School of Industrial and Systems Engineering
Data Science and Analytics Institute
Gallogly College of Engineering
University of Oklahoma

ISE/DSA 5113: ADVANCED ANALYTICS AND METAHEURISTICS
Spring 2022
Online and on-campus (T/R 12:00-1:15P Felgar 304)

Instructor: Charles Nicholson
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Office: Zoom (see announcements for link)
Office hours: Mon: 9:30-11a; Wed: 11a-12p

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Office hours: TBD	**Office hours:** TBD

All times listed are in the US Central Time Zone.

Course description: Advanced Analytics and Metaheuristics explores and applies advanced techniques for addressing complex decision problems. Focus is on developing and employing problem solving strategies using advanced methods in the context of Data Science and Analytics. Topics include both continuous and combinatorial optimization with an emphasis on traditional techniques such as mathematical programming as well as modern heuristics such as simulated annealing, evolutionary algorithms, and swarm optimization. Students will use programming skills to implement algorithms and solve problems.

Student outcomes: Students will demonstrate competence in the following three areas:

(1) Identification of pros/cons/issues in a variety of problem types and solution approaches
(2) Collaborative development of solution strategies
(3) Implementation of advanced analytics method to solve complex problems

Textbooks: We will use excerpts of several textbooks throughout the course – each is accessible for free for students currently enrolled at the University of Oklahoma.

Abbreviation	Textbook and link
HTSI	Michalewicz, Z. and D. Fogel. 2004. *How to Solve It: Modern Heuristics*. Springer http://link.springer.com/book/10.1007%2F978-3-662-07807-5
HM	Gendreau, M. and Potvin, J-Y. (Eds.). 2010. *Handbook of Metaheuristics*. Springer. http://link.springer.com/book/10.1007%2F978-1-4419-1665-5
AMPL	Fourer, R., D. Gay, and B. Kernighan. 2002. **AMPL: A Modeling Language for Mathematical Programming**. Cengage Learning, 2nd Edition. http://ampl.com/resources/the-ampl-book/
PO	Chinneck, J. **Practical Optimization: A Gentle Introduction**. Carleton University: Canada, 2016. http://www.sce.carleton.ca/faculty/chinneck/po.html

AMP	Bradley, S. P., Hax, A.C., Magnanti, T.L. **Applied Mathematical Programming**. 1977. Addison-Wesley. Out of print, but available here: http://web.mit.edu/15.053/www/AMP.htm)
EAMOP	Coello, C., G. Lamont, and D. Van Veldhuizen. **Evolutionary Algorithms for Solving Multi-objective Problems**. Second Edition. Barcelona, Spain: Springer Science Business Media, LLC http://link.springer.com/book/10.1007%2F978-0-387-36797-2

Note on accessing digital versions of textbooks

To get free access, you will need to go through the university system. This is easily done if you are on campus (because you are within the physical proxy). However, if you are off campus, you will need to go through the library proxy, so the publisher site knows you should be granted access.

Each link must start with the OU Library proxy link: "http://libraries.ou.edu/access.aspx?url="

For example – take the link for How to Solve It (see above) and prefix it with the proxy link: http://libraries.ou.edu/access.aspx?url=http://link.springer.com/book/10.1007%2F978-3-662-07807-5

Software, IDE's, and Links (note: free unlimited or student access is available for each of these)

Modeling Software:	AMPL	http://ampl.com/
Solvers:	Gurobi	http://www.gurobi.com/
Server-based Solver:	NEOS	http://www.neos-server.org/neos/solvers/
Software Resource:	Python	http://www.python.org/
Python IDE*:	WingIDE	http://wingware.com/

*There are many IDEs available for Python. You may use what you like.

Grading Policy:

All assignments must be uploaded to course platform by the due date and time indicated on the course website unless otherwise announced. Ensure your familiarity with the system in advance, and allot a sufficient amount of time for assignment submission *and any technical difficulties that may arise*. Assignments should be submitted in advance of an anticipated absence.

Late assignments will be penalized. See table for breakdown:

Submission is:	Maximum possible grade:
On time + up to 10 min late	100%
Up to 12 hours late	80%
12 to 24 hours late	60%
More than 24 hours late	0%

Exam dates will be announced well in advance. Missing an exam without substantial PRIOR notification will result in a zero grade for that exam. *Late exams will not be accepted.*

Grading Details:

Percentages of course grading requirements are as follows:

Content	Weight
Homework	60%
Exams	25%
Participation	15%

The homework assignments will consist of a variety of written and programming problems. Students will program in AMPL and/or Python. Various homeworks may be created as team assignments (TBD).

Exams will be *take-home exams* but must be completed entirely as individual work.

Participation: Online students are expected to view all videos. Campus students are expected to attend each class. All students are expected to complete the required readings and participate in the online discussions, quizzes, etc. Participation is evaluated and counts toward your final grade.

Grading scale:
Total grade percentages in the following intervals result in the associated letter grade:
[90-100] ← A, [80-90) ←B, [70,80) ← C, [60,70) ← D, [0,60) ←F .

Grading discrepancy review: Homework and exam grades can be reviewed and possibly revised if (i) a student **requests a grade review**, and (ii) requests are made **within one week** of the grade posting.

Tentative Schedule:

Module	Week of	Unit	Notes	Due
Problem Formulation and Exact Methods	17-Jan	Problem Solving Mathematical optimization overview	Review syllabus Install AMPL	Reading: HTSI, PO (see website for details) *Check Canvas for quiz/discussion most weeks*
	24-Jan	Intro to Linear Programming and AMPL Linear Programming Modeling		Reading: PO, AMPL **HW#1 (Sun, 30-Jan @ 11:59 pm)**
	31-Jan	Linear Programming Modeling (continued)		Reading: PO, AMPL
	7-Feb	Network Flows		Reading: AMP, AMPL
	14-Feb	Network Flows (continued)		
	21-Feb	Integer Programming		**HW#2 (Tue, 22-Feb @ 11:59 pm)** Reading: AMP
	28-Feb	Integer Programming		
	7-Mar	Multiple Objective Optimization	Mid-term exam	**HW#3 (Tue, 8-Mar @ 11:59 pm)** **Mid-term Exam (10/11-Mar) @ 11:59p**
	14-Mar	*Spring Vacation! March 12-20, 2022*		
The need for heuristics	21-Mar	Branch-and-Bound / Algorithm Complexity		Reading: HTSI
Metaheuristics	28-Mar	Intro to heuristics Neighborhood-based heuristics	Install Python	Reading: HTSI, HM
	4-Apr	Neighborhood-based heuristics (cont'd)		Reading: HM **HW#4 (Sun, 10-Apr @ 11:59 pm)**
	11-Apr	Population-based heuristics: Genetic Algorithms		Reading: HM, "Metaphors Exposed"
	18-Apr	Population-based heuristics: GA and PSO		Reading: HTSI, HM **HW#5 (Sun, 24-Apr @ 11:59 pm)**
	25-Apr	Population-based heuristics: PSO/ACO		Reading: HTSI, EAMOP
	2-May	Metaheuristic Multiple Objective Optimization: NSGA-II and MOPSO		Reading: EAMOP **HW#6 (Fri, 6-May @ 11:59 pm)**
	9-May	*Final Exam: 10-12 May: due 5/12/2022 @ 11:59p*		

Slack day: Each student will be allocated *one slack day* per semester. A slack day is a 24-hour extension for a *homework* assignment (not a project/quiz/exam/or other assessment task). The slack day may be

invoked only once per student, but it may be used as the student sees fit. To invoke the slack day please provide a comment in the submission location when the work is submitted.   For team assignments, each slack day value is equal to 24 hours / # of students on the team. For example, if there are two students, and one student uses their slack day, there will be a 12-hour extension. If all students invoke their slack days, then there will be a 24-hour extension.

Required material: There may be reading material, videos, or tutorials outside of the textbook and lectures. These supplemental items will help you learn vital skills such as AMPL, Python, or other relevant tools. Information regarding this material will be posted in the course website.

Professional behavior: While many of the tools necessary for the completion of this course will be discussed in the course content or via guided assignments, nevertheless considerable work outside of class in learning AMPL, Python or researching analytical techniques is expected if needed.

Academic honesty: Cheating, plagiarism, or any act of dishonesty will **NOT** be tolerated. This policy applies to all parties involved in the incident. Never take credit for anyone else's intellectual property, be it on an exam or homework assignment. **This includes, but is not limited to, copying from another student's paper, copying from a paper from a previous semester, using forbidden information on exams, and copying from published writings.**   Students are responsible for knowing the requirements of the Academic Misconduct Code. Please see http://integrity.ou.edu/students_guide.html for a student's guide to academic integrity. If you decide to cheat, please do not be surprised at the consequences.

Reasonable accommodation policy
Students requiring academic accommodation should contact the Disability Resource Center for assistance at (405) 325-3852 or TDD: (405) 325-4173. For more information please see the Disability Resource Center website http://www.ou.edu/drc/home.html. Any student in this course who has a disability that may prevent him/her from fully demonstrating his/her abilities should contact me personally as soon as possible so we can discuss accommodations necessary to ensure full participation and facilitate your educational opportunities.

Title IX Resources and Reporting Requirement
For any concerns regarding gender-based discrimination, sexual harassment, sexual assault, dating/domestic violence, or stalking, the University offers a variety of resources. To learn more or to report an incident, please contact the Sexual Misconduct Office at 405/325-2215 (8 to 5, M-F) or smo@ou.edu. Incidents can also be reported confidentially to OU Advocates at 405/615-0013 (phones are answered 24 hours a day, 7 days a week). Also, please be advised that a professor/GA/TA is required to report instances of sexual harassment, sexual assault, or discrimination to the Sexual Misconduct Office. Inquiries regarding non-discrimination policies may be directed to: Bobby J. Mason, University Equal Opportunity Officer and Title IX Coordinator at 405/325-3546 or bjm@ou.edu. For more information, visit http://www.ou.edu/eoo.html.

Religious Observance
It is the policy of the University to excuse the absences of students that result from religious observances and to reschedule examinations and additional required classwork that may fall on religious holidays, without penalty.

Adjustments for Pregnancy/Childbirth Related Issues

Should you need modifications or adjustments to your course requirements because of documented pregnancy-related or childbirth-related issues, please contact your professor or the Disability Resource Center at 405/325-3852 as soon as possible. Also, see http://www.ou.edu/eoo/faqs/pregnancy-faqs.html for answers to commonly asked questions.

Final Exam Preparation Period
Pre-finals week will be defined as the seven calendar days before the first day of finals. Faculty may cover new course material throughout this week. For specific provisions of the policy please refer to OU's Final Exam Preparation Period policy (https://apps.hr.ou.edu/FacultyHandbook#4.10).

Emergency Protocol
During an emergency, there are official university procedures that will maximize your safety.
Severe Weather: If you receive an OU Alert to seek refuge or hear a tornado siren that signals severe weather 1. LOOK for severe weather refuge location maps located inside most OU buildings near the entrances 2. SEEK refuge inside a building. Do not leave one building to seek shelter in another building that you deem safer. If outside, get into the nearest building. 3. GO to the building's severe weather refuge location. If you do not know where that is, go to the lowest level possible and seek refuge in an innermost room. Avoid outside doors and windows. 4. GET IN, GET DOWN, COVER UP. 5. WAIT for official notice to resume normal activities.

Armed Subject/Campus Intruder
If you receive an OU Alert to shelter-in-place due to an active shooter or armed intruder situation or you hear what you perceive to be gunshots: 1. GET OUT: If you believe you can get out of the area WITHOUT encountering the armed individual, move quickly towards the nearest building exit, move away from the building, and call 911. 2. HIDE OUT: If you cannot flee, move to an area that can be locked or barricaded, turn off lights, silence devices, spread out, and formulate a plan of attack if the shooter enters the room. 3. TAKE OUT: As a last resort fight to defend yourself. For more information, visit http://www.ou.edu/emergencypreparedness.html

Fire Alarm/General Emergency
If you receive an OU Alert that there is danger inside or near the building, or the fire alarm inside the building activates: 1. LEAVE the building. Do not use the elevators. 2. KNOW at least two building exits 3. ASSIST those that may need help 4. PROCEED to the emergency assembly area 5 ONCE safely outside, NOTIFY first responders of anyone that may still be inside building due to mobility issues. 6. WAIT for official notice before attempting to re-enter the building.

Mental Health Support Services
If you are experiencing any mental health issues that are impacting your academic performance, counseling is available at the University Counseling Center (UCC). The Center is located on the second floor of the Goddard Health Center, at 620 Elm Rm. 201, Norman, OK 73019.
To schedule an appointment call (405) 325-2911. For more information please visit:
http://www.ou.edu/ucc

All students are responsible for any changes/additions to this syllabus announced in class.