Universität Stuttgart
Institut für Kernenergetik
und Energiesysteme

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und Reaktorsicherheit

Student Project

AI-Guided Counterfactual Analysis and Inverse Design of Debris Bed Coolability

Title:
AI-Guided Counterfactual Analysis and Inverse Design of Debris Bed Coolability

Description:
This project investigates how the position of a low porosity, high density cake region affects debris-bed coolability. Selected simulations from the existing database will be used as reference cases. For each case, only the cake position parameters will be shifted together, keeping cake properties, and all other parameters unchanged.
The resulting simulations will be analysed to determine favourable cake positions, and coolability. A machine-learning surrogate will be trained to predict coolability outcome from cake position and properties. The surrogate will then be queried using counterfactual analysis to identify the minimum position change required for quenching and generalize favourable cake positions across different debris-bed conditions.
Active learning may be used to efficiently identify critical cake-position ranges.

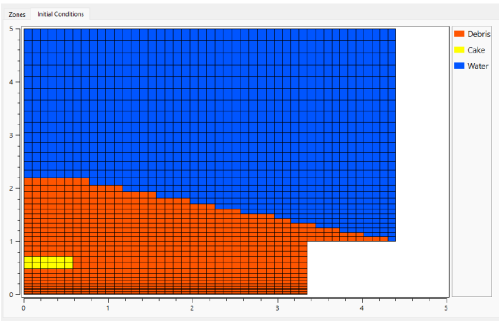

Image: Cake region within a debris bed, modelled using COCOMO-3D

Approach:
- Generate cake-position variants from reference cases
- Analyze coolability vs. cake position
- Train surrogate model for outcome prediction
- Apply counterfactual analysis for minimum position change
- Validate against already-Quenched cases

Requirements:
- Good written and spoken English
- Strong Python and programming skills
- Interest in machine learning and computational physics
- Independent and structured way of working

Start: Immediately or by arrangement

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