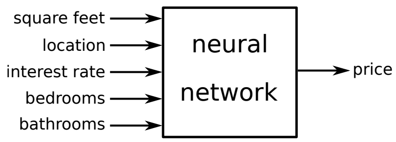
1 Neural Networks as Functions

1 Definition (Neural Network)
A neural network is a function that maps inputs to outputs.

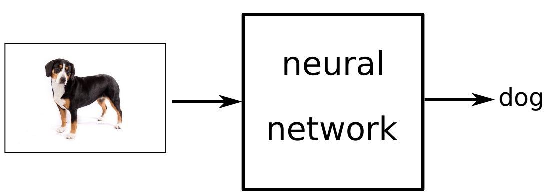
2 Example (Housing Prices Neural Network)
Real estate agents want to know what price a house will sell for. A neural network can predict the selling price.



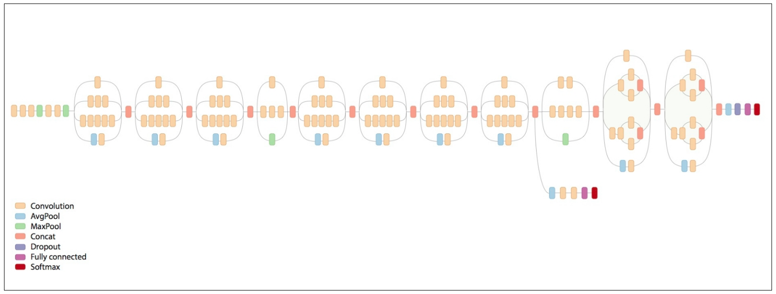
The inputs are called **features** and are application specific. If the output is continuous, the network is a **regression network**. If the output is discrete, then the network is a **classification network**. The function that maps features to prices is learned from a large number of training examples.

3 Example (Feature Engineering)
If we had thousands of features (inputs) direct programming of the housing prices neural network would be difficult and require **feature engineering** which is a process of combining input features to construct more abstract and useful features. Deep learning automates feature engineering, i.e. the housing prices neural network can be trained **end-to-end** using the raw data.

4 Example (Image Classifier)



5 Example (InceptionV3)



6 Example (ImageNet)
ImageNet is a dataset of over 14 million images from 20,000 categories.

7 Example (Jupyter Notebook Image Classifier)
Implement a Jupyter notebook image classifier using the InceptionV3 neural network trained on ImageNet.

8 Example (Trainable Parameters)
How many trainable parameters does InceptionV3 have?

Hint Use Kera's `.summary()` method.

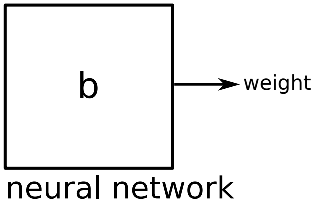
9 Definition (Simple Bias Network)
The simplest possible neural network has no input and has a contant output called the **bias** of the network. The simple bias network has a single trainable parameter called b for bias.

10 Example (Weight Prediction)
Assume we are interested in designing playground equipment. We need to predict the weight of a child. Assume children are defined to be humans who are 18 years old or younger. Below is a list of the weights (in pounds) of 10 randomly selected children. What weight should we predict for a child?[1]

weights
128
123
129
143
132
142
112
118
108
119

11 Example (Simple Bias Network)
Lets train a neural network to predict a child's weight. This network will be unusual because we have no features available to use as inputs to the network. It has a single parameter b, the bias of the network.

[1]Data source: SOCR Data



We will learn an appropriate value for b from the data provided. First we need to define a **loss function** that tells us how good the network is at predicting the weight of a child.

12 Definition (L^1 Loss Function)
Assume n equals the number of available outputs from our dataset. The L^1 loss function for a neural network is:

$$\frac{1}{n}\sum_{i=1}^{n} |\text{predicted output} - \text{target output}|$$

13 Definition (L^2 Loss Function)
Assume n equals the number of available outputs from our dataset. The L^2 loss function (Mean Square Error or MSE) for a neural network is:

$$MSE = \frac{1}{n}\sum_{i=1}^{n} (\text{predicted output} - \text{target output})^2$$

14 Example (Simplest Network, L^2 Version)
Repeat the previous Lesson except use an L^2 loss function in place of the L^1 loss function.

In general, training a neural network with an L^2 loss will give a different network than training with an L^1 loss. The L^2 loss is easier to use. Note that the L^2 loss function is smoother than the L^1 loss function.