MATH3082 Optimization (2024-25 Class)

Coursework

Instructions: This piece of work accounts for 20% of the overall mark for MATH3082. You may analyze the problem using any mathematical programming package of your choice, e.g., Xpress-IVE, GAMS, Matlab, Python, R, etc. Your coursework should be computer processed by using a software of your own choice, e.g., LaTex or Word. Ensure that you take frequent and multiple backups of your work, since excuses concerning lost or corrupted files will not be treated sympathetically. As a rough guide, prepare no more than 5 A4 sides of description. Include any extra material as an appendix (e.g., the computer code, output, references, etc.) which does not count towards this page limit.

Submission: Submit your work via Blackboard by 18:00, May 31, 2025. The deadline is strict. However, late submission up to five days after the deadline is also accepted, but with 10% penalty each day (e.g., for work submitted on the fifth working day after the deadline it will only receive 50% of the total credit awarded). Therefore, no credit will be given for late submissions more than ten days after the deadline.

You are expected to complete the coursework without help from staff; instead, for anything that is unclear to you, make valid assumptions and list them.

AI use: Please familiarize yourself with the University's Generative AI policy. If you use any Generative AI software for this coursework (e.g, Copilot, ChatGPT etc.), please list out the commands you provided to the software in sequential order; provide this in the appendix. That is, list out the instructions provided to the software one-by-one. This is more for my understanding of how such software can be employed rather than your evaluation.

Note: Following the project, you may be contacted either by me or Dr. Athina Thoma to study how you approached this problem. Our decision to contact you, and your decision to respond, will have absolutely no effect on your evaluation for both this coursework and the exam.

Bismark Singh

March 2025

Formulating and Solving Creative Optimization Problems

Study these two articles (copies of which are provided on Blackboard):

1. "The Four Strongest" at the National Museum of Mongolia by Uuganbaatar Ninjbat. *The Mathematical Intelligencer*. https://doi.org/10.1007/s00283-020-09979-9
   This work ("first work") poses a puzzle that is framed as a mathematical problem. The author solves it via enumeration after justifying some assumptions.
2. A Mathematical Programming Approach for Mongolia's "The Four Strongest" Puzzle by Bismark Singh. *INFORMS Transactions on Education*. https://doi.org/10.1287/ited.2024.0112
   This work ("second work") takes the problem from the first work and proposes *one* mathematical optimization model towards a solution. The model is a linear program (with binary restrictions). After providing some assumptions, and constructing appropriate data, the author solves it via a standard optimization solver. Enumeration is avoided in this approach.

Task: Your task is to:

1. Critically review the optimization model proposed in the second work, studying the strengths and weaknesses plus the assumptions made.
2. Develop an alternative formulation than that in the second work. Then, solve this formulation using a mathematical optimization solver. Clearly state all assumptions you make.
3. Quantify whether your developed model performs better or worse than the formulation in the second work. To do so, provide an answer to Exercise 4 of the second work. Performing worse does not mean your work will be negatively evaluated.

Data: You are provided with absolutely no data beyond that already available in the two works and their appendices. In your writing ensure that you provide a clear description of the data you use or create to conduct your analysis. As mentioned above, ensure that you make appropriate and valid assumptions to design your data. To help you in this regard, engage with Exercises 1 and 2 from the second work and provide your responses.

What to include in your report: Your report should include:

1. a clear explanation of your model formulation,
2. a clear description of any assumptions made and your rationale for these,
3. a brief description of how you solved it,
4. a presentation of the results,
5. and, a summary of recommendations and limitations.

An ideal report will challenge the assumptions made and additionally provide an analysis of what happens when these assumptions are removed.