Bayesian Nonparametric Techniques with Applications

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Aims: Existing literature shows that the Dirichlet process mixture (DPM) structure has great potential to bring novel insights in many economic problems. This lecture is designed to enable students to apply the DPM structure as one building block of their own econometric models.

Prerequisite: Students are expected to be familiar with basic Bayesian concepts such as prior, posterior, likelihood, conditional distribution and marginal likelihood. Students should also know basic computational techniques such as importance sampling, Gibbs sampling and Metropolis-Hastings method.

Posterior inference algorithms are implemented in the tutorial by using the provided MATLAB code and explained in a line-by-line fashion. Please bring your own laptop with MATLAB installed. I can arrange a lab computer if you do not have access to MATLAB.

Timetable

- Day 1: [Finite Mixture Model]
  - Session 10am-12pm:
    How to consider a prior when a model becomes complicated. I will

discuss a practical guide to setting the prior that is both plausible and fast.

Re-define the Dirichlet distribution to mimic the Dirichlet process for Day 2.

- Session 1pm-3pm:

  MCMC for a finite normal mixture model with applications.

  Application 1: a multimodal distribution density estimation.

  Application 2: Kim, Shephard and Chib's (1998) method for a stochastic volatility model.

- Session 3pm-4pm

  An exercise in financial econometrics by using a finite mixture model.

- Day 2: [Dirichlet Process Mixture Model]

  - Session 10am-12pm:

    Review the definition and a new representation of the Dirichlet distribution and introduce the Dirichlet process definition and its properties.

    A Dirichlet distribution has three definitions/representations: original, Chinese restaurant and stick breaking. These three definitions/representations are useful for posterior inference.

  - Session 1pm-3pm:

    Introduce the slice sampler for posterior simulation. The slice sampler stochastically reduces an infinite dimension state space to a finite one.

    Delineate an MCMC algorithm for a Dirichlet mixture model. The DPM is applied to a density estimation problem. I will also discuss some easily encountered numeric traps in the posterior sampler. A practical modelling guide is proposed.

  - Session 3pm-4pm

    An exercise in nonparametric estimation by using DPM.

- Day 3: [A Research Paper] shows how to apply DPM to research.

  - Session 10am-12pm:

Introduce a nonparametric regression model with dependent variables along with an exercise of algebra derivation. The conditional distribution of $y \mid x$ is also an infinite mixture model. It is a natural way to work on clusters.

– Session 1pm-3pm:

  Use a proprietorial clinical data, apply the DPM to study the effect of coffee intake on liver stiffness. I will show how to compute marginal effects of x on y and how to detect outliers.

  Several potential research topics in applied microeconomics, macroeconomics and financial econometrics will be discussed.

– Session 3pm-4pm

  An exercise in nonparametric regression.