SYLLABUS FOR MATH 858L (Mathematical Methods in Machine Learing), SPRING 2016

Tuesday, Thursday 11:00 p.m. - 12:15 p.m.

MTH 0405

Instructor: Dr. Wojciech Czaja

Office: MTH 2105

Office Hours: TBD

Phone: (301) 405 - 5106

Prerequisite: A class like MATH 411.

Text: No textbook

Presentation: At the end of smester, each student shall give an in-class presentation on a paper related to the class topic. The presentation is in lieu of the final exam. List of candidate papers will be given in February. The presentation is worth up to 200 points.

Homework: Homeworks will be assigned on Thursdays and are due the next Thursday. Each one is worth 10 points, and there will be 10 of such assignments. HWs may be combined, i.e., two HWs in one submission with double time.

Grading: The maximum point total is 300 points and the total used to calculate the final grade is the minimum of the two numbers: 200 points and the largest score in the class. The setting of letter grades will be based on this number of points and will be **no worse than**: 50% - D, 60% - C, 75% - B, 90% - A.

Academic integrity: The University makes me remind you about its academic integrity policies (http://www.shc.umd.edu/code.html). So I do. Nobody, however, has to remind me that part of my job is to make sure that these policies are obeyed.

Attendance and absences: You are responsible for the material covered in class, whether you attend or not. You are also responsible for the announcements made during class; they may include changes in the syllabus.

The instructor will adhere strictly to the official university policy on makeup exams.

In particular, it is the policy of the University to excuse the absences of students that result from the following causes: illness of the student, or illness of a dependent; religious observance (where the nature of the observance prevents the student from being present during the class period); participation in university activities at the request of University authorities; and compelling circumstance beyond the student's control. Students claiming excused absence must apply in writing and furnish documentary support for their assertion that absence resulted from one of these causes. Moreover, foreseeable absences (such as those resulting from religious holidays or participation in university-sponsored events) must be submitted in writing to the instructor by Feb. 5. (See also http://www.testudo.umd.edu/soc/atedasse.html)

Disabilities: If you have a disability disallowing you to test under the usual time or in-class conditions, you may contact the office of Disabled Students Services (DSS) in Shoemaker. (**Please let me know by Feb. 7 if you think you may require these services.**) If they assess you as meriting private conditions and/or extra time, then you may arrange to take your tests at DSS, with extra time as they indicate. You must arrange this well in advance of a test (in particular: no retakes). **Remember: I need to sign the document.**

Emergency closures: In case of an emergency that closes the University check the University's home page or call 301-405-SNOW for snow closure information.

Course evaluations: Your participation in the evaluation of courses through CourseEvalUM is important to us, and helps improve teaching and learning at the University. CourseEvalUM will be open for you to complete your evaluations for the Fall semester courses between Tuesday, April 29 and Friday, May 14. Please provide feedback on the course and the professor. Evaluations are anonymous and will not be available to faculty and TAs until next semester, so they cannot possibly affect your grade.

OUTLINE OF MATERIAL

The class will be devoted to mathematical and analytic aspects of modern machine learning. We shall start with an overview of nonlinear dimension reduction and data organization methods, talk about geometric multiresolution analysis, preimage maps and inverse problems for these complicated nonlinear settings, and we'll talk about operators on graphs abstractly, then we'll deal with recent developments in compressive sensing, and we shall complement it all with a closer look at Mallat's recent scattering transforms.

The unifying theme behind this eclectic selection is the attempt to describe the best that mathematics has to offer to deal with big data, which I understand as mostly unstructured data.

Topics include:

- nonlinear dimension reduction
- manifold learning
- diffusion wavelets
- endmember demixing
- classification schemes
- compressed sensing
- sparse representations
- fusion frames
- composite wavelets
- wavelet packets

Applications to:

- biomedical imaging
- remote sensing
- data classification
- target detection
- distributed sensor networks