Nonlinear correlations in EEG signals

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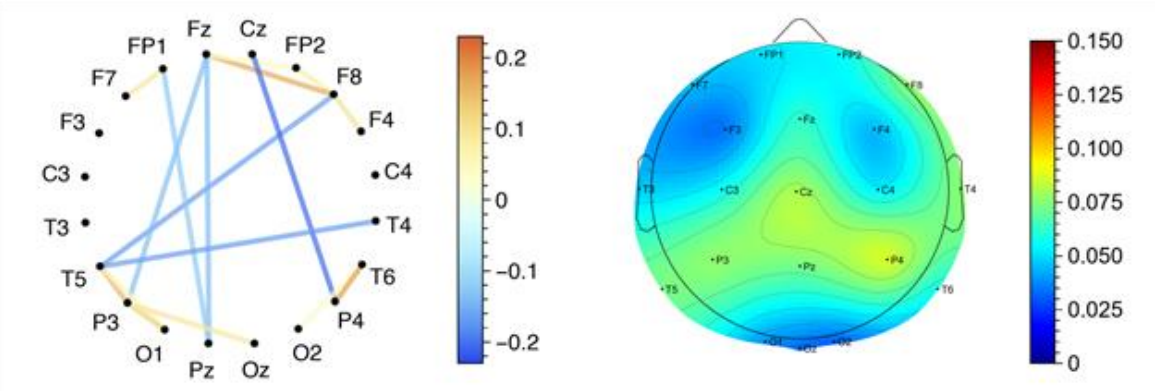
The multiscale methodology is one of the primary methods for studying complex systems and analyzing complex time series, which are undoubtedly EEG signals from the human brain [1]. In the study, statistical analysis of the EEG data recorded during the resting state was performed for patients of the same age 30-40 with multiple sclerosis and the corresponding control group. The idea of the research was to examine differences in nonlinear cross-correlations, measured by the q-dependent detrended cross-correlation coefficient ρ(q,s) [2], between brain regions represented by electrodes for various factors such as the duration of the disease, the stage of the disease, which is measured by the Expanded Disability Status Scale (EDSS), and medications administered during treatment. The results presented in Fig contain the connections between two electrodes that exist, when the difference between the two groups for these electrodes is statistically significant. The most significant differences are observed in the case where correlation matrices for patients in different stages of the disease (quantified by EDSS) with EDSS>1 and with EDSS<=1 are compared. Differences between groups of patients who were being treated with Tecfidera, and patients who were being treated with Interferon. Furthermore, the the fractal and multifractal properties of the EEG time series for 20 representative electrodes were also studied by using a multifractal detrended fluctuation analysis [3]. These measures can quantitatively describe the persistence and complexity of the considered time series [4,5]. Looking at the differences in the width of the multifractal spectrum and Hurst exponent values, it was possible to distinguish between the stage of the disease and the type of drug. There was almost no difference when the duration of the disease was taken into account. All observed differences were stronger in the phase of the experiment with closed eyes, which may be related to the delta waveform. It is also worth noting that the highest differences were observed in the time scale range s = 200ms−2500ms (5Hz−0.4Hz), which corresponds to the delta wave.



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