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Teaching Statement

At the University of Massachusetts, Amherst, I have taught one course at the undergraduate level — *Introduction to Computer Vision (370)*[1] which included an honors colloquium, and two courses at the graduate level — *Computer Vision (670)*[2] and *Machine Learning (689)*[3]. Table 1 describes the schedule and enrollment for these courses, which are a core component of the AI curriculum.

I believe it is important to teach students both the theoretical underpinnings of AI, as well as the practical details of algorithms and software infrastructure. I strive to achieve these goals in coursework in a number of ways. I incorporate the latest *scientific advances* and *applications* of computer vision in the lecture materials. I provide *detailed course projects* that encourage critical thinking. Finally, I emphasize the role of *projects, presentations, and class participation* over written examinations.

Outside the university, I lectured on machine learning topics at the Hokkaido university, a part of ongoing collaboration with the University of Massachusetts, at TTIC Nagoya during my time at TTI Chicago, as well as tutorials and workshops at various computer vision conferences.

Another aspect of my teaching is in the form of *advising* and *mentoring* students. My research group currently consists of *eight* PhD students. I have mentored four undergraduate and several Masters students on research projects, and have served or currently on the thesis committees of *seventeen* PhD students.

Below I outline my approach and specific contributions to teaching and advising.

1 Graduate Teaching

I regularly teach the **computer vision** course at the graduate-level (CMPSCI 670, Table 1). The course covers topics from the underlying mechanisms of image formation based on physics and geometry, to the latest algorithms for extracting information from images for various applications. I teach both classical and data-driven approaches, emphasizing their strengths and weaknesses.

This is a "core" course in the PhD track and caters to students with interests ranging from computer vision, to natural language processing, and systems building. I have developed the course to be self-contained; It only assumes a basic background in geometry, linear algebra, and probability, as well an ability to program in Matlab or Python. The goal is to teach students the principles behind computer vision techniques rather than how to use computer vision libraries as a black box. To this end some of the key changes I made compared to past offerings of the course were:

- An up-to-date material based on recent developments in computer vision (e.g., an increased emphasis on machine learning) reflecting similar courses taught at places like CMU, UC Berkeley and MIT.
- Reading assignments for students interested in investigating a topic further.
- The majority of the grade based on five mini-projects for which detailed instructions were provided. Each project starts with the construction of a basic system and can be improved through a cycle of error analysis and model redesign. This allows students to add complexity for extra credit.
- A final project that requires investigation of a single topic or application in greater depth.

[1] https://sites.google.com/view/cmpsci370
[2] https://sites.google.com/view/cmpsci670
[3] http://www-edlab.cs.umass.edu/~smaji/cmpsci689

Academic year	Term	Level	Course title	Enrollment
AY 14-15	Fall 2014	Graduate	Computer Vision (670)	27
	Spring 2015	Graduate	Machine Learning (689)	29
AY 15-16	Fall 2015	N/A[1]	N/A	N/A
	Spring 2016	Undergraduate	Intro. to Computer Vision (370)	39
	Spring 2016	Undergraduate	+ Honors colloquium (370HH)	4
AY 16-17	Fall 2016	Graduate	Computer vision (670)	39
	Spring 2017	Undergraduate	Intro. to Computer Vision (370)	40
AY 17-18	Fall 2017	Graduate	Computer vision (670)	66
	Spring 2018	Undergraduate	Intro. to Computer Vision (370)	51
AY 18-19	Fall 2018	Graduate	Computer vision (670)	61
	Spring 2019	Undergraduate	Intro. to Computer Vision (370)	53
AY 19-20	Fall 2019	Graduate	Computer vision (CMPSCI 670)	100[2]

Table 1: **Summary of courses I taught at the University.** I have taught **370** and **670** four times each, and **689** once. [1] I had a teaching release in Fall 2015. [2] This is the enrollment at the time of writing.

I am also comfortable teaching machine learning courses and have the **machine learning** course at the graduate-level in Fall 2015 (Table 1). The course was designed to provide a broad understanding of various topics in machine learning to beginner graduate students. In addition to a final project and several mini-projects, I added weekly homework assignments that included two to three short questions which were graded as pass/fail. This allowed me to get feedback on how well the students were following the lectures and include additional explanations in subsequent lectures if needed. The course feedback was extremely positive compared to prior years.

I focus my efforts on creating high-quality teaching materials and homework assignments. The students have rated my preparedness in class and the clarity of presentation significantly above the department averages for both courses across semesters. Most students also found the lectures to be engaging and interesting. The materials I have prepared are already in use at other places, such as the University of Michigan, University of Pittsburgh, and University of Maryland.

A challenge is that the enrollments for all AI courses have been steadily increasing, with a growing number of Masters students who have different goals and diverse backgrounds compared to the PhD students. I am planning to address these issues by providing more mentoring with the support of TAs, and support the use of cloud-based platforms for course project development.

2 Undergraduate Teaching

I regularly teach the **introductory computer vision** course to undergraduate students (CMPSCI 370, Table 1). The class is sometimes accompanied by an *honors colloquium*, where we discuss advanced topics. Furthermore, the students prepare a presentation and written report at the end of the class on a topic of their choice. The introductory course goes into the basics of image formation and simple image-processing algorithms for extracting information and enhancing images. The course also provides an introduction to statistical approaches for pattern recognition.

The course follows the same philosophy as the graduate-level course. One difference is that in addition to the mini-projects, the students were given feedback through a mid-term and a final exam. I also provide optional reading material and extra credit questions in homework assignments, exposing them to some

open problems in computer vision.

I often find that the course encourages students to pursue advanced courses and independent projects in the area of machine learning and computer vision. Several students apply to graduate schools for Masters and PhD degrees. The ratings and feedback from students for this class have also been very positive. A challenge is that the enrollment has been growing steadily over the years, and we expect the numbers to grow even more in the coming years reflecting the nationwide trends. I aim to follow best practices from places like UC Berkeley and Georgia Tech to keep teaching effective.

3 Advising and Mentoring Students

I co-direct the **Computer Vision Lab** with Erik Learned-Miller. It is also co-located with the **Computer Graphics** lab that Rui Wang and Evangelos Kalogerakis direct. This provides an opportunity for me to mentor a large number of PhD students through collaborations and other interactions.

In AY 2018-19, my research group consisted of eight graduate students, one undergraduate student, and two masters students[4]. My research is collaborative and several students of mine are co-advised by other faculty, in particular Erik Learned-Miller, Rui Wang, Evangelos Kalogerakis, and Daniel Sheldon. Two of my students (Hang Su and Tsung-Yu Lin) are expected to graduate at the end of Fall 2019, with two more (Jong-Chyi Su and Chenyun Wu) expected to propose their thesis in Fall 2019. Apart from my own students, I have served on the PhD thesis committees of eleven students, and collaborated with other students through "synthesis" projects, a unique aspect of UMass, where students complete a year-long project under the joint supervision of two or more faculty in an interdisciplinary area.

I strive to create a collaborative and nurturing research environment in my lab. Students are encouraged to present their projects and discuss related work in weekly group meetings which are also attended by other vision and graphics faculty. This exposes the students to new research topics and develop their presentation skills. I promote collaboration within the group through shared code repositories and discussion tools such as Slack. PhD students in their first year are also encouraged to attend a top-tier conference in computer vision (typically CVPR) which exposes them to the breadth of research topics that the community is working on. Besides these, I help organize regional workshops, such as the *New England Computer Vision* workshop, where students present their ongoing research to an audience consisting of students and faculty from universities in the New England area.

At a personal level I work closely with my students, especially early in their program, to select research problems and provide help with software infrastructure, experimental design, interpreting results, and editing. This provides a first-hand experience of good research practices. Often I jump-start a project by providing them with a well-formulated idea and even a partial implementation. This allows me to understand the important implementation details and help debug ideas. Gradually, I reduce the level of supervision for them to mature as independent researchers.

Besides PhD students, I mentor masters and undergraduate students through *independent projects* and *summer internships*. So far I have mentored five undergraduate interns through the REU data science program hosted at UMass, honors thesis projects, and summer internships. These students have gone on to pursue Masters and PhD degrees at top computer science departments.

[4] Please see my curriculum vitae for details.