Math Camp II, Summer 2024

Lecture: Aug 26-27 (Monday, Tuesday), 29-30 (Thursday, Friday) 9:30AM-12:00PM
Q&A Session: Aug 26-30 (Monday - Friday) 1-2PM

Instructor:	Shuning Ge
Classroom:	E53-485
Q&A Session Location:	E53-485
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Faculty advisors:	In Song Kim, Danny Hidalgo

Course Description: Math Camp II will prepare students to take Quant III and Quant IV. The goal of the class will be to refresh students on mathematical concepts that are useful for Quant III and Quant IV. Math Camp II specifically is designed to accomplish 3 goals:

1. Present mathematical concepts essential for Quant III/IV – while the range of material covered in math camp II is daunting, I have made an effort to focus on only material that is directly useful for Quant III or Quant IV.

2. Build a depth of understanding/ mathematical maturity – it is likely previous treatments of the math camp II material you have encountered are presented as bewildering series of properties. Such presentations are typically rather shallow and do not build sufficient familiarity with the underlying concepts. By focusing on a smaller number of topics, my hope is to build this kind of mathematical maturity in areas that are directly relevant for the second half of the quant sequence.

3. Computational skills – where possible, I'll attempt to illustrate mathematical concepts with simulations in R. My hope is that this will get you used to functions/ programming concepts in R that will help you with the kinds of simulations that frequently appear on Quant III/ IV problem sets.

Prerequisites: One of the challenges of teaching statistics is that it tends to borrow concepts from a rather eclectic set of mathematical topics. For example, calculus and linear algebra are typically taught as separate classes, but matrix calculus is fairly ubiquitous in statistics. I'll try to emphasize these sorts of connections where they seem applicable, but doing so will likely mean referencing concepts from probability/ statistics before I've had a chance to really formally define them.

What this means in practice is that I'll be assuming you have some vague memory of concepts from the start of Quant I like random variables, the probability axioms, expectation of a random variable, vectors/ matrices, etc. If you're interested in doing some review before Math Camp II starts, this would be a sensible place to look. Quant II material will be referenced much less directly.

Course Structure: The short course will meet for 5 days with a lecture session lasting 2.5 hours in the morning (9:30AM to 12:00PM) and a Q&A session from 4-5PM. The goal of the Q&A session is principally to address the problem sets. Because math camp only includes 4 psets, I'll skip the final Q&A session on the last day.

Problem Sets: There will be four problem sets. I'll try to post problem sets the night before the relevant lecture (if not earlier) so feel free to take a look before lecture starts. Like the rest of math

camp, the problem sets are entirely ungraded, but I'd love to discuss any questions you might have if you choose to do psets in the Q&A session. You're of course welcome to revisit the problem sets at your leisure after this, but math camp should be a LOW pressure experience, so please don't feel obligated to do more than look over the solutions when they're posted.

Latex is not required for any of the psets. Indeed, for questions that involve doing matrix arithmetic by hand, latex is a total waste of time, and I would really discourage you from typing up those answers.

Course Textbook: There is no required textbook for the class. Lecture notes will be uploaded. You might also find some of the textbooks from Quant I to be useful as well.

Course Outline:

Day 1-2 Calculus: Limits, infinite sums and series, differential and integral calculus, Taylor series, Convex optimization, maximum likelihood estimation

Day 3-4 Linear Algebra: Vector/ matrix operations, determinants and inverses, eigenstuff, derivatives of matrix/ vector functions, Geometry of OLS and partialing out

Day 5 Probability: Basic probability review, common distributions, statistics as inverse probability, Bayes theorem, law of large number/ central limit theorem