Concept of a Neural Network

Neuron is the basic unit of information processing.

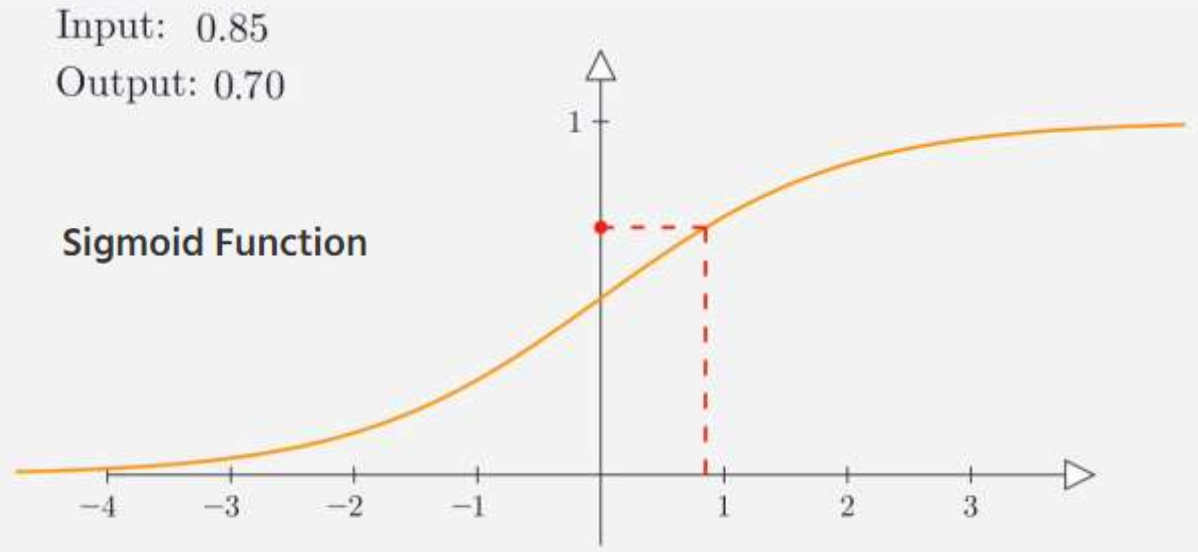
Weights are special coefficients that determine how important each input is to the neuron.

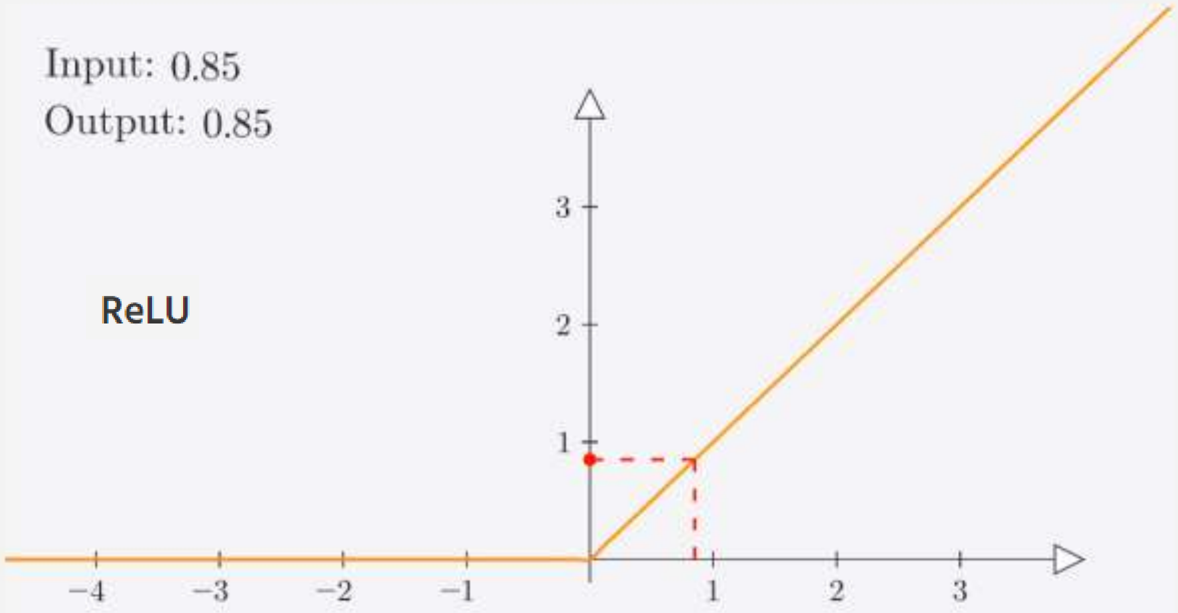
The **process of training a neural network** is to adjust the weight of each neuron in such a way that the results they give are the most accurate.

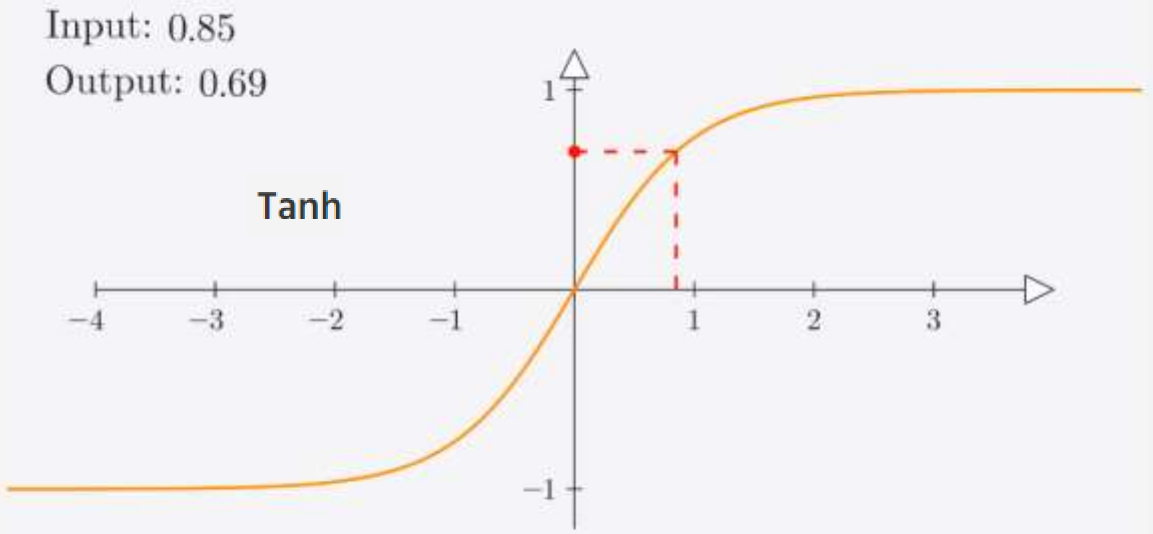
The **activation function** converts the sum to the neuron's output value.

Examples of activation functions include:

1. **Sigmoid Function**
2. **ReLU**
3. **Hyperbolic Tangent**

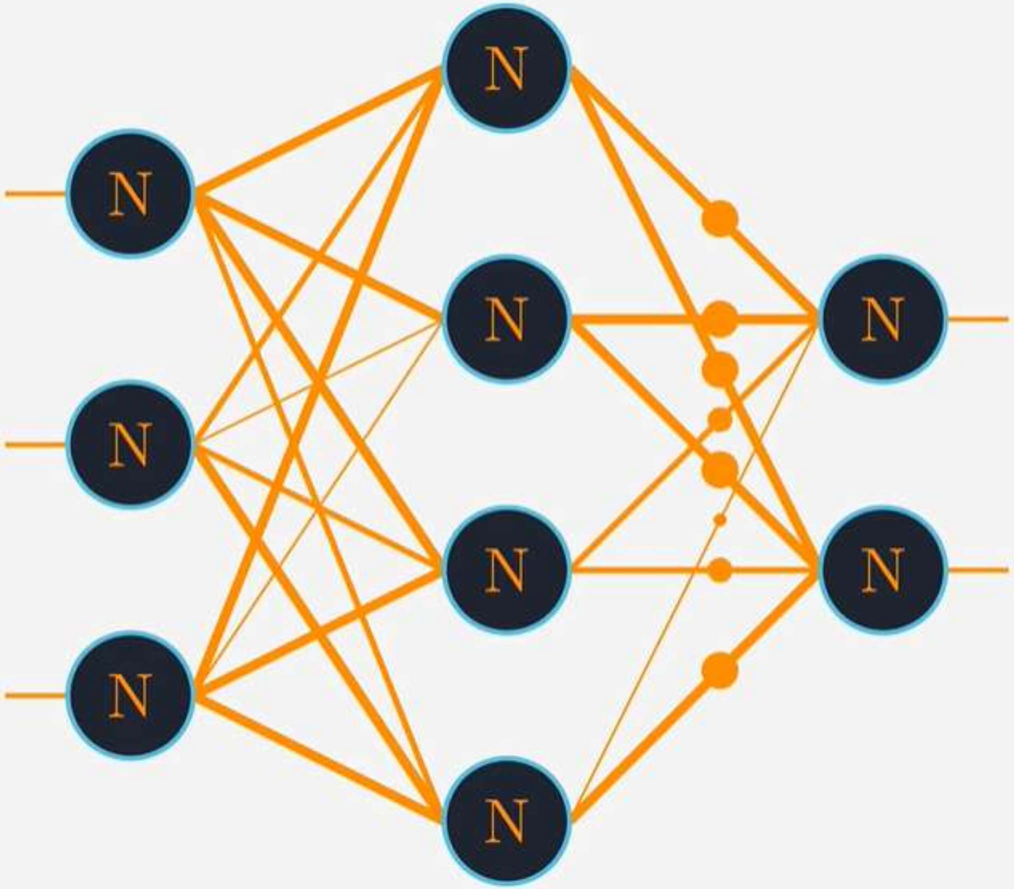






Forward propagation is the process by which information passes through the Neural Network from the input layer to the output layer. When the information reaches the output layer, the network makes a prediction or inference based on the data it has processed.

Backpropagation is the process in which the error information is used to traverse the network back and adjust the weights of the neurons.

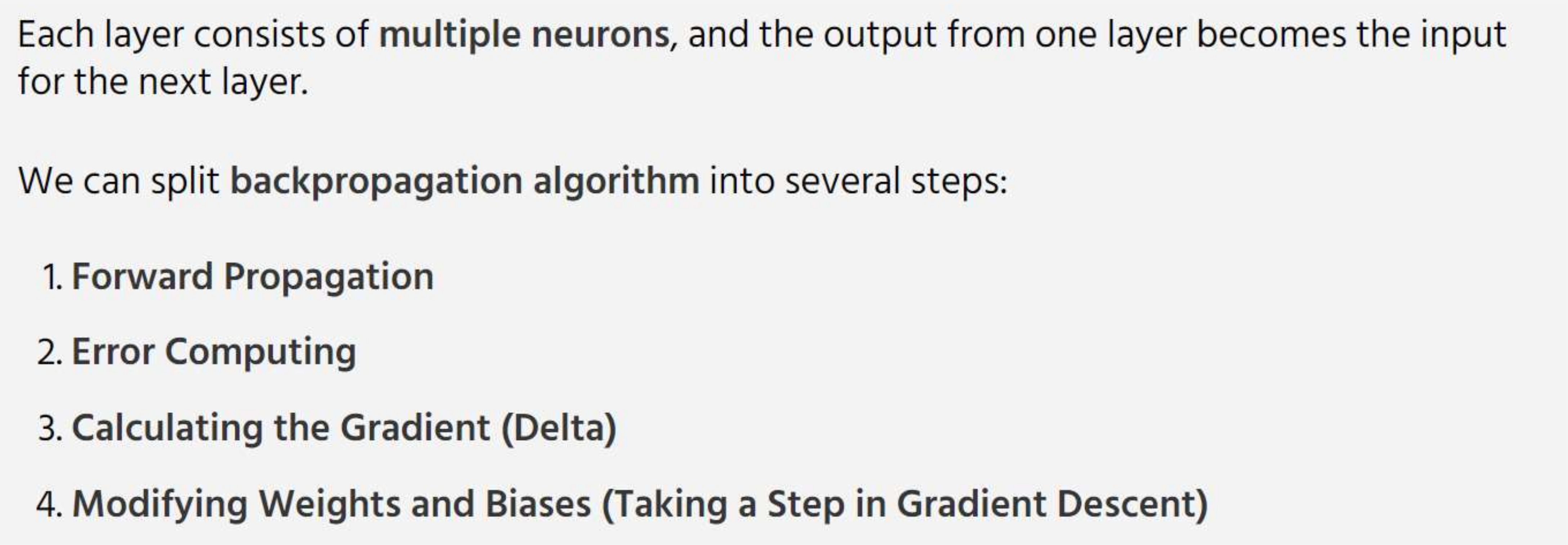


Neural Network from Scratch

The **bias** allows the neuron to shift its output, adding flexibility to the modeling capability. Bias of the neuron is also a trainable parameter.

Multilayer Perceptron can have multiple layers:

1. **An input layer:** It receives the input data.
2. **Hidden layers:** These layers process the data and extract patterns.
3. **Output layer:** Produces the final prediction or classifications.



Each layer consists of **multiple neurons**, and the output from one layer becomes the input for the next layer.

We can split **backpropagation algorithm** into several steps:

1. **Forward Propagation**
2. **Error Computing**
3. **Calculating the Gradient (Delta)**
4. **Modifying Weights and Biases (Taking a Step in Gradient Descent)**

Learning rate is an integral component of the **gradient descent** algorithm, the learning rate can be visualized as the pace of training. A higher learning rate accelerates the training process; however, an excessively high rate might cause the neural network to overlook valuable insights and patterns within the data.

There are many different ways to **calculate the quality of a model**:

1. **Accuracy**
2. **Mean Squared Error (MSE)**
3. **Cross-entropy (Cross-entropy)**
4. And many others...

Creating a model:

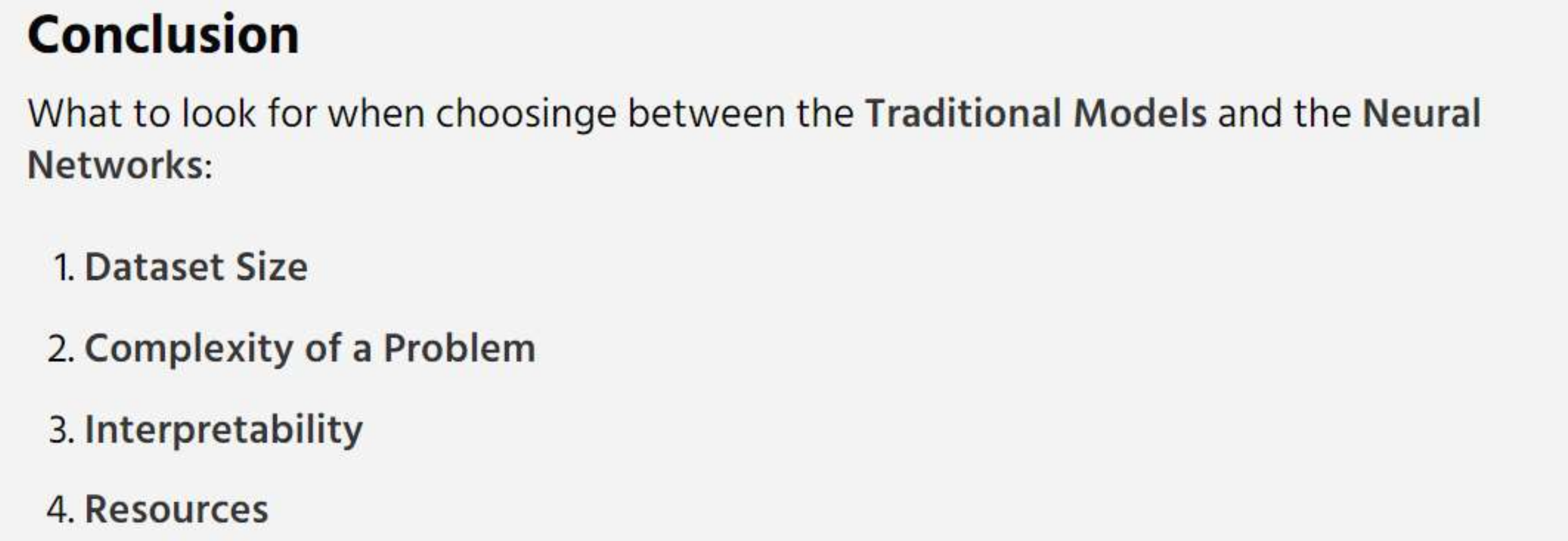
```python
from sklearn.neural_network import MLPClassifier

model = MLPClassifier(max_iter=200, hidden_layer_sizes=(10, 20, 30), learning_rate_init=0.01)
```

Training a model:

```python
model.fit(X, y)
```

Predict output values:

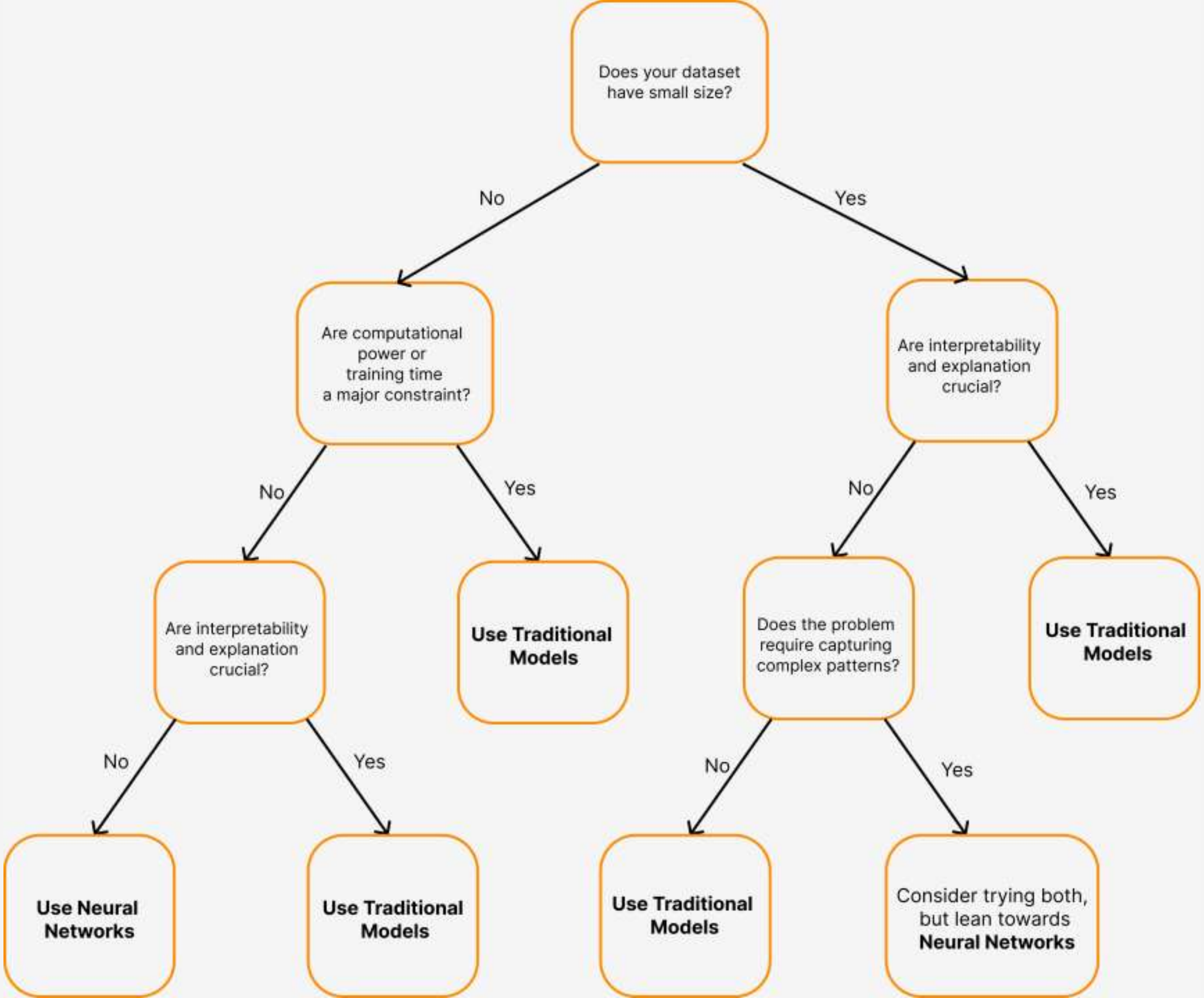
```python
y = model.predict(X)
```



Conclusion

What to look for when choosinge between the **Traditional Models** and the **Neural Networks**:

1. **Dataset Size**
2. **Complexity of a Problem**
3. **Interpretability**
4. **Resources**



Does your dataset have small size?

No

Yes

Are computational power or training time a major constraint?

Are interpretability and explanation crucial?

No

Yes

No

Yes

Are interpretability and explanation crucial?

Use Traditional Models

Does the problem require capturing complex patterns?

Use Traditional Models

No

Yes

No

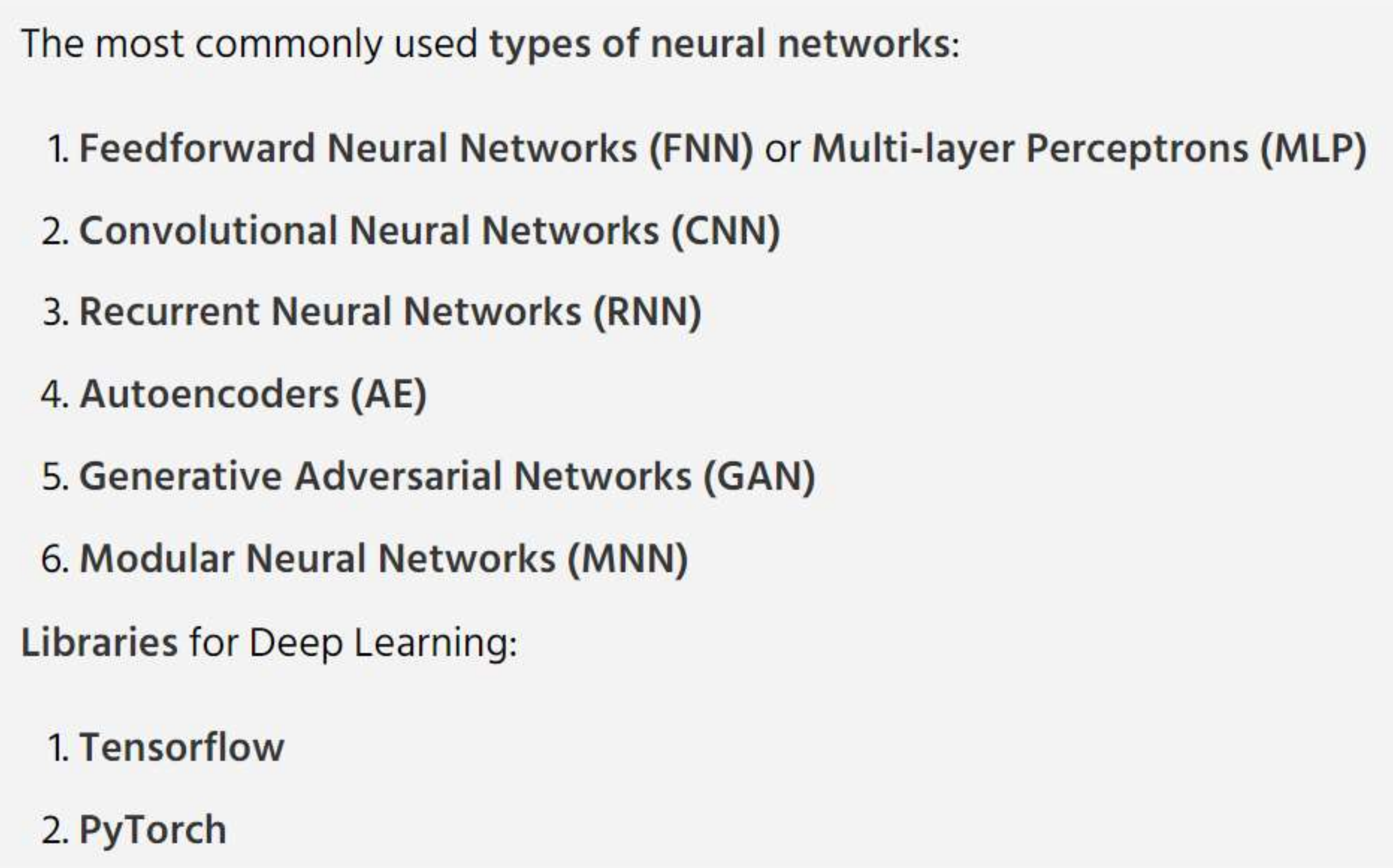
Yes

Use Neural Networks

Use Traditional Models

Use Traditional Models

Consider trying both, but lean towards **Neural Networks**



The most commonly used **types of neural networks**:

1. **Feedforward Neural Networks (FNN)** or **Multi-layer Perceptrons (MLP)**
2. **Convolutional Neural Networks (CNN)**
3. **Recurrent Neural Networks (RNN)**
4. **Autoencoders (AE)**
5. **Generative Adversarial Networks (GAN)**
6. **Modular Neural Networks (MNN)**

Libraries for Deep Learning:

1. **Tensorflow**
2. **PyTorch**