CSC 298/578 Deep Learning and Graphical Models

Computer Science, University of Rochester
Syllabus for Spring 2017

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Course Webpage: `http://www.cs.rochester.edu/~cxu22/t/298S17/`

Meeting Times & Locations: MW 10:25-11:40 in 301 GAVET

Prof. & TA's Office Hours: See Prof. Website.

Course Information Flow: This course primarily uses Blackboard to manage information flow. The course ID is *CSC298.2017SPRING.83650*. It will be used for announcements, lecture notes, assignments, discussions and submitting work.

The instructor's course website is primarily the public portal to the site for broad research in what the course covers. It contains an outline of course schedule. It may not be updated regularly throughout the term.

Course Description: Probabilistic graphical models are a powerful framework that leverages probability theory and graph representation to model complex problems with large collections of inter-related variables. Numerous applications can be found in machine learning, computer vision and beyond. On the other hand, recent developments in neural networks (aka deep learning) have greatly advanced the performance of state-of-the-art in visual recognition and artificial intelligence. This course will cover the essentials (representation, learning and inference) in both probabilistic graphical models and neural networks with an emphasis in analyzing image and video data.

Course Goals: Provide a deep dive into deep learning and probabilistic graphical models with both theoretical and practical topics. Students will be familiar with deep learning tools and environments, and be able to design and implement neural networks and structured models to solve real problems.

Prerequisites: Students entering the class should have a pre-existing working knowledge of probability, statistics, linear algebra and programming. Students should also obtain some basic knowledge of machine learning through extra readings if they have not taken machine learning related course before.

Textbooks:

- *Probabilistic Graphical Models: Principles and Techniques*, Daphne Koller and Nir Friedman, The MIT Press, 2009. (Textbook for the course.)
- *Deep Learning*, Ian Goodfellow, Yoshua Bengio and Aaron Courville, The MIT Press, 2016. (Recommended, but not required.) Free version available online: `http://www.deeplearningbook.org/`.

The following textbooks are extra readings for a broader view of machine learning.

- *Pattern Recognition and Machine Learning*, Christopher M. Bishop, Springer, 2006.
- *Machine Learning: A Probabilistic Perspective*, Kevin P. Murphy, The MIT Press, 2012.

We do not have a required textbook for deep learning. However, there are many awesome deep learning related online courses, tutorials and blogs freely available. We will cover the theoretical fundamentals in lectures but the success of training a deep learning model depends on many practical tricks that may not be covered in

the form of lecture; hence, supplementary reading of online materials is highly encouraged. A useful index can be found here: `https://github.com/ChristosChristofidis/awesome-deep-learning`.

Course Topics

The following topics from deep learning will be covered:

- Feedforward Neural Networks
- Convolutional Neural Networks
- Recurrent Neural Networks

The following topics from probabilistic graphical models will be covered:

- Representation: Bayesian Networks, Markov Networks
- Inference: Variable Elimination, Belief Propagation, Sampling, MAP Estimation
- Learning: MLE in Bayesian Networks and Markov Networks, Structure, Missing Data

We will also have case studies that bring together deep learning and graphical models to solve computer vision problems such as image segmentation and activity recognition.

Course Work and Evaluation

- Homework: (30%)
  There will be three homework assignments over the term. Each will be a mix of analytical problems and programming problems to test whether students are understanding the foundational topics. These assignments will be done independently by each student.
- Exam: (20%)
  There will be one in-class exam in April.
- Project (50%)
  Students will form groups of three to select, formulate and implement a project involving probabilistic graphical models or deep learning or both in a real-world situation, such as image understanding, robot navigation, acoustic speech recognition, etc. Topics will be selected and proposed by the group and then approved / rejected-for-revisions by the instructor. Full-scale project developments will be made through the term culminating in a conference-length paper and a public poster / demo session at the end of the term. Equal scores will be assigned to students in the same group.
- Extra five points will be given to students who have a high rate of 1) class participation and 2) bring good questions to instructor's or TA's office hours.

Late Work Policy: **No** late work will be accepted. Ample time will be given to complete the assignments; use it wisely.

Standards of Conduct – Behavioral Expectations

The following are classroom "etiquette" expectations:

- Attending classes and paying attention. Do not ask an instructor in class to go over material you missed by skipping a class or not concentrating.
- Not coming to class late or leaving early. If you must enter a class after lecture has clearly begun, do so quietly and do not disrupt the class by walking between the class and the instructor. Do not leave class unless it is an absolute necessity.
- Not talking with other classmates while the instructor or another student is speaking. If you have a question or a comment, please raise your hand, rather than starting a conversation about it with your neighbor.
- Showing respect and concern for others by not monopolizing class discussion. Allow others time to give their input and ask questions. Do not stray from the topic of class discussion.
- Not eating during class time.

- Turning off the bothersome electronics: cell phones, pagers, and beeper watches.
- Avoiding audible and visible signs of restlessness. These are both rude and disruptive to the rest of the class.
- Focusing on class material during class time. Sleeping, talking to others, doing work for another class, reading the newspaper, checking email, and exploring the internet are unacceptable and can be disruptive.
- Not packing bookbags or backpacks to leave until the instructor has dismissed class.

Disabilities: If you need an accommodation based on the impact of a disability, please contact me privately during the first two weeks to discuss your specific needs. Alternatively, contact Center for Excellence in Teaching and Learning at 585-275-9049 in room 1-154 Dewey Hall to coordinate reasonable accommodations.

Academic Honesty: All assignments and activities associated with this course must be performed in accordance with the University of Rochester's Academic Honesty Policy. More information is available at: www.rochester.edu/college/honesty. You are expected to read, understand and follow the policy.