

Optimisation & Operations Research

Haide College, Spring Semester

Assignment 1 (5%)

Due: 30 March 2025, 23:59

Instructions:

- Answer the below questions and submit via Cloudcampus as a single PDF file.
- It is strongly recommended that you type your assignment (for example with LaTeX/Overleaf, as a MATLAB Live Script). A handwritten/scanned submission is acceptable provided it is neat and legible.
- Show all your working. Marks will be deducted if your answers do not include sufficient explanation, are illegible or are otherwise difficult to understand.
- In submitting this assignment you agree to have abided by the principles of academic integrity. You may discuss your assignment with other students but the written submission must be your own work and reflect your own understanding of the material.
- You must submit your assignment by the due date. Late assignments will incur a 50% penalty up to 48 hours after the due date, and a 100% penalty after that. You may request an extension, but please do this at least 24 hours before the due date.

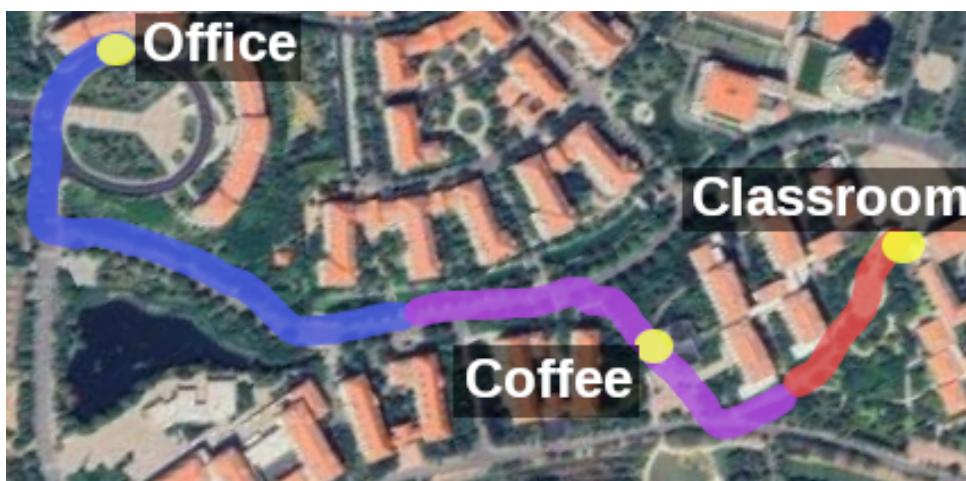
10

marks

1. *Translate the following scenario into a linear program.*

A maths lecturer is visiting OUC.

It is currently 9:40am and they have a class that starts at 10:10am. They would like a coffee before class, so will go from their office to the coffee shop and then to the classroom. The route they will take is shown in the picture below.



For the first part of their journey they will walk slowly (shown in blue). For the second part of their journey they will walk fast (shown in purple). For the last part of their journey they will run (shown in red).

The length of each part of this journey shown in the picture an indication only, the lecturer would like to figure out how long each part of the route should be.

The total length of the journey is 1 km. The lecturer would like to use less than 250 kJ in energy to make this journey. Speed and energy required for slow walking, fast walking and running are shown in the table below.

	Slow walk	Fast walk	Run
Speed (km/hr)	3	6	12
Energy (kJ/hr)	734	1304	3586

Similar to the route shown in the picture they intend to walk (slow or fast) for most of the journey. The distance walked at a fast pace should be **no more than** the distance walked slowly. The distance run should be **no more than half** the distance walked fast.

It takes 15 minutes to order and drink a coffee (during this time the lecturer stops at the coffee shop and neither walks or runs).

How far should the lecturer walk slowly, walk fast and run in order to get to class as quickly as possible?

- State the variables (including units), the objective and the constraints.
- MATLAB Grader.** Enter your linear program from part (a), and solve it using linprog.
- Using the output from linprog, state the optimal solution. This should include the value of the objective and the values of the variables. Make sure you include units for all quantities.
- How much energy does the lecturer use to make this journey?
- Does the lecturer get to the classroom on time? How many minutes is the lecturer early (or late!) to class?

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2. Consider the following linear program

marks

$$\max z = 2x + 2y,$$

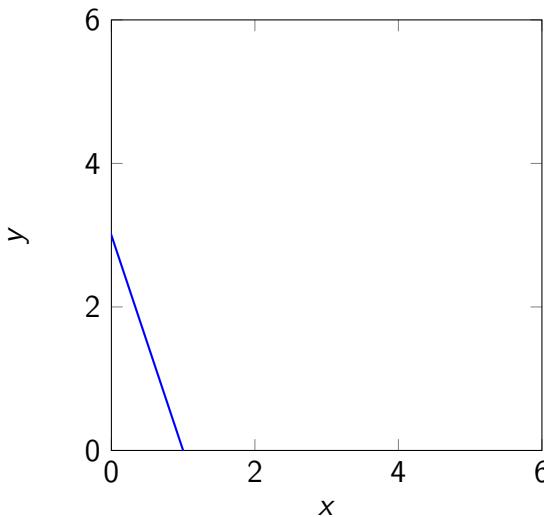
subject to

$$\begin{aligned} -3x - y &\leq -3 \\ -2x + y &\leq 3 \\ y &\leq 5 \\ 3x + y &\leq 14 \\ 2x - y &\leq 6 \end{aligned}$$

with $x, y \geq 0$.

- Draw the feasible region. Do this either by hand or with MATLAB (or similar). Your drawing should include:
 - the edges of the feasible region
 - the vertices of the feasible region

Hint: start by drawing one line for each constraint to show the edges of the feasible region. To get you started, here is a line representing the first constraint:



- b) Consider the region from part (a). State the feasible vertices. How many are there?
- c) Calculate the objective at each feasible vertex. What is the optimal solution?
- d) You should find that **two pairs** of vertices have the same value of the objective function. Explain what is happening here with reference to both the objective function and the shape of feasible region.

Finally, state **with some explanation** a different objective function of the form $z = ax + by$ with the following properties:

- there are two pairs of vertices with the same value of the objective
- there is a unique maximum to the linear program
- the coefficients of the objective are not equal, that is $a \neq b$.

- e) **MATLAB Grader.** Check your answer using `linprog`.
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