

# 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)