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Selection of Important Input Parameters Using Neural Network Trained with Genetic Algorithm for Damage to Light Structures

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The Building Housing Commission owns and manages over 73,000 properties across Victoria. Over 30 percent of the properties are over 30 years old and most have reached the age at which they require major refurbishments or demolition. Over 200 damage reports are conducted annually with budget of $1M/annum. The problem of deterioration of the housing stock is being assessed through research being conducted by Swinburne University of Technology. A series of studies of the deterioration of the housing stock have been made. Some with a view to determine the type and amount of work by the building trades to rehabilitate the property and others with the objective of discovering the problem and finding an engineering solution. A database has been proposed and developed based on the reports from the Building Housing Commission. The problem addressed in this paper is that of determining the influence of the input parameters causing damage to light structures with regards to changing conditions (i.e. climate) and establishing a uniform system of data capture that best describes the parameters leading to the deterioration. Two databases incorporating missing and complete parameters based on the existing database are described and the parameters influencing the deterioration are explained and ranked.

A neural network trained with a genetic algorithm was used. More than 600 reports dating back from 1980 to 2003 were reviewed and incorporated into the proposed database. A hybrid function and roulette selection mechanism were used in the genetic algorithm. A two layer neural network with eight input nodes, one hidden layer with five neurons and one output layer was adopted for the "original" network. A supervised feedforward backpropagation with log-sigmoid as the activation function for both the input to the hidden layer and the hidden layer to the output layer were adopted. The initial weights for neural network were generated in the genetic algorithm. The eight input parameters adopted in the network are region (R), construction wall (CW), construction footing (CF), age, vegetation (V), geology (G) and climate; Thonthwaite moisture index 1940-1960 (TMIO) and Thonthwaite moisture index 1960-1990 (TMIN). Damage condition is the output parameter. The performance error of the network for the database with complete parameters shows a lower performance error of 0.04 compared to 0.06 for the database with missing parameters. Eventhough the neural network can handle databases with missing data, it performs better when it is trained with a complete database.

The sensitivity of the input parameters was determined using the clamping method, connection weights analysis and Garson's algorithm for both databases. The performance of the "original" network is compared with four networks. Two networks have the TMIO parameter and TMIN parameter clamped using their mean values respectively. The other two networks have another input parameter added to the existing eight original input parameters. One with a dummy input parameter to prove that the input parameter has no effect on the generalisation performance of the network. The other network is a substitution from the dummy input parameter to the Chg TMI input parameter, where Chg TMI is the difference between TMIO and TMIN. The generalisation performance and the impact ratio of all the networks were calculated. A larger impact ratio indicates that the particular input parameter is more important and has a stronger impact on the output. From the results obtained the dummy input parameter and the clamped TMIN parameter have less impact on the network output since they fall in the second last ranked of the input parameters. Chg of TMI parameter and clamped TMIO parameter have more impact than the clamped dummy parameter and clamped TMIN parameter. This indicates that they are more significant as they influenced the other input parameters in the network. Therefore, based on the results obtained, there are four distinct important input parameters. These are construction wall which is ranked first followed by construction footing, geology and Chg TMI. The results also indicate that, the Chg TMI has an affect on both the TMIO and TMIN. This is proven in the result obtained using the Spearman rank correlation which determines the correlation between the input parameters. The result for the correlation between the clamped Chg TMI parameter showed that there are three strong correlations (TMIO, G and VC), four weak correlations (CF, R, TMIN, CW) and one without correlation (Age).

The results in this paper indicate that neural network and genetic algorithm have the ability to predict the important input parameters for damage to light structure when presented with any kind of data be it with missing or without missing attributes. The advantage of a neural network is that it can always be updated to obtain better results by presenting new training examples as new data becomes available. The genetic algorithm on the other hand is very useful in improving the learning process of the neural network.