CSC 480/580 : Principles of Machine Learning

Mon/Wed 5:00 – 6:15pm, Gould-Simpson 906

Course Description

Machine learning is about automatic ways for computers to collect and/or adapt to data to make predictions, make decisions, or gain insight. It can also be seen as a fundamentally different way of writing computer programs from traditional programming, which is often an attractive way of solving practical problems. Students will learn the fundamental frameworks, computational methods, and algorithms that underlie current machine learning practice, and how to derive and implement many of them. They will also learn both advantages and unique risks that this approach offers.

Instructor and Contact Information

Jason Pacheco, Gould-Simpson 707, *pachecoj@arizona.edu*

Office Hours: TBD

Teaching Assistants:
Emiliano Islas, eislasq@arizona.edu
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D2L CSC480: https://d2l.arizona.edu/d2l/home/1815945

D2L CSC580: https://d2l.arizona.edu/d2l/home/1815948

Piazza: https://piazza.com/arizona/fall2026/csc480580

Gradescope CSC480: https://www.gradescope.com/courses/1364018 **Entry Code: 3ZGDGX**

Gradescope CSC580: https://www.gradescope.com/courses/1364022 **Entry Code: ZPDJDB**

Course Webpage: https://pachecoj.com/courses/csc480-580_fall26/

Course Format and Teaching Methods

This course will consist of regular in-person lectures. In-class discussion as well as Q&A is encouraged.

Course Objectives

A successful student will be able to implement and explain the limitations of many of the central methods and techniques in machine learning:

- *Basic binary classifiers: decision trees, logistic regression*
- *Supervised vs. unsupervised learning - what's possible in the absence of labels*
- *Reductions - how to handle imbalanced data; how to build multiclass classifiers*
- *Practical issues - how to detect overfitting and underfitting; how and when to use feature Engineering*
- *Efficiency issues - how to create classifiers that work well in the presence of large training sets, and large feature sets*
- *Modern techniques - students will be introduced, via classroom materials and projects, to recent methods in machine learning (this could include, for example, deep learning, reinforcement learning, A/B testing, and multi-armed bandits)*

For a more granular description of the learning objectives, see the week-by-week schedule and the description of the assignments below.

Machine Learning is a big field, and there is no way we can cover all of it in one course. With that said, this course covers a large amount of material, and the assignments are a central part of the course. ***Students are expected to dedicate a significant amount of time on the course outside of the classroom, especially if they have background deficiencies to make up.***

Course objectives describe what the instructor plans to cover in the course. The objectives should be related to the Course Catalog description and the scheduled topics.

Expected Learning Outcomes

Expected learning outcomes of the course are:

- *To be able to explain the meaning of generalization in machine learning, and why common* machine learning algorithms are expected to generalize.
- To be able to list the common supervised and unsupervised learning algorithms and the practical values of each.
- To be able to implement representative machine learning algorithms such as logistic regression, k-nearest neighbors, k-means clustering, etc.
- To be able to identify real-world problems that can be formulated into machine learning problems, perform feature engineering, choose appropriate methods, detect overfitting/underfitting, and evaluate them with statistical significance.
- To be able to explain key challenges in reinforcement learning that supervised/unsupervised learning paradigms do not share.
- To be able to prove the fact that no classifiers can have a smaller test error than the Bayes classifier.
- To be able to mathematically derive the forward-backward algorithm for the hidden Markov model and prove its correctness.

  Those taking CSC 580 have the additional expected outcome:

- To be able to survey a subfield of machine learning, identify gaps in the research literature, and develop initial solutions for filling those gaps.

Transferable Career Skills

National Association of Colleges and Employers (NACE) Career Readiness:

Career readiness is a foundation from which to demonstrate requisite core competencies that broadly prepare the college-educated for success in the workplace and lifelong career management. For new college graduates, career readiness is key to ensuring successful entrance into the workforce.

There are eight career readiness competencies, each of which can be demonstrated in a variety of ways. (NACE, 2025)

- Career & Self Development
- Communication
- Critical Thinking
- Equity & Inclusion
- Leadership
- Professionalism

- Teamwork
- Technology

In this course, we will focus on the following competencies:

- Technology: Students will learn data analysis and machine learning algorithms, implement them, and apply them to real-world datasets in a hands-on manner.
- Teamwork: The course will include lectures, in-class discussions, and activities, with a strong emphasis on teamwork through paired assignments and group projects that require collaboration with other students both during and outside of class.
- Communication: Students are encouraged to emphasize communication by interacting with teaching assistants and using various channels, such as D2L, email, class discussions, and Piazza, to stay updated on course materials.
- Critical Thinking: Students will learn best practices and common pitfalls in applying machine learning algorithms and be able to use such knowledge to tailor their algorithms to their own applications.

Makeup Policy for Students Who Register Late

If you register late for this class, contact me as soon as you do. You will be expected to submit all missed assignments within a week of your registration. It is your responsibility to catch up to the class content.

Course Communications

We will use D2L for the main communications, including important announcements and discussions. We will use Piazza for Q&A.

Required Texts or Readings

We will use Hal Daumé's Course in Machine Learning (http://ciml.info/) for the main textbook, fully and freely available online.

We will also use the book Moritz Hardt and Benjamin Recht, "Patterns, Predictions, and Actions: A story about machine learning" (https://mlstory.org) and take reading materials there.

Assignments and Examinations: Schedule/Due Dates

HW0 is due in 7 days and HW1-4 are each due in 10 days.

- *HW0 - 8/24*
- *HW1 - 9/02*
- *HW2 - 9/21*
- *Project Proposal - 9/30*
- *Midterm - 10/14*
- *HW3 - 10/28*
- *HW4 - 11/16*
- *Final Project - Due 12/09*
- *Final Exam - 12/17*

Final Examination

The final exam will be in-person on 12/17 at 1:00 – 3:00pm in the regular classroom. Please see the final exam regulations and schedules here: https://registrar.arizona.edu/finals

Grading Scale and Policies

You will be assessed based on your performance on programming assignments, one final exam, and one project.

The instructing staff will assign grades on a scale from 0 to 100, with the following weights:

- *Assignments: 40%*
- *Project: 25% (Proposal 10% + Final project report 15%)*
- *Midterm: 15%*
- *Final Exam: 20%*

Your final grade in the course will be a direct calculation of the above components and letter grades are as

follows:

- *90% or better: A;*
- *80% or better: B;*
- *70% or better: C;*
- *60% or better: D;*
- *below 60%: E.*

For due dates see the course webpage. A homework will be returned to students before the next homework is due. Grading delays beyond promised return-by dates will be announced as soon as possible with an explanation for the delay. As a rule, homework will not be accepted late except in case of documented emergency or illness.

By your last day to withdraw, you will know more than 40% of your grade by weight. Before the last day to withdraw (the end of the 10th week), the student will be aware of three homework scores (25%), 10 quiz scores (10%), and the project proposal assignment (5%). These sum to 40%.

For Those Taking CSC 580

Each homework assignment and exam will have additional questions marked "advanced" that are not required for 400-level credit. In addition, the project requirements will be different between 400- and 500-level credit. Those taking the class for the undergraduate level will not be required to pursue novel research projects. It will be sufficient for undergraduate students to reimplement an existing algorithm, or apply an algorithm to a new dataset and report results. The difference in requirements will lead to different learning experiences as graduate-level students will be required to pursue novel research. As such, graduate-level students will survey the current state of research, identify an area for novelty, and make contributions. Whereas undergraduate-level students will use the project to further their understanding of a topic of their choice.

Incomplete (I) or Withdrawal (W):

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at https://catalog.arizona.edu/policy/courses-credit/grading/grading-system.

Dispute of Grade Policy

Any grading disputes should be communicated to the professor within one week of having received the

grade. The professor will announce in class and on Piazza when grading is complete for each assignment. If a student has not received a grade on a submitted assignment it must be communicated to the adviser within one week of this announcement. If no assignment was submitted it will receive a score of zero.

Honors Credit

Students wishing to contract this course for Honors Credit should e-mail me to set up an appointment to discuss the terms of the contact and to sign the Honors Course Contract Request Form. The form is available at http://www.honors.arizona.edu/honors-contracts

Scheduled Topic and Activities

Week 1	Introduction + Course Overview	Out: HW0
	Basics - Decision Trees and Learning Algorithms	
Week 2	Geometry, NN classifiers, K-Means	
	Limits - Optimal Bayes Rate Classifier / Overfitting / Underfitting	Out: HW1
Week 3	**Labor Day : No Classes**	
	Practical Issues - Performance measures, under / over-fitting, CV, pred. Conf	
Week 4	Practical Issues (Cont')	
	Linear Models - Regression	
Week 5	Linear Models - Classification	Out: HW2
	Linear Models (Cont')	
Week 6	Linear Models (Cont')	
	Nonlinear Models	Out: Project Proposal
Week 7	Nonlinear Models (Cont'd)	
	Unsupervised Learning	
Week 8	Unsupervised Learning (Cont'd)	
	Midterm Exam	Midterm
Week 9	Probability, Naive Bayes, PGMs	
	Probability, Naive Bayes, PGMs (Cont'd)	Project Proposal Due
Week 10	Neural Networks - Backpropagation	
	Neural Networks - Convolutional	Out: HW3
Week 11	Neural Networks - Autoencoder	

	Generative Adversarial Networks	
Week 12	Generative Adversarial Networks	
	Veteran's Day : No Classes	
Week 13	Large Language Models (LLMs)	Out: HW4
	LLMs (Cont'd)	
Week 14	LLMs (Cont'd)	
	Reinforcement Learning	
Week 15	Reinforcement Learning (Cont'd)	
	Makeup	
Week 16	Makeup	
	Final Lecture	Final Project Due
	Final Exam Due - 12/17	

Classroom Behavior Policy

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Students are asked to refrain from disruptive conversations with people sitting around them during lecture. Students observed engaging in disruptive activity will be asked to cease this behavior. Those who continue to disrupt the class will be asked to leave lecture or discussion and may be reported to the Dean of Students.

Some learning styles are best served by using personal electronics, such as laptops and iPads. These devices can be distracting to other learners. Therefore, students who prefer to use electronic devices for note-taking during lecture should use one side of the classroom.

Notification of Objectionable Materials

This course will contain material of a mature nature, which may include explicit language, depictions of nudity, sexual situations, and/or violence. The instructor will provide advance notice when such materials will be used. Students are not automatically excused from interacting with such materials, but they are encouraged to speak with the instructor to voice concerns and to provide feedback.

Safety on Campus and in the Classroom

For a list of emergency procedures for all types of incidents, please visit the website of the Critical Incident Response Team (CIRT): https://cirt.arizona.edu/case-emergency/overview

Also watch the video available at

https://arizona.sabacloud.com/Saba/Web_spf/NA7P1PRD161/app/me/ledetail;spf-url=common%2Flearningeventdetail%2Fcrtfy000000000003841

University-wide Policies link

All students must familiarize themselves with the policies and resources at the following link: https://catalog.arizona.edu/syllabus-policies

- Threatening Behavior Policy
- Student Code of Academic Integrity
- Nondiscrimination and Anti-Harassment Policy
- Disability Syllabus Statement
- Religious Accommodation Policy
- Absences pre-approved by the University Dean of Students (or dean's designee) will be honored.

Department-wide Syllabus Policies and Resources link

Links to the following departmental syllabus policies and resources are provided here, https://www.cs.arizona.edu/cs-course-syllabus-policies :

- Department Code of Conduct
- Illnesses and Emergencies
- Obtaining Help
- Confidentiality of Student Records
- Land Acknowledgement Statement

Subject to Change Statement

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.