THE UNIVERSITY OF CHICAGO
Booth School of Business
Business 41912, Applied Multivariate Analysis
Spring Quarter 2018, Mr. Ruey S. Tsay

COURSE INFORMATION: Applied Multivariate Analysis

Because of the COVID-19, we are in a new era of online learning. This is my first time to do everything online for a class so I wanted to let you know that we may experience some bumps along the way, but efforts will be made to make your learning as smooth and effective as possible. Please feel free to contact me via email, or Zoom when we are connected, if you have any questions.
Although I used Zoom before for meetings and discussions, but my experience is limited so I will post notes concerning lectures on canvas weekly. Since this is a PhD course, we may emphasize more on discussions rather than lecturing. I also plan to do more on data analysis and cut down some theoretical derivations.
Here are some special notes:

1. I always use Chicago time to set deadlines for homework assignments and exams. Many of you are in different time zones, or even in different countries, so please pay attention to the time difference between your hometown and Chicago.

2. All lectures will be on the scheduled time slots. My office hour will also follow the announced schedule.

3. I encourage you to form a small study group so that you can discuss and exchange ideas efficiently and frequently.

4. For the lectures, I plan to follow 50m with 10m break format, instead of a single 20m break at the middle.

5. We will make some adjustments on the topics as we only have 9 weeks this quarter.

Course web: See Canvas of the University of Chicago

Class: Tuesday, 8:30 am − 11:30 am, Room: Zoom.

Course Objective:

- To learn knowledge and methods for analyzing multi-dimensional data (including visualization)

- To study multivariate distributions and their properties, especially Gaussian distribution
- To understand multivariate statistical inference and applications in scientific fields
- To discuss various methods for dimension reduction, including principal component analysis, factor model, multi-dimensional scaling, sliced inverse regression, independent component analysis, etc.
- To introduce recent developments in high-dimensional statistical analysis, including penalized regularization and machine learning

Textbooks: (highly recommended)

- *Applied Multivariate Statistical Analysis* by R.A. Johnson and D.W. Wichern, Prentice-Hall, 6th Ed., 2007. ISBN 0-13-187715-1.
- *An Introduction to Statistical Learning with Applications in R* by G. James, D. Witten, T. Hastie, and R. Tibshirani (2013), Springer, ISBN: 978-1-4614-7137-0

Lecture Notes: Some handouts will be posted on the course web before lectures.

References: (Optional)

1. *An Introduction to Multivariate Statistical Analysis* by T.W. Anderson (2003), 3rd Edition, Wiley. ISBN 0471-36091-0.
2. *Independent Component Analysis* by Hyvärinen, A., Karhunen, J. and Oja, E. (2001), John-Wiley. ISBN 0-471-40549-X.
3. *The Elements of Statistical Learning* by Hastie, Tibshirani, and Friedman. (2009). Second Edition, Springer. ISBN 0387848576.
4. *Statistics for High-Dimensional Data* by Peter Bühlmann and Sara van de Geer, (2011), Springer. ISBN 3-642-20191-2.
5. *Introduction to High-Dimensional Statistics* by Christophe Giraud, (2015), CRC Press, Boca Raton, FL. ISBN: 978-1-4822-3794-8.

Articles: If reading materials from journals are assigned, I shall not post the article due to copyright concerns. But you can visit UC library online to downlad the article (e-journals). If needed, please let me know, and we will figure out a way to assist you.

Office hour

Wednesday 1:30 pm to 2:30 pm or by appointment. Room: Zoom.
My phone number 702-6750.
E-mail: ruey.tsay@chicagobooth.edu (this is the easiest way to make contact with me)

Grading:
Mid-term (30%), Final Exam (45%), and Homework Assignments (25%).

Special notes:

- Homework is due **before** the class on due date.
- No late homework assignments will be accepted. Solutions or discussions will follow after the assignments are handed in.
- **You may discuss assignments with each other, but must turn in your own answers**.
- Mid-term: Week 5, exact time will be set later.
- Final exam is in the exam week as scheduled. Again, exact time will be fixed later.

Computing:
The main package is R (see www.r-project.org). You may use any software of your choice. You may use regular R or `RStudio`. To install `RStudio`, you need to install R first.

Course Outline: All topics include applications

1. Multivariate Normal distributions (multivariate-t)
2. Inferences about a mean vector and comparisons
3. Multivariate linear regression
4. Principal component analysis & Independent component analysis
5. New developments in dimension reduction
6. Factor analysis and discriminant analysis
7. Canonical Correlation Analysis: prediction
8. Discrimination and Classification
9. Clustering and introduction to data mining
10. LASSO regression and machine learning

Important Notes:

- *Booth Honor Code Pledge:* Each student shall sign the following pledge on each exam:I pledge my Honor that I have not violated the Chicago Booth Honor Code during this examination. At the discretion of the professor, this pledge may be required on any other graded work for a course.

- *Accommodations for disabilities verbiage:* The University of Chicago is committed to ensuring the full participation of all students in its programs. If you have a documented disability (or think you may have a disability) and, as a result, need a reasonable accommodation to participate in class, complete course requirements, or benefit from the University's programs or services, please contact Student Disability Services as soon as possible. To receive a reasonable accommodation, you must be appropriately registered with Student Disability Services. Please contact the office at 773-702- 6000/TTY 773-795-1186 or disabilities@uchicago.edu, or visit the website at disabilities.uchicago.edu. Student Disability Services is located at 5501 S. Ellis Avenue.

  If you have an approved accommodation from Student Disability Services that you plan to use in this course, please contact Academic Services (AcademicServices@lists.chicagobooth.edu) as soon as possible. Academic Services will provide support to you and your instructor and coordinate the details of your accommodations on your behalf.