# Math3401 Assignment 3

## Data

The profit for each type of fridge:

| **Refrigerator type** | Alaska | Elsa | Lumi |
|---|---|---|---|
| **Profit per unit** | $131 | $164 | $170 |

**For communication 1:**

The expected sales for each type of refrigerator given the number placed on display:

| Displayed | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Alaska | 0.0 | 0.3 | 3.5 | 4.4 | 4.6 |
| Elsa | 0.0 | 0.5 | 2.8 | 3.8 | 4.1 |
| Lumi | 0.0 | 1.9 | 3.1 | 3.5 | 3.8 |

Maximum number of fridges we can display in total: 8

**For communication 2 and 3:**

The table below shows the probability of each demand for each type of refrigerator:

| **Demand** | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|
| Alaska | 0.00 | 0.16 | 0.20 | 0.31 | 0.24 | 0.09 |
| Elsa | 0.11 | 0.17 | 0.29 | 0.25 | 0.18 | 0.00 |
| Lumi | 0.09 | 0.20 | 0.32 | 0.24 | 0.15 | 0.0 |

They will be delivered instantaneously and that we pay for a full week of rental space for the newly arrived refrigerators, plus those previously in stock.

Warehouse space rental costs: $30 per refrigerator per week
Length of the trial: 4 weeks
Delivery cost from the supplier to warehouse: $150 per truckload
Capacity of each truck: 7 fridges
Maximum number of delivery truckloads per week: 2

Maximum number of each type of fridge at the warehouse at anytime: 8

## Stages, states, actions and the transition and value functions:

### Communication 1:

Stages: We have 3 stages of putting each type of the fridge for display
States: The number of positions left for display ( initially we have 8)
Actions: The number of each type of fridge we put for display at each stage.

Value function: Profit(s,t) where s is the state and t is the stage. We are looking for the value of Profit(8,0) to get the value of the most profit

Transition function: Profit(s-x,t+1) where x in the number of fridges of type t put on display. The new state will be s-x and we go to next stage t+1.

To get answer: run Profit(8,0)

### Communication 2:

Stages: For each type of fridge, the stage is the week we are in, so we have 4 stages.
States: For each type of fridge, the state is the number of fridges in the warehouse at the beginning of the week.
Actions: For each type of fridge, the number of fridges we order each week.

Value function: Profit2(f,t,w) where f is the type of the fridge, t is the stage ( the number of week) we are in and w is the number of each type of fridge we have in the warehouse at the beginning of the week.
We are looking for Profit(f,0,0) to find the profit of optimum strategy for each fridge type f. The function Profit2a(0,0) gives the maximum profit for each type of fridge, how many of each type of fridge we should buy and the total maximum profit.

Transition function: Profit2(f,t+1,max(0,x+w-(d+1))) where for each type of fridge, the number of fridges left in the warehouse for next week is what is ordered plus what has already been in the warehouse minus what is sold. If the demand is higher than the warehouse content it will be zero.

To get answer: run Profit2a(0,0)

### Communication 3:

Stages: The stage is the week we are in, so we have 4 stages.
States: The state is the number of fridges in the warehouse at the beginning of the week for all fridge types.
Actions: The number of fridges we are ordering each week for all types of fridges

Value function: Profit3(t,w1,w2,w3) where t is the stage or the week we are in and w1,w2 and w3 are the number of fridges of each type we have in the warehouse at the beginning of each week. For the maximum profit we are looking for Profit3(0,0,0,0).

Transition function:
Profit3(t+1,-f1+max(f1,x1+w1),-f2+max(f2,x2+w2),-f3+max(f3,x3+w3)

Where like the previous communication, we update the number of fridges in the warehouse for the next stage(next week). The difference is we need to consider all fridge types at once.

Since there are so many for loops here, it takes a long time to calculate the function for the desired values. I have used the main function to calculate the values and a wrapper function to get the desired result without going through unnecessary loops. So the answer for the maximum profit (Profit3(0,0,0,0) ) is given by the wrapper() function.

To get answer: run wrapper()