SOICT 2026 Student Contest
Integrated Passenger and Parcel Transportation

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1 Problem Statement

A transportation company has K taxis, indexed by $k \in \{1, \ldots, K\}$. Taxi k is initially located at point O_k and is available at time 0. A taxi may finish its route at any point and is not required to return to its initial location.

The company receives N passenger requests and M parcel requests. A request is either fully served or not served; partial service is not allowed. Each served request is assigned to exactly one taxi. The taxis must satisfy all time-window and parcel-capacity constraints.

The travel time and travel cost from point u to point v are denoted by $t(u, v)$ and $c(u, v)$, respectively. These values are given for every ordered pair of points. Travel times and costs are nonnegative, and they are not necessarily symmetric.

1.1 Passenger Requests

Passenger request i, $1 \leq i \leq N$, is specified by:

- pickup point P_i^n;
- drop-off point D_i^n;
- revenue T_i^n;
- pickup time window $[E_i^n, L_i^n]$;
- pickup and drop-off service duration S_i^n.

If taxi k serves passenger request i, let arrP_i^n be its arrival time at P_i^n. The pickup is feasible only if

$$\mathrm{arrP}_i^n \leq L_i^n.$$

The pickup service starts at

$$\mathrm{srvP}_i^n = \max\{\mathrm{arrP}_i^n, E_i^n\}$$

and finishes at

$$\mathrm{depP}_i^n = \mathrm{srvP}_i^n + S_i^n.$$

After pickup, the taxi travels directly to D_i^n. Between the pickup and drop-off of passenger i, the taxi may not visit or serve any pickup or drop-off point belonging to another request. In particular, no parcel may be picked up or delivered during this interval. Thus,

$$\mathrm{arrD}_i^n = \mathrm{depP}_i^n + t(P_i^n, D_i^n).$$

Drop-off service starts immediately upon arrival and finishes at

$$\mathrm{depD}_i^n = \mathrm{arrD}_i^n + S_i^n.$$

A taxi can transport at most one passenger at a time.

1.2 Parcel Requests

Parcel request j, $1 \le j \le M$, is specified by:

- pickup point P^h_j;
- drop-off point D^h_j;
- pickup time window $[E^{h,p}_j, L^{h,p}_j]$;
- drop-off time window $[E^{h,d}_j, L^{h,d}_j]$;
- pickup and drop-off service duration S^h_j;
- revenue T^h_j;
- parcel weight w_j.

For every served parcel, pickup and drop-off must be performed by the same taxi, and pickup must occur before drop-off. Let arrP^h_j be the taxi's arrival time at P^h_j. Pickup is feasible only if

$$\mathrm{arrP}^h_j \le L^{h,p}_j.$$

The pickup service starts at

$$\mathrm{srvP}^h_j = \max\{\mathrm{arrP}^h_j, E^{h,p}_j\}$$

and finishes at

$$\mathrm{depP}^h_j = \mathrm{srvP}^h_j + S^h_j.$$

The taxi eventually travels to D^h_j. Let arrD^h_j be the taxi's arrival time at D^h_j. Delivery service is feasible only if

$$\mathrm{arrD}^h_j \le L^{h,d}_j.$$

If the taxi arrives before the earliest delivery time, it waits until that time. Delivery service starts at

$$\mathrm{srvD}^h_j = \max\{\mathrm{arrD}^h_j, E^{h,d}_j\}$$

and finishes at

$$\mathrm{depD}^h_j = \mathrm{srvD}^h_j + S^h_j.$$

1.3 Taxi Capacity

Taxi k has parcel capacity Q_k. When parcel j is picked up by taxi k, the current load of that taxi increases by w_j. When parcel j is delivered, the load decreases by w_j. At every moment, the load must satisfy

$$\mathrm{load}_k \le Q_k.$$

Passenger occupancy does not contribute to this capacity constraint.

1.4 Routes and Travel Cost

A route of taxi k is an ordered sequence of visited points $R_k = (v^k_0, v^k_1, \dots, v^k_{m_k})$, where $v^k_0 = O_k$ is the initial location of taxi k (available at time $\mathrm{dep}(v^k_0) = 0$), and each subsequent $v^k_r \in \{P^n_i, D^n_i, P^h_j, D^h_j : 1 \le i \le N, 1 \le j \le M\}$ is a pickup or drop-off point of a served request. In other words, taxis do not need to return to depot after finishing their routes or while waiting for next requests.

For every two consecutive points $u = v^k_{r-1}$ and $v = v^k_r$ $(1 \le r \le m_k)$ in route R_k, the taxi spends $t(u, v)$ time units traveling from u to v and incurs travel cost $c(u, v)$. A route must satisfy all precedence, direct-passenger-trip, time-window, and parcel-capacity constraints. The total number of service nodes and taxi initial depots (vertices) in the network is $2N + 2M + K$.

2 Objective

Let S_N be the set of served passenger requests and let S_M be the set of served parcel requests. Let $R_k = (v_0^k, v_1^k, \ldots, v_{m_k}^k)$ be the route sequence of taxi k. The benefit of a schedule is

$$\begin{aligned} \text{Benefit} = & \sum_{i \in S_N} T_i^n + \sum_{j \in S_M} T_j^h \\ & - \sum_{k=1}^{K} \sum_{r=1}^{m_k} c(v_{r-1}^k, v_r^k). \end{aligned}$$

The goal is to compute a feasible schedule that maximizes Benefit. The company does not need to serve all passenger or parcel requests.

3 Example

An example of scheduled routes for two taxis is illustrated in Figure 1.

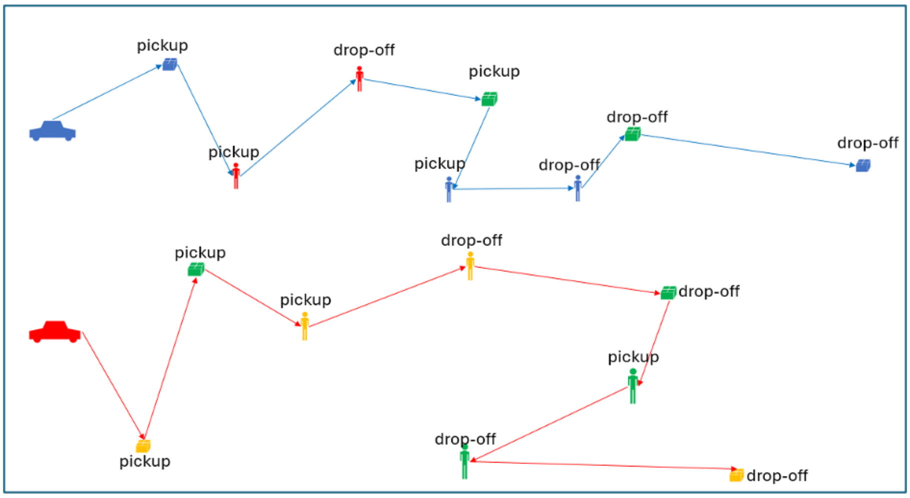

Figure 1: Illustration of scheduled routes for two taxis.