Probabilistic Models of Human and Machine Intelligence
CSCI 5822
Spring 2021

Instructor:
Rebecca Morrison
ECOT 820
rebeccam@colorado.edu

Class details:
Class meetings: MWF 1:50 – 2:40, ECCR 1B40/Zoom
TA: Tzu-Chi Yen, tzuchi.yen@colorado.edu
IS: Chou Yi, yi.chou@colorado.edu
Tech Co-Pilot: Michela Puni Nimako, michela.puninimako@colorado.edu
Office hours:
Mon 3:00 – 5:00p (CY)
Tu 2:00 – 4:00p (TY)
Wed 9:15 – 10:45a (RM)
and by appointment

Materials:
Bayesian Reasoning and Machine Learning by David Barber
Available online: http://web4.cs.ucl.ac.uk/staff/D.Barber/textbook/240415.pdf
Lecture notes (R. Morrison)
Canvas for announcements, video recordings of the class, and to post and collect homework
Zulip for questions about the course and student-led discussions
Various papers and book chapters (will be available on Canvas)

*******Email to instructor should be used as a last resort.*******

Course description

This course will introduce the basic concepts of probabilistic models: directed, undirected, and factor graphs, and the computations we can do with them. Probabilistic modeling—at the intersection of graph theory and probability—is an incredibly powerful area of mathematics and computer science with countless applications. In this class, we will learn how to leverage known probabilistic structures to make sense of large data, and how to learn unknown structure. Topics include the fundamentals of Bayesian inference; expressiveness of graphical models; conditioning, marginalization, and message passing; junction trees, triangulation, and moralization; the exponential family; maximum likelihood estimation; learning with hidden variables; fundamentals of machine learning; Gaussian processes; discrete and continuous Markov models; sampling methods; and variational inference.

Course outline, by week*

Week 0 (1/15)	Introductions
Week 1 (1/20, 1/22)	Ch 1: Probabilistic Reasoning
Week 2 (1/25, 1/27, 1/29)	Ch 2: Basic Graph Concepts, Ch 3: Belief Networks
Week 3 (2/1, 2/3, 2/5)	Ch 4: Graphical Models
Week 4 (2/8, 2/10, 2/12)	Ch 5: Efficient Inference in Trees
Week 5 (2/15, 2/19)	Ch 6: The Junction Tree Algorithm
Week 6 (2/22, 2/24, 2/26)	Ch 8: Statistics for Machine Learning
Week 7 (3/1, 3/3, 3/5)	Ch 9: Learning as Inference
Week 8 (3/8, 3/10, 3/12)	Ch 10: Naive Bayes, Ch 11: Learning with Hidden Variables
Week 9 (3/15, 3/17, 3/19)	Ch 12: Bayesian Model Selection, Ch 13: Machine Learning Concepts
Week 10 (3/22, 3/24, 3/26)	"Break Week:" No new book material (Paper discussion)
Week 11 (3/29, 3/31, 4/2)	Ch 14: Nearest Neighbor Classification, Ch 18: Bayesian Linear Models
Week 12 (4/5, 4/7, 4/9)	Ch 19: Gaussian Processes, Ch 20: Mixture Models
Week 13 (4/12, 4/14, 4/16)	Ch 23: Discrete-State Markov Models, Ch 24: Continuous-State Markov Models
Week 14 (4/19, 4/21, 4/23)	Ch 27: Sampling
Week 15 (4/26, 4/28)	Ch 28: Deterministic Approximate Inference
Finals slot (TBA)	Reserve for Project Presentations

*Note that this schedule is approximate and subject to modifications.

Course work and grading

Grades will be determined based on homeworks (70%) and a final project (30%).

- **Homework:** Homeworks will be assigned approximately every two weeks on Canvas. You will be asked to either upload a pdf and/or a Jupyter notebook. You may complete homework assignments alone or in groups of two. The homework grade with the lowest score will be dropped. If you are very sure that the homework has been misgraded, you may contact Tzu-Chi directly. Otherwise, please accept the grade and try to understand what you could do better or make clearer next time.
  - **Late policy:** Because of the large class size, late homework will not be accepted.
- **Final project:** For the final project, please work in groups of size at least two, and not bigger than five. You will have the option to either work on something related to your own research, or complete an assigned project. More information will be given during break week, but these projects will not be much longer than the assignments (3–5 pages). We will use the finals slot for very quick final presentations.

Note: You may choose whether or not to attend class, and I aim to make class worth your time. If you do attend, I expect you to arrive on time and stay until the end.

Syllabus Statements

Classroom Behavior

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on classroom behavior and the Student Code of Conduct.

Requirements for COVID-19

As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements, and public health orders in place to reduce the risk of spreading infectious disease. Required safety measures at CU Boulder relevant to the classroom setting include:

- maintain 6-foot distancing when possible,
- wear a face covering in public indoor spaces and outdoors while on campus consistent with state and county health orders,
- clean local work area,
- practice hand hygiene,
- follow public health orders, and
- if sick and you live off campus, do not come onto campus (unless instructed by a CU Healthcare professional), or if you live on-campus, please alert CU Boulder Medical Services.

Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct and Conflict Resolution. For more information, see the policies on COVID-19 Health and Safety and classroom behavior and the Student Code of Conduct. If you require accommodation because a disability prevents you from fulfilling these safety measures, please see the "Accommodation for Disabilities" statement on this syllabus.

All students who are new to campus must complete the COVID-19 Student Health and Expectations Course. Before coming to campus each day, all students are required to complete the Buff Pass.

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home. In this class, if you are sick or quarantined, **please watch the recorded videos and talk with your peers about the missed class material**.

Accommodation for Disabilities

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see Temporary Medical Conditions on the Disability Services website.

Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the Honor Code Office website.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by members of our

community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, anonymous reporting, and the campus resources can be found on the OIEC website.

Please know that faculty and graduate instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, **please come talk to me during office hours with at least a week's notice, and we can figure something out**.

See the campus policy regarding religious observances for full details.