EEG curiosities – follow-up

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Abstract

To further examine the results presented in *EEG curiosities* the EEG data was normalized and then visualized using t-SNE as well as trained on a neural net once again. Furthermore, data of several other participants and series has been tested in the same manner.

1 Revisiting *Participant 1, Series 1*

The EEG dataset of *Participant 1, Series 1* was normalized to a range of values between -1 and $+1$. Then another t-SNE plot was created to determine if this had any effect. Figure 2 shows the result and no obvious difference compared to the previous runs without normalization.
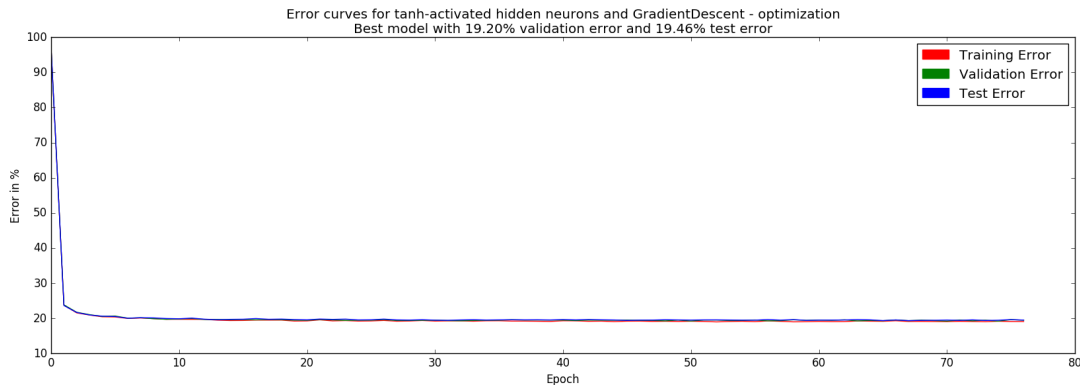

Figure 1: Classifying participant 1, series 1 trials using a feedforward neural net

The now normalized data was also run through a feedforward neural net, trying to classify the various trials. Using the following settings, an error on the validation set of 19.20% and en error on the test set of 19.46% was achieved, which is a slight improvement over the best run without normalization:

- Hidden Layer: 1
- Input neurons: 32
- Hidden neurons: 300
- Output neurons: 34
- Activation function: tanh
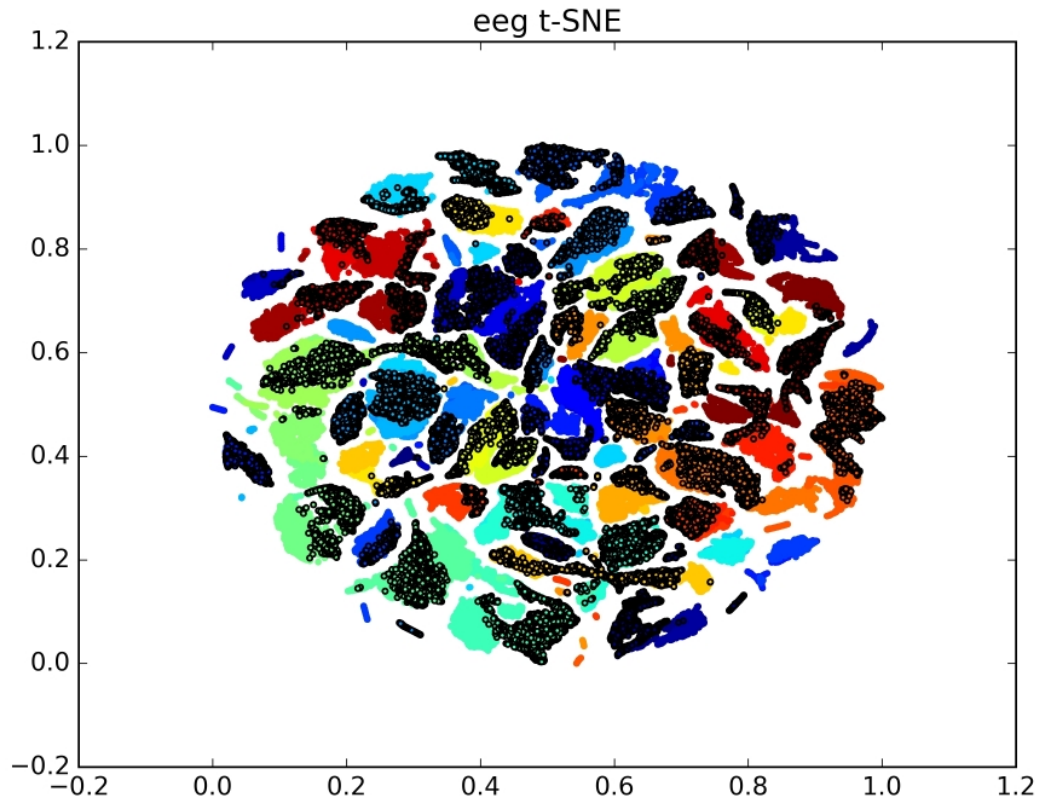- Optimizer: Gradient Descent

Figure 2: t-SNE plot for normalized participant 1, series 1 EEG data

A plot of the resulting error rates is shown in figure 1

2 Analyzing data of other participants and series

A random selection of datasets of other participants and series was chosen and the same procedure as before was applied to them. That is, for each dataset a t-SNE plot as well as a neural net run was performed. In the following the t-SNE plot and neural net results for *Participant 1, Series 1* will be used as a reference, the new tests will be compared to. One may have to emphasize, the very extreme error rates noted in the table are NO typos. The results are shown and briefly discussed in table 2. The images were cropped down for better readability. Bigger versions are attached as separate files.

3 Conclusion

Normalizing the datasets did not make any notable difference for participant 1, series 1. Running the same test on other participants and series revealed rather insane results. The trials of some of those sets could be classified basically perfectly. As these results are hard to believe, it is worth to mention once more that the correct function of both the t-SNE script as well as the neural net had been checked multiple times again using, inter alia, the reference datasets introduced in the previous paper.
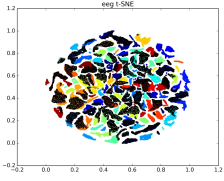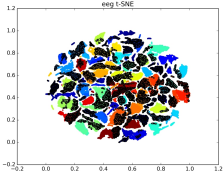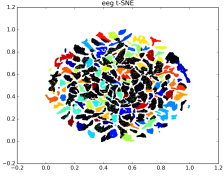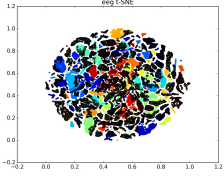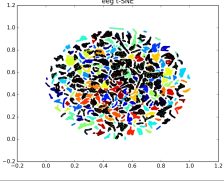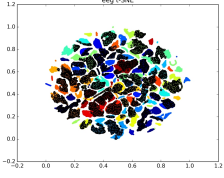
t-SNE plot	Dataset	Test error	Comment
	Participant 1, Series 2	0.08%	In the t-SNE plot the data is even better separated. The neural net can perfectly classify the trials (0.08% is not a typo)
	Participant 4, Series 9	16.75%	Not as well separated data with correspondingly worse performance on the neural net.
	Participant 6, Series 3	0.04%	Clearly separated data, which leads to extremely good performance on the neural net.
	Participant 7, Series 8	29.99%	Significantly more overlapping areas in the t-SNE plot. This is also reflected in the much worse error rate.
	Participant 9, Series 5	0.03%	Clearly separated data. Compared to other plots very many but small clusters are formed. The extreme error is again NOT a typo.
	Participant 12, Series 2	0.11%	Again clearly separated data and extreme error rate.

Figure 3: Running the same tests on various participants and series