

ABE 6017: Stochastic modeling in ecology and hydrology

FALL 2020, 3 credit hours

ONLINE

Time: Mondays – Period 5 (11:45 AM - 12:35 PM)

Wednesdays – Period 5-6 (11:45 AM - 1:40 PM)

Pre-requisites: MAC2312 or equivalent

Basic calculus and college-level probability courses

Instructor: Rachata Muneeppeerakul, PhD

rmuneepe@ufl.edu; Phone: (352) 294-6729

Frazier Rogers Hall 227; Office Hours: by appointments

Graduate Teaching Assistants (email, office hours and location): N/A

Course Description

Stochastic modeling is introduced through a problem-based approach. Selected papers are studied in depth; derivation of their main results unpacked. Examples include stochastic models of biodiversity, soil moisture, and rainfall. Students pick stochastic models to study for final projects. Students enjoy deeper understanding from unpacking these otherwise seemingly mysterious results.

Learning Objectives:

Upon completion of this course, students will be able to:

- Unpack and explain the derivations of the basic results of stochastic models
- Apply the analytical techniques discussed in class to solve problems in other stochastic models
- Articulate the effects of stochastic fluctuation on the resulting dynamics based on the analysis of stochastic models

Assessment and Evaluation:

The final grade breakdown: Class participation: 15% | Assignments: 55% | Final project: 30%

Final grade will be rounded to the nearest integer; 85.5 will be rounded to 86.

**91-100 = A | 86-90 = A- | 81-85 = B+ | 76-80 = B | 71-75 = B- | 66-70 = C+ | 61-65 = C
| 56-60 = C- | 51-55 = D+ | 46-50 = D | 41-45 = D- | 0-40 = E**

Textbooks: None

Tentative Weekly course schedule:

Week	TOPIC*
1	Basic concepts in probability theory: random variables, expected value, variance, probability mass function (PMF), probability density function (PDF); Properties of selected standard random variables (binomial, exponential, Gaussian)
2	Basic concepts continued: Moment generating function (MGF) Examples of simple stochastic processes: Markov chain, 1st-order autoregressive (AR) model
3	Leigh, EG Jr. (2007) – Neutral theory of diversity: Relative species abundance (RSA)
4	RSA (cont'd); Probability of two random individuals belonging to the same species (F)
5	F under spatial settings; Generating function of the branching process
6	Rodriguez-Iturbe et al. (1999) – Soil moisture dynamic: Introduction and intuitive understanding of the process; Marked Poisson process; Memorylessness of exponential pulses; loss function
7	Combining the discussed elements; Derive forward Kolmogorov equation
8	Solve forward Kolmogorov equation for steady-state probability density function for soil moisture; Crossing properties
9	Wiener process: Introduction; Forward & backward Kolmogorov eqs; First passage time (FPT)
10	First passage time (FPT) Rodriguez-Iturbe et al. (1987) – Rectangular pulse models of rainfall: Introduction; Derive expected value and variance of the process
11	Moment generation function of the rainfall process <i>PROJECT PROGRESS REPORTS</i>
12	Derive autocorrelation coefficient, PDF of the number of active rain cells
13	Neyman-Scott process: Introduction; Derive expected value, variance, autocovariance
14	<i>PROJECT PROGRESS REPORTS</i> <i>WORKSHOPS TO HELP WITH FINAL PROJECTS</i>
15	TBD*
16	FINAL PROJECT PRESENTATIONS

* The schedule is tentative. Actual schedule would depend on progress and interest in class.

Assignments

Assignments are usually due within 1-1.5 weeks after the date they are assigned.

HW	Will be assigned in week	Brief description*
1	2	State problems of your interest Calculate expected value and variance of a random variable Analyze 1 st -order autoregressive model of annual stream flow
2	4	Memo on <i>Leigh (2007)**</i> Calculate the probability that two random selected individuals belong to the same species in a neutral model Analyze a property of moment generating function
3	7	Memo on <i>Rodriguez-Iturbe et al. (1999)**</i> Derive statistics of a compound Poisson random variable Derive the probability density function (pdf) for a marked Poisson process with a constant loss function Compile potential papers for your project
4	9	Derive steady-state probabilities of different states in a random telegraph process Derive the autocovariance of Wiener process
5	11	Memo on <i>Rodriguez-Iturbe et al. (1987)**</i> Derive the pdf of the number of active rain cells in a rectangular pulse model of rainfall

* The assignment descriptions are based on a recent offering and are subject to change.

** For memos, please refer to the papers in Sample Readings below. The papers to be discussed in class may change based on the class interests.

For the final project, students will form groups based on their common interest. Each group will select, with the instructor's guidance and approval, a stochastic modeling paper in their field, in which some basic results of the stochastic model are reported the derivation of those results are omitted or unclear. The group's main task is to work out the detailed derivation of these results and report to the class. Throughout the semester, each group will present 2 or 3 progress reports to inform the instructor and the class on where they are and, importantly, what difficulty they are facing in deriving the results in their selected paper, so that the instructor can provide assistance in a timely manner. These progress reports are designed to keep the group's work on track and are not worth any points.

Sample Readings:

(Notes: we would likely *not* have time to cover all papers listed below; we may cover them in a different order; and we may even switch to different papers, depending on the interest and progress of the class.)

Leigh, E.G. Jr. 2007. Neutral theory: a historical perspective. *Journal of Evolutionary Biology* **20**: 2075-2091.

Volkov, I., J.R. Banavar, S.P. Hubbell, & A. Maritan. 2003. Neutral theory and relative species abundance in ecology. *Nature* **424**: 1035-1037.

McKane, A.J., D. Alonso, & R. V. Solé. 2004. Analytical solution of Hubbell's model of local community dynamics. *Theoretical Population Biology* **65**: 67-73.

Chave, J. & E.G. Leigh Jr. 2002. A spatially explicit neutral model of β -diversity in tropical forests. *Theoretical Population Biology* **62**: 153-166.

Rodriguez-Iturbe, I., A. Porporato, L. Ridolfi, V. Isham, & D.R. Cox. 1999. Probabilistic modeling of water balance at a point: the role of climate, soil and vegetation. *Proceedings of the Royal Society, London, A* **455**: 3789-3805.

Laio, F., A. Porporato, L. Ridolfi, & I. Rodriguez-Iturbe. 2001. Mean first passage times of processes driven by white shot noise. *Physical Review E* **63**, 036105.

Leigh, E.G. Jr. 1981. The average lifetime of a population in a varying environment. *Journal of Theoretical Biology* **90**: 213-239.

Rodriguez-Iturbe, I., D.R. Cox, & V. Isham. 1987. Some models for rainfall based on stochastic point processes. *Proceedings of the Royal Society, London, A* **410**: 269-288.

Grades and Grade Points

For information on current UF policies for assigning grade points, see

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

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:

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance>.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-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/

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

COVID-19-related policies

In response to COVID-19, the following policies and requirements are in place to maintain your learning environment and to enhance the safety of our in-classroom interactions.

- You are required to wear approved face coverings at all times during class and within buildings. Following and enforcing these policies and requirements are all of our responsibility. Failure to do so will lead to a report to the Office of Student Conduct and Conflict Resolution.
- This course has been assigned a physical classroom with enough capacity to maintain physical distancing (6 feet between individuals) requirements. Please utilize designated seats and maintain appropriate spacing between students. Please do not move desks or stations.
- Sanitizing supplies are available in the classroom if you wish to wipe down your desks prior to sitting down and at the end of the class.
- Follow your instructor's guidance on how to enter and exit the classroom. Practice physical distancing to the extent possible when entering and exiting the classroom.
- If you are experiencing COVID-19 symptoms ([Click here for guidance from the CDC on symptoms of coronavirus](#)), please use the UF Health screening system and follow the instructions on whether you are able to attend class. [Click here for UF Health guidance on what to do if you have been exposed to or are experiencing Covid-19 symptoms](#).
- Course materials will be provided to you with an excused absence, and you will be given a reasonable amount of time to make up work. [Find more information in the university attendance policies](#).
- Student Behavioral Expectations. The university released a policy on student behavioral expectations in response to covid-19. <https://policy.ufl.edu/policy/student-behavioral-expectations-in-response-to-covid-19/>

Campus Helping Resources

Health and Wellness

U Matter, We Care: Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, 3190 Radio Road, 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the Office of Title IX Compliance, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. <https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu>

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. <https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. <https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus:

https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.