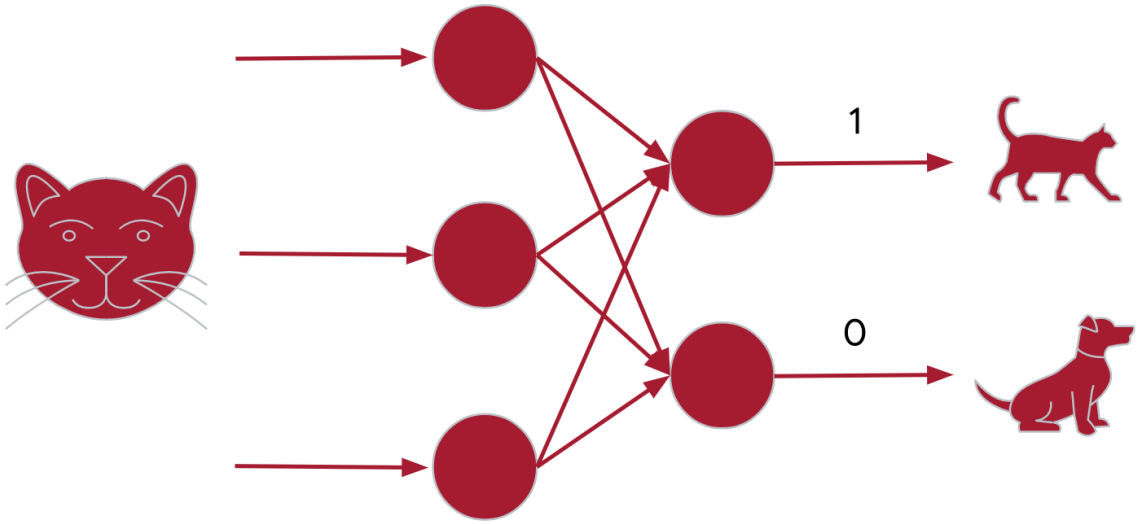
Neural Network Layers

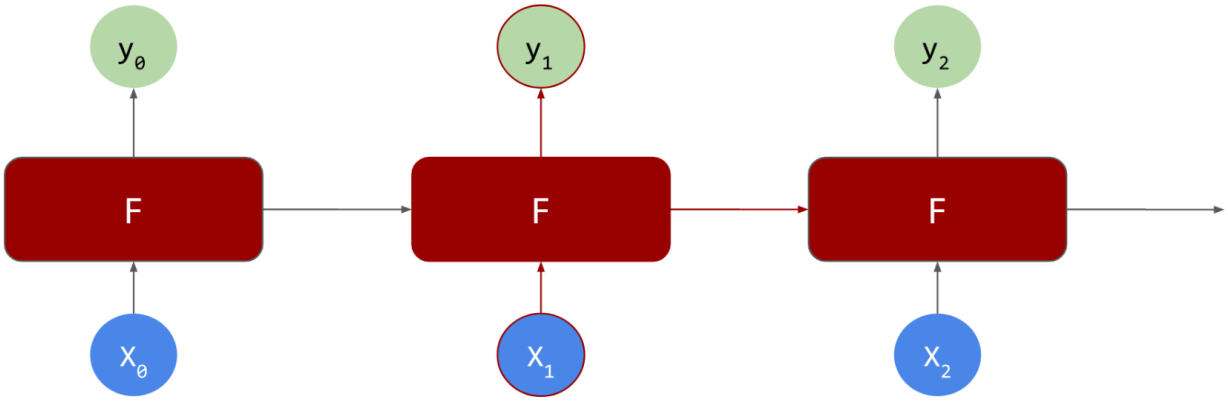
Machine Learning goes beyond simple neurons that just learn parameters 'w' and 'b' in the Y = wX + b scenario.

When neurons are used together, in layers, more complex relationships can be figured out. In ***classification*** problems, multiple output neurons are used, where each neuron could have a role in the final output. This is perfect for computer vision. Below is a simplified neural network diagram illustrating classification -- does the network 'see' a dog or a cat?



Basic neurons, stacked together as shown above form a ***Dense*** layer, because they're densely connected to each other. When there are multiple layers between the input and the output, the neural network is called a ***Deep Neural Network***, which gives us the term ***Deep Learning***. Additionally, the layers between the input and the output are often called ***hidden*** layers.

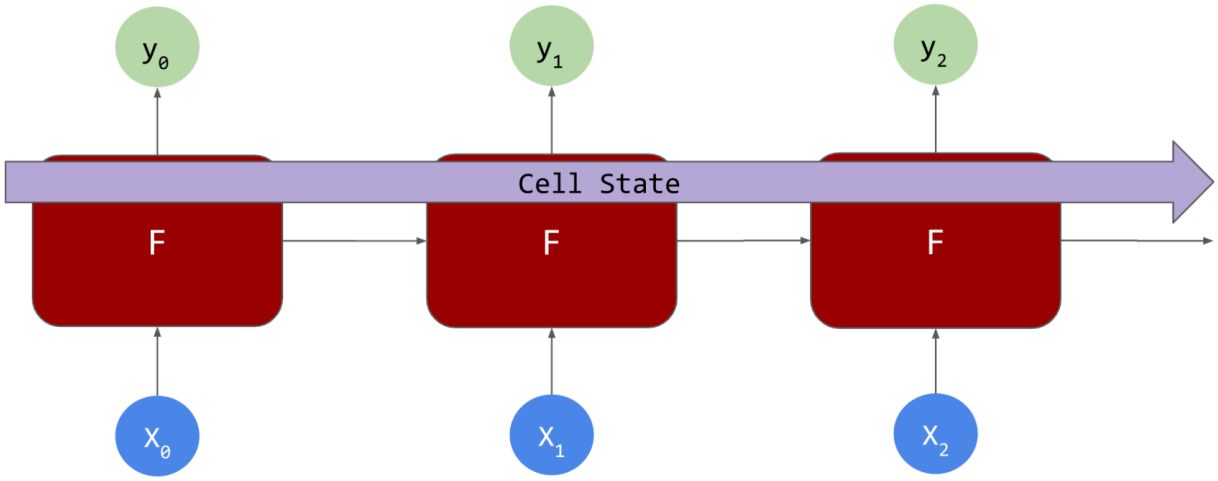
There are other types of layers that learn parameters different from the 'w' and 'b' that a neuron learns. For example, there are ***Recurrent*** layers that learn values in a sequence -- each neuron learns values *and* passes those values to another neuron in the same layer. The basic idea can be represented as:



Here, let us assume that for values X0, X1, X2 we want to learn a corresponding sequence Y0, Y1, Y2. Then the idea is that the neurons (F) can not only try to match X0 -> Y0, but also pass values along the sequence, indicated by the right pointing arrows. Hence, for example, the input to the second neuron is the output from the first neuron as well as X1. From these, the second neuron can learn the parameters for Y1 and so on.

There are many variations on this idea, but a very powerful one is called ***Long Short Term Memory*** where not only are values passed from neuron to neuron, so that X0 can impact Y1, X1 can impact Y2, but values from further back can also have an impact -- so that X0 could impact Y99 for example. This is achieved using a data structure called a *Cell State* where context can be preserved across multiple neurons.

Neural networks with Recurrent Layers are called **Recurrent Neural Networks** and find use in applications such as Language Modeling, Speech Recognition, Text Summarization and so on.



Another type of neural network layer is called a ***Convolution layer***, where a filter that can transform data, particularly image data, can be learned. The neural networks with Convolutional Layers are called **Convolutional Neural Networks** and find use in applications such as Image Classification, Video Analysis, Facial Recognition and so on. We'll explore these next!