Problem setting (CVRP + one booking as one location)

Given a map $G = (L, E)$ with a set of locations L, a set of bookings $b_i \in \mathcal{B}$ and an unlimited set of vechicle $v_j \in \mathcal{V}$. Each location has a set of bookings to be delivered to. Each booking b_i associate with its seats s_i and locations $l_i \in \mathcal{L}$. Each vechicle has its own operation fee f_j and capacity c_j. The goal is to select a subset of vechicles, each associates with a path p_j covering a subset of locations $L(p_j) \subset \mathcal{L}$ and for each vechicle, select a subset of clients to be delivered by. The vehicles take its clients to their destinations with minimum cost.

Remarks

- If we have pretty fast CVRP IP solver, we could consider to use this formalization to solve the problem.

counterpart in codebase

booking ↔ booking
location ↔ booking (in this formalization, we take each booking as one location.)
trip ↔ trip
vehicle ↔ vehicle

Annotations

Constants:

G :$G = (L, E)$. A graph showing the location and route of the cus

L :A collection of locations represeting bookings. The location th

E :Set of direct pathes connecting each hotel $e_{ij} = (i, j)$.

V :$V = \{1, 2, \ldots, |J|\}$. Set of vehicles.

s_i :$s_i \geq 0$. Seats of booking i, i.e. number of customers w.r.t booki

c_j :vehicle's capacity (Not all vehicles have the same maximum ca

d_{ij} :Travel distance between location i and j (distance between i a

f_j :fee to operate vehicle to manage trip j. Fees could be determin

Variables:

y_j^T :$y_j^T = \begin{cases} 1 & \text{if trip } j \text{ is selected} \\ 0 & \text{otherwise} \end{cases}$

$x_{ii'}^j$:A decision variable that indicates whether the vehicle j has tal

$x_{ii'}^j = \begin{cases} 1 & \text{taken} \\ 0 & \text{otherwise} \end{cases}$

Formalization (LP)

The goal is to minimize cost:

$$\min \sum_{k \in K} \sum_{(i,i') \in E} (\alpha \cdot f_j + \beta \cdot d_{ii'} \cdot x_{ii'}^j) \cdot y_j$$

While satisfies:

$$\sum_{j \in V} x_{ii'}^j \geq 1 \qquad \forall i \in L \backslash \{0\} \tag{1}$$

$$\sum_{i \in L, i \neq i'} x_{ii'}^j - \sum_{i \in L} x_{i'i}^j = 0 \qquad \forall i, i' \in L, \quad \forall j \in V \tag{2}$$

$$\sum_{i \in L} \sum_{i' \in L \backslash \{0\}, i \neq i'} s_k x_{ii'}^j \leq c_j \qquad \forall j \in V \tag{3}$$

$$\sum_{j \in V} \sum_{(i,i') \in S, i \neq i'} x_{ii'}^j \leq |S| - 1 \quad S \subseteq L \backslash \{0\} \tag{4}$$

$$y_j, x_{ii'}^j \in [0, 1] \qquad \forall j \in V, \quad \forall (i, i') \in E \tag{5}$$

(1) Each hotel should be vistied at least once

(2) Constraint which means “the number of vehicles coming in

and out of a location is the same”
(3) Constraint which means “the delivery capacity of each vehicle should not exceed the vehicle's maximum capacity”
(4) Constraint for “removal of subtours”
α and β are weights to manually control.