A

Mini-Project Report On

CONSTRUCTION COST PREDITION USING ARTIFICIAL NEURAL NETWORK

Under the Course

"Environmental Project" (SH2602)

Submitted by

Second Year B.Tech. (CS & IT)

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Under the Guidance of

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(An Autonomous Institute Affiliated to Shivaji University, Kolhapur)

CERTIFICATE

This is to certify that below mentioned students of S.Y.B.Tech. (CS & IT) have successfully completed the project entitled *"CONSTRUCTION COST PREDICTION USING ARTIFICIAL NEURAL NETWORK."* under the course "Environmental Project" (SH2602). The content of this report, in full or in parts, have not been submitted to any other institution or university for the award of any degree.

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Prof. Dr. A. C. Adamuthe
Head, CS & IT. Engg. Dept.
Project Guide.

Place : R.I.T., Rajaramnagar.
Date   : 10-05-2021.

DECLARATION

We, the undersigned, the students of S. Y. B. Tech. (Computer Science and Information technology) hereby declare that the project entitled *"CONSTRUCTION COST PREDICTION USING ARTIFICIAL NEURAL NETWORK."* under the course "Environmental Project" (SH 2602) is a genuine work conducted by us through practical on–site observations, and the data collected by us is true to the extent of our awareness.

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Abstract

The backbone of economic development is profoundly based on infrastructural development. Construction industry in India generates about 10-12 million tons of waste annually. This produced waste leads to various types of pollution that harm the environment. The waste responsible for pollution mainly consists of construction material used like Construction dust: Construction and demolition operations contribute to windblown dust problems ,Noxious vapors from oils, glues, thinners, paints, treated woods, plastics, cleaners and other hazardous chemicals that are widely used on construction sites, also contribute to air pollution and C&D Waste: The waste comprising of building materials, debris and rubble resulting from construction, re-modeling, repair. So, in order to reduce the pollution level, it is necessary to use only required amount of construction material and avoiding extra material which leads to pollution. This can be achieved by predicting construction cost at pre-design stage and hence estimating the material required. To predict the construction cost we have used Artificial Neural Network (ANN). The reason for choosing ANN is that NN work better at predictive analytics because of Hidden layers. With the help of hidden layers, NN are able to give more accurate results. The performance of NN improves as they grow bigger and work on more and more data, unlike other machine learning algorithms that which can reach a plateau after they reach a certain point.

Keywords: Cost Prediction, ANN, NN, Hidden Layers, Machine Learning Algorithms.

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Abbreviation

ANN - Artificial Neural Network

NN - Neural Network

AI – Artificial Intelligence

MLP - Multilayer perceptron

1. Introduction

The back-bone of economic development is infrastructure. All construction sites generate high levels of pollution and this can carry for large distances over a long period of time. Construction industry in India generates about 10-12 million tons of waste annually. Source of pollution at Construction Sites include:1] Construction dust: Construction and demolition operations contribute to windblown dust problems 2] Noxious vapors from oils, glues, thinners, paints, treated woods, plastics, cleaners and other hazardous chemicals that are widely used on construction sites, also contribute to air pollution 3] C&D Waste: The waste comprising of building materials, debris and rubble resulting from construction, re-modeling, repair. So, in order to reduce the pollution level, it is necessary to use only required amount of construction material and avoiding extra material which leads to pollution.

1.1 Motivation

So as discussed above, to reduce the pollution we need to know the exact amount material needed and also, we need to know which material or we can say parameter is affecting more. This can be achieved by cost prediction. For cost prediction we have used ANN. The reason for choosing ANN is that NN work better at predictive analytics because of Hidden layers. With the help of hidden layers, NN are able to give more accurate results. The performance of NN improves as they grow bigger and work on more and more data, unlike other machine learning algorithms that which can reach a plateau after a point.

1.2 Problem Statement

To the predict the cost of construction with as much accuracy as possible on the basis of area in terms of per square foot.

1.3 Project Objectives

- To apply artificial neural network algorithm for cost prediction.
- To alter tuning parameters of the algorithms for enhancement of the performance.
- To study the design of an ANN model for cost estimating at the pre-design stage.

2. Background and Literature Review

2.1 Prediction Problem

- The continuous development, jointly with the world economical interaction phenomenon has contributed to the competitiveness increase between producing and delivering companies of product and services.
- Cost prediction is the process of estimating the effort required to develop a system.
- It can help to classify and prioritize development projects with respect to an overall business plan.
- It can be used to determine what resources to commit to the project and how well these resources will be used.
- It can be used to assess the impact of changes and support re-planning.
- Projects can be easier to manage and control when resources are better matched to real needs.
- Customers expect actual development costs to be in line with estimated costs.

2.2 Artificial neural network

- An artificial neural network (ANN) is the piece of a computing system designed to simulate the way the human brain analyses and processes information.
- It is the foundation of artificial intelligence (AI) and solves problems that would prove impossible or difficult by human or statistical standards.
- Artificial neural networks are built like the human brain, with neuron nodes interconnected like a web.
- An ANN has hundreds or thousands of artificial neurons called processing units, which are interconnected by nodes. These processing units are made up of input and output units.
- The input units receive various forms and structures of information based on an internal weighting system, and the neural network attempts to learn about the information presented to produce one output report.
- An ANN initially goes through a training phase where it learns to recognize patterns in data, whether visually, aurally, or textually.
- After training the model, testing is done. The model is tested based on the loss and the accuracy of predicting.
- The performance of NN improves as they grow bigger and work on more and more data, unlike other machine learning algorithms that which can reach a plateau after a point.
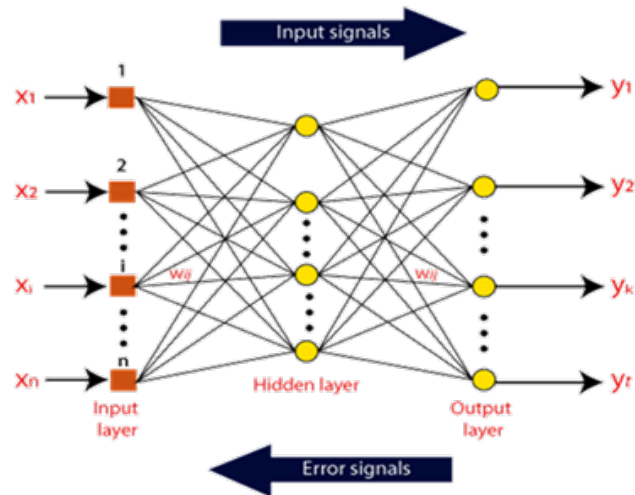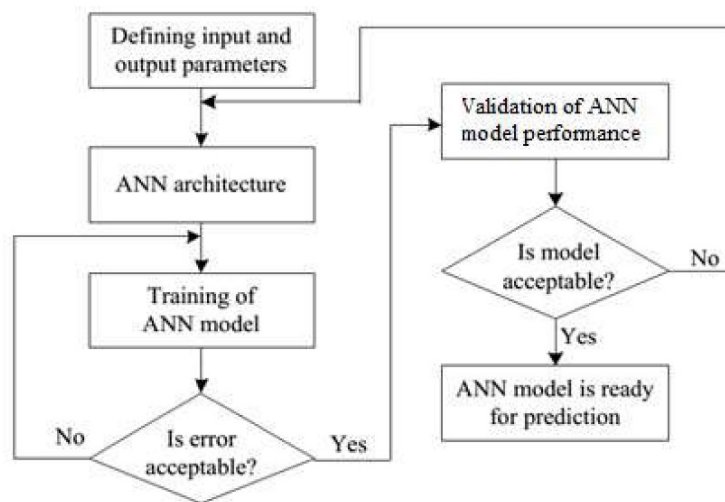
Fig 1- A sample of ANN layers.

Fig 2- How ANN works for prediction.

2.3 Literature review

2.3.1 Smita K. Magdum and Amol C. Adamuthe, Oct 2017

- This paper presents construction cost prediction as multiple regression model with cost of six materials as independent variables.
- The objective of this paper is to develop neural networks and multi-layer perceptron-based model for construction cost prediction.
- Different models of NN and MLP are developed with varying hidden layer size and hidden nodes.
- Four artificial neural network models and twelve multilayer perceptron models are compared.
- MLP and NN give better results than statistical regression method.
- As compared to NN, MLP works better on training dataset but fails on testing dataset.
- 'elu' transfer function gives better results than other transfer function.

2.3.2 Bipin Pal, Feb 2018

- The objective of this study is to review cost estimation models which used Artificial Neural Network (ANN) tool and to suggest the most effectual algorithm for cost prediction and the factors predominantly affecting the total construction costs of building projects.
- The developed neural network model examines the data set into distinct cases classified on the basis of hidden layers. Each of them containing the independent input neurons, hidden layers and a dependent output neuron.
- The results of the trained models indicated that neural network reasonably succeeded in estimating the Total construction cost of building projects at the planning stage itself.
- The average error of test dataset for the adapted model was largely acceptable and can perform as a good indicator regarding the ability of the proposed model to predict the total construction cost of any future construction project at an appreciated degree of accuracy.
- This paper gives a clear review of implementing the ANN tool in prediction of total cost of building construction projects and the relevant factors affecting it.

2.3.3 Michał Juszczyk, Sept 2019

- The balancing (symmetry) between time of calculation and satisfaction of reliable estimation was the reason for developing a new model for cost estimation in construction.
- This paper reports some results from the authors' broad research on the modelling processes in engineering related to estimation of construction costs using artificial intelligence tools.
- The aim of this work was to develop a model capable of predicting a construction site cost index that would benefit from combining several artificial neural networks into an ensemble.

3. ANN for Construction Cost Prediction

3.1 Data Collection

The data we have used for this project is pseudo data. We have prepared a pseudo dataset to test our ANN prediction algorithm. The dataset consists of eight variables. The variables are the materials and services required for construction of any project. The variables are as follows: - cement, sand, steel, aggregate, mason, skilled labor, contract cost and exit state. The dataset consists of three hundred rows of data of all the input variables and output variable.

cement	sand	steel	aggregate	mason	Skilled labor	contractor cost	Exit state
200	50	30	68	400	560	600	1
205	55	60	67	468	596	692	1
210	60	54	63	490	600	598	0
215	55	45	69	433	609	600	1
220	57	46	56	500	640	633	1
225	65	49	56	520	633	690	1
230	98	61	69	537	679	700	1
235	45	62	64	557	660	630	1
240	78	55	63	496	680	670	0
245	98	56	62	491	674	700	0

Table 1 – A sample of dataset used.

3.2 ANN Algorithm

1) We are designing an ANN model for construction cost prediction. So, for this, we have taken a pseudo dataset to test it with our python code.
2) The model comprises of 3 main layers namely, input, hidden, and output layers. Here, the input from the dataset is considered by the model which is passed to the hidden layer where the input or the independent variables will be multiplied by the weights.
3) The weights are linked between these layers, all nodes enclosed by weights from inputs to hidden layer and also from hidden layer to output layer.
4) The model observes the complete dataset and then train itself for the further prediction. To train the model in our case, we are using an approach of supervised training i.e., both inputs and output is provided to the model and the network then processes the inputs and compares its resulting output against the desired output.
5) After training the model, testing is done. The model is tested based on the loss and the accuracy of predicting the construction cost at the end in every epoch generated in an ANN model.
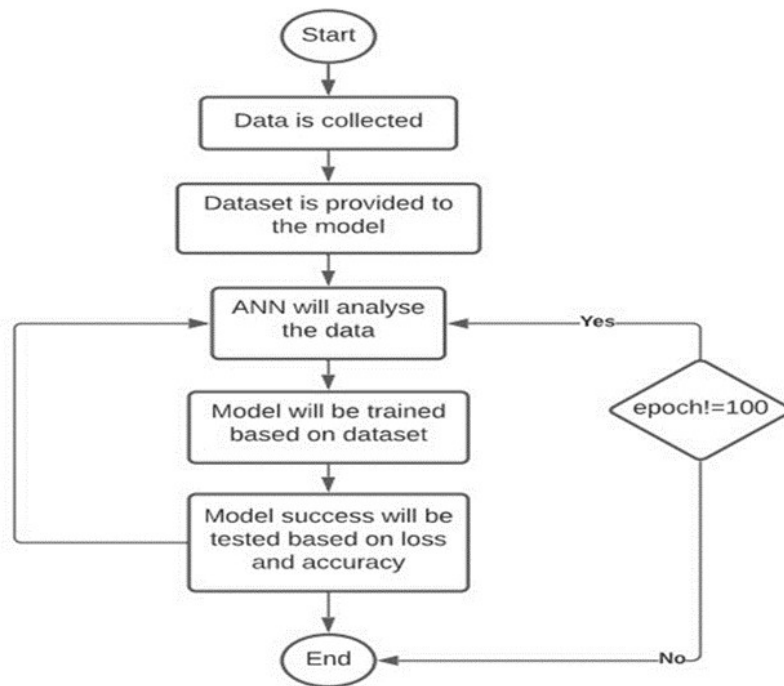
Fig 3 – ANN Algorithm.

4. Results and Discussion

4.1 Results

- ▪ Here we predict the accuracy for the construction cost. The final accuracy for construction cost prediction is as follows:

Epochs
Epoch 35/50
3/3 [==============================] - 0s 23ms/step - loss: 0.6789 - accuracy: 0.6907 - val_loss: 0.6642 - val_accuracy: 0.6522
Epoch 36/50
3/3 [==============================] - 0s 23ms/step - loss: 0.6798 - accuracy: 0.6482 - val_loss: 0.6641 - val_accuracy: 0.6667
Epoch 37/50
3/3 [==============================] - 0s 24ms/step - loss: 0.6763 - accuracy: 0.6818 - val_loss: 0.6639 - val_accuracy: 0.6812
Epoch 38/50
3/3 [==============================] - 0s 28ms/step - loss: 0.6824 - accuracy: 0.6457 - val_loss: 0.6637 - val_accuracy: 0.6812
Epoch 39/50

Table 2- Epoch and accuracy of three hidden layers.

Graphs:
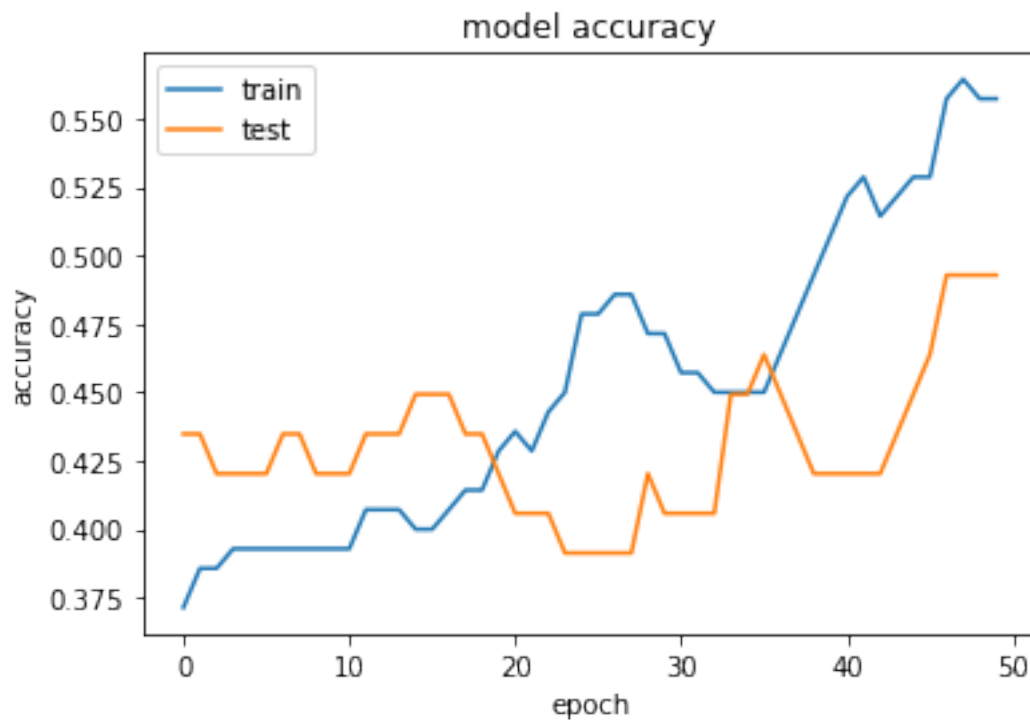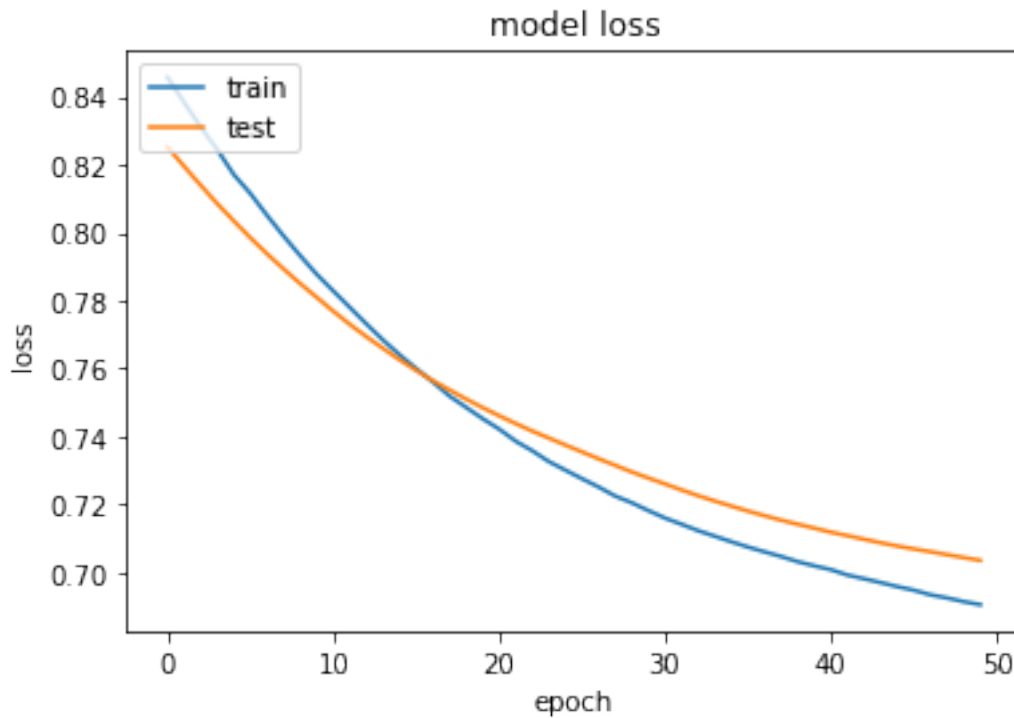**sigmoid function with 3 hidden layers**

Figure 4

Figure 5

- Here Table 2 indicates about the epoch and accuracy. Figure 4 is the graph of model accuracy of sigmoid function with 3 hidden layer and figure 5 is the graph about model loss.
- For tuning parameter we considered the no. of hidden layers. Figure 1 and 2 indicates the model accuracy and model loss respectively with 3 hidden layer. While figure 6 and 7 is the graph about model accuracy and model loss respectively with 2 hidden layers. Table no. 3 indicates epoch and accuracy of sigmoid function with 2 hidden layer.

Epoch 13/50
3/3 [==============================] - 0s 30ms/step - loss: 0.8063 - accuracy: 0.5636 - val_loss: 0.8488 - val_accuracy: 0.4638
Epoch 14/50
3/3 [==============================] - 0s 27ms/step - loss: 0.8404 - accuracy: 0.5511 - val_loss: 0.8430 - val_accuracy: 0.4638
Epoch 15/50
3/3 [==============================] - 0s 25ms/step - loss: 0.7542 - accuracy: 0.5861 - val_loss: 0.8380 - val_accuracy: 0.4638
Epoch 16/50
3/3 [==============================] - 0s 25ms/step - loss: 0.7650 - accuracy: 0.5761 - val_loss: 0.8331 - val_accuracy: 0.4493
Epoch 17/50

Table 3 – Epoch and accuracy of two hidden layers.

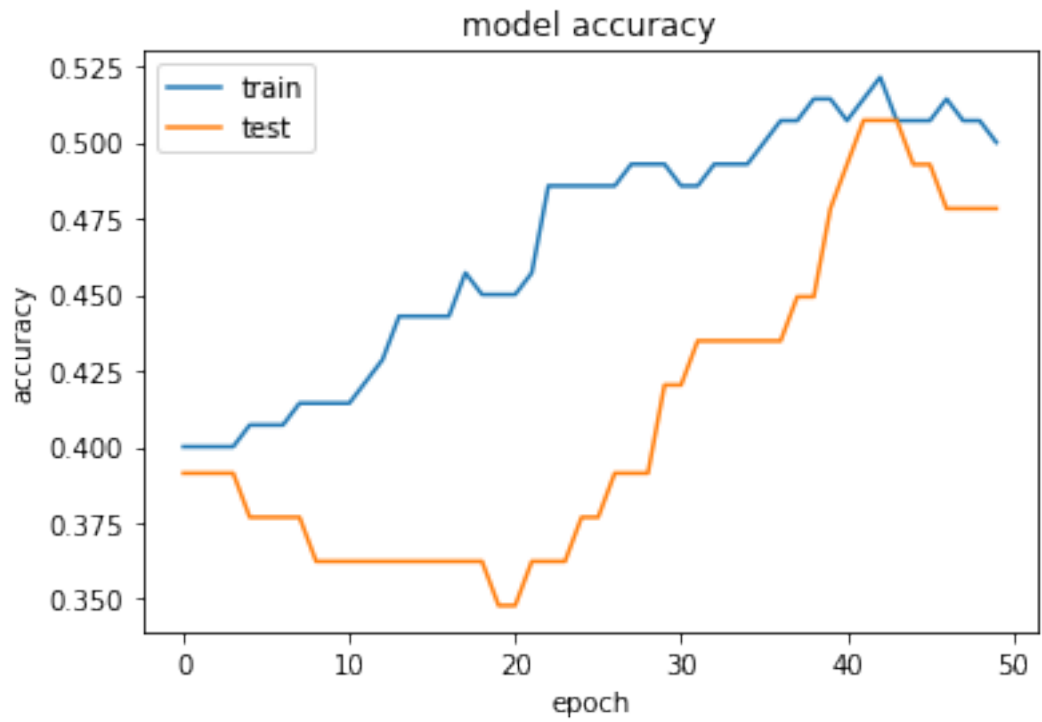Graphs:
sigmoid function with 2 hidden layers
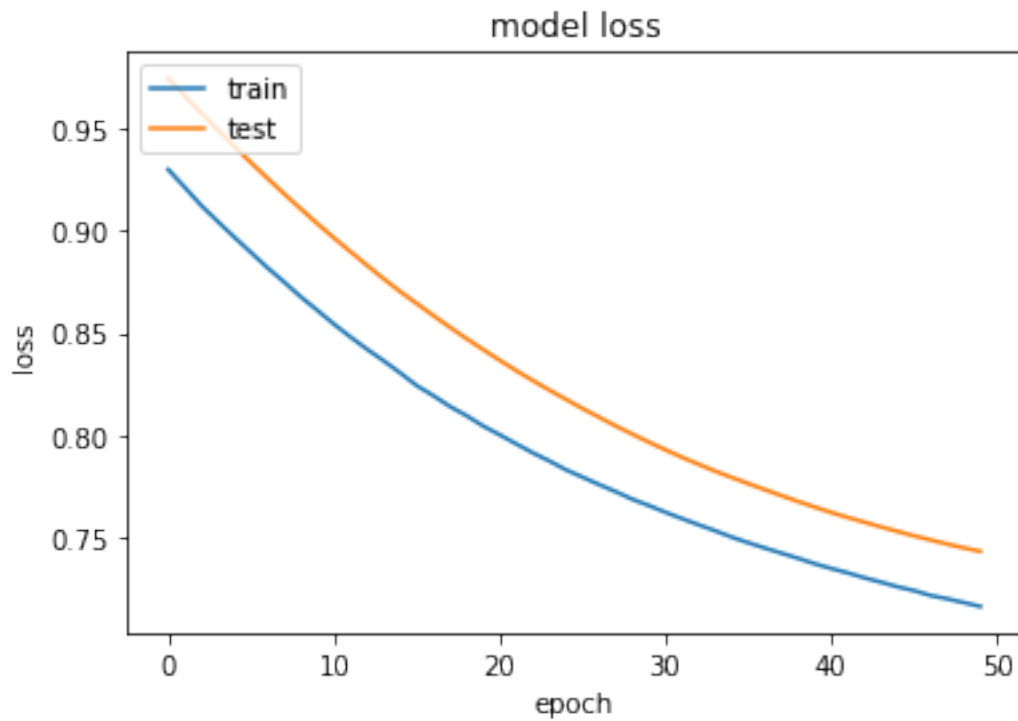
Figure 6

Figure 7

4.2 Conclusion

- From this project we were able to implement Artificial neural network algorithm for predicting construction cost.
- By tuning parameters, we were able to conclude that three layered ANN gives better results in terms of accuracy, i.e., in general the larger the number of hidden layers, more accurate results obtained.
- Finally, we were able to predict construction cost at pre-design stage with the help of ANN.

4.2 References

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