

DEPARTMENT OF PREVENTIVE MEDICINE

SYLLABUS: PM 520: ADVANCED STATISTICAL COMPUTING.

Instructor: Paul Marjoram, Ph.D.
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Teaching Assistants: TBD

Office Hours : By appointment.

Class Meets: Monday, 1pm-4pm.

Course Objective:

The objective of the course is to give you the skills to enable you to both be able to program, and better understand, statistical machinery using the R programming language. Note that this is not really a course about R, as such. Instead, we use R as a way of illustrating how to write code to perform a number of probabilistic and statistical procedures. We will introduce the R details as we go, but students will be expected to invest some time of their own each week, outside class, in which they improve their R programming skills if necessary.

Each week's lecture (60-90 minutes) will focus on one or more areas in probability and statistics, describing how those procedures are performed. The rest of the class (90-120 minutes) will be a lab in which students will sit down and start to code those procedures in class. Students will be encouraged to show their work "in progress". For example, you've written 30 lines of code and it isn't working properly: we will put the code on the screen and we will all try to work out what is wrong. In other words, we will learn by doing, and by learning from our mistakes, rather than relying upon the traditional method of listening to a member of faculty drone on for 3 hours. In doing so we hope to make the course more interactive. As the saying goes: turn-about is fair play. So, as the instructor, I will also display bugged code of my own to the rest of the class, so that we can learn from my mistakes as well.

The course will be examined by a number of projects during the course. These projects will involve writing R code to perform a particular task (optimize a function, fit a regression, simulate a stochastic process,...). That code will be turned in to me and I will run it on some test problems to see how it does. In addition, the final exam will consist of your giving small group (2-3 people) presentations regarding statistical computing methods.

Recommended Textbook: "Scientific Programming and Simulation Using R" – Owen Jones, Robert Maillardet and Andrew Robinson, CRC Press. This book will (I think) be available from the USC bookstore, but can also ordered from Amazon (\$70 to buy; \$50 to rent).

Please note that each student will also be required to bring a laptop to each class so that they can actively write code during the lab.

Other Material: Copies of slides will be posted, as will example bits of code.

Grading: 60% projects + 30% final presentation + 10% participation.

Pre-requisites: None, but you will need to have some basic statistics and probability. If you are not sure, come and see me to talk about it.

PROPOSED COURSE OUTLINE:

Most weeks will be based upon one of the chapters from the course text, but some of the latter weeks will digress from the text and use material that will be distributed or described in class [labeled “(external material)”].

Week 1: Introduction – Random number generation and Monte Carlo Estimation. How to estimate things that you cannot calculate. Coin-tossing. Occupancy problems. Hypercubes. Golf balls.

Week 2: More Monte Carlo Estimation: Estimating π , Random variable simulation, Likelihood Estimation. Bayesian methods. Accept/Reject Algorithms (external material).

Week 3: Methods for finding function roots and fixed points. Math as art. (Chapter 10 of course text).

Week 4: Probability and Stochastic Simulation – Urn Models and Chinese Restaurants (Chapter 18 vol 1; or *Chapter 20, in the 2nd ed.*).

Week 5: Optimization and Regression (chapter 12)

Week 6-8: Markov Chain Monte Carlo [MCMC] Methods. Adaptive MCMC, Parallel Tempered-MCMC, Code-breaking (external material).

Week 9: Gibbs Sampling, Accept/Reject Algorithms (external material).

Week 10: Permutation tests, Numerical Integration and Importance Sampling (Chapters 19 and 22; *chaps. 21 and 24 in the 2nd ed.*).

Week 11: Approximate Bayesian Computation, ABC-Rejection, ABC-MCMC (external material).

Week 12: Sequential Monte Carlo Methods, Regression-adjusted ABC (external material)

Week 13: Hidden Markov Models, Genetic Algorithms. (external material)

Closing Project: Short presentation from a topic we haven't covered in the course: e.g. E-M algorithms, fancy MCMC version, (e.g. Hamiltonian MCMC, Empirical Bayes methods, Boot-strapping,...), or a related project from your own research.

STATEMENT FOR STUDENTS WITH DISABILITIES:

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

STATEMENT ON ACADEMIC CONDUCT AND SUPPORT SYSTEMS

Academic Conduct:

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, “Behavior Violating University Standards” policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, policy.usc.edu/scientific-misconduct.

Support Systems:

Student Health Counseling Services - (213) 740-7711 – 24/7 on call
engemannshc.usc.edu/counseling

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 – 24/7 on call
engemannshc.usc.edu/rsvp

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) | Title IX - (213) 740-5086
equity.usc.edu, titleix.usc.edu

Information about how to get help or help a survivor of harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following protected characteristics: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations.

Bias Assessment Response and Support - (213) 740-2421
studentaffairs.usc.edu/bias-assessment-response-support

Avenue to report incidents of bias, hate crimes, and microaggressions for appropriate investigation and response.

The Office of Disability Services and Programs - (213) 740-0776
dsp.usc.edu

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Support and Advocacy - (213) 821-4710

studentaffairs.usc.edu/ssa

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101

diversity.usc.edu

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

dps.usc.edu, emergency.usc.edu

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call

dps.usc.edu

Non-emergency assistance or information.