Deep Learning

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1 What is Neural Network

From this week, I begin to learn the Deep Learning introduced by Andrew Ng. As we know ,Neural Network is a powerful learning algorithm inspired by how the brain works [1]. In information technology, a neural network is a system of hardware and software patterned after the operation of neurons in the human brain. Neural networks – also called artificial neural networks – are a variety of deep learning technologies.

1.1 Single Neural Network

Andrew Ng introduced a single neural network. Given the data on the size of the housing market in the real estate market, we hope to be able to find the function of predicting its price. This is a linear regression problem because the price as a function of size is a continuous output.

Because we know that the prices can never be negative ,we make the line end up at zero. We create a function called Rectified Linear Unit(ReLU) which starts at zero as shown in Fig. 1. The input is the size of the house(x), the output is the price(y), the "neuron" implements the function ReLU (blue line).

Figure 1: Housing price prediction

1.2 Multiple Neural Network

The price of a house can be affected by other features such as size, location, number of bedrooms and wealth. The role of the neural network is to predicted the price and it will automatically generate the hidden units. We only need to give the inputs x and the output y as shown in Fig. 2.

2 Supervised Learning for Neural Network

In supervised learning, given a data set and already know what our correct output should look like, having the idea that there is a relationship between the input and the output.

Supervised learning problems are divided into "regression" and "classification" issues. In a Regression problem, we try to predict the result in continuous output, which means we try to map input variables into some continuous functions. In the classification problem, we try to predict the result in discrete output. In other words, we are trying to map input variables to discrete categories.

Here are some examples of supervised learning in Table.1.

I learn that there are different types of neural networks, such as convolutional neural networks (CNN), often used for image applications and Recurrent Neural Networks (RNN) for one-dimensional sequence data, such as translating English into Chinese or time components such as text transcripts. . As for autonomous driving, it is a hybrid neural network architecture.

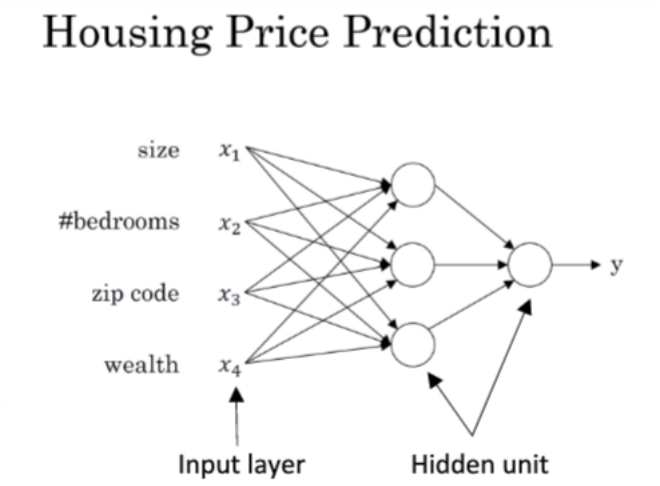

Figure 2: Housing price prediction

Input(x)	Output(y)	Application
Home features	Price	Real Estate
Ad, user info	Click on ad?	Online Advertising
Image	Object(1,...,1000)	Photo tagging
Audio	Text transcript	Speech recognition
English	Chinese	Machine translation
Image,Radar info	Position of other cars	Autonomous driving

Table 1: examples of supervised

There are two kinds of data type, they are structured data and unstructured data. Structured data has a defined meaning such as price, age and so on. However, unstructured data is something like pixel, raw audio, text and so on, as shown in Fig. 3.

3 Binary Classification

In a binary classification problem, the result is a discrete value output.

3.1 Cat vs Non-Cat

The goal is to train a classifier that the input is an image represented by a feature vector, x, and predicts whether the corresponding label y is 1 or 0. In this case, whether this is a cat image (1) or a non-cat image (0).

An image is store in the computer in three separate matrices corresponding to the Red, Green, and Blue color channels of the image as shown in Fig. 4. The three matrices have the same size as the image, for example, the resolution of the cat image is 64 pixels $\times$ 64 pixels, the three matrices (RGB) are 64 $\times$ 64 each. The value in a cell represents the pixel intensity which will be used to create a feature vector of ndimension. In pattern recognition and machine learning, a feature vector represents an object, in this case, a cat or no cat.

To create a feature vector, x, as shown in Fig. 5 the pixel intensity values will be "unroll" or "reshape" for each color. The dimension of the input feature vector x is $n_x = 64 \times 64 \times 64 \times 3 = 12,288$

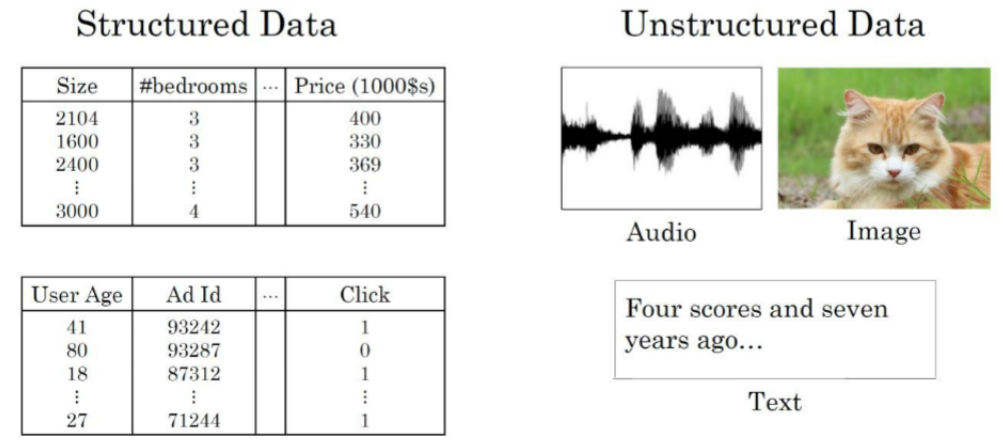

Figure 3: Housing price prediction

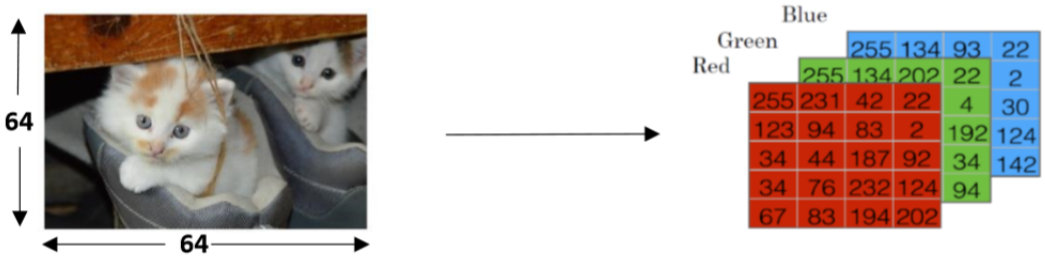

Figure 4: RGB channels

4 Logistic Regression

Logistic regression is a learning algorithm used in a supervised learning problem when the output y are all either 0 or 1. The goal of logistic regression is to minimize the error between its prediction and training data.Given an image represented by a feature vector x, the algorithms will evaluate the probability of a cat being in that image.

$$Given\ x, \hat{y} = P\left(y = 1|x\right), where\ 0 \leq \hat{y} \leq 1 \tag{1}$$

The parameters used in Logistic regression are:

- The input features vector: $x \in \mathbb{R}^{n_x}$, where n_x is the number of features

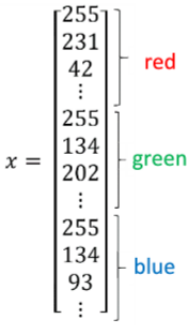

Figure 5: feature vector x

- The training label: $y \in (0, 1)$
- The weights: $w \in \mathbb{R}^{n_x}$, where n_x is the number of features
- The threshold: $b \in \mathbb{R}$
- The output: $\hat{y} = \sigma\left(w^{\mathrm{T}} + b\right)$
- Sigmoid function: $s = \sigma\left(w^{\mathrm{T}} + b\right) = \sigma\left(z\right) = \frac{1}{1+e^{-z}}$

References

[1] A. Ng. Neutral network and deep learning. https://study.163.com. 1