Predicting External Curve Length of Horseshoe using Artificial Neural Network

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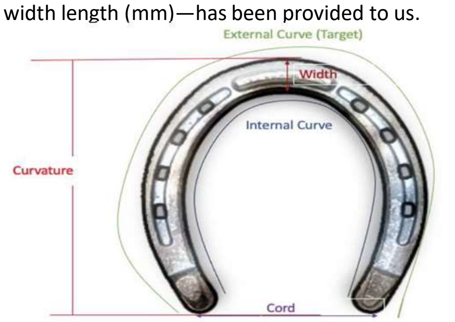
ABSTRACT

We have been asked to figure out a method to obtain the external curve length of a horseshoe given four distinct measurements from the Royal Kerckhaert Horseshoe Factory. It is essential to comprehend and accurately forecast the length of the horseshoe's exterior curvature in order to guarantee the horse's comfort and performance. Using the MATLAB neural network toolkit, a regression predictive neural network was developed as a solution to assist the Kerckhaert farriers in crafting the ideal size horseshoes for every individual horse. A dataset of 219 horseshoe samples with 4 (Inputs) different measurements—curvature (cm), internal curve (cm), cord (cm), and width length (mm)—has been provided to us.



After examining the information and findings, it is possible to draw the conclusion that the Horseshoe ANN is more than capable of accurately (94 + %) predicting the target output given 4 inputs. Consequently, the installation & implementation of an artificial neural network at the Royal Kerckhaert factory will improve the production of horseshoes quickly and precisely, with measurements that are exact.

Introduction

A horse's posture, pace, and general health will all be impacted by the exterior curve length of the shoe. Since a horseshoe can only be made for a maximum of two months, four must be made for a single horse every eight weeks. As such, it is essential that the farriers build it to the highest standard possible. Thus, the reason for this project originates from the need for accuracy in predicting the external length. In order to solve this issue more quickly and affordably, artificial neural networks and machine learning technologies will be used. I have developed a neural network-based regression predictive method using MATLAB, and it has produced excellent results in correctly predicting the external curve. I've played around with various functions, models, and hyperparameters.

The Horseshoe ANN designed is a feedforward neural network that is able to identify the three hyperparameters that have the lowest mean square error (MSE) value. The three hyperparameters are neurons, learning rate & epochs. The neural network will experiment with 27 possible configurations of these hyperparameters in total. We will identify the optimal hyperparameter combination that yielded the lowest MSE value after the testing is concluded.

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Best Neuron Number: 50
Best Learning Rate Value: 0.01
Best Epochs Number: 15
Lowest MSE Value Obtained: 0.0017
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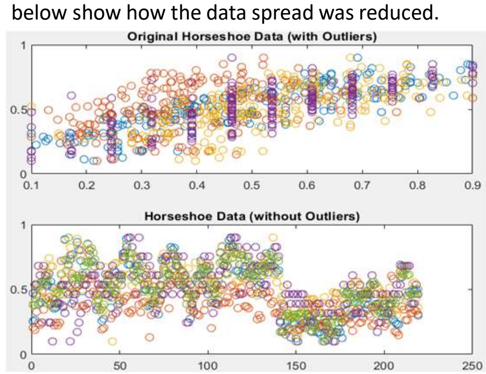
Methods

First, using MS Excel, the horseshoe data samples were normalised into a range of 0.1 to 0.9. Normalisation will enable faster convergence and better generalisation, which will improve the coefficient correlation (R) results.

Data has been split into 3 ways. The training set, comprising of 70% of the data, is crucial for the network to learn and identify patterns. Validation (15%) prevents overfitting, while the 15% testing set ensures unbiased analysis on unseen data, maintaining the neural networks' reliability.
The trainlm transfer function has been exercised. It offers a quicker convergence time as well as high generalization results (R value).

The neural network determines which samples are outliers in the horseshoe dataset provided, and then replaces those samples by estimating the value of the outliers using a linear interpolation method based on the remaining horseshoe values. Hence, reducing the impact that outliers have on the MSE and correlation coefficient values. The scatter plots below show how the data spread was reduced.

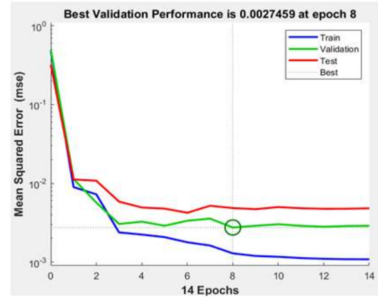


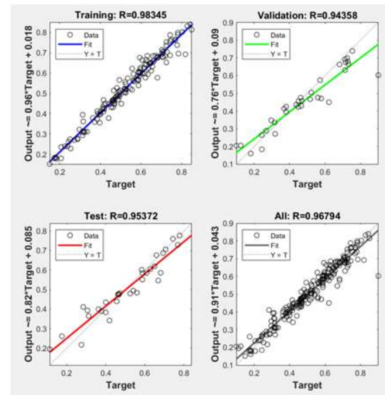
The dividerand and divideind are the two functions that were tested to divide the horseshoe data. Dividerand are distributed at random. Strong values were obtained. Allocating set samples is called divideind. This is where samples 1-153 (representing 70% of the data) are used for training. But because the outcomes were less favourable, I decided to use the random allocation (dividerand). Given that the horseshoe problem at hand is a regression problem, the linear functions were selected as activation functions. In the output layer, the function purelin was utilised and poslin was selected. Stable convergence is achieved during training of the neural network by optimising these two functions.

Various topologies underwent testing. The neural network's complexity increased with more than one hidden layer, which increased the training and testing times. In the business world, acquiring results quickly is essential. Horseshoe ANN thus has one hidden layer. The farriers can now obtain measurements in under twenty seconds because of the reduction in complexity. Results obtained are still very high making it practical to be used.

The mean squared error (MSE) was selected as the evaluation metric. It is appropriate for the horseshoe ANN since it is more frequently used for regression problems. The confusion matrix was also extensively used in the research, but the results were poor and hard to understand because the confusion matrix is frequently used to solve classification problems.

Results





Runs	Neurons	Learning Rate	Epochs	Training R Value	Validation R Value	Testing R Value	MSE Values
1	50	0.10	15	96%	96 %	95%	0.17%
2	25	0.01	50	98%	91%	96%	0.17%
3	50	0.01	15	97%	97%	95%	0.19%
4	50	0.01	15	97%	93%	96%	0.18%
5	50	0.01	15	96%	94%	94%	0.18%
6	25	0.10	15	97%	90%	97%	0.19%
7	50	0.01	15	93%	96%	94%	0.17%
8	50	0.05	30	98%	93%	92%	0.18%
9	50	0.01	50	98%	96%	91%	0.18%
10	50	0.05	30	98%	95%	93%	0.18%

Mean Values
Testing = 97%
Validation = 94%
Training = 94%
MSE = 0.18%

Conclusions

The table of results shows the neural network's 10 runs, gathered the optimal hyperparameter combinations, and R values for training, validation, and testing. To sum up, the neural network has produced amazing results, with average accuracy of 94% + & MSE values of average 0.18% in both training and testing. These remarkable outcomes demonstrate how well neural networks generalise to brand-new, unseen horseshoe data. As a result, it proved to be efficient and accurate to determine a horseshoe's external curve, enabling Royal Kerckhaert Farriers to construct the ideal-sized horseshoes for every individual horse. The ANN's only drawback is that results are not instantaneous; they can take up to 20 seconds to be generated.

Key limitations established during the research and creation of the ANN was the need for a larger dataset & better quality of horseshoe samples (no outliers). The more samples Royal Kerckhaert can offer, the more effective the training becomes leading to improved generalization ability. Future recommendations would include providing more (400 +) horseshoe data samples as well as checking for outliers in data that might have occurred from faulty measurement equipment's or wrong readings. These two have a significant affect on results.