MTH 453: Basic Random Processes

Spring 2018

University of Rhode Island, Department of Mathematics

INSTRUCTOR:	**Jonathan A. Chávez Casillas**
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LECTURE TIMES:	Tuesday and Thursday, 14:00 - 15:15. Lippitt Hall 201
OFFICE:	Lippitt Hall 200A
OFFICE HOURS:	Wednesday 11 am - 2pm (Or by appointment)[1]

※ **Course Objectives and Goals:** This course will provide the student with the basic theoretical and practical tools needed to understand and develop basic models where randomness is a driving force. The intention of this course is to develop a wide variety of models that go farther from rolling dice, flipping coins, and gambling games, but to the spread of infectious diseases, the evolution of genetic sequences, models for climate change, and the growth of the World Wide Web. This course assumes that the student has taken a calculus-based probability course and is familiar with matrix algebra, particularly spectral theory of eigenvalues and eigenvectors. However, the course does not assume background in combinatorics, differential equations, or real analysis. All the necessary mathematics is introduced as needed. It is important to say that one of the main objectives of the course is to introduce and analyze the theory with the aid of simulation, using particularly the freeware R. The use of simulation, will become pivotal for the development of applied work and further theoretical research.

※ **Brief Course Description:** The course will be divided mainly in three parts:

- **Probability Review, Conditional Expectation and the usage of R** A concise review of the concepts needed in probability will be made. Also, the concept of conditional probability and expectation will be studied and explained as to why is a cornerstone of random processes. Finally, a brief introduction to R programming language and functions will be given.

- **Introduction to Random Processes and Markov Chains:** A very brief introduction to Random processes and random evolution in time will be given. Further, the foundation and ergodicity of Markov chains (in discrete and continuous time) will be discussed and applied to model random phenomena. Finally, the theory will be complemented by using simulation to predict and understand the random outcomes.

[1] The student should supply a reason why he/she cannot attend the regular office hours

- **Examples of more General Random Processes:** After understanding the fundamental example that Markov chains provide, the course will focus on briefly analyzing different types of random models, starting from Poisson processes, going through their time and space generalizations as renewal processes and point processes. Next an introduction to Markov Chain Monte Carlo (MCMC) methods will be discussed and if time permits Brownian motion will be introduced.

※ **Textbook:** The official textbook that will be used for the class will be

- "Introduction to Stochastic Processes with R" by Robert Dobrow.

You can find this book at the campus bookstore. Other important textbooks that will be used are:

- "Probability for Statistics and Machine Learning" by Anirban DasGupta.
- "Essentials of Stochastic Processes" by Rick Durrett.
- "Basic Stochastic Processes" by Brzezniak and Zastawniak.
- "Stochastic Processes: Theory for Applications" by Robert Gallager.

※ **Grade Description:** There will be two Midterm and a *Cumulative* Final Exam. There are no make-up homeworks or exams. If you need to be absent from a class or test for valid reasons, you should notify the instructor with anticipation and the weight will be sent to the final examination. For reference, see section 8.51 of the University Manual. The grade will be computed as follows:

Exam 1:	20%	Feb 20th, Evening Exam
Exam 2:	20%	April 3rd, Evening Exam
Homework:	30%	Might be once every lecture.
***Cumulative* Final Exam:**	30%	TBA

- **Exams:** The midterms and the *Cumulative* Final Exam will be a combination of multiple choice, true or false (justified) questions and open answer questions. There is no partial credit for the multiple choice questions. However, there will be partial credit in the true/false and open answer questions. **There are no make-up exams**. If, for any **valid** reason (up to the discretion of the instructor), you cannot attend the midterm, the weight will be shifted towards the final exam. The midterm exams will be proctored on the evening to avoid loosing class periods.

- **Homework:** Homework may be assigned at the end of each lecture. It is the student's responsibility to complete all the assign exercises and to go to office hours or ask in class if there are questions. The homework may use theoretical knowledge learnt from calss and it may involve the student reading extra material to complete it. Computer simulations will be used also on homeworks.

※ **Attendance and Course Expectations:** The student is expected to attend all the lectures even-though there is no official "roll call". **This is a very demanding course** and it is expected hard work from the students. Students are responsible for all missed work, regardless of the reason for absence. It is also the student's responsibility to get all missing notes and material covered within that missed lecture. Moreover, the student is expected to:

- **Clear Writing:** All the student work presented to the instructor (quizzes, exams, homework questions) should be legible and clean. No steps should be skipped when doing a rational deduction.

- **Homework:** Do all the homework assigned even-though it is not graded. The fast pace of the class require that the student perform work out of class.

- **Prepare for lecture:** The student is expected to read the material of the class prior to attending. The different topics and fast pace require that the student reads the textbook before coming to class.

- **Ask for questions:** If the student does not understand some points of the lecture, the student is expected and encouraged to ask questions in lectures and attend office hours if needed.

- **Standards of behavior:** Students are responsible for being familiar with and adhering to the "Community Standards of Behavior: University Policies and Regulations" (found at `web.uri.edu/studentconduct/university-student-handbook`). If the student arrives late to class, he/she should not disrupt the class. All cell phones or any electronic devices must be turned off.

※ **Make up policy:** As mentioned above, there are no make-up exams or homeworks. If there is a valid reason for missing a test, the weight will be redistributed towards the final exam.

※ **Academic Honesty Policy:** Cheating is defined in the University Manual section 8.27.10 as the claiming of credit for work not done independently without giving credit for aid received, or any unauthorized communication during examinations. Students are expected to be honest in all academic work. Consequences for any charge of cheating or plagiarism will follow the guideline established in the University Manual 8.27.10-8.27.21, `http://web.uri.edu/manual/chapter-8/chapter-8-2/`.

※ **Special Needs:** Students with disabilities should contact the instructor at the beginning of the semester so that he/she is provided reasonable accommodations. Students must also contact Disability Services for Students: Office of Student Life, 330 Memorial Union, 874-2098 to determine the appropriate accommodations.

※ **Religious holidays:** Per policy of the University of Rhode Island, on an individual basis, the student has the opportunity to observe their traditional religious holidays. However, a written notification to each instructor is required.

※ **Tentative Course Outline:** The weekly coverage might change as it depends on the progress of the class. Some sections may be ommitted.