Fast Predictions with Extreme Learning Machines

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Why use ELMs?

- Lightweight and easy to use algorithm for training Single Layer Feedforward Neural network (SFLNs).
- Randomised approach avoids bias problems.
- Lower training times than other traditional techniques like Back Propagation.
- It is a linear training process.

Principle of Operation for ELM

- The basic training of ELM can be regarded as two steps: Random Initialization and Linear Parameter solution.
- ELM uses random parameters w_i and b_i in its hidden layer, and they are frozen during the whole training process.
- Moore-Penrose Inverse: A pseudo-inverse form of matrix which helps to compute the best fit solution to a system of linear equations which lacks a unique solution.

Training set: $\boldsymbol{S = [(x_i, y_i) | x_i \in R^n, y_i \in R^m, i = 1, \ldots, N]}$

Initialization:

Assign random values to hidden weight $\boldsymbol{w_i}$ and bias $\boldsymbol{b_i}$ and calculate the output matrix of hidden layer H using training set.

Analytical solution:

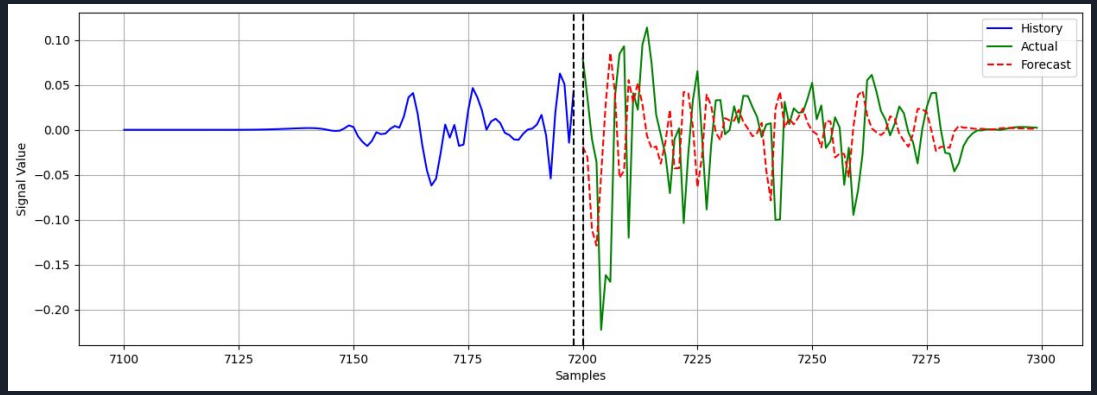
Obtain $\boldsymbol{\beta}$ from $\mathbf{H\beta = T}$ by Moore Penrose inverse. $\boldsymbol{\beta = H^{\dagger}T}$, where $\mathbf{H^{\dagger}}$ is the Moore–Penrose generalized inverse of matrix $\mathbf{H}$

Results Obtained

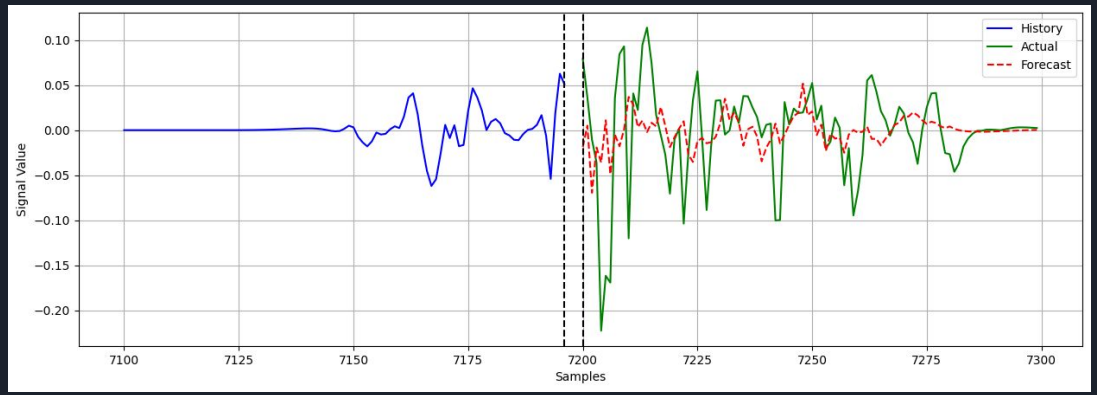
- The ELM Model was run for multiple time steps ahead ranging from 0 min (immediate) to 90 minutes ahead forecast horizons.
- The table below shows the results obtained:

Time (min)	RMSE	MAE	R^2 (%)
0	0.0203	0.0063	78.0397
5	0.0284	0.0088	57.2428
15	0.0427	0.0157	3.8489
30	0.0441	0.0162	-2.4288
90	0.0411	0.0137	11.7849

Forecast Plots



Immediate Forecast Horizon



90 minutes ahead Forecast Horizon

Conclusion

- It can be observed that the ELM Model performs better than all the model used in this project.
- The randomised process helps to better generalise the complex time varying data.
- Single Layer of hidden neuron significantly cuts down the training time of the model.
- Future Work: ELMs can be combined and modified further to better suit different situations of machine learning problems.

Thank you