Dynamic snow ploughing on a rolling horizon basis

Georg E. A. Fröhlich

Department of Business Decisions and Analytics, University of Vienna, Austria

Email: georg.erwin.adrian.froehlich@univie.ac.at

Margaretha Gansterer

Department for Operations Management and Logistics, University of Klagenfurt, Austria

Karl F. Doerner

Department of Business Decisions and Analytics, University of Vienna, Austria

Data Science @ University of Vienna

Snow ploughing is a relevant real-world problem that is often studied in a non-urgent, static fashion, where plans are created offline. Research regarding more dynamic versions, such as severe snowstorms that threaten to shut down the whole infrastructure and quickly replenish the amount of snow, are not well studied. We aim to close this gap by focusing on a dynamic model, where a snowstorm is currently taking place and the precise amount of snowfall, and its trajectory are not known. Our aim is to keep the street network reasonably secure during the storm. Whether a street segment is deemed secure, is determined by the piled-up snow. For the overall security of the street network, we weigh individual street segments according to the importance (e.g., high weights for main roads, access streets to hospitals).

To tackle this, we implement a metaheuristic that is required to deliver good solutions within a limited computation time and to adapt to the current state of the system and new data – our method of choice here being an adaptive large neighbourhood search (ALNS). New plans are created as a rolling horizon, using predictions based on the current state and the snowfall, to account for sudden changes.

Since our problem characteristics are not fully comparable to other published results, we benchmark the proposed ALNS against classical benchmark instances for the team orienteering arc routing problem (modified Hertz instances by Archetti et al. [1]), where we can show that percentage gaps to the optimal/best found solutions are neglectable. Furthermore, we run with tests on real-world-based instances using the data from the city of Vienna (Austria). Instances are created based on the city's districts, where we cover about 8,000 arcs. Different snowstorm movements, updating times, and prediction schemes are applied to derive profound managerial insight.

References

[1] C. Archetti, M. Speranza, Á. Corberán, J. Sanchis, and I. Plana, "The Team Orienteering Arc Routing Problem", *Transportation Science* 48(3), 442-457, 2014.