IE4850/6850 Survey of Optimization Methods and Applications MW 4:00 - 5:15 pm, Brackett Hall-220

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Office Hours: 2:30-3:30 pm Monday and Wednesday, and by appointment.

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Office Hours: 10:00-11:00 am Tuesday, and by appointment.

Textbooks:

- Model Building in Mathematical Programming 5th edtion by H. Paul Williams (Online available from Clemson Library)
- Integer Programming by M. Conforti, G. Cornuejols and G. Zambelli (recommended for advanced learners)
- Practical Optimization by J. Chinneck (PDF available from `http://www.sce.carleton.ca/faculty/chinneck/po.html`).

Main Software: Julia and its JuMP package (Julia for Mathematical Programming)

- You can use **JuliaBox**, an online platform for writing, running, and displaying Julia scripts: `next.juliabox.com`. You can essentially use all functionality of Julia inside your internet explorer such as Google Chrome. The only thing you need is internet.
- (Recommended) You can also write and run Julia locally on your computer by following instructions on `http://www.chkwon.net/julia/book/juliabook-preview.pdf` for installing Julia on your local computer. By using IJulia and JuPyTer Notebook, you have the same access to the platform on JuliaBox.

More information about JuMP:

(a) There are many online tutorial videos and courses on Julia. Here is a collection of introduction videos of Julia on Youtube at `https://www.youtube.com/watch?v=VwZvUvXX-vY&feature=youtu.be&list=PLP8iPy9hna6TSRouJfvobfxkZFYiPSvPd`

(b) Pros: Simple interface with state-of-the-art FREE optimization software and solvers; maintained by a group of excellent researchers from MIT.

(c) Cons: Julia is a new language, JuliaOpt is very dynamic and needs updates frequently.

Prerequisites: IE4850: One of IE 3800 or MATH 4400; and one of IE 3810 or MATH 4410. IE6850: IE 8030; or MATH 6400 and MATH 6410; or MATH 8030 and MATH 8100.

Catalog Description: Survey of deterministic and stochastic optimization methods, theory and algorithms. Modeling, analysis and applications of optimization to modern industrial engineering problems.

Course Objective: This course will address advanced models and algorithms for optimization. These techniques include linear programming models with associated special structures such as network optimization and discrete (integer) programming. Students will also be trained to apply optimization modeling techniques through practical application projects.

Detailed Course Objectives: After taking this course, my objective is that you will be able to do the following:

- Take an abstract decision problem, model it as an appropriate optimization problem, solve the model using computer-based software (e.g., JuliaOpt), and interpret the solution;
- How to write a project report and interpret your solution to practitioners;
- Understand the relationship between a linear program and its dual, and understand their meaning in practice;
- Perform sensitivity analysis to understand how changes in the data input impact the optimal solution;
- Understand the importance of networks for modeling many operations research problems, and know how to model an optimization problem that is not necessarily network-related;
- Understand how to model logical constraints using integer decision variables;
- Understand the strength of integer programming formulations;
- Understand the branch-and-bound algorithm used in discrete optimization.

Course Plan

1. Network Optimization Fundamentals
    - Graph representation, graph search, flow decomposition
    - Maximum flow, minimum cut
    - Shortest path
    - Minimum cost network flow, the network simplex algorithm
    - Minimum spanning tree
2. Computational Complexity
    - P, NP, NP-complete, NP-hard
    - Typical NP-complete problems
3. Integer Programming Fundamentals
    - Branch-and-bound algorithm
    - Polyhedral theory, fundamental theorem of integer programming
    - Disjunctive programming formulations
    - Valid inequalities and branch-and-cut algorithm
4. Decomposition Algorithms
    - Lagrangian relaxation

- Column generation
- Dantzig-Wolfe decomposition

5. Classical Computational Integer Programming Problems
    - Knapsack problem
    - Traveling salesman problem
    - Vehicle routing problem

Grading Policy: The grade is distributed into the following sections:

- Homework: 25%
- 1st mid-term exam: 25%
- 2nd mid-term exam: 25%
- Final exam/project: 25%

No makeup exams will be given unless a university-approved excuse is provided. When possible, excuses should be provided at least ten days prior to the exam.

Grading scale:

- A: ≥ 85 (IE4850); $\geq$90 (IE6850)
- B: $75 - 84.9$ (IE4850); 80-89.9 (IE6850)
- C: $65 - 74.9$ (IE4850); 70-79.9 (IE6850)
- D: $55 - 65.9$ (IE4850)
- F: <55 (for IE4850); <70 (for IE6850)

Other policies:

1. Waiting: Students must wait 10 minutes before leaving the classroom if I am late.
2. Attendance: I will not take attendance. However, if you miss a class you are responsible to make sure that you are aware of what was discussed in class.
3. Disability: Students with disabilities needing accommodations should contact the Office of Student Disability Services in Suite 239, Academic Success Center building 864-656-6848, to discuss specific needs within the first month of classes.
4. Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. The policy is located at `http://www.clemson.edu/campus-life/campus-services/access/non-discrimination-policy.html`. Alesia Smith serves as Clemson's Title IX Coordinator and may be reached at alesias@clemson.edu or (864) 656-3181.

5. 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 to charges of violations of academic integrity." (`http://gradspace.editme.com/AcademicGrievancePolicyandProcedures#integritypolicy`)