Course Syllabus
Nonparametric Econometrics
CEU, Spring 2017

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Course level: Ph.D.
Credits: 2
Pre-requisites: Advanced Econometrics 2
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Office hours: by appointment

Course Description This econometrics field course is aimed at giving a brief introduction to the statistical theory of nonparametric density and regression function estimation. I discuss several statistical and econometric applications with cross-sectional (i.i.d.) data.

Learning Outcomes By successfully completing Nonparametric Econometrics students will be able to:

- Estimate a probability density function nonparametrically using a kernel density estimator
- Estimate a regression function nonparametrically using various methods (kernel, local linear, series)
- Perform basic bias-variance calculations, understand the bias-variance tradeoff fundamental to nonparametric methods
- Select the appropriate value of smoothing parameters in practice
- Apply these methods in various settings, e.g., in
  - estimating regression discontinuity models
  - estimating conditional average treatment effects
  - estimating sample selection models

Assessment (Tentative!) Two homeworks and a take-home final (30%, 30%, 40%)

Recommended texts [S] Silverman, B.W. (1986): *Density Estimation for Statistics and Data Analysis.* Chapman and Hall. This book is a classic. Obviously, it does not have the most cutting edge results and applications, but it is still one of the best, easy-to-read, and intuitive introductions into kernel density estimation.

[PU] Pagan, A. and A. Ullah (1999): *Nonparametric Econometrics.* Cambridge University Press. A very well-known text that covers many topics. Maybe a bit dated in terms of applications.

[Su] Su, L. (2011): *A Brief Introduction to Nonparametric Econometrics.* Lecture notes, Singapore Management University. A more technical but also more modern treatment of many different topics by a former classmate. I will make this available as a reader.

Articles These are required articles that I will discuss in the last two weeks of the course. I will add some recommended articles (*) to this list later on.

Abrevaya, J., Y-C. Hsu and R.P. Lieli (2015): "Estimating Conditional Average Treatment Effects," *Journal of Business and Economic Statistics*, 33, pp. 485-505.

Calonico, S., M.D. Cattaneo and R. Titiunik (2014): "Robust Nonparametric Confidence Intervals for Regression Discontinuity Designs," *Econometrica*, 82, pp. 2295-2326.

Das, M., W.K. Newey and F. Vella (2003): "Nonparametric Estimation of Sample Selection Models," *Review of Economic Studies*, 70, pp. 33-58.

Software The assignments will have problems that will require programming in Matlab. You can also use Stata or some other software if you prefer. I'll provide simple pre-written routines in Matlab to help you with this part of the course (e.g., I have code that implements the kernel density estimator or does local linear regression). These will be directly useful for solving homework problems, but you can also learn general programming trick from them. I won't provide assistance with Stata or any other software. The bottom line is that basic programming skills are required for the course.

Course Schedule

Lecture 1 Parametric vs. nonparametric statistical models. The histogram and the kernel density estimator. [S 1, 2.1-2.4, PU 2.2.1-2.2.3, Su 1.1.1-1.1.2]

Lecture 2 Statistical properties of the kernel density estimator. Bias-variance tradeoff. [S 3.1-3.3, PU 2.5, Su 1.1.3]

Lecture 3 Further statistical properties. Bandwidth choice in theory and practice. Kernel choice. [S 3.4, PU 2.4.2-2.4.3, Su 1.1.7]

Lecture 4 Multivariate kernel density estimator. Curse of dimensionality. [S 4, PU 2.8, Su 1.2.1-1.2.4]

Lecture 5 Some direct statistical applications of kernel density estimation. [PU 2.9, Su 1.3]

Lecture 6 Nonparametric regression: kernel estimator (Nadaraya-Watson) and local linear regression estimator. [PU 3.1-3.2, Su 1.4-1.5]

Lecture 7 Statistical properties of the Nadaraya-Watson and local linear regression estimator. Series estimation. [PU 3.3.1-3.3.2, 3.4.1]

Lecture 8 Some direct applications of nonparametric regression. [PU 5.1-5.2, Su 1.7]

Lecture 9-10 Application: estimating conditional average treatment effects. [article]

Lecture 10-11 Application: estimating regression discontinuity models. [article]

Lecture 11-12 Application: estimating sample selection models. [PU 8.1-8.3, article]