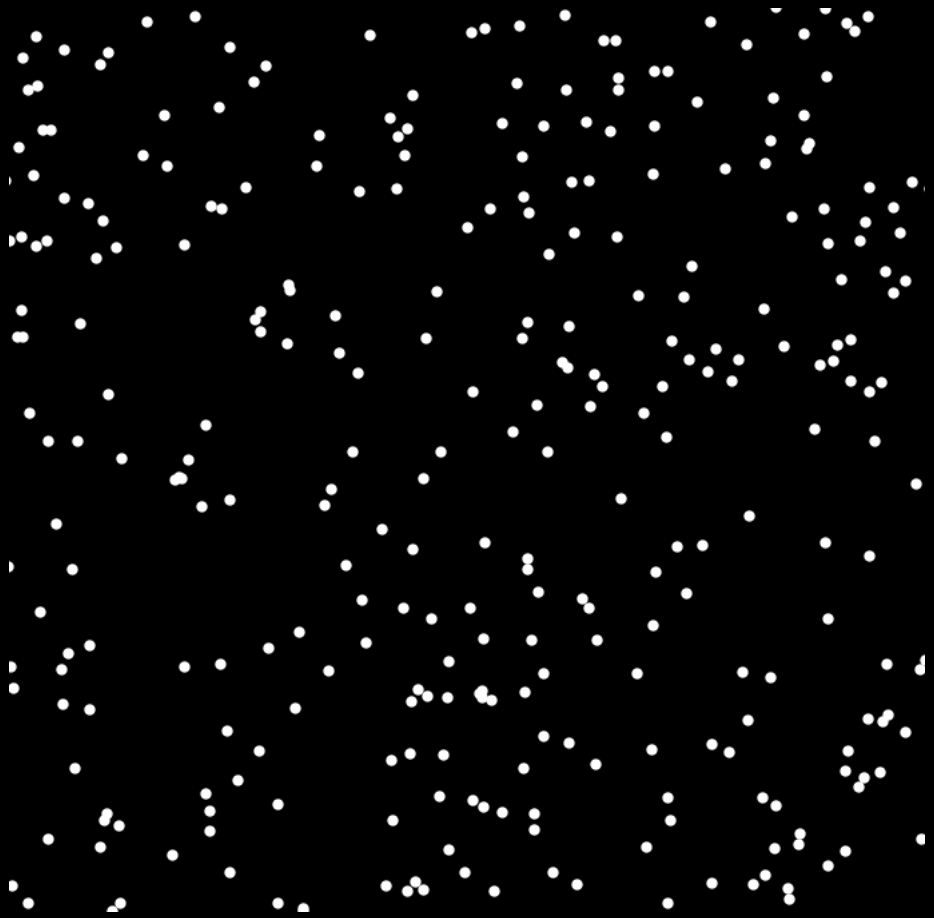
A Quick Decision



A Quick Decision

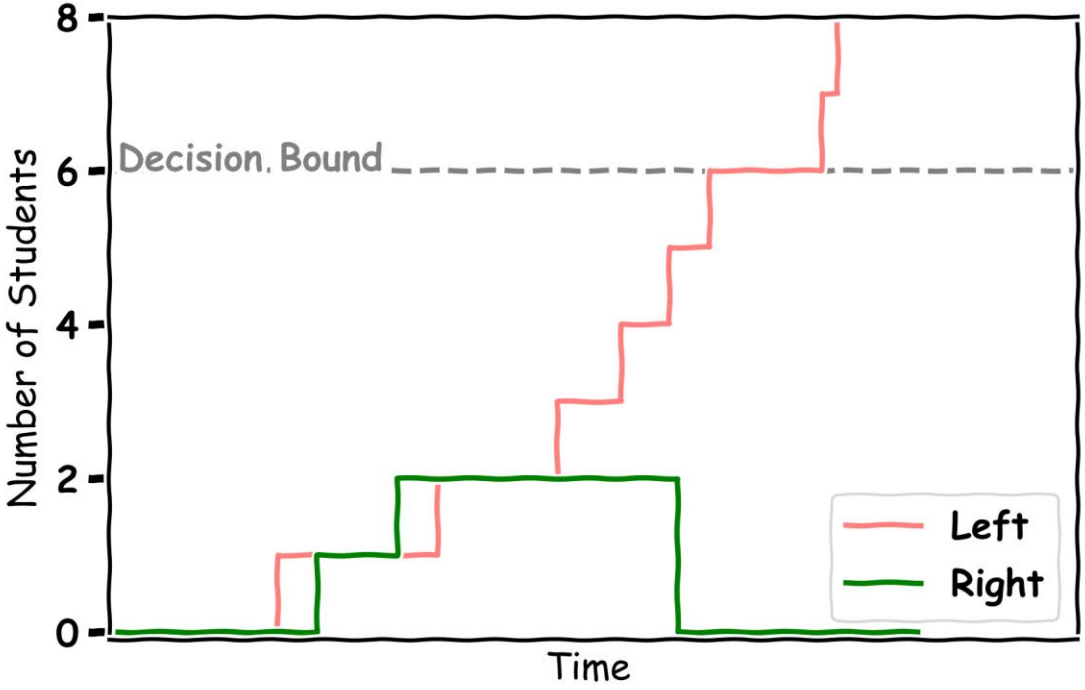


Left Or Right?

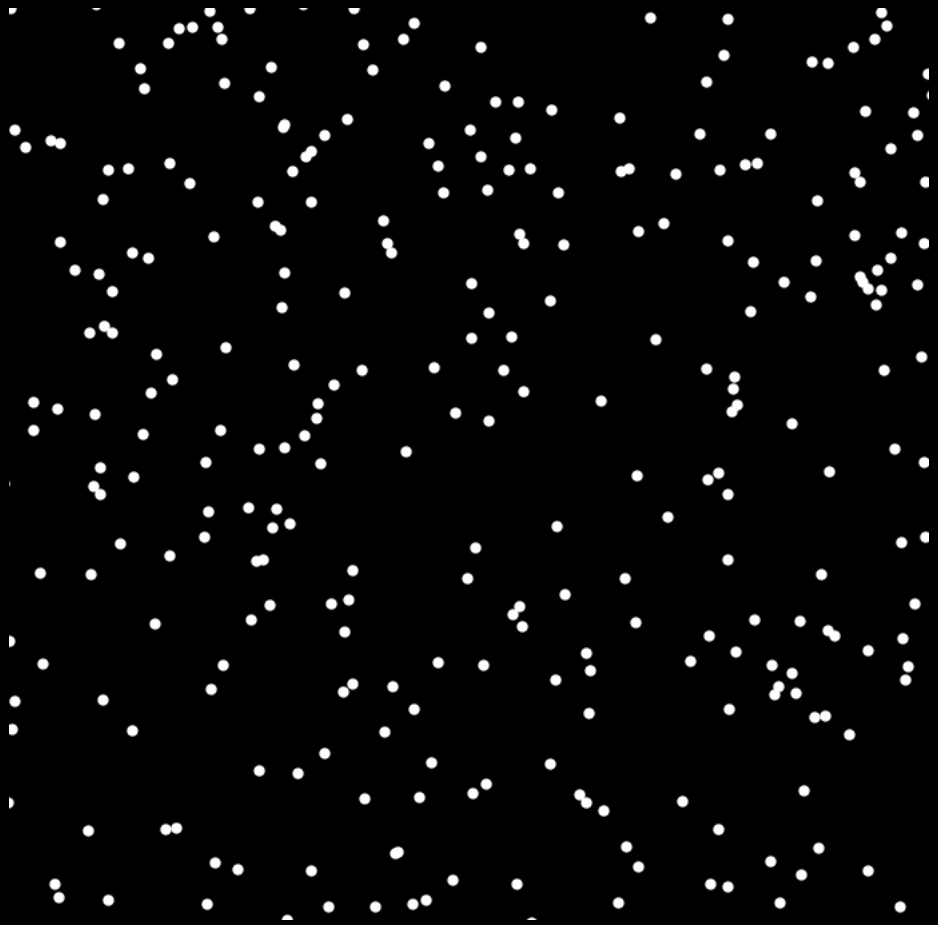


No Noise

Left Decision

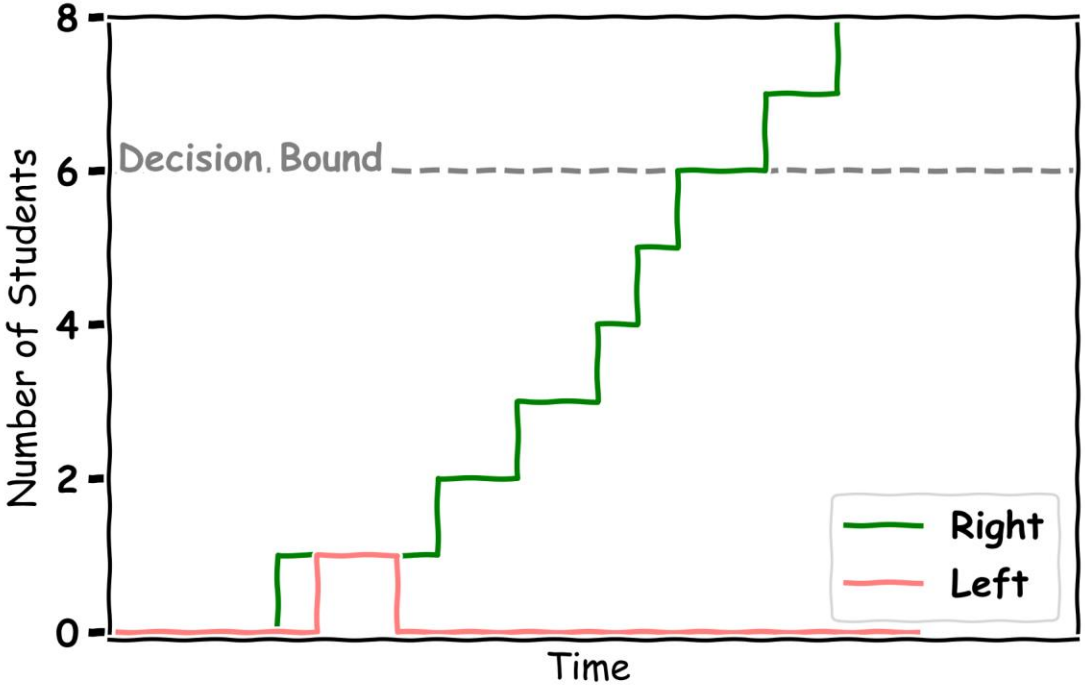


Left Or Right?



No Noise

Right Decision



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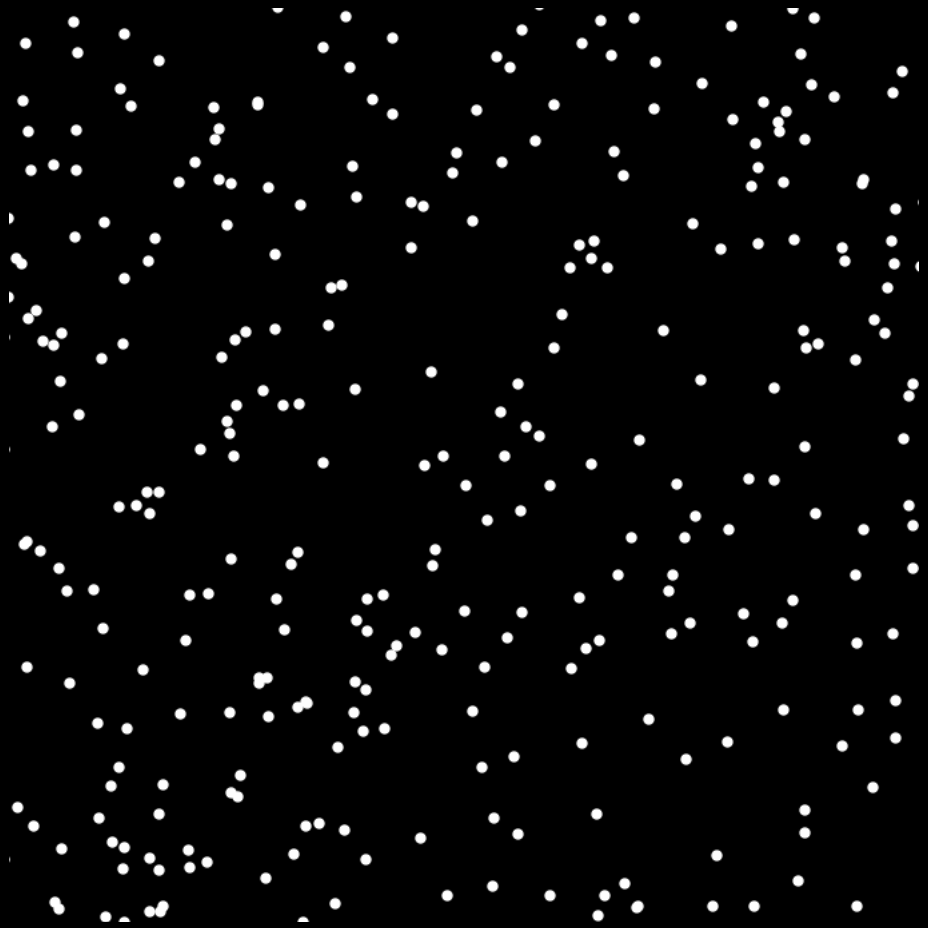
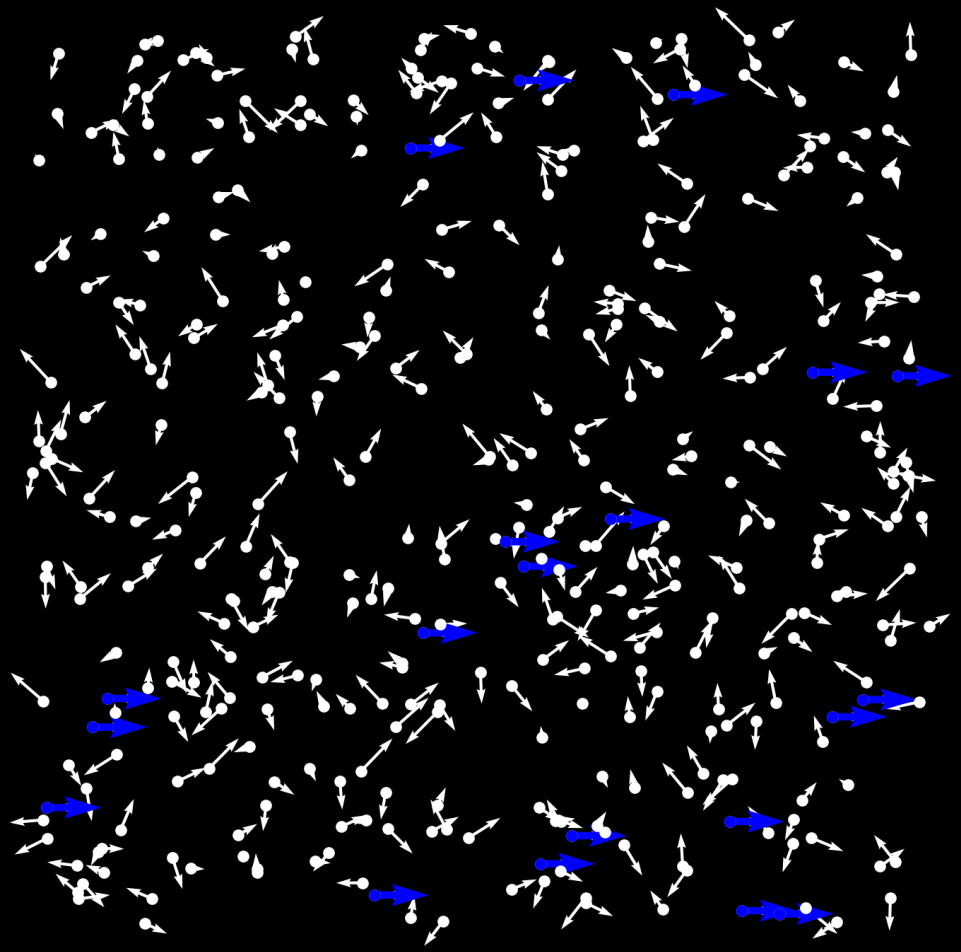
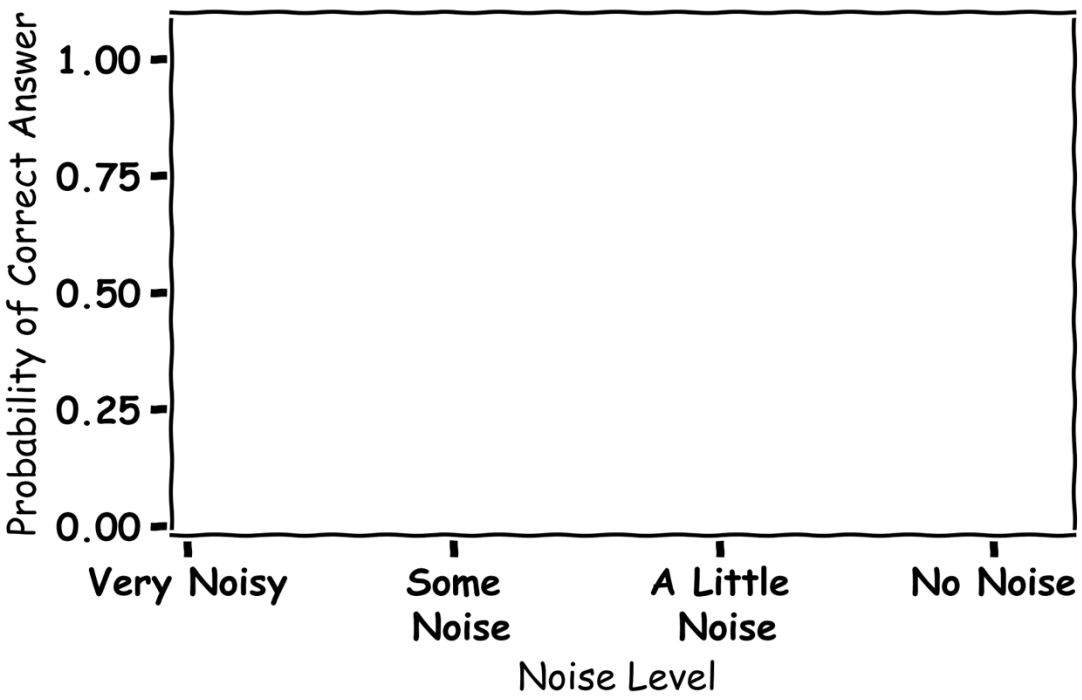


Some Noise

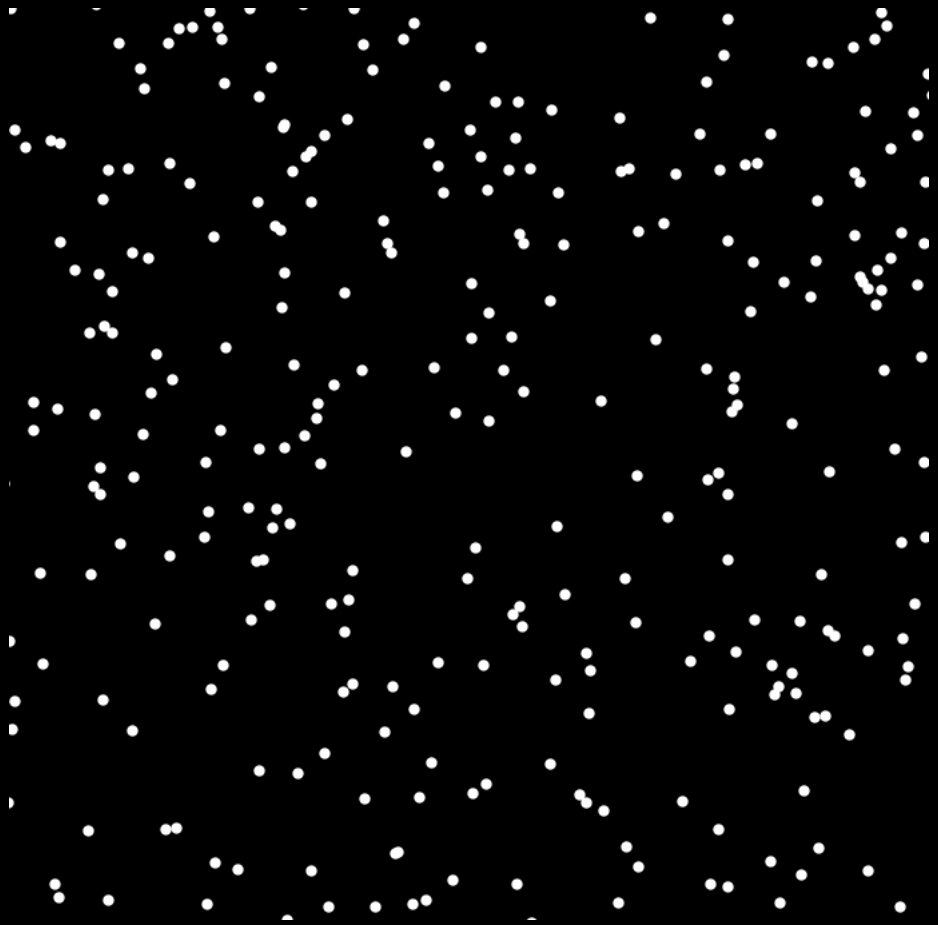
Snapshot



Noise

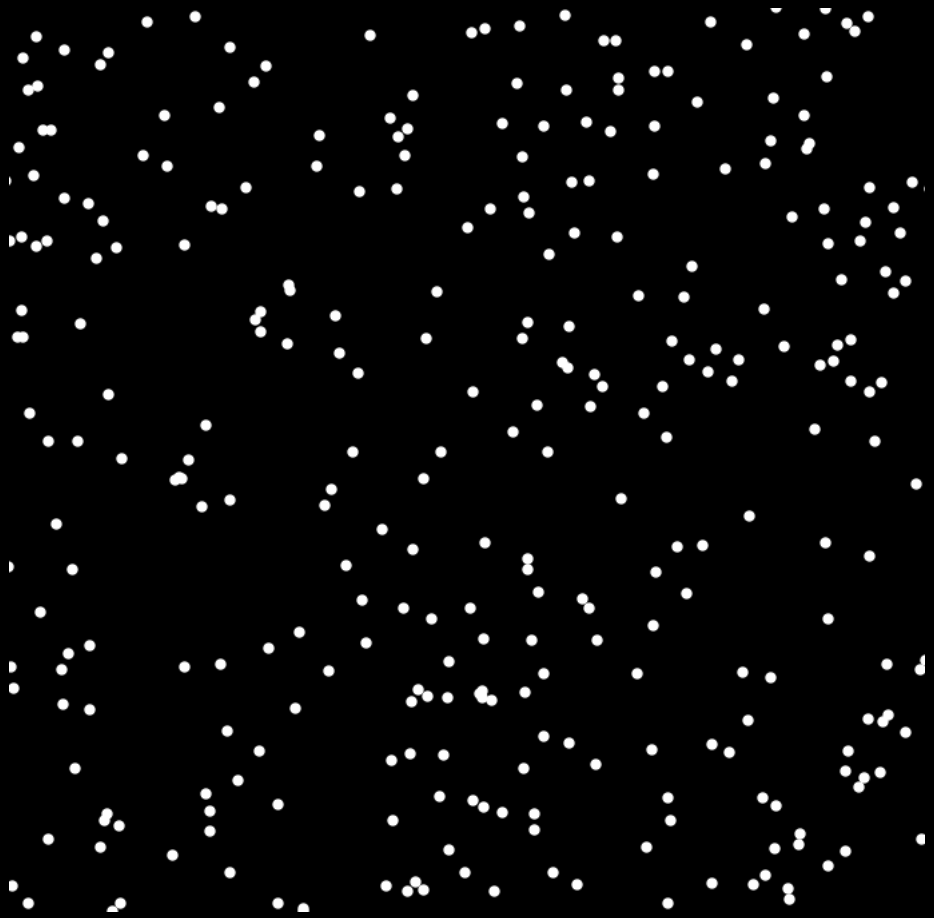

Probability of Correct Answer
1.00
0.75
0.50
0.25
0.00
Very Noisy
Some Noise
A Little Noise
No Noise
Noise Level

Left Or Right?



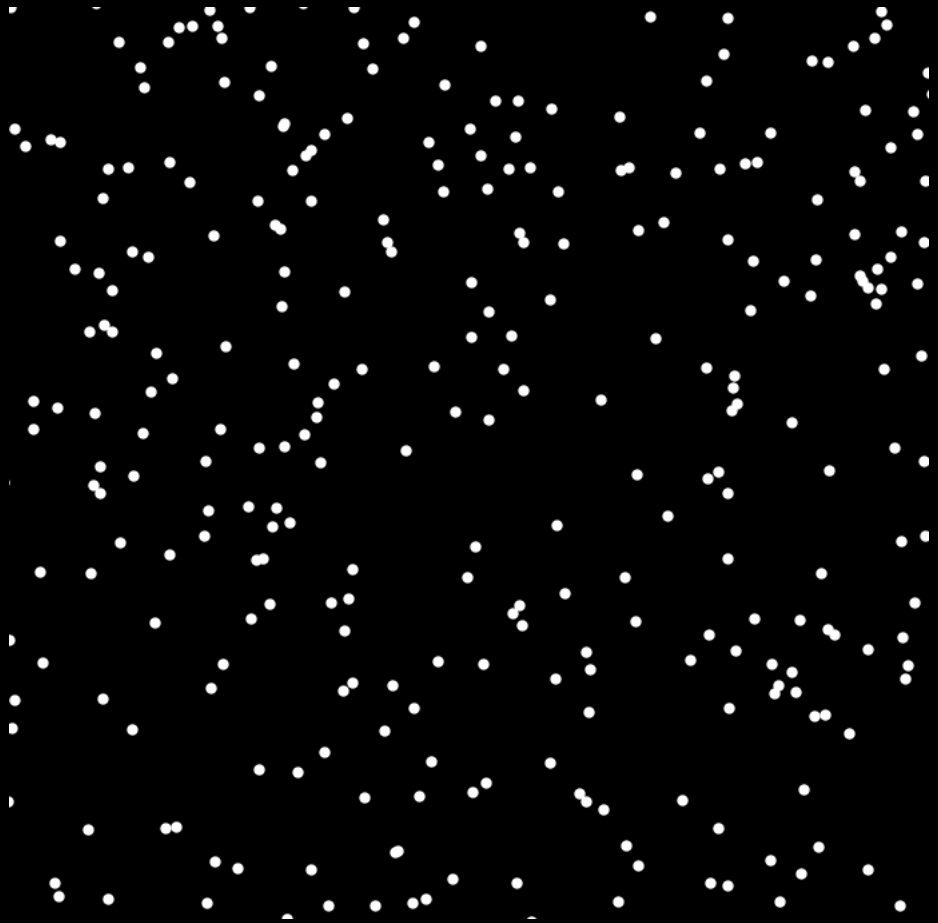
No Noise

Left Or Right?



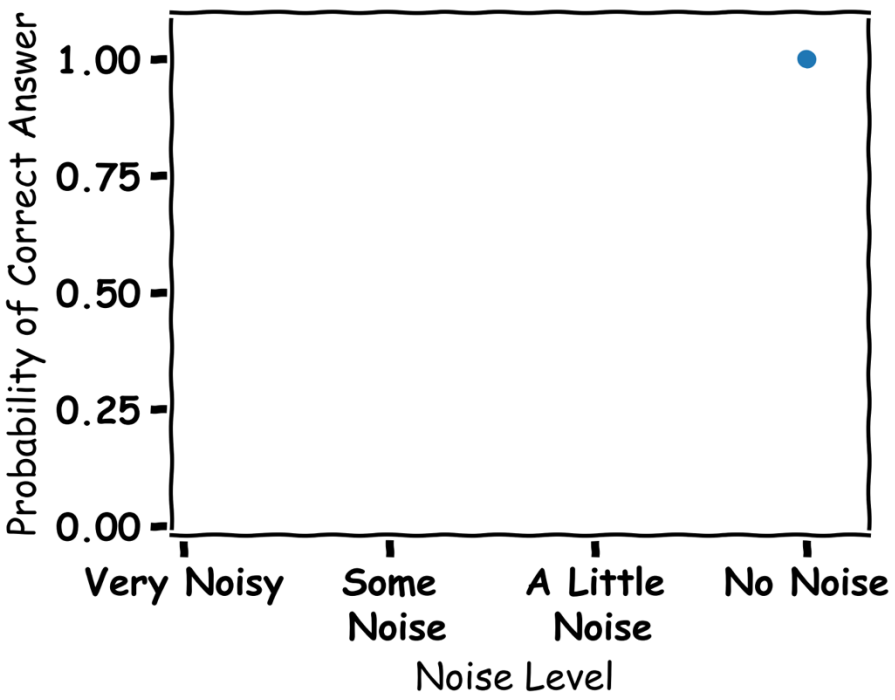
No Noise

Left Or Right?



No Noise

Answers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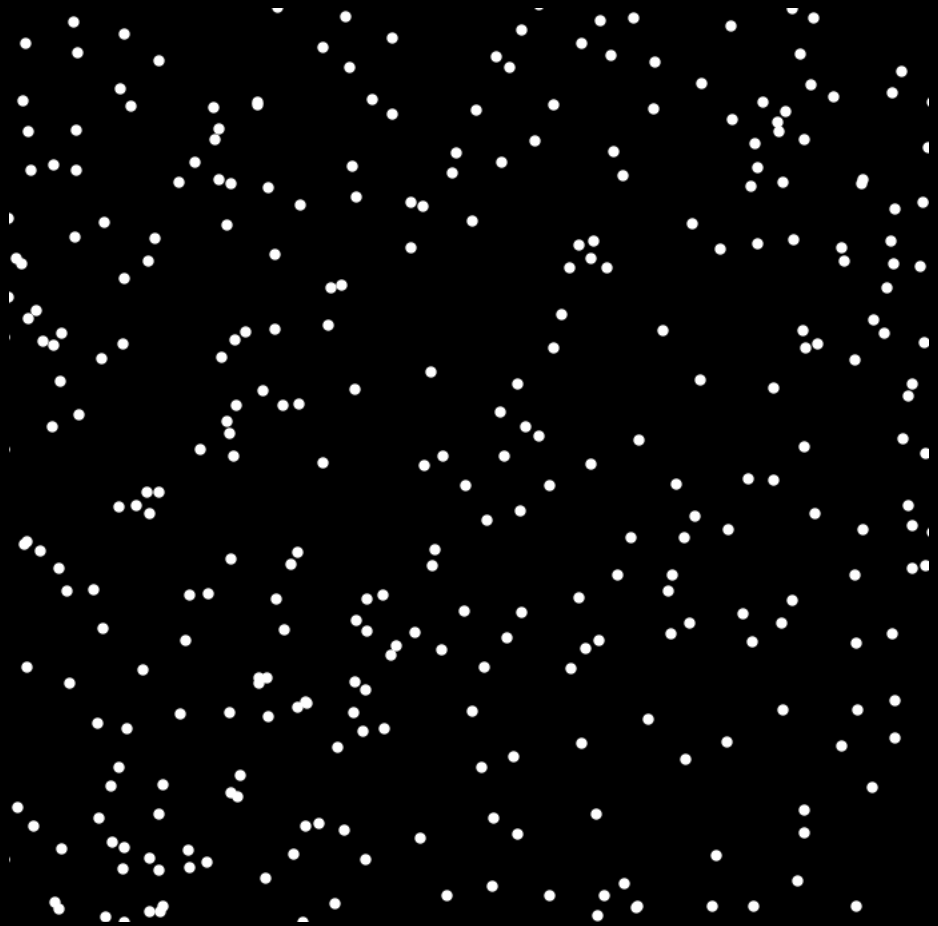
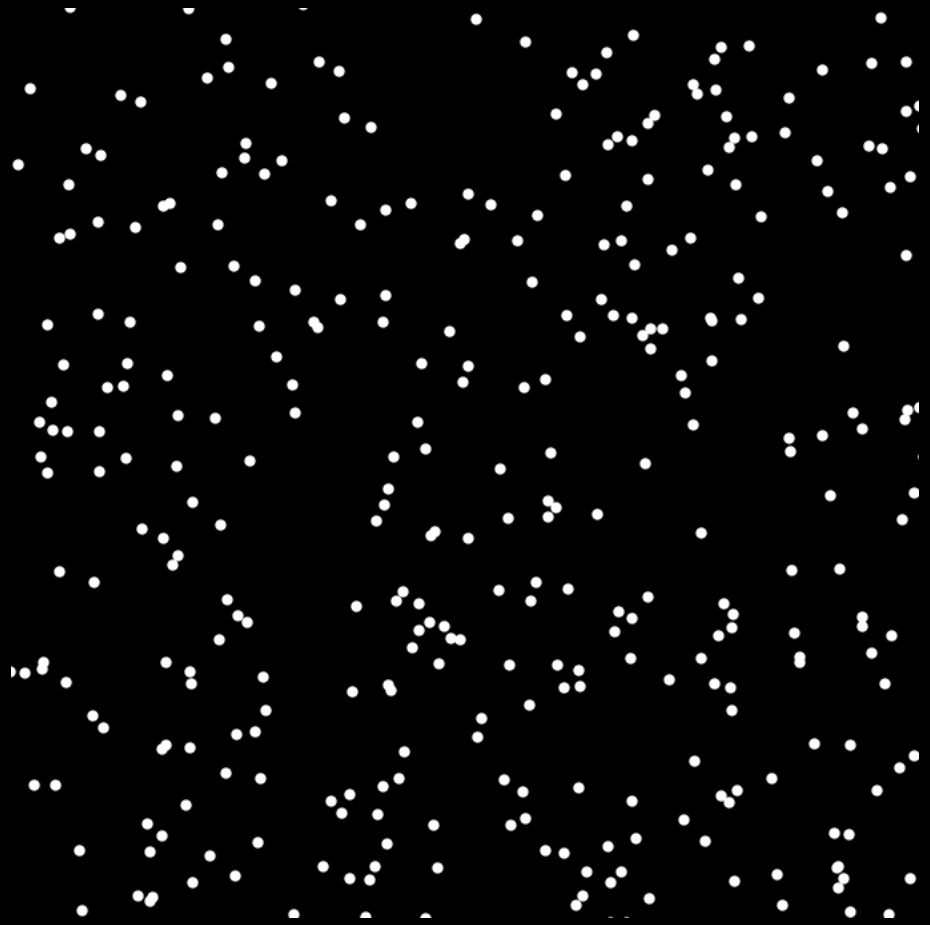


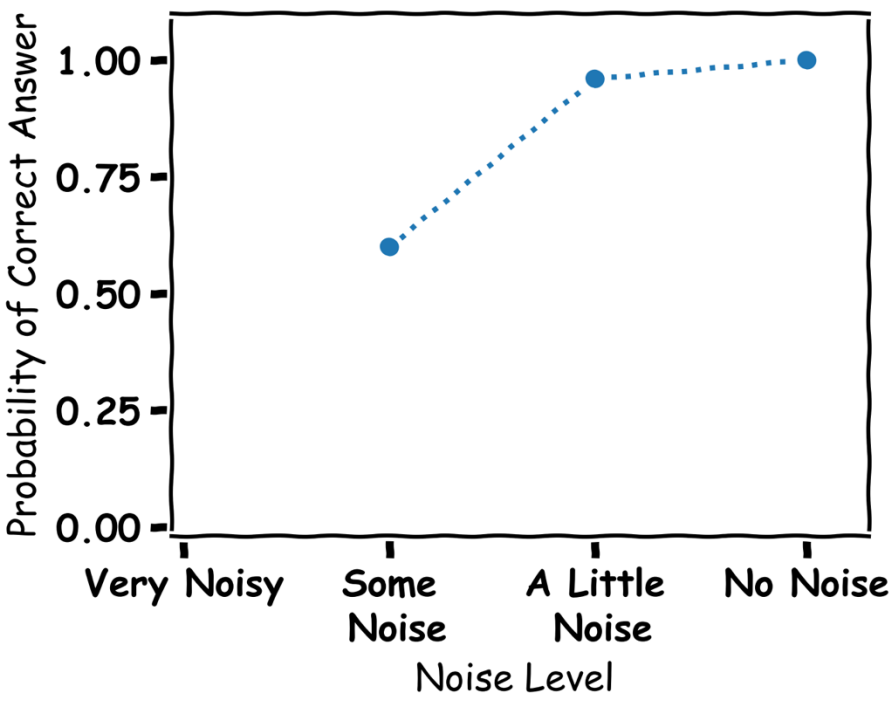
A little Noise

Left Or Right?



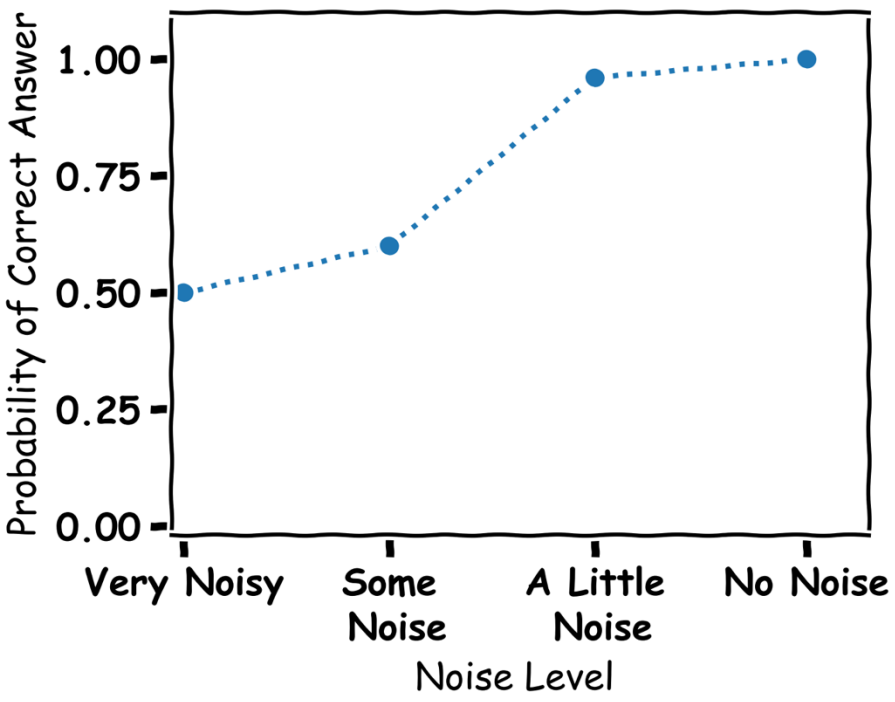
Some Noise

More Answers



Left Or Right?

Answers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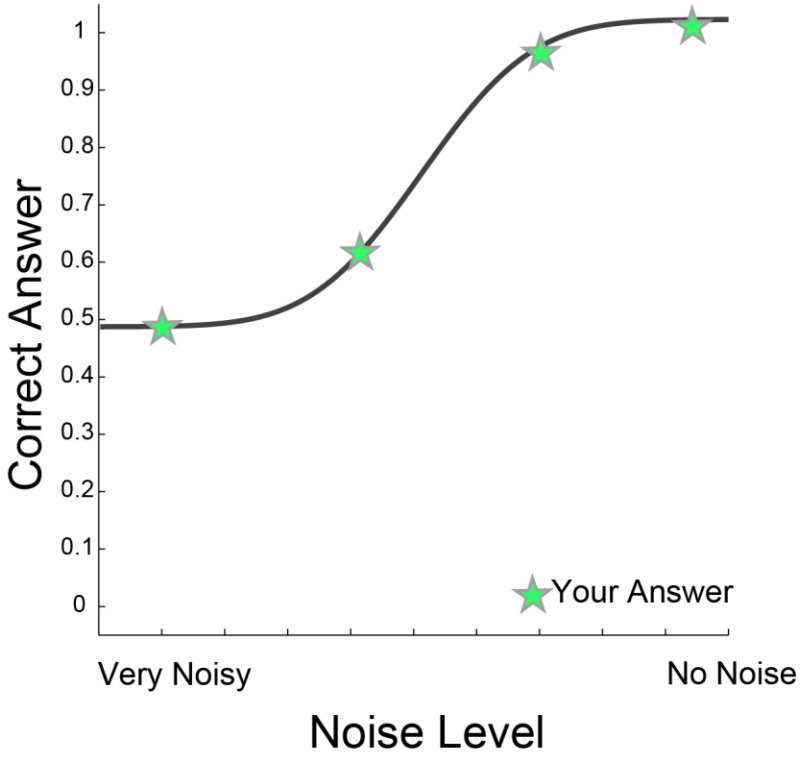
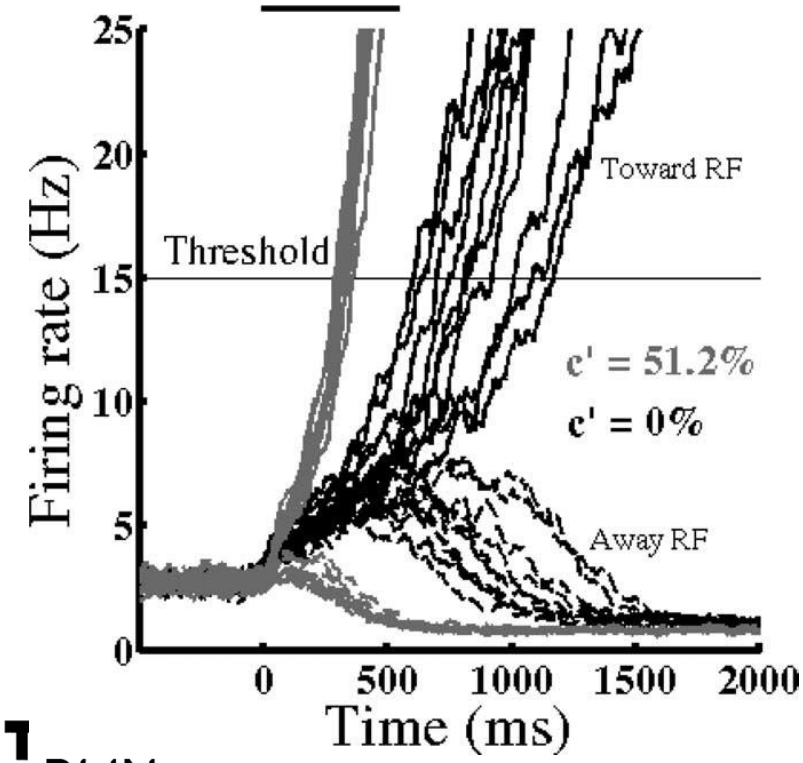
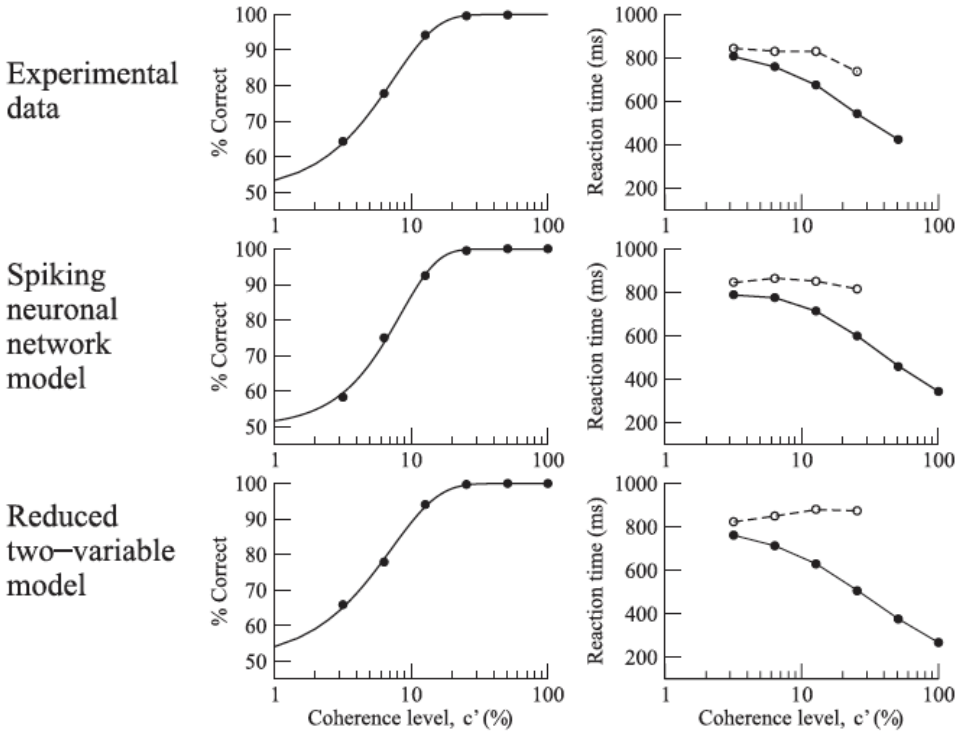


Modeling Directions

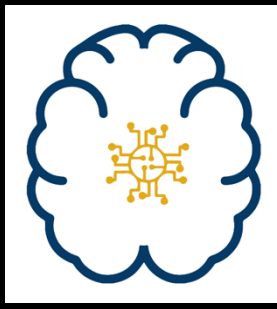
MODEL OUTPUT



MAPPED TO DECISIONS



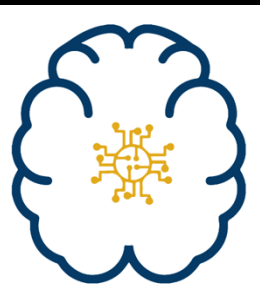
Wong and Wang 2006



Machine Learning

Algorithms

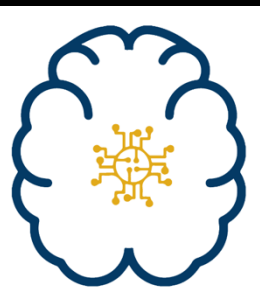
What is Machine Learning



- Machine learning is teaching computers to learn and make decisions.

- Well animals are good at learning and making decisions
- Let's try to do it like them

Visual System

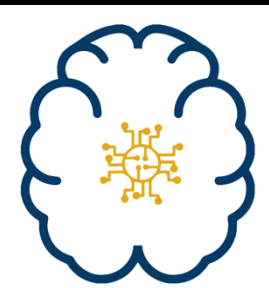


- Object Classification
  Tiger or Tree

- Motion Detection
  Am I moving
  Is the tiger moving

- Motion Discrimination
  Which Direction am I moving
  Which Direction is the tiger

Perceptron (node)



Input

Node

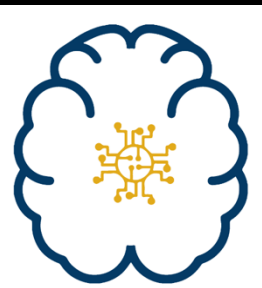
A BIT OF MATHS

Output

0

1

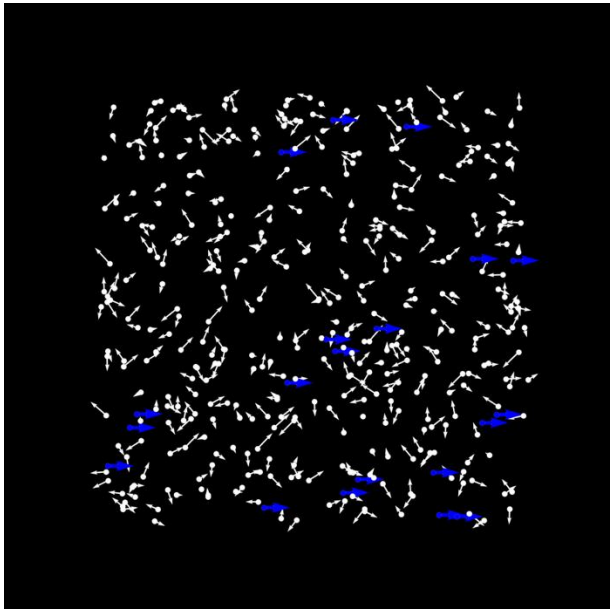
Perceptron (node)

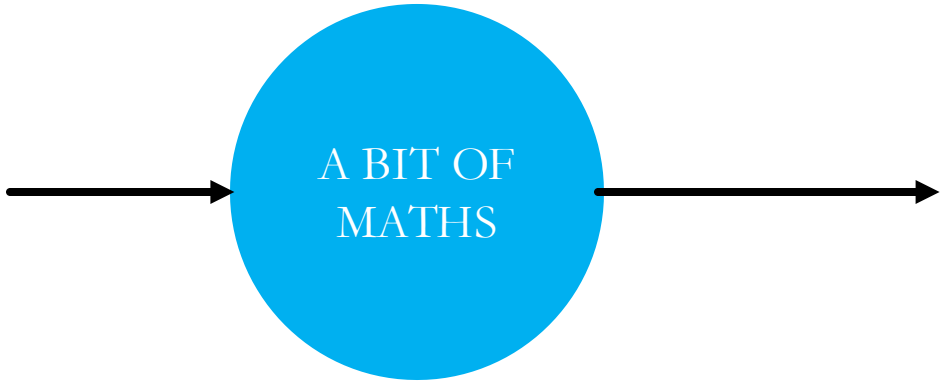


Input

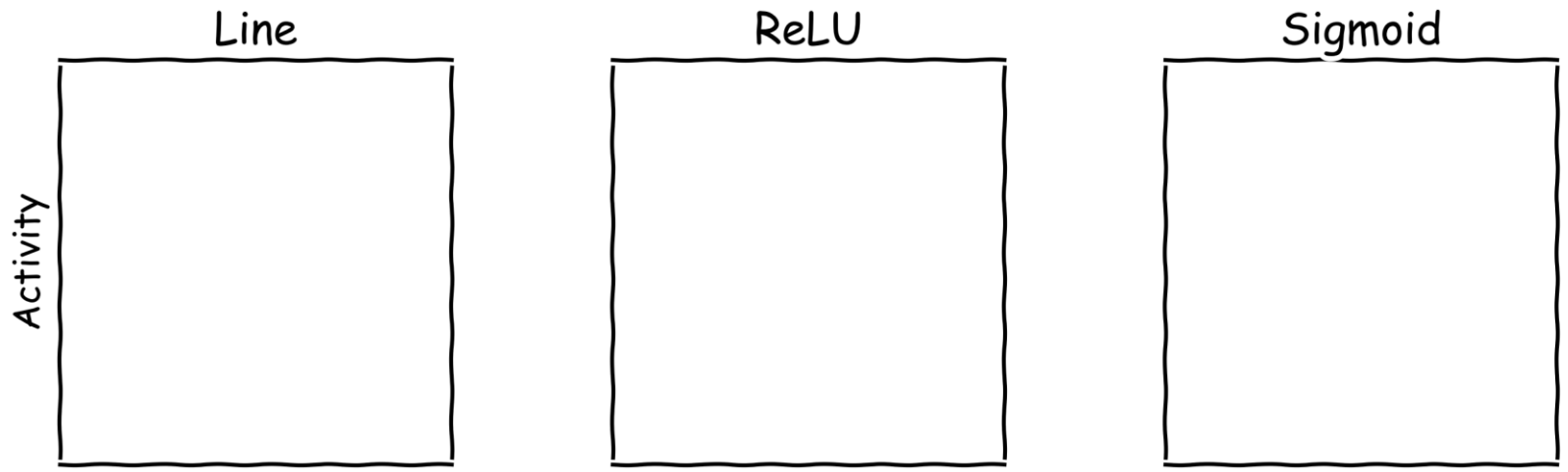
Node

Output

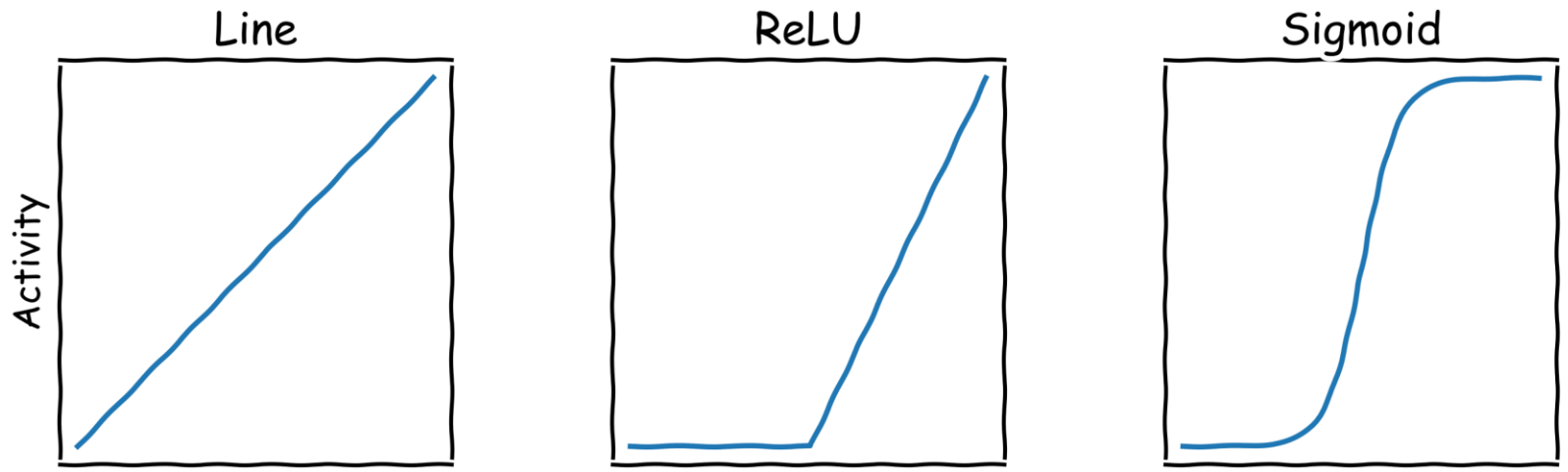




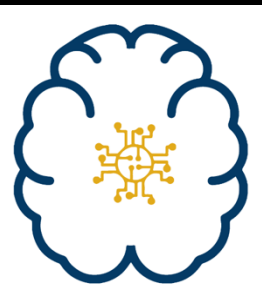
Activation Function



Activation Function

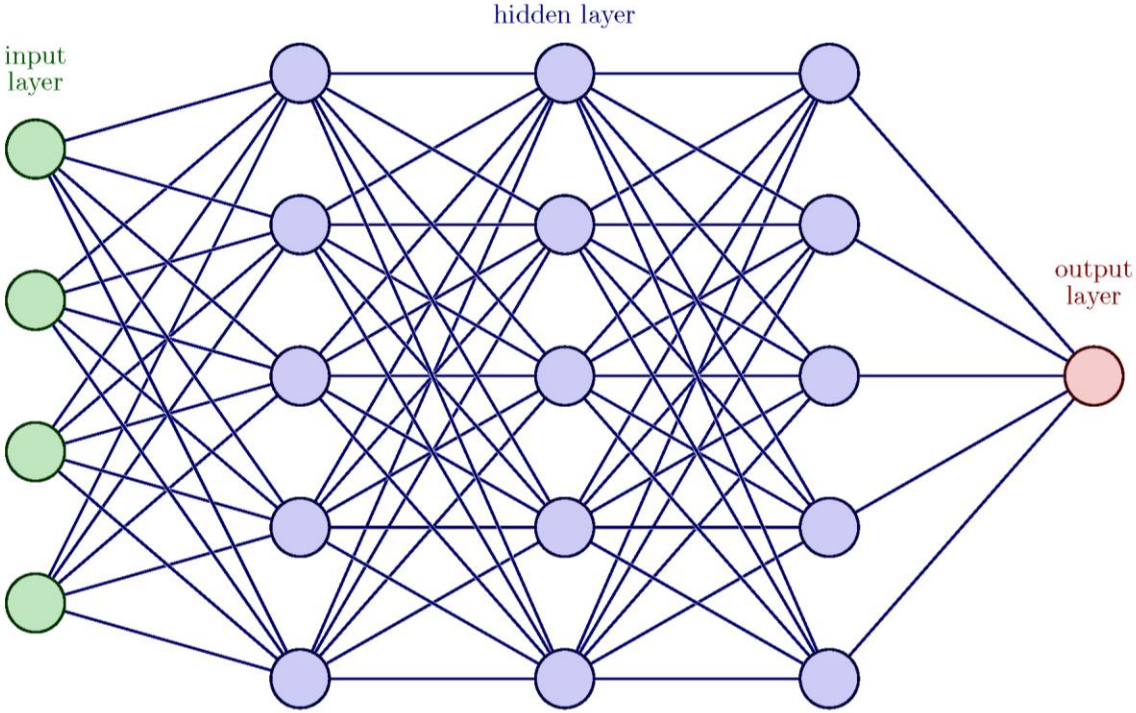


Loads of Nodes an Artificial Neural Network



Input

Neural Network

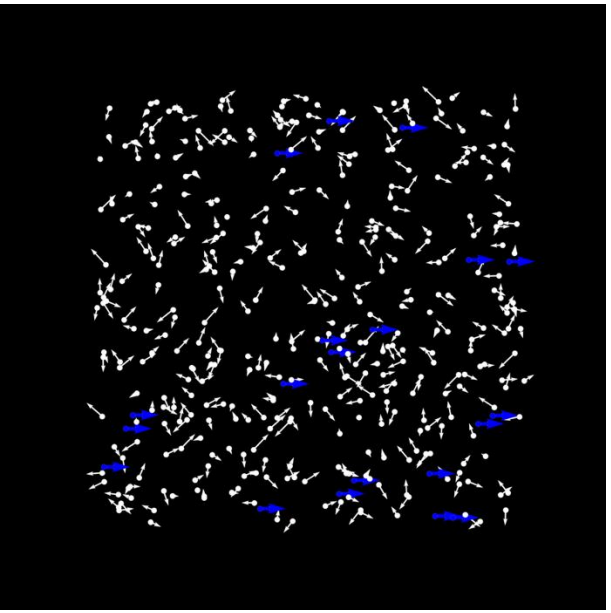


Output

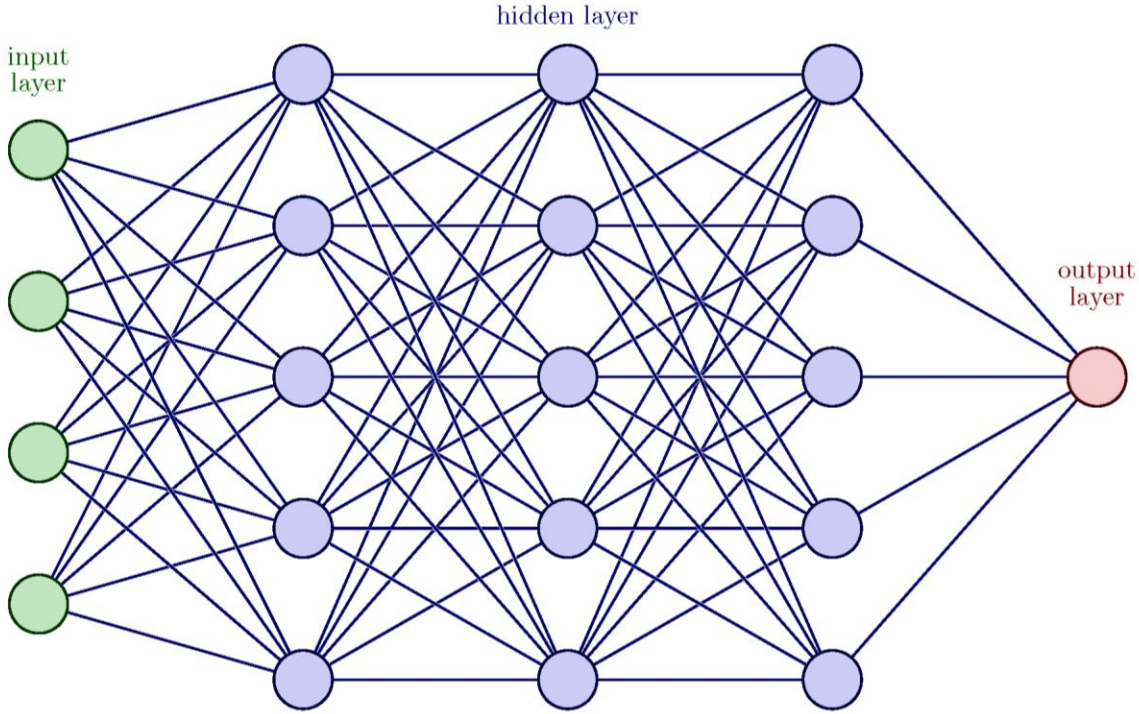
How does it learn?

- It must learn the connections

Input

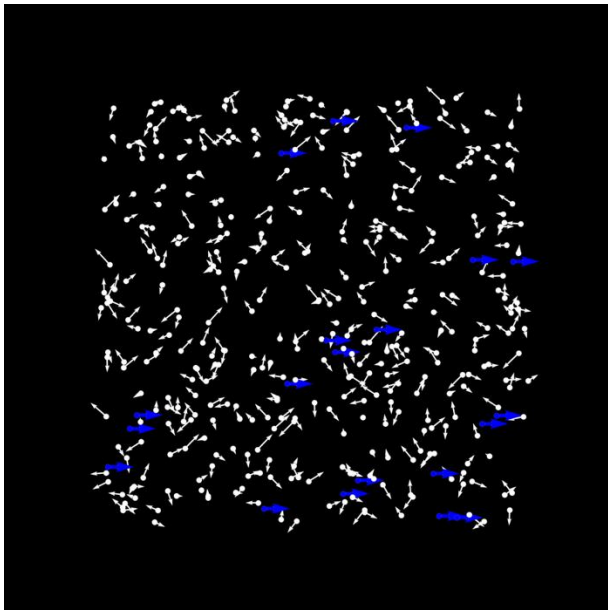


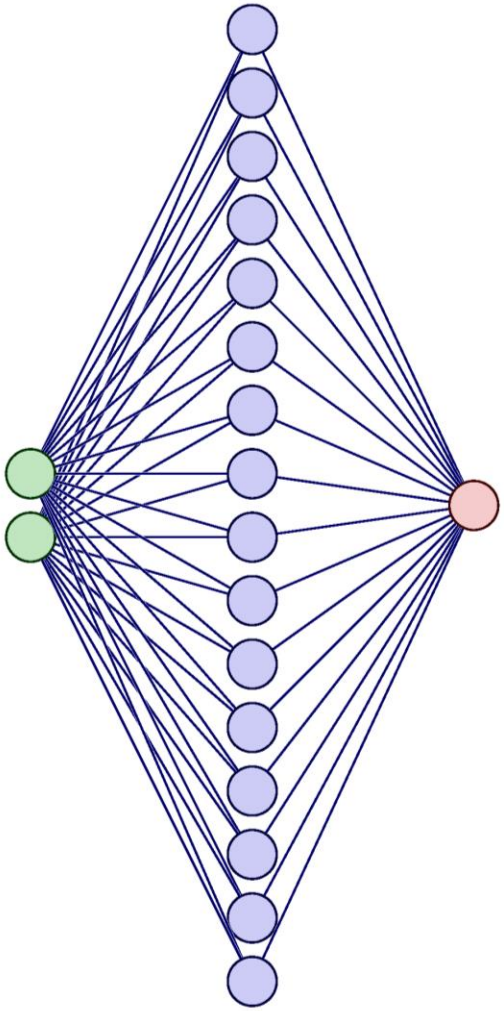
Neural Network



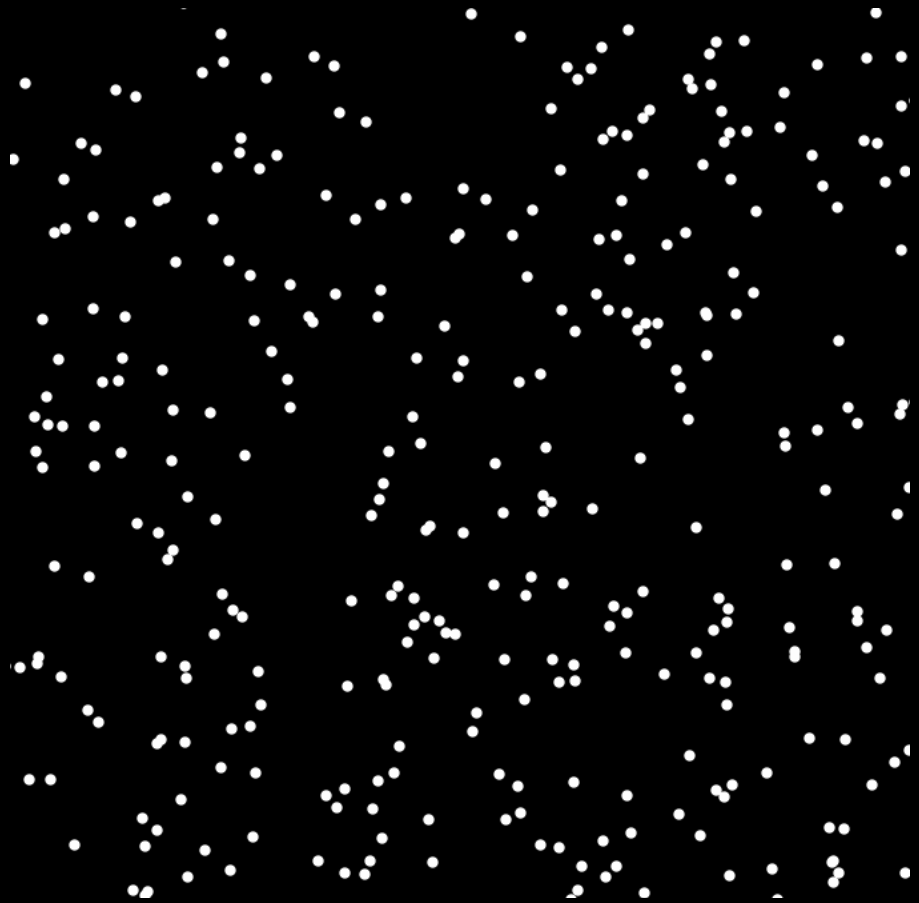
Output

How does it learn?





Left Or Right?

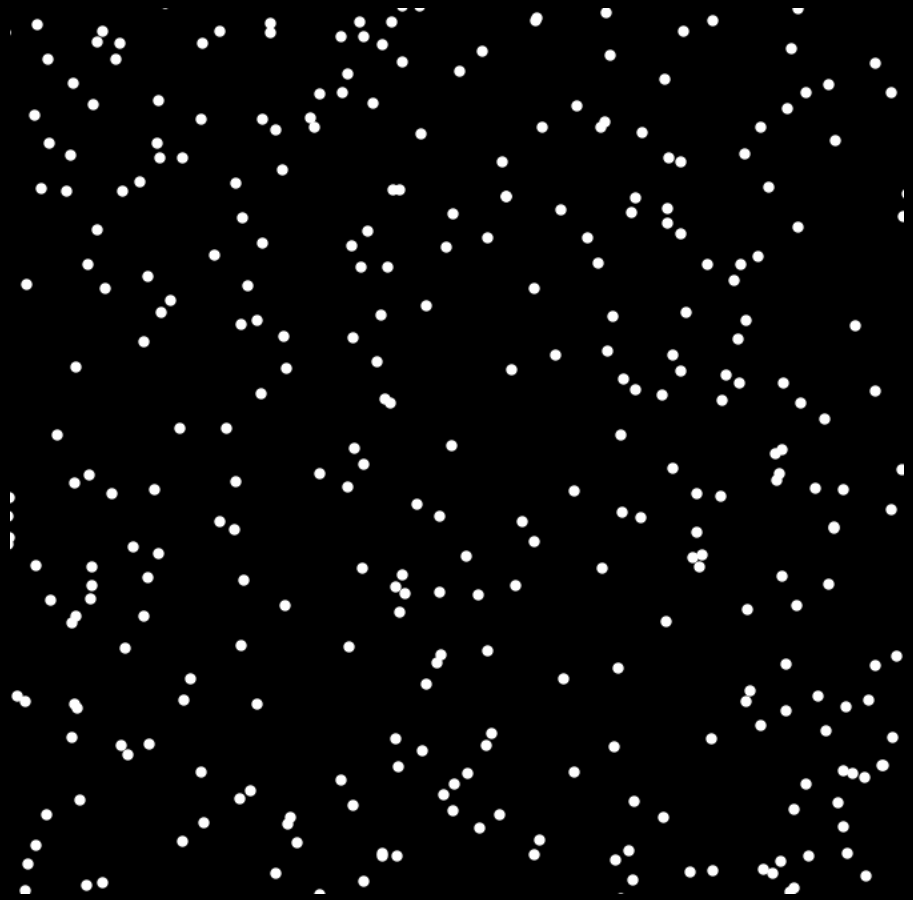


Some Noise

Left Or Right (again)?

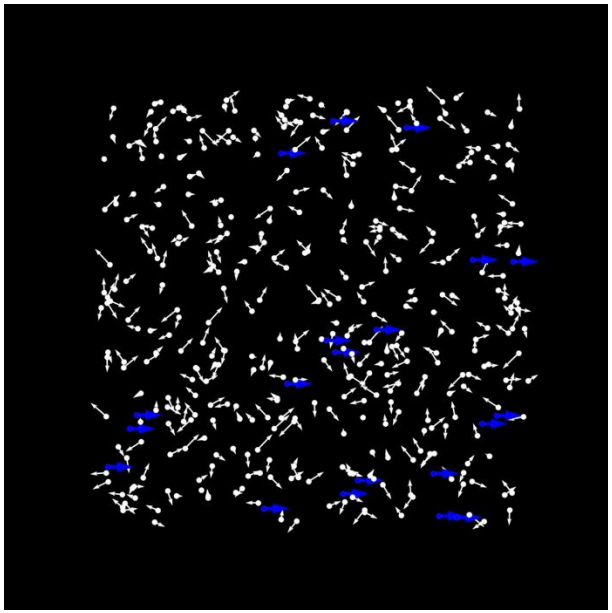
Some Noise

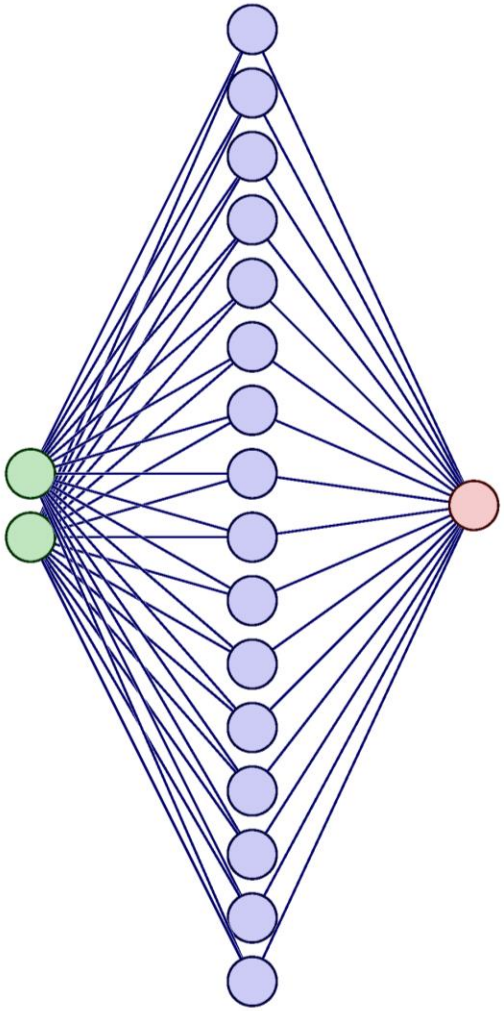
Left Or Right (again and again)?



Some Noise

What does it learn?





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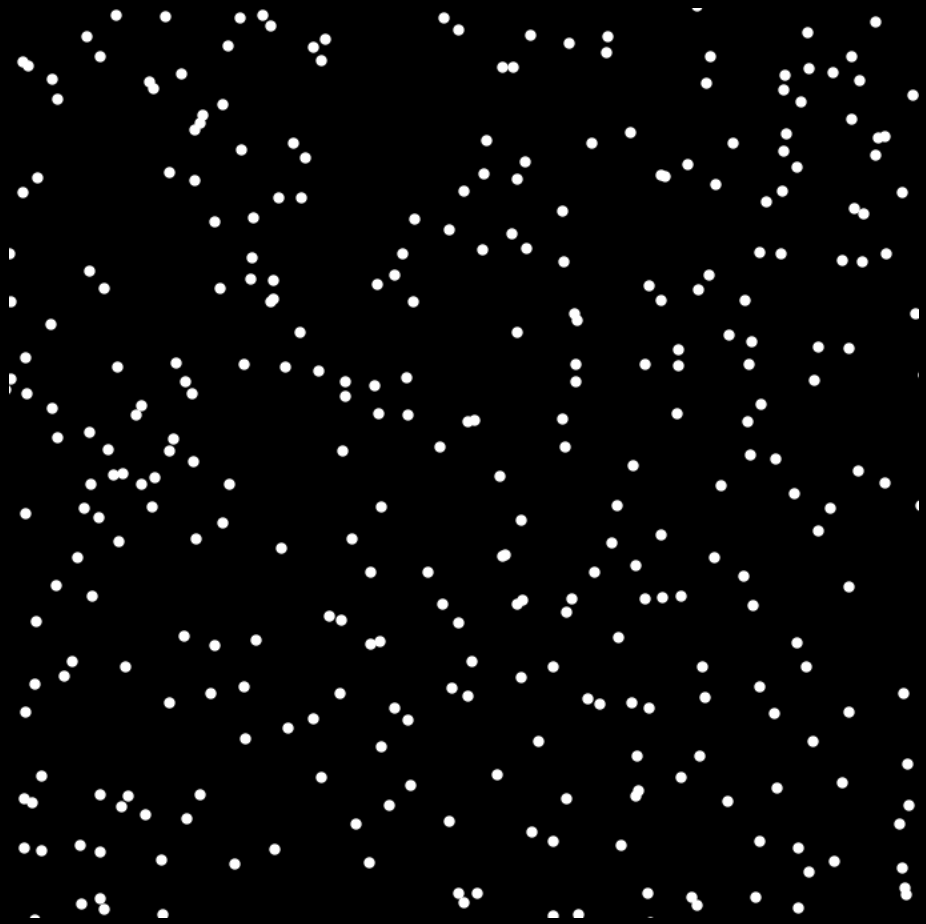
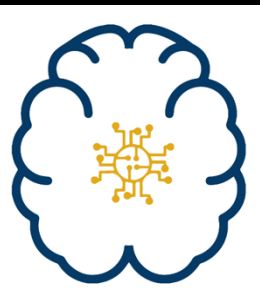


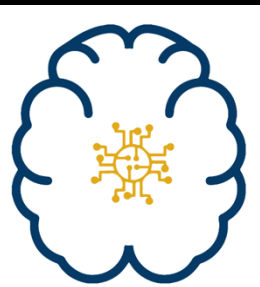
Neural Networks



You are smarter than a computer

- Cannot answer if it is not trained on (seen) it

Uses of Neural Networks



- Image Recognition
- Speech Recognition
- Playing Games.
- Creating Art
- Language Translation.
- Medical Diagnosis.

Thank you for Listening