MGSC-662-075 - Decision Analytics
Routing Problem

November 30, 2022

Description

Intro

Solution Approach

We solve this model in a following approach.

1. Starting with 1 cluster split wind farms based on their location (using K-Means algorithm)
2. If a cluster where demand exceeds capacity exists, increase number of clusters by 1 and go to step 1
3. Minimize travel cost for each cluster (using Miller-Tucker-Zemlin (MTZ) formulation)

Clustering Model

The k-means clustering algoritm from Python scikit-learn package is used. With normal standardization used to scale locations of wind farms.

Optimization Model

The following optimization model is used in step 3 of the solution approach

Sets

W - wind farm

Data Requirements

wx_w - longitude of wind farm w
wy_w - latitude of wind farm w
wb_w - average yearly wind blades waste from wind farm w
wdi_{w1w2} - manhattan distance between wind farm $w1$ and $w2$

dco - driving cost per truck per km
tco - fixed cost of buying truck
tca - yearly truck capacity
ph - planning horizon (years)
dk - conversion of latitude/longitude to km

Decision Variables

vt_{w1w2} - binary variable indicating whether truck should go from wind farm $w1$ to farm $w2$
vb_w - integer variable used in MTZ constraints for wind farm w

Constraints

Must enter location once

$$\sum_{w1} vt_{w1w2} = 1 \quad \forall w2 \tag{1}$$

Must exit location once

$$\sum_{w2} vt_{w1w2} = 1 \quad \forall w1 \tag{2}$$

Self subtour

$$vt_{w1w2} = 0 \quad \forall w1, w2, w1 = w2 \tag{3}$$

MTZ Constraints

$$\begin{aligned} vu_{w1} - vu_{w2} + W vt_{w1w2} \leq & \quad W - 1 \quad \forall w1 \in \{2, W\}, w2 \in \{2, W\}, w1 \neq w2 \\ vu_w \geq & \quad 1 \quad \forall w \in \{2, W\}, \\ vu_w \leq & \quad W - 1 \quad \forall w \in \{2, W\}, \end{aligned} \tag{4}$$

Objective Function

$$min \quad ph * dk \sum_{w1w2} (vt_{w1w2} * wdi_{w1w2}) \tag{5}$$