CS 760: Machine Learning Spring 2022

Syllabus

Instructor: Daniel L. Pimentel-Alarcón

DO NOT POLLUTE! AVOID PRINTING, OR PRINT 2-SIDED MULTIPAGE.

Course Description

This course introduces the main ideas behind some popular machine learning techniques. At the end, the student will have gained insights on how these machine learning methods work, why, when a method may be better than other, how to adapt or tailor methods for a particular application, and a clear understanding to develop new theory or methods for open problems. Students should have prior exposure to basic statistics, linear algebra, and should feel comfortable coding. Students may use Julia, Python, Matlab, or their preferred coding language.

Instructor

Daniel L. Pimentel-Alarcón
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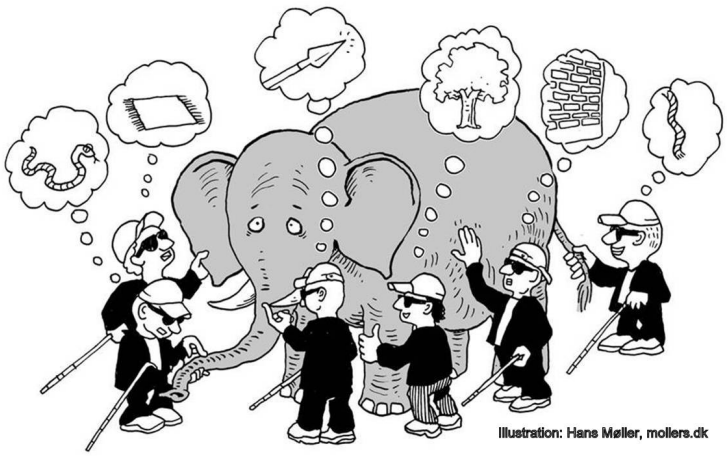
WID, Room 2176.

Lectures

Wednesday, Friday
2:30pm-3:45pm
BASCOM 272

Office Hours

Wednesday, 1:30pm-2:30pm,
By appointment



As we move along the course, we will dive into some math. We will see some equations, some theorems, some algorithms, etc. Knowing your math is important. It is important to understand the steps of an equation or the proof of a lemma. Each of these is an important **piece of the problem**. However, be careful not to loose track of what is the problem! It is equally important (or perhaps even more so) to **understand the big picture** and how the pieces come together.

Prerequisites

Basic background in:

- Linear Algebra
- Probability/Statistics
- Programming

Grading (curved)

- 50% Homework
- 50% Project

Topics

- Linear regression
- Logistic regression
- Cross-validation
- Decision trees
- Random forests
- Nearest neighbors
- Naive bayes
- A posteriori estimators
- Bayesian networks
- Support vector machines
- Neural networks
- K-means clustering
- Dimensionality reduction
- Subspace clustering

Lecture Materials

All lecture materials, such as sample code and lecture notes will be posted at:

`https://danielpimentel.github.io/teaching.html`

Homework

There will be 5 or 6 homework assignments, which will be posted at:

`https://danielpimentel.github.io/teaching.html`

Homework should be submitted in a **.pdf** file through Canvas. Students are strongly encouraged to work together on homework assignments, but each student must submit their own individual writeup. Plagiarism of material written by classmates, book or article authors, or web posters is prohibited. Academic integrity will be strictly enforced.

There is a strict no-late policy. However, there is a **homework backup (HWB)** you may use. This HWB may be used towards your final grade instead of a homework of your choosing (e.g., the lowest-graded homework), and it consists on a set of captioned images verifying that you performed 5 activities that have a positive impact on the environment. Details will be discussed during the lectures, and posted at

`https://danielpimentel.github.io/teaching.html`

Project

The project will challenge you to use the tools learnt on this course (and ideally others) to analyze a real dataset related to Opportunistic Cardiometabolic Screening. Details will be discussed during the lectures, and posted at

`https://danielpimentel.github.io/teaching.html`

Teaching Assistants

- Benjamin Jacobsen. Office Hours: Thursday 11:45am-12:45pm, through Canvas.
- Shin Changho. Office Hours: Tuesday 1pm-2pm, through Canvas.

Recommended Textbooks

I recommend getting one of these:

- *An Introduction to Statistical Learning*, by G. James, D. Witten, T. Hastie, and R. Tibshirani; Springer 2017.
- *Machine Learning*, by T. Mitchell; McGraw Hill, 1997.
- *Pattern Recognition and Machine Learning*, by C. Bishop; Springer, 2011.

I also recommend readings from these two online books:

- *Machine Learning: A Probabilistic Perspective*, by K. Murphy; MIT Press, 2012.
- *Understanding Machine Learning: From Theory to Algorithms*, by S. Shalev-Shwartz and S. Ben-David; Cambridge University Press, 2014.

Additional Resources

- *Linear Algebra*, by Stephen Friedberg, Arnold Insel, and Lawrence Spence, Pearson, 2019.
- *Probability and Random Processes for Electrical and Computer Engineers*, by John Gubner, Cambridge University Press, 2006.
- *Convex Optimization*, by Stephen Boyd and Lieven Vandenberghe, Cambridge University Press, 2009.
- *Numerical Optimization*, by Jorge Nocedal and Stephen Wright, Springer, 2006.
- *Neural Networks and Deep Learning*, by Michael Nielsen, 2019, available at `http://neuralnetworksanddeeplearning.com/index.html`
- *Deep Learning*, by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, MIT Press, 2016, available at `http://www.deeplearningbook.org`

Academic Policies

- The course syllabus provides a general plan for the course; deviations may be necessary.

- **Quarantine or Isolation due to COVID-19** Students should continually monitor themselves for COVID-19 symptoms and get tested for the virus if they have symptoms or have been in close contact with someone with COVID-19. Students should reach out to instructors as soon as possible if they become ill or need to isolate or quarantine, in order to make alternate plans for how to proceed with the course. Students are strongly encouraged to communicate with their instructor concerning their illness and the anticipated extent of their absence from the course (either in-person or remote). The instructor will work with the student to provide alternative ways to complete the course work.

- **Recordings.** Lecture materials and recordings of this course are protected intellectual property at UW-Madison. Students in this course may use the materials and recordings for their personal use related to participation in this class. Students may also take notes solely for their personal use. If a lecture is not already recorded, you are not authorized to record lectures without permission unless you are considered by the university to be a qualified student with a disability requiring accommodation. [Regent Policy Document 4-1] Students may not copy or have lecture materials and recordings outside of class, including posting on internet sites or selling to commercial entities. Students are also prohibited from providing or selling their personal notes to anyone else or being paid for taking notes by any person or commercial firm without the instructor's express written permission. Unauthorized use of these copyrighted lecture materials and recordings constitutes copyright infringement and may be addressed under the university's policies, UWS Chapters 14 and 17, governing student academic and non-academic misconduct.

- **UW-Madison face covering guidelines** While on campus all employees and students are required to wear appropriate and properly fitting face coverings (i.e., covering both mouth and nose) while present in any campus building unless working alone in a laboratory or office space. If any student is unable to wear a face-covering, an accommodation may be provided due to disability, medical condition, or other legitimate reason. Students with disabilities or medical conditions who are unable to wear a face covering should contact the McBurney Disability Resource Center or their Access Consultant if they are already affiliated. Students requesting an accommodation unrelated to disability or medical condition should contact the Dean of Students Office.

  Students who choose not to wear a face covering may not attend in-person classes, unless they are approved for an accommodation or exemption. All other students not wearing a face covering will be asked to put one on or leave the classroom. Students who refuse to wear face coverings appropriately or adhere to other stated requirements will be reported to the Office of Student Conduct and Community Standards and will not be allowed to return to the classroom until they agree to comply with the face covering policy. An instructor may cancel or suspend a course in-person meeting if a person is in the classroom without an approved face covering in position over their nose and mouth and refuses to immediately comply.

- **Evaluations.** Your constructive assessment of this course plays an indispensable role in shaping education at UW-Madison. Upon completing the course, please take the time to fill out the online course evaluation.

- **Academic Integrity.** By enrolling in this course, each student assumes the responsibilities of an active participant in UW-Madison's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in disciplinary action. This includes but is not limited to failure on the assignment/course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be forwarded to the Office of Student Conduct & Community Standards for additional review.

- **Accommodations for Students with Disabilities.** McBurney Disability Resource Center syllabus statement: The University of Wisconsin-Madison supports the right of all enrolled students to a full and

equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), andUW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty will work either directly with the student or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA.

- **Diversity and Inclusion.** Institutional Statement on Diversity: Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals. The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from everybackground – people who as students, faculty, and staff serve Wisconsin and the world.

- **Religious Observances.** UW faculty policy states that mandatory academic requirements should not be scheduled on days when religious observances may cause substantial numbers of students to be absent. Refer to the university's Academic Calendar for specific information.