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Inventory Monitoring in a Petrol Refinery via Data Reconciliation

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A typical inventory infrastructure in a refinery consists of a multitude of interconnected technological blocks with an extensive network of liquid storage tanks. Although measurements of input and output flows to some of these blocks and tank levels might be available, the precise flows to, from, and between individual storage tanks are not necessarily directly metered.
The goal of this work is to design a data reconciliation system coupled with mass balance to estimate the incoming, interconnecting, and outflowing streams for product storage tanks in the Slovnaft refinery, an industrial partner. We use mixed-integer quadratic programming (MIQP) to mathematically formulate the reconciliation problem using all known connections between tanks and physical laws, such as mass balances. The advantage of this method is the inclusion of binary variables, which naturally allows us to model behaviours where a stream can either enter a tank or not, and the outflow from a tank can enter only one specific block stream. This was implemented using YALMIP in MATLAB, specifically the Gurobi solver.
Subsequently, we used the optimisation results to train a feedforward neural network in order to achieve similar results in reduced central processing unit (CPU) time for real-time reconciliation. The neural network was also implemented in MATLAB.
The results showed that the neural-network-based optimiser was able to find the solution successfully for 98% of the given data, significantly lowering the measurement noise. The neural network model achieved high accuracy, with a correlation coefficient of 0.9982, and generated solutions 300 times faster on average than the optimiser.
In conclusion, this solution radically improves the accuracy of refinery monitoring, detects systematic errors, and demonstrates that neural networks are suitable tools for the use in real-time optimisation.

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