EECS 542 Advanced Topics in Computer Vision

Electrical Engineering and Computer Science

University of Michigan

Syllabus for Winter 2017

Instructor: Jason Corso (jjcorso), 4238 EECS

GSI: Abhishek Venkataraman (abhven)

Course Webpage: http://web.eecs.umich.edu/~jjcorso/t/542W17.

Canvas LMS Website: https://umich.instructure.com/courses/117273.

Meeting Times / Location:

- Main Course: F 1500–1800 in 1670 BBB

Prof. Office Hours: See Prof. Website.

Course Information Flow and A Note On Contacting The Instructor: This courses primarily uses Canvas to manage information flow. It will be used for announcements, lecture notes, assignments, discussions and possibly for submitting work (details provided later).

The Canvas link is https://umich.instructure.com/courses/117273.

The instructor's course website is primarily the public portal to the site for broad reach in what the course covers, it will not be updated regularly throughout the term.

We also use Nota Bene (NB) for week-to-week readings and idea exchange. More details are below.

Nearly all questions you have about the course, both logistical and technical should be posted to canvas discussions. Only in the event of a concern of privacy, should you directly email the instructor.

Students are expected to help each other through postings and discussions on the Canvas site and notes on NB.

Course Description: The course will focus on learning structured representations and embeddings for high-level problems in computer vision. Approaches for structured prediction, deep learning, and dictionary learning will be covered, all with an emphasis on modeling certain classes of structure, such as affine invariance and sparsity. The course will be highly interactive with a mix of readings, homeworks, quizzes and a course project.

Each week will emphasize a particular topic in this area through a foundational reading, an application reading, a (small) problem-set, and a quiz. Three-to-four longer term group homeworks will be assigned during the term to allow for deeper inquiry. Finally, one project will be conducted near the end of the term.

The course uses engaged learning with an emphasis on active, asynchronous individual and team-based learning. Evaluation is largely through effort and team-engagement rather than classical scoring. The course will be both fun and intellectually rewarding.

Course Goals: Provide a deep dive into high-level computer vision with both theoretical and practical topics. Students will also learn how to read academic papers. Students will gain practical experience with modern computer vision systems, languages, tools, and environments.

Prerequisites: EECS 442 Computer Vision or 504 Foundations of Computer Vision. Students will be expected to bring a (working) laptop to class (with the programming environment of need working on it). Note that GPUs will be allocated to the course via FLUX at no cost to the student.

Textbooks: There is no required textbook for this course. Instructor notes and papers will be made available as external reading.

Course Work and Evaluation

Planned and subject to change based on time and class size; more details below.

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Homeworks/Reading/Participation  55% (one assignment every 10 is dropped)
Quizzes                          20% (one quiz every 5 is dropped)
Project                          25%
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Engaged Learning:

Much of the material on Engaged Learning is taken from Prof. Fessler, Prof. Yalisove, and Prof. Mazur.
More information: Overview Why You NB / In-Class Homework

This course will use a different approach to learning than traditional engineering courses, which emphasize professor lecturing during the course and students work on problems and assignments after the class.

Traditional approach in engineering lecture courses:

- Week 1: Professor lectures on a topic (typically, students are passive)
  - A few questions are asked by students during class, possibly.
  - Maybe the professor asks students a few questions.
  - Typically just a few students answer most of those questions.
- Week 2: Student reads text, works on homework problems, submits solutions.
- Week 3: Grader grades homework.
- Week 4: Graded homework is returned to the student.

Undesirably long delay between student action and feedback.

Traditional approach in graduate discussion-oriented engineering classes:

- Week 1: Professor assigns reading.
- Week 2: Student presenters read paper and prepare a presentation.
  Possibly other students read the paper, provide a written report.
- Week 3: Students make presentation in class. Professor asks questions during the presentation. Other students mostly passively observe, perhaps asking a few questions.
- Week 4: Comments provided by professor on written reports.

Disengagement on the topic across most students.

We will leverage a style of classroom organization called engaged learning to overcome the limitations of both of these traditional styles of engineering courses.

Engaged learning approach:

- Students read *and interact* with textbook, papers, notes before class.
  - NB (Nota Bene = "note well") interactive PDF annotation: nb.engin.umich.edu.
  - Students engage with material by posting questions that show thoughtful reading.
  - Students engage with material by answering questions (peer instruction) that show thoughtful reading.
  - Students answer some "reading questions" and "comprehension questions" to assess comprehension and provide accountability (e.g., via Canvas quizzes)
  - Students attempt homework (e.g., problems, programming, etc.) individually before class.
- Class time
  - Facilitated discussion about any remaining areas of confusion in reading.
  - Address issues arising from answers to "reading questions" (dynamic lecturing)
  - Team-based final solutions to homework (teams will be assigned and evolve over the term).
  - Other team-based work, including derivations, problem-solving, paper discussion, and programming.
  - Immediate feedback on correct homework and reading assignments.

Again, this approach is adapted from previous professors who have used it for more lecture-oriented material. We will be using this approach for this advanced course that had been more discussion oriented. To that end, a typical week will look like the following.

```
Week-to-Week Work

Friday (after class) >>> Homework Assigned (Reading, Problems)
                         Two readings per week (one more foundation and
                         one more applied)
                         Some problems per week (derivations and
                         programming, small-scale)

Saturday -- Wednesday >> Students interact with homework (Read, NB, Problems)
                         (Individually)  Students make more than 4 thoughtful
                         comments in NB on the foundational reading before
                         11AM on Friday
                         (Students may also make comments on applied reading)

Thursday >>>>>>>>>>>>>>> Student write one-page report on applied reading
                         (Format to be described below and in class)
                         Submit to Canvas before the class.

Thursday >>>>>>>>>>>>>>> Professor/GSI releases quiz on Canvas by 12PM

Friday >>>>>>>>>>>>>>>>> Students individually attempt quiz before 11AM



In Class

20-30 mins  >>> Professor reviews the foundational paper in a mini-lecture
20-30 mins  >>> Professor reviews the hot-points in the NB annotations
                  and quiz questions

20-30 mins  >>> Students teams discuss week-to-week problems and make
                  revisions in class.  Professor and GSI discuss with
                  individual teams.  Students submit updated version of
                  these week-to-week problems to Canvas.

20-30 mins  >>> Students teams discuss their one-page writeup to the
                  application paper.  Make a combined team-based writeup.
                  Professor reveals a canonical reading of the paper
                  during discussion.
                  Each student from team submits both along with a
                  paragraph reflecting on the differences.

 5 mins     >>> Break

60 mins     >>> Students teams work together on longer-term projects.
                  Professor and GSI discuss with individual teams.
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Note that we will have some systems-level programming assignments that span more then one week; these will be attempted in an engaged manner each week as well. One hour of class will be set aside for such longer-term work for teams to engage.

Engagement:

- 55% of the grade is "homework" which is a broad category for everything but the quizzes and project.

  - 10% for NB annotations (thoughtful questions and/or answers to the foundational week-to-week reading); see next page.
  - 15% for one-page writeups on the application papers.

    * Effort is 75% of this and checked via the upload made before class.
    * 25% of this is based on team-writeup and student reflection.
  - 15% for week-to-week problems, questions.
    * Answer problems before class individually. Effort checked beforehand.
    * Rewrite/rework answers based on group work in class.
    * Correct answers given in class.
    * Write a short reflection about individual work vs. group work vs. correct solutions in class.
    * Grades based on effort and honesty. Submit final composite work in class.
  - 15% for longer-term group-based assignments. Again, emphasis on learning and collaboration. Details discussed later.

- 20% of the grade is "quizzes"
  Quizzes will be released on Thursday and due in class on Friday. They are to be attempted individually, exclusively. Quiz questions will have both reading questions and comprehension questions; rarely will a quiz have a derivation question. Quizzes are to be attempted without any resource other than the specified weekly reading.
  Each quiz question, including reading questions, is worth 8 points.
  75% of this grade is based on **effort**. Students receive 0 points if not attempted, 1 point if attempted in a completely nonsensical way, 6 points if attempted in a reasonable way.
  25% of this grade is based on **correctness**. Students receive 0 points if attempted but not correct or 2 points if attempted and correct.
  Quizzes will be graded in class by individual students under the Honor Code similar to how it was done in EECS 504.

- 25% of the grade is "project"
  This is the final team-based project that will span at least a month at the end of the semester, and not be tied to any specific lecture by the professor. More on the project below.

Participation and Laptop Needs: Because of the emphasis on teamwork and in-class work, it is important that all students attend and participate in class. Due to the collaborative nature of the activities, it is not possible to *make this up later*.

Because the in-class revisions to week-to-week problems and one-page reports may involve paper and/or computer work, students are expected to supply their own fresh paper and bring their laptop to class.

Because much of the longer-term work will involve programming and this will be discussed as a team, students are required to bring laptops to class and be ready to work together on the programming in class.

Project: The final project will span 3-5 weeks at the end of the semester and require student teams to invent a solution to one of a small set of agreed upon problems. Each problem will be well-defined by the professor, along with datasets and evaluation regimen. Students groups will be aligned together according to which problem they choose. Students will work together in class and outside of class to invent and implement the system to solve this problem. Each set of student groups focusing on a specific problem will work together in preparation for the last class meeting during which they will have 20-30 total minutes to present the space of solutions that were developed, comparing and contrasting them on a technical level as well as an evaluation-based level.

Annotations: why:

Portions of this text Prof. Fessler, Prof. Yalisove, and Prof. Mazur.

Overview

Students will be assigned two readings weekly; one foundational and one application-oriented. We will post a pdf version on the canvas web site and an annotatable version on nb.engin.umich.edu. Students will annotate sections of the text there. The annotations will be visible to the student's sub-class (about 20 students rather than the full class of 100+) and instructor. Students can rephrase difficult to understand concepts, fill in confusing steps in derivations, identify errors, provide better ways to illustrate the ideas than the examples in the book/text, ask great questions, and answer (correctly) others questions. Students will be graded based on the quantity, quality and timeliness of their annotations. One annotation per reading assignment is too little and more than 20 annotations is probably too much. Providing 5 excellent annotations, including correct answers to another students good questions, will earn full credit for the week as long as they are completed in time and cover the material reasonably completely (i.e., are not just all in the first section).

Why annotate?

Annotating the text helps you and us. First, you get practice reading technical material. Once you graduate, papers and books will be your primary vehicle for learning and learning does not stop when you graduate. If you can learn from such texts, you have mastered an important lifelong skill. Second, by reading with attention and with an inquiring mind, you take ownership of your learning. That skill too will be useful for your whole life (you may want to start reading ahead in some of your other classes to get more out of them; youll have to read those books at some point anyway!). Third, by annotating the text, you reverse the roles of student and teacher: for a change you are the one determining whats wrong or confusing. In a traditional class, the teacher tells you what is wrong or confusing about your work. When you annotate the text because you are confused, you have identified a problem in the text: you are right and the author is wrong! By communicating that confusion to others, you create an opportunity to address the confusion and learn. If many people in the class express confusion about a particular topic, we will know that we need to address that confusion in class or online.

How (much) should I annotate? (what we expect)

Without lectures, the reading is your initial (and in some sense primary) exposure to the content of this class. It is therefore essential that you study each chapter with an inquisitive mind. Your annotations can either be queries, comments, or answers/reactions to queries or comments posted by others. When we look at your annotations we want them to reflect the effort you put in your study of the text. It is unlikely that that effort will be reflected by just one or two annotations per chapter, unless your annotations are unusually thoughtful and stimulate a deep discussion. On the other extreme, 20 per chapter is probably too many to be practical. Somewhere in between these two extremes is about right.

Annotations: how: Your annotations will be evaluated based on quality, quantity, and timeliness. Your goal is demonstrating substantive, thorough, timely, and thoughtful reading of the text.

- Insufficient: This confuses me
- Better: "This equation appears to contradict (previous equation) or seems counter-intuitive because ..."
- Insufficient: Yes/No answers to questions without explanation.
- For more examples, see this link.

Final score (per assignment) is the average of the top 5 quality scores (below) × their timeliness scores - 1 point for lack of reasonably even coverage in the text.

Quality Score	Description and Criteria
6	Demonstrates thorough and thoughtful reading and insightful interpretation of the text.
2	Demonstrates reading, but little or only superficial interpretation of the text.
0	Does not demonstrate any thoughtful reading of the text.

Quantity

Each student must enter a minimum of 5 annotations per reading assignment (This number subject to change).

Timeliness

Timeliness Factor	Description and Criteria
1	Submitted by the reading deadline, which is 11AM Friday, gets 1 timeliness factor.
0.5	Submitted by Friday midnight, gets 0.5 timeliness.
0	Submitted after Friday midnight, get 0 timeliness, but still helpful in learning.

This timeliness score is computed by machine. Do not miss the deadline, even by a second.

One-page Writeups on Application-oriented Papers: Learning how to read a technical paper to garner its meaning in a crisp and concise manner is a goal of the class. To that end, students will use Prof. Corso's **PACES** mnemonic to guide this process. For each writeup, you need to answer five questions about the paper; i.e., you need to go through your *paces*.

1. **P**roblem – What is the problem described in the paper?
2. **A**pproach – What is the core approach to the problem?
3. **C**laim – What are the claims in the paper?
4. **E**valuation – How are the approach and claim evaluated?
5. **S**ubstantiation – Does the evaluation about the approach substantiate the claim made for the problem?

An example of this will be provided in the first class.

Late Work and Missed Exam Policy: **No** late work will be accepted. Ample time will be given to complete the assignments; use it wisely. As discussed below, the course is team-based and highly interactive, therefore attendance at nearly all lectures is critical.

Regrading: Any questions about the grading of a piece of work must be raised within one week of the date that the work was returned by the GSI or the instructor. In other words, if you do not pick up your work in a timely fashion, you may forfeit your right to question the grading of your work.

Additional Information

Differences from EECS 442: EECS 442 introduces students to computer vision. EECS 542 builds on this introduction to take a deep dive into a particular topic area in computer vision.

Differences from EECS 504: Like EECS 442, EECS 504 introduces the foundation of modern computer vision. EECS 542 builds on this foundation by driving into a deep study of a particular topic area within modern computer vision. These courses are, hence, both depth courses, but they have complementary goals.

General Notes

If you don't understand something covered in class, ask about it right away. The only silly question is the one which is not asked. If you get a poor mark on an assignment or exam, find out why right away. Don't wait a month before asking. The instructor and GSI(s) (if associated). Don't be afraid to ask questions, or to approach the instructor or TA in class, during office hours, through the discussion board or through e-mail. This course is intended to be hard work, but it is also intended to be interesting and fun. We think computer vision is interesting and exciting, and we want to convince you of this.

Disabilities

If you think you need an accommodation for a disability, please let me know at your earliest convenience. Some aspects of this course, the assignments, the in-class activities, and the way the course is usually taught may be modified to facilitate your participation and progress. As soon as you make me aware of your needs, we can work with the Office of Services for Students with Disabilities (SSD) to help us determine appropriate academic accommodations. SSD (734-763-3000; http://ssd.umich.edu) typically recommends accommodations through a Verified Individualized Services and Accommodations (VISA) form. Any information you provide is private and confidential and will be treated as such.

Counseling Center

Your attention is called to the Counseling and Psychological Services (734-764-8312), 3100 Michigan Union. The Counseling Center staff are trained to help you deal with a wide range of issues, such as how to deal with exam-related stress and other academic and non-academic issues. Services are free and confidential and do not impact student records. Shivaun Nafsu is the CAPS consultant directly within COE: snafsu@umich.edu or 734-763-8211. Their web site is `http://caps.umich.edu/`.

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.

College of Engineering Honor Code

The full Engineering Honor Code is available at `http://www.eecs.umich.edu/acal/honor.html`. All students are expected to read, understand and follow the honor code.

The Honor Code outlines certain standards for ethical conduct for persons associated with the College of Engineering at the University of Michigan. The policies of the Honor Code apply to graduate and undergraduate students, faculty members, and administrators.

In 1915, the students of the College of Engineering petitioned for the establishment of an Honor Code. The Code was promptly adoped with faculty approval and has been basic to life in the College of Engineering.

The Honor Code rests upon the following principles:

- Engineers must possess personal integrity both as students and as professionals. They must be honorable people to ensure safety, health, fairness, and the proper use of available resources in their undertakings.
- Students in the College of Engineering are honorable and trustworthy persons.
- The students, faculty members, and administrators of the College of Engineering trust each other to uphold the principles of the Honor Code. They are jointly responsible for precautions against violations of its policies.
- It is dishonorable for students to receive credit for work which is not the result of their own efforts.

The Engineering Honor Code is based on the principle that students will follow all guidelines for study and prepared work set forth by the instructor, and that students can be trusted to take examinations without cheating.

Students are responsible for reporting infractions of the honor code.