

# 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

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

## Constraints

$$x_{cq} \geq 0 \quad \forall c \in C, \forall q \in Q \quad (1)$$

$$s_{cq} \geq 0 \quad \forall c \in C, \forall q \in Q \quad (2)$$

$$\sum_{c \in C} x_{cq} \leq 10000 \quad \forall q \in Q \quad (3)$$

$$i_c + x_{cf} - d_{cf} = s_{cf} \quad \forall c \in C \quad (4)$$

$$s_{c(q-1)} + x_{cq} - d_{cq} = s_{cq} \quad \forall c \in C, \forall q \in Q \setminus \{f\} \quad (5)$$

$$s_{cl} \geq 3000 \quad \forall c \in C \quad (6)$$

$$s_{cq} \leq m_c \quad \forall c \in C, \forall q \in Q \quad (7)$$

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.
- Constraint (6) ensures that there at least 3000 barrels in storage in each port by the end of the last quarter.
- Constraint (7) ensures that we do not exceed the capacities of our facilities in each port.