Sparkathon

August 2024

1 Data

1. **Historical Data for Area Wise Demand**
   A time-series of product demand in a hypothetical area from year 2010 to 2017. We have divided total land as a map of 3000 equisized grid blocks (using pincode, etc).For ease of use, we have flattened the map and used location index, latitude, longitude, and year wise product demand for each grid location.

Index	Latitude	Longitude	2010	:	2017
0	24.66818	71.33144	8.475744	:	5.180296
1	24.66818	71.41106	24.02978	:	42.12695
⋮	⋮	⋮	⋮	⋮	⋮
3000	20.15456	73.16282	0.621228	:	0.226953

	Destination Index					
Source Index	**0**	**1**	**2**	**3**	**:**	**3000**
0	0	11.3769	20.4557	38.1227	:	681.4235
1	11.3769	0	9.0788	28.9141	:	679.1758
2	20.4557	9.0788	0	22.3791	:	679.7786
3	38.1227	28.9141	22.3791	0	:	678.969
:	:	:	:	:	:	:
3000	679.2328	676.9851	677.5878	677.9406	:	0

2. The objective of the problem is to minimize the overall cost which comprises of 3 components:

   1. Cost of transportation ($Cost_{transport}$): This cost depends on the quantity of goods being transported and the respective distance, as we have 4

layers of transportation our total cost would be across all of them

$$Cost_{transport} = \left(\sum_{i,j} Dist1_{i,j} \times Goods1_{i,j}\right) + \left(\sum_{i,j} Dist2_{i,j} \times Goods2_{i,j}\right) + \left(\sum_{i,j} Dist3_{i,j} \times Goods3_{i,j}\right) + \left(\sum_{i,j} Dist4_{i,j} \times Goods4_{i,j}\right)$$

2. Cost of goods forecast mismatch ($Cost_{forecast}$): This cost depends on how far the forecasted goods is to the actual goods availability in every location.

$$Cost_{forecast} = \sum_{i} |Demand_{forecast,i} - Demand_{true,i}|$$

3. Cost of underutilization ($Cost_{underutilization}$): This cost depends on whether each asset i.e., the warehouses are utilized to their maximum operating capacity.

$$\begin{aligned} Cost_{underutilization} = & \sum_{j} \left(Cap_{Manufacturing\ Warehouse} - \sum_{i} Goods1_{i,j}\right) \\ & + \sum_{k} \left(Cap_{Storage\ Warehouse} - \sum_{j} Goods2_{j,k}\right) \\ & + \sum_{k} \left(Cap_{Distribution\ warehouse} - \sum_{j} Goods3_{j,k}\right) \\ & + \sum_{k} \left(Cap_{Retail\ Stores} - \sum_{j} Goods4_{j,k}\right) \end{aligned}$$

4. Final cost would be a linear function of all the costs we have formulated:

$$\text{Cost} = a \times Cost_{transport} + b \times Cost_{forecast} + c \times Cost_{underutilization}$$