Online Supplements: The Stochastic Two-Echelon Production Routing Problem with Adaptive Routing

Ali Kermani, Jean-François Cordeau, Raf Jans
HEC Montréal, CIRRELT, and GERAD, 3000 chemin de la Côte-Sainte-Catherine, Montréal, H3T 2A7, Canada
ali.kermani@hec.ca, jean-francois.cordeau@hec.ca, raf.jans@hec.ca

This file contains supplementary materials for the paper titled "The Stochastic Two-Echelon Production Routing Problem with Adaptive Routing". It provides detailed information on how the instances were generated for both the deterministic and stochastic versions of the problem.

---

1 Instance Generation

In this section, we provide details on how we generated datasets for the two-echelon production routing problem. All instances are available in the repository at Instances Repository. To generate the new instances, we used the existing benchmarks from the PRP introduced by Archetti et al. (2011) and further modified by Adulyasak et al. (2014). For the stochastic instances, we also employed the logic presented by Adulyasak et al. (2015); however, some values were adjusted to reflect the differences between the problem addressed in this study and those in previous works.

Given the large number of instances provided by Archetti et al. (2011), we selected a subset to generate the deterministic 2EPRP instances. We considered four classes of instances: the standard cost setting, high production costs, high transportation costs, and no customer inventory holding cost. For each class, we used the first instance with 50 customers from the original dataset. Consistent with the original setup, the number of periods is set to 6 in all instances. We generated instances with 2 to 5 warehouses and with 10 to 50 customers, in increments of 10, resulting in $4 \times 16 = 64$ instances.

We also considered three different vehicle configurations for the plant and warehouses: (i) one vehicle at the plant and one per warehouse, (ii) two vehicles at the plant and two per warehouse, and (iii) two vehicles at the plant and three per warehouse. This leads to a total of $3 \times 64 = 192$ instances for the deterministic problem.

The production capacity at the plant was set as $C = 2\sum_{i\in\mathcal{N}_c}\sum_{t\in\mathcal{T}} d_{it}/T$, and the storage capacity at the plant was defined as $L_0 = C/2$, following the settings in Adulyasak et al. (2014). Since the original dataset does not provide information on warehouse nodes, we generated them synthetically. We first used the K-means algorithm to cluster customer nodes into w groups, where w corresponds to the number of warehouses in the instance. For each cluster, we identified the centroid and placed the corresponding warehouse randomly within a circular sector, located between 20% and 80% of the distance from the centroid to the farthest customer in that cluster.

After generating the warehouse nodes, we virtually assigned each customer to its nearest warehouse. That is, the set of customers virtually assigned to warehouse w is defined as

$$\mathcal{C}^w = \left\{ i \in \mathcal{N}_c \;\middle|\; w = \arg\min_{w'} (c_{w',i}) \right\}.$$

Based on this assignment, the warehouse storage capacity was sampled from a uniform distribution:

$$U\left[\frac{1}{T}\sum_{i\in\mathcal{C}^w}\sum_{t\in\mathcal{T}} d_{it},\ \frac{1.5}{T}\sum_{i\in\mathcal{C}^w}\sum_{t\in\mathcal{T}} d_{it}\right].$$

The inventory holding cost for warehouses was drawn from an integer uniform distribution $U[3,6]$.

Finally, the capacity of vehicles at the plant was determined using the following formula:

$$Q^p = \left\lfloor \frac{\gamma \overline{\overline{L}}}{K_p} \right\rfloor \tag{1}$$

where $\gamma = \left\lfloor \frac{N_c}{10} + 1 \right\rfloor$ and $\overline{\overline{L}} = \max_{i\in\mathcal{N}_c}\{L_i\}$. The capacity of each vehicle at the warehouses was calculated as:

$$Q^w = \max\left\{ \overline{\overline{L}},\ \frac{\gamma \overline{\overline{L}}}{N_w K_w} \right\} \tag{2}$$

References

Y. Adulyasak, J.-F. Cordeau, and R. Jans. Formulations and branch-and-cut algorithms for multivehicle production and inventory routing problems. *INFORMS Journal on Computing*, 26(1):103–120, 2014. doi: 10.1287/ijoc.2013.0550.

Y. Adulyasak, J.-F. Cordeau, and R. Jans. Benders decomposition for production routing under demand uncertainty. *Operations Research*, 63(4):851–867, 2015. doi: 10.1287/opre.2015.1401.

C. Archetti, L. Bertazzi, G. Paletta, and M. G. Speranza. Analysis of the maximum level policy in a production-distribution system. *Computers & Operations Research*, 38(12):1731–1746, 2011. doi: 10.1016/j.cor.2011.03.002.