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A COMPREHENSIVE STUDY: ANALYZING THE DEVELOPMENT OF ARTIFICAL NEURAL NETWORK ARCHITECTURES WITH VARYING NEURON SIZES

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Abstract

Air pollution poses a dire global crisis that requires effective management strategies. One of the most promising methods is the utilisation of air quality prediction techniques. Recent studies have demonstrated the potential of artificial neural networks (ANNs) in accurately forecasting air pollutants. To delve deeper into this, a comprehensive study encompassing a 10-year period was conducted, focusing on the study area. The meteorological and pollution parameters for the model development were selected using Principal Component Analysis (PCA) and Cluster Analysis of meteorological and pollution parameters. The Output for PCA consists of a) Descriptive statistics b) Correlation matrix c) Rotated Component matrix. For all the four seasons KMO test sampling adequacy is found to be higher than 0.5, and Significance from Bartlett's test is lesser then 0.00 which implies the analysis is satisfactory. Whereas the output for Cluster analysis consist of Dendrogram, which helps in identifying a meaningful subgroup. For further validity the results of PCA and CA were compared. A total of 108 artificial neural network (ANN) models were developed based on the selection of input data by accuracy and efficiency. These models varied in the number of neurons, with sizes of 10, 15, and 20, each using different sets of data. The research utilized a two-layer neural network model employing the non-linear time series prediction and modelling tool (ntstool). The standard NARX network structure consisted of a two-layer feedforward network with a sigmoid transfer function in the hidden layer and a linear transfer function in the output layer. However, only 21 models demonstrated compatibility with the R and MSE values, with the data producing the minimum error being deemed compatible. Interestingly, it was noted that the MSE and R values showed no significant changes for models with 15 and 20 layers, leading to the decision to halt the modelling process after 20 layers. The study used MATLAB software to analyse the accuracy of model predictions. Three plots were used: Performance, Error histogram, and Response plot. The error histogram indicates positive or negative test results. During summer, certain parameters had positive histograms, indicating lower values than targets. Post-monsoon, CO, NOx, and VOC parameters had positive histograms, while PM and Xyelene parameters had more negative errors. Winter season showed positive histograms for CO, NOx, SO_2, Benzene, and Toluene.

Key words: Artificial Neural Networks, air pollution, MATLAB, neurons, prediction

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