PhD course: Statistical Models

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This course will focus on advanced statistical models: parametric and nonparametric models accounting for dependence among observations and variables and for complex structures of data.

List of topics

- ✓ What is a statistical model

  - Path of discovery
  - Modelling approach
  - Two cultures
  - To explain or to predict

- ✓ Nonparametric statistics

  - Nonparametric estimation of distribution functions and quantiles
  - Jackknife and Bootstrap
  - Density estimation
  - Nonparametric regression: kernel smoother and local regression
  - Nonparametric regression: orthogonal series estimators
  - Nonparametric regression: splines
  - Linear smoothers
  - Multivariate local regression
  - Additive models

- ✓ Experimental design

  - Basic techniques: randomization, blocking, factorial designs.
  - Modern techniques: sequential design, bandits.

- ✓ Statistical models for high-dimensional data

- Empirical Bayes techniques

- Ridge Regression

- Lasso and its extensions

- Inference in the context of the lasso

- Graphical models

✓ Reproducible research and R best practices

✓ Random effects, multilevel models, hierarchical models

- Linear mixed models inference

- Generalized mixed models inference

- Diagnostic of mixed models

- Bayesian hierarchical models

- Generalized Estimating Equation

- Hierarchical GAM

- Nonlinear mixed models

✓ From linear to nonparametric regression

- Bayesian regression model with alternative prior specifications;

- Generalised linear models;

- Model selection & sparsity;

- Gaussian process regression;

- Examples.

✓ Time series models

- Multivariate regression models;

- Dynamic autoregressive models;

- Bayesian inference for autoregressive models;

- Prior shrinkage and variable selection;

- Factor analysis;

- Kalman Filter and State Space Models (Siem Koopman)