Neurophysiological Data Analysis
Assignment 2.

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The aim of our second assignment of the *Neurophysiological Data Analysis* course is the correlation analysis of an ECoG recording. Our task was to reveal the changes in correlation structure between channels of the recording during different phases of an epileptic seizure. We had to work with the previously used *.mat* file. For the data process, I used *MATLAB*.

A review of the previous part of the analysis

The given recording contains 43 channels, and its total length is 226 s. Based on Figure 1 the duration of the seizure was about 30 s, from 90 s to 120 s. Its center was somewhere near to the 16th channel

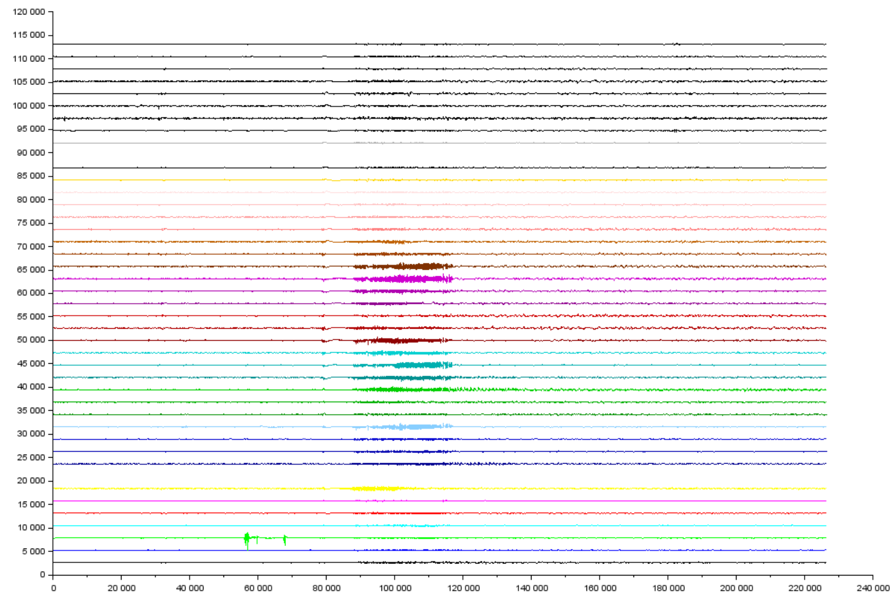

Figure 1: Visualization of the ECoG data looking at the channels individually

Correlation

Correlation is a statistical value that shows the linear relationship between two values. If the correlation of two numbers is zero, it means that they are not correlated, thus independent, there is no relationship between them. The greater the correlation, the stronger the dependence.

The correlation analysis of the data

As a first step, I calculated the correlation matrix of the entire data.

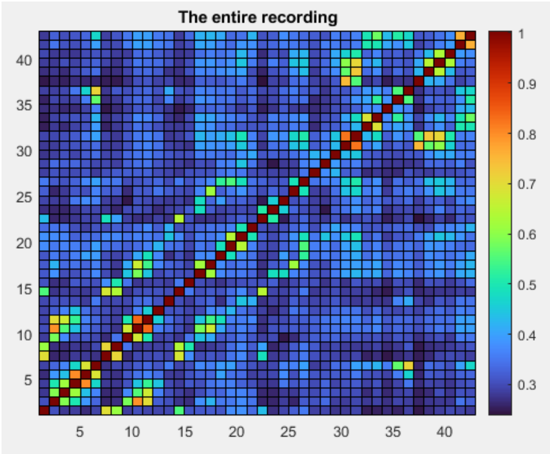

Figure 2: The correlation matrix between 1 - 226 s.

We can see that it is a symmetric matrix, because $corr(x_i, x_j)$ is always equal to $corr(x_j, x_i)$. Besides that, we cannot observe any noticeable, significant properties, regarding the seizure, so we have to check the data phase by phase.

As the next step, I checked the correlation matrices in the different stages of the recording, using my previous analysis. Then I compared the results. I used 20 s long phases.

First, I looked at the correlation matrix before the seizure, at the beginning of the recording, between 1 - 20 s. The result is shown on figure 3.

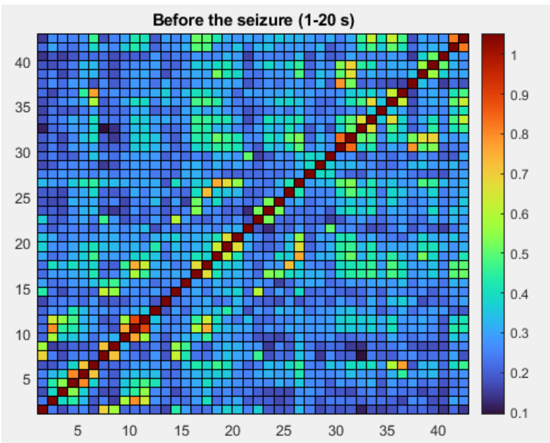

Figure 3: The correlation matrix between 1 - 20 s.

We can not see any significantly strong correlations, only smaller dots near the diagonal. It can be explained by the fact, that closer channels have a higher possibility to be strongly correlated.

As the next part, I checked the correlation matrix during the seizure, between 95 - 115 s. (Figure 4.)

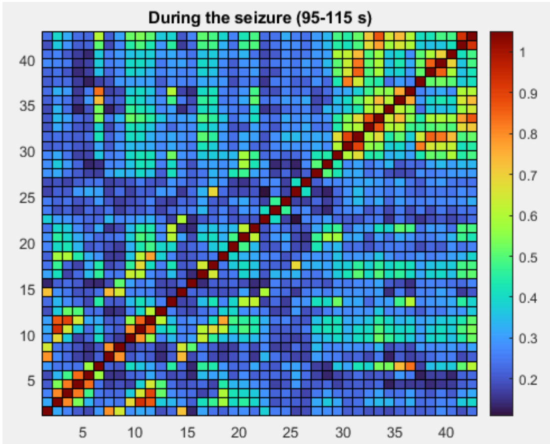

Figure 4: The correlation matrix between 95 - 115 s.

As we can see, there are more darker spots with strong correlation. When a seizure happens, it propagates in a wavelike manner, so we can notice a greater connection between areas in the same phase. This is called periodic correlation.

Finally, I checked the data, after the seizure, near the end of the recording, between 180 - 200 s. (Figure 5.)

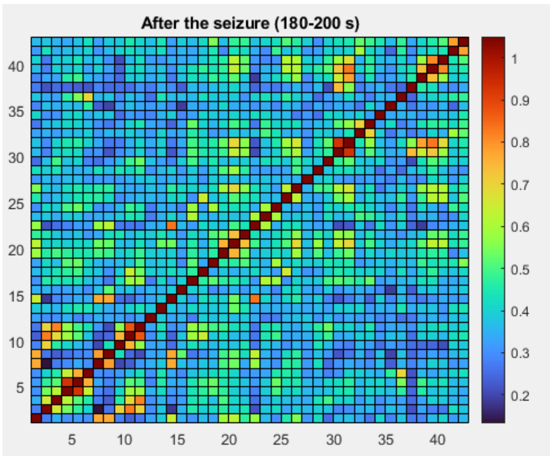

Figure 5: The correlation matrix between 180 - 200 s.

It is really similar to the correlation matrix before the seizure, we do not notice any significant spots.

Conclusion regarding the dynamics of the seizure

As the last part of the analysis, I checked the channels' correlations individually with the total correlation through the whole recording. This way we can observe the temporal changes. (Figure 6.)

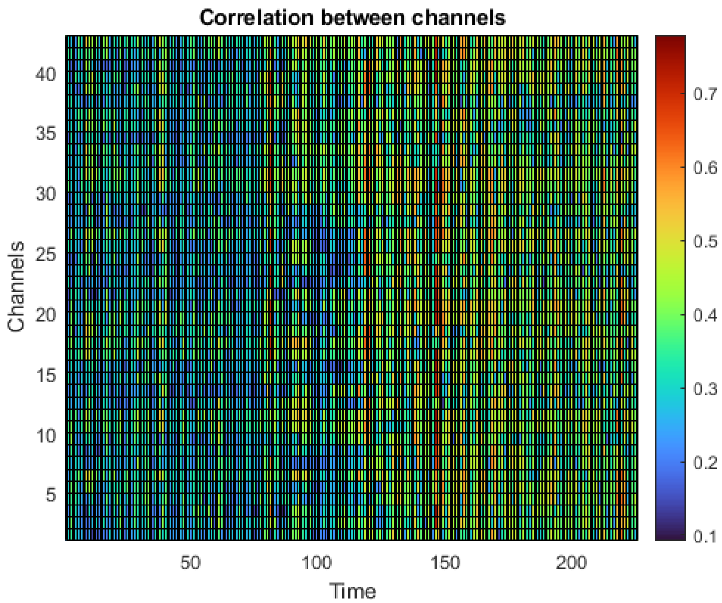

Figure 6: The correlation of the channels one by on with the total correlation strength through the entire recording. The time is shown on the x axis, while the channels are represented on the y axis.

If we look at the diagram, we can notice a clear red line at around 85 seconds, meaning that there is a strong correlations between channels at that phase. This also verifies the results of the previous analysis. There is no significant event before around 80 s, than there is a sharp change in the correlation dynamics, meaning that the seizure occurred there. Then, it lowers again by the end of the recording.