MATH1326
Advanced Optimisation with Python

Week 5

- Loading/Packing Problems
- Cutting Problems
- PuLP Modelling & Solution

Barge Loading – *Knapsack Problem*

- A shipper on the river Rhine owns a barge of carrying capacity 1500 m3. He has seven regular customers who load and unload practically at the same places. The shipper knows his costs of transport from long experience and according to his personal preferences has concluded agreements with his clients for the price charged to them for the transport of their wheat. Every client wishes to transport a certain number of lots, deciding himself the size of his lots in m3.

Table 9.3: Lots to transport

Client	Available quantity (no. of lots)	Lot size (in m^3)	Price per lot (in €)	Transport cost (in €/m^3)
1	12	10	1000	80
2	31	8	600	70
3	20	6	600	85
4	25	9	800	80
5	50	15	1200	73
6	40	10	800	70
7	60	12	1100	80

Barge Loading – Q1 – Unlimited

Table 9.4: Profit per lot

Client	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Profit/lot (in €)	200	40	90	80	105	100	140
Profit/m³ (in €)	20	5	15	8.8889	7	10	11.6667

$$\text{maximize} \sum_{c \in CLIENTS} PROF_c \cdot load_c$$

$$\sum_{c \in CLIENTS} SIZE_c \cdot load_c \leq CAP$$

$$\forall c \in CLIENTS : load_c \geq 0$$

Barge Loading – Q2 – Limited availability

$$\text{maximize} \sum_{c \in CLIENTS} PROF_c \cdot load_c$$

$$\sum_{c \in CLIENTS} SIZE_c \cdot load_c \leq CAP$$

$$\forall c \in CLIENTS : load_c \geq 0$$

$$\forall c \in CLIENTS : load_c \leq AVAIL_c$$

Barge Loading – Q3 – Lots cannot be divided

$$\text{maximize} \sum_{c \in CLIENTS} PROF_c \cdot load_c$$

$$\sum_{c \in CLIENTS} SIZE_c \cdot load_c \leq CAP$$

$$\forall c \in CLIENTS : load_c \geq 0$$

$$\forall c \in CLIENTS : load_c \leq AVAIL_c$$

$$\forall c \in CLIENTS : load_c \in \mathbb{N}$$

Cutting steel bars– *Cutting Stock Problem*

Table 9.10: Possible cutting patterns for every bar type

	Pattern number	Leg types 40cm	60cm	70cm	Loss (in cm)
Bar type 1	1	0	0	2	10
(1.5m)	2	0	1	1	20
	3	2	0	1	0
	4	0	2	0	30
	5	2	1	0	10
	6	3	0	0	30
Bar type 2	7	0	1	2	0
(2m)	8	0	2	1	10
	9	1	0	2	20
	10	3	0	1	10
	11	0	3	0	20
	12	5	0	0	0

Cutting steel bars

$$\text{minimize} \sum_{p \in PAT1} LEN_1 \cdot use_p + \sum_{p \in PAT2} LEN_2 \cdot use_p - \sum_{s \in SIZES} 4 \cdot DEM_s \cdot s$$

$$\forall s \in SIZES : \quad \sum_{p \in PATTERNS} CUT_{ps} \cdot use_p \geq 4 \cdot DEM_s$$

$$\forall p \in PATTERNS : use_p \in \mathbb{N}$$