INDE 572/STAT 572: Stochastic Processes and Simulation

Date: Spring 2020
Time: TTh 1:00 pm – 2:15 pm
Location: Herzstein Hall HRZ 210

Instructor:
Prof. John A. Dobelman
dobelman@stat.rice.edu
Duncan Hall 2100: 713 348 5681
Office Hours: By appointment.

Teaching Assistant (TA):
Logan Smith, DH 3066
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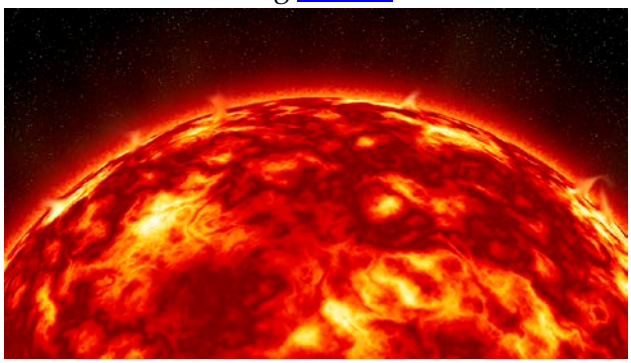
Office Hours: Tu/Th afternoons or by appointment

Course Website:
http://dobelman.rice.edu (see courses)
We will also be using Canvas



Sponsored Message Regarding Student Responsibility

The Committee on Examinations and Standing has asked that we reiterate the responsibilities of the student to comply with deadlines affecting their status and standing. Essentially this means that you need to be aware of the deadlines for which you alone are responsible (i.e., not your advisor, etc.). This data is maintained at registrar.rice.edu/calendars.

Course Text

Bruce Hajek, *Random Processes for Engineers*, Cambridge: Illinois 2015, ISBN 978-1-107-10012-1.

James R. Thompson, *Simulation, a Modeler's Approach*, John Wiley & Sons: New York, 2000. ISBN: 978-0-471-25184-2.

Thompson, J.R. and J. Koronacki, *Statistical Process Control: The Deming Paradigm and Beyond, 2nd edition*, Chapman and Hall/CRC: New York, 2002. ISBN: 978-1-584-88242-8.

In addition to the course texts, a myriad of other resources is available; for example, we have compiled a list of good source materials and some standard textbooks that cover various parts of a course in advanced methods. This reading list is available at ReadingList.AdvancedMethods.pdf. Notes or references to course material will be given throughout the semester; some are posted in the Canvas Files areas (Reference & Texts or Handouts)

Textbook

Students are expected to have purchased their required texts during the first week of class. If the text is available at the "Rice" bookstore, and the student elects to purchase the book elsewhere, and this elsewhere-obtained book is not in hand, the student is nonetheless responsible for all assignments and readings. Rice University is generally not able to provide copies of these texts for your use.

Course Objectives:

This course is designed to provide an overview of stochastic processes and simulation at an advanced undergraduate or graduate level suitable for applications in Industrial Engineering. Background in a

calculus-based probability and statistical inference course is assumed. Topics include: Markov chains, renewal processes, queueing theory, statistical quality control, discrete-event simulation, random number generators, Monte Carlo methods, resampling methods, Markov Chain Monte Carlo, importance sampling and simulation based estimation for stochastic processes.

Course outcomes

By the end of the course the student will be able to combine the developed concepts to come up with an approach, and perform the necessary calculations needed to solve, specific mathematical statistical stochastic process, simulation and statistical process control problems.

Course Content:

Statistical process control

Design of experiments
Quality control
Statistical process control

Stochastic processes

Memorylessness

Stochastic process
Filtration
State space
State-space representation and control
Markov property
Markov chain
Birth-death process
Queueing theory
Agner Krarup Erlang
Erlang distribution
Poisson Siméon Denis
Poisson point process
Poisson process compound
Renewal theory

Simulation

Random number generation
Stochastic simulation
Discrete-event simulation
Monte Carlo method
Markov chain Monte Carlo
Importance sampling
Rejection acceptance sampling
Rare event sampling

Grading:

Grading for this course will consist of homework exercises from the texts or mini-projects (25%), a midterm examination (30%), a final examination (35%), and 10% course participation.

Assignment Submission and Late policy

All assignments must be submitted in class on the date due as hard copy to the instructor or his designee. You MUST INCLUDE the homework cover page available on Canvas (Files/Reference & Helpfiles). The instructors/TA will not be able to print out e-mailed or online-only assignment submissions. Late papers will in general not be accepted without a university approved excuse. A 20% penalty for HW turned in by next class may be applied; no credit for submissions later than this, although you might be able to negotiate with the grader.

Examinations

Exams will usually be closed-book and closed-notes, except that a single piece of paper "cheat-sheet" is permitted. Calculators are permitted, under pledged conditions; NO INTERNET is permitted. Usually a computer is not required.

Final Examination

Final examinations will be conducted in accordance with the registrar's policy on such exams. The final is expected to be based on material covered since the mid-term exam, but which will necessarily be cumulative! The final will be held on the date designated by the Registrar, and is provided around the middle of the semester on the Course Schedule and Catalog website. If you are planning on traveling after the semester is completed, DO NOT MAKE TRAVEL PLANS until the final exam date has been set by the Registrar's office; the safest approach is to not travel until after the last day of finals period.

Attendance:

Students are expected to attend class. Much material is presented in class which might not otherwise be in texts, notes, etc. Attendance will be reflected in the Class Participation portion of the course grade. Although we plan on keeping the course website up to date, if a student misses a class, then he/she is responsible for keeping up with the course material and finding out if any exams, quizzes, or homeworks have been assigned or scheduled. Similarly, changes to important due dates might sometimes be made in class to your benefit which might not be immediately posted on Canvas.

Laptops and Wearable/Portable Electronic Devices (PED).

Unless so requested by the instructors, please do not use these devices during class, they are a distraction to other students. Prohibited devices include laptops, headphones, earbuds, gaming devices, mp3/music/media players, cell/smart-phones, PDA's, Kindle/e-book readers, tablet computers/readers, Apple watch/i* devices, multi-purpose wrist communicators, cameras, GPS/GIS devices, Google glasses, VR devices, etc. etc. Hearing aids are acceptable to use in accordance with the last item (disabilities) and procedures herein. From time to time the instructors may ask a student to look something up, but in most cases this is not necessary. If the student requests, such devices may be permitted, if the purpose is clearly articulated in advance. The student will be asked to put away their PED's if they are taken out in class; upon the second request, the student will be dismissed from class.

Use of Canvas

The Canvas system is the course management tool for announcements, assignments, resources, etc. All course management will take place through Canvas. Please do not email the instructor/TA questions about the course or assignments, but rather post as a discussion on Canvas so that all can see the conversation. Post your question on the Canvas website under the 'Discussions' tab. Discussion among students both on the forum and in person is HIGHLY encouraged. If you see a question posted on the discussion forum and you know the answer, please feel free to respond. If online submission for assignments is required, please upload in the appropriate area (usually in the assignments section).

Software

Although this is a mathematically-oriented course, which could theoretically provide for no calculations whatsoever, such an approach today is unrealistic. Many problems you will be solving would benefit from numerical likelihood calculations, inversions, bootstrapping, numerical integration/optimization, etc., if only to check theoretical results.

It is impossible to perform statistical/quantitative data analysis today without some sort of computer software, and it is expected that the student will become proficient with one or more statistical software packages. The most widely used data analysis software in the real world today is Microsoft Excel, and its capabilities are impressive. However, more specialized software is sometimes needed, such as Matlab, R, S-Plus, SAS, Resampling Stats, SPSS, Stata, StatTools, StatExact, Lisrel, @Risk, Maple, Mathematica, C-Plex, SQL, etc. Of these, R has become the choice of many because of its ease of use and low cost (FREE!) Download information for some of these packages is available on the course website(s).

One can also program most statistical procedures in a "high-level" programming language such as Java, C/C#/C++, Fortran, VB, etc., along with specialized add-in routine libraries, but these require a lot of work to code and debug. Additionally, you will find that most corporate employers will not be paying for the nice software that is available for you here on campus. Consequently, to enhance your value to your future employer, we suggest that you become proficient in Excel, R/Python and SQL/SAS. Note that a good word processor will also be required in order to prepare reports and presentations; Microsoft Word, OpenSource, LaTeX, etc., are candidates for use in preparing these documents, although use of LaTeX in the business world is sparse. Online collaborative solutions such as Google Docs may be useful for initial collaboration, but your final work product will be a standalone document; please submit all work as a Microsoft product (i.e., not .wpd, .pages, etc.) Additionally, not all persons have the required Google account in order to use Google Docs.

Rice Honor Code:

Before enrolling in this course, you must understand and agree to abide by the Honor System in place at Rice University which protects the academic integrity of all coursework. All students (including graduate students) at Rice are bound by the Rice Honor Code. The Honor Code is a unique feature at Rice, one that is valued highly, and is of profound importance. New students should familiarize themselves with the Honor Code before starting classes. **Honor Code violations are very serious, and can lead to dismissal from the University**. Suspected violations will be processed in accordance with applicable procedures; see http://honor.rice.edu.

Examinations, if held, are conducted under pledged conditions. Proper recitation and use of the Honor Pledge on examinations will be enforced. Note that the use of prior years' and other solutions to pledged exercises is considered UNAUTHORIZED AID and is not permitted under the Rice Honor code.

If homework and individual assignments/projects may be worked on with other class members, each student must submit their own work for credit. Homeworks should be submitted by each person, but you should indicate with whom you worked when applicable. No direct copying is allowed. Group projects and assignments may be submitted by the group, per submission requirements above.

Disabilities:

Any student with a documented disability wishing academic adjustments or accommodation is required to speak with the instructor about it during the first two weeks of class. All discussions will remain confidential. Additionally, you must make sure this documentation is on file with Disability Resource Center, Room 111 | adarice@rice.edu | x5841) in order to register your disability and to determine the accommodations you need. The instructor cannot make accommodation without the appropriate letter from Rice DRC. Additional program and documentation requirements and responsibilities are spelled out at http://drc.rice.edu/.

Changes to Syllabus

Changes to this syllabus may be published from time to time, with notice and explanation given in class and via Canvas (if used).

Rev: 1/3/2020