LECTURE 5. ANN

MANU 465

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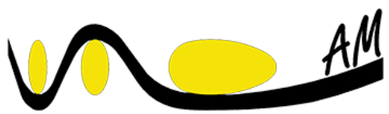

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Objective

An introduction to ANN (Artificial Neural Network)

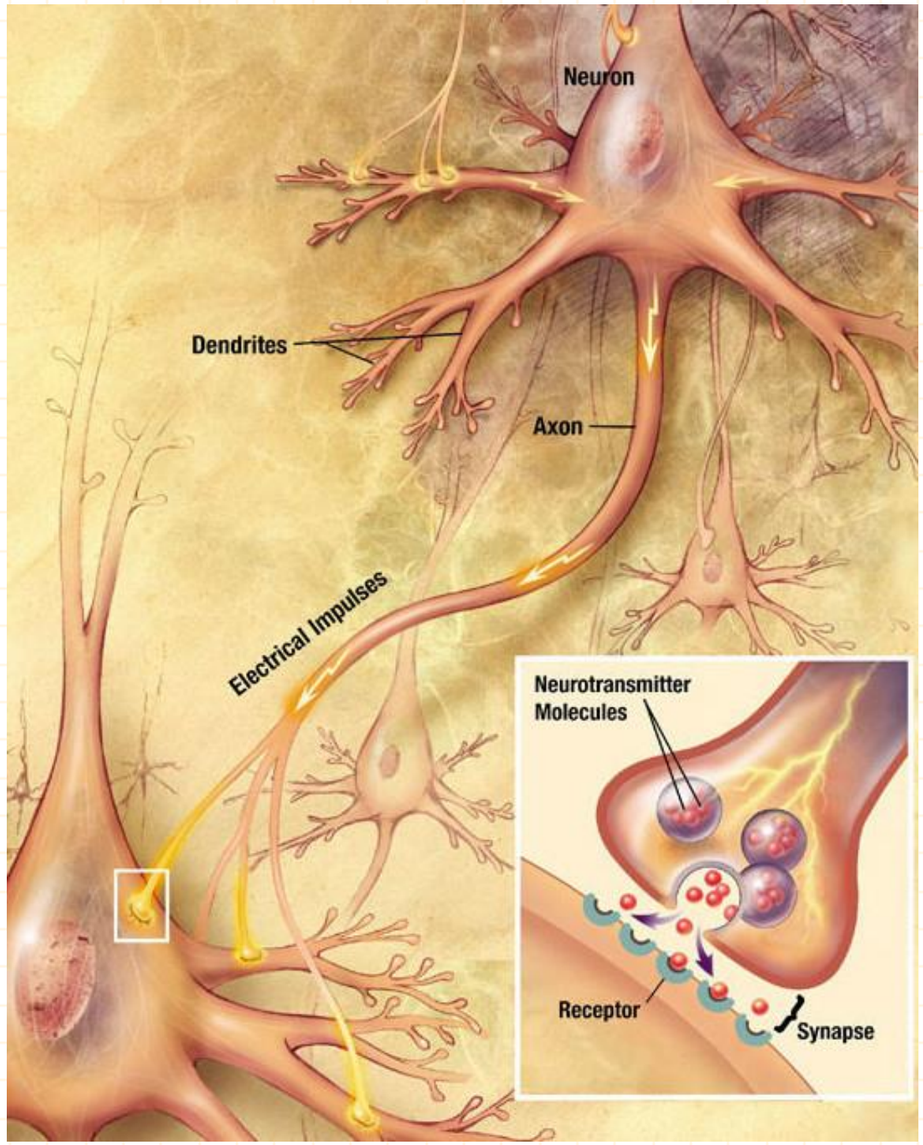
A. By the end of this lecture, you will become familiar with:
   - The Neuron
   - The activation Function
   - How do NNs works?
   - How do NNs learn?
   - Batch Gradient Descent
   - Stochastic Gradient Descent
   - Back-Propagation

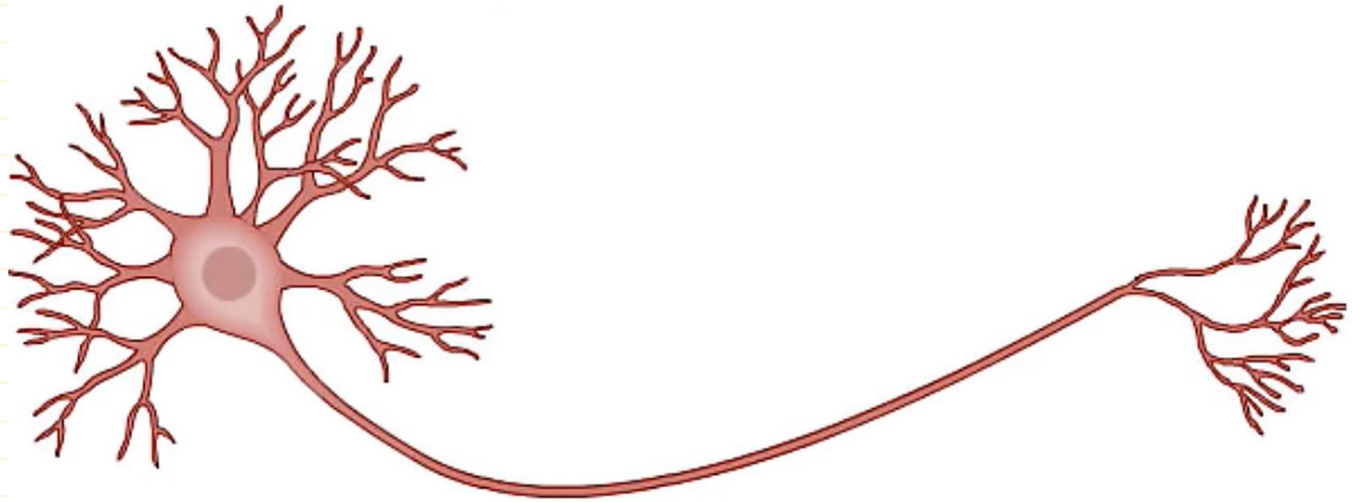
B. On Thursday lecture:
   - Review an Example in PYTHON

C. Practice Problems (DIY) Examples 12-15 on *Perceptron*, *ANN Classifier*, *ANN Regressor*, *and ANN for Image Classification*

D. Tutorial 4 (next Mon, Oct 10th)

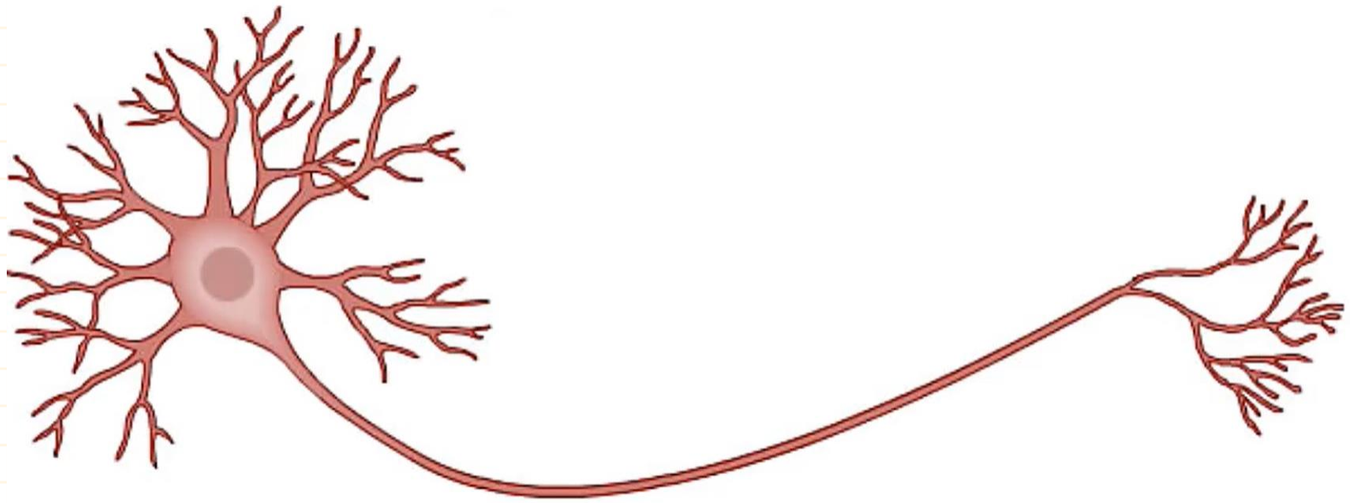
The Neuron

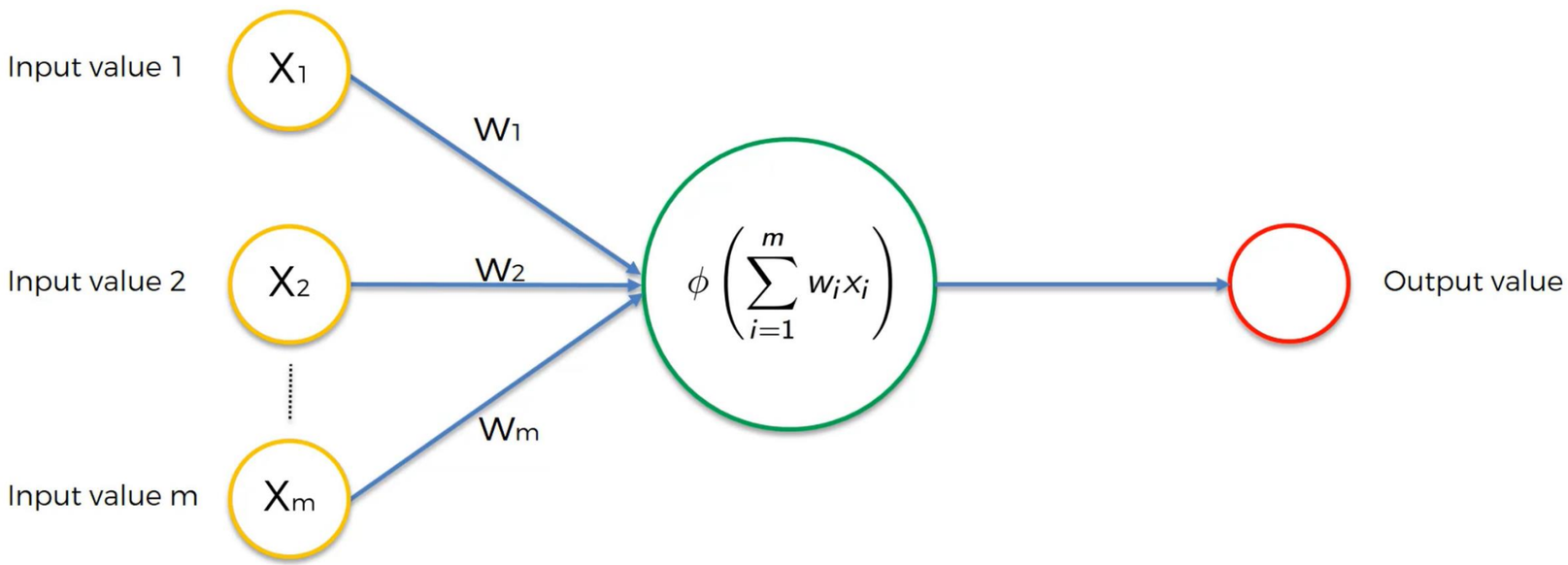

Neuron
Dendrites
Axon
Electrical Impulses
Neurotransmitter Molecules
Receptor
Synapse



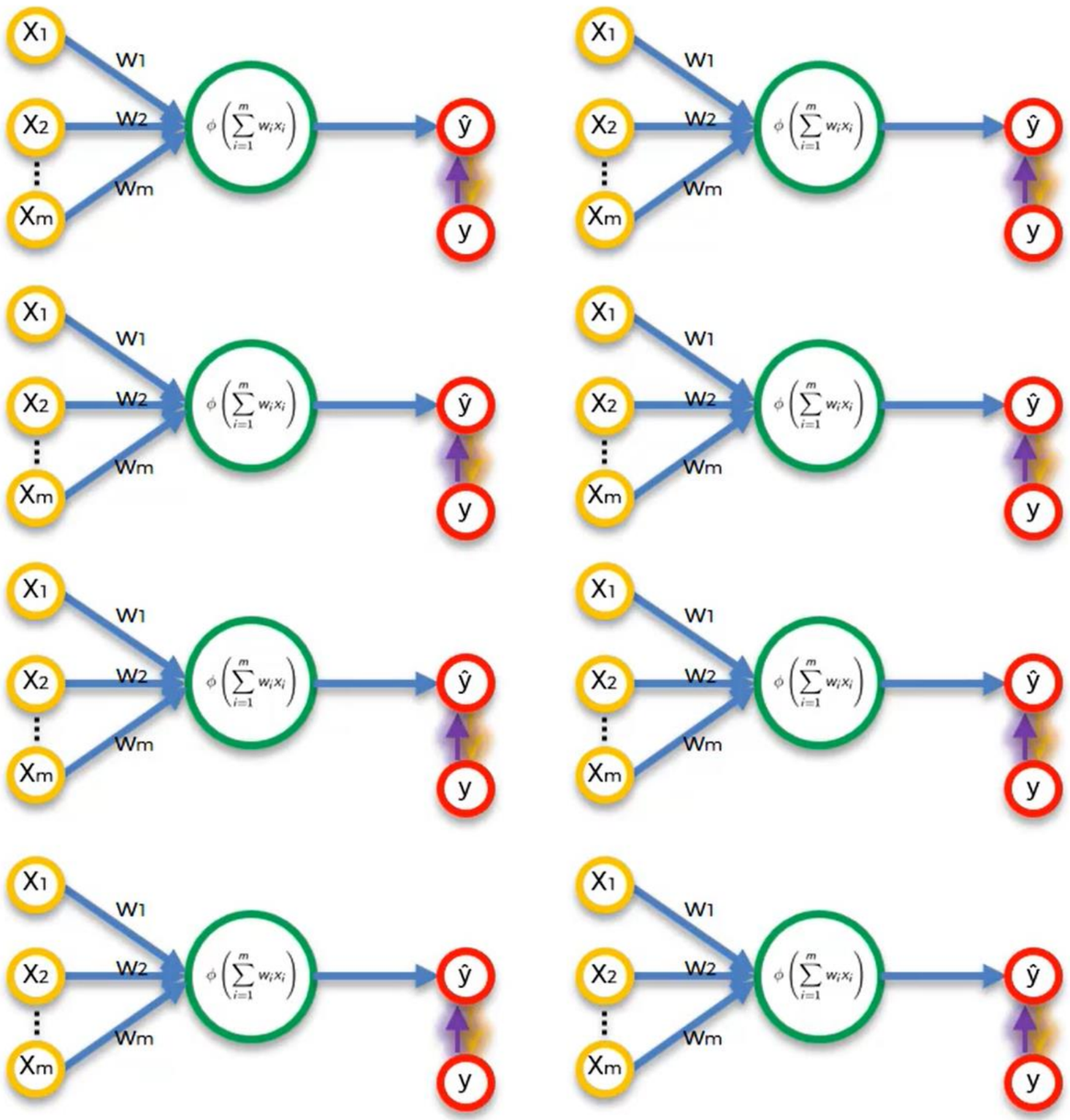
The Activation Function

How does Perceptron Work?



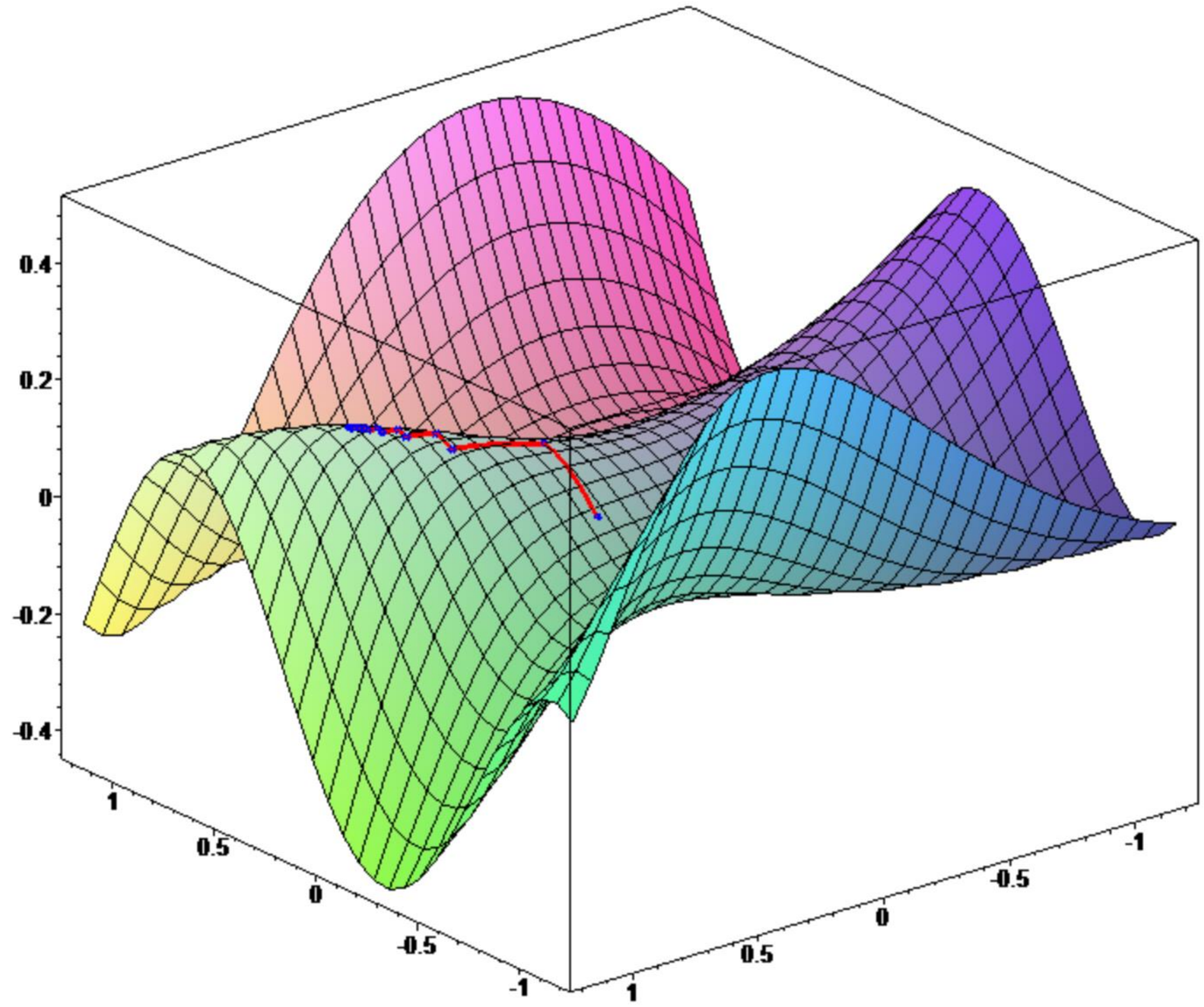


How does Perceptron learn?



Gradient Descent (GD)

- General GD
- Batch GD
- Stochastic GD (SGD)



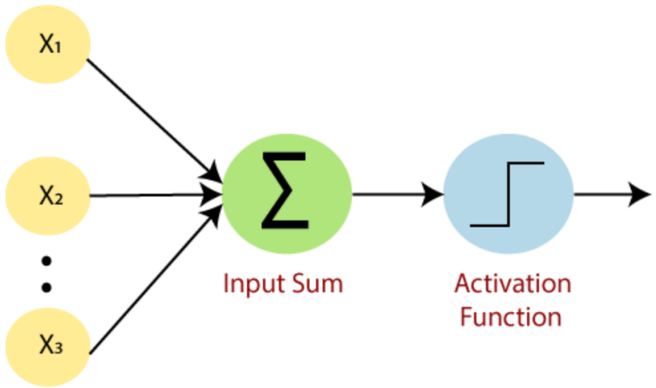
Building a Perceptron in Python is easy:

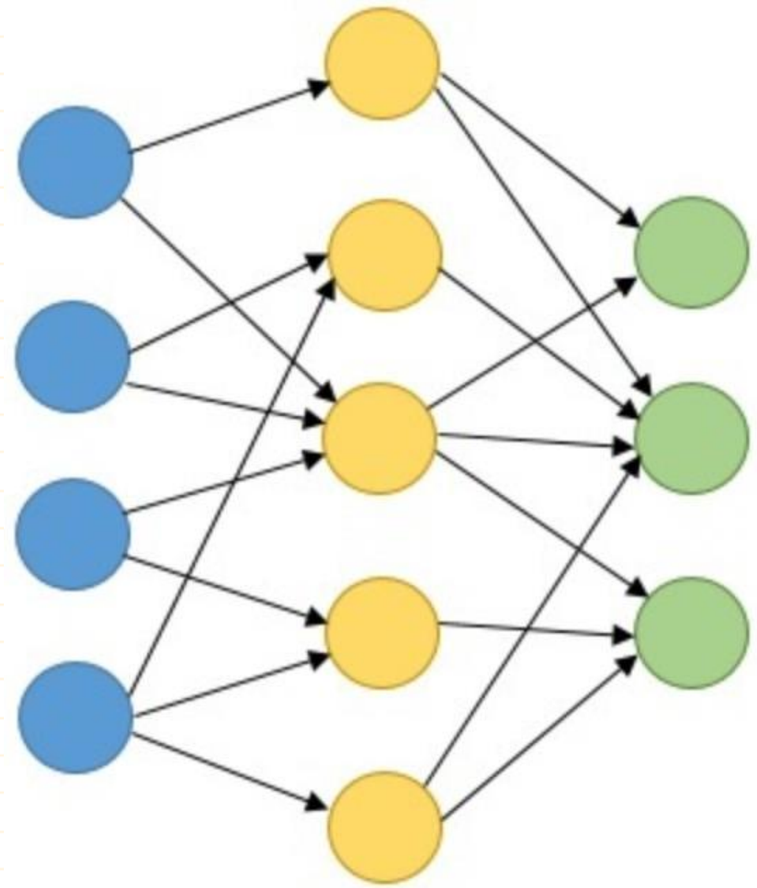
```
from sklearn.linear_model import Perceptron
Clasifier=Perceptron()
Clasifier.fit(X,y)

y_pred= Clasifier.predict([[New X]])
```

(See Example 12 on Canvas)

Neural Networks

A multi-layer perceptron is called Neural Networks.



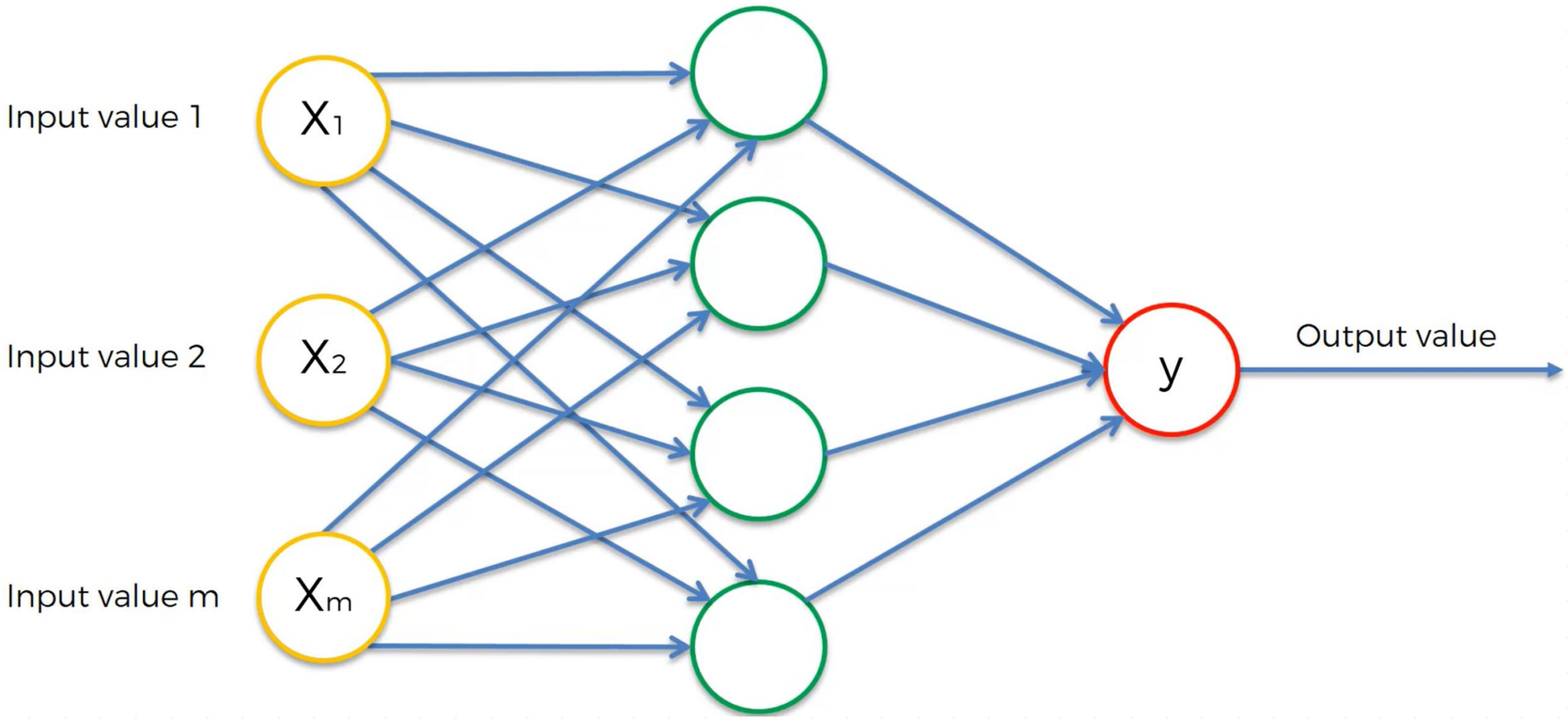


Example) House price prediction

Example) A large corporation will give a $10,000 bonus at the end of each year to some employees. There has been a lawsuit against the company that they are biased toward certain employees, based on their gender, nationality, and marital status. You have been hired to investigate this and prepare a report for the court.

Emplyee	Hours Training	Geography	Gender	Age	Years of Experience	Number of Machines S/he can work with	Married	Has a Bachelor or Higher Degree	Annual Salary	Reciev Bonus
0	619	USA	Female	42	2	1	1	1	101349	1
1	608	Canada	Female	41	1	1	0	1	112543	0
2	502	USA	Female	42	8	3	1	0	113932	1
3	699	USA	Female	39	1	2	0	0	93827	0
4	850	Canada	Female	43	2	1	1	1	79084	0
...	...	...	...	...	...	...	...	...	...	...
9995	771	USA	Male	39	5	2	1	0	96271	0
9996	516	USA	Male	35	10	1	1	1	101700	0
9997	709	USA	Female	36	7	1	0	1	42086	1
9998	772	Mexico	Male	42	3	2	1	0	92889	1
9999	792	USA	Female	28	4	1	1	0	38191	0

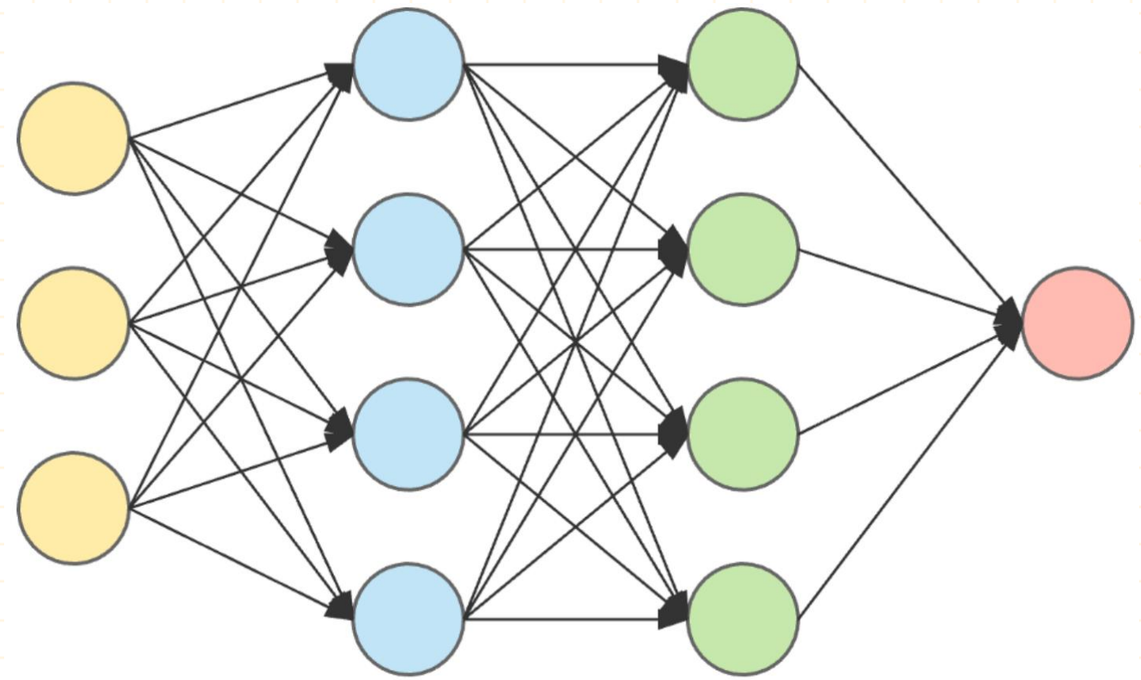
How do we decide on the "Architecture" of a Neural Network?



Please study more on this topic here, https://machinelearningmastery.com/how-to-configure-the-number-of-layers-and-nodes-in-a-neural-network/

What is Deep Learning?

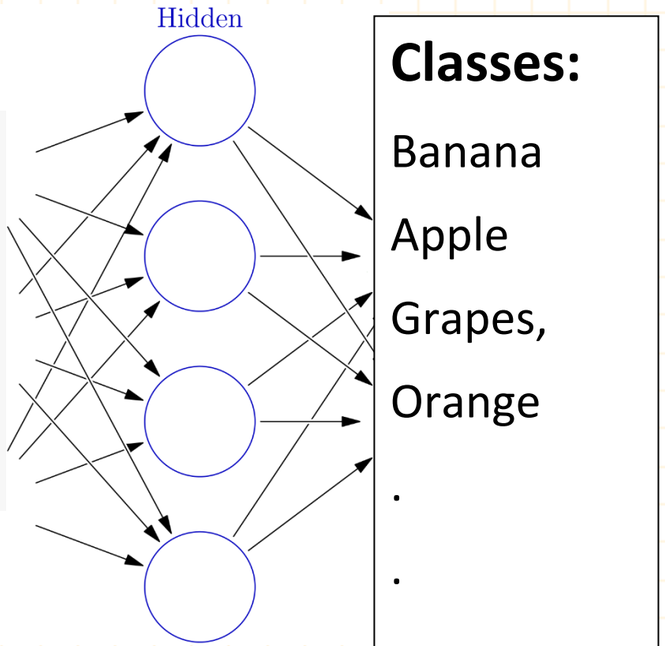
An ANN that is made up of more than three layers – i.e. an input layer, an output layer and multiple hidden layers – is called a 'deep neural network', and this is what underpins deep learning.



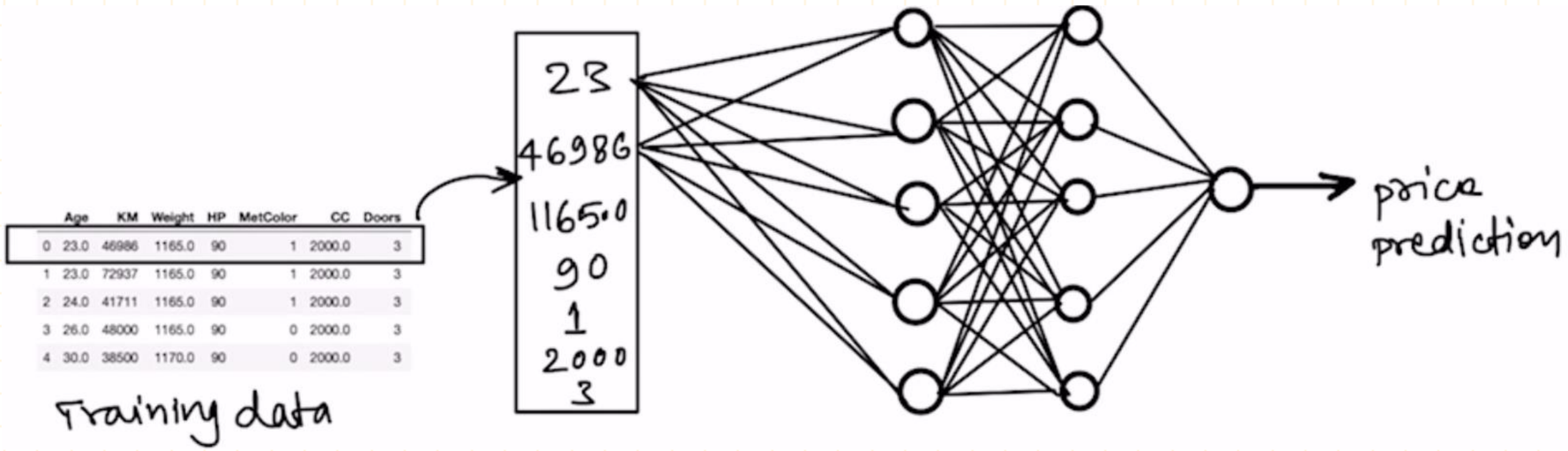
Terminologies:

ANN is a Supervised Learning algorithm.

Type 1. ANN Classifier



Type 2. ANN Regressor



Tensorflow, Keras, and PyTorch

TensorFlow is an open-source deep learning library that is developed and maintained by Google. It offers dataflow programming which performs a range of machine learning tasks. It was built to run on multiple CPUs or GPUs and runs in several languages like Python, C++, or Java.

KERAS is an open-source Neural Network library written in Python that runs on top of Theano or Tensorflow. It is designed to be modular, fast, and easy to use. It was developed by François Chollet, a Google engineer. It is a useful library to construct any deep learning algorithm.

If interested to know more: *Tensorflow vs. Keras*

PyTorch is an open-source machine learning library which was developed by Facebook's AI Research Group. It can be integrated with Python and C++. It is popular because of its efficient memory usage and the ability to debug neural networks easily.

If interested to know more: *Keras vs PyTorch*

What to use?

Keras is a high-level API which is running on top of TensorFlow, CNTK (Microsoft Cognitive Toolkit), and Theano. Keras is perfect for quick implementations while Tensorflow is ideal for Deep learning research, complex networks, and PyTorch for computer vision and natural language processing. In this course, we use Tensorflow and Keras.

Optional (Learn PyTorch on your own with this Step-by-Step Tutorial and Example).

Install Tensorflow

Run “Anaconda Prompt” as Administrator:

(base) C:\WINDOWS\system32>>> pip install TensorFlow

To check that you have installed it successfully:

Open a Jupyter Notebook, and run these lines:

```
import tensorflow as tf
from tensorflow import keras
```

(it takes some time, be patient!)

Check the version:

```
tf.__version__
```

```
'2.10.0'
```

```
keras.__version__
```

```
'2.10.0'
```

```
In [2]: import tensorflow as tf
        from tensorflow import keras

In [3]: tf.__version__
Out[3]: '2.10.0'

In [4]: keras.__version__
Out[4]: '2.10.0'

In [ ]:
```

Building a Neural Networks:

Step 1. Initialize the Model

```
Model=tf.keras.models.Sequential()
```

Step 2. Build the Input layer

```
Model.add(tf.keras.layers.Dense(units=6, activation='relu'))
```

Step 3. Build the first hidden layer

```
Model.add(tf.keras.layers.Dense(units=3, activation='relu'))
```

Step 4. Build the output layer

```
Model.add(tf.keras.layers.Dense(units=1, activation='sigmoid'))
```

Step 5. Compile the Model

```
Model.compile(optimizer = 'sgd', loss = ' mean_squared_error ', metrics = ['accuracy'])
```

- *optimizer = 'adam' or 'sgd'*
- *loss='binary_crossentropy', 'sparse_categorical_crossentropy' or mean_squared_error*

Step 6. Train the Model

```
Model.fit(X_train, y_train, batch_size = 32, epochs = 100)
```

Step 7. Evaluate the Model

```
Model.evaluate(X_test,y_test)
```

Step 8. Use the Model to predict

```
y_pred = Model.predict(X_New)
```

Can ANN be used for Image Classification? Yes, See Example 15 on Canvas.

The Fashion MNIST contains 70,000 gray images of 28x28 pixels, with 10 classes (T-Shirt/Top, Trouser, Pullover, Dress, Coat, Sandal, Shirt, Sneaker, Bag, Ankle Boot).

Goal: Build a model to recognize an unlabeled image from this dataset.