Shopee Supply Chain

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空间管理



# 01 Model

由 Muxin Sun创建, 最后修改于2022-12-09

## Mid-mile simulation algo instruction

-- from SOC to LM hub

### Background

Execution of transportation tasks from an SOC to $n_{hub}$ LM hubs, such that there are $n_{hub}$ routes in total. Vehicles can be shared between different routes, but can only execute one task at the same time. It is possible that send multiple vehicles to the same hub at the same time.

- When ground-truth demand is used for simulation, output is for review
- When forecasted demand is used, output is for planning

Note: loading logics are not considered in the current version.

### Definition

- Route: from SOC to certain LM hub
- Task: a task departs at certain time for a certain route, duration depends on route
- Shift: a shift corresponding to all tasks departing at certain time for a certain route
- Trip: a certain vehicle executes a certain task, with some loading range
- Unit of time: hour and a time step $t$ denotes the time range [t, t+1)
- Loading ranges: different types of vehicles are denoted by [LB, UB], which could be time-varying
- Stock: cumulative amount of parcels at the beginning of time step, i.e. after outbound and before inbound for times step $t$

### Rule

*Special rules for time*

- **[R-1]** A day is defined from 15:00 to next 14:00
- **[R-2]** The first available time for planned task is $t_{\rm avai}$, last available time is $t_{\rm f}$, any planned task not in available time $T_{avai}$ will be cancelled
- **[R-3]** On $t_{c}$, stock should be cleared and vehicles should be sent ignoring its lower bound when the stock is over $s_c$; finally, when the remaining stock is no more than $s_{v}$, set the stock to zero directly
- [R-4] For time range for last batch $T_{\rm last}=[t_1, t_2]$, set the lower bound of vehicles to $\rm LB_{last}$
- **[R-5]** Each batch end time is denoted by $T_{bend}= {t^i_{bend}}$, for each batch $t^i_c$ could be fixed daily time or based on $t^i_c$ minus lead hour
- **[R-17]** For the last shift of certain batches $B={b_i}$ on each day for each route, postpone all the corresponding trips to $t^b_{c}$ of the corresponding batch if the delayed time is within $t_{postpone}$ hour
- **[R-18]** For each first batch send at least one trip

*Ops*

1. For each route, check the stock at each time step
   a. [R-5] If the current stock exceeds upper bound of next pending task in this route, send the vehicle at current time (when there are multiple, follow FIFO)
   b. **[R-6]** If the current time equals to the planned departure time of next pending task in this route and the stock is no less than its lower bound, send the vehicle at current time
   c. **[R-7]** If the current time equals to the planned departure time of next pending task in this route and the stock is less than its lower bound, cancel the vehicle at current time
   d. **[R-8]** If the stock is no less than upper bound of the largest vehicle of the route, send a standby vehicle immediately, such that the remaining stock is less than this upper bound
2. [R-9] When a trip is cancelled, the corresponding vehicle waits at the same time on the route of its next task

*Vehicle selection*

1. [R-10] All used standby vehicles will be put into a standby resource pool, when a standby vehicle is needed, firstly, search for the available best match from (larger vehicle type is allowed), if not found, add a new vehicle with the required type
2. **[R-11]** All vehicles are in the same resource pool, when a vehicle is needed, there are two scenarios:
   a. **[R-12]** if the task is planned, choose a vehicle with the same type, it none is available, add a new vehicle to the resource pool;
   b. **[R-13]** if the task is standby, first try to find an available vehicle with same type, if not possible, then try to find a bigger vehicle if there is any standby vehicle available, if still none is available, add a new vehicle of the originally desired type to the resource pool
3. **[R-14]** Resource pool is initialized by planned trips, each vehicle has a planned schedule for certain routes at certain times and is tagged as planned vehicle; all used vehicles are in the same resource pool, while standby vehicles with a standby tag. When a vehicle is needed, there are two scenarios:
   a. **[R-15]** if the task is planned, execute exactly the planned trip
   b. **[R-16]** if the task is standby, firstly, try to find an available vehicle among the planned vehicles with at least a scheduled route identical to the current desired route; secondly, find among the available standby vehicles with at least a past route identical to the current desired route; thirdly, find among other available standby vehicles; finally, add a new standby vehicle to the resource pool and execute the task.
4. **[R-19]** Except daily last shift of each batch, the UB of vehicle decreased to $\alpha_0*{\UB}$, for daily last shift is $\alpha_1*{\UB}$
5. **[R-20]** The capcity ratios $\alpha_i$ are different for planning and review. #### Parameter

Vehicle capacity $[\text{LB,UB}]*{CDE}= [1350, 2700]$ & $[\text{LB,UB}]*{CDD}=[2150, 4300]$

$t_{\rm avai}$ = 16:00 $t_{\rm f}$ = 13:00

$t_{c} = [4:00,10:00,13:00]$ or $t^{i_c} = t^i_{bend}-{\rm lead~hour}$ , $s_{c}=[1500,1000,0]$, $s_v=0$

$T_{\rm last}=[null, null]$, $\rm LB_{last}=500$

### Versions

- v0.1.0 - First version without sharing standby vehicles (deprecated)
- v0.1.1 - [R1-R8, R10] Add resource pool for standby vehicles (deprecated)
- **v0.2.0 - [R1-3,5,6-8,11-13]** All vehicles share the same resource pool, which is initialized by vehicles for planned trips
  - [R-12] for planned task, could not change to bigger vehicle
  - [R-13] for real-time standby task, could use bigger vehicle if the available vehicle is standby
- **v0.2.1 - [R1-3,5,6-8,11-13,17-19]**
- **v0.3.0 - [R1-3,5,6-8,14-16]** With planned schedule and a shared resource pool, which is initialized by vehicles for planned trips
  - [R-15] for planned task, should be finished by the planned vehicle
  - [R-16] try to find a used vehicle with scheduled or past route identical to the current route
- **v1.0 - [R1-3,5,6-8,11-13,17-20]**

### Variable

1. Inbound amount of parcels for each route at each time step (route, time, parcels)
2. Planned tasks for each route (route, time, vehicle type)
3. Trips for each route

### Dynamics

For simplicity, we use $(t)$ to denote the exact time point, $(t^{+/-})$ the time after or before $(t)$ for a infinitesimal deviation and $(t^{++})$ for twice the deviation.

For each time step $t$, i.e. time horizon $[t,t+1)$, the beginning stock is denoted by $s(t)$, the total outbound is denoted $x_{out}(t^+)$, the total inbound $x_{in}(t)$, thus the ending stock for the current time step is

$$ s\left({t+1}^-\right) = s(t) - x_{out}(t^{+}) + x_{in}(t^{++}) $$

The beginning stock for next time step is

$$ s(t+1) = s\left({t+1}^-\right) $$

which means beginning stock for time step $t+1$ is obtained at $t^{++}$.

It is assumed that outbound is happened before inbound, thus the remaining stock after outbound is

$$ r(t^{+}) = s(t)- x_{out}(t^{+}) $$

which is used for [R-8].

### Metrics

1. Trips: planned, standby, total, daily
2. Vehicles: planned, standby, total, daily
3. Fees: vehicle monthly rent fee

**Note**, business values of v0.2.0 and v0.3.0 are the same, but with difference in execution.