Course Syllabus

INTRODUCTION TO MACHINE LEARNING

Instructor Dr. William Regli
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Class Meets Monday & Wednesday
15:30 – 1645
ESJ #2204

Office Hours 2173 A.V. Williams Bldg
Wednesday 1400 – 1530
and by appointment

Teaching Assistants & Office Hours

Jason Fan	asonfan@umd.edu	TUESDAY/THURSDAY 0900-1000
John Kanu	john.d.kanu@gmail.com	FRIDAYS, 1000-1200
Kevin Chen	kev@umd.edu	FRIDAYS, 1200-1400

Office hours will be held in A.V. Williams 4101 and/or 4103.

Course Prerequisites
MATH461: Linear Algebra for Scientists and Engineers
MATH240: Introduction to Linear Algebra
CMSC351: Introduction to Algorithms
CMSC330: Organization of Programming Languages
CMSC320: Introduction to Data Science

Interestingly, neither CMSC421 Intro to AI nor STAT100/STAT420: Introduction to Prob & Stat are pre-requisites.

Course Description

Machine Learning (ML) studies representations and algorithms that allow machines to improve their performance on a task from experience. This course provides a broad overview of existing methods for machine learning and an introduction to adaptive systems in general. Emphasis is given to practical aspects of machine learning and data mining.

Machine learning is all about finding patterns in data to get computers to solve problems. Instead of explicitly programming computers to perform a task, machine

learning lets us program the computer to learn from examples and improve over time without human intervention. This requires we address several difficult questions, including how to generalize beyond the examples that have been provided at "training time" to new examples that you see at "test time".

It's an exciting time to study machine learning! This course is a broad overview of existing methods for machine learning and an introduction to adaptive systems in general. Emphasis is given to practical aspects of machine learning, connectionist approaches and reinforcement learning. The techniques we will cover are broadly applicable, and have led to significant advances in many fields, including stock trading, game playing, robotics, machine translation, computer vision, medicine and many more.

Topics Covered and Learning Outcomes

Upon successful completion of this class you should have both working and theoretical understanding of topics such as:

- Supervised Learning vs Unsupervised Learning
- Inner workings (and limits) of fundamental ML techniques
- Decision trees, clustering, support vector machines
- Regression, Support Vector Machines
- Connectionist Approaches
    - Perceptrons, neural networks, Deep learning
- Reinforcement learning
- Advanced Topics
    - Adversarial learning, neuromorphic computing, mathematical limits of learning
- Practical issues
    - data preparation, computational time, bias, overfitting, boosting,
- Ethical issues and professional responsibility
    - Cognitive hijacking, injection advertising, adversarial inputs, deep fakes, systems engineering with ML

By the end of the course you should

- understand both the mathematics and implementation of fundamental ML techniques;
- be able to conduct experimentation using these algorithms and techniques; and,

- know how to judge the appropriateness of various techniques to specific problems, as well as their theoretical, practical and ethical implications.

Required Resources

Course Piazza: http://piazza.com/umd/fall2018/cmsc422
Course Canvas: https://elms.umd.edu/

Required Text:
We believe you should be able to be successful in this class without purchase of a physical text book, given the abundance of high-quality on-line materials.

A Course in Machine Learning
by Hal Daumé III
http://ciml.info/
(totally online, free, UMD-standard resource)

Other Resources:
Vast amounts of machine learning material are available online. Discerning the "good stuff" from the rest can be daunting, as much of the material available is aimed toward tools and technology training rather than principled scientific understanding. Another good online resource is:

Information Theory, Inference, and Learning Algorithms
Sir David MacKay
http://www.inference.org.uk/mackay/itila/
http://www.inference.org.uk/mackay/itila/book.html
(Freely available PDF)

For those with learning styles that benefit from the more structure narrative of a text, the following two text books are strongly recommended as essential elements of any good AI library:

Artificial Intelligence: A Modern Approach
by Stuart Russell and Peter Norvig
http://aima.cs.berkeley.edu/
(if you are serious about AI, you should own a copy)

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Machine Learning
Tom Mitchell
http://www.cs.cmu.edu/afs/cs.cmu.edu/user/mitchell/ftp/mlbook.html
(Key reference, very expensive, but maybe there's a used copy somewhere?)

Course Communication

It is expected that you reach and check your email every day (I do!). Communications, updates, assignments will be disseminated through Piazza and email lists on Canvas/ELMS. Please use the discussion forms available for Piazza to post questions, comments, and examples---the Teaching Assistants and I will be monitoring this site and use it liberally to enhance the classroom presentations.

Campus and Departmental Policies

It is our shared responsibility to know and abide by the University of Maryland's policies that relate to all courses, which include topics like:

- Academic integrity
- Student and instructor conduct
- Accessibility and accommodations
- Attendance and excused absences
- Grades and appeals
- Copyright and intellectual property

In this course you are responsible for both the University's Code of Academic Integrity and the University of Maryland Guidelines for Acceptable Use of Computing Resources. Any evidence of unacceptable use of computer accounts or unauthorized cooperation on tests and assignments will be submitted to the Student Honor Council, which could result in an XF for the course, suspension, or expulsion from the University.

Please visit
www.ugst.umd.edu/courserelatedpolicies.html
for the Office of Undergraduate Studies' full list of campus-wide policies and follow up with me if you have questions.

Please visit
http://www.cs.umd.edu/class/resources/academicIntegrity.html

for a detailed description of the Academic Integrity policies for the University of Maryland Computer Science Department.

The University of Maryland Policy on Excused Absences in available at https://www.president.umd.edu/sites/president.umd.edu/files/documents/policies/V-1.00G.pdf

Course Related Policies for University of Maryland Undergraduate Students http://www.ugst.umd.edu/courserelatedpolicies.html

Activities, Learning Assessments, & Expectations for Students

There will be two 75min lectures per week intended to introduce the technical topics, provide examples or review. We will augment these with various links (to supplementary documents, videos, etc) as appropriate via the course management software systems (Canvas/Piazza). You'll be expected to be engaged via these digital means (i.e., if we post it, we will assume you have read it within 24hrs of posting it).

There will written homework and/or programming assignments due approximately every 2-to-3 weeks. Assignments are designed with the expectation that an average student wishing to earn an average grade ('C' -- 'B') should expect to spend 5-6 hours on a given assignment. Your level of effort may vary, depending on a number of factors, but it is safe to assume that you will not be able to complete assignments the night before they are due. For best results, you should start assignments the day they are handed out and leave ample time for reflection, experimentation and revision.

Programming assignments will typically require experimentation and modification of some amount of existing code. The intention at this time is that we will leverage libraries written in Python, provide scaffolding, and design assignments that involve experimentation (rather than those that emphasize writing algorithms from scratch).

Homeworks and the output or analysis of programming assignments must be legible and submitted as PDF documents via online submission mechanisms before the start of class on the day the assignment is due.

Course-Specific Policies

I expect you to make the responsible and respectful decision to refrain from using your cellphone in class. If you have critical communication to attend to, please

excuse yourself and return when you are ready. For more information about the science behind the policy watch: http://youtu.be/WwPaw3Fx5Hk

No Late Homework
The instructors and the teaching assistants reserve the right to not accept late homework. Homework problems may be reviewed in the class upon when they are due, rendering late homework unacceptable as the answers are then given.

Honesty and Integrity
Here are the most direct ways to do poorly (or possibly fail) in this class: (1) ignore all of the programming assignments by not handing them in or by handing in projects that do not run, in an effort to get partial credit; (2) fail to hand in more than 50% of the homeworks; (3) miss any one exam or obtain less than 25% on all of the exams; (4) falsify results; (5) copy or brainlessly paraphrase answers from solution guides which have been copied various places on line; (6) mis-represent another's work as your own (i.e., plagiarism) or violate the course ``Discussion and Collaboration Policy."

There will be absolutely ZERO tolerance of instances of cheating or unscrupulous activity. Any appearance of such activity will be investigated. Automated software tools may and will be used to aide in any investigation. Suspected or verifiable occurrences of such activity
will be immediately dealt with in accordance with University policies. Possible ramifications range from failure in the course to expulsion from the institution and loss of your degree privileges. The best way to avoid problems in this area is to work to avoid all appearance of possible impropriety. Specific suggestions include:

- Work alone on all project assignments; use only textbooks as references; turn your computer off while solving non-programming problems.
- Stick to auxiliary resources available through the course.
- Do not Google™, Bing™ or AltaVista™ for answers to questions.
- Wikipedia is but one reference, use it only as a vehicle to find other primary sources (textbooks, papers, etc). Do not use it as a way to find answers.
- Attribute any libraries or source code from others you use when writing up your assignment.
- Ask the instructor BEFORE doing something that may possibly result in a problem. If you are not absolutely 100% sure, ASK.

Discussion and Collaboration Policies

All students should be familiar with the University's policies on academic dishonesty, as well as those governing all aspects of our collegial life, as described in various University resources. Incidents of academic dishonesty will be handled rigorously. While I encourage students
to collaborate, all homework, proofs, and code submitted as part of assignments must be the student's own (except as noted above).

Makeup Exams & Accommodations
Those with documented needs necessitating accommodations, must make arrangements with the instructor in advance to insure your accommodations are met.

Those with conflicts that are in accordance with University policies (religious holiday, etc), must also make arrangements with the instructor in advance to insure your accommodations are met.

To get credit for a missed exam after the fact, you will need a valid medical excuse. This means an official letter (including the dates of incapacitation for your illness), either from your private physician or from the University's Health Center. If you have a valid medical excuse, I'll give you credit for the missed exam based on your performance on the other assignments and exams.

Get Some Help!

You are expected to take personal responsibility for you own learning. This includes acknowledging when your performance does not match your goals and doing something about it. Everyone can benefit from some expert guidance on time management, note taking, and exam preparation, so I encourage you to consider visiting http://ter.ps/learn and schedule an appointment with an academic coach. Sharpen your communication skills (and improve your grade) by visiting http://ter.ps/writing and schedule an appointment with the campus Writing Center. Finally, if you just need someone to talk to, visit http://www.counseling.umd.edu.

Everything is free because you have already paid for it, and everyone needs help… all you have to do is ask for it.

Excused Absences

Any student who needs to be excused for an absence from a single lecture, recitation, or lab due to a medically necessitated absence shall:

- Make a reasonable attempt to inform the instructor of his/her illness prior to the class.
- Upon returning to the class, present their instructor with a self-signed note attesting to the date of their illness. Each note must contain an acknowledgment by the student that the information provided is true and correct. Providing false information to University officials is prohibited under Part 9(i) of the Code of Student Conduct (V-1.00(B) University of Maryland Code of Student Conduct) and may result in disciplinary action.

The self-documentation may not be used for the Major Scheduled Grading Events as defined below and it may only be used for only 1 class meeting (or more, if you choose) during the semester. Any student who needs to be excused for a prolonged absence (2 or more consecutive class meetings), or for a Major Scheduled Grading Event, must provide written documentation of the illness from the Health Center or from an outside health care provider. This documentation must verify dates of treatment and indicate the timeframe that the student was unable to meet academic responsibilities. In addition, it must contain the name and phone number of the medical service provider to be used if verification is needed. No diagnostic information will ever be requested. The Major Scheduled Grading Events for this course include: the midterm exam, and the final exam.

Disability Support

Any student eligible for and requesting reasonable academic accommodations due to a disability is requested to provide, to the instructor in office hours, a letter of accommodation from the Office of Disability Support Services (DSS) within the first TWO weeks of the semester.

Anti-Harassment

The open exchange of ideas, the freedom of thought and expression, and respectful scientific debate are central to the aims and goals of this course. These require a community and an environment that recognizes the inherent worth of every person and group, that fosters dignity, understanding, and mutual respect, and that embraces diversity. Harassment and hostile behavior are unwelcome in any part of this course. This includes: speech or behavior that intimidates, creates discomfort, or interferes with a person’s participation or opportunity for participation in the course. We aim for this course to be an environment where harassment in any form does not

happen, including but not limited to: harassment based on race, gender, religion, age, color, national origin, ancestry, disability, sexual orientation, or gender identity. Harassment includes degrading verbal comments, deliberate intimidation, stalking, harassing photography or recording, inappropriate physical contact, and unwelcome sexual attention. Please contact an instructor or CS staff member if you have questions or if you feel you are the victim of harassment (or otherwise witness harassment of others).

Names/Pronouns and Self Identifications

The University of Maryland recognizes the importance of a diverse student body, and we are committed to fostering equitable classroom environments. I invite you, if you wish, to tell us how you want to be referred to both in terms of your name and your pronouns (he/him, she/her, they/them, etc.). The pronouns someone indicates are not necessarily indicative of their gender identity. Visit trans.umd.edu to learn more.

Additionally, how you identify in terms of your gender, race, class, sexuality, religion, and dis/ability, among all aspects of your identity, is your choice whether to disclose (e.g., should it come up in classroom conversation about our experiences and perspectives) and should be self-identified, not presumed or imposed. I will do my best to address and refer to all students accordingly, and I ask you to do the same for all of your fellow Terps.

Grades

Grades are not given, but earned. Your grade is determined by your performance on the learning assessments in the course and is assigned individually (not curved). If earning a particular grade is important to you, please speak with me at the beginning of the semester so that I can offer some helpful suggestions for achieving your goal.

Grading levels are expected to be: >90='A', 80--89='B', 70-79='C', 60-69='D', <60='F'. An ``A" grade requires excellence in all of the grading categories, with all homeworks completed in their entirety and handed in on the due date in class. A passing grade requires the demonstration of a minimum proficiency in each aspect of the class (exams, homework and programming). Failing grades occur when there is some gross deficiency.

Please do not ask for “extra credit” assignments as they will not be provided---just focus on the assignments that are given and do your best.

All assessment scores will be posted on the course ELMS page. If you would like to review any of your grades (including the exams), or have questions about how something was scored, please email me or one of the teaching assistants (as appropriate) to schedule a time to meet and review. Given the nature of the material and size of the class, there is the potential for errors and omissions. If you feel a mistake has been made, please let us know as soon as possible so we can evaluate and immediately correct it. Any formal grade disputes must be submitted in writing and within one week of receiving the grade.

Course evaluations

We welcome your suggestions for improving this class, please don't hesitate to share it with the instructor or the TA during the semester! You will also be asked to give feedback using the CourseEvalUM system at the end of the semester. Your feedback will help us make the course better.

Right to change information

Although every effort has been made to be complete and accurate, unforeseen circumstances arising during the semester could require the adjustment of any material given here. Consequently, given due notice to students, the instructor reserves the right to change any information on this syllabus or in other course materials.

Course Schedule (subject to change)

Week	Topics	Readings Assignments/Exams Starting
8/27	Intro/Overview Supervised vs unsupervised: Geometric thinking	
9/5	Decision Trees	
9/10	Decision Trees/Clustering **Add/Drop deadline**	
9/17	Clustering	**Asmt #1 (09/17)**

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9/24	Regression	
	Principle Component Analysis	
10/1	Practical/Ethical Issues // Review	**Exam #1**
(10/03)		
10/8	Review Exam	
	Linear Models	
	Kernels, SVMs	
10/15	Non-linear SVMs	
	Practical/Ethical Issues // Review	**Asmt #2**
(10/17)		
10/22	Perceptrons	
	Neural Networks	
	Withdraw deadline	
10/29	Backpropogation	**Asmt #3 (10/31)**
11/5	Deep learning	**Exam #2**
(11/07)		
11/12	Neuromorphic Computing	
11/19	Reinforcement Learning	**Asmt #4 (11/19)**
	Thanksgiving Break	
11/26	Reinforcement Learning	
12/3	TBD	
12/10	Last Class	**Asmt #5 (12/10)**
12/12 -- 12/18 FINALS		**Exam #3**
(TBD)		

Other Possible Highlights

- Entropy & Information Theory
- Turing-Good Estimation Theorem
- Applications in finance
- How to win at Atari
- How to win at Go
- How your Facebook feed controls you
- Netflix recommendations
- ImageNet
- Adversarial AI
- Scientific Discovery

Note: This is a tentative schedule, and subject to change as necessary – monitor the course ELMS page for current deadlines. In the unlikely event of a prolonged university closing, or an extended absence

from the university, adjustments to the course schedule, deadlines, and assignments will be made based on the duration of the closing and the specific dates missed.