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BIOS 9231: Bayesian Statistics I

Jing Kersey

Georgia Southern University, Jiann-Ping Hsu College of Public Health, jkersey@ega.edu

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Georgia Southern University
Jiann-Ping Hsu College of Public Health

BIOS 9231: Bayesian Statistics I
Fall 2021

<u>Instructor:</u>	Dr. Jing Kersey
<u>Office:</u>	TBD
<u>Phone:</u>	762-218-3105 (Call & Text)
<u>E-Mail Address:</u>	jkersey@ega.edu OR jingkersey@gmail.com
<u>Office Hours:</u>	By appointment
<u>Class Meets:</u>	2020 Hendricks Hall Monday 2:30 to 5:15

Course Catalog available at:
<http://em.georgiasouthern.edu/registrar/resources/catalogs/>
under Jiann-Ping Hsu College of Public Health Programs

Prerequisites: *BIOS 9131 and BIOS 9133*

FOLIO Access: <https://my.georgiasouthern.edu/portal/portal.php>

Access to course materials are available for up to one year after graduation.

Catalog Description

This course provides the student with an introduction Bayesian analysis and compares Bayesian methods to that of frequentists. The course includes selection of prior distributions, computing posterior distributions, and conjugate models such as the Beta-Binomial, Normal-Normal, and Gamma-Poisson models. Bayesian inference using point and interval estimation, Bayesian hierarchical models, and exchangeability will be explored. Topics including Empirical Bayes versus a fully Bayes approach, Markov Chain Monte Carlo methods and model checking using Bayes factors and sensitivity analyses will be included. Prerequisite: A minimum grade of "B" in BIOS 9131, or permission from instructor.

Textbook:

Gelman, A., Carlin, J.B., Stern, H.S., and Rubin, D.B. (2014) *Bayesian Data Analysis, Third Edition*. Boca Raton, FL: Chapman & Hall/CRC Press.

References:

Ronald Christensen, Wesley Johnson, Adam Branscum and Timothy Hanson. (2011). *Bayesian Ideas and Data Analysis: Introduction For Scientists and Statisticians*. : Chapman & Hall/CRC Press.

Berry, D.A. and Stangl, D.K. (1996) *Bayesian Biostatistics*. New York, NY: Marcel Dekker.
Moye, L.A. (2008) *Elementary Bayesian Biostatistics*. Boca Raton, FL: Chapman & Hall/CRC Press.

Albert, J. (2007) *Bayesian Computation with R*. New York, NY: Springer.

Gilks, W.R., Richardson, S., and Spiegelhalter, D.J. (1996) *Markov Chain Monte Carlo in Practice*. Boca Raton, FL: Chapman & Hall/CRC Press.

Bolstad, W.M. (2004) *Introduction to Bayesian Statistics*. Hoboken, NJ: John Wiley & Sons, Inc.

DrPH Core Student Learning Outcomes

1. Apply evidence-based practice and research methods to advance the field of public health.
2. Develop culturally-sensitive public health policies or programs using interdisciplinary approaches grounded in legal and ethical principles.
3. Integrate knowledge, legal and regulatory approaches, ethical frameworks and varied stakeholder interests in addressing public health problems.
4. Communicate public health information to diverse stakeholders, including individuals at all levels of health literacy, for purposes of influencing behavior and policies.
5. Propose strategies for health improvement and elimination of health inequities including stakeholders, researchers, practitioners, community leaders and other partners.

CEPH Concentration Competencies

1. Interpret analytic methods used in the public health and biomedical journals, as well as critique published reports of public health and biomedical experiments as to the validity of the inferential conclusions.
2. Analyze public health and biomedical data using appropriate statistical methods and demonstrate the proficiency in statistical software such as SAS and R.
3. Develop new biostatistical methods and new ideas for applying existing biostatistical methods to applications in public health and the biomedical sciences.
4. Demonstrate the ability to incorporate prior knowledge to solve biomedical problems via Bayesian analysis.
5. Demonstrate the cognition of the underlying statistical theory that supports the biostatistical methodology.

CEPH DrPH Competencies

Data & Analysis

1. Explain qualitative, quantitative, mixed methods and policy analysis research and evaluation methods to address health issues at multiple (individual, group, organization, community and population) levels
2. Design a qualitative, quantitative, mixed methods, policy analysis or evaluation project to address a public health issue
3. Explain the use and limitations of surveillance systems and national surveys in assessing, monitoring and evaluating policies and programs and to address a population's health

Leadership, Management & Governance

4. Propose strategies for health improvement and elimination of health inequities by organizing stakeholders, including researchers, practitioners, community leaders and other partners
5. Communicate public health science to diverse stakeholders, including individuals at all levels of health literacy, for purposes of influencing behavior and policies
6. Integrate knowledge, approaches, methods, values and potential contributions from multiple professions and systems in addressing public health problems
7. Create a strategic plan
8. Facilitate shared decision making through negotiation and consensus-building methods
9. Create organizational change strategies
10. Propose strategies to promote inclusion and equity within public health programs, policies and systems
11. Assess one's own strengths and weaknesses in leadership capacities including cultural proficiency
12. Propose human, fiscal and other resources to achieve a strategic goal
13. Cultivate new resources and revenue streams to achieve a strategic goal

Policy & Programs

14. Design a system-level intervention to address a public health issue
15. Integrate knowledge of cultural values and practices in the design of public health policies and programs
16. Integrate scientific information, legal and regulatory approaches, ethical frameworks and varied stakeholder interests in policy development and analysis
17. Propose interprofessional team approaches to improving public health

Education & Workforce Development

18. Assess an audience's knowledge and learning needs
19. Deliver training or educational experiences that promote learning in academic, organizational or community settings
20. Use best practice modalities in pedagogical practices

Performance-Based Objectives Linked to Course Activities (Note: Assessment Activities Described in Next Section)

1. Understand how to compare Bayesian to Classical approaches of biostatistical analyses and distinguish conditions for when a Bayesian approach is similar, or equivalent, to a frequentist approach of analysis. Understand and use the commonly used Bayesian methodological concepts and apply conjugate models, such as the Beta-Binomial, Normal-Normal, or Gamma-Exponential models, to public health and biomedical data in order to obtain closed-form conditional distributions.
2. Understand how to solve single-parameter and multi-parameter Bayesian biostatistical problems for calculating posterior distributions and how to choose the prior distribution in Bayesian analyses in public health and biomedical literature.
3. Demonstrate use of the Bayesian statistical software package R and WinBUGS to compute posterior distributions and their characteristics such as posterior means and credible intervals and understand how interpret credible intervals and other Bayesian results in the context of a public health and biomedical data analysis.
4. Understand how to use Markov Chain Monte Carlo (MCMC) methods for public health and biomedical applications and demonstrate the use of MCMC methods using a statistical software package, such as R and WinBUGS, for public health and biomedical applications.

Assessment of Student Learning

Activity 1: Use course lectures and class discussions to explain the basic terminology and definitions of Bayesian and compare it to classical approaches of biostatistical analyses and distinguish conditions for when a Bayesian approach is similar, or equivalent, to a frequentist approach of analysis. Also, understand and use the commonly used Bayesian methodological concepts and apply conjugate models, such as the Beta-Binomial, Normal-Normal, or Gamma-Exponential models, to public health and biomedical data in order to obtain closed-form conditional distributions; understand how to solve single-parameter and multi-parameter Bayesian biostatistical problems for calculating posterior distributions and how to choose the prior distribution in Bayesian analyses in public health and biomedical literature. Competence in basic terminology will be evaluated using two activities: (1) weekly homework (2) midterm exam and final exam.

Activity 2: Use course lectures, class discussions and class exercises to illustrate the use of the Bayesian statistical software package R and WinBUGS to compute posterior distributions and their characteristics such as posterior means and credible intervals and understand how interpret credible intervals and other Bayesian results in the context of a public health and biomedical data analysis and understand how to use Markov Chain Monte Carlo (MCMC) methods for public health and biomedical applications and demonstrate the use of MCMC methods using a statistical software package, such as R and WinBUGS, for public health and biomedical applications. Competence in will be evaluated using three activities: (1) weekly homework (2) in-class midterm exam (3) in-class final project presentation.

Activity 3: Use course lectures, class discussions and real theoretical illustration to explain the basic applications of the Bayesian approach as well as the integration of the Bayesian theories and applications across the biostatistics and public health spectrum. Competence in ability to

integrate theories will be evaluated using challenging theoretical published papers for the students to write a report and present the theoretical concept of these papers in the class.

Computing: In a world where technology is increasingly pertinent to everyday tasks, we will learn how the statistical software packages R and WinBUGS are used in simplifying Bayesian computation and analyses. Both of these software are free downloads from the internet, so you will need to download both programs to your personal computer if you choose to use these software away from the university. Otherwise, the Public Health Computer Lab (1002 Hendricks Hall) will have R and WinBUGS loaded on the computers. However, these programs will not be loaded on the Hendricks' computers until late August.

Course Schedule:

<i>Date</i>	<i>Topic</i>	<i>Chapters</i>	<i>Homework</i>
8/16	Probability and inference	Notes & Ch1	
8/23	Single-parameter model	Notes & Ch2	
8/30	Introduction to multi-parameter Models	Notes & Ch3	
9/6	Labor Day- No Class Meeting		
9/13	Hierarchical models	Notes & Ch5	
9/20	Midterm Exam Review	Ch1,2,3, & 5	
9/27	Midterm Exam		
10/4	Introduction to Bayesian computations (Monte Carlo)	Notes & Ch10	
10/11	Basics of Markov chain simulation	Notes & Ch11	
10/18	Model checking	Notes & Ch6	
10/25	Evaluating comparing and expanding models	Notes & Ch7	
11/1	Modeling accounting for data collection	Notes & Ch8	
11/8	Decision analysis	Notes & Ch9	
11/15	Regression models and Hierarchical linear models	Notes & Ch14, 15	
11/22	Thanksgiving Break 11/22—11/28		
11/29	Final Project Presentation		

Portfolio Inclusion

Samples of your work may be reproduced for search purposes and/or inclusion in the professor's teaching portfolio. You have the right to review anything selected for use, and subsequently ask for its removal.

Instructional Methods

Class meetings will be a combination of lecture, class discussion, and computer software demonstration. Written homework assignments and examinations constitute the basis of student evaluation.

Exam Schedule and Final Project Presentation:

Midterm Exam: Monday 9/27

Final Project Presentation: Monday 11/29

Grading

Weighting of assignments for purposes of grading will be as follows:

Assignments & Project	(Learning Objectives: 1-5)	50 points (50%)
Midterm Exam	(Learning Objectives: 1, 2, 3)	25 points (25%)
Final Project	(Learning Objectives: 4, 5)	25 points (25%)
Total Possible Points		100 points (100%)

Your grades will be posted on Folio. There are times when extraordinary circumstances occur (e.g., serious illness, death in the family, etc.). In such circumstances, and/or if you need additional time to satisfactorily complete any course requirement, please consult with the instructor within a reasonable amount of time. Note: Extensions are not guaranteed and will be granted solely at the discretion of the instructor.

NO EXTRA CREDIT PROJECTS WILL BE ASSIGNED!

Inclusive Excellence at Georgia Southern University

At Georgia Southern University, we are committed to supporting our students and fostering an environment that is free of bias, discrimination, and harassment in the classroom and in the broader University community. As such, we have an expectation that our learning community is inclusive and respectful. Our diversity may be reflected by differences in race, culture, age, religion, sexual orientation, gender identity, ability, political beliefs, socioeconomic background, and myriad other social identities and life experiences. The goal of inclusiveness, in a diverse community, encourages and appreciates expressions of different ideas, opinions, and beliefs, so that conversations and interactions that could potentially be divisive turn instead into opportunities for intellectual and personal enrichment.

We are a faculty that strives to model reflection, advocacy, and care for the community in order to work toward an equitable, democratic, and sustainable society. We value your participation in

this process. If you believe that our courses, programs, or department fall short of this commitment, we encourage you to engage in dialogue with us.

General Expectations

1. For every one-credit hour, you should expect to work roughly two hours outside the classroom each week. For example, for a three credit hour course, during a regular fifteen week semester, you should expect approximately ninety hours of work outside of class.
2. Students are expected to keep up with the class, to read the required material, and to submit assignments and activities by due dates and times.
3. Students are expected to independently complete all activities, exercises, assignments, and assessments including exams.
4. Students are expected to produce quality work. Typos and grammar errors should be kept to a minimum. The format and readability of submissions will be taken into consideration when assigning a grade.
5. Remember to check when assignments are due. It is recommended that you stay ahead of schedule on the assignments, so if an emergency happens, your assignment will be completed and ready to submit within the designated time frame. It is your responsibility to keep track of the due dates for each assignment.

Texting and Use of Cell Phones (and Other Technologies)

Please do not text in class or use your cell phone during class! Texting during class (or in a meeting) is disruptive and rude...at least to me. My preference is that you put cell phones away during class meetings, so they are not a source of temptation. Offenders will be asked to leave.

Class Attendance and Participation Policy

Federal regulations require attendance be verified prior to distribution of financial aid allotments. Regular attendance is expected. Your attendance will be verified at the first regular class session.

It is the policy of the University to permit students, faculty, and staff to observe those holidays set aside by their chosen religious faith. The faculty should be sensitive to the observance of these holidays so that students who choose to observe these holidays are not seriously disadvantaged. It is the responsibility of those who wish to be absent to make arrangements in advance with their instructors.

Students participating in authorized activities as an official representative of the University (i.e., athletic events, delegate to regional or national meetings or conferences, participation in

university-sponsored performances, and **JPHCOPH funded**) will not receive academic penalties and, in consultation with the instructor of record, will be given reasonable opportunities to complete assignments and exams or given compensatory assignment(s) if needed. The student must provide written confirmation from a faculty or staff advisor to the course instructor(s) at least 10 days prior to the date for which the student will be absent from the class. The student is responsible for all material presented in class and for all announcements and assignments. When possible, students are expected to complete these assignments before their absences. In the event of a disagreement regarding this policy, an appeal may be made by either the student or the instructor of record to the corresponding college dean. (*University Graduate Catalog*)

Academic Misconduct

As a student registered at this University, it is expected that you will adhere to only the strictest standards of conduct. It is recommended that you review the latest edition of the *Student Conduct Code* book, as well as the latest *Undergraduate & Graduate Catalog* to familiarize yourself with the University's policies in this regard. Your continued enrollment in this course is an implied contract between you and the instructor on this issue; from this point forward, it is assumed that you will conduct yourself appropriately.

Plagiarism:

According to the Academic Dishonesty Policy of Georgia Southern University, Plagiarism includes (but is not limited to):

- A. Directly quoting the words of others without using quotation marks or indented format to identify them.
- B. Using published or unpublished sources of information without identifying them.
- C. Paraphrasing material or ideas without identifying the source.
- D. Unacknowledged use of materials prepared by another person or agency engaged in the selling of term papers or other academic material.

If you are accused of plagiarism by a JPHCOPH, the following policy, as per the Judicial Affairs website: (<http://students.georgiasouthern.edu/judicial/faculty.htm>) will be enforced:

PROCEDURES FOR ADJUDICATING ACADEMIC DISHONESTY CASES

First Offense - In Violation Plea

1. If the professor and the Dean of Students agree that the evidence is sufficient to warrant a charge of academic dishonesty, the professor should contact the Office of Judicial Affairs to determine if this is a first violation of academic dishonesty. The incident will be reported via the following website: <http://students.georgiasouthern.edu/judicial/faculty.htm>
2. If it is a first violation, the professor should talk with the student about the violation. **If the student accepts responsibility in writing and the professor decides to adjudicate the case, the following procedures will be followed:**
 - a. The student will be placed on disciplinary probation for a minimum of one semester by the Office of Judicial Affairs.
 - b. The student will be subject to any academic sanctions imposed by the professor (from receiving a 0 on the assignment to receiving a failing grade in the class).

c. A copy of all the material involved in the case (Academic Dishonesty Report Form and the Request for Instructor to Adjudicate Form) and a brief statement from the professor concerning the facts of the case and the course syllabus should be mailed to the Office of Judicial Affairs for inclusion in the student's discipline record.

First Offense - Not in Violation Plea (student does not admit the violation)

If the professor and the Dean of Students agree that the evidence is sufficient to warrant a charge of academic dishonesty, the professor should contact the Office of Judicial Affairs to determine if this is the first or second violation of academic dishonesty. The student will be charged with academic dishonesty and the University Judicial Board or a University Hearing Officer would hear the case. If the student is found responsible, the following penalty will normally be imposed:

- a. The student will be placed on Disciplinary Probation for a minimum of one semester by the Office of Judicial Affairs.
- b. The student will be subject to any academic sanctions imposed by the professor.

Second Violation of Academic Dishonesty

If the professor and the Dean of Students agree that the evidence is sufficient to warrant a charge of academic dishonesty, and if it is determined this is the second violation, the student will be charged with academic dishonesty and the University Judicial Board or a University Hearing Officer would hear the case.

If the student is found responsible, the following penalty will normally be imposed:

- a. Suspension for a minimum of one semester or expulsion.
- b. The student will be subject to any academic sanctions imposed by the professor.

NOT RESPONSIBLE FINDING

When a student is found not responsible of academic dishonesty, the work in question (assignment, paper, test, etc.) would be forwarded to the Department Chair. It is the responsibility of the Chair to ensure that the work is evaluated by a faculty member other than the individual who brought the charge and, if necessary, submit a final grade to the Registrar. For the protection of the faculty member and the student, the work in question should not be referred back to the faculty member who charged the student with academic dishonesty.

In the case of a Department Chair bringing charges against a student, an administrator at the Dean's level will ensure that the student's work is evaluated in an appropriate manner.

CONFIDENTIALITY

In accordance with provisions of the Family Educational Rights and Privacy Act of 1974 and the Georgia Open Records Act, any information related to a violation of academic dishonesty or the outcome of a judicial hearing regarding academic dishonesty, is prohibited and must be treated as confidential by members of the faculty."

Disability-related Accommodations

Georgia Southern University is committed to providing reasonable accommodations to students with documented disabilities as required under federal law. Disabilities may include ADD or AD/HD, autism spectrum disorder, brain injury, chronic medical conditions, communication disorders, hearing loss, learning disabilities, mobility impairment, psychological disorders, visual

impairment or temporary injuries. The purpose of disability accommodation is to provide equal access to the academic material and equal access to demonstrate mastery of the material. If you have a disability and need accommodations, please contact the Student Accessibility Resource Center (SARC). You will need to meet with a SARC staff member who can help you gather documentation of your disability or refer you to an appropriate resource for assessment. Once documentation of the disability is approved, SARC staff will provide you with an accommodation letter detailing the approved accommodations which you should present to me so we can discuss and implement your accommodations. Disability accommodations work best starting at the beginning of the semester, but can be approved and started at any point in the semester. Accommodations start at the time the accommodation letter is presented to faculty within reasonable timelines; accommodations are not given retroactively. SARC on the Statesboro campus is located on the second floor of Cone Hall and the phone number is (912) 478-1566. SARC for Savannah and Liberty campuses is located on the second floor of Memorial College Center and the phone number is (912) 344-2572.

Basic Needs Statement

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students Office for support. The Dean of Students Office web address is <https://students.georgiasouthern.edu/dean>. You may also reach the Dean of Students Office for the Statesboro campus at (912) 478-3326 or deanofstudents@georgiasouthern.edu. For the Armstrong and Liberty campuses, you can also reach the Dean of Students Office at (912) 344-2514 or rmdeanofstudents@georgiasouthern.edu. Furthermore, please notify the professor if you are comfortable in contacting the Dean of Students Office for support. This will enable the professor to provide any other resources that they may possess.

University Calendar for the Semester

The University Calendar is located with the semester schedule, and can be found at: <http://em.georgiasouthern.edu/registrar/resources/calendars/>

One Final Note

The contents of this syllabus are as complete and accurate as possible. The instructor reserves the right to make any changes necessary to the syllabus and course material to ensure better student learning. The instructor will announce any such changes in class. It is the responsibility of the student to know what changes have been made in order to successfully complete the requirements of the course.

This syllabus, my lecture notes, and all materials distributed and presented during this course are protected by copyright law. You are authorized to take notes in this class but that authorization extends to only making one set of notes for your personal use and no other use. You are not authorized to sell, license, commercially publish, distribute, transmit, display, or record notes from this class unless you have my written consent to do so.

STUDENT CONDUCT CODE

The Student Conduct Code is the official University publication governing student conduct and behavior. It is the responsibility of each student to become familiar with the rules and regulations governing student life. Student conduct procedures, appeal procedures, and disciplinary sanctions are found in the Student Conduct Code at <http://students.georgiasouthern.edu/conduct>. I acknowledge that I have read and understand this statement referencing the Student Conduct Code.

ACADEMIC DISHONESTY

The University goal is to foster an intellectual atmosphere that produces educated, literate people. Because cheating and plagiarism are at odds with that goal, they shall not be tolerated in any form. Students are expected to adhere to the rules and regulations as set forth in the Student Conduct Code. Therefore, all work submitted by a student must represent that student's own ideas and effort; when the work does not, the student has engaged in academic dishonesty. Plagiarism occurs when a person passes in another person's work as his or her own, borrows directly from another person's work without proper documentation, and resubmits his or her own work that has been previously submitted without explicit approval from the instructor. For example, academic dishonesty occurs whenever a student participates in any of the following: Cheating submitting material that is not yours as part of your course performance; using information or devices that are not allowed by the faculty; obtaining and/or using unauthorized materials; fabricating information, research, and/or results; violating procedures prescribed to protect the integrity of an assignment, test, or other evaluation; collaborating with others on assignments without the faculty's consent; cooperating with and/or helping another student to cheat; demonstrating any other forms of dishonest behavior. Plagiarism directly quoting the words of others without using quotation marks or indented format to identify them; using sources of information (published or unpublished) without identifying them; paraphrasing materials or ideas without identifying the source; self-plagiarism - resubmitting work previously submitted without explicit approval from the instructor; unacknowledged use of materials prepared by another person or agency engaged in the selling of term papers or other academic material. NOTICE: The list above is intended only to provide general guidelines for recognizing and avoiding common types of academic dishonesty. It is in no way an exhaustive or comprehensive list of all the types of academic dishonesty. For more information about academic honesty, see the Student Conduct Code at <http://students.georgiasouthern.edu/conduct>. I acknowledge that I have read and understand the Academic Dishonesty Policy.

I have read the syllabus and understand the contents and course requirements.

Student Name (print)

Student Signature

Date