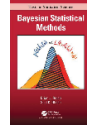


A short course on Bayesian Analytics in Practice

Lecture Series



Prof. Sujit K. Ghosh

Department of Statistics, NC State University

Schedule:

Date	Time	Venue
20-Feb-2024	11:35 am to 1:00 pm	Room 216, Mathematics Department
22-Feb-2024	11:35 am to 1:00 pm	Ramanujan Hall, Mathematics Department
5-Mar-2024	11:35 am to 1:00 pm	Ramanujan Hall, Mathematics Department
7-Mar-2024	11:35 am to 1:00 pm	Ramanujan Hall, Mathematics Department
12-Mar-2024	11:35 am to 1:00 pm	Ramanujan Hall, Mathematics Department
9-April-2024	11:35 am to 1:00 pm	Ramanujan Hall, Mathematics Department
11-April-2024	11:35 am to 1:00 pm	Ramanujan Hall, Mathematics Department

Overview: The Bayesian paradigm provides a natural and practical way for building complex analytical models by expressing the joint model through a sequence of simpler conditional models, making it useful for various hierarchical data structures. This series of lectures will first introduce the general notions of Bayesian methods via hierarchical models, and then expand the topic with the more realistic and complex models which have recently emerged as a result of current Machine Learning (ML) literature. These models will be illustrated through practical applications to various real case studies avoiding much of the theoretical underpinnings. However, pointers to relevant theory will be provided as supplements with additional resources. Participants with basic knowledge of probability theory and statistical inferential framework will find the lectures useful in expanding their toolkit with the advanced use of Bayesian analytical methods. Popular topics such as prior sensitivity analysis, model comparisons, and uncertainty quantification for machine learning methods will be covered. In particular, the lectures will provide necessary theory and practice of handling missing and censored data, a topic largely ignored in traditional ML methods. The concepts and methods discussed will be demonstrated primarily using R software illustrations, but methodologies presented can also be carried out by other software (e.g., Python). Group activities during lab will be encouraged, allowing participants to have a hands-on experience. Lecture materials used for the workshop will be distributed electronically to registered participants.

OUTLINE *(subject to minor changes)*

Part I - Introduction to Bayesian Hierarchical Models (3 lectures)

A. Basic concepts in Bayesian Methods (Priors, Likelihood and Posteriors)

- B. Predictive Distributions and Model Selection
- C. Computational Methods using Monte Carlo
- D. Illustrative Examples based on independent data

Part II - Primer on R and Bayesian MCMC Packages (2 lectures)

- A. Software Review: BUGS, JAGS, R (Python resources)
- B. Various R packages to implement Bayesian ML methods
- C. Illustrative Examples based on dependent data

Part III – High-dimensional Models in Practice (2 lectures)

- A. Linear and Generalized Linear models
- B. Nonparametric Models
- C. Illustrative Examples using R packages

LEARNING OUTCOMES

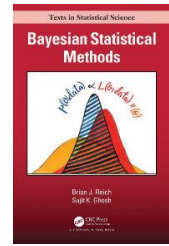
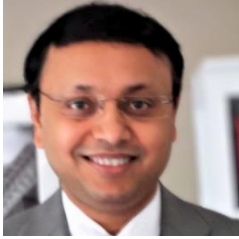
(a) Lecture series objectives:

This lecture series aims to familiarize attendees with the essential concepts and computational methods of the Bayesian analytics, specifically in context of hierarchical modeling. Attendees will learn how to deal with practical issues which arise from Bayesian analysis, especially those of multilevel modeling. Participants with basic knowledge of probability theory and statistical inferential framework will find the course useful in expanding their knowledge of the advanced use of Bayesian analytical methods. Another goal is to help attendees become familiar with the use of software to conduct Bayesian inference using machine learning methods. The how-to part of the lectures is presented using a variety of examples from different applied settings, with particular emphasis on the explaining the code in detail.

(b) Content and delivery methods:

Bayesian methods are becoming ever more popular in many applied fields. The lecture series is designed from a practical point of view, covering a wide range of popular hierarchical analytical models practically applied to several different data (simple rectangular data structure to complex data structure with missing and/or censored observations). The lecture series emphasizes practical aspects of Bayesian computation methods using standard software packages. Demonstrations will use examples from realistic settings, with the resulting code explained in detail. Examples are presented primarily using R, but other software packages will also be mentioned for comparative analysis. Most of these examples are derived from the book co-authored by the speaker. Attendees will be provided access to the online book resources. Although it is recommended that attendees bring their laptop to the course, but it is not required.

SPEAKER'S BIO



[Professor Sujit Kumar Ghosh](#) is currently a Full Professor in the Department of Statistics at North Carolina State University (NCSU). He has over 30 years of experience in conducting, applying, evaluating and documenting statistical analysis of biomedical and environmental data. Prof. Ghosh is actively involved in teaching, supervising and mentoring graduate students at the doctoral and master levels. He has supervised over 45 doctoral graduate students. Prof. Ghosh was awarded D.D. Mason Faculty award in 2023 and Cavell Brownie Mentoring Award in 2014 by the Statistics department at NCSU. He co-authored a popular book titled "[Bayesian Statistical Methods](#)" which is being used as a textbook at several universities. He has given over 185 invited lectures, seminars at national and international meetings. Prof. Ghosh received the International Indian Statistical Association (IISA) Young Investigator Award in 2008; was elected a Fellow of the American Statistical Association (ASA) in 2009 and was elected as the President of the NC Chapter of ASA in 2013 and also the President of the IISA in 2017. He served as the Program Director in the Division of Mathematical Sciences (DMS) within the Directorate of Mathematical and Physical Sciences (MPS) at NSF in 2013-2014. He has also served as the Deputy Director at the Statistical and Applied Mathematical Sciences Institute (SAMSI) in 2014-2017 and interim Department Head of Statistics at NCSU during 2022-2023. Currently, he is an Honorary Visiting Professor in the Department of Mathematics at IIT-B.