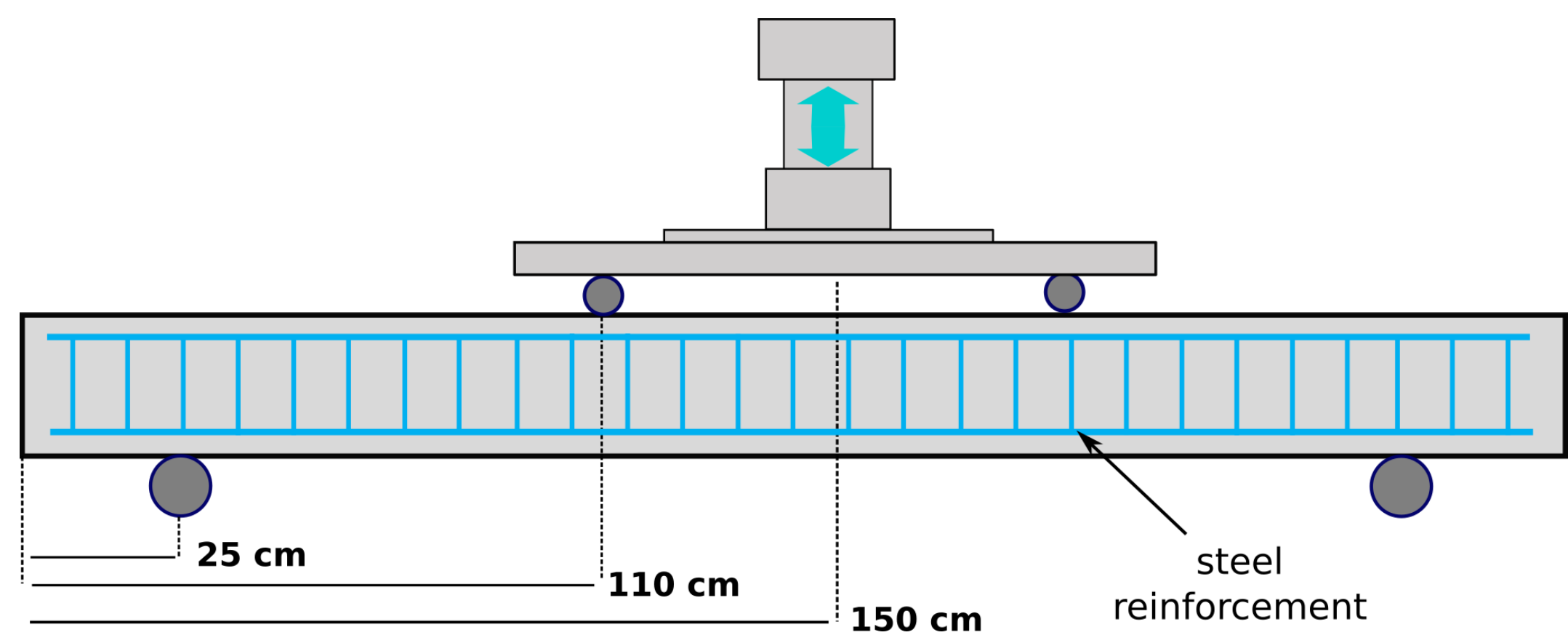


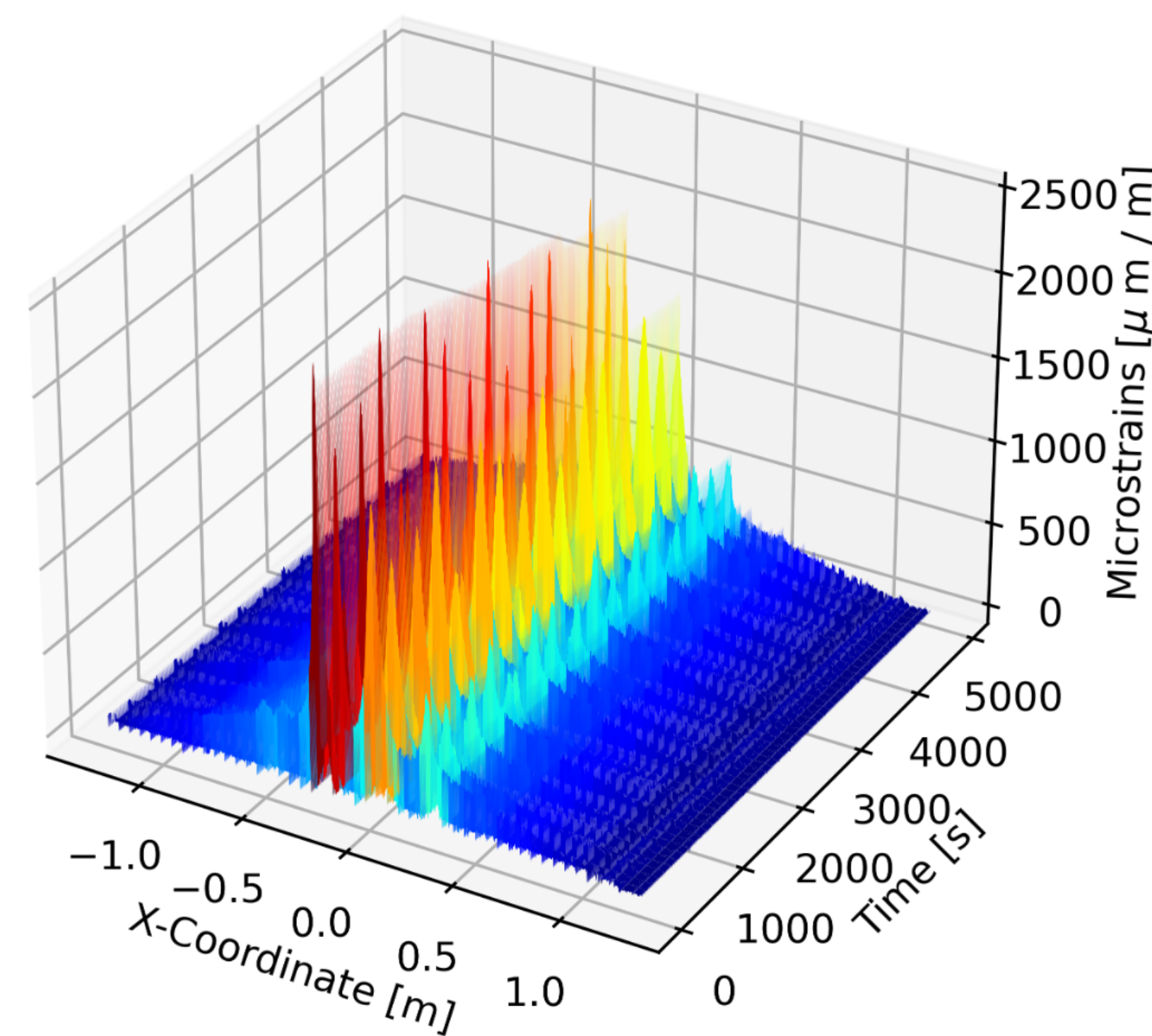
Crack Detection Problem

- Four-point bending test with a cyclic load on a steel-reinforced concrete beam specimen.
- The analysis is divided into two components: fixed-time and fixed-position.
- Fixed-time → Evaluate the extreme values over all the beam measurements.
- Fixed-position → Time series analysis of specific points of the beam.



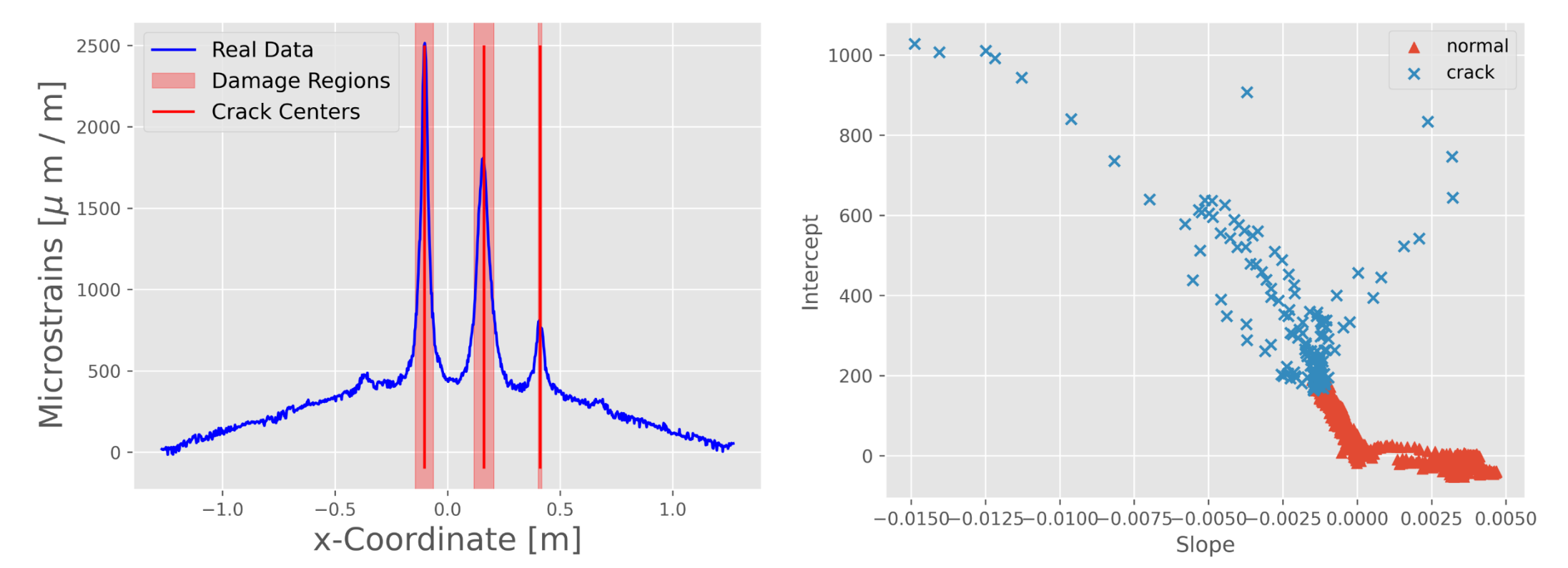
Braml, Thomas, et al. „Erfordernisse an die Datenaufnahme und -verarbeitung zur Erzeugung von intelligenten Digitalen Zwillingen im Ingenieurbau.“ In Innsbrucker Bautage 2022 (eds Berger, J.) (Studia, 2022), 31-49.

Methodology



Milani, Rudy, et al. „Automatic concrete bridge crack detection from strain measurements: a preliminary study.“ International Conference on Critical Information Infrastructures Security. Cham: Springer Nature Switzerland, 2022.

Results and Future Works



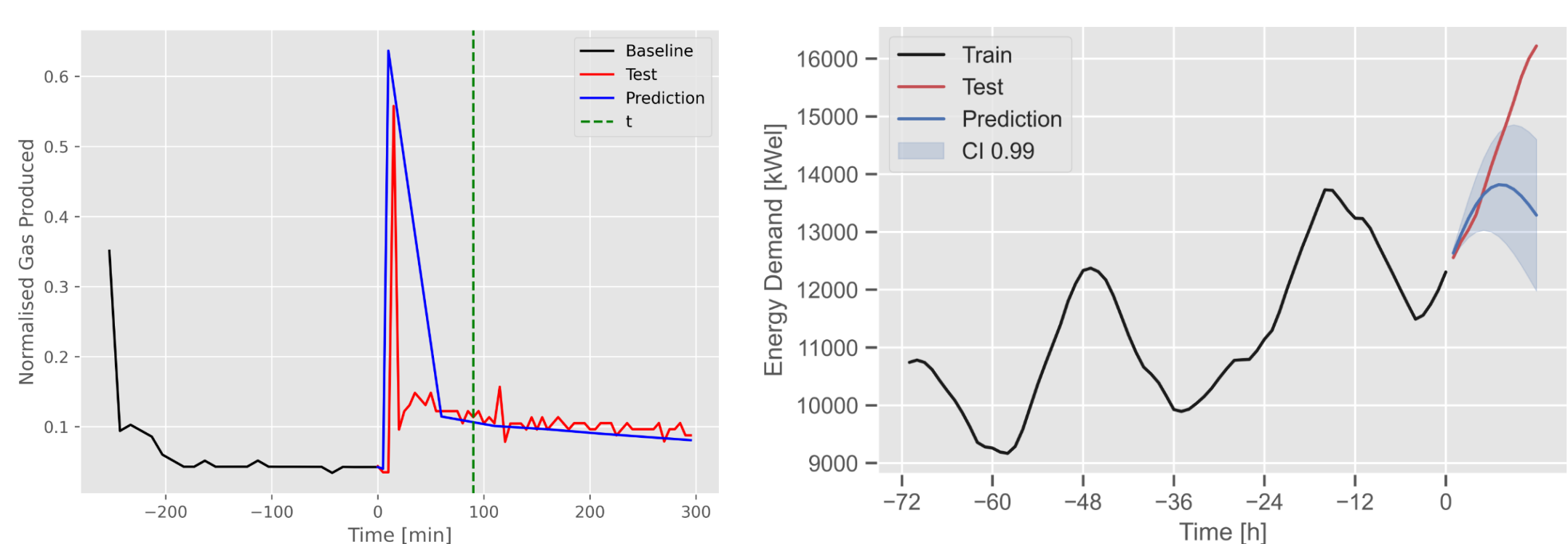
- Fixed-time results → 80% cracks identified in different loading cycles (fixed parameters).
- Fixed-position results → simple rule for damaged regions through linear approximation of trend.
- Future Work → Find general rule for parameter settings.

Biogas Problem

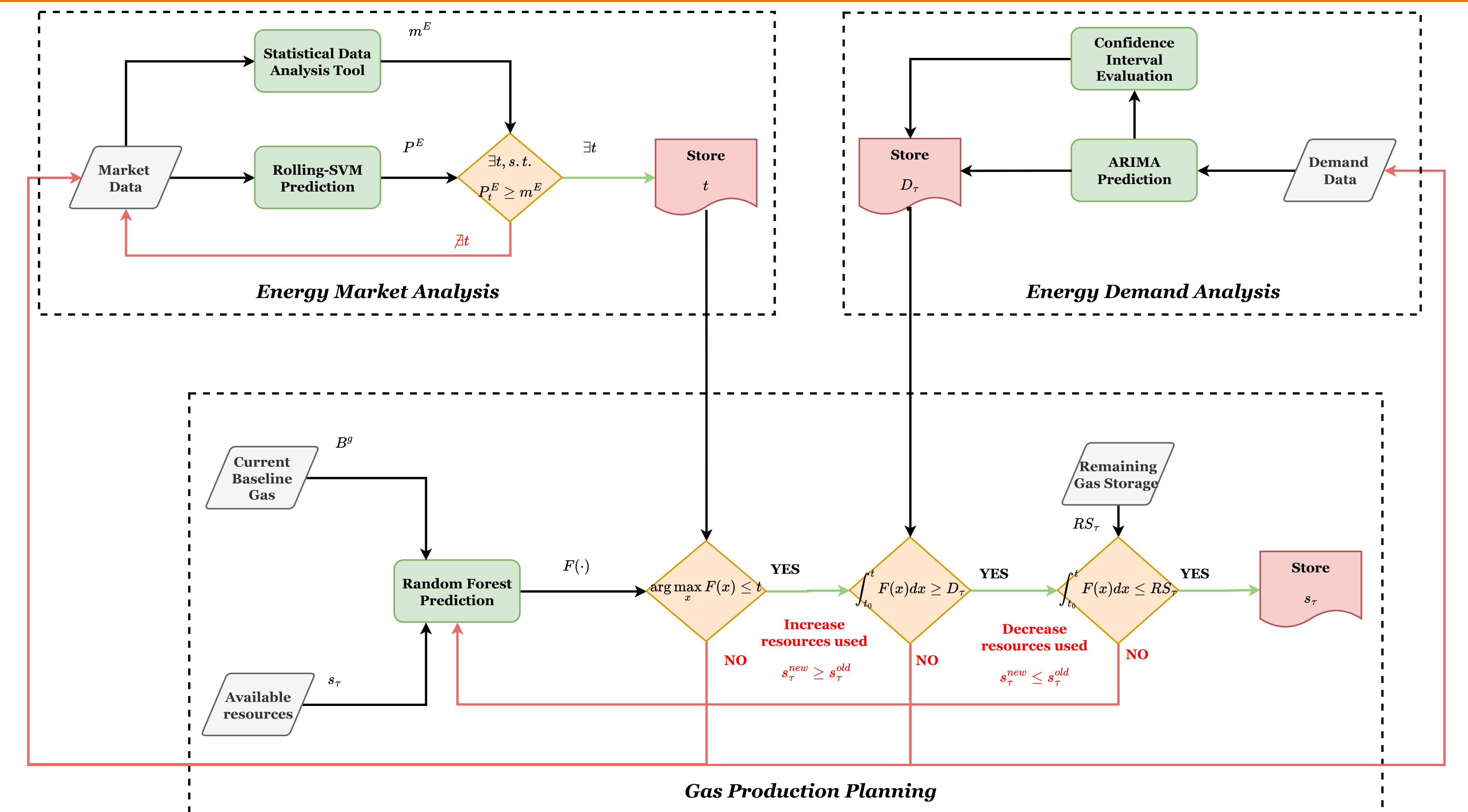
Optimization of the Biogas production scheduling considering:

1. Biogas production estimation → Good approximation of gas curve ($R^2=0.92$)
2. Hourly energy market prices forecasting → Decent Rolling output first hours ($R^2= 0.94, 0.86, 0.78$)
3. Energy demand prediction → To improve hourly demand identification ($R^2=0.80$)

Results and Future Works



Methodology

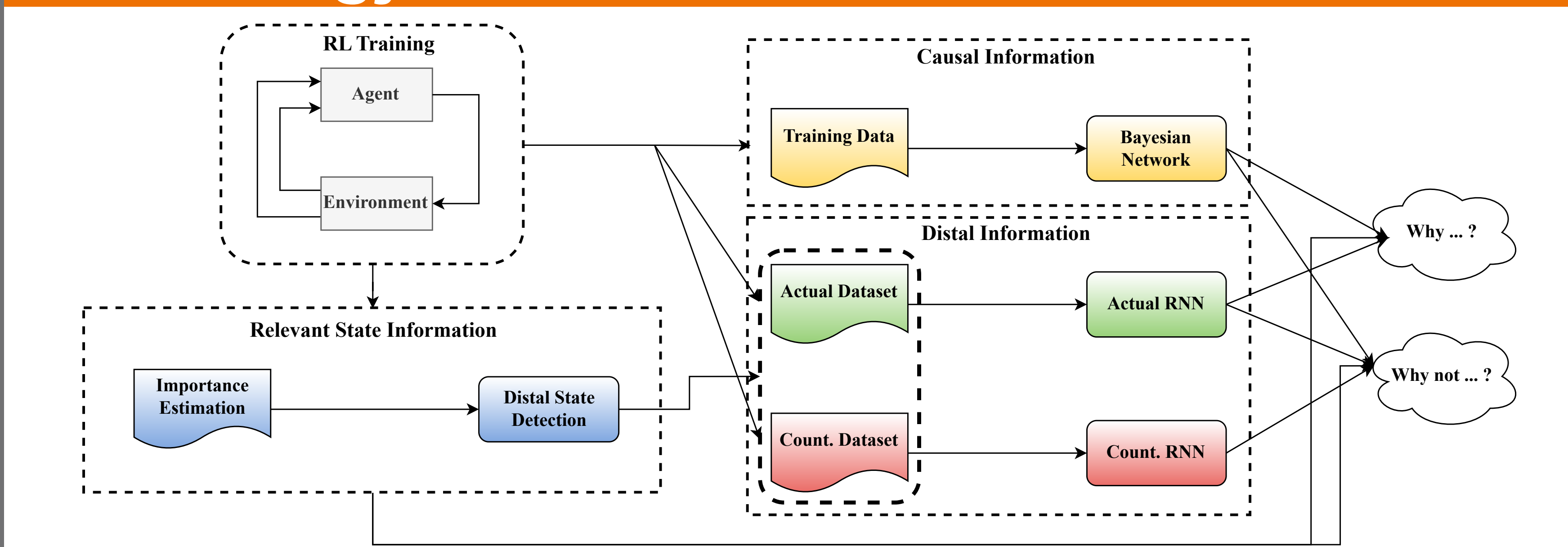


Explainable RL in Digital Twins

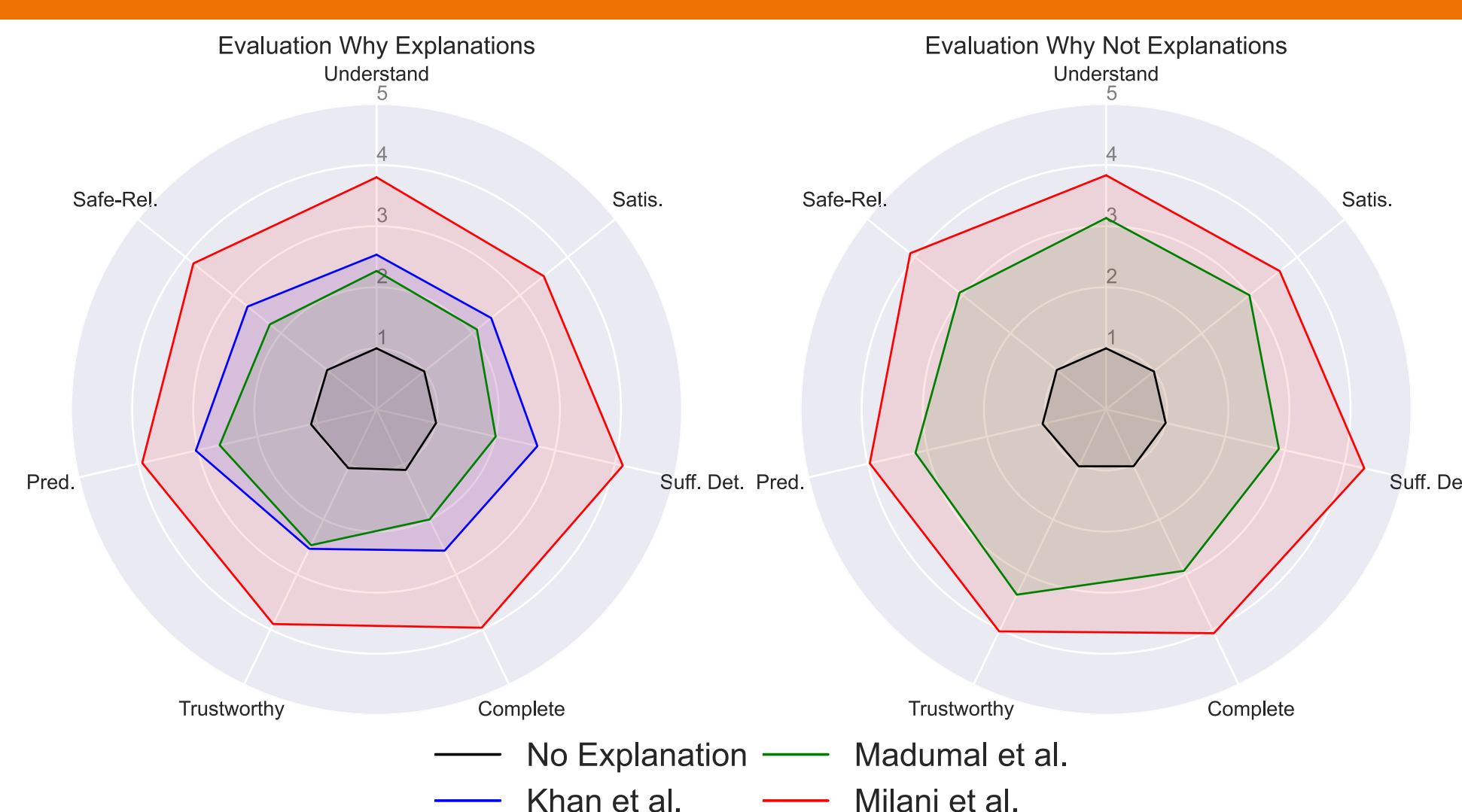
- Reduction of the residual errors between virtual representations and the physical systems
- Difficult to comprehend → Novel automatic explainable approach:
 1. Bayesian Network → Causal reasoning
 2. Recurrent Neural Networks (RNNs) → The distal information (data enabled by chain of actions)
 3. Importance metrics → Relevant information recognition

Milani, Rudy. „Towards an Automatic Ensemble Methodology for Explainable Reinforcement Learning.“ 2024 IEEE 14th Annual Computing and Communication Workshop and Conference (CCWC). IEEE, 2024.

Methodology



Results and Future Works



- Computational results on Taxi → Accuracy 99.88% (Literature best 86.19%)
- Human evaluation → Best average scores and statistically significant differences (7/7 for „why“ and 3/7 for „why not“)
- Future works → Engineering and robotics applications

Milani, Rudy, et al. „A Bayesian Network Approach to Explainable Reinforcement Learning with Distal Information.“ Sensors 23.4 (2023): 2013.