Bachelor/Master Thesis

Karlsruher Institut für Technologie

Institut für Programmstrukturen und Datenorganisation (IPD)
Lehrstuhl für Systeme der Informationsverwaltung, Prof. Böhm

**Bachelor/Master Thesis**

# Explainable Artificial Intelligence for Decision Support

Decision-makers, such as managers and politicians, face a continuous need to make decisions that, in the end, will affect future company revenues, society welfare, lead to a global catastrophe or allow to avoid it: Which airport development strategy is desirable? How to get prepared for possible mineral scarcity? When and how the global energy system can/should arrive at a low-carbon emissions state?

Computer simulations in conjunction with Machine Learning (ML) methods can help find admissible decisions given a highly uncertain future [1]. A popular approach to do so is "scenario discovery" [2]. It consists of simulating the future for many different states of the world (combinations of inputs values of a simulation model) and identifying those resulting in an acceptable outcome of the proposed decision. Scenario discovery yields a set of rules like the following:

```
IF population_growth_pace < 1%
AND volcanic_activity < 10 units
THEN Earth_temperature_increase is < 1.5
```

Many methods from the explainable artificial intelligence (XAI) domain can learn such rules. However, only PRIM and CART were used so far. This thesis aims to identify suitable XAI methods and perform a user study to assess their practical usability for scenario discovery.

This results in the following tasks:

- Literature review focusing on rule-producing ML methods.
- Proposing and implementing a framework to compare these methods.
- Collecting data and methods' implementations, e.g., from here[a].
- Extensive experiments involving a scenario discovery expert to evaluate the outcome.
- Proposing a scenario discovery tool based on the expert's feedback

To successfully conduct this thesis project, the student must possess:

- Knowledge of programming, Python in particular. A strong interest in Data Mining.
- The ability to plan and work independently. Working knowledge of English.
- A high level of motivation, enthusiasm, and curiosity.

To help you with this task, we offer:

- Thorough mentoring and recurrent meetings with your advisor.
- Access to our institute's computing infrastructure (if required).
- Established collaboration with a scenario discovery expert.
- Help in publishing parts of your results in peer-reviewed scientific journals/conferences.

During this work, the student will acquire practical experience in Machine Learning, XAI in particular, and make a real contribution to decision support tools. The student will also participate in a collaboration with a scenario discovery expert (the first author of [1]), who will provide feedback on results.

[1] J. H. Kwakkel and E. Pruyt. "Exploratory Modeling and Analysis, an approach for model-based foresight under deep uncertainty". In: *Technological Forecasting and Social Change* 80.3 (2013), pp. 419–431.
[2] V. Arzamasov and K. Böhm. "REDS: Rule Extraction for Discovering Scenarios". In: *SIGMOD Conference*. ACM, 2021.

[a] KEEL software and GitHub repository

**Ansprechpartner**

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