UC San Diego

COGS 118B – Introduction to Machine Learning II

Spring 2021
Online class
M/W/F 11:00-11:50am

Course Information

Welcome to COGS 118B. The goal of this course (combined with 118A) is to prepare students for machine learning careers, but also to teach the knowledge and foundational material we would like to have in our incoming machine learning graduate students. Towards this goal, we don't just present and use the algorithms, but teach you the mathematics and reasoning behind the algorithms.

Assignments are designed to be challenging but really help you to solidify your understanding. The plan is for you to struggle with the homework, and to ask for help in office hours and section, but make sure that you eventually fully understand the solutions – hopefully before submission, but if not at least after the solutions are released. The tests are designed to be similar to the homework and should be easy if you truly understand the homework.

Course Description	This course is an introduction to computational modeling and machine learning, focusing mostly on unsupervised learning. Topics include: density estimation, clustering, self-organizing maps, principal component analysis, expectation maximization, and basic neural networks. The emphasis will be on learning the mathematics behind the basic building-block algorithms. We will also relate the basic mathematics to current methods in machine learning and discuss a little about how they might be used to understand cognitive phenomena.
Prerequisites	• Programming (e.g., COGS 18 or CSE 11 or CSE 8B) • Linear Algebra (e.g., MATH 18 or MATH 31AH) • Probability Theory (e.g., MATH 180A) • Vector Calculus (e.g. MATH 20E)
Credits	4.00 units
Instructor	Marcelo G Mattar, Ph.D. <mmattar@ucsd.edu>
TAs	Homero Esmeraldo <hesmeraldo@ucsd.edu> Felix Binder <fbinder@ucsd.edu>
IAs	Anya Bouzida <abouzida@ucsd.edu> Lulu Ricketts <lrickett@ucsd.edu>

Learning Outcomes

Upon completion of this course, students will be able to:

- Explain the pros and cons of Bayesian Estimation and Maximum Likelihood Estimation and to estimate parameters in very simple cases using both methods.
- Fit model parameters to data even when some aspects of the data are missing
- Explain and use various methods for uncovering structure in data
- Discuss the issue of overfitting in machine learning and know how to avoid it
- Discuss their final project in a professional manner

Course Format

The format of this course is online, including both synchronous (real time) and asynchronous (complete on your own time) elements. Students are encouraged to attend lectures synchronously (MWF 11:00a-11:50a) and one of the synchronous discussion sections (W 1:00p-1:50p; W 2:00p-2:50p; W 3:00p-3:50p). Note that synchronous participation is encouraged but not required. However, asynchronous participation using Canvas and Campuswire is required for all students.

In order to get the most out of our synchronous lectures, you should also complete the required readings before each lecture. This allows us to focus our synchronous meetings on reviewing the material, answering questions, and working through exercises together.

Synchronous online lectures:

Zoom room url: https://ucsd.zoom.us/j/92739852070
Day/Time: MWF 11:00a-11:50a

Synchronous online discussion section:

1. Day/Time: W 1:00p-1:50p https://ucsd.zoom.us/j/94493663702
2. Day/Time: W 2:00p-2:50p https://ucsd.zoom.us/j/99438591399
3. Day/Time: W 3:00p-3:50p https://ucsd.zoom.us/j/93314266893

Asynchronous (online) course elements:

UC San Diego's Learning Management System: https://canvas.ucsd.edu
Login: UC San Diego Active Directory credentials
Purpose: Announcements, assignment submissions, course materials

Campuswire: https://campuswire.com/
Sign-up on https://campuswire.com/p/G2D9B7622
Access code: **2855**
Purpose: Class-related discussions

PS: Please do not share the zoom or Campuswire links outside of the class.

Course Materials and Tools

Textbook
Bishop, C.M. Pattern Recognition and Machine Learning
Available for free for download (click on the link above)

We will also use some copied pages from Stork, Duda, Hart Pattern Classification (but I will provide the needed pages as downloadable handouts).

Course Finder
UC San Diego's Learning Management System: https://coursefinder.ucsd.edu/
Login: UC San Diego Active Directory credentials

Technology Requirements
We will provide ETS accounts with Matlab. Python may also be used but the assignment starter code and solutions are in Matlab. Projects can be done in any language, but for best assistance we recommend Matlab or Python. More details will be forthcoming on the accounts.

If you wish to use your own computers for assignments, Matlab can be obtained free (for UCSD students) here: https://matlab.ucsd.edu/student.html

Assignments, Projects, and Grading

Summary of Grade Criteria

Assignment	Weight
Tests (x3)	30%
Assignments (x4)	40%
Final Project	25%
Comments on other projects	5%
TOTAL	**100%**

Grading Scale

A = 90-100% **B** = 80-89% **C** = 70-79% **D** = 60-69% **F** = 59%-below

Final Project

There is a final project and no final exam. Presentations will be submitted as a recorded video along with a brief written paper, both due during the final exam period. Projects may be done in groups of 1-3 people. You are also required to give respectful comments on 3 other projects (this is done by each person alone – not as a team).

Grading Details
You may resubmit ONE homework. This resubmission is allowed even after consulting the solutions as long as you complete the homework without copying – as with help from others, you may get help but must write your final solution without copying (you must understand what you are writing). Resubmissions must be done before the last test. Please consult the HW solutions before the tests regardless.

Attendance and Participation
Class participation is highly encouraged. There will be many participation items, including pre-class reading assignments, in-class participation (via live polls, discussions, and group exercises in breakout rooms), collaborative readings, and discussion forums. Participation is also encouraged through asking and answering questions on Campuswire and through attendance at discussion sections.

Note that, due to the pandemic, synchronous class participation will not be graded. We will do our best to ensure that synchronous elements of the course are also offered asynchronously for students who are in different time zones or otherwise unable to be present at specific class times.

Late or Missing Assignments
It is highly recommended that you hand the assignments in on time as they build on each other and getting behind will impact your ability to keep up with new material. For this reason, we penalize late submissions. You lose 10% per day up until 50% of the points. You will be best off to hand in what you have completed at each deadline. Exceptions can be granted for illnesses, emergencies, and other reasonable requests (sometimes verification will be required). Sometimes we will extend the deadline for all if circumstances warrant. You can resubmit one HW (after consulting and learning from but not directly copying the solutions).

Academic Integrity
Students agree that by taking this course all required papers/homeworks will be subject to submission for textual similarity review to Turnitin.com for the detection of plagiarism. All submitted papers will be included as source documents in the Turnitin.com reference database solely for the purpose of detecting plagiarism of such papers. Use of the Turnitin.com service is subject to the terms of use agreement posted on the Turnitin.com site.

UC San Diego

Instructional Team

Instructor


Marcelo

Marcelo G Mattar
Assistant Professor
http://mattarlab.com

Virtual Office Hours:
Fridays, 1pm-2pm

Teaching Assistants


Homero

Homero Esmeraldo
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hesmeraldo@ucsd.edu

Virtual Office Hours:
Tuesdays, 5pm-6pm


Felix

Felix Binder
Ph.D. Student
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Virtual Office Hours:
Wednesdays, 9am-10am

Course Schedule (tentative)

Week	Topics	Activities, Assessments, and Due dates	Book sections
0 + 1	Intro, Discrete probabilities, conditional independence, Bayes rule Maximum likelihood estimation, Bayesian estimation, Bernoulli random variables, Continuous pdfs, expectation, variance, covariance, entropy, Gaussian distribution	PRETEST assigned PRETEST due HW 1 assigned	1.2, 1.2.3 2.1 1.2.2, 2.1.1, 2.2, 1.2.4, 2.3, 2.3.4, 2.3.6, 1.6, 1.6.1
2	Gaussians, entropy cont'd K-means, self-organizing maps	HW 1 due HW 2 assigned	1.2.2, 2.1.1, 2.2, 1.2.4, 2.3, 2.3.4, 2.3.6, 1.6, 1.6.1 (same as above) 9, 9.1, 9.1.1, 9.2
3	Mixture of Gaussians More general EM (fitting Gaussians to 2D data where one of the datapoints is missing an x-value)		9.2, 9.2.1, 9.2.2,9.3 DH&S handout
4	Review for TEST 1 EM Project discussion	HW 2 due HW 3 assigned TEST 1	12, Bishop Appendix C
5	Spectral clustering	HW3 due HW4 assigned	12, Bishop Appendix C
6	Review for TEST 2 PCA	Form project groups TEST 2	Appendix C (Bishop text)

7	PCA cont'd Neural Networks Review for TEST 3	HW4 due	5, 5.1 (all subsections), 5.2, 5.3 (all subsections) Also backpropnotes.pdf (in modules)
8	Neural Nets cont'd	TEST 3	
9	Project work and advice Neural Networks		7.1
10	Optional topics		7.1

Overall Course Expectations

What you can do to support your success in the course:	What I will do to support your success in the course:
Read the syllabus and stay current with course information	Be prepared and bring my enthusiasm for teaching to each session
Keep up with readings and lab assignments, as each one builds on the previous one.	Respond to emails in a timely manner and provide timely feedback on assignments / submissions.
Contribute to the learning environment with fairness, cooperation, and professionalism	Establish a learning environment with fairness, cooperation and professionalism, and will take action if these principles are violated.
Treat your classmates, instructional assistants and myself honestly and ethically	Treat you honestly and ethically, and will address any concerns you might have
Commit to excel with integrity[1]. Have the courage to act in ways that are honest, fair, responsible, respectful & trustworthy.	Uphold integrity standards and create an atmosphere that fosters active learning, creativity, critical thinking, and honest collaboration.
Manage your time, so you can stay on track with the course and complete tasks on time	Only assign work that is vital to the course and work to meet the standard credit hour allotment for the course.
Communicate with me if you determine that a deadline cannot be met due to extenuating circumstances	Consider requests for adjustments and will make reasonable exceptions available to all students when approved

1. Please read UC San Diego's Policy on Integrity of Scholarship and take the integrity pledge!

Note on Inclusivity: Everyone will come to this course with different backgrounds, knowledge, and perspective. We want to create a classroom culture that respects and revels in this human diversity. If you have any concerns related to inclusivity or feel your identities (Race, Gender, sexuality, religion, ability, etc.) is not being honored, please let us know! Accommodations can be made for students with a letter from the OSD. For more information on campus & community resources, check triton ed.

UC San Diego

Resources for Support and Learning

Learning and Academic Support	
Ask a Librarian: Library Support Chat or make an appointment with a librarian to focus on your research needs **Course Reserves, Connecting from Off-Campus and Research Support** Find supplemental course materials **First Gen Student Success Coaching Program** Peer mentor program that provides students with information, resources, and support in meeting their goals **Office of Academic Support & Instructional Services (OASIS)** Intellectual and personal development support	**Writing Hub Services in the Teaching + Learning Commons** One-on-one online writing tutoring and workshops on key writing topics **Supplemental Instruction** Peer-assisted study sessions through the Academic Achievement Hub to improve success in historically challenging courses **Tutoring – Content** Drop-in and online tutoring through the Academic Achievement Hub **Tutoring – Learning Strategies** Address learning challenges with a metacognitive approach
Support for Well-being and Inclusion	
Basic Needs at UCSD Any student who has difficulty accessing sufficient food to eat every day, or who lacks a safe and stable place to live is encouraged to contact: foodpantry@.ucsd.edu | basicneeds@ucsd.edu | (858) 246-2632 **Counseling and Psychological Services** Confidential counseling and consultations for psychiatric service and mental health programming **Triton Concern Line** Report students of concern: (858) 246-1111 **Office for Students with Disabilities (OSD)** Supports students with disabilities and accessibility across campus	**Community and Resource Centers** **Office of Equity, Diversity, and Inclusion** As part of the Office of Equity, Diversity, and Inclusion the campus community centers provide programs and resources for students and contribute toward the evolution of a socially just campus (858).822-.3542 | diversity@ucsd.edu **Get Involved** Student organizations, clubs, service opportunities, and many other ways to connect with others on campus **Undocumented Student Services** Programs and services are designed to help students overcome obstacles that arise from their immigration status and support them through personal and academic excellence