

# CSE 891 Selected Topics: Geometric Algorithms for Machine Learning

January 9, 2017

**Credits:** 3

**Description:** Machine learning is a discipline that concerns the construction and study of algorithms for learning from data, and plays a critical role in many other fields, such as computer vision, speech recognition, social network, bioinformatics, etc. Many machine learning problems have deep connections to geometry (low or high dimensional space). We can often see trends or clusters in data by graphing or plotting—giving geometric form to data. As data increases in volume and complexity, giving it geometric form and then developing computational geometry algorithms is a fruitful way to approach machine learning.

In this course, students will study several advanced machine learning topics through geometric perspective, and a set of efficient geometric algorithms in both theoretical and practical aspects. Students will present selected papers and participate several carefully designed projects. The papers are from top algorithms conferences STOC/FOCS/SODA/SOCG, top machine learning conferences NIPS/ICML/COLT, or other top conferences KDD/SIGGRAPH/CVPR/ICCV/ECCV/MICCAI/IPMI, etc.

**Time and Location:** Tue& Thu 12:40pm-2pm, 1300 EB

**Instructor:** Hu Ding, [huding@msu.edu](mailto:huding@msu.edu), office 2140 EB, office hours 1:30pm-3:30pm Mon

**Prerequisites:** Knowledge comparable to that taught in:

1. CSE 830 Design & Theory of Algorithms

**Class notes:** The class notes will be posted on the course web site.

**Content (tentative):**

- dimension reduction, random projection, metric embedding
- core-set, frank-wolfe algorithm
- high dimensional clustering, classification
- topic modeling, non-negative matrix factorization (geometric perspective and approach)
- high dimensional nearest neighbor search
- VC-dimension, range space
- sampling, multiplicative re-weighting (e.g., adaboost), randomization
- matching, registration, reconstruction, distance (e.g., earth mover's distance), computational topology

- other hot machine learning topics relating to geometry could also be covered

**Graded work:**

- paper presentation (two papers) 25%+25%
- project 40%
- class participation 10%

Grading: The final grades will be assigned based on the following scale:

1.  $\geq 90\%$ : 4.0
2. 85%: 3.5
3. 75%: 3.0
4. 70%: 2.5
5. 60%: 2.0

The instructor reserves the right to make changes to the grading scale. Specifically, the score required to obtain each mark may be lowered.

**Re-grading policy:** All requests for re-grading must be submitted as a written document detailing the request. The written request must be received by the course instructor no later than one week after the graded item was returned to the student. Since graded items will typically be returned during class, students are advised to pick up their graded items in a timely manner. Any requests for re-grading that do not follow these guidelines will not be considered.

**Homework deadlines:** All homework assignments are due at the start of class on the deadline date specified on the assignment handout. A homework assignment submitted after the start of class but before the end of class will be accepted with a late penalty of 10% off of the final grade. Homework will not be accepted after the end of class on the deadline date. In case of a documented crisis, such as illness, the student should submit an official document to arrange for alternate grading. Advance notification is required for late submission unless this is impossible.

**Academic Integrity:** As scholars and scientists, academic integrity is of the utmost importance. CSE 891 will adhere to the Michigan State University policies of academic integrity as set forth in the General Student Regulations, the All-University Policy on Integrity of Scholarship and Grades, and the Department of Computer Science and Engineering Graduate Student Handbook. Students violating the policies and regulations regarding academic dishonesty will be penalized accordingly. Furthermore, additional penalties may be imposed at the discretion of the instructor.

**Students with disabilities:** The course instructor is committed to accommodating students with disabilities according to the policy of the Michigan State University Resource Center for Persons with Disabilities (RCPD), stated as follows (reproduced from the RCPD Model Statement): “Michigan State University is committed to providing equal opportunity for participation in all programs, services and activities. Requests for accommodations by persons with disabilities may be made by contacting the Resource Center for Persons with Disabilities at 517-884-RCPD or on the web at [rcpd.msu.edu](http://rcpd.msu.edu). Once your eligibility for an accommodation has been determined, you will be issued a verified individual services accommodation (“VISA”) form. Please present this form to me at the start of the term and/or two weeks prior to the accommodation date (test, project, etc). Requests received after this date will be honored whenever possible.”