

# Computer Science 4033/5033: Machine Learning

Instructor: Dimitris Diochnos

Fall 2020

## 1 Course Overview

By taking this course, you will learn about current techniques that enable machines to learn and adapt their behavior over time and to new situations. You will take a small step into creating intelligent machines for the future by choosing and completing a team-based semester-long machine learning project. You will also gain experience at teamwork and at presenting your work professionally through the project and homework.

## 2 Learning Objectives

The general/overall learning objectives are:

- Be able to explain the different types of ML methods and articulate why they are different and what types of problems each is aiming to solve
- Be able to implement any of the basic techniques in ML
- Select the ML solution best-suited for a novel domain and justify your choice
- Synthesize one area of machine learning in depth and apply it to a novel application
- Implement and evaluate the effectiveness of your ML method applied to a novel application
- Communicate ideas clearly to a variety of audiences both in oral and written form
- Function effectively in a team

The specific topics we will cover (not necessarily in this order) include:

### **Supervised learning**

- Regression, Logistic regression, Elastic Nets
- Neural nets and Convolutional Neural Nets/Deep Learning
- Tree based methods including Decision trees, Random Forests, and Gradient Boosted Regression Trees
- Kernel methods and Support Vector Machines

### **Reinforcement learning**

- The RL problem
- Dynamic Programming
- Temporal Difference Learning
- Function Approximation

### **General techniques/concepts**

- Ensemble methods
- Overfitting
- Expectation Maximization (EM)

### **Graphical models**

- Bayesian Networks: using them, inference, building/creating them, learning them automatically both from observed and unobserved evidence

ABET Student Outcomes to be addressed

- A: An ability to apply knowledge of computing and mathematics appropriate to the discipline
- C: An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs
- D: An ability to function effectively on teams to accomplish a common goal
- F: An ability to communicate effectively with a range of audiences,

- H: Recognition of the need for and an ability to engage in continuing professional development: An ability to use current techniques, skills, and tools necessary for computing practice
- J: An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices
- K: An ability to apply design and development principles in the construction of software systems of varying complexity

### 3 General Information

**Class time:** Monday/Wednesday 5:30pm-6:45pm

**Class location:** Dale Hall 218

**Prerequisites:** MATH 4753 or ENGR 3293 or IE 3293 or MATH 4743 or permission of the instructor. **Prior programming experience is assumed.**

**Required materials:**

- *Elements of Statistical Learning* by Hastie, Tibshirani, and Friedman. This is available online for free. Download the latest edition, which is the 12th printing. <http://web.stanford.edu/~hastie/ElemStatLearn/>
- *Reinforcement Learning* by Sutton and Barto. This one is also available online for free. Download the latest (2nd) edition of the book. <http://incompleteideas.net/book/the-book-2nd.html>.

**Optional Materials:** There are several optional books that are listed on the class website. <https://www.cs.ou.edu/~diochnos/teaching/CS4033-5033/2020F/index.php>.

**Instructor:** Dimitris Diochnos

- *Office:* Devon Energy Hall 244
- *Phone:* Send me email [diochnos@ou.edu](mailto:diochnos@ou.edu)
- *URLs for class:*

- Canvas will have the official grade book and anything we upload to share for class. <http://canvas.ou.edu>
- My website has a schedule for the readings and deadlines.  
<https://www.cs.ou.edu/~diochnos/teaching/CS4033-5033/2020F/index.php>
- *Email:* diochnos@ou.edu
- *Office hours:* Monday/Wednesday 10:30am-12:30pm. I am also available by appointment! Please note open door policy on my door and stop by if the door is open.

Please note that while anyone is welcome during the entire 2-hour time period on Mondays and Wednesdays, CS 5970 will have precedence during the first hour (10:30am-11:30am) and CS 4033/5033 will have precedence during the second hour (11:30am-12:30pm).

**TA:** TBA

- *Email:* TBA
- *Office hours:* TBA

**How to email us:** This is a useful guide on how to send emails to any of your faculty and TAs. <http://bit.ly/2bbU7Ms>

## 4 Evaluation

You will be learning and practicing many aspects of machine learning. What you get out of a course will depend on what you put into it! In order to give you a fair grade at the end of the semester, I will evaluate you using the following weighting.

- Semester-long project: 50%
- Homeworks: 50%

**Undergraduates:** Students taking 4033 will have shorter homework assignments and a smaller project. The grade cutoff lines are not required to be the same for the two courses.

**Grade questions:** To maintain fairness in grading, the items should be brought to the person who graded it. To maintain fairness, all disagreements about the grading of projects should be brought to our attention within one week of when the item was returned.

**Online Grade Summary:** Canvas has a grade book that I will use to store all of your grades. It is your responsibility to verify that the grades on Canvas are correct. If an error is found, bring the document to me and I will correct Canvas.

**Borderline grades:** Borderline final grades will be decided by your class participation which means that being an active participant in class can push you over a grade boundary.

**Final Examination:** Because this class contains a semester project which is presented at the poster session, there will be no final examination.

**Due dates:** To be fair to everyone and to minimize disruption to class, homeworks and projects are due at the beginning of class on the day listed in the schedule.

- Your lowest homework grade will be dropped
- Any late items will be marked 10% per day late for a maximum of 3 days late.

**Projects:** Your final project will be due the last week of classes. Per university policy, you may turn this project in prior to pre-finals week if you have completed the project.

## 5 Course Policies

The following set of rules will help keep us all on the same page all semester and help to ensure fair treatment for all students.

**Masking Policy:** As outlined by the University of Oklahoma's Chief COVID Officer, until further notice, employees, students, and visitors of the OU community will be mandated to wear masks

1. when they are inside University facilities and vehicles and
2. when they are outdoors on campus and social distancing of at least six feet is not possible.

For the well-being of the entire university community it is important that everyone demonstrate the appropriate health and safety behaviors outlined in the University Mandatory Masking Policy (<https://www.ou.edu/coronavirus/masking-policy>). As this mandate includes all campus classrooms, please make sure you are wearing your mask while in class. If you do not have a mask or forgot yours, see the professor for available masks. If you have an exemption from the Mandatory Masking Policy, please see the professor to make accommodations before class begins. If and where possible, please make your professor aware of your exemption and/or accommodation prior to arriving in class.

If a student is unable or unwilling to wear a mask and has not made an accommodation request through the ADRC, they will be instructed to exit the classroom.

**Food and Drink Policy:** Food is not allowed classrooms. Consuming food in learning spaces is a significant concern for transmission of illness and therefore is prohibited. Students that may need to eat for health reasons, such as blood sugar regulation, should step outside the classroom to a social distanced location. If you are in a course that extends more than an hour, please be aware that some students may need to need to eat for health and may need to step out of classes briefly.

Drinking in classes is generally discouraged. It is acceptable, specifically in longer course formats, for students to take a sip from a water bottle or cup with a lid by temporarily moving their mask to do so and immediately replacing the mask. Faculty may also need to take sips of water while they are teaching. Discretion should be used while drinking in the classroom and temporary movement of a mask should be momentary and replaced after the sip.

- III.3.1 <https://ou.edu/coronavirus/masking-policy> Students may remove masks when inside University facilities only
  1. when alone in an enclosed room and
  2. while participating in activities in which a face mask cannot practically be worn, such as eating and drinking or playing a musical instrument or singing as part of an academic assignment.

**Attendance Policy:** A temporary university policy has been established to protect the OU community by ensuring that students who are ill or required to isolate feel encouraged to remain at home. Missing a class session or other class activity due to illness or isolation will not result in a penalty for the absence, and the student will not be asked to provide formal documentation from a healthcare provider to excuse the absence.

This policy is based on all students and faculty adhering to the principles of integrity, honesty, and concern for others.

Students who are experiencing symptoms of COVID-19, including cough, fever, shortness of breath, muscle pain, headache, chills, sore throat, loss of taste or smell, congestion or runny nose, nausea or vomiting, or diarrhea or who have been in close contact with others who have symptoms should:

- Remain at home to protect others
- Ensure that any needed screening has been conducted (COVID-19 Screening and Reporting Tool<sup>1</sup>) and any needed treatment obtained<sup>2</sup>
- Contact the instructor prior to absence or inability to participate, if possible, and provide an honest report of the reason for which you cannot attend class or complete a course activity
- Continue to complete coursework to the extent possible, using Canvas, zoom, and other online tools
- Submit assignments electronically to the extent possible and as directed by the instructor
- Communicate with the instructor to arrange modifications to deadlines or work requirements or reschedule exams or other important course activities, when it is necessary

**Chegg and Other Online Tutoring Sources:** There are a wide variety of tutoring resources available through paid websites. Many of these sites have students upload assignments and solutions and surreptitiously provide these documents to other students. What appears to be a session with a tutor may be, behind the scenes, the tutor doing a search of their company database of solutions to share. By using these sites you risk being charged with academic misconduct, either by supplying other students with answers they did not author or by receiving someone else's answer that you did not author. Since these companies are not open with students about their practices, you cannot know whether a tutor is providing meaningful support (for example, identifying misunderstandings of content and explaining them) or simply feeding you someone else's solution a bit at a time. The tutor's actions can result in different students submitting answers that are identical, which may be flagged as academic misconduct during grading.

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<sup>1</sup><https://covidreporting.ouhsc.edu/>

<sup>2</sup><https://www.ou.edu/healthservices/COVID-101>

**Academic Misconduct:** Academic misconduct hurts everyone but particularly the student who does not learn the material. All work submitted for an individual grade should be the work of that single individual and not his/her friends. It is fine to ask a fellow student for help as long as that help does not consist of copying any computer code, or solutions to other assignments. Students working on joint projects may certainly help one another and are expected to share code within the project group. However, they may not share beyond the group.

1. Collaboration is encouraged for homework and projects. For the projects, you will work within your groups. For the homework, you may form study groups so long as each homework is in your own words. Write your study partners' names on your homework when you turn it in.
2. Do not show another student (or group) a copy of your projects or homework before the submission deadline. The penalties for permitting your work to be copied are the same as the penalties for copying someone else's work.
3. Make sure that your computer account is properly protected. Use a good password, and do not give your friends access to your account or your computer system. Do not leave printouts or thumb drives around a laboratory where others might access them.

Upon the first documented occurrence of academic misconduct, I will report it to the Campus Judicial Coordinator. The procedure to be followed is documented in the University of Oklahoma Academic Misconduct Code<sup>3</sup>. In the unlikely event that I elect to admonish the student, the appeals process is described in <http://www.ou.edu/integrity>.

**Project code:** Your project code and writeups must be written exclusively by you or your group. **Use of any downloaded code or code taken from a book (whether documented or undocumented) is considered academic misconduct and will be treated as such.** Exceptions from this policy (such as a project that builds on an existing open-source project) may be granted but you **MUST** speak with me first.

**Classroom Conduct:** Disruptions of class will not be permitted. Examples of disruptive behavior include:

- Allowing a cell phone or pager to repeatedly beep audibly.
- Playing music or computer games during class in such a way that they are visible or audible to other class members.

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<sup>3</sup><http://www.ou.edu/studentcode>

- Exhibiting erratic or irrational behavior.
- Behavior that distracts the class from the subject matter or discussion.
- Making physical or verbal threats to a faculty member, teaching assistant, or class member.
- Refusal to comply with faculty direction.

In the case of disruptive behavior, I may ask that you leave the classroom and may charge you with a violation of the Student Code of Responsibilities and Conduct.

**Class Web Page:** Login to the canvas website using your 4+4 (first four letters of your last name followed by the last four digits of your student number), using your standard OU password. If you have difficulty logging in, call 325-HELP. This software provides a number of useful features, including a list of assignments and announcements, an electronic mailing list, newsgroups, and grade book. All handouts are available from Canvas. You should check the site daily. When I update the site, I will post an announcement telling you what has been added and where it is located. You are responsible for things posted on the site with a 24 hour delay.

**Class evaluations:** The College of Engineering utilizes student ratings as one of the bases for evaluating the teaching effectiveness of each of its faculty members. The results of these forms are important data used in the process of awarding tenure, making promotions, and giving salary increases. In addition, the faculty uses these forms to improve their own teaching effectiveness. The original request for the use of these forms came from students, and it is students who eventually benefit most from their use. Please take this task seriously and respond as honestly and precisely as possible, both to the machine-scored items and to the open-ended questions

**Class Email Alias:** Urgent announcements will be sent through email. It is your responsibility to:

- Have your university supplied email account properly forwarded to the location where you read email.
- Make sure that your email address in Canvas is correct, and forwards email to the place where you read it. I'll send out a test message during the first week of class. If you do not receive this message, it is your responsibility to get the problem resolved immediately.

- Have your email program set up properly so that replying to your email will work correctly the first time. You can send email to yourself and reply to yourself to test this.

If you need assistance in accomplishing any of these tasks, contact 325-HELP.

**Newsgroups and Email:** The newsgroup on Canvas should be the primary method of communication, outside of class. This allows everyone in the class to benefit from the answer to your question. If you email me a question of general interest, I may post your question and my answer to the newsgroup. Matters of personal interest should be directed to email instead of to the newsgroup, e.g. informing me of an extended personal illness. Posting guidelines for the newsgroup are available on Canvas.

**Religious Holidays:** It is the policy of the University to excuse the absences of students that result from religious observances and to provide without penalty for the rescheduling of examinations and additional required classwork that may fall on religious holidays.

**Incompletes:** The grade of I is intended for the rare circumstance when a student who has been successful in a class has an unexpected event occur shortly before the end of the class. I will not consider giving a student a grade of I unless the following three conditions have been met. 1. It is within two weeks of the end of the semester. 2. The student has a grade of C or better in the class. 3. The reason that the student cannot complete the class is properly documented and compelling.

**Accommodation of Disabilities:** The University of Oklahoma is committed to providing reasonable accommodation for all students with disabilities. Students with disabilities who require accommodations in this course are requested to speak with the professor as early in the semester as possible. Students with disabilities must be registered with the Office of Disability Services prior to receiving accommodations in this course. The Office of Disability Services is located in 730 College Ave, phone 405/325-3852 or TDD only 405/325-4173.

**Adjustments for Pregnancy/Childbirth Related Issues** Should you need modifications or adjustments to your course requirements because of documented pregnancy-related or childbirth-related issues, please contact me as soon as possible to discuss. Generally, modifications will be made where medically necessary and similar in scope to accommodations based on temporary disability.

Please see <http://www.ou.edu/eoo/faqs/pregnancy-faqs.html> for commonly asked questions.

**Title IX Resources** For any concerns regarding gender-based discrimination, sexual harassment, sexual misconduct, stalking, or intimate partner violence, the University offers a variety of resources, including advocates on-call 24.7, counseling services, mutual no contact orders, scheduling adjustments and disciplinary sanctions against the perpetrator. Please contact the Sexual Misconduct Office 405-325-2215 (8-5) or the Sexual Assault Response Team 405- 615-0013 (24.7) to learn more or to report an incident.

## Acknowledgements

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