

Mathematics of Data Science

MATH 5750/6880 - 001, Fall 2021

Credit Hours: Three

Meeting Time: TuTh 12:25pm - 1:45pm, WEB L120

Homepage:

Math 5750: <https://utah.instructure.com/courses/718430>

Math 6880: <https://utah.instructure.com/courses/723883>

Instructor: Bao Wang

Office Hours: WF 2:00pm - 3:30pm.

Email: bwang@math.utah.edu

Textbook: No specific textbook required, and we will send out course lecture notes.

References:

[Zhang et al., Dive into Deep Learning](#)

[Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning: From Theory to Algorithms](#)

Christopher Bishop, Pattern Recognition and Machine Intelligence

Yuxin Chen, Large-Scale Optimization for Data Science (ELE 522)

A. S. Bandeira, A. Singer, T. Strohmer, Mathematics of Data Science, Preprint.

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1 COURSE DESCRIPTION

Three credits. Prerequisites: calculus, linear algebra, probability, ordinary differential equation, and Python programming.

2 COURSE DETAILS

- **Course Type:** In person.
- **Location & Meeting Times:** TuTh 12:25 pm - 1:45 am, WEB L120.
- **Attendance & Punctuality:** It is strongly recommended that students attend the class at the scheduled class time. Attendance will be taken.
- **COVID-19 Considerations:** According to the CDC, wearing a mask remains an effective means of preventing infection for both unvaccinated and vaccinated people. Regardless of what someone chooses (mask or no mask), the university seeks to foster a sense of community and asks everyone on campus to be respectful of individual decisions on mask wearing. While Utah law prohibits state universities from requiring COVID-19 vaccinations, all members of the University of Utah community are encouraged to receive a COVID-19 vaccine.

While masks are no longer required outside of Health Sciences facilities, UTA buses and campus shuttles, CDC guidelines now call for everyone to wear face masks indoors.

Students must self-report if they test positive for COVID-19 via coronavirus.utah.edu.

- **Instructional Support Team:** We expect to have a homework reader for this class. Details will be provided when available.
- **Course Materials:** No textbook is required. Course materials will be available on line at the course webpage and in canvas.
- **Technical requirements:** Students are expected to be computer literate and Canvas and zoom navigation skills are expected. Knowledge and navigation of canvas and zoom is critical to access all features and resources of this course. It is expected expectation that students log into Zoom for class with audio and video enabled.

Additional software/computing requirements: students will be asked to perform some Python programming, knowledge about Python programming is required.

For technical assistance, review the Canvas Getting Started Guide for Students and/or contact TLT, Knowledge Commons.

- **Syllabus subject to change:** This syllabus is meant to serve as an outline and guide for our course. Please note that I may modify it with reasonable notice to you. I may also modify the Course Schedule to accommodate the needs of our class. Any changes will be announced in class and posted on Canvas.

3 CONTENT OVERVIEW

Topics include statistical machine learning and deep learning models, e.g. linear models for regression and classification, kernel methods, clustering, dimension reduction, compressed sensing, convolutional neural networks, recurrent neural networks, graph neural networks, and transformers; optimization algorithms for machine learning, e.g. gradient descent, subgradient methods, proximal gradient methods, heavy-ball and Nesterov acceleration, stochastic gradient descent, and Adam; and some theoretical analysis of machine learning models.

4 COURSE EXPECTED LEARNING OUTCOMES

Upon successful completion of this course, a student should be able to:

- Understand popular statistical machine learning and deep learning models, and can implement them.
- Understand first-order optimization algorithms for machine learning.
- Know theoretical performance bound of popular machine learning and deep learning models.
- Know how to find the literature of advances of machine learning and foster interest in data science.

5 COURSE DESIGN

Material will be presented in lectures and read from the text and internet sources. Any supplementary materials will also be made available in canvas at least by 5:00 pm the day before lecture. The course contains several projects and one final project proposed by students themselves. We encourage students to form teams with each team contains three to five members.

6 EVALUATION METHODS AND GRADING

- **Lecture notes scribe 20%:** We will present the lecture using slides and each team needs to scribe each lecture and submit one copy of the lecture notes in PDF along with the latex source. We will provide a latex template.
- **Course projects 50%:** There will be three projects in total, and the lowest score will be dropped. For each project you will need to write a report and submit it along with the source code.
- **Final project 30%:** Each team need to propose one project related to the course material and conduct reasonably in-depth research. Each team will present their final project.
- **Course grade:**

P	90	85	80	77	70	68	66	50	45	40
Grade	A	A-	B+	B	B-	C+	C	C-	D+	D

7 CLASS SCHEDULE and IMPORTANT DATES

Class meets at TuTh from 12:25pm - 1:45pm in person starting Aug 23 and ending Dec 9.

Last day to register is Sep 3. Last day to drop class is Oct 22. Please check the academic calendar for more information pertaining to dropping and withdrawing from a course. Withdrawing from a course and other matters of registration are the student's responsibility.

Holidays: There will be no class on Sep 6 (Labor Day), Oct 10-17 (Fall break), Nov 25-28 (Thanksgiving).

8 ACADEMIC CODE OF CONDUCT

Students are encouraged to review the Student Code for the University of Utah: <https://regulations.utah.edu/academics/6-400.php>. In order to ensure that the highest standards of academic conduct are promoted and upported at the University, students must adhere to generally accepted standards of academic honesty, including but not limited to refraining from cheating, plagiarizing, research misconduct, misrepresenting one's work, and/or inappropriately collaborating. A student who engages in academic misconduct as defined in Part I.B. may be subject to academic sanctions including but not limited to

a grade reduction, failing grade, probation, suspension or dismissal from the program or the University, or revocation of the student's degree or certificate. Sanctions may also include community service, a written reprimand, and/or a written statement of misconduct that can be put into an appropriate record maintained for purposes of the profession or discipline for which the student is preparing. Incidents of academic misconduct (e.g. cheating, plagiarizing, misrepresenting one's work, and/or inappropriately collaborating on exams) will be subject to penalty per Section V of Policy 6-400, the Student Code. Incidents of academic dishonesty on homework assignments will result in a minimum penalty of a full letter-grade reduction and up to a failing grade (E) or the course. Incidents of academic dishonesty on exams will result in a minimum penalty of a failing grade (E) for the course, and the incident(s) will be referred to the dean of your major-department college for possible further sanction.). I endorse the Chemistry Department's Code of Conduct at this link <https://csme.utah.edu/chemistry-code-of-conduct/>

9 ADDITIONAL POLICIES AND RESOURCES

- **Inclusivity Statement:** It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: age, color, disability, gender, gender identity, gender expression, national origin, political affiliation, race, religion, sexual orientation, and veteran status, and other unique identities. gender, sexuality, disability, age, socioeconomic status, ethnicity, race, culture, and other unique identities. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you. <https://csme.utah.edu/sample-inclusivity-statements/>.
- **Discrimination and Harassment:** If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or Office of the Dean of Students, 270 Union Building, 801-581-7066. To report to the police, contact the Department of Public Safety, 801-585-2677(COPS). Please see Student Bill of Rights, section E <http://regulations.utah.edu/academics/6-400.php>. I will listen and believe you if someone is threatening you.
- **Names/Pronouns:** Canvas allows students to change the name that is displayed AND allows them to add their pronouns to their Canvas name. Class rosters are provided to the instructor with the student's legal name as well as "Preferred first name" (if previously entered by you in the Student Profile section of your CIS account, which managed can be managed at any time). While CIS refers to this as merely a preference, I will honor you by referring to you with the name and pronoun that feels best for you in class or on assignments. Please advise me of any name or pronoun changes so I can help create a learning environment in which you, your name, and your pronoun are respected. If you need any assistance or support, please reach out to the LGBT Resource Center.
- **English Language Learners:** If you are an English language learner, please be aware of several resources on campus that will support you with your language and writing development. These resources include: the Writing Center <http://writingcenter.utah.edu/>, the Writing Program <http://writing-program.utah.edu/>, the English Language Institute <http://continue.utah.edu/eli/>. Please let me know if there is any additional support you would like to discuss for this class.
- **Undocumented Student Support:** Immigration is a complex phenomenon with broad impact—those who are directly affected by it, as well as those who are indirectly affected by their relationships with family members, friends, and loved ones. If your immigration status presents obstacles to engaging in

specific activities or fulfilling specific course criteria, confidential arrangements may be requested from the Dream Center. Arrangements with the Dream Center will not jeopardize your student status, your financial aid, or any other part of your residence. The Dream Center offers a wide range of resources to support undocumented students (with and without DACA) as well as students from mixed-status families. To learn more, please contact the Dream Center at 801.213.3697 or visit dream.utah.edu.

- **Veterans Center:** If you are a student veteran, the U of Utah has a Veterans Support Center located in Room 161 in the Olpin Union Building. Hours: M-F 8-5pm. Please visit their website for more information about what support they offer, a list of ongoing events and links to outside resources: <http://veteranscenter.utah.edu/>
- **Wellness Statement:** Personal concerns such as stress, anxiety, relationship difficulties, depression, cross-cultural differences, etc., can interfere with a student's ability to succeed and thrive at the University of Utah. For helpful resources contact the Center for Student Wellness at 801-581-7776 or www.wellness.utah.edu
- **Student Success Advocates:** The mission of Student Success Advocates is to support students in making the most of their University of Utah experience (ssa.utah.edu). They can assist with mentoring, resources, etc. Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact a Student Success Advocate for support <https://asuu.utah.edu/displaced-students>
- **The Americans with Disabilities Act:** The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability & Access, 162 Olpin Union Building, 801-581-5020. CDA will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification to the Center for Disability & Access.
- **Addressing Sexual Misconduct:** Title IX makes it clear that violence and harassment based on sex and gender (which includes sexual orientation and gender identity/expression) is a Civil Rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran's status or genetic information. If you or someone you know has been harassed or assaulted on the basis of your sex, including sexual orientation or gender identity/expression, you are encouraged to report it to the University's Title IX Coordinator; Director, Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or to the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to police, contact the Department of Public Safety, 801-585-2677(COPS).
- **Campus safety:** The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit safeu.utah.edu
- **University Counseling Center:** The University Counseling Center (UCC) provides developmental, preventive, and therapeutic services and programs that promote the intellectual, emotional, cultural, and social development of University of Utah students. They advocate a philosophy of acceptance, compassion, and support for those they serve, as well as for each other. They aspire to respect cultural, individual and role differences as they continually work toward creating a safe and affirming climate for individuals of all ages, cultures, ethnicities, genders, gender identities, languages, mental and physical abilities, national origins, races, religions, sexual orientations, sizes and socioeconomic statuses.

- **Office of the Dean of Students:** The Office of the Dean of Students is dedicated to being a resource to students through support, advocacy, involvement, and accountability. It serves as a support for students facing challenges to their success as students, and assists with the interpretation of University policy and regulations. Please consider reaching out to the Office of Dean of Students for any questions, issues and concerns. 200 South Central Campus Dr., Suite 270. Monday-Friday 8 am-5 pm.