ESI 6410 Optimization in Operations Research

Spring, 2019

Department of Industrial and Management Systems Engineering

University of South Florida

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Class Meeting Times: 3:30-4:45 p.m. (Mon and Wed)
Office Hours: TBD
Final exam: TBD

- All contents (and even the timeline) in this document can possibly change during the semester.

Course Description:

Optimization in Operations Research intends to deliver fundamental knowledge about mathematical programming in three applied dimensions including modeling, algorithms, and implementation. It is known that many real-life optimization problems can be formulated as a mathematical program. Fortunately, in the last three decades, exact optimization solvers (such as Gurobi, CPLEX, and FICO Xpress) have improved significantly and they are now able to solve many of such programs. So, one of the main goals of this course is to make the students familiar with the art of modelling in order to formulate a problem as a mathematical program. Another goal of this course is to make the students familiar with the existing optimization solvers and their limits. Finally, for the challenging optimization problems that cannot be solved using any existing solver, some fundamental knowledge about developing heuristic solution approaches for computing high-quality solutions will be delivered.
Textbook (Required):


Prerequisites:

- Good understanding of the basic mathematical concepts including but not limited to vectors, matrices, sets, functions.
- Good knowledge of (or being interested in learning) an arbitrary programming language of your choice. Examples include but not limited to R, C, Python, Visual Basic, MATLAB, ...
- Students should install IBM ILOG CPLEX Optimization Studio in their personal computer (it is free for students).
- Students should install Julia and Matlab in their personal computer.

Course Topics:

The following topic will be covered if we find enough time.

- Basic linear algebra
- Linear programming models (including diet, work-scheduling, capital budget, short-term financial planning, blending, and production process problems) and algorithms
- Introduction to network models and algorithms (assignment problem, transshipment problems, shortest path, maximum flow problems, CPM, PERT, and minimum cost network flow problems)
- Goal programming
- Data Envelope Analysis
- Integer programming models and solvers
- Heuristic techniques (including Simulated Annealing, Genetic Algorithm and Tabu Search)
- An introduction to Game Theory
Course objectives:

At the end of this class, it is expected that every single student:

- To be familiar with well-known optimization problems and their corresponding modeling techniques.
- To develop basic linear and mixed integer programming formulations.
- To be able to use existing exact solvers to solve linear programs and integer programs.
- To be able to apply Goal Programming and Data Envelope Analysis in practice.
- To develop a heuristic solution approach for challenging optimization problems.
- To have some basic knowledge about game theory and its relationship to mathematical programming.
<table>
<thead>
<tr>
<th>Week</th>
<th>Monday (3:30-4:45)</th>
<th>Wednesday (3:30-4:45)</th>
<th>Homework</th>
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<tbody>
<tr>
<td>1</td>
<td>7-Jan A PhD student will teach: Model Building</td>
<td>9-Jan Introduction to Linear Algebra</td>
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<td>2</td>
<td>14-Jan Basics of Linear Programming (Part I)</td>
<td>16-Jan Basics of Linear Programming (Part II)</td>
<td>HW1- out (Jan-23)</td>
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<td>3</td>
<td>21-Jan No Class- Martin Luther King</td>
<td>23-Jan Diet, Work-Scheduling, Capital Budgeting problems</td>
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<td>4</td>
<td>28-Jan A PhD student will teach: Programming Session</td>
<td>30-Jan A PhD student will teach: Programming Session</td>
<td>Due of Hw2 (Feb-1)</td>
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<td>5</td>
<td>4-Feb Short Term Financial Planning, Blending, Production Process problems</td>
<td>6-Feb Transportation and Assignment Problems</td>
<td>HW2- out (Feb-6)</td>
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<td>6</td>
<td>11-Feb Transshipment Problem, Shortest Path Problems (Part I)</td>
<td>13-Feb Transshipment Problem, Shortest Path Problems (Part II)</td>
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<td>18-Feb Maximum Flow and Minimum Cost Network Flow Problems (Part I)</td>
<td>20-Feb Maximum Flow and Minimum Cost Network Flow Problems (Part II)</td>
<td>Due of Hw2 (Feb-22)</td>
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<td>8</td>
<td>25-Feb Midterm 1 (Covers contents in HW1 and HW2)</td>
<td>27-Feb Goal Programming</td>
<td>HW3- out (Feb-27)</td>
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<td>4-Mar Data Envelope Analysis</td>
<td>6-Mar Basics of Integer Programming</td>
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<td>10</td>
<td>11-Mar No Class- Spring Break</td>
<td>13-Mar No Class- Spring Break</td>
<td>Due of Hw3 (March-15)</td>
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<tr>
<td>Week</td>
<td>Tuesday (9:30-10:45)</td>
<td>Thursday (9:30-10:45)</td>
<td>Homework</td>
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<td>Date</td>
<td>Topic</td>
<td>Date</td>
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<td>13</td>
<td>1-Apr</td>
<td>Complexity Theory</td>
<td>3-Apr</td>
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<tr>
<td>14</td>
<td>8-Apr</td>
<td>Midterm 2 (Covers contents in HW3 and HW4)</td>
<td>10-Apr</td>
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<td>15</td>
<td>15-Apr</td>
<td>Genetic Algorithm</td>
<td>17-Apr</td>
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<tr>
<td>16</td>
<td>22-Apr</td>
<td>Introduction to Game Theory</td>
<td>24-Apr</td>
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**Policy:**

- The deadlines are **STRICT**, and late submissions will **NOT** be accepted. The **LAST** time that you can submit the requested materials is at **11:00 p.m.** on the specified dates. All submissions **MUST** be done electronically in Canvas.
Office hours, homework, exams and grades:

- **Help:** Please feel free to ask for help during the class or office hours. You can also send an email to make an appointment. Please note again that the format of the title of your emails should be as follows:

  ESI-6410-Spring-2019: <The Title>

- **Final Grade:** The final grade follows the below rules:
  
  - $60 - 62.9 = D^-$; $63 - 66.9 = D$; $67 - 69.9 = D^+$
  - $70 - 72.9 = C^-$; $73 - 76.9 = C$; $77 - 79.9 = C^+$
  - $80 - 82.9 = B^-$; $83 - 86.9 = B$; $87 - 89.9 = B^+$
  - $90 - 92.9 = A^-$; $93 - 96.9 = A$; $97 - 100 = A^+$

  - If the weighted sum of your marks is close to some bound then extra credits will be considered in the final grade.

- Class participation (5%), Homework (45%), midterm exams (30%), the final exam (20%).
- Any complains about your marks related to the final project and your homework assignments must be received by me within one week after you receive your marks. For example, if I tell you your mark about homework 1 on date X, and you want to talk to me about it, you should do it by X+7 (days).

- **Class participation:** You will find this course very practical and enjoyable if you fully understand the underlying concepts of the course. So, you are highly encouraged to NOT miss any session. I believe that to get more out of this course, you should ASK questions as many as you can in the class, PARTICIPATE in discussions, and BRAINSTORM your ideas in the class.
• **Homework:** There will be FIVE regular homework assignments which should be submitted by the specified deadline in the table. The assignments are usually challenging. You should write up each homework **YOURSELF**, but that does NOT mean that you cannot obtain help from the others. The assignment should be uploaded in Canvas as a **PDF file**. Also, if you would like to scan your document (instead of typing it), please make sure that the generated PDF file has a high quality before sending it to me.

• **Midterm exams:** There will be two exams. The first one is based on Homework assignments 1-2 and the second one will be based on Homework assignments 3-4.

• **Final exam:** There will be ONE final exam based on Homework assignments 1-5.

**General:**

• I highly recommend to all students who still use WORD for preparing their text files to switch to LATEX TODAY. LATEX is FREE, easy to use, nicer, more professional, and (more importantly) it is specifically designed for users that need to work with mathematics a lot. There are two steps to install LATEX:

  (1) **Step 1** (Install a Tex distribution for instance TeXLive):  

  (2) **Step 2** (Install an editor for instance TeXstudio):  

  A minimal working example can be found here:
http://www.electronics.oulu.fi/latex/examples/example_1/

- It is very important that you frequently check your mails, massages and calendars on CANVAS system. Important announcements, and dates will be posted there.
- If USF suspends normal operations due to an EMERGENCY event, it is your responsibility to monitor your emails, CANVAS, all related websites (main USF, college, department and etc), and in general any other related tools for important information. Also, during this time, the delivery of instruction may be done differently for instance through online tools (SKYPE, ...), or even we may have to reschedule the class.

**Academic Integrity of Students:**

Academic integrity is the foundation of the University of South Florida System’s commitment to the academic honesty and personal integrity of its university community. Academic integrity is grounded in certain fundamental values, which include honesty, respect, and fairness. Broadly defined, academic honesty is the completion of all academic endeavors and claims of scholarly knowledge as representative of one’s own efforts. The process for faculty reporting of academic misconduct, as well as the student’s options for appeal, are outlined in detail in USF System Regulation 3.027: [http://www.usf.edu/undergrad/documents/academic-policies/1academic-integrity-of-students.pdf](http://www.usf.edu/undergrad/documents/academic-policies/1academic-integrity-of-students.pdf). The final decision on an academic integrity violation and related academic sanction at any USF System institution shall affect and be applied to the academic status of the student throughout the USF System, unless otherwise determined by the independently accredited institution.

**Disruption to Academic Process:**

Disruptive students in the academic setting hinder the educational process. Disruption of the academic process is defined as the act, words, or general conduct of a student in a classroom or other academic environment which in the reasonable estimation of the instructor: (a) directs attention away from the academic matters at hand, such as noisy distractions, persistent, disrespectful or abusive interruption of lecture, exam, academic discussion, or general University operations, or (b)
presents a danger to the health, safety, or well-being of self or other persons.

Student Academic Grievance Procedures:

The purpose of these procedures is to provide all undergraduate and graduate students taking courses within the University of South Florida System an opportunity for objective review of facts and events pertinent to the cause of the academic grievance. An “academic grievance” is a claim that a specific academic decision or action that affects that student’s academic record or status has violated published policies and procedures, or has been applied to the grievant in a manner different from that used for other students.

Disability Access:

Students with disabilities are responsible for registering with Students with Disabilities Services (SDS) (SVC 1133) in order to receive academic accommodations. SDS encourages students to notify instructors of accommodation needs at least 5 business days prior to needing the accommodation. A letter from SDS must accompany this request.

Sexual Misconduct/Sexual Harassment Reporting:

USF is committed to providing an environment free from sex discrimination, including sexual harassment and sexual violence (USF System Policy 0-004). The USF Center for Victim is a confidential resource where you can talk about incidents of sexual harassment and gender-based crimes including sexual assault, stalking, and domestic/relationship violence. This confidential resource can help you without having to report your situation to either the Office of Student Rights and Responsibilities (OSSR) or the Office of Diversity, Inclusion, and Equal Opportunity (DIEO), unless you request that they make a report. Please be aware that in compliance with Title IX and under the USF System Policy, educators must report incidents of sexual harassment and gender-based crimes including
sexual assault, stalking, and domestic/relationship violence. If you disclose any of these situations in class, in papers, or to me personally, I am required to report it to OSSR or DIEO for investigation. Contact the USF Center for Victim Advocacy and Violence Prevention: (813) 974-5757.

**Teaching Improvement:**

- I would like to improve myself and my teaching style as much as possible. Therefore, I highly appreciate all your comments and feedback, regarding my teaching style or anything related to this class. You can freely tell me what you think about the class in any way that you feel is the best: face-to-face conversations, emails, notes, and etc. Your comments and suggestions are very valuable for me, and will definitely have positive impacts. In addition to the formal survey that will be carried by the department (at the end of the semester), some informal teaching surveys will also be conducted by me to hopefully help me to improve my teaching skills during the semester.