Internship Proposal: Symbolic Data Analysis for robustness and flexibility of Heat Exchanger Network

March 12, 2020

Project

The performance of an industrial site is greatly dependent of process variations and its ability to satisfy the operational specifications under exogenous disturbances. The Internship subject is about Heat Exchanger Network (HEN) sensibility and flexibility modeling and analysis. Flexibility of the HEN is one of factors which affect the operability of the system. Sensibility analysis investigates how the variation in the output of a model can be attributed to variations of its input factors. Numerous works are dedicated to the design of HEN for nominal operating systems. However, the operability aspects of such networks have not been extensively studied.

The robustness of such systems is determined by its ability to absorb disturbances without changing the flow rates of utilities. Since the early 80's, studies were carried out on the flexibility aspect of HEN to solve the operability issue with works such as Saboo et al. (1985) [2] and Swaney and Grossmann (1985) [3] that use non-linear programming (NLP) to optimize flexible HEN.

Using linear programming, Floquet et al. (2016) [1] introduced a methodology based on interval arithmetic concepts for modeling impacts of process parameters fluctuations on the behavior of the HEN. Assuming that some parameters can vary on an interval [min, max], a linear system can be solved where the left term involves interval matrices (fluctuations of the HEN characteristics, except topology) and right hand side involves fluctuations of input temperature of the HEN. Following the same idea, the project aims is the use symbolic data analysis (SDA) to study how uncertainty in the output of a model can be apportioned to different sources of uncertainty in the model input factors. The choice of SDA is that it can offer an efficient and effective way of knowledge extraction from correlated sources of uncertainty.

The main objective of the internship is to acquire a mechanistic understanding of Robustness aspects of HEN using symbolic data analysis. Targeted student will work

towards a tool that in the long term would ease a lot the conversion of Mathematical real algorithm description into Python/Julia/R, or Matlab fix point computations.

Qualifications / Requirements

1. Currently, enrolled in Master-level degree program
2. Student with a strong interest in data analysis
3. Some knowledge of Symbolic Analysis techniques and/or arithmetic will be appreciated
4. Demonstrates effective written and oral communication, integrity, critical thinking/analytical skills, agility/flexibility, a continuous learning mindset and teamwork and collaboration

Duration:

4 months

Fee covered:

Internship allowances

Contact

Rachid OUARET (rachid.ouaret@toulouse-inp.fr). Please send me your application (resume and cover letter).

References

[1] Pascal Floquet, Gilles Hétreux, Raphaele Hétreux, and Lucille Payet. Analysis of operational heat exchanger network robustness via interval arithmetic. In *Computer Aided Chemical Engineering*, volume 38, pages 1401–1406. Elsevier, 2016.

[2] Alok K Saboo, Manfred Morari, and Duncan C Woodcock. Design of resilient processing plants viii. a resilience index for heat exchanger networks. *Chemical Engineering Science*, 40(8):1553–1565, 1985.

[3] Ross E Swaney and Ignacio E Grossmann. An index for operational flexibility in chemical process design. part ii: Computational algorithms. *AIChE Journal*, 31(4):631–641, 1985.