

ASE-4046 Exercise Set 6 (Multiobjective optimisation)

Problem 1

You are shopping for a new smartphone, and your minimisation criteria are *mass* and *number of rechargings per week*. You have gathered the following data:

option	A	B	C	D	E
mass (oz)	2	3	4	5	6
rechargings (per week)	4	2	3	2	1

- Plot the options' "costs". Which options are Pareto optimal? Which options are weakly Pareto optimal?
- What is the best option if you use a weighted sum of the criteria with weights $a = [1, 1]$? Plot the indifference curve through this option.
- What is the best option if you use goal attainment with weights $w = [1, 1]$ and goal: weight = 0, rechargings = 3.
- As in (c) but with weights $w = [1, 0]$.

Problem 2

In this truss design problem, you seek the bars' cross-sectional areas $A_{1:4}$ that minimise the truss mass

$$M = \rho L(2A_1 + \sqrt{2}A_2 + \sqrt{2}A_3 + A_4)$$

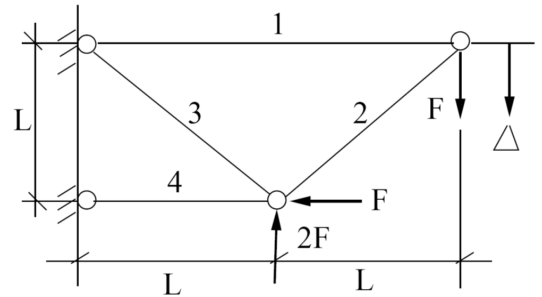
and minimise the joint displacement

$$\Delta = \frac{FL}{E} \left(\frac{2}{A_1} + \frac{2\sqrt{2}}{A_2} - \frac{2\sqrt{2}}{A_3} + \frac{2}{A_4} \right)$$

subject to the bar stress constraints

$$\frac{\sigma}{3} \leq \frac{F}{A_1} \leq \sigma, \quad \frac{\sigma}{3} \leq \frac{F}{A_2} \leq \frac{\sigma}{\sqrt{2}}, \quad \frac{\sigma}{3} \leq \frac{F}{A_3} \leq \frac{\sigma}{\sqrt{2}}, \quad \frac{\sigma}{3} \leq \frac{F}{A_4} \leq \sigma$$

where $F = 10$ kN, $E = 2 \times 10^5$ kN/cm², $L = 200$ cm, $\sigma = 10$ kN/cm², $\rho = 0.0077$ kg/cm³.



- Find the "utopia point" in objective space.
- Find a "weighted sums" solution, assuming that you consider 1 kg more mass to be as bad as 0.005 cm more deflection.
- Find a goal attainment solution that has the same relative underattainment of all goals; use "utopia" as the goal. What is the goal attainment factor?
- Draw the Pareto front (points in the cost space that are Pareto optimal.)

Answers 1. (a) {A,B,E}; {A,B,D,E}. (b) B. (c) A. (d) B. 2. (a) 10.78 kg, 0.0028 cm; (b) 12.58 kg, 0.0275 cm; (c) 20.89 kg, 0.0054 cm, $\gamma = 0.9376$