PHP 2690B

Introduction to Bayesian Inference: Hierarchical Models and Spatial Analysis

Tuesday, Thursday 2:30 – 3:50 121 S Main St Rm 241

Instructor Information

Crystal Linkletter

121 South Main St. Rm 746

Office Hours: Wednesday 2-3 pm

Thursday 1-2:30 pm

Course Objectives

This is a graduate seminar intended as a first introduction to Bayesian inference. Relevant theoretical background will be reviewed, and the Bayesian paradigm will be introduced, including choice of prior distributions and calculation of posterior distributions. The main emphasis of the course will be on how to use Bayesian thinking to develop models for data with complex structure. Hierarchical models, meta-analysis, Bayesian design and shrinkage estimation will be covered. The benefits of hierarchical modeling will be applied to spatial data analysis as a special topic. Students will be introduced to Bayesian computing and WinBUGS, which is a necessary skill for many modern analyses.

Reading

There is no required textbook for this class, but required reading and course notes will be distributed by the instructor throughout the semester. I will be drawing much of my material from the textbook "Bayesian Ideas and Data Analysis" by Christensen, Johnson, Branscum and Hanson, but I will not be following the book directly.

Prerequisites

Prior exposure to statistics is a requirement for this class. PHP 2510 and 2511 or their equivalents meet this requirement. Any additional exposure to statistical inference, statistical computing, calculus and matrix algebra will be useful for the class.

Computational Requirements

Computing strategies for Bayesian inference will be discussed in class. Previous exposure to statistical computing and software packages would be helpful. WinBUGS (and possibly R) will be used for coursework. Computational proficiency is essential for modern Bayesian analysis and will be heavily emphasized.

Course Requirements

Grades for the class will be assigned according to performance in four areas:

Assignments (30%)
Midterm Exam (20%)
Class Participation and Presentation (20%)
Final Exam (30%)

Course Outline

PART 1: Introduction to Bayesian Inference

Week 1: Review of important probably concepts
Week 2: The Bayesian paradigm
Week 3: Prior Selection and Elicitation; Introduction to WinBUGS
Week 4: Exchangeability and conditional independence: specifying joint distributions

PART 2: Bayesian Model-Building and Applications

Week 5: Introduction to hierarchical models
Week 6: Fixed effects versus random effects: the Bayesian solution
Week 7: The practice of meta-analysis
Week 8: Bayesian design and shrinkage estimation
Week 9: Model selection

PART 3: Applications in Spatial Data Analysis

Week 10: Introduction to spatial data; spatial autocorrelation
Week 11: Empirical Bayes smoothing
Week 12: Hierarchical models for disease mapping and clustering
Week 13: Special topics/Presentations
Week 14: Special topics/Presentations

Bayesian Textbooks
Bayesian Statistics: An Introduction – Lee
Bayesian Statistical Modeling – Congdon
Bayesian Methods: A Social and Behavioral Sciences Approach – Gill
Bayesian Data Analysis – Gelman et al.
A First Course in Bayesian Statistical Methods – Hoff
Bayesian Methods for Data Analysis – Carlin and Louis