MATH 9810-001: Computer Experiments and Uncertainty Quantification

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Instructor: Dr. Qiong Zhang, Office: Martin Hall O-302; Email: qiongz@clemson.edu
Lecture Time: 9:05 AM–9:55 AM MWF, Aug 18, 2021 - Dec 10, 2021

Reference Books:

1 T. Santner, B.J. Williams, W.I. Notz. The Design and Analysis of Computer Experiments. Springer 2003

2 Williams, Christopher KI, and Carl Edward Rasmussen. Gaussian processes for machine learning. The MIT Press, 2006

3 Powell, Warren B., and Ilya O. Ryzhov. Optimal learning. John Wiley & Sons, 2012.

4 R.B. Gramacy. Surrogates: Gaussian Process Modeling, Design and Optimization for the Applied Sciences. Chapman Hall/CRC 2020. Free online version: `https://bobby.gramacy.com/surrogates/`.

Course Prerequisites: One of MATH 4070/6070, MATH 8050, MATH8010, STAT8020 or Equivalent; Students should be familiar with a computer programming language (e.g., R, Matlab, Python, C, Fortran or others)

Course Description: We will introduce basics and recent developments in experimental design, statistical modeling, and uncertainty quantification of computer experiments. The tentative contents include:

1. Overview the role of statistics in computer experiments with motivating examples. The potential examples we will work on through the semester include:
   - Building energy consumption simulation: learning complex input-output relationship, Bayesian optimization
   - Queueing network: stochastic Kriging, input uncertainty
   - Wind farm location selection via simulation: Bayesian optimization, sequential design
   - Three-dimensional printing: calibrate 3D printing design with scanned observations.
2. Statistical analysis of computer experiments: classical response surface modeling, Gaussian process regression, modeling spatial data.
3. Sequential design and Bayesian optimization: ranking and selection, efficient global optimization, etc.
4. Space-filling designs: basic criterions, design with special structures, theoretical properties of space-filling designs.
5. Uncertainty quantification, sensitivity analysis.
6. Examples of statistical calibration to field data.

Learning Outcomes: Solid understanding of the methodological foundation on statistical essentials in computer experiments; basic computational skills for statistical analysis and experimental designs in computer experiments.
Lecture Format: 90% led by the Instructor; 10% given by invited guest lecturers and/or by students' project presentations.

Grading: 75% Homework Assignments; 25% Final Project

The tentative grading scale:

- A: 93-100; A-: 90-92
- B+: 87-89; B: 83-86; B-: 80-82
- C+: 77-79; C: 73-76; C-: 70-72
- D+: 67-69; D: 63-66; D-: 60-62
- F: 0-59

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Inclement Weather: Any exam that was scheduled at the time of a class cancellation due to inclement weather will be given at the next class meeting unless contacted by the instructor. Any assignments due at the time of a class cancellation due to inclement weather will be due at the next class meeting unless contacted by the instructor. Any extension or postponement of assignments or exams must be granted by the instructor via email or Blackboard within 24 hours of the weather related cancellation.

This syllabus is subject to change at any time at the discretion of the instructor.