IE 598AC Syllabus

Statistical Inference for Stochastic Systems with Long Memory

Instructor: **Alexandra Chronopoulou**
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Class Time: T/Th 9:00AM – 10:20AM
Office Hours: T/Th 2:00PM – 3:00PM (*or by appointment*)

Course Objective

The focus of this course is on the probabilistic and statistical properties of stochastic processes that exhibit long memory (or long-range dependence). Specifically, we will study limit theorems for processes with long-memory and consider the problems of parameter estimation and filtering in fully and partially observed stochastic systems with long-memory. Applications of these models will also be discussed, with a particular focus on Mathematical Finance.

By the end of this course, students will be able to:

– identify the presence of long-range dependence in time-series data
– use processes with long-memory as models in different applications.
– estimate parameters in such models.

Prerequisites

Master level course on Stochastic Processes, and ideally on Probability Theory.

References

1. *Long-Memory Processes: Probabilistic properties and statistical methods* (2013), Beran, J., Feng, Y., Ghosh, S., and Kulik, R., Springer.

2. *Statistics for Long-Memory Processes* (1993), Beran, J., Chapman and Hall.

Grading

50% Homework: There will be 2-3 homework assignments throughout the semester.
50% Paper Presentation: The students will be responsible for an in-class presentation of research paper(s) related to the topics discussed in class.

IE 598AC Topics

Main Topics:

1. *Introduction to Long-Range Dependence (LRD):* Origins, definition and applications.
2. *Limit Theorems for Long-Memory Processes:* Limit theorems for sums with finite moments (ARCH(∞), LARCH models); sample covariances; quadratic forms.
3. *Parameter Estimation for LRD Processes:* Heuristic estimation of long memory. Exact and approximate maximum likelihood (Whittle) method, Method of moments. Non-parametric methods (variations-based and wavelets).
4. *Non-linear Models with LRD:* Inference for partially observed models, LARCH and ARCH(∞) processes.
5. *Forecasting for Linear Processes:* Forecasting for fractional ARIMA and FEXP processes.
6. *Simulation Methods for LRD Processes*: Exact and approximate techniques for simulation: Wood-Chan algorithm, Wavelet approach, etc.
7. *Application to Mathematical Finance:* Long memory and rough stochastic volatility models.

Additional Topics (depending on students' interest):

- *Continuous-time LRD processes:* Fractional Brownian motion (definition/ properties), Fractional Ornstein-Uhlenbeck process.
- Drift estimation for linear fractional SDEs.
- Filtering for continuous-time LRD models.
- Applications to queuing theory with heavy-tailed input.