Spring 2019 - Math 689
Deep Learning and Optimization with Uncertainty

Lectures: Monday 12:00pm - 2:40pm

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Prerequisites. The first part of this course require undergraduate level Linear Algebra and some basic optimization. The second part of the course will assume some familiarity with functional analysis and measure theory, however a comprehensive overview will be provided in the class.

Course description:* The course consists of 2 parts:

1. **Deep learning and optimization:** The first part of this course consists of role of optimization in deep learning. We will cover:
   - **Linear approaches for classification:** Least-squares, iterative methods for least-squares, Newton method for classification.
   - **Neural networks (NN):** Nonlinear models, single layer NN, deep NN, differentiating deep NN, stochastic gradient descent.
   - **Parametric models/CNNs and relation to Partial Differential Equations (PDEs).**
2. **Optimization and control under uncertainty:** The second part of this course consists of optimization and control under uncertainty. We will cover:
   - Basic functional analysis and measure theory.
   - Basic PDE theory and Sobolev spaces.
   - PDE constrained optimization under uncertainty.
   - Risk measures and probabilistic optimization.
   - Methods for Stochastic Optimization: Stochastic Approximation (SA), Progressive Hedging, Sample Average Approximation (SAA), Adaptive Stochastic Collocation.

*Handwritten notes will be provided.

Exams (30%): The FINAL exam / project will be comprehensive and will constitute 30% of the grade.

Homework (70%): There will be several HOMEWORKS which will amount to 70% of the final grade. There will be a penalty of 10% per day late; homeworks will not be accepted after one week.

Students are encouraged to work in groups of up to three students but must hand in an individual self written proofs and answers.

Academic Integrity: GMU is an Honor Code university; please see the Office for Academic Integrity for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind) please ask for guidance and clarification.

Mason email accounts. Students must use their MasonLIVE email account for any correspondence during this course. For more information see: `http://masonlive.gmu.edu`.

Office of Disability Services. If you are a student with a disability and you need academic accommodations, please see me and contact the Office of Disability Services (ODS) at 993-2474, `http://ods.gmu.edu`. All academic accommodations must be arranged through the ODS.

University policies The University Catalog, `http://catalog.gmu.edu`, is the central resource for university policies affecting student, faculty, and staff conduct in university academic affairs. Other policies are available at `http://universitypolicy.gmu.edu`. All members of the university community are responsible for knowing and following established policies.