Topics in Time series analysis WS 24/25

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September 16, 2024

Course goals and key learning objectives: This course focuses on multivariate, particularly high-dimensional, time series, which can serve as models for large, complex systems evolving over time. The syllabus outlines the topics to be covered, which include several modern statistical approaches, such as sparsity and penalized estimation, factor models, PCA and related methods, models for discrete data, and neural networks, all adapted to the more challenging context of temporally dependent multivariate and high-dimensional data.

The course will emphasize methodology and theory over data analysis, though illustrations may be included as time and preparation allow. Several applications will be considered throughout. In the first part, which covers mainly continuous-valued linear models, applications will include fMRI data for modeling brain activity and financial or economic time series. In the second part, which addresses discrete-valued models, the focus will be on link dynamics in temporally evolving networks and categorical responses recorded for individuals over time.

Target audience: Master students and advanced Bachelor students in Mathematics, Data Science, Computer Science, Economics.

Prerequisites: I will assume that you have seen basic linear algebra (matrix manipulation, eigenvectors, eigenvalues, etc.), basic probability (multivariate random variables, covariance, correlation, etc.) and statistics (multivariate regression, maximum likelihood estimation, hypotheses testing, etc.). Familiarity with real analysis (especially Fourier transforms) might also be helpful for certain topics. From the computing side, I expect that you are familiar with R or Python (or can pick up their basics quickly).

List of Topics

- Sparse vector autoregressive models
- Dynamic factor models
- Estimation and testing (Graphical Models)
- Non-stationarity
- Discrete-valued time series
- Neural network models such as RNN, LSTM and variants

The course is available for students who major in Mathematics, Mathematics in economics, CAM, and Data Science.