Data Science/Machine Learning/Deep Learning Workshop

Nueva Ecija University of Science and Technology (NEUST)

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Day 2 : Neural Networks and Practical Application

Topic 1: Fundamentals of Neural Network-based Simple Linear Regression (SLR)

- **Introduction to Simple Linear Regression**
- **The simple linear regression model**
- **Implementing SLR using Neural Networks**

Topic 2: Fundamentals of Neural Network-based Multiple Linear Regression (MLR)

- Introduction to Multiple Linear Regression
- The multiple linear regression model
- Using categorical variables in regression models
- Implementing SLR using Neural Networks

Topic 3: Fundamentals of Neural Network-based Binary Logistic Regression (BinLogRes)

- Introduction to Binary Logistic Regression
- The logistic regression model
- Implementing Binary LogRes using Neural Networks
- Performance metrics for logistic regression

Topic 4: Fundamentals of Neural Network-based Multinomial Logistic Regression (MulLogRes)

- Introduction to Multinomial Logistic Regression
- The multinomial logistic regression model
- Assumptions of multinomial logistic regression
- Classifying Image Data using NN-based MLR implementation

Introduction to Linear Regression

- The most basic approach in machine learning is measuring two variables on the same data object in order to explore the nature of the relationship among these variables. This relationship can be expressed in the form of a function.
- Function: a mathematical relationship enabling us to predict what values of one variable (**Y**) correspond to given values of another variable (**X**).
  1. **Y**: is referred to as the **dependent variable**, the **response variable** or the **predicted variable**.
  2. **X**: is referred to as the **independent variable**, the **explanatory variable** or the **predictor variable**.

Why Simple Linear Regression?

- It has been applied in many biological, behavioral, environmental and social sciences.
- Simple linear regression model have an important role in the business.
- It serves as a building block for other more advanced algorithms.

Problems for Linear Regression

We often hear subscription companies using factors such as marketing budget to calculate how much new subscribers they will be able to gain. The question is: is this assumption true? Is there a relationship between the marketing budget and the number of new subscribers that a company can gain, and if there is, can we find it?

In this case, the statement can be read as; is ***Y is a function of X***. (i.e., Is the number of subscription a function of the amount of budget allocated for marketing?

Two kinds of explanatory variables:

- Those we can control
- Those over which we have little or no control.

Question needing answer...

- What is the *association* between Y and X?
- How can changes in Y be explained by changes in X?
- What are the *functional relationships* between Y and X?

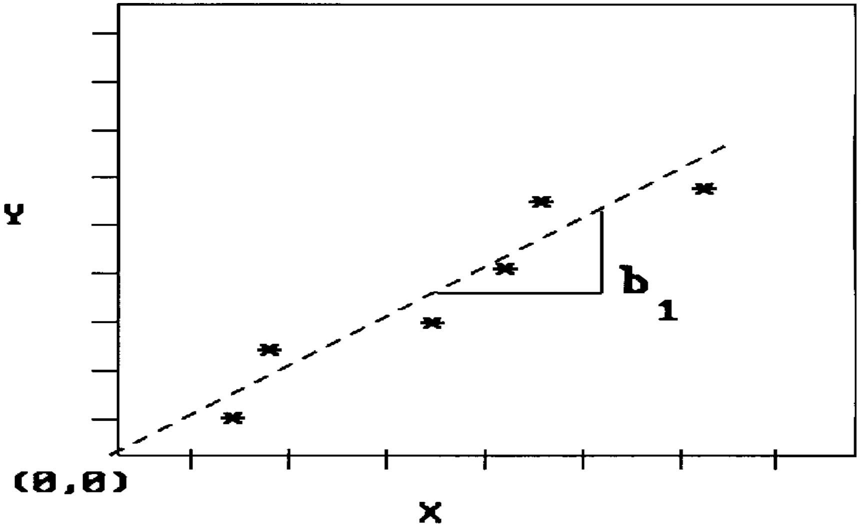
A functional relationship is symbolically written as:

Eq: 1 $$Y = f(X)$$

Example: New subscriptions is a function of the marketing budget

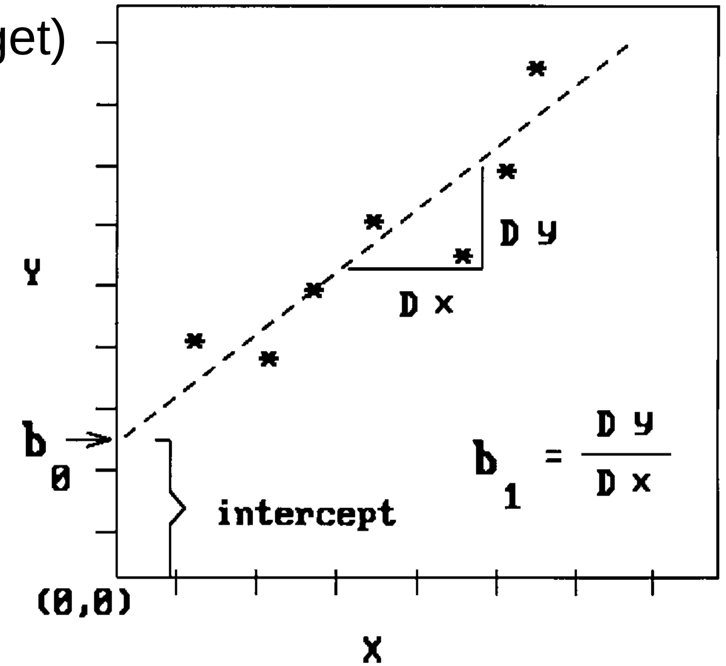
$$\boxed{Y = b_1 X}$$

b_1 is the **slope** of the line.



The complete equation...

Example: Linear relationship (e.g.
Y=New_subscription versus, X=marketing_budget)



Here ***Y*** is the dependent variable and *X* is the independent variable. Hence, the change in variable ***X*** produces a change in variable ***Y***.

So, in a linear regression task our job is to find the appropriate values of the slope b_1 and the intercept value b_0 so that we can get an accurate estimated value of ***Y*** for any given ***X***.

$$\boxed{Y = b_0 + b_1 X}$$

b_0 is the intercept,
b_1 is the slope.

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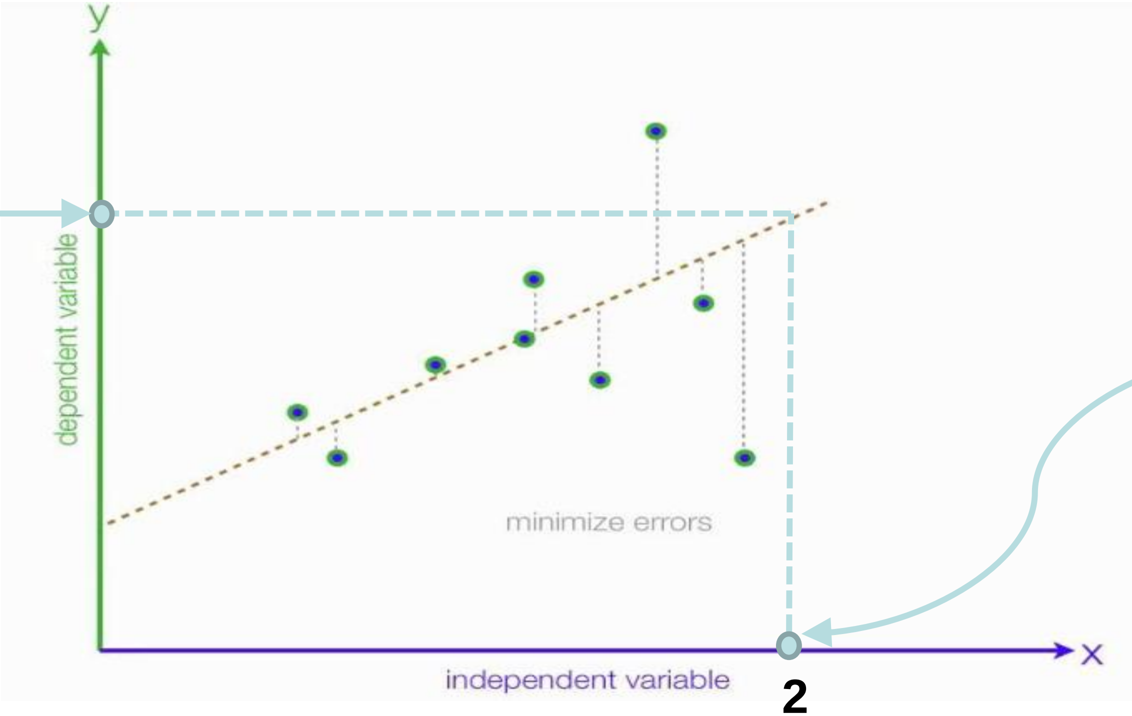
Predicting through the Best-fit line

Prediction for value of Y

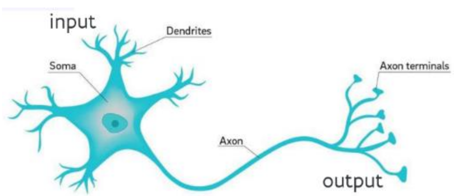


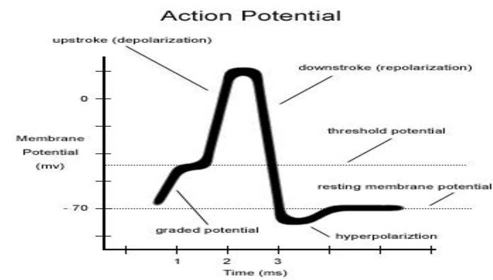
New value for X

2
2

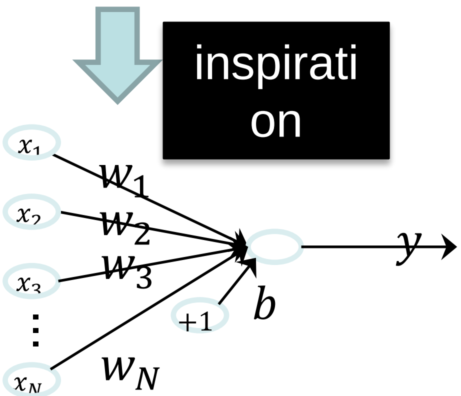
Neural Network for Simple Regression

Neural network algorithm is inspired by the biological operations of specialized cells called neurons.

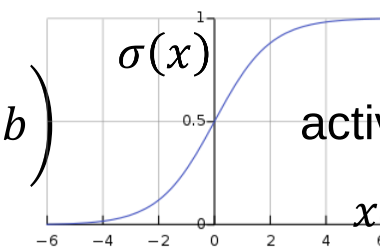




inspiration



$$y = \sigma\left(\sum_{i=1}^{N} w_i x_i + b\right)$$



activation function

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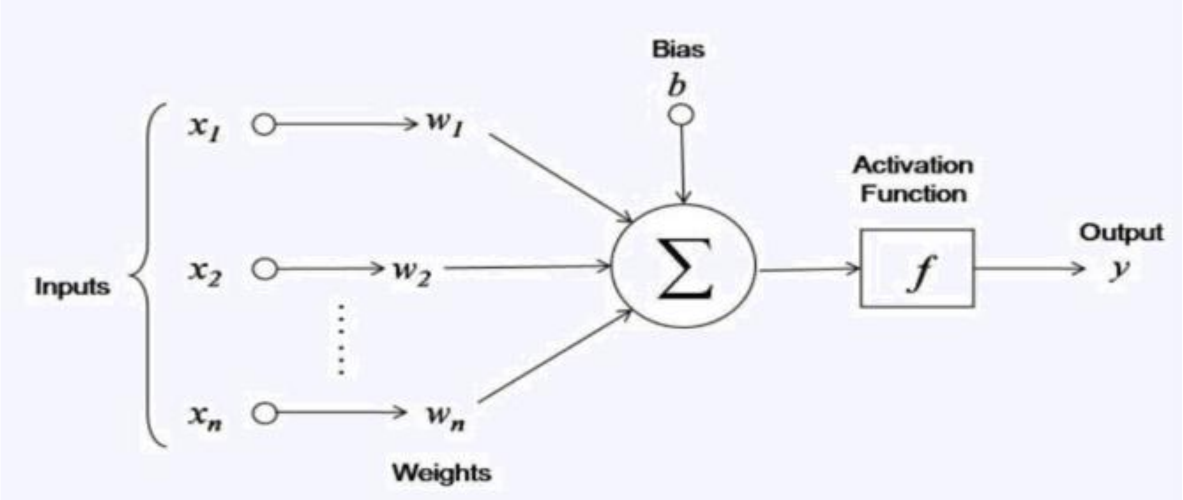
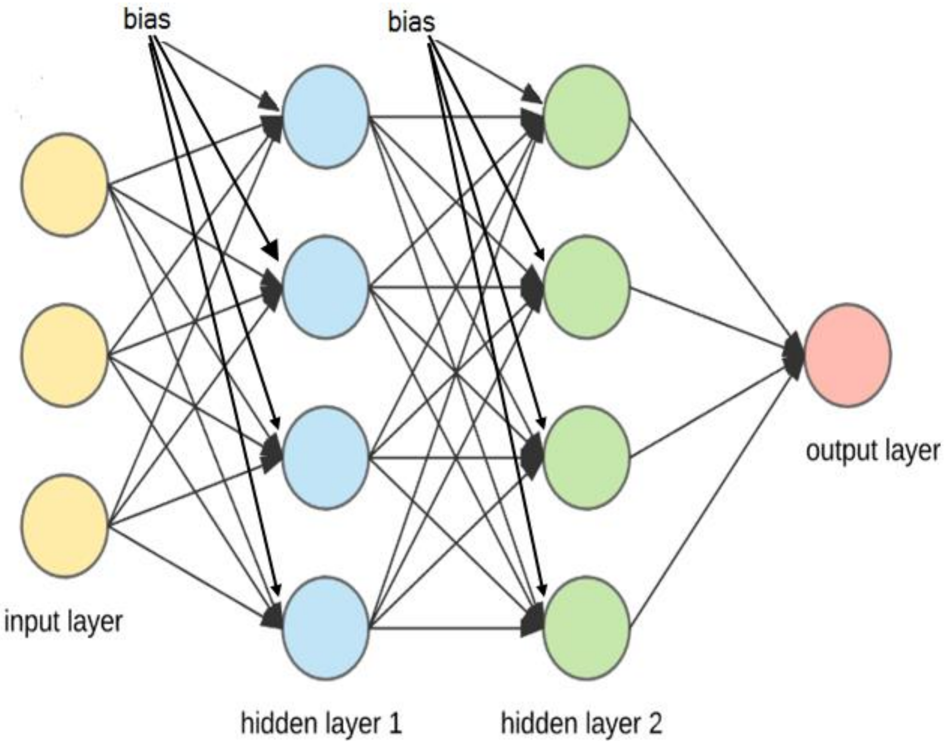
Functions of a single Artificial Neuron

Neural network algorithm is inspired by the biological operations of specialized cells called neurons.



Neural Network for Simple Regression

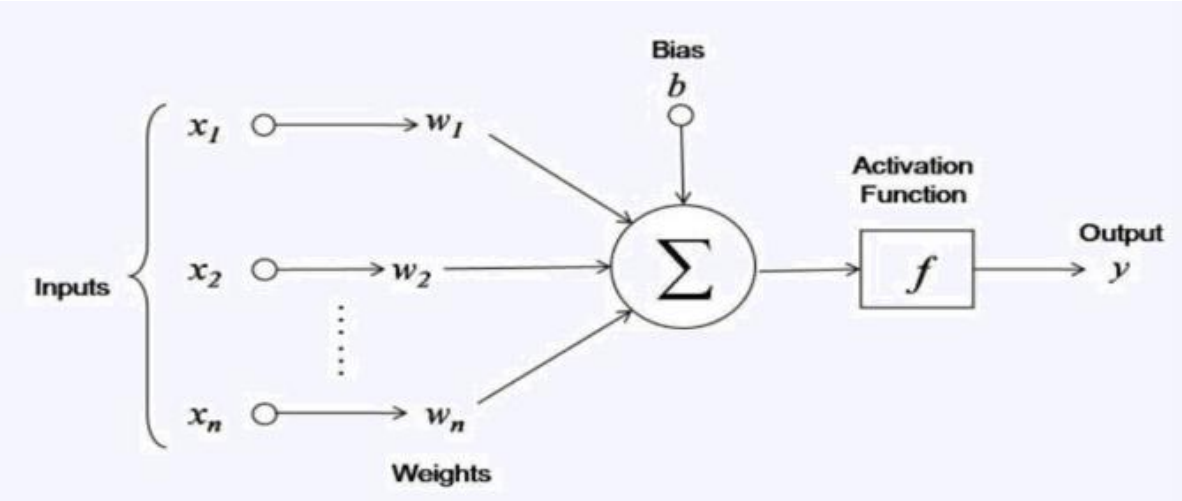
- Neural Networks work in layers:
  1. Input Layer
  2. Varying number of Hidden Layers
  3. Output Layer.
- Each layer can be made up of one or several numbers of nodes or neurons.
- The middle or hidden layer is where most of the jaw-dropping computations is done.
- Graph shows the notional representation of Artificial Neural Networks.



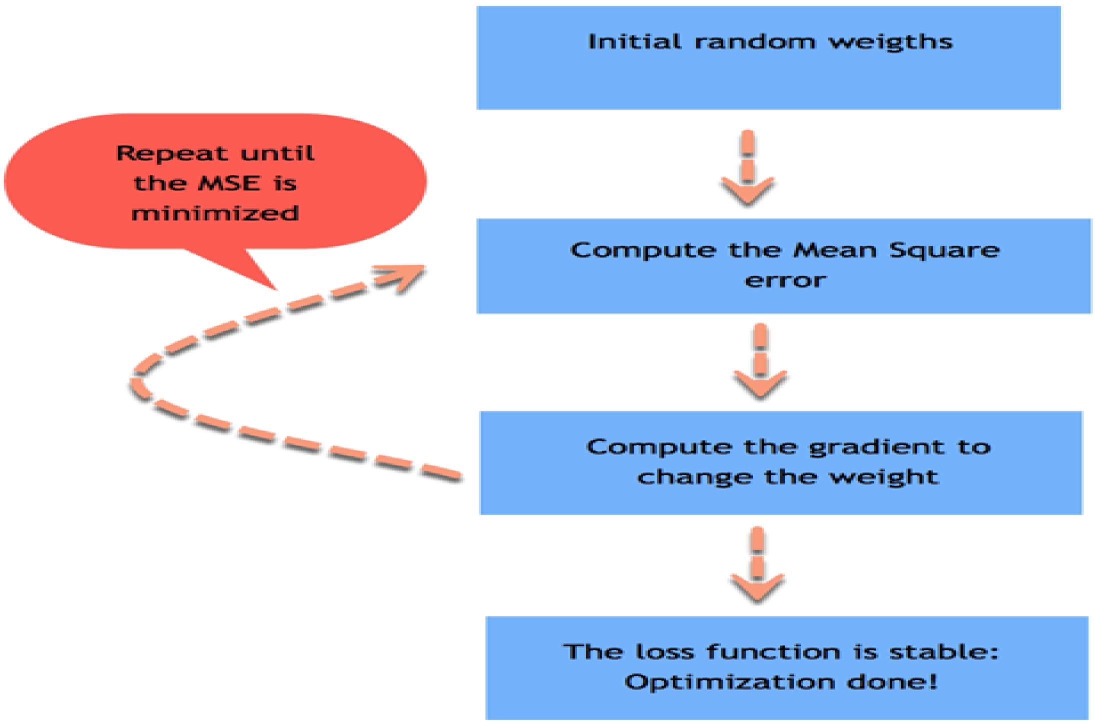
Neural Network for Simple Regression

Some terms to know about Neural Networks

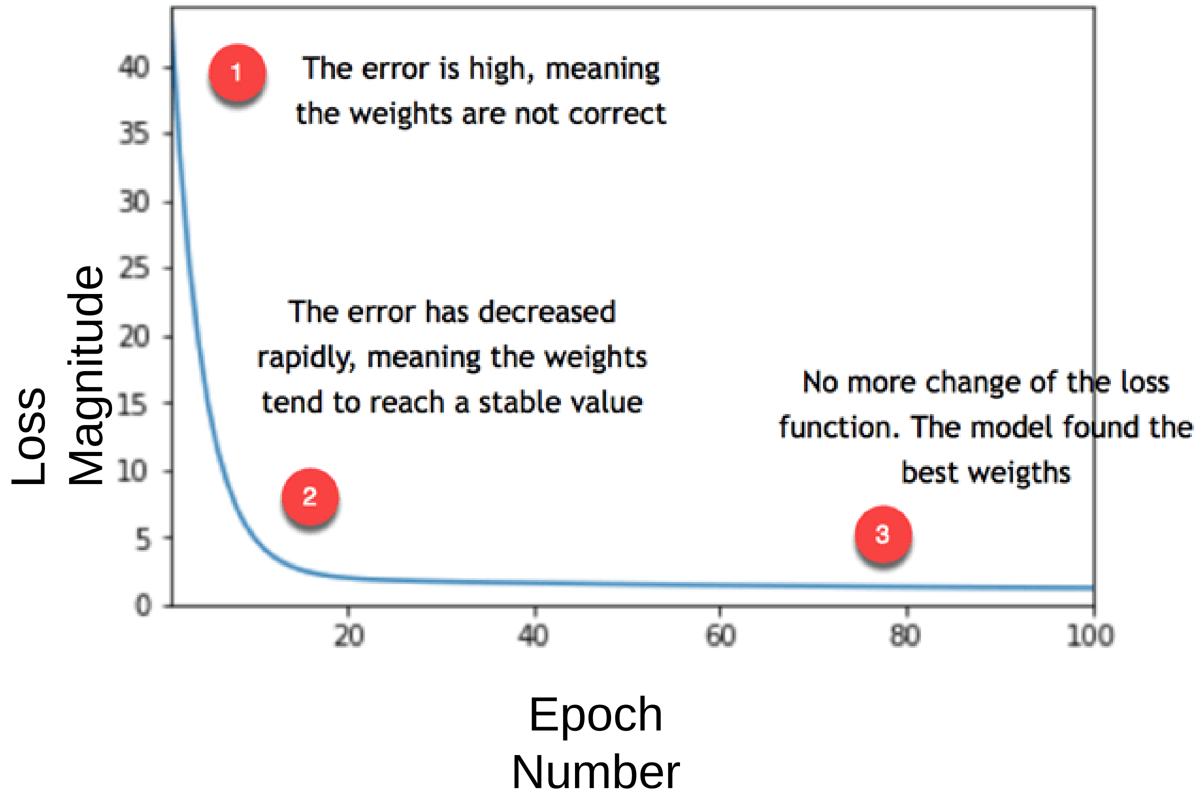
1. Weights
2. Biases
3. Activation Function
4. Epoch
5. Learning rate
6. Optimization
7. Performance Metric



How the algorithm works…



Interpreting the training history chart



Neural Network for Simple Regression

Demo Time !!!

Activity 1:

Normalize the dataset and run it again through the network. Observe the effects in the model performance. Did it help improve the performance of the prediction model?