CIVIL-606

Inference for large-scale time series with application to sensor fusion

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Cursus	Sem.	Type
Civil & Environmental Engineering		Opt.

Language of teaching	English
Credits	2
Session	
Exam	Oral presentation
Workload	60h
Hours	**30**
Courses	12
Exercises	8
TP	10
Number of positions	

Frequency

Every 3 years

Remark

Next time: Spring 2025, block course

Summary

Large-scale time series analysis is performed by a new statistical tool that is superior to other estimators of complex state-space models. The identified stochastic dependences can be used for sensor fusion by Bayesian (e.g. Kalman) filtering or for studying changes in natural/biological phenomena.

Content

Linear dynamic systems
- state-space notation and propagation of errors
- modeling of sensor errors and state vector augmentation
- the need for stochastic model identification and parameter estimation in Bayesian filtering

Time series fundamentals
- measuring dependence, examples
- stationarity and fundamental representation
- ARMA models

Properties of estimators
- extremum estimators
- Maximum Likelihood
- Generalized Method of Moments
- consistency and asymptotic normality

Allan Variance
- Allan Variance definition, properties and estimation
- Allan Variance-based estimation of stochastic parameters

Generalized Method of Wavelet Moments (GMWM)
- wavelet variance
- GMWM estimator and its properties
- model selection

GMWM Extensions

- covariate-dependent models and examples
- multivariate-based modeling

GMWM usage
- 'R' and its GMWM package with documentation
- on-line computational platform
- examples

Keywords

Statistics, modeling, estimation, sensor-fusion, time-series, Bayesian/Kalman filtering, state-space models

Learning Prerequisites

Required courses

Linear algebra, basic signal processing, basic statistics, basic programming

Learning Outcomes

By the end of the course, the student must be able to:

- Calculate Allan/Wavelet variances from time time-series data
- Identify structure of latent stochastic processes within a time series
- Estimate model parameters together with its confidence intervals
- Apply estimated models in state-space estimation

Expected student activities

The lectures alternates with labs during 2 week block. Students then work on a 32h project (distributed data or -after an agreement - their own data). The evaluation is based on written project report that is presented first orally before its due date - 1.5 month after block end.

Resources

Bibliography

Applied Time Series Analysis with R: https://smac-group.github.io/ts/
An Introduction to Statistical Programming Methods with R: https://smac-group.github.io/ds/
Moodle: (TBD)

Notes/Handbook

Freely accessible website with "tutorial / exercises" and slides.
https://gmwm.netlify.com

Websites

- https://gmwm.netlify.com

Moodle Link

- https://go.epfl.ch/CIVIL-606