STAT 633 Statistical Computing

Spring 2021

Instructor: Dr. Seungchul Baek
Class Time/Place: 4:00-5:15pm TTh via Blackboard
Office Hours: 3:00-4:00pm TTh via WebEx or by appointment
Email: baek@umbc.edu
Course website: (primary) Blackboard; (secondary) http://baek.math.umbc.edu/stat633s21.html/

Textbook (optional):

[1] Geof H. Givens and Jennifer A. Hoeting (2013). *Computational Statistics*, 2nd edition. John Wiley & Sons, Inc.

[2] Robert & Casella (2014). *Monte Carlo Statistical Methods*, 2nd Edition. Springer.

[3] Maria L. Rizzo (2019). *Statistical Computing with R*, 2nd Edition. Chapman & Hall/CRC.

Course Overview:

This course is an introduction to statistical computing at the graduate level. We will discuss the following topics: random number generation; transformation method; acceptance-rejection sampling method; importance sampling; optimization; root-finding algorithms; EM algorithms; Markov Chain Monte Carlo methods—Metropolis-Hastings, Gibbs sampling, convergence diagnostics; bootstrap, jackknife and cross validation; smoothing splines; kernel density estimation.

Prerequisite:

A good background for probability and statistics is desirable, e.g., a grade of "B" or higher for STAT 355 or STAT 451-453 or STAT 611. If you are familiar with R, it is good, but not necessarily.

Learning Outcomes:

By the end of the semester successful students should be able to do the following:

- Be familiar with the existing statistical algorithms for the commonly seen problems
- Understand the theoretic background to those fundamental algorithms
- Build computational skills needed for their research and dissertation work.

Grade Breakdown:

Your course grade will be determined by your performance on **homework (35 percent), the midterm (20 percent), the final exam (25 percent), and the project (20 percent)**.
Final course grades will be assigned according to the following protocol: A=[90,100), B=[80,90),

C=[70,80), D=[60,70), and F=[0,60).

Homework:
The homework assignments are an important part of this course and are weighed heavily. Homework must be submitted with a careful and concise write-up of the results (including any necessary mathematical derivations, a description of an algorithm, numerical output organized neatly into a table or graph, and analysis/interpretation of numerical results). Any necessary codes should also be attached, however, a solution to a problem that consists of only code and output will receive no credit. **Late homework will NOT be accepted.**
Working together on homework assignments is permitted and encouraged. However, each student must write up his/her solutions independently of others. Copying someone else's work is not tolerated. If it happens, both parties will receive a 0 for the assignment as well as being reported to the University Academic Integrity Committee.

Exams:
We will have midterm and final exams, and all of them will be take-home.

- Midterm Due: **Tuesday, March 30**. Will be posted: Tuesday, March 23 (Tentative)
- Final Due: **Thursday, May 13**. Will be posted: Thursday, May 6

Please note that I do not give make-up examinations unless your absence is due to a university function or emergency case, you have given me appropriate documentation, and you have discussed it with me at least one week in advance.

Project:
Every student in class of STAT 633 is required to complete a course project. You need to submit a proposal about what you are going to do for the project by **Tuesday class on March 23**. This proposal should contain a brief introduction to your project, and it should be 2-3 pages long. The final report should be 10-25 pages long and will be due by **Tuesday class on May 4**. Each student is supposed to give a presentation on her/his project for about 25-30 minutes in class. A specific time for a presentation will be assigned.
You can either analyze an interesting data set, evaluate a certain method (estimation or testing), compare some computational algorithms, or propose a new (or modified) method for the problem you work on using the techniques learned in this class. Each project report is expected to contain three parts: introduction, main content, and discussion. The introduction part should clearly state what the research questions are and why they are worth studying. The main content should present the methods you use, the main results you obtain, together with the supporting evidences—such as simulation results and/or real data analysis. The discussion part can contain a brief summary of your results and provide some comments on the research topic or/and the method. A section of

references is recommended after the discussion section if your report cites some important results from other people.

If you summarize a literature article, you must state clearly what you have learned from the paper. It would be great if you can conduct some numerical analysis to help you understand the concept and approach better. For example, you can try to reproduce their simulation or data analysis, or provide an alternative for a comparison.

The report should be typed, double-spaced, using complete sentences, good grammar, and transition between the various sections. The report will be graded based on its clarity and completeness, and the correctness of applying statistical methods and of interpreting your results.

Computing:

Algorithms will be broadly illustrated using R. You are encouraged to learn and use a compiled language such as C++ or Fortran for your dissertation work on your own.

Recommended Study Habits:

- Attend every class and be on time although we are meeting virtually.
- Ask questions if you do not understand something or wish to know more.
- Check email often for announcements.
- Form small study groups to work on homework and to prepare for the exams.
- Email me as soon as possible if you have any questions.
- Make it your goal to understand everything we do.

Academic Integrity in the Online Instruction Environment:

Academic integrity is an important value at UMBC. By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal. These principles and policies apply in both face-to-face and online classes. Resources for students about academic integrity at UMBC are available at https://academicconduct.umbc.edu/resources-for-students/.

Accessibility and Disability Accommodations, Guidance and Resources:

Support services for students with disabilities are provided for all students qualified under the Americans with Disabilities Act (ADA & ADAAA) and Section 504 of the Rehabilitation Act who

request and are eligible for accommodations. The Office of Student Disability Services (SDS) is the UMBC department designated to coordinate accommodations that would create equal access for students when barriers to participation exist in University courses, programs, or activities.

If you have a documented disability and need to request academic accommodations in your courses, please refer to the SDS website at http://sds.umbc.edu for registration information and office procedures.

SDS email: disAbility@umbc.edu
SDS phone: (410) 455-2459

If you will be using SDS approved accommodations in this class, please contact me (instructor) to discuss implementation of the accommodations. During remote instruction requirements due to COVID, communication and flexibility will be essential for success.

Official UMBC Title IX Guidance: (link)