

# SSP 100 - 10

## How Computers See

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# Today's Topics

- Questions? / Comments?
- Next main topic is Optical Character Recognition
- But first since much of computer vision is done via Convolutional Neural Networks
  - Artificial Neuron
  - Biological neuron inspiration
  - Artificial Neural Networks
  - Convolutional Neural Networks

# Definition of a machine learning algorithm

- A machine learning algorithm is an algorithm that is able to learn from data.
- Mitchell (1997) “A computer program is said to learn from experience  $E$  with respect to some class of tasks  $T$  and performance measure  $P$ , if its performance at tasks in  $T$ , as measured by  $P$ , improves with experience  $E$ .”

# Experience

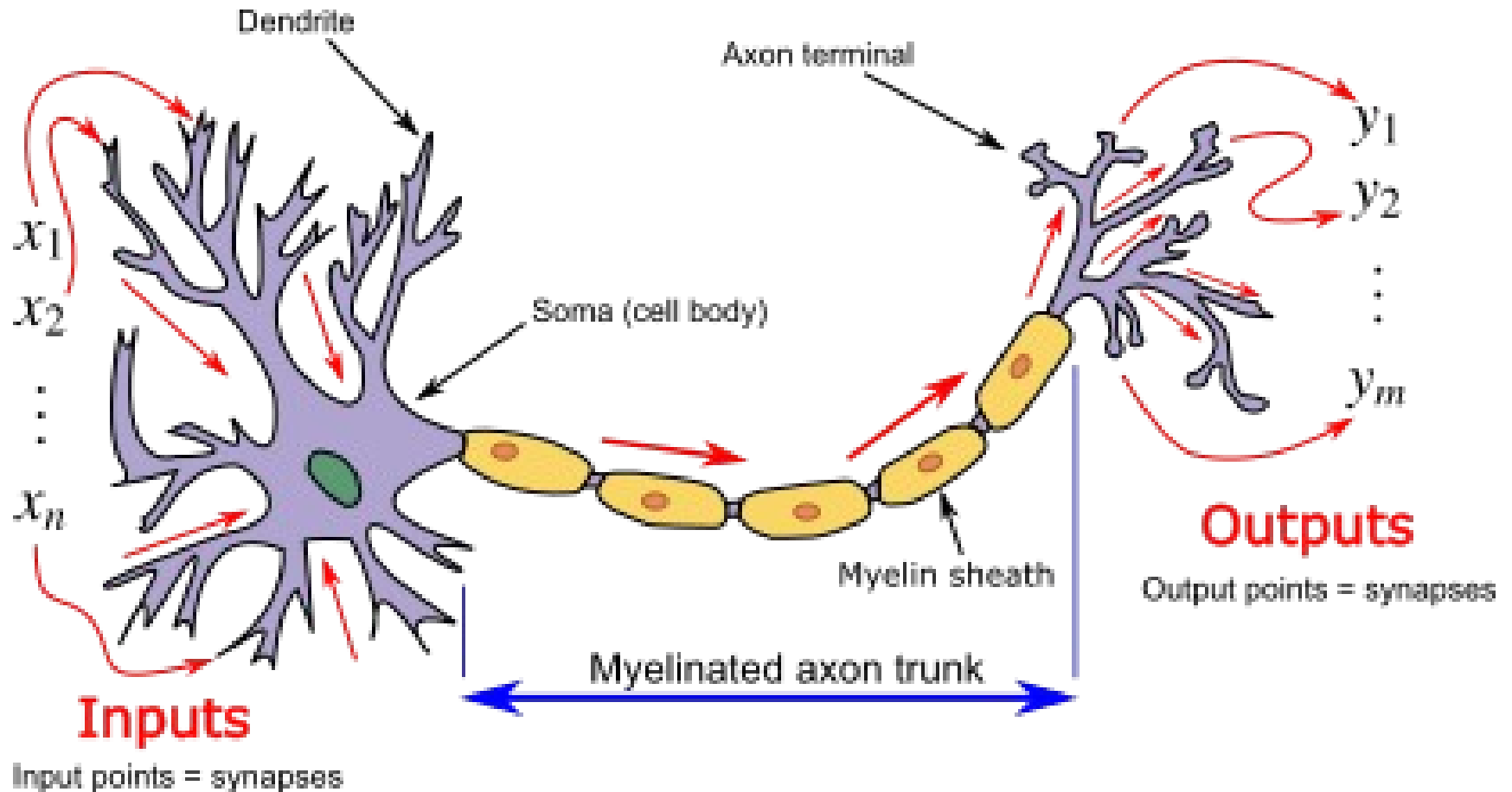
- Experience is the dataset that the learning algorithm is provided.
- For supervised learning this includes the correct label for each.

# Biological Neuron

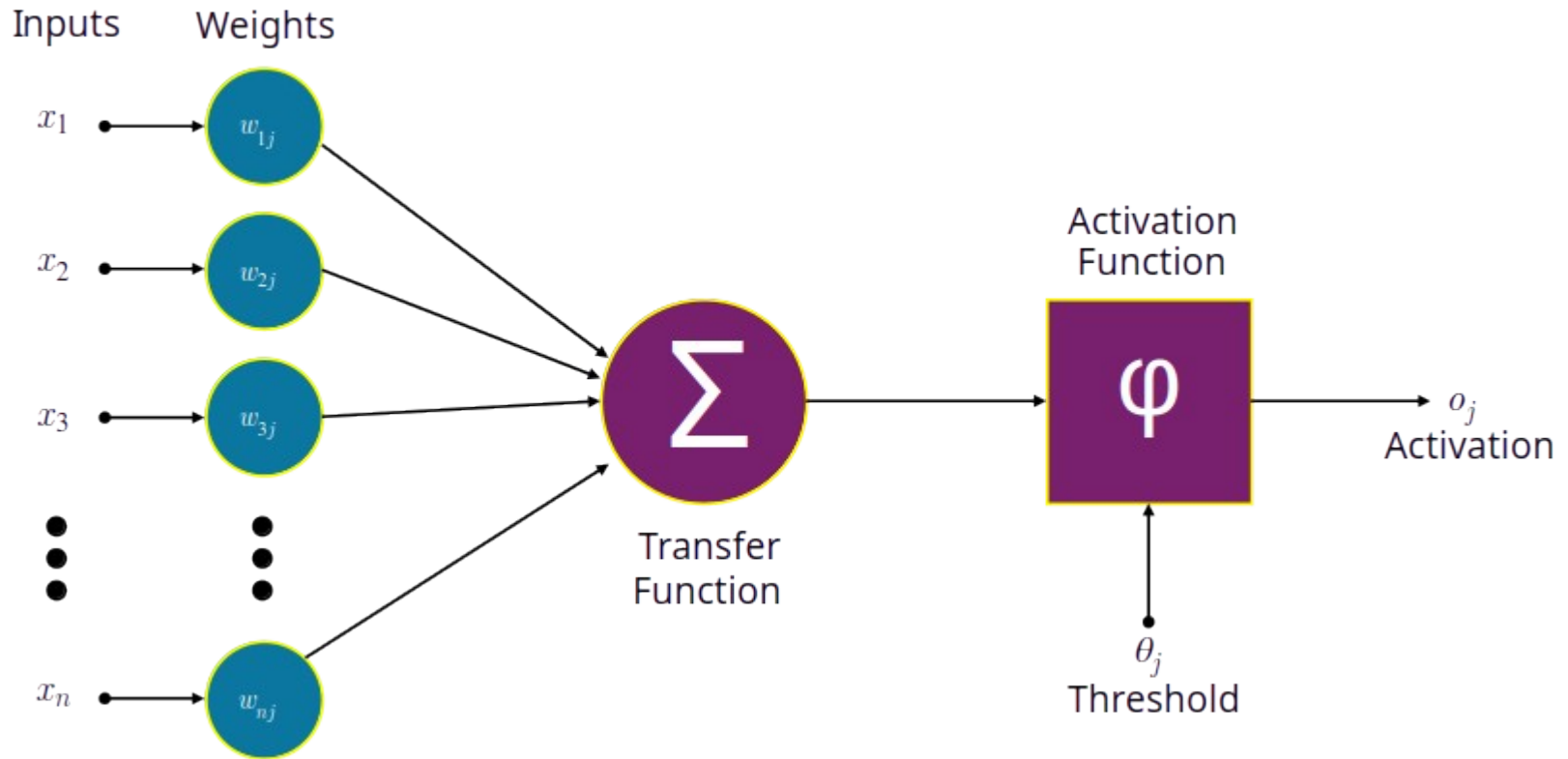
The artificial neuron is inspired by the biological neuron.

Artificial neural networks (ANNs) are loosely modelled on biological neural networks. ANNs are simplified mathematical models of actual biological neural networks.

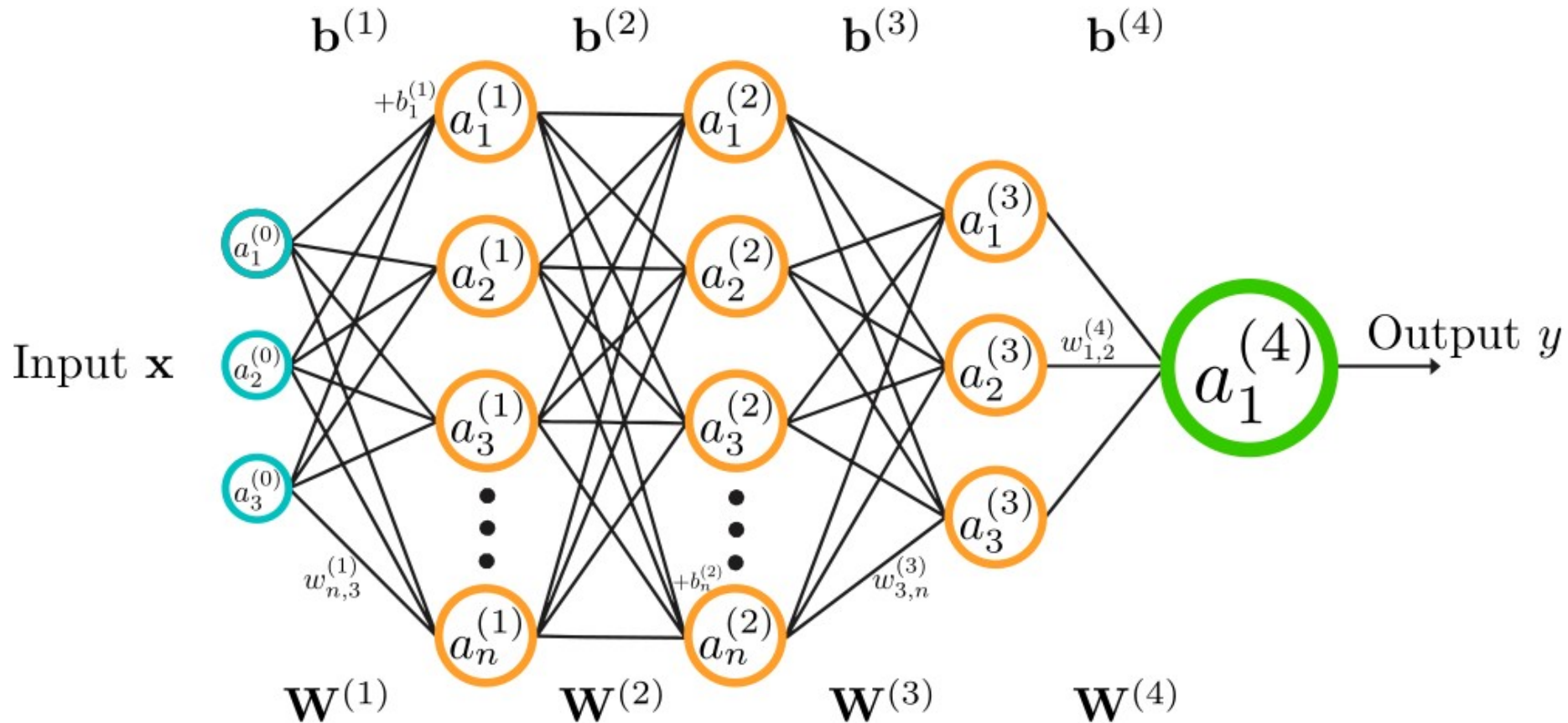
# Biological Neuron diagram



# Artificial Neuron diagram



# Artificial Neural Network diagram



# Biological neuron modelled by artificial neuron

- Dendrites / input
- How the biological neuron acts on the chemical and electrical signals is modelled by mathematical functionality on the inputs of an artificial neuron
- Axon / output

# Biological neural networks modelled by ANNs

- Biological neurons are combined into a network / artificial neurons are combined into an ANN
- Strength of the connections of biological neurons is modelled by the values of the weights across connections between artificial neurons
- Biological neuron firing / activation
- Plasticity of biological synapses / weights change along connections during learning

# Example of ANNs and learning

- Before we get to discussing how to input images into ANNs let's first look at something simpler like points with x and y coordinates as inputs
- And the network is classifying the points into 1 of 2 classes
- <https://playground.tensorflow.org/>

# Handwritten digit Recognition

- Before we get to OCR, let's first look at a simpler classification of handwritten digits MNIST.
- MNIST data set
  - Made from handwritten digits on forms
  - Human performance: reports of 98.3 % to 99.8 % accuracy
- [https://en.wikipedia.org/wiki/MNIST\\_database](https://en.wikipedia.org/wiki/MNIST_database)

# Machine learning programs

- Let's first see some of the training samples and their labels
- Then let's see an implementation of a ML solution with the images flattened into 784 values without retaining their spatial relationships
- Then an implementation of a CNN solution with the images coming in as 28x28 which retain their spatial relationships
- And we can compare the results

# Machine learning programs

- I'll run a deeper CNN that gets better accuracy but takes longer to train
- I'll also show a program that shows visualization of what the quicker CNN program learned (3x3 filters)