ME 8930: Special Topics in Surrogate and Agent Based Optimization

CRN 20206 – Location TBD

Professor: Cameron J. Turner, Ph.D., P.E.
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Class: MWF 9:05AM-9:55AM
Office Hours: TBD, or by Appointment

Course Description:

Students are introduced to the underlying concepts and methods associated with Surrogate Modeling and Optimization with Surrogate Models, including: Response Surface Models, Kriging, Spline-Based Models, Radial Basis Function Models, and Support Vector Machines, amongst other techniques. Agents will be developed using these techniques to define the basis for an Agent Based Optimization approach. This approach is increasingly applied to enable optimization of complex systems, including: ships, aircraft, automobiles, robotics and manufacturing systems, power plants, wind farms, etc. Students are expected to have some level of programming experience and prior experience with optimization algorithms. ***Prereq:*** *ME8710 or equivalent, or permission of the instructor.*

Textbooks (Currently for Consideration):

Forrester, A., Sobestor, A., and Keane, A. (2008). *Engineering Design via Surrogate Modelling: A Practical Guide*, John Wiley and Sons: Chichester, United Kingdom.

Salamon, T. (2011). *Design of Agent-Based Models*, Lightning Source UK Ltd.: Pitfield, United Kingdom.

Expectations:

Students will learn to select and apply surrogate modeling methods to optimization problems. Many of these methods will require at least some programming, and the integration of optimization algorithms. While optimization algorithms will not be explicitly covered in the class, students should be familiar with the underlying methods employed in the Simplex Algorithm and within Sequential Quadratic Programming. Additionally, students will be designing and implementing Agents to perform optimization tasks and will therefore learn about the underlying issues with the design of appropriate data structures, and programming methods to effectively implement Agent-Based approaches to engineering problems.

Submissions:

Unless otherwise stated, all submissions will be made electronically through Canvas. Assignments that are late are penalized 10% per day or portion thereof.

Weighting for Grade:

Category	Description	Weighting
Homework	I anticipate 4-6 homework assignments over the semester	30%
Exam I	Surrogate Modeling and Optimization Exam	20%
Exam II	Agent-Based Optimization Exam	20%
Project	Semester Project Applied to an Engineering Application	30%
	Total	**100%**

If this were a private professional setting, grades should be taken to reflect the following standards:

A Exceptional performance, worthy of an immediate promotion.

B Outstanding performance. Continued delivery of work meeting this standard will lead to promotion.

C Satisfactory performance, however, continued development of professional or technical skills is necessary for promotion to become a consideration.

D Unsatisfactory performance with flawed professional or technical skills. Further training is essential to determine if a continued investment in the employee is justified.

F Unsatisfactory performance with unacceptable professional or technical skills. Immediate termination is necessary.

As this is a graduate class, I expect you to come to class interested and prepared.

Sharing Code

While students are encouraged to discuss and collaborate on the development of algorithms and in cross-checking each other's solutions, all code should be your own. Sharing code amongst individuals in this class will NOT be tolerated. You may choose your programming language, whether it is MatLAB, Fortran, or C++, or something else.

Ethical Behavior

Ethical behavior and professional standards are expected in this class. Fundamentally, this class is governed by the NSPE Code of Professional Ethics. Note that all work submitted is to be that of the individual student unless cooperative effort is specifically authorized. In the case of team assignments, ALL team members are responsible for the work submitted by the team. The College of Engineering, Computing and Applied Science Honor Code and the Clemson University Student Handbook will be observed. Refer to your student handbook regarding University policies on academic dishonesty. ***Any copying, plagiarism, or other unethical behavior will be referred to the appropriate authorities and a failing grade will be earned by the offending student.***

Academic Integrity

As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form. In instances where academic standards may have been compromised, Clemson University has a responsibility to respond appropriately and expeditiously to charges of violations of academic integrity.

Schedule:

Because this is a graduate class, I expect that the schedule will be somewhat fluid. If we spend more time on a topic because of specific interests, then that is worth it, and I will adjust topics accordingly. However, a rough outline is as follows:

1. Surrogate Models (4 weeks)
    a. Response Surface Models
    b. Kriging Models
    c. Spline-Based Models
    d. Radial Basis Functions
    e. Support Vector Machines
2. Surrogate Optimization (4 weeks)
    a. Integration of Algorithms
    b. Model Conditioning
    c. Convergence
    d. Pareto Optimization
3. Agent-Based Models (3 weeks)
    a. Design of Agents
    b. Design of Agent Environments
    c. Interaction Modeling
4. Agent-Based Optimization (2 weeks)
    a. Optimization Methods
    b. Problem Design
    c. Implementation Issues
5. Applications (2 weeks)

Where appropriate, we will introduce various data structures that may make your coding easier.