Course Syllabus

# CSci 5525

# Advanced Machine Learning

# Fall 2023

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This course is scheduled as an in-person course. I intend to hold all class sessions in-person except if situational factors arise, such as illness or bad weather (e.g., snow), when the class may be held synchronously via Zoom or recorded for later viewing.

**Lecture time and location**: 4:00-5:15 PM Central time, T/Th, Mechanical Engineering 212

**Instructor**:

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|---|---|
| **Name** | Nicholas Johnson |
| **Email** | njohnson (at) cs (dot) umn (dot) edu |
| **Office Hours** | 5:30-7:30 PM Tuesday |
| **Office** | Keller Hall 6-196 |

**TAs**:

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|---|---|
| **Name** | Harshavardhan "Harsha" Battula |
| **Email** | battu018 (at) umn (dot) edu |
| **Office Hours** | 5:30-7:30 PM Thursday |
| **Office** | Keller 1-201 |

**Texts**:

- Christopher Bishop. ***Pattern Recognition and Machine Learning*** **(https://www.microsoft.com/en-us/research/uploads/prod/2006/01/Bishop-Pattern-Recognition-and-Machine-Learning-2006.pdf)** (main textbook)
- Shai Ben-David and Shai Shalev-Shwartz. ***Understanding Machine Learning: From Theory to Algorithms*** ***(https://www.cs.huji.ac.il/~shais/UnderstandingMachineLearning/copy.html)***
- Ian Goodfellow, Yoshua Bengio, and Aaron Courville. ***Deep Learning*** **(https://www.deeplearningbook.org/)**
- Richard S. Sutton and Andrew G. Barto. **Reinforcement Learning: An Introduction (2nd Edition)** **(http://incompleteideas.net/book/RLbook2020.pdf)**

There may also be other resources linked to the class web page. **To be successful in the class, I strongly recommend reading the material *before* lecture.**

**Class Website**: Primary website will be canvas. It will be used to post the schedule, lecture notes, assignments, grades, and announcements. It will also be used to submit assignments, ask questions on the forum, and coordinate with classmates. Please check the schedule frequently for any changes.

**Email**: I encourage you to use the **class forum (https://canvas.umn.edu/courses/391265/discussion_topics)** to post questions, but if you need to email us please include the substring "CSCI 5525" to begin a meaningful subject line. Emails which omit this substring may not be promptly responded to. Also be sure to include all course staff to decrease response time.

**Prerequisites**: Before taking this course, you should have:

- Undergraduate level understanding of linear algebra, multivariate calculus, statistics, probability, and optimization;
- Strong programming ability in Python;
- CSCI 5512, CSCI 5521, or an equivalent introduction to machine learning experience (e.g., Coursera, work experience, etc.).

**General Course Description**: This is a graduate-level course in Machine Learning. We will cover (most of) the following: models of learning; supervised algorithms such as perceptrons, logistic regression, and large margin methods (SVMs, boosting); hypothesis evaluation; learning theory; online algorithms; unsupervised algorithms, dimensionality reduction, spectral methods; and recent developments in deep learning and reinforcement learning. **There will be lots of math and lots of programming.**

**Course Work:**

The course work will consist of 3 types of assignments:

- homeworks,
- project,
- paper review.

All assignments are to be done individually. You must complete all assignments with a score > 0 on each to pass the class.

**Homework (55%):** 6 homeworks (HW0 must be completed/submitted to remain enrolled in the course). Homeworks will likely include both theoretical and programming questions. All programming must be written in Python 3.6+ and PyTorch (not PyTorch Lightning). When submitting homeworks, your code and environment file (requirements.txt, yaml file, etc.) with instructions on how to set up your environment must be provided. The homeworks must be done individually. You may discuss them at a high level but you must write up and code the solutions on your own. You also must mention the names of the students you discuss with.

| Assignment | % of Final Grade |
|---|---|
| Homework 0 | 0% |
| Homework 1 | 11% |
| Homework 2 | 11% |
| Homework 3 | 11% |
| Homework 4 | 11% |

| | |
|---|---|
| Homework 5 | 11% |

**Project (35%):** The project should be application-focused and must include a significant programming component (theoretical-only projects are not allowed). You are allowed to use any programming tool or open-source code to complete your project. However, you must implement at least 1 algorithm yourself (or significantly modify existing code). The project will consist of 3 components: proposal, progress, and final. Each component will have a written and peer review part. Additionally, there will be a pre-recorded final presentation video. As a guide, the amount of effort the project should take in total should be roughly equal to 3 homeworks.

| Project Component | Written Part | Presentation Part | Peer-review Part |
|---|---|---|---|
| Proposal (5%) | Written project proposal of no more than 1 page. Should include: motivation, problem to solve, why use ML?, initial idea on how to solve it/algorithms, data needed. (3%) | -- | Review and provide feedback on at most 2 **written** proposals. See rubric for details. (2%) |
| Progress Report (8%) | Written progress report of no more than 2 pages detailing the work done thus far. Should include: solutions attempted, initial results, challenges faced, next steps, expected outcome, how you used peer-review feedback. Make sure to also submit and describe the code/algorithm you've written yourself. To get full-credit, you must have made significant progress. (6%) | -- | Review and provide feedback on at most 2 **written** progress reports. See rubric for details. (2%) |
| Final Report (22%) | Written final report of no more than 5 pages + references. Must be self-contained and should include: high-level problem, technical ML problem, description of data/preprocessing, algorithms used, results with in-depth discussion, next steps, and how you used peer-review feedback. Make sure to also submit and describe the code/algorithm you've written yourself. (16%) | No more than 10 min pre-recorded video presentation on your project. This should be self-contained, make use of multimedia, and should supplement your written report. Do not just repeat what is in your written report. A live demo would be a good idea. (3%) | Review and provide feedback on at most 2 groups' **written** progress report. See rubric for details. (3%) |

**Paper reviews (10%)**: You will review 1 state-of-the-art paper, write a summary review, and do a pre-recorded video presentation. Choose a paper from a top AI/ML or related conference (ICML, NeurIPS, AAAI, ICLR, CVPR,

IJCAI, NAACL, etc.) published in the last 10 years. You are encouraged to discuss the paper reviews with other students but you must write your own review.

| Paper Review Component | Description |
|---|---|
| Written Review (7%) | Your summary is to be no more than 2 pages and must provide a clear overview of the paper including: the main problem (question) solved (studied), motivation, main technique/algorithm used or introduced, important results. A significant portion (~ half) of your review must also be a discussion of the paper: why is it interesting (or not), what could be done to improve the algorithm or results, what are strengths/weaknesses, etc. |
| Video Presentation (3%) | No more than 10 min pre-recorded video presentation on the paper. This should be self-contained, make use of multimedia, and should supplement your written report. Do not just repeat what is in the paper or your written report. Note: we will post the videos to the class website and anyone who watches a video (not including their own) and writes a 1 page summary report will receive extra credit. |

**Submitting Assignments**: All assignments are due at 11:59 PM central time on the date specified on the **class schedule (https://canvas.umn.edu/courses/391265/pages/schedule)** . We strongly recommend using software to format math, tables results, etc. in an easy to read manner (**latex (https://www.latex-project.org/)** is ideal) with submissions in 12 point font and in PDF format; handwritten submissions are OK if they are legible - points may be taken off or grading delayed for illegible submissions.

**Late Submission Policy**: You have a total of 5 grace days which you can use to submit homework assignments late. (You can only use grace days for homeworks 1-5.) Note, you cannot use grace days on the project or paper review. You can use as many grace days as you have available to submit a homework late (for example, you can submit one homework 5 days late, 5 homeworks each one day late, and any other such combination). Grace days are rounded up to a day (for example, submitting late by 45 minutes means you used 1 grace day, submitting late by 23 hours and 45 minutes means you used 1 grace day).

If you are out of grace days and submit late, you will be penalized as follows:

- Late by 0-24 hours: you receive 50% of actual score
- Late by 24-48 hours: you receive 25% of actual score

For example, if you submit 30 hours late and your actual score is 80 then you will receive 80*0.25 = 20. Anything submitted late by more than 48 hours will receive a score of 0.

You do not need to tell us you're using a grace day, we will keep track using your submissions times on Canvas. If you want to know how many grace days you have left, please email us.

**Grading**:

For all graded work, please address any concerns within two weeks of receiving the grade. Here is the amount each of the items will contribute to your overall grade:

```
Homework      55%
Project       35%
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Paper review 10%
```

Grading for this course is on an absolute scale, so that the performance of others in the class will not negatively affect your grade. Final grades will be assigned based the following scale:

```
90.0% -- 100.0%   A
88.0% --  90.0%   A-
86.0% --  88.0%   B+
76.0% --  86.0%   B
74.0% --  76.0%   B-
72.0% --  74.0%   C+
62.0% --  72.0%   C
60.0% --  62.0%   C-
58.0% --  60.0%   D+
50.0% --  58.0%   D
 0%   --  50.0%   F
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For S/N grading, a satisfactory grade (S) requires a C- (weighted score of 60% or above).

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**Makeup Work for Legitimate Absences.** See University policy **here (https://policy.umn.edu/education/makeupwork)** .

**COVID-19**: You should stay at home if you experience any signs of illness or have a positive COVID-19 test result. If this occurs, please consult with your healthcare provider about an appropriate course of action. I will follow these same protocols and will let you know if the delivery of this course has to be temporarily changed as the result of my own circumstances. Absences related to illness, including COVID-19 symptoms, for yourself or your dependents, are **legitimate "excused" absences (https://policy.umn.edu/education/makeupwork)**

The above policies and guidelines are subject to change. The University regularly updates guidelines in response to guidance from health professionals and in relation to the prevalence of the virus and its variants in our community.

**Scholastic conduct**: All assignments must be completed individually (unless explicitly stated otherwise). This means your discussions about the questions can only cover the general approaches necessary to solve the problem. You should never share your work or see another student's answer to any part of the problem. It is also not allowed to work so closely together that your answers appear very similar, even if nothing was ever explicitly shared. In addition to this guideline, students are expected to be familiar with and adhere to the following expected conduct **here (https://communitystandards.umn.edu/syllabus-insertion)** . If you have any questions about what is and is not allowable in this class, please ask the course instructor. If you are caught cheating, you will receive a failing grade. **Additionally, you may not use AI tools such as: GPT-3, ChatGPT, etc. to explicitly solve homework questions or write the paper review (unless mentioned otherwise). Any unauthorized use of these tools will earn a failing grade.**

**Disability Accommodations**: We desire to make learning rewarding and fun for all students and make every attempt to accommodate anyone who has a desire to learn. If you require special classroom or test-taking accommodations, you need to contact the University Disability Services and also notify the instructor as soon as possible at the start of the semester (no later than 3 weeks prior to the first examination).

Also be aware of the following University-wide policies:

- **Student Conduct Code (https://regents.umn.edu/sites/regents.umn.edu/files/2022-07/policy_student_conduct_code.pdf)**
- **Makeup Work for Legitimate Absences (http://policy.umn.edu/education/makeupwork)**
- **Appropriate Student Use of Class Notes and Course Materials (http://policy.umn.edu/education/studentresp)**
- **Sexual Harassment (https://regents.umn.edu/sites/regents.umn.edu/files/policies/Sexual_Harassment_Sexual_Assault_Stalking_Relatio**
- **Equity, Diversity, Equal Opportunity, and Affirmative Action (http://regents.umn.edu/sites/regents.umn.edu/files/policies/Equity_Diversity_EO_AA.pdf)**
- **Disability Accommodations (https://disability.umn.edu/)** If you require special accommodation for examinations, you should notify the instructor in the first two weeks of the semester. Any special arrangements to take exams outside of class are to be arranged with the Disability Office.
- **Mental Health and Stress Management (http://www.mentalhealth.umn.edu/)**

**Video Lecture/Zoom Recordings.** This course may include video and audio recordings of class lectures. These recordings will be used for educational purposes and the instructor will make these available to students currently enrolled in this course. Students must seek instructor permission in order to share either course recordings or course content/materials. Similarly, instructors who wish to share zoom recordings with other sections or classes must seek and document permission from students whose image or voice are in these recordings.

**Online Learning Expectations.** See **here (https://communitystandards.umn.edu/know-code/online-learning-expectations)** for details.

**UNITE.** Streaming video archives of class meetings are available to students registered in the on-campus section of this course on a TEN-DAY delay for the length of the semester. UNITE will not make media available to students enrolled in on-campus sections for any reason past the final exam, including when assigned an Incomplete by the instructor. See UNITE's Policy for On-Campus students (link below) for details of access for on-campus students.

This ten-day delay is lifted one week prior to scheduled exams and one week prior to finals as long as students are also enrolled in the course through UNITE Distributed Learning. If there are no UNITE enrollments, the ten-day delay may only be lifted the week prior to finals week.

Access these videos through the UNITE Media Portal with your University of Minnesota Internet I.D. and password (this is what you use to access your University of Minnesota email account).

UNITE partners with the DRC in implementing accommodations approved by University of Minnesota's Disability Resource Center (DRC) consultants. Students working with the DRC may have their DRC consultant contact UNITE directly.

DO NOT ask the instructor or teaching assistants any questions related to the UNITE Media (such as access, technical or troubleshooting assistance). Instead, use the UNITE Troubleshooting FAQ or "Submit a Trouble Report to UNITE" link found on all pages within the UNITE Media Portal or send an email message to UNITE.

UNITE's Policy for On-Campus Students: **https://cse.umn.edu/unite/unite-streaming-video-access-campus-students (https://cse.umn.edu/unite/unite-streaming-video-access-campus-students)**

Technical FAQ: **https://cse.umn.edu/unite/troubleshoot-unite-media (https://cse.umn.edu/unite/troubleshoot-unite-media)**

UNITE Media Portal: **https://media.unite.umn.edu/secure/ (https://media.unite.umn.edu/secure/)**