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**Math 617/801: Optimization for machine learning**  
**Spring 2022**

**Department of Mathematical Sciences, UWM**

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### Lecture Time

5:00 PM - 7:40 PM, Monday, EMS Building, Room E495

### Instructor:

Professor Dexuan Xie

Office: EMS, Room W411

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Office Hours: 3:00 PM -4:00 PM, Monday and Wednesday

### Reference Books

- *Numerical Optimization*, by Jorge Nocedal and Stephen J. Wright, 2<sup>nd</sup> Edition, Springer, 2006, ISBN-10: 0-387-30303-0
- *Optimization for Machine Learning*, Edited by Suvrit Sra, Sebastian Nowozin, and Stephen J. Wright, The MIT Press, 2011, ISBN-13: 978-0262537766

### Prerequisite

Grade of C or better in either Math 321 or 602, or graduate students. Note: Students who do not meet prerequisites can consult the instructor for enrollment permission.

### Course Overview

The lectures are given based on Instructor's teaching notes. They will cover the following topics:

- Optimization formulation for a supervised learning problem
- Stochastic Gradient descent methods: *Automatic differentiation for computing gradients, convergence analysis, and implementation issues (such as initial iterate selection, learning rate issues, and normalization techniques)*.
- Unconstrained nonlinear optimization: *Line search methods, conjugate gradient methods, modified Newton's methods, quasi-Newton methods*
- Least-squares problems: *Singular value decomposition for linear least-squares problems, Gauss-Newton methods for nonlinear least-squares problems*
- Constrained nonlinear optimization: *Linear programming (Simplex algorithm), Lagrange multipliers, Kuhn-Tucker conditions, sequential quadratic programming methods, and Penalty and augmented Lagrange methods*
- Global Optimization of Neural Networks: *Global properties of loss functions, global landscape analysis of deep networks, algorithmic analysis of deep networks*

## Grading

- Five homework evaluations: 70%.
- Final Exam: 30 %.

Grading scale: A (90-100), A- (85-89), B+ (80-84), B (75-79), C (65-74), D (55-64), F (below 55).

## Important Dates

- January 24: First day of classes.
- February 20: Last day to drop without "W" on academic record.
- March 20-27: Spring Break.
- April 10: Last day to drop.
- May 9: Last day of classes.
- May 16: **Final Exam**: 3:00-5:00 PM on EMS E423.

## Homework Assignments

Homework is assigned in class. It is required to be done on a notebook. You must copy the problems and describe your solutions in detail. The due dates are announced one week earlier in class. Some homework problems will be discussed in class and selected for the final exam.

## Additional Information

- Texting and photo-taking are not permitted during class time. Cell phones and smart watches should be turned off.
- Books, notes, and calculators/computers are NOT allowed in the final exam.
- No makeup for the final examination except missed for religious observance, military service, or illnesses (with a documented medical emergency).
- Room changes and cancellations are valid only if posted outside the classroom door on Math Department letterhead and sent via email.
- Students with disabilities or who qualify for accommodations (VISA) should contact me early in the semester to discuss the assistance they may need.

## Statement of Academic Misconduct

The university has a responsibility to promote academic honesty and integrity and to develop procedures to deal effectively with instances of academic dishonesty. Students are responsible for the honest completion and representation of their work, for the appropriate citation of sources, and for respect of others' academic endeavors. Further information can be found at

<http://uwm.edu/academicaffairs/facultystaff/policies/academic-misconduct/>.

## Other important university policies

They can be found here:

<http://uwm.edu/secu/wpcontent/uploads/sites/122/2016/12/Syllabus-Links.pdf>