

36-710: Advanced Statistical Theory II

Fall 2021

Instructor:

Alessandro Rinaldo

Email: arinaldo@cmu.edu

Phone: x8-7362

Office: Baker Hall 229I

Office Hour: by appointment.

Lectures:

Monday and Wednesday, 8:35am - 9:55am, WEH 4625.

Class Website:

<http://www.stat.cmu.edu/~arinaldo/Teaching/36710/F21/>

Please check the website on a regular basis.

Prerequisites:

- 36-709: Advanced Statistical Theory I or instructor's permission.

Topics:

The course will cover a selection of topics in modern mathematical statistics, focussing on concentration inequalities and concentration of measure. 710 is a natural progression of 36709, which is a pre-requisite. The bulk of the course will cover material found in Chapters 2 through 9 of the book *Concentration Inequalities: A Nonasymptotic Theory of Independence*, by S. Boucheron, G. Lugosi and P. Massart, Oxford University Press, 2013. The main goal of this course is to provide you with some theoretical background and mathematical tools to read and understand the current statistical literature on high-dimensional models.

Class material:

Textbooks:

1. *Concentration Inequalities: A Nonasymptotic Theory of Independence*, by S. Boucheron, G. Lugosi and P. Massart, Oxford University Press, 2013.
2. *High-Dimensional Probability, An Introduction with Applications in Data Science*, by R. Vershynin, 2018+, available [here](#)

A classic, excellent reference on concentration is the book

1. *The concentration of Measure Phenomenon*, by M. Ledoux, 2005, American Mathematical Society.

Course Grading:

Your assessment and grades will be determined as follows:

- Exercises (20%).
- Scribe duties (10%).
- Final Project (70%).

Any failure to turn in any assignment, to fulfill the scribe duties and to miss a significant number of lectures without informing me of your absence or without a reasonable excuse will result in a lower grade.

Scribe duties:

Each student will take turn in transcribing the notes of every lecture in electronic format using the latex template available at <http://www.stat.cmu.edu/~arinaldo/Teaching/36710/F21/schedule.html>. The scribe has to attend class, take good and accurate notes, check for mistakes and inconsistencies, write them up in latex, add references and expand the material if appropriate and after consulting with me. The resulting pdf and latex files have to be submitted for my approval within one week. The pdf files containing the lecture notes will be posted on the class website.

Exercises:

There will be 4 sets of exercises. The problems will be mostly of theoretical nature. There is a great value in discussing problems and sharing knowledge with your classmate, so you are encouraged to engage in group work. In some cases, the assigned exercises will involve reading assignments (reading and summarizing parts of some recent papers). Exercises will be checked for effort and not correctness.

Attendance and Involvement:

It is important that you attend class, as the selection and organization of the topics will be on occasion different from the recommended textbooks.

Final Project:

The final project involves picking a topic of interest, reading the relevant results in the area and then writing a short paper (8-12 pages) summarizing the key ideas in the area. You may focus on a single paper if you prefer. You are NOT required to do new research, but you are welcome to. The paper should include background, statement of important results, and brief proof outlines for the results. If appropriate, you should also include numerical experiments or an application with real data.

- You may work by yourself or in teams of two.
- The goals are (i) to summarize key results in literature on a particular topic and (ii) present a summary of the theoretical analysis (results and proof sketch) of the methods (iii) implement some of the main methods. You may develop new theory if you like but it is not required.
- You will provide: (i) a proposal, (ii) a progress report and (iii) and final report.
- The reports should be well-written.

Proposal. Due October 1. A one page proposal. It should contain the following information: (1) project title, (2) team members, (3) precise description of the problem you are studying, (4) anticipated scope of the project, and (5) reading list. (Papers you will need to read).

Progress Report. Due November 1. Three pages. Include: (i) a high quality introduction, (ii) what have you done so far, (iii) what remains to be done and (iv) a clear description of the division of work among teammates, if applicable.

Final Report. Due December ??. The paper should be in NeurIPS format¹. (pdf only). Minimum 8 pages, maximum 12 pages. No appendix is allowed. You should submit a pdf file electronically. It should have the following format:

1. Introduction. Motivation and a quick summary of the area.
2. Notation and Assumptions.
2. Key Results.
3. Proof outlines for the results.
4. Implementation (simulations or real data example.)
5. Conclusion. This includes comments on the meaning of the results and open questions.

Wellness:

Course work at this level can be intense, and we encourage you to take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, socializing, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress. All of us benefit from support during times of struggle. If you are having any problems or concerns, do not hesitate to come speak with either of us. There are also many resources available on campus that can provide help and support. Asking for support sooner rather than later is almost always a good idea. If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at <http://www.cmu.edu/counseling/>. Consider also reaching out to a friend, faculty member, or family member you trust to help get you the support you need.

Disability Resources

If you require a special accommodation, such as needing more time to finish exams, please visit the Office of Disability Resources to obtain appropriate documentation. See <http://www.cmu.edu/hr/eos/disability/students/>

Class expectations related to COVID-19:

In order to attend class meetings in person, all students are expected to abide by all behaviors indicated in [A Tartan's Responsibility](#), including any timely updates based on the current conditions. In terms of specific classroom expectations, whenever the requirement to wear a facial covering is in effect on campus, students are expected to wear a facial covering throughout class. Note: the requirement to wear a facial covering is in effect for the start of the Fall 2021 semester. If you do not wear a facial covering to class, I will ask you to put one on (and if you don't have one with you, I will direct you to a distribution location on campus, see <https://www.cmu.edu/coronavirus/health-and-wellness/facial-covering.html>). If you do

¹The NeurIPS 2021 style files can be found here: <https://neurips.cc/Conferences/2021/PaperInformation/StyleFiles>

not comply, you will be referred to the Office of Community Standards and Integrity for follow up, which could include student conduct action. Finally, please note that sanitizing wipes should be available in our classroom for those who wish to use them.

Diversity and Inclusion:

We must treat every individual with respect. We are diverse in many ways, and this diversity is fundamental to building and maintaining an equitable and inclusive campus community. Diversity can refer to multiple ways that we identify ourselves, including but not limited to race, color, national origin, language, sex, disability, age, sexual orientation, gender identity, religion, creed, ancestry, belief, veteran status, or genetic information. Each of these diverse identities, along with many others not mentioned here, shape the perspectives our students, faculty, and staff bring to our campus. We, at CMU, will work to promote diversity, equity and inclusion not only because diversity fuels excellence and innovation, but because we want to pursue justice. We acknowledge our imperfections while we also fully commit to the work, inside and outside of our classrooms, of building and sustaining a campus community that increasingly embraces these core values.

Each of us is responsible for creating a safer, more inclusive environment.

Unfortunately, incidents of bias or discrimination do occur, whether intentional or unintentional. They contribute to creating an unwelcoming environment for individuals and groups at the university. Therefore, the university encourages anyone who experiences or observes unfair or hostile treatment on the basis of identity to speak out for justice and support, within the moment of the incident or after the incident has passed. Anyone can share these experiences using the following resources:

- Center for Student Diversity and Inclusion: csdi@andrew.cmu.edu, (412)268-2150
- **Report-It** online anonymous reporting platform: reportit.net username: tartans password: plaid

All reports will be documented and deliberated to determine if there should be any following actions. Regardless of incident type, the university will use all shared experiences to transform our campus climate to be more equitable and just.