DATA SOCIETY:

IntroToNeuralNetworks - Basics - 1

One should look for what is and not what he thinks should be. (Albert Einstein)

Basics: Topic introduction

In this part of the course, we will cover the following concepts:

- Introduction to neural networks
- Neural networks use cases

Module completion checklist

Objective	Complete
Describe neural networks and identify their use cases	
Discuss the architecture of a simple neural network and identify its components	

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Neural networks: introduction

- Our brain uses **neural networks** to process information around us with the help of neurons that respond to the input from the environment
- An **artificial neural network (ANN)**, often called a **neural network (NN)**, is a host of well-known machine learning algorithms that attempt to mimic the neural network a human brain uses
- It uses **interconnected nodes or neurons** in a layered structure that resembles the human brain

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Meet A.N.N

- Let's watch a video explaining how artificial neural networks work
- *Click here to meet A.N.N.*

Breakout: neural networks use cases

- Neural network is a popular method and several industries are using it to perform different tasks
- Read the article assigned to your group and discuss the following:
  - How this could be related to your work?
  - How can neural networks help in your current role or field?
- Nominate a representative to share the the synopsis of your discussion

1. *Adopting AI in Drug Discovery*
2. *How Neural Networks help delivery Robots navigate*
3. *Neural Networks for Marketing*
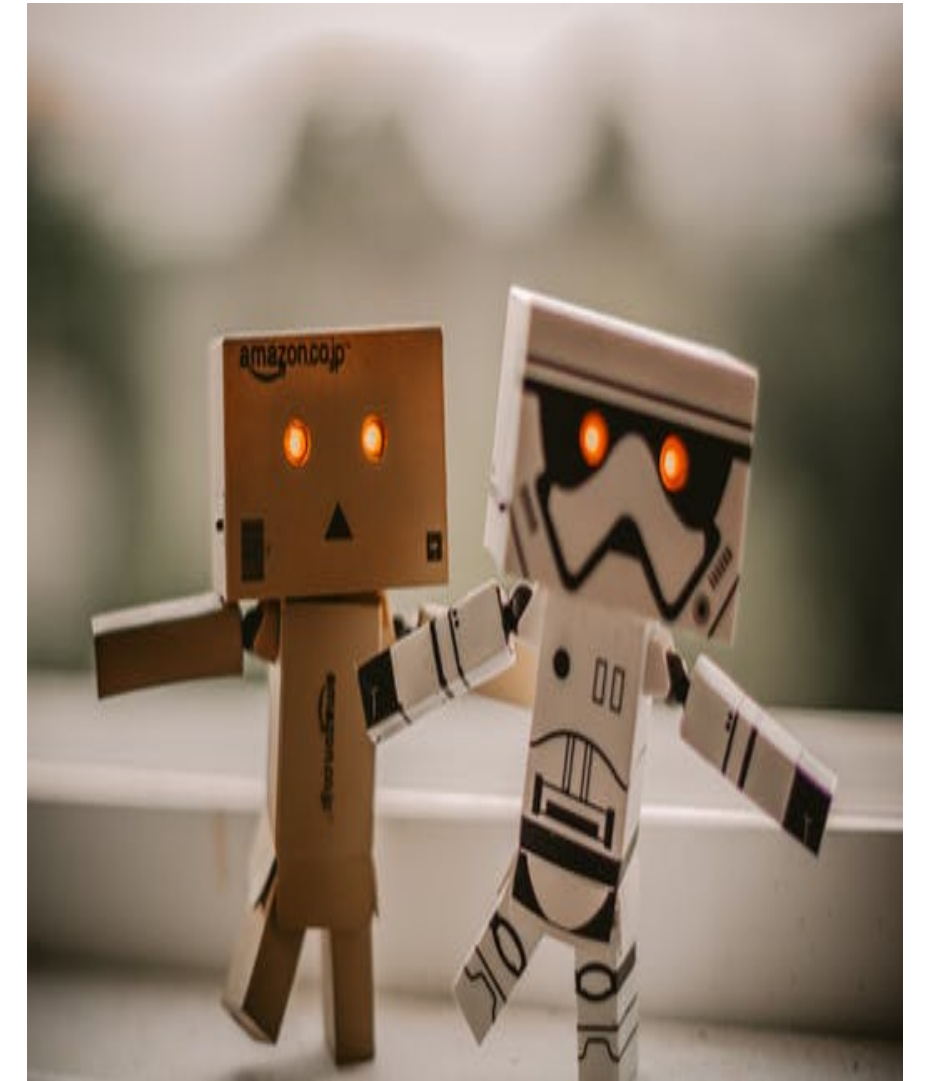
Use cases by data type

- Let's see what type of data can be used for different purposes:

Data type	Use case
Raw text	Analyze emails and chats from customer support database to detect most common issues customers face
Audio data	Help identify whether a person is under distress by analyzing recorded phone calls to a hotline
Stock prices	Determine price trends, detect anomalies, asses risk
Sensor data	Insight into preventing fatalities, based on data collected from car sensors

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Use cases by algorithm type

Algorithm type	Use case
Classification	This image represents a horse; this email looks like spam; this transaction is fraudulent
Clustering	These two sounds are similar; these documents belong to the same topic / domain
Recommender systems	Given their web activity, this customer looks like they are going to stop using your service

- Chat question: Can you think of use cases from projects that you have been working on?

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Simple neural network

- Now that we've discussed the use cases of neural networks, we will walk through a simple neural network architecture and discuss its components

- **Note:** Later in the course, we will go through a more complex neural network called **deep learning**
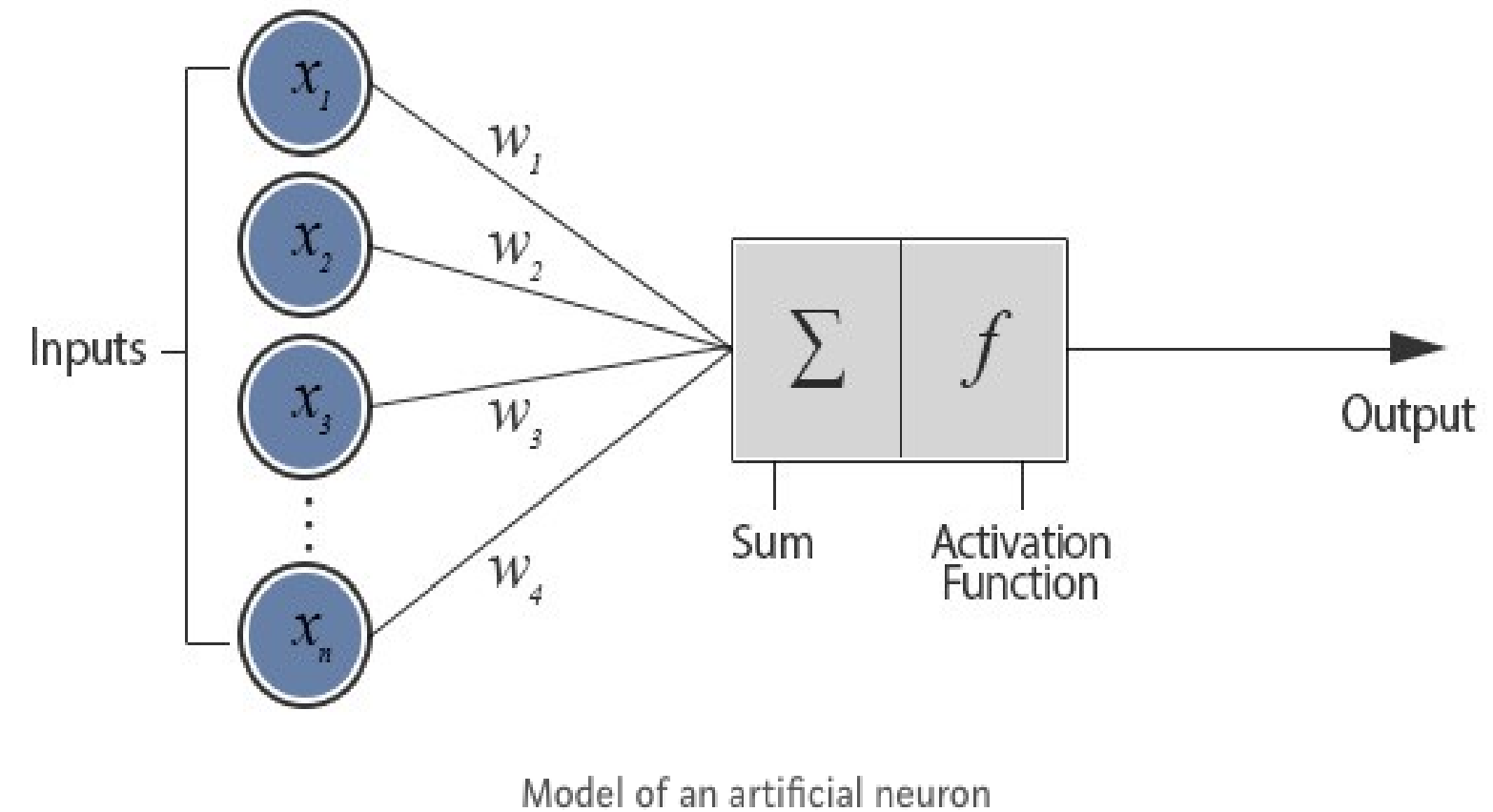
Perceptron

- A **perceptron**, a fundamental concept in machine learning, is a type of artificial neural network
- The image below depicts a perceptron, a neuron, connected with *n* other neurons
- It is the simplest type of neural network and we will discuss each of the components in the subsequent slides
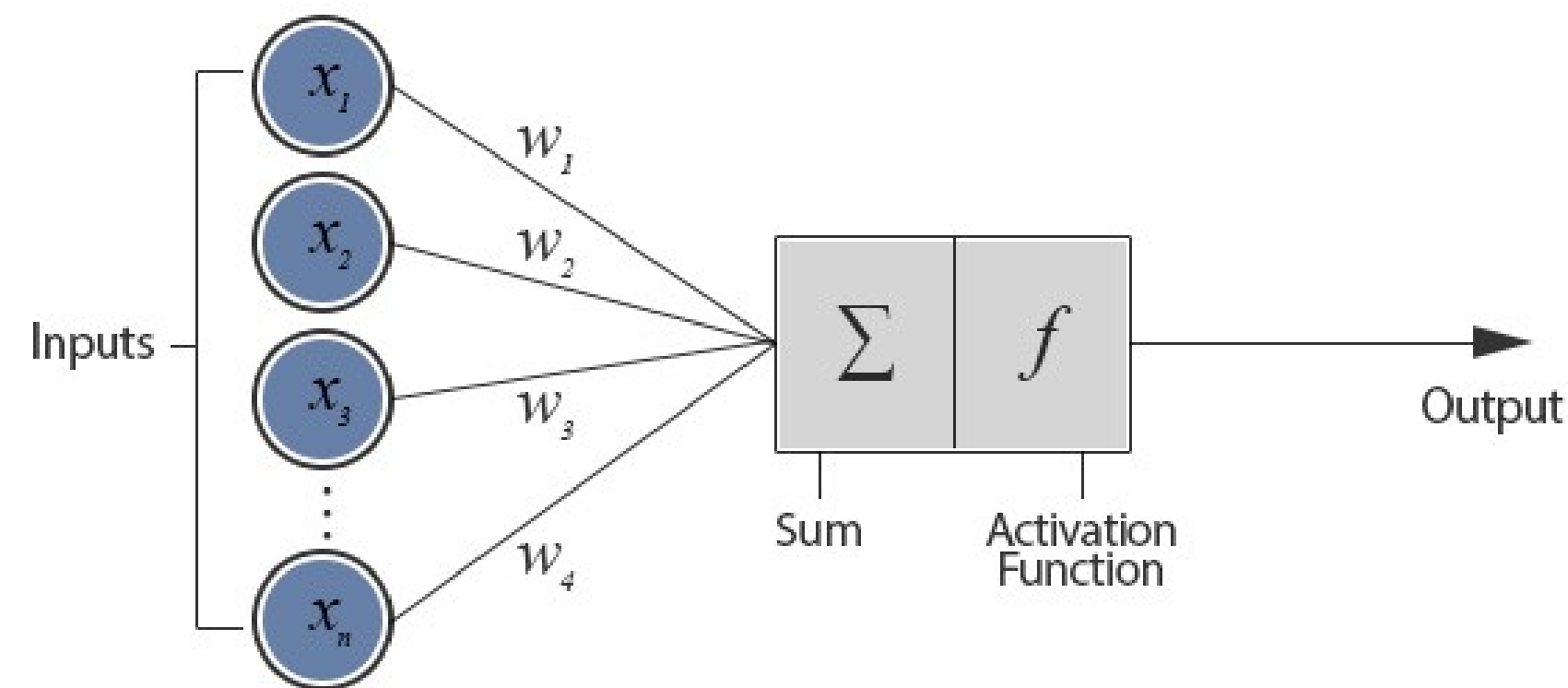
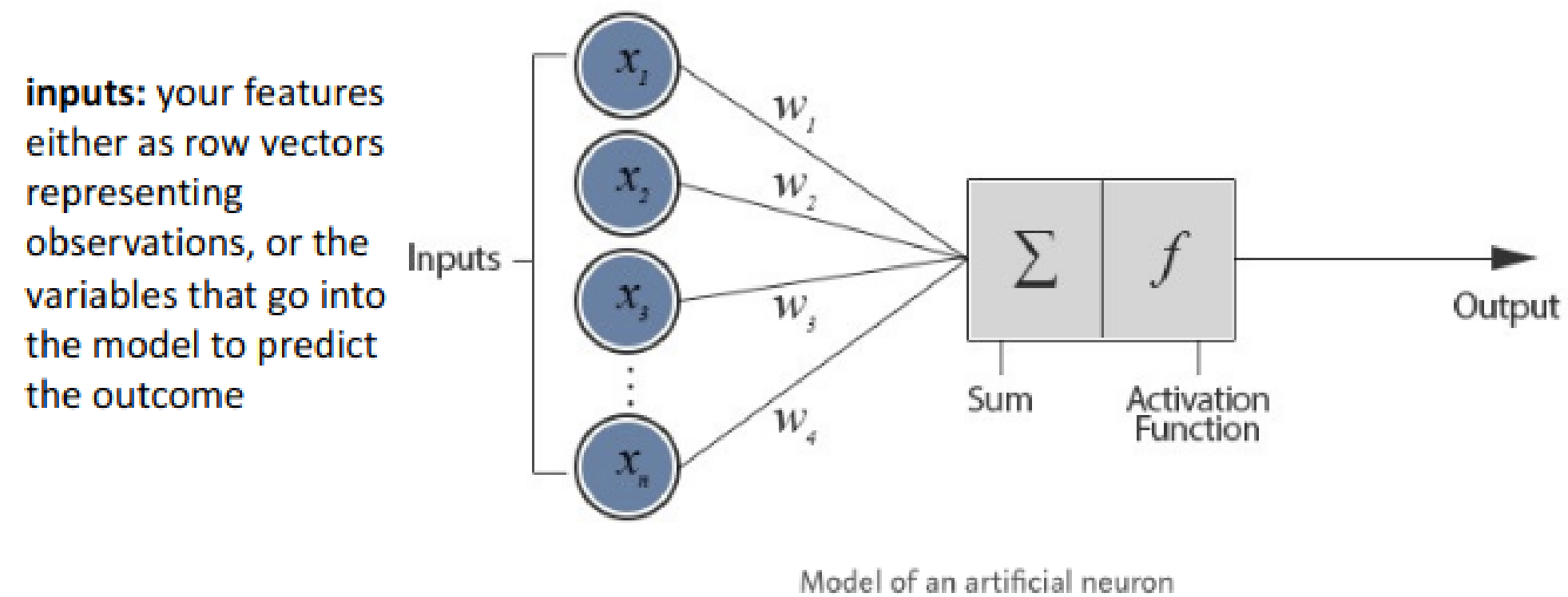Model of an artificial neuron

Neural networks: layers

- The major components of a neural network are the:
  - inputs
  - weights
  - summation processor
  - activation function
  - outputs

Model of an artificial neuron

Inputs

inputs: your features either as row vectors representing observations, or the variables that go into the model to predict the outcome

Model of an artificial neuron

Weights

weights: weights for each input
based on the training of the model
will change as the model iterates

inputs: your features
either as row vectors
representing
observations, or the
variables that go into
the model to predict
the outcome

Model of an artificial neuron

Summation processor

weights: weights for each input based on the training of the model will change as the model iterates

inputs: your features either as row vectors representing observations, or the variables that go into the model to predict the outcome

Inputs

x_1, x_2, x_3, ... x_n

w_1, w_2, w_3, w_4

Σ f

Sum   Activation Function

Output

summation processor: combines the inputs into one single activation

Model of an artificial neuron
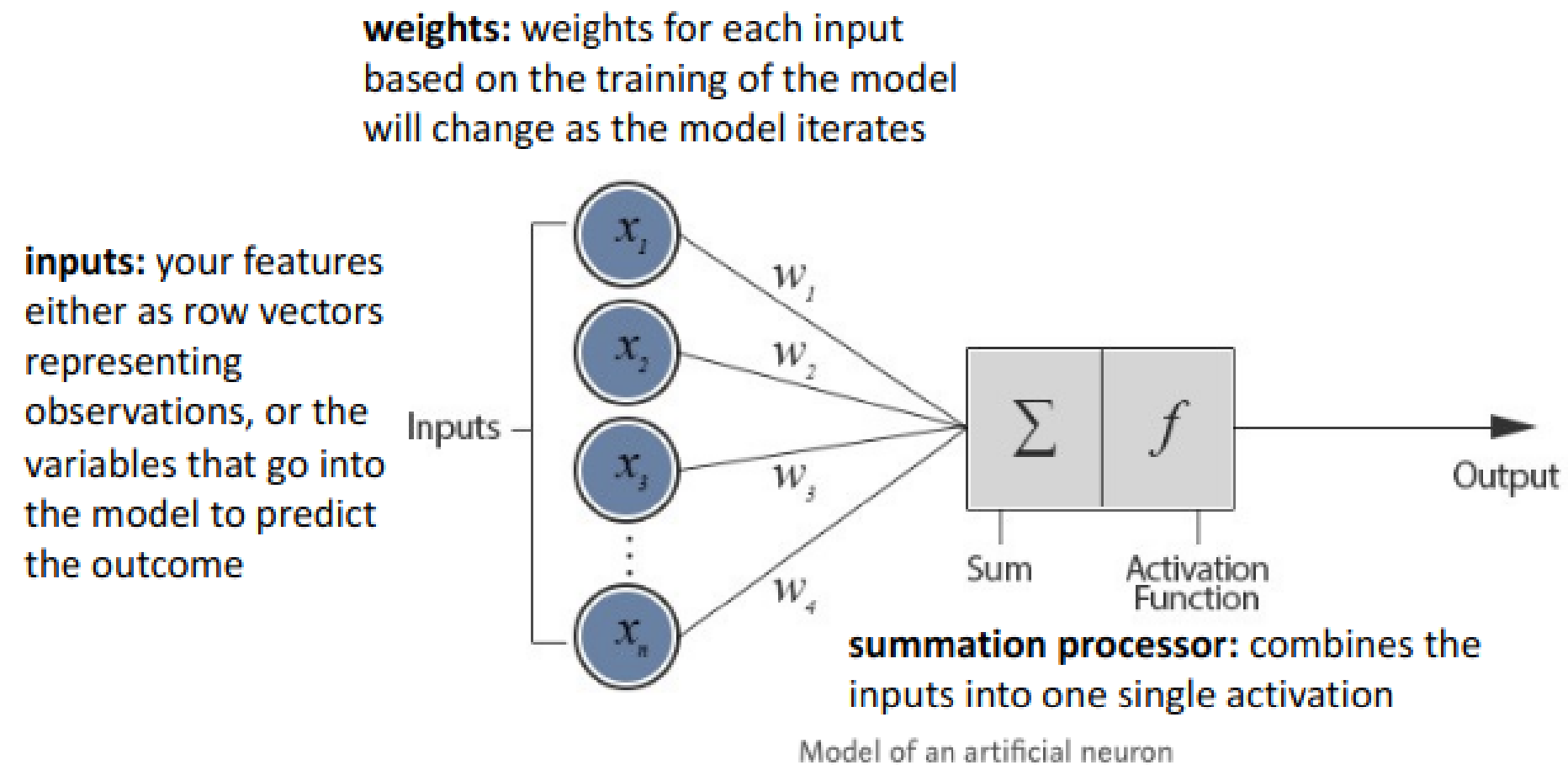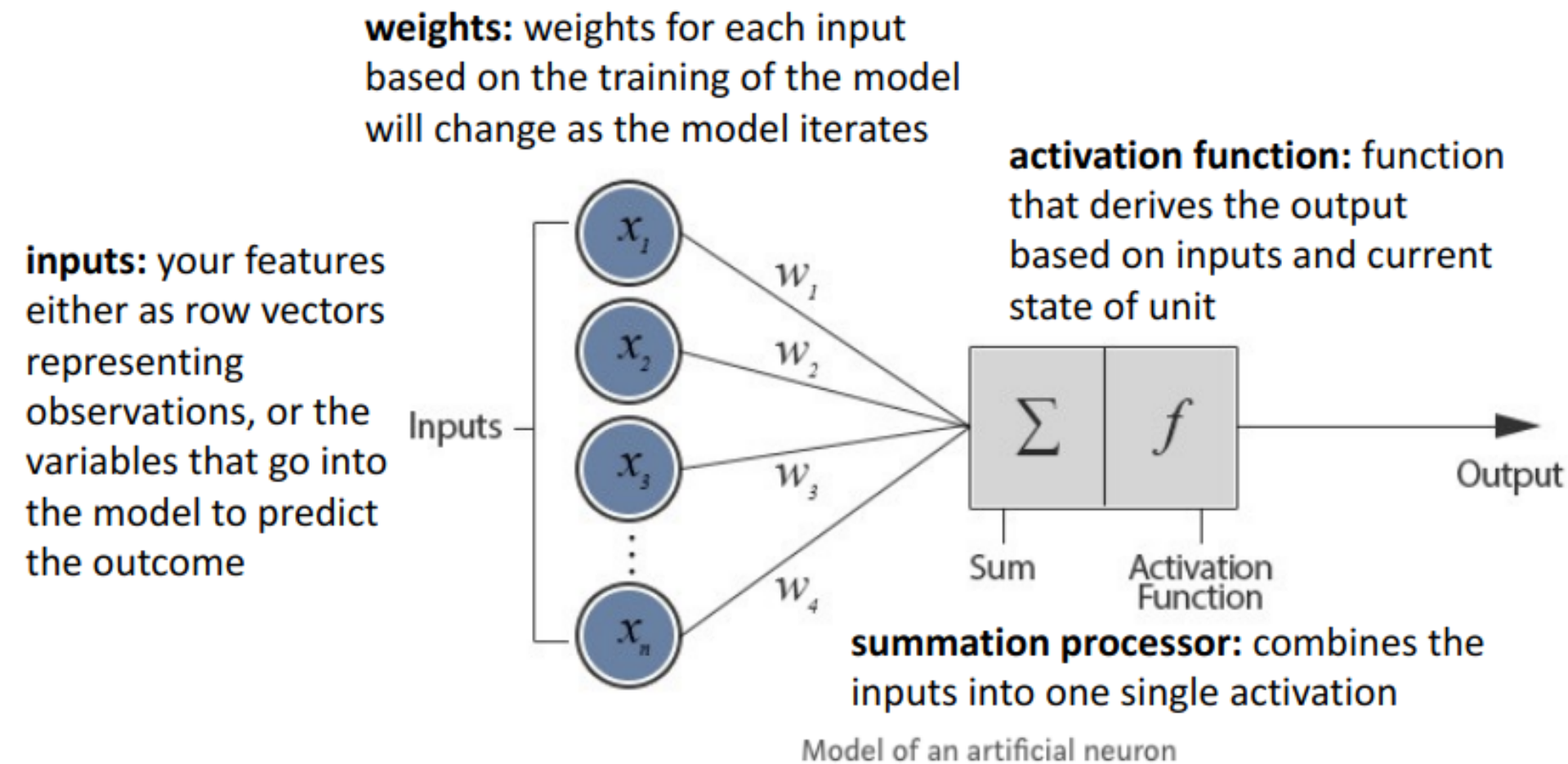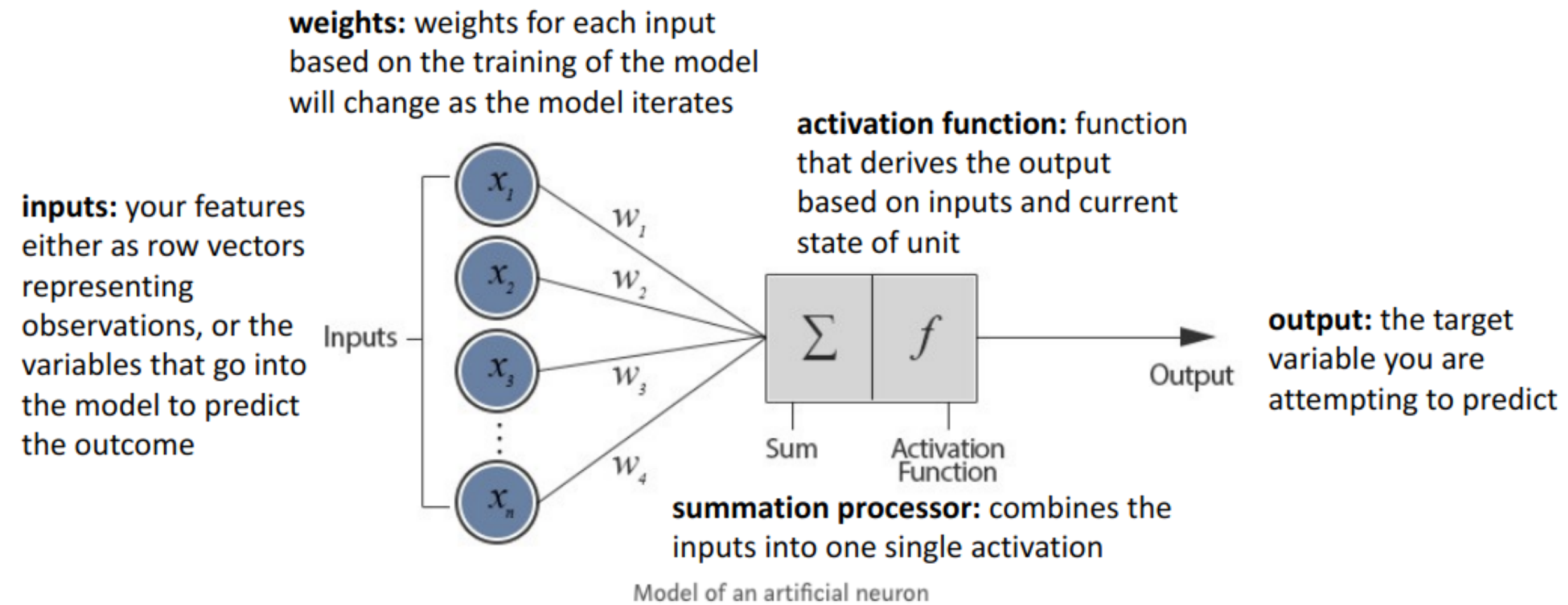
- Before the summation processor "squeezes," the computation goes through one or more **hidden** layers *(this is where the black box concept of a neural network comes from)*
- A simple neural network will have up to two hidden layers, and anything over two hidden layers becomes a type of deep learning network

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Activation function

weights: weights for each input based on the training of the model will change as the model iterates

inputs: your features either as row vectors representing observations, or the variables that go into the model to predict the outcome

activation function: function that derives the output based on inputs and current state of unit

summation processor: combines the inputs into one single activation
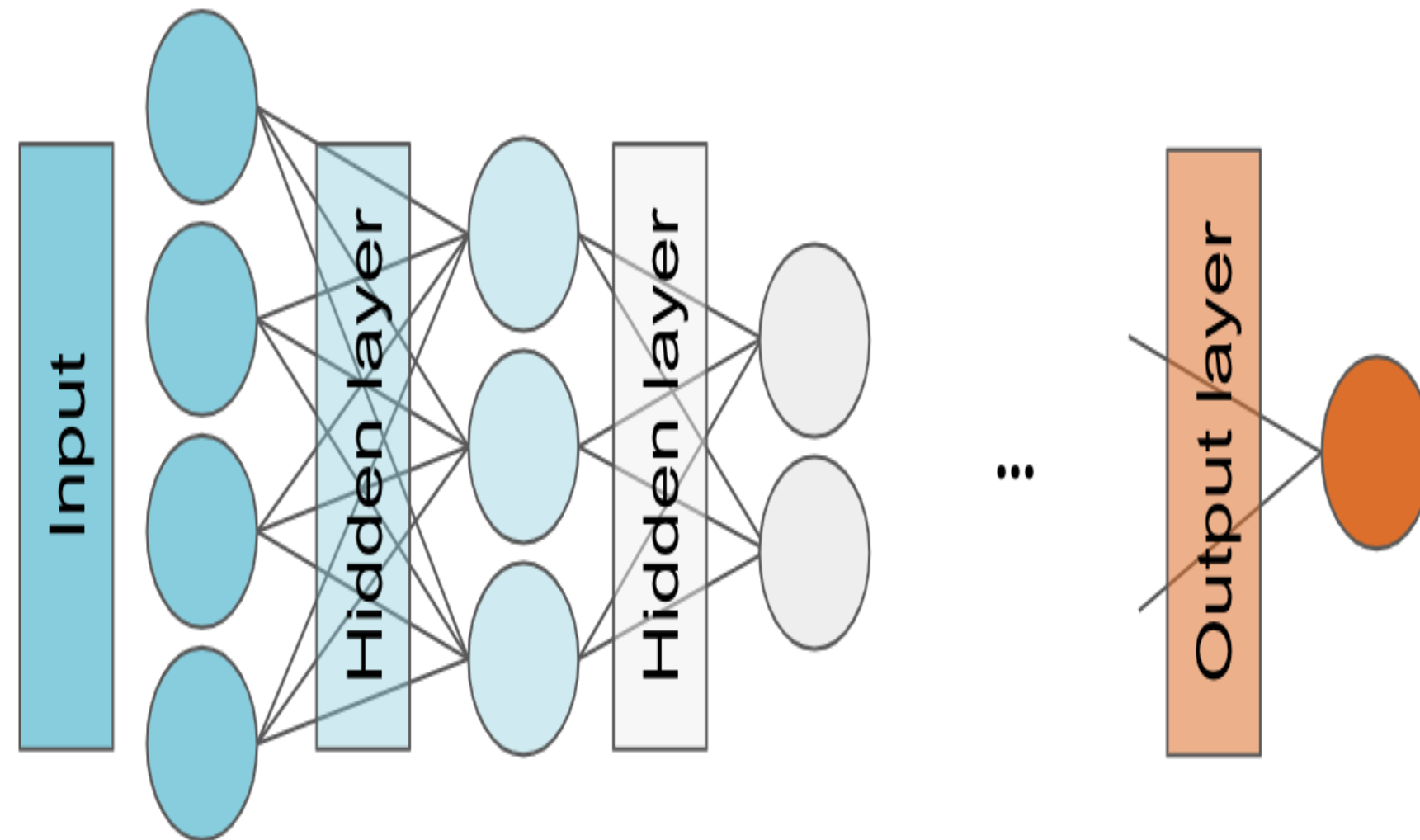
Model of an artificial neuron

- There are many types of activation functions such as `ReLU`, `sigmoid`, `tanh`, and `softmax`
- Based on the inputs, the function derives its current state, and outputs an activation value

Outputs

weights: weights for each input based on the training of the model will change as the model iterates

inputs: your features either as row vectors representing observations, or the variables that go into the model to predict the outcome

activation function: function that derives the output based on inputs and current state of unit

summation processor: combines the inputs into one single activation

output: the target variable you are attempting to predict

Inputs

x_1
x_2
x_3
$\vdots$
x_n

w_1
w_2
w_3
w_4

Σ | f

Sum | Activation Function

Output

Model of an artificial neuron

Neural networks: architecture

- **Note:** There is no single NN architecture that works well for all problems!

- The general architecture of a simple NN looks like a piece of layered cake
- Depending on the **number of hidden layers**, layer type and its configuration (e.g., the number of neurons in it, the activation function and other parameters), each NN architecture might yield drastically different results for the same problem
- Choosing the right NN architecture for the problem and tuning the model is instrumental to successful NN implementation

Deep learning vs. simple neural networks

- Typically, one or two hidden layers are enough for most problems
- Deep learning is a branch of machine learning that uses deep neural networks (DNNs)
- DNNs are essentially the same as ANNs, with more complex architecture that calls for the use of multiple layers
- Here is a diagram of how the two differ architecturally:
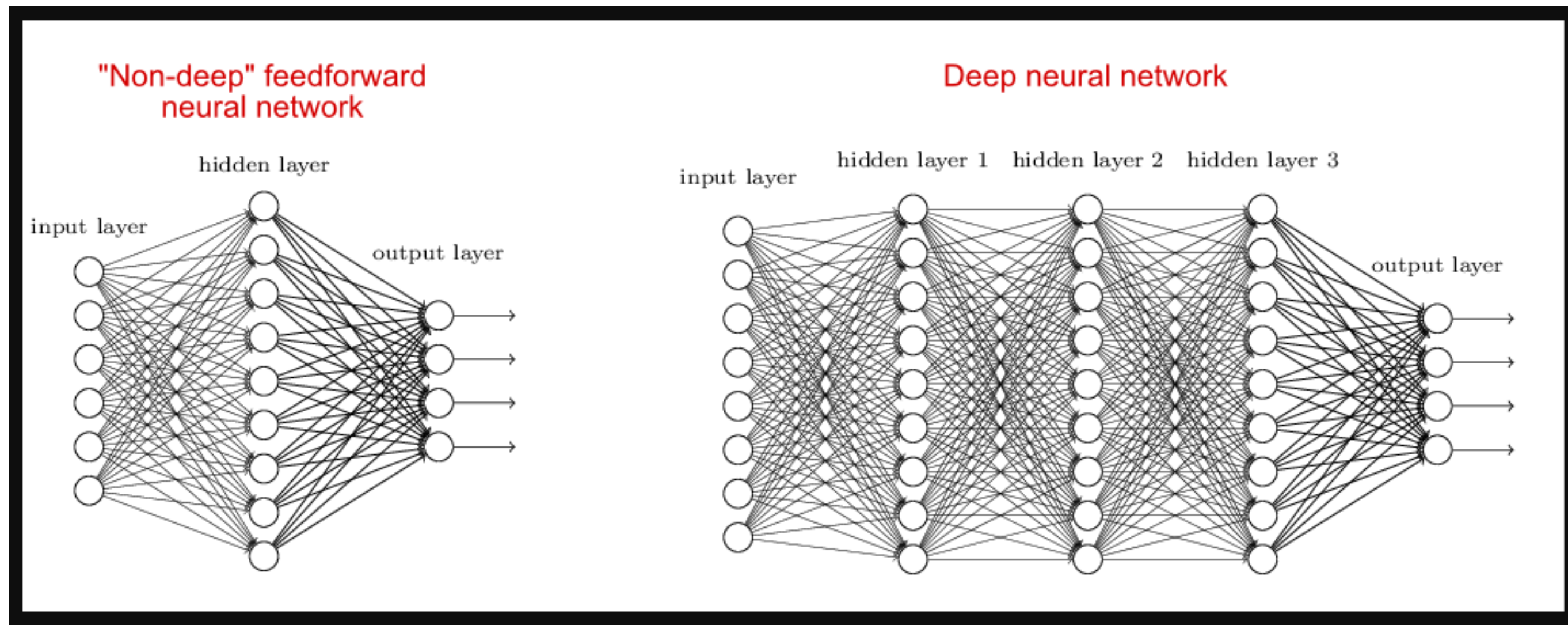
Knowledge check

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Basics: Topic Summary

In this part of the course, we have covered:

- Introduction to neural networks
- Neural networks use cases

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Congratulations on completing this module!