CS 533 - Spring 2019

Experimental Methods in Computer Science

This course explores the design, experimentation, testing, and pitfalls of empirical research in Computer Science. In particular, students will learn how to use a data-driven approach to understand computing phenomena, formulate hypotheses, design computing experiments to test and validate or refute said hypotheses, evaluate and interpret empirical results. Overall, the goal of this course is to provide the students with the foundations of rigorous empirical research.

Instructors

Prof. Abdullah Mueen

Assistant Professor, Email: <u>mueen@unm.edu</u> Room: 3020, Farris Engineering Center (FEC) Office Hours: Tuesday 2:00PM-3:00PM, Wednesday 10AM-12PM

Prof. Matthew Fricke

Research Assistant Professor, Email: mfricke@unm.edu Office: Farris Engineering Center 3330 Office Hours: Monday 9:00-10:00am or by appointment.

Hoss Craft

Graduate Teaching Assistant Email: wdcraft@unm.edu Office: 2085 Farris Engineering Center (FEC) Office Hours: Tues & Thurs 12:30–1:45 PM, other times happily available by appointment. TA office hours may change over the semester to better accommodate student need.

Textbooks

Most lectures in the first half of the semester will be loosely based on the following **optional** textbooks:

 Applied Statistics and Probability for Engineers 6th Edition by Douglas C. Montgomery (Author), George C. Runger (Author)



2. Simulation Modeling and Analysis (Mcgraw-hill Series in Industrial Engineering and Management) 5th Edition - by Averill M Law (Author)

POLICIES

Academic honesty

Unless otherwise specified, you must write/code your own homework assignments. You cannot use the web to find answers to any assignment. If you do not have time to complete an assignment, it is better to submit your partial solutions than to get answers from someone else. Cheating students will be prosecuted according to University guidelines. Students should get acquainted with their rights and responsibilities as explained in the Student Code of Conduct http://dos.unm.edu/student-conduct/academic-integrityhonesty.html

Any and all acts of plagiarism will result, at the sole discretion of the instructors, in an immediate dismissal from the course and an official report to the dean of students.

Instances of plagiarism include, but are not limited to: downloading code and snippets from the Internet without explicit permission from the instructor and/or without proper acknowledgment, citation, or license use; using code from a classmate or any other past or present student; quoting text directly or slightly paraphrasing from a source without proper reference; any other act of copying material and trying to make it look like it is yours.

Note that dismissal from the class means that the student will be dropped with an F from the course.

The best way of avoiding plagiarism is to start your assignments early. Whenever you feel like you cannot keep up with the course material, your instructor is happy to find a way to help you. Make an appointment or come to office hours, but DO NOT plagiarize; it is not worth it! It hurts the other students and yourself in the long run,

Class attendance

Attendance to class is expected (read mandatory) and note taking encouraged. Important information (about exams, assignments, projects, policies) may be communicated only in the lectures. We may also cover additional material (not available in the book) during the lecture. If you miss a lecture due for reasons described in the University absence policy, you should determine what material was covered and if any announcements were made. For more information see https://pathfinder.unm.edu/campus-policies/class-absences-and-student-attendance.html.

"Students should not assume that nonattendance results in being dropped from class. It is the student's responsibility to initiate drops or complete withdrawals within published deadlines utilizing LoboWeb or via forms available on the Registrar Web site (<u>http://registrar.unm.edu</u>)."

Excerpt from: http://catalog.unm.edu/catalogs/2015-2016/student-services-information.html

ADA

In accordance with University Policy 2310 and the Americans with Disabilities Act (ADA), academic accommodations may be made for any student who notifies the instructor of the need for an accommodation. If you have a disability, either permanent or temporary, contact Accessibility Resource Center at 277-3506 for additional information.

Please discuss ADA accommodations with Prof. Mueen at the beginning of the course.

Title IX

Our classroom and our university should always be spaces of mutual respect, kindness, and support, without fear of discrimination, harassment, or violence. Should you ever need assistance or have concerns about incidents that violate this principle, please access the resources available to you on campus, especially the LoboRESPECT Advocacy Center and the support services listed on its website (http://loborespect.unm.edu/). Please note that, because UNM faculty, TAs, and GAs are considered "responsible employees" by the Department of Education, any disclosure of gender discrimination (including sexual harassment, sexual misconduct, and sexual violence) made to a faculty member, TA, or GA must be reported by that faculty member, TA, or GA to the university's Title IX coordinator. For more information on the campus policy regarding sexual misconduct, please see: https://policy.unm.edu/university-policies/2000/2740.html.

Citizenship and/or Immigration Status

All students are welcome in this class regardless of citizenship, residency, or immigration status. Your professors will respect your privacy if you choose to disclose your status. As for all students in the class, family emergency-related absences are normally excused with reasonable notice to the professors, as noted in the attendance guidelines above. UNM as an institution has made a core commitment to the success of all our students, including members of our undocumented community. The Administration's welcome is found on our website: http://undocumented.unm.edu/.

ASSIGNMENTS

These assignments reinforce what you learned in class by materializing abstract concepts into practical problems. Every project usually consists of a programming assignment. Tentative schedule is as follows:

- Assignment 1, Random Number Generation and Hypothesis Testing
- Assignment 2, Traffic Simulation
- Assignment 3, Algorithm Performance on Real Computers
- **Assignment 4**, Experiment Driven Coding Applied to the Pathway Complexity Problem. This project will result in an open source linux package.

You can discuss assignments with other classmates but all the code have to be written by you. Any student suspected of plagiarizing code will be prosecuted according to the University guidelines. Project reports and code have to be uploaded to UNM Learn. No late assignments will be accepted unless there is a documented mitigating factor in accordance with university policy and ADA requirements.

EXAMS

Exams are our formal evaluation tool. In the exams you will be tested with respect to the learning goals of this course (see the schedule below for the list of learning goals). Exams will comprise a mix of practical exercises and concepts.

There will be one midterm exam before Spring break on March 7, 2019 in the class, and one final exam during the scheduled examination period during final exam week.

If you miss an exam you must provide documentation of the issue. We will schedule a make-up exam at our discretion and in accordance with University policy. Make-up exams will likely be significantly more difficult than the original exam to reflect the extra study time.

PARTICIPATION

You are expected to attend all of the meetings, participate in discussions, and be prompt and punctual on assignments and projects. There may be small surprise assignments in the class meetings to evaluate your participation grade (10% of your final grade)

GRADING

1st half of the course:

- Participation (5%)
- Assignment 1 (10%)
- Assignment 2 (15%)
- Midterm Exam (20%)

2nd half of the course:

- Participation (5%)
- Assignment 3 (15%)
- Assignment 4 (15%)
- Final exam (15%)

Prof. Fricke and Prof. Mueen will record assignment grades for their respective halves of the course. At the end of the course Prof. Mueen will assign final course grades based on student performance on all the assignments, class participation, and exams. Grades will be based on your earned points, following a relative scale. Final grades will be curved so that at most 15% of the students will receive A or more. Grades of "withdraw or drop" will be included when curving. There will be **No Extra Credit** assignments.

Please note:

• A grade of Incomplete can be assigned only for a documented medical reason or other absence excused by University policy.

• Change of grade to CR/NC after the semester deadline will be granted ONLY under special, documented extenuating circumstances.

SCHEDULE

1st Half of the Course

Random Number Generation - 1 week

MLE Estimators - 0.5 week

Central Limit Theorem - 0.5 week

Confidence Intervals - 0.5 week

Hypothesis Testing - 1.5 week

- Single-sample Hypothesis Testing
- Two-sample Hypothesis Testing

Non-parametric Testing - 2 week

- Statistical methods
- Randomization tests
- Non parametric tests

Monte Carlo Methods - 1 week

Second Half Commences after Spring Break

This schedule is subject to change according to the pace at which we move through the material. We may add or subtract topics as we go. We cover several topics in tuning code for hardware and evaluating randomized algorithms. These are useful topics in their own right - but our emphasis will be the proper design and evaluation of scientific experiments.

Week 9

Tuesday - March 19 : Why Experimental Methods matter to Computer Scientists

Thursday - March 21: Algorithm Engineering: Tuning, Speedup, Speedup Anomalies

Week 10

Tuesday - March 26 : Algorithm Engineering: Machine Independent Measurements, Test instances, Reliable Measurements

Thursday - March 28 : Presenting Results from Experimental Algorithmics, Effective Visualization and Plotting I

Week 11

Tuesday - April 2: Assignment 2: Discussion

Thursday - April 4: Effective Visualization and Plotting II

Monday - April 7th - 5:00pm Assignment 3 Due

Week 12

Tuesday - April 9 : Comparing Distributions with Maximum Likelihood Methods

Thursday - April 11: High Performance Algorithm Engineering: Measuring GPU vs CPU Performance I

Week 13

Tuesday - April 16 : High-Performance Algorithm Engineering: Measuring GPU vs CPU Performance II

Thursday - April 18 : Distributed Algorithm Engineering: Measuring Distributed Scale up I

Week 14

Tuesday - April 23: Distributed Algorithm Engineering: Measuring Distributed Scale up II

Thursday - April 25 : Using Finite Experiments to Study Asymptotic Performance

Week 15

Tuesday - April 30: Case study: Jackknife, Bootstrap, and Noise Shaping revisited

Thursday - May 2 : Final Exam Review

Friday - May 3rd - 5:00pm : Assignment 4 Due

Final Exam Week - May 4-May 11th (Time and day will be announced in the class)