Aalto-yliopisto
Perustieteiden
korkeakoulu

Alternative distance functions for change minimization in manufacturing network optimization

Tuomas Ojavuo

16.06.2023

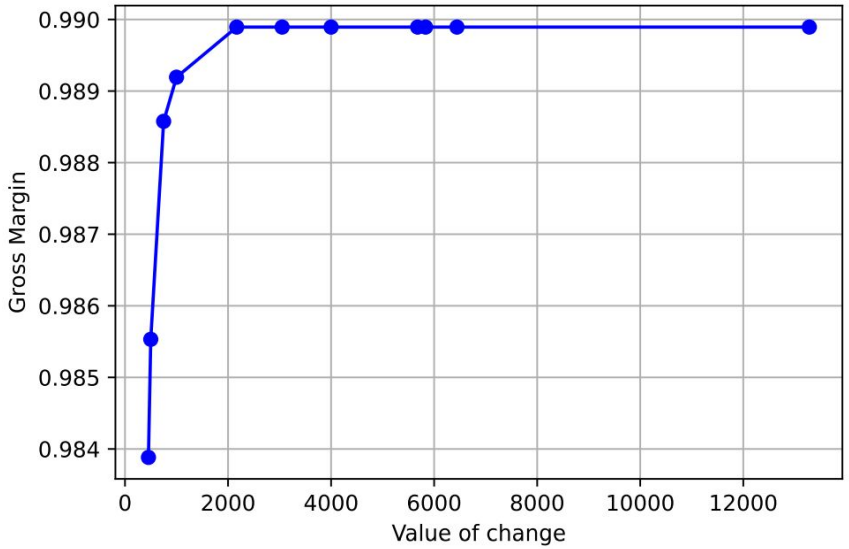
Advisor: *DI Tuomas Suominen*
Supervisor: *Prof. Fabricio Oliveira*

Systeemianalyysin
laboratorio

Background

Bi-objective model for optimizing a renewable fuel production network

- First objective: maximize gross margin
- Second objective: minimize deviation from the reference plan
- Uses the ε-constraint multi-objective method



Reference: *Vuola: Bi-objective model for scenario optimization of a manufacturing network (2022)*

Current distance function

- Change minimization objective uses the L_1 norm for measuring the change in material flow across all arcs
- L_1 norm does not adequately represent the real-life phenomena

$$\mathbf{x} = \begin{pmatrix} 2 \\ 2 \\ 3 \\ 2 \\ 0 \\ 10 \end{pmatrix}, \mathbf{y} = \begin{pmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 0 \\ 20 \end{pmatrix} \Longrightarrow \begin{aligned} ||\mathbf{x} - \mathbf{y}||_1 &= \sum_{i=1}^{6} |x_i - y_i| \\ &= |2-1| + |2-4| + |10-20| \\ &= 13 \end{aligned}$$

Goals

- Develop a method that incorporates the number of individual changes to the volume of change and preferably combines them into the same objective function
- Implement, test and report

Possible approaches

- Incorporating the number of changes to the existing change minimization function
  - advantage: directly implementable to the existing model
  - challenge: setting weights for the two functions

- Adding a third objective function containing the number of changes
  - advantage: no need to set weights for the two functions
  - challenge: requires additional changes to the existing model and increases solving time, difficult to visualize in 2D

- Using the number of changes as a constraint
  - advantage: no need to set weights for the two functions
  - challenge: setting a specific number of changes we can tolerate

Methods

- Literature review
- Implementation in Python, using production model and test data set provided by client company

Key dates

- Presentation of the topic: June 2023
- Implementation of the algorithm: by August 2023
- Writing the thesis: June-August 2023
- Results and the thesis ready: September 2023

Literature and references

- Vuola: Bi-objective model for scenario optimization of a manufacturing network (2022)
- Fang, S. C., Qi, L.: Manufacturing network flows: A generalized network flow model for manufacturing process modeling (2003)
- Miettinen, K.: Nonlinear multiobjective optimization (2012)
- Ehrgott, M., Ruzika, S.: Improved ε-Constraint Method for Multiobjective Programming (2008)
- Theodoridis, S., Koutroumbas, K.: Pattern recognition (2006)