INESC TEC - Report I

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1 Introduction

This report contains the experiments and results of the task to predict the features in table 1, given the input on table 2. Both originate from the modified IEEE case 24, as present on figure 2. The input dataset contains 8760 instances.

Feature	mean	std	max	min
Magnitude tensão barramento 11	0.996	0.022	1.035	0.952
Magnitude tensão barramento 12	0.997	0.021	1.033	0.954
Magnitude tensão barramento 24	0.993	0.022	1.022	0.950
Potência ativa injetada barramento 11	44.794	32.319	159.904	-27.532
Potência ativa injetada barramento 12	65.017	46.834	233.979	-45.061
Potência ativa injetada barramento 24	98.532	53.707	261.649	-29.155
Potência reativa injetada barramento 11	-15.602	11.060	16.029	-34.601
Potência reativa injetada barramento 12	-3.120	15.984	-30.759	47.883
Potência reativa injetada barramento 24	25.756	10.809	57.933	-0.197

Table 1: Predicted features' description

Feature	mean	std	max	min
Carga subrede de 138 kV	894.463	154.940	1332.000	551.537
Potência solar gerada subrede 138 kV	254.433	152.138	547.328	1.193
Potência eólica gerada subrede 138 kV	138.489	170.325	416.505	0.000
Carga subrede de 230 kV	1080.104	171.249	1518.000	649.787
Potência solar gerada subrede 230 kV	115.776	86.384	362.113	0.787
Potência eólica gerada subrede 230 kV	47.634	66.786	229.942	0.000

Table 2: Input features' description

2 Methodology

An ensemble of neural networks was built to address the issue of predicting each feature in table 1. For each feature, a netural network was trained. Variations of this architecture was tested, e.g, a single neural network for each of the feature groups, "Magnitude tensão", "Potência ativa injetada" and "Potência reativa injetada", however, the error was always bigger than the final used architecture.

Initially, each feature was predicted with solely the six input features, however, features "Potência ativa injetada" and "Potência reativa injetada" did not achieve acceptable results, therefore, another architecture just for both of them was designed. As input, apart from the already present six input features, the respective predictions of the "Magnitude tensão" features was used, therefore, nine columns were available. The decision was based on the low RMSE error from the "Magnitude tensão" features, meaning that the predictions could be used as the actual values with a relatively high confidence. Figure 1 contains the final architecture.

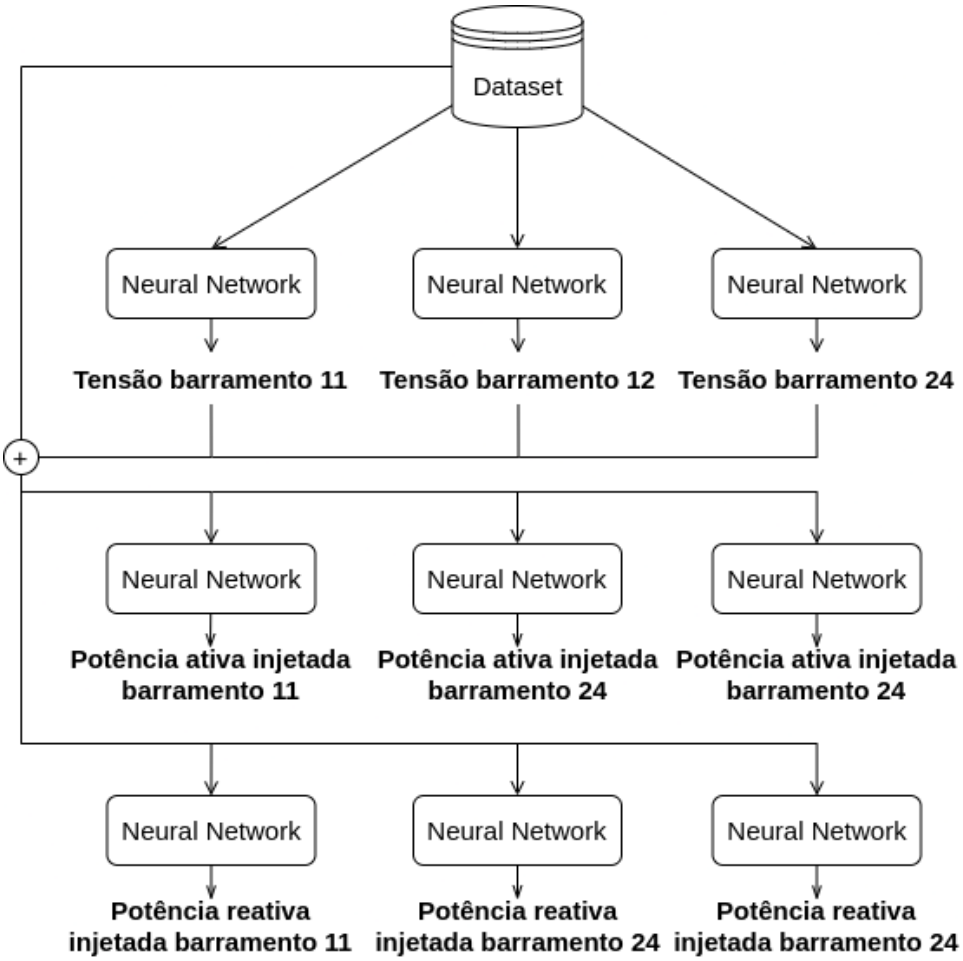

Figure 1: Architecture

Each of the nine neural networks were identical, consisting on a Multilayer Perceptron with the layers as follows:

- Input Layer / 21 neurons
- Hidden Layer / 441 neurons / ReLU activation function
- Dropout Layer / 0.2 rate
- Hidden Layer / 21 neurons / ReLU activation function
- Dropout Layer / 0.2 rate
- Output Layer / 1 neuron

For the hyperparameters, the epoch count was set to 20 and the batch size to 10. An early stopping mechanism was also present and set to 10 epochs. The Adam optimizer was used and the MSE (Mean Squared Error) as the loss function.

3 Results

Since the models are stochastic, they were executed 10 times and the average of the errors taken. Table 3 contains the results.

Feature	RMSE
Magnitude tensão barramento 11	0.0077
Magnitude tensão barramento 12	0.0079
Magnitude tensão barramento 24	0.0076
Potência ativa injetada barramento 11	2.565
Potência ativa injetada barramento 12	4.584
Potência ativa injetada barramento 24	6.497
Potência reativa injetada barramento 11	4.532
Potência reativa injetada barramento 12	4.961
Potência reativa injetada barramento 24	3.564

Table 3: RMSE results

Initially, the RMSE may be interpreted as high, however, once the standard deviation and range of each feature is taken into account, the error can be seen as low. For example, "Potência ativa injetada barramento 24" has a range of 290.804 and a standard deviation of 53.707 (also the biggest among the features), therefore, a RSME of 6.497 is enough. The same follows for the other features, the biggest the standard deviation, the biggest the RMSE.

The lowest RMSEs are from the "Magnitude tensão" features, and as already mentioned, helped increase the accuracy of the remaining features by being used together with input dataset.

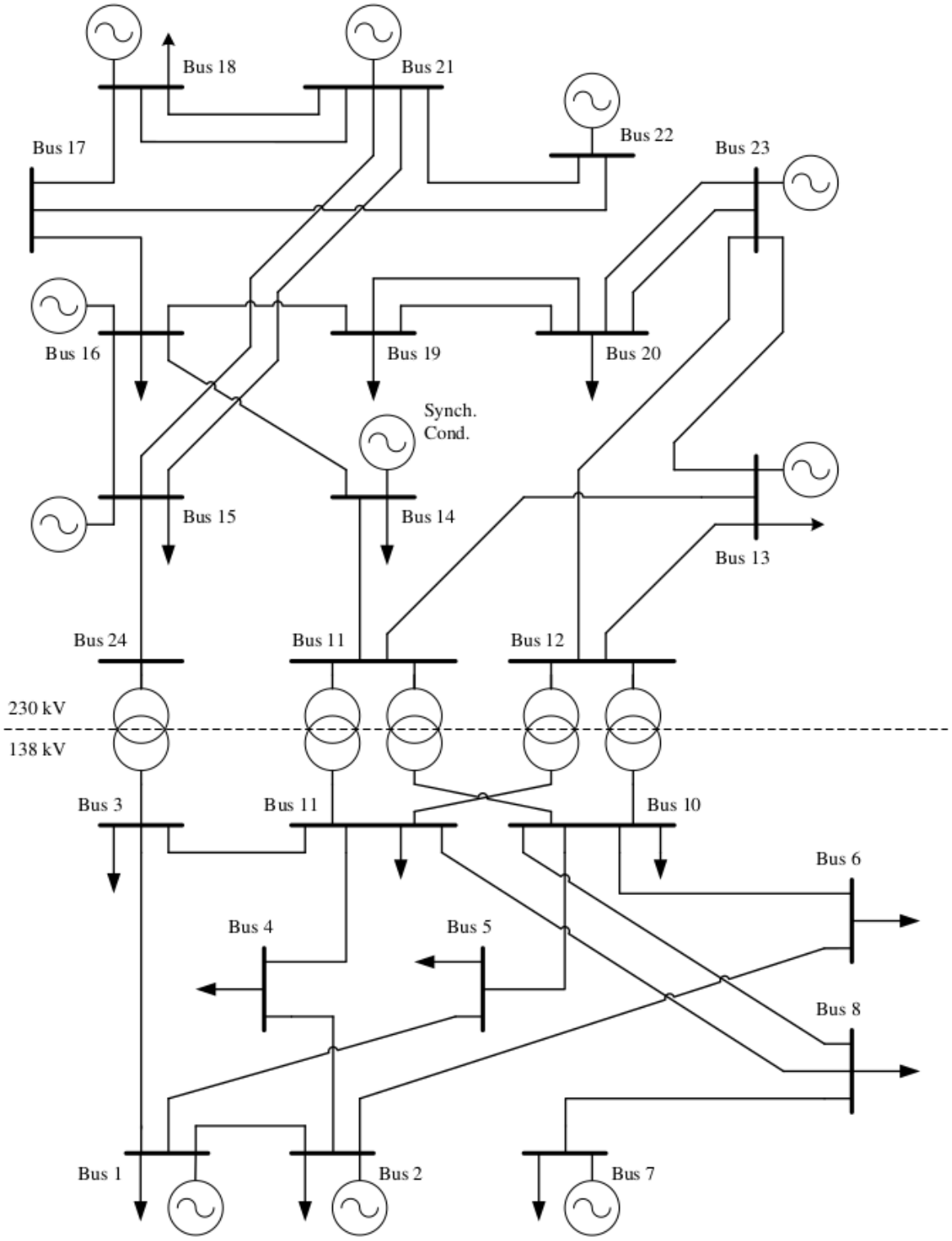

Figure 2: Modified IEEE case 24