

MSc thesis or Study project proposal

Sensitivity Analysis for Sequential Decisions

Motivation and Objectives

Effective maintenance planning is essential to ensure infrastructure reliability, safety, and long-term performance. However, such planning often relies on simulation models, which may fail to fully capture real-world conditions; a problem commonly known as the simulation-to-real gap. Advanced decision policies, such as Deep Reinforcement Learning (DRL), have shown promise in this domain, but their performance can degrade significantly when deployed in environments where key modeling assumptions do not hold. Making models more accurate is challenging, often requiring richer real-world data and adjustments to the model's design. Understanding which information actually drives decisions can help prioritize what to measure or model more carefully. For example, consider a railway inspection: if we examine the state of one rail, which other rail should we inspect before deciding on maintenance? Should we inspect any additional rails at all? Can maintenance be postponed, or is immediate action required?

The goal of this project is to identify which pieces of information most strongly influence maintenance decisions. We will focus on a straightforward sequential decision problem and explore how the expected value of partial perfect information (EVPI) can guide information prioritization.

Methodology

- Literature review on sequential decision making and EVPI
- Implementation of sequential EVPI in Python
- Comparison with online learning methods

Requirements

- Solid programming skills (Python preferred)
- Risk analysis, reliability analysis

Starting date

Flexible, as soon as possible

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References

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- Theresa Hefele, Daniel Hettegger, and Daniel Straub. Investigations on the sim-to-real gap in predictive maintenance planning for infrastructure systems. Technical paper, Technical University of Munich, 2026.
- Daniel Straub, Wolfgang Betz, Mara Ruf, Amelie Hoffmann, Angela Landgraf, Lea Friedli, and Iason Papaioannou. Sensitivity measures for engineering and environmental decision support. *arXiv preprint arXiv:2507.08488*, 2025. URL <https://arxiv.org/abs/2507.08488>.