

**USC Viterbi School
of Engineering**

**EE 546, Mathematics of High-dimensional
Data**

Units: 04

Fall 2018—Mon and Wed—Time: 10:00-11:50 AM

Location: VKC 150

Instructor: Mahdi Soltanolkotabi

Office: EEB430

Office Hours: 5:30-7:00 PM

Contact Info: soltanol@usc.edu

Teaching Assistant: Mukul Gagrani

Office:

Office Hours: TBA

Contact Info:

Course Description

modern developments in data representation/analysis, convex optimization, efficient first-order algorithms for smooth and non-smooth optimization, iterative algorithms and non-convex optimization, non-asymptotic random matrix theory, randomized numerical linear algebra, sketching, dimensionality reduction, clustering, low-rank models, inverse problems, applications in computational imaging, signal processing, machine learning, computer vision and neuroscience.

Learning Objectives

Students will learn some of the key mathematical methods and results that should form an essential toolbox for a data scientist. The students will be exposed to numerous applications in a multitude of applied and theoretical disciplines.

Prerequisite(s): EE441 (Linear Algebra), EE 503 (Probability), and Mathematical maturity

Co-Requisite (s):

Concurrent Enrollment: course(s) that must be taken simultaneously: N/A

Recommended Preparation: N/A

Course Notes

Grading Type: letter grade

The course is Web-Enhanced (**Blackboard**).

Copies of lecture slides and other class information will be posted on Blackboard.

Technological Proficiency and Hardware/Software Required

Familiarity with a numerical solver such as MATLAB, R, or Python is required.

Required Readings and Supplementary Materials

Required textbook:

None.

Description and Assessment of Assignments

Students will be assigned a homework every few weeks. Homework will consist of solving textbook problems and will sometimes include a “research-oriented” problem to stimulate and probe students’ creativity.

Homeworks are to be submitted in class on the due date. Late homeworks will not be accepted unless prior approval for late submission has been obtained.

Grading Breakdown

| Assignment | Points | % of Grade |
|---------------|--------|------------|
| participation | | 10% |
| homework | | 40% |
| project | | 50% |
| | | |
| | | |
| TOTAL | | 1 |
| | | |

Assignment Submission Policy

Homework to be submitted in class two weeks after assignment. Late homeworks will not be accepted unless prior approval for late submission has been obtained. Best 4 of 5 homeworks will count towards final grade.

Additional Policies

Attendance of the lectures is expected.

Course Schedule: A Weekly Breakdown

| | Topics/Daily Activities | Readings and Homework | Deliverable/ Due Dates |
|-------------------------|--|-----------------------|------------------------|
| Week 1 Dates | Introduction to mathematics of data, sample applications, Optimization basics. | | |
| Week 2 Dates | Optimization for modern data analysis I: First order methods, accelerated schemes. | | Homework #1 assigned |
| Week 3 Dates | Optimization for modern data analysis II: sub-gradients and non-smooth optimization, incremental and stochastic schemes. | | |
| Week 4 Dates | Basics of concentration of measure and high dimensional probability. | | Homework #1 due, |
| Week 5 Dates | non-asymptotic random matrix theory and matrix concentration. | | Homework#2 assigned. |
| Week 6 Dates | Dimension reduction, sketching, and applications. | | |
| Week 7 Dates | Fast and randomized methods for numerical linear algebra. | | Homework #2 due, |
| Week 8 Dates | Clustering I: Matrix perturbation theory. | | Homework#3 assigned |
| Week 9 Dates | Clustering II: Spectral algorithms, application in community detection. | | |
| Week 10 Dates | Linear inverse problems I: Compressive sensing and sparsity, Recommender systems, matrix completion and low-rank modeling | | Homework #3 due, |
| Week 11 Dates | Linear inverse problems II: recovery of ne-scale data from coarse-scale measurements: applications in deblurring, uorescence microscopy, wireless communications, medical imaging and computer vision. | | . Homework#4 assigned |
| Week 12 Dates | Modern theory of linear inverse problems; Iterative algorithms and non-convex optimization; Phase retrieval and computational imaging. | | |

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|-------------------------|--|--|--|
| Week 13 Dates | Discrete and submodular optimization and learning | | Homework #4 due, Homework#5 assigned. |
| Week 14 Dates | Learning representations, sparse coding, word embeddings | | |
| Week 15 Dates | Kernel methods, "shallow" and "deep" learning. | | Last homework # 5 due. |
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Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, “Behavior Violating University Standards” policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

Support Systems:

Student Counseling Services (SCS) – (213) 740-7711 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. engemannshc.usc.edu/counseling

National Suicide Prevention Lifeline – 1 (800) 273-8255

Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) – (213) 740-4900 – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender-based harm. engemannshc.usc.edu/rsvp

Sexual Assault Resource Center

For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: sarc.usc.edu

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086

Works with faculty, staff, visitors, applicants, and students around issues of protected class. equity.usc.edu

Bias Assessment Response and Support

Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. studentaffairs.usc.edu/bias-assessment-response-support

The Office of Disability Services and Programs

Provides certification for students with disabilities and helps arrange relevant accommodations. dsp.usc.edu

Student Support and Advocacy – (213) 821-4710

Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. studentaffairs.usc.edu/ssa

Diversity at USC

Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. diversity.usc.edu

USC Emergency Information

Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. emergency.usc.edu

USC Department of Public Safety – UPC: (213) 740-4321 – HSC: (323) 442-1000 – 24-hour emergency or to report a crime.

Provides overall safety to USC community. dps.usc.edu