Course Title: FOR6934.0373

Introduction to Bayesian Statistics in Environmental and Agricultural Sciences

Time and location: T/R, period 2 in RLA 302.
Instructor: Denis Valle, 408 McCarty Hall C, 352-392-3806, drvalle@ufl.edu
Credits: 3

Office hours: TBD
TA: TBD

Course Description:
The aim of the course is to introduce environmental and agricultural scientists to Bayesian statistics. We will explore basic ideas regarding integration through simulation (Monte Carlo integration), the philosophy and strengths of Bayesian statistics, and the Markov Chain Monte Carlo (MCMC) algorithms needed to fit such models.

We will focus on several real world examples and how to transform these problems into statistical models. This course will rely on substantial extra-class work, in order to provide students with extensive hands on experience on conceptualizing, implementing, and interpreting the results of these models. Ideally, this experience will be enough to enable students to develop their own Bayesian models after this course is over.

We will try to cover simple (e.g., Normal and Poisson), mixed effect and multi-level regression models but this will fundamentally depend on the speed with which the class is able to follow the course. Implementation of these models will be done both with JAGS as well as customized R code.

Course Learning Objectives
By the end of the course, the student will be expected to:
• Be able to solve real problems: think through a problem and how to translate that into a biologically sensible statistical model (instead of pre-built standard models)
• Be comfortable in interpreting MCMC output
• Be able to implement Bayesian models in JAGS
• Be able to read and modify R code that implements a Gibbs sampler from scratch

Grading:

Point range (%)	Letter Grade	GPA equivalent
> 90	A	4
86.7 - 89.9	A-	3.67
83.3 - 86.6	B+	3.33
80.0 - 83.2	B	3
76.7 - 79.9	B-	2.67
73.3 - 76.6	C+	2.33
70.0 - 73.2	C	2
66.7 - 69.9	C-	1.67
63.3 - 66.6	D+	1.33
60.0 - 63.2	D	1
56.7 - 59.9	D-	0.67
< 56.7	E	0

My philosophy is that you just learn by doing, thus this course is heavily based on extra-class work. Therefore, grades will be entirely based on weekly assignments (i.e., no exams), due on the following Monday. These assignments should be handed-in as word documents, basically showing how you solved the different problems (include your commented code) and the final results, together with their interpretation. I think it is important to emphasize that modeling is best learnt individually. You can certainly discuss with your colleagues if you get stuck but you should try as much as possible to solve these assignments by yourself.

All assignments are graded from 0 to 1 and the overall grade is the arithmetic average of all grades. Assignments that are not handed in receive a grade of 0. I will make general comments about common mistakes during class and I will provide my answers/code to solve the assignments.

List of required and recommended materials

Textbooks (Not required): sections of these books will be used and will be made available when needed to registered students
- Hoff, P. D. 2009. A first course in Bayesian statistical methods. Series: Springer Texts in Statistics.
- Michael A. McCarthy. 2007. Bayesian methods for ecology. Cambridge University Press.
- Andrew Gelman and Jennifer Hill. 2007. Data analysis using regression and multilevel/hierarchical models. Cambridge University Press.
  - Allen B. Downey. 2012. Think Bayes: Bayesian statistics made simple. Green Tea Press (available at http://www.greenteapress.com/thinkbayes/)

Software (Required):
- R, freely available at http://www.r-project.org
- JAGS, freely available at http://mcmc-jags.sourceforge.net/
- A text editor, such as NotePad++ (http://notepad-plus-plus.org/) or RStudio (http://www.rstudio.com/)

Pre-requisites:
- STA6166 or a similar introductory statistics course
- Conceptual understanding of integrals
- The student should be comfortable working with R (required)

Important observation: It is extremely helpful (but not required) to have a previous course on mathematical statistics (e.g., "ZOO6927 Statistical Principles for the Biological Sciences" by Jose Ponciano or "STA 5325 Fundamentals of Probability")

Weekly course schedule (tentative):

Week	Topic	Overarching topic
1	Intro. frequentist and Bayesian statistics Review: Joint, conditional and marginal probabilities; law of total probability; Bayes theorem Review: Likelihood, priors, posterior, pmf/pdf and their characteristics (e.g., moments)	Introduction
2	Simple examples with conjugate priors	
3	MCMC basics: integration through simulation / transformation of variables	
4	Introduction to conceptual (generative) models / generating fake data Inverse modeling	
5	Gibbs sampling and full conditionals / Site occupancy example	
6	Gaussian regression model: conceptual model and fake data Implementation in JAGS	Gaussian regression
7	Monitoring convergence / interpreting MCMC output	

	Model predictive check	
8	Deriving full conditionals Implementation in R	
9	Model over-fitting / Multiple shrinkage prior for regression models Implementation in JAGS Convergence / Interpreting MCMC output Model predictive check	Model selection / avoiding over-fitting
10	Deriving full conditionals Implementation in R	
11	Mixed effects models: conceptual model and fake data Implementation in JAGS Convergence / Interpreting MCMC output Model predictive check	Mixed models
12	Deriving full conditionals Implementation in R	
13	Multi-level regression models: conceptual model and fake data Implementation in JAGS	Multi-level models
14	Interpreting MCMC output / model predictive check Deriving full conditionals Implementation in R	
15	Poisson regression model: conceptual model and fake data Implementation in JAGS Interpreting MCMC output / model predictive check	GLM

Note: topics may change

Attendance and Make-Up Work
Requirements for class attendance and make-up exams, assignments and other work are consistent with university policies that can be found at:
https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx.

Online Course Evaluation Process
Student assessment of instruction is an important part of efforts to improve teaching and learning. At the end of the semester, students are expected to provide feedback on the quality of instruction in this course using a standard set of university and college criteria. These evaluations are conducted online at https://evaluations.ufl.edu. Evaluations are typically open for students to complete during the last two or three weeks of the semester; students will be notified of the specific times when they are open. Summary results of these assessments are available to students at https://evaluations.ufl.edu/results.

Academic Honesty
As a student at the University of Florida, you have committed yourself to uphold the Honor Code, which includes the following pledge: *"We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity."* You are expected to exhibit behavior consistent with this commitment to the UF academic community, and on all work submitted for credit at the University of Florida, the following pledge is either required or implied: *"On my honor, I have neither given nor received unauthorized aid in doing this assignment.*"

It is assumed that you will complete all work independently in each course unless the instructor provides explicit permission for you to collaborate on course tasks (e.g. assignments, papers, quizzes, exams). Furthermore, as part of your obligation to uphold the Honor Code, you should report any condition that facilitates academic misconduct to appropriate personnel. It is your individual responsibility to know and comply with all university policies and procedures regarding academic integrity and the Student Honor Code. Violations of the Honor Code at the University of Florida will not be tolerated. Violations will be reported to the Dean of Students Office

for consideration of disciplinary action. For more information regarding the Student Honor Code, please see: http://www.dso.ufl.edu/sccr/process/student-conduct-honor-code.

Software Use:
All faculty, staff and students of the university are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against university policies and rules, disciplinary action will be taken as appropriate.

Services for Students with Disabilities
The Disability Resource Center coordinates the needed accommodations of students with disabilities. This includes registering disabilities, recommending academic accommodations within the classroom, accessing special adaptive computer equipment, providing interpretation services and mediating faculty-student disability related issues. Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation. 0001 Reid Hall, 352-392-8565, **www.dso.ufl.edu/drc/**

Campus Helping Resources
Students experiencing crises or personal problems that interfere with their general well-being are encouraged to utilize the university's counseling resources. The Counseling & Wellness Center provides confidential counseling services at no cost for currently enrolled students. Resources are available on campus for students having personal problems or lacking clear career or academic goals, which interfere with their academic performance.

- *University Counseling & Wellness Center, 3190 Radio Road, 352-392-1575,* **www.counseling.ufl.edu/cwc/**
  Counseling Services
  Groups and Workshops
  Outreach and Consultation
  Self-Help Library
  Wellness Coaching

- *Career Resource Center,* First Floor JWRU, 392-1601, **www.crc.ufl.edu/**