This course will provide an introduction to the theory behind a selection of statistical problems that play a key role in modern statistics. Most undergraduate statistics courses are restricted to the study of parametric models; here we will no longer assume that our distributions belong to finite dimensional classes and will instead study fundamental nonparametric problems such as the estimation of a distribution function, a density function or a regression function. We will also study minimax lower bounds, which characterise the intrinsic difficulty of a statistical problem, and provide benchmarks against which statistical procedures can be compared.

An outline of the course is as follows:


- Kernel density estimation: Definition, bounds on bias and variance, uniform nonasymptotic bounds on MSE and MISE. Bandwidth selection via least squares cross validation and Lepski’s method, choice of kernel, multivariate density estimation.

- Nonparametric regression: Local polynomial estimation, bounds on weights, bias, variance and MSE. Cubic splines, natural cubic smoothing splines, choice of smoothing parameter.

- Minimax lower bounds: Reduction to testing, \( f \)-divergences, Le Cam’s two point lemma, Assouad’s lemma, the data processing inequality, Fano’s lemma; examples.

**Pre-requisites**

A good background in undergraduate probability theory, elements of linear algebra and real analysis. Measure theory is not necessary but may be helpful; similarly for a preliminary course in mathematical statistics. Though the material in the Modern Statistical Methods course will not be needed here, the two courses complement each other well.

**Literature**

The lecturer is currently writing a book based on the course, and this should be available (if not published) in time for the course. Some of the material is covered in:


**Additional support**

Three examples sheets will be provided and associated examples classes will be given. There will be weekly office hours during Michaelmas and a revision class in the Easter Term.