Assignment 1 - Linear Programming - Section A

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Sets

C Set of cities
Q Set of quarters

Data

i_c Current number of barrels in city $c \in C$
d_{cq} Predicted demand of barrels in $c \in C$ for quarter $q \in Q$
c_q Predicted cost of dollars per barrel for quarter $q \in Q$
m_c Maximum storage capacity of barrels in $c \in C$

Variables

x_{cq} Number of barrels to deliver to city $c \in C$ in quarter $q \in Q$
s_{cq} Number of barrels to store in city $c \in C$ at the end of quarter $q \in Q$

Objective

$$\min \sum_{c \in C} \sum_{q \in Q} 25 s_{cq} + c_q x_{cq}$$

Constraints

$$
\begin{aligned}
& x_{cq} \geq 0 && \forall c \in C,\ \forall q \in Q && (1)\\
& s_{cq} \geq 0 && \forall c \in C,\ \forall q \in Q && (2)\\
& \sum_{c \in C} x_{cq} \leq 10000 && \forall q \in Q && (3)\\
& i_c + x_{cq} - d_{cq} = s_{cq} && \forall c \in C,\ \forall q \in \{f\} && (4)\\
& s_{c(q-1)} + x_{cq} - d_{cq} = s_{cq} && \forall c \in C,\ \forall q \in Q \setminus \{f\} && (5)\\
& s_{cl} \geq 3000 && \forall c \in C && (6)\\
& s_{cq} \leq m_c && \forall c \in C,\ \forall q \in Q && (7)
\end{aligned}
$$

where f is the first quarter, and l is the last quarter, where $f, l \in Q$.

- Constraints (1) and (2) are basic non-negativity constraints on our variables.

- Constraints (3) ensures that the amount shipped per quarter does not exceed the ships capacity.

- Constraints (4) and (5) describe a recursive relationship between initial supplies, new deliveries, demand, and the amount stored at the end of each quarter.

- Constarint (6) ensures that there at least 3000 barrels in storage in each port by the end of the last quarter.

- Constarint (7) ensures that we do not exceed the capacities of our facilities in each port.