University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

Applied Bayesian Statistics

1 credits

MEES 608R
Fall 2020

Course Objectives / Overview

This seminar will explore the advanced practices of Bayesian network and graphical model to high dimensional inter-disciplinary environmental data. Through hands-on experience and real studies from Bayesian perspectives, students will learn the basics of evaluating Bayesian network and graphical analyses, and interpreting and communicating the results. Case studies involving ecological and environmental science will be used to illustrate Bayesian analyses. The statistical programming language R and software packages such as OpenBUGS, JAGS and STAN will be used in illustrating Bayesian models.

Expected Learning Outcomes

Students will learn to evaluate a Bayesian network and graphical study, with particular focus on applying Bayesian structural learning to high dimensional data analyses problems. The outcomes involve skills in interpretation and communicating the results through oral and written presentations.

Students will independently analyze high dimensional data sets of their choices. Examples include by not limited to genomics data, high throughputs chemical measurements, imaging based data, acoustic data, remote sensing data and phytoplankton community data.

Course Assessment / Grading

Grades will be based on a Pass and Fail system. Students are encouraged to carry out projects involving development of a Bayesian model of high dimensional data to problems of their own choosing. Alternative choices of grading include leading a synthesis of papers of a class of papers involving applications of Bayesian methods in the students' disciplines.

INSTRUCTOR DETAILS:
Dong Liang
dliang@umces.edu
410-326-7452

CLASS MEETING DETAILS:
Dates: Tuesday, Thursday
Times: 8:30 – 9:20 am
Originating Site: CBL
IVN bridge number: (800414)
Zoom number:(*****)
Phone call in number: (***)
Room phone number:(*****)

COURSE TYPE:
Check all that apply
☐ Foundation
☒ Professional Development
☐ Issue Study Group
☐ Seminar
☒ Elective

Prerequisites
MEES698B or equivalent courses, students are encouraged to discuss with the instructor.

Teaching Assistant
N/A

Tentative Weekly Course Schedule

Module	Weeks	Topics	Reading
Introduction	1	Bayes and inference for proportions	Cowles Ch 1-3
	2	Bayesian computing	Cowles Ch 8
	3	Hierarchical models	Cowles Ch 10
	4	Bayesian regression	Cowles Ch 9
Structure Learning	5	Bayesian network introduction	Scutari Ch 1
	6	Parameter learning	Scutari Ch 2
	7	Computing in Bayesian Net	Scutari Ch 3
	8	Hierarchical regressions	Cowles Ch 10
Case Studies	9	Model Selection	Zurr Ch 5
	10	Graphical Analysis	Case Papers
	11	Ecosystem Factors	Case Papers
	12	Genetic Analysis	MCMC Ch 21
	13	High Throughput Analysis	Case Papers
Summary	14	Class Presentations	Case papers

Required textbooks, reading and/or software or computer needs

Cowles, 2013 Applied Bayesian Statistics.
Hobbs & Hooten, Bayesian Models: A Statistical Primer for Ecologists
Scutari & Denis, 2014, Bayesian Networks with Examples in R

Course Communication

We will be using the distance learning tool, Moodle for storing and disseminating class information – class notes, computer code and output, assigned readings, and even discussion threads if you wish. Each student will be given a personal login and password to access the site. Materials for the next class will be posted no later than 12 hours before the beginning of the class. You are strongly encouraged to download and bring the R code and output to each class as these are critical components of the lectures and may be hard to follow without having these in front of you. For the first several class periods, we will email reminders to get the info for class and where the info will be located. Please bookmark the Moodle site (https://moodle.cbl.umces.edu/login/index.php) in your web browser so that you can rapidly get there.

Resources

Rue, H. et al., www.r-inla.org

Campus Policies

The University of Maryland Center for Environmental Science has drafted and approved of various academic and research-related policies by which all students and faculty must abide.

Please visit http://www.umces.edu/consolidated-usm-and-umces-policies-and-procedures for a full list of campus-wide academic policies.

Course-Specific Policies and Expectations

Student project involves analyzing a real data set from their research. This might involve description of the research question and dataset, selecting an appropriate model, determining appropriate values for prior parameters, fitting the model using STAN or R-INLA, checking convergence, and reporting and interpreting the results.

They also have the option of leading the discussion of a peer reviewed paper. Discussion papers can be selected by students based on research interests. Please first consent the instructor. Discussion items will include understanding what the authors did, if or why a Bayesian approach was a good option, whether their choice of methods was appropriate, and whether you agree with the authors' interpretation.
Projects

Projects will be carried out in three phases. Please consult with the instructor at least once while you are working on each phase.

1. Project proposal is a detailed description of what you plan to do, including question(s) to be addressed, dataset to be used, methods to be applied. Also specify the method of presentation that you intend for the final project.
2. Project interim report will indicate that your project is on track. All computing should be done at this time. The report will include results obtained thus far and a brief summary (hand-written is OK) of what they mean and what remains to be done.
3. Project presentation (papers or presentation materials must be posted or submitted). Projects must be finalized in a form that can be shared with the entire class, such as posting a document on the course web page, preparing a poster, and giving an oral presentation with overheads, slides, or computer images. Posters and oral presentations will be given in class during the final week of classes.