Doctoral School: **Biology Doctoral School**
Doctoral Program: Neuroscience and Human Biology

Subject code: **BIO/7/58**
Subject title: **Data analysis in neurophysiology PR**
Teacher and Neptun code: **Dr. Somogyvári Zoltán (V7T8WL)**
Credits: 4
Class hours: 2 hours/week, practical

Aims of the course
The aim of the practical course is to present the analysis methods used to process the measurement data obtained during neurophysiological research, through the examples of some specific software.
Contents of the course
1. Statistical conclusion and its errors. Presentation of errors often made in statistical conclusions and their possible avoidance, multiple comparisons, publication bias, data selection bias.
2. Origin and modeling of neural electrical signals. Derivation and properties of the Hodgkin-Huxley equations, multicompartmental models, and extracellular space of neurons.
3. Regression, correlation coefficient, cross-correlation function and event-bound averaging. The simplest methods for determining the relationships between two datasets, properties and shortcomings of the linear correlation coefficient.
4. Fourier transformation, spectrum and filtering, Wavelet transformation, cross-spectrum and coherence. Principles of the Fourier transform, orthonormalized vector bases, base transformations, properties and types of Wavelet bases, properties and types of filters.
5. The R statistical software package. Demonstration of the use and advantages and disadvantages of the R statistical software package through examples, basic statistical tests, one-sample and two-sample tests, ANOVA.
6. Mutual information, ARMA models, Granger causality, transfer entropy. Information theory measures and their use to detect nonlinear relationships between data sets using the Wiener-Granger causation principle, directional relationship detection with causality analysis.
7. Phase space reconstruction, attractor dimension, Sugihara causality. Phase space reconstruction from the measured data using the Takes delayed embedding theorem, the concept of fractal dimension and methods of measurement, causality in dynamic systems.
8. Introduction to the Python programming language. Demonstration of the use and properties of the Python programming language with simple data analysis applications on electrophysiological example data.
9. Principal component and independent component analysis (PCA, ICA, ISA). The cocktail party problem and its possible solution methods, the assumptions of the main and independent component methods and their solution methods, independent subspace analysis.
10. Clustering, K-means, spike sorting, gaussian mixtures, Model fitting, Bayesian information criterion (BIC), Expectation-Maximization. The basic task of the classification, its implementation methods and application to recognize the action potentials of individual neurons, the basic task and methods of model fitting, the determination of the optimal model complexity.
11. Imaging methods, CT, MRI. Extraction of spatial information from data, solution of under- and over-definite inverse problems based on X-ray computed tomography and fMRI imaging methods.
12. Source determination, dipole fitting and subspace methods (MUSIC), imaging procedures, Laplace, LORETA, CSD. Source determination based on electrical measurements, linear and nonlinear inverse problems and their solution methods, regularization.
13. Project presentations and their evaluation 1.
14. Project presentations and their evaluation 2.
Requirements
Project work and written test.

Literature

lecture slides are available