Artificial Intelligence (AI) techniques applied to dose Prediction chest CT scan

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Introduction

CT scan used to produce accurate digital cross-sectional images of the body that are relatively free of tissue superimposition that has a highly effective diagnostic tool.
CT has a benefits for the health-care system, which include;
- Improved diagnosis.
- Better treatment.
- High-quality images.

In CT, the radiation dose is higher which provides a better image quality, comparing it with the general x-ray which prevent overexposure or underexposure, as the X-rays need specific exposure ranges.

OBJECTIVES

Predicting the Dose Length Product (DLP) of chest CT scan by Artificial Neural Network using MATLAB®-Neural Fitting (NF) Tool.

METHODOLOGY

MATLAB stands for matrix laboratory, it's a software where it solves the data fitting problem with a two-layer feed forward neural network.
It helps in selecting the data., create & train a network, validate & use the network & evaluate its performance using square error and regression analysis.

Function fitting is the process of training a neural network on a set of inputs to produce an associated set of target output.

The mean square error performance = average squared error between the network output and target output. Each squared error contributes the same amount to the performance function to reduce the error in the model output.

$(MSE) = 1 / n \ (\Sigma(ti - a'i) \ n12$

Training data:
A Feed-forward artificial neural network is created when several neurons are arranged into layers and connected so that the output of one-layer feeds into the input of another layer.

Test data:
The test data provides an independent measure of network performance during the training

Figure 1. Outputs of (a) training (b) test (c) all data sets by Levenberg-Marquardt algorithm, Bayesian algorithm and Scaled-Conjugate Gradient algorithm as a function of actual (target) DLP

Figure 2. Obtained Simulink by Levenberg-Marquardt algorithm

Results

Figure 1 (a). shows the R values of training data of each plot were 0.96593, 0.99298, and 0.88235, respectively. For the Levenberg-Marquardt algorithm, Bayesian algorithm, and Scaled-Conjugate Gradient algorithm. The Bayesian algorithm had the highest R-value for the overall training process (R= 0.99298).

Figure 1 (b). Reported the R values of test data are 0.97328, 0.49996, and 0.88861, respectively. For the Levenberg-Marquardt algorithm, Bayesian algorithm, and Scaled-Conjugate Gradient algorithm. The maximum R-value for the overall training process (R= 0.99298) was reported for the Bayesian algorithm, which provided an equation for the output as 0.99*Target + 2.5, where the real and observed.

Figure 1 (c). That the correlation of all learning algorithms was reported to be greater than 0.88253 in the **Scaled-Conjugate Gradient algorithm** . the highest prediction rate of 0.96897 in the Levenberg-Marquardt algorithm.

Figure 2. shows the Simulink diagram obtained by Levenberg-Marquardt algorithm. The input has a ten different parameters, that described in x1 Simulink's constant box. The obtained results demonstrated that the proposed algorithm is capable of accurately estimating DLP values
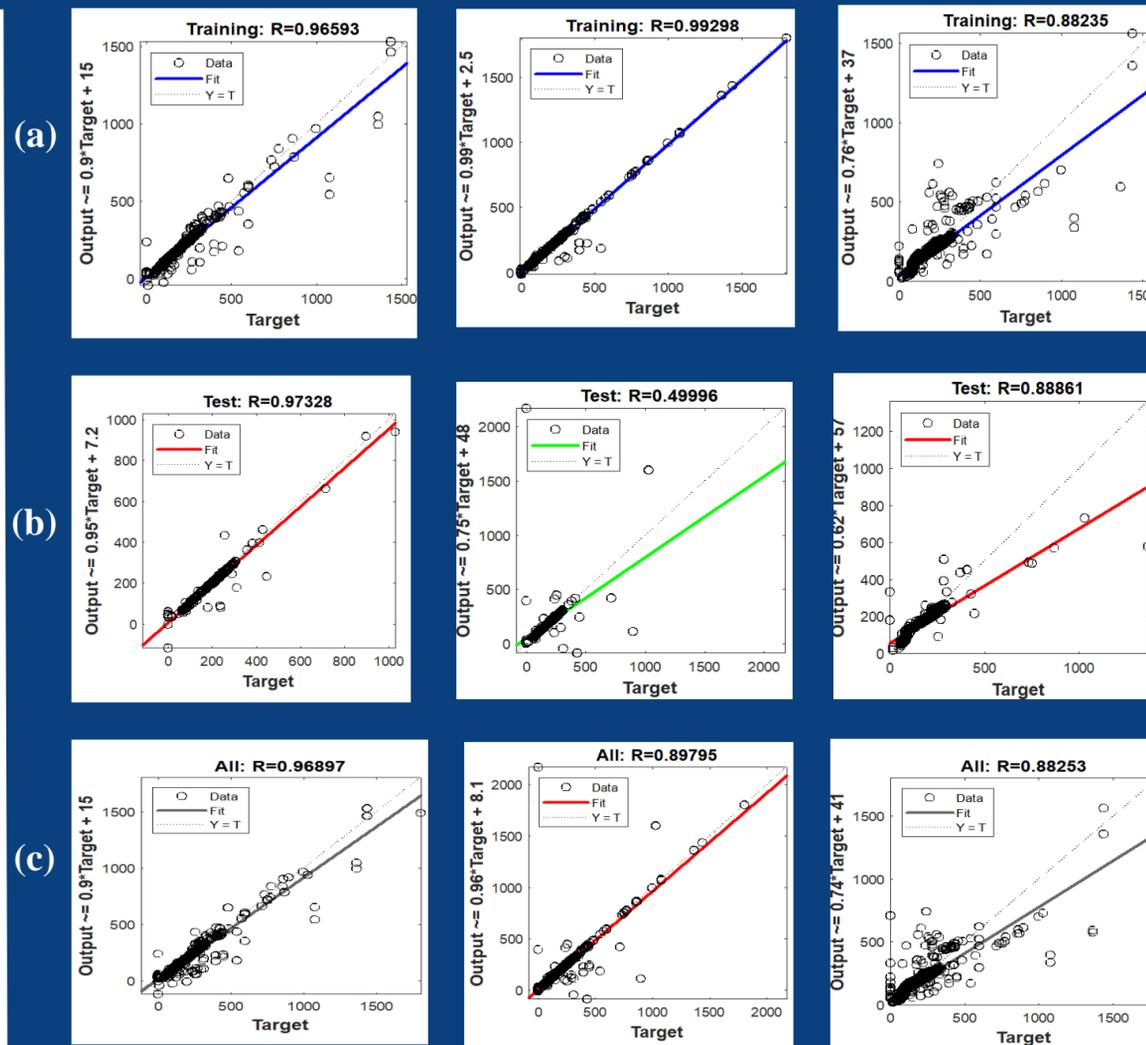
Conclusion

- Radiation safety principle (ALARA), which stands for As low as reasonably achievable. It is done by three basic protective measures in radiation safety:
1. Time to minimize the exposure.
2. Distance increase the distance from radiation source.
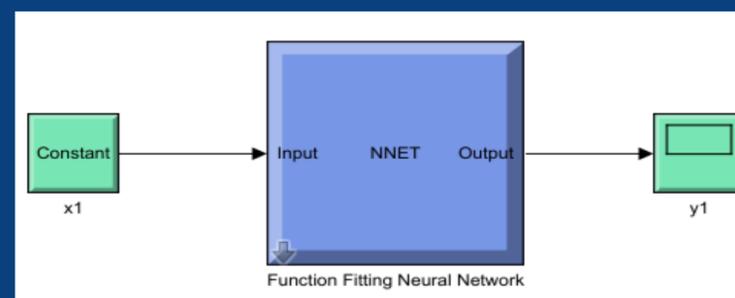3. Shielding use appropriate shielding.

- The Levenberg-Marquard based learning algorithm has the highest prediction rate of DLP values from chest CT Scan.

References

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