

Resilience Assessment of Water and Heat Supply Network using a Knowledge Graph

Master Thesis

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What is the challenge?

A significant part of city dwellers relies on the daily availability of water and heat supply networks. Whether these networks are able to fulfill their function depends on a great number of factors, ranging from engineering-related to environmental and geopolitical. One approach to consider such a vast number of factors in the design and operation of networks is *resilience*. Being a complex property, the assessment of resilience is a challenging task.

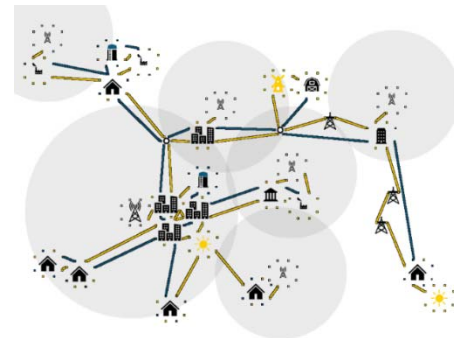


Fig. 1: Parallelity of critical infrastructure

How do we solve it?

To date, state-of-the-art literature propose different methods to measure and assess the resilience of critical infrastructure, such as water network, electrical grid or district heating network [1–3]. However, a comprehensive comparison and validation of different resilience metrics has not been performed with real-world data. Hence, at the Chair of Fluid Systems and in cooperation with the Pattern Recognition Lab at Friedrich-Alexander University Erlangen (FAU), we want to assess resilience of real-world water and district heating networks using heterogenous data from a utility company. Moreover, we want to identify parameters/data that are relevant for resilience assessment and use these for knowledge modelling based on a knowledge graph. If possible, we also want to account for interdependencies and analogies between the two systems. This way, we want to lay the foundation for resilience assessment of piped networks.

How can you contribute?

You will lead the data analysis project from the very beginning to the end. In the first step, you will inspect the raw data from the provider and transform them into a format suitable for further analysis. Then, you will identify, evaluate and compare suitable resilience metrics. You will study which parameters of the network and data are important for resilience assessment and use the results to create a knowledge graph in the graph database neo4j.

What do we offer?

You will get a thorough experience in data analysis and knowledge modelling in Python and using the graph database neo4j. Working with an interdisciplinary group, we will provide you insights into the field of resilience and critical infrastructure. You will also learn about efficient data management and versioning with Git, as well as improve your communication and presenting skills.

We can discuss the focus and tasks together in an interview over Zoom. Please contact us per mail if you have any questions.

References

- [1] Gasser, Patrick, Lustenberger, Peter, Cinelli, Marco, Kim, Wansub, Spada, Matteo, Burgherr, Peter, Hirschberg, Stefan, Stojadinovic, Božidar, and Sun, Tian Yin. "A review on resilience assessment of energy systems." *Sustainable and Resilient Infrastructure* (2019): pp. 1–27. DOI 10.1080/23789689.2019.1610600.
- [2] Liu, Wei and Song, Zhaoyang. "Review of studies on the resilience of urban critical infrastructure networks." *Reliability Engineering & System Safety* Vol. 193 (2020): p. 106617. DOI 10.1016/j.ress.2019.106617.
- [3] Shin, Sangmin, Lee, Seungyub, Judi, David, Parvania, Masood, Goharian, Erfan, McPherson, Timothy, and Burian, Steven. "A Systematic Review of Quantitative Resilience Measures for Water Infrastructure Systems." *Water* Vol. 10 No. 2 (2018): p. 164. DOI 10.3390/w10020164.