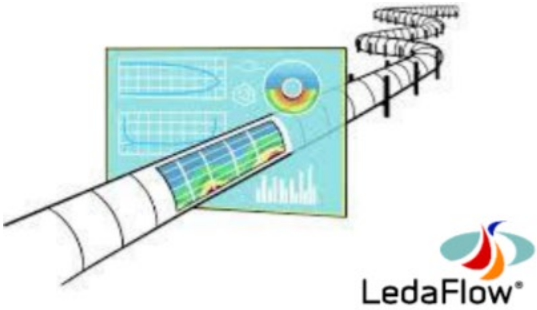
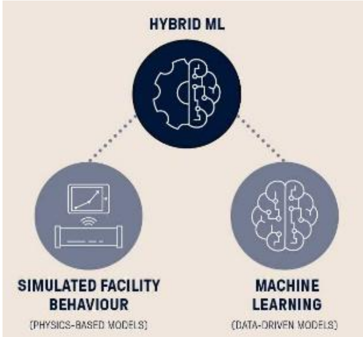
Hybrid Machine Learning





Company description:

Kongsberg Digital (KDI) is a leading provider of software and digital solutions to customers within the maritime, oil & gas, and renewables & utilities industry. We are more than 500 software experts working within internet of things, smart data, machine learning, automation and autonomous operations. Kongsberg Digital is the group-wide centre of digital expertise for KONGSBERG, and the Analytics team in Kongsberg Digital is the Centre of Excellence in machine learning and related methodology for the whole KONGSBERG group.

Problem description:

The main goal of this research project is to explore the possibilities and limitations for transfer learning based on simulated data. Relevant research questions are:

- In which situations can machine learning model successfully be trained on similar/synthetic data and then transferred to actual data?
- How similar must the data be for transfer learning, and what is the inherent uncertainty induced by the differences between actual and synthetic data?

The developed methodologies and results may be general, but the provided data will be will from process simulator tools (K-Spice/LedaFlow) and multiphase flow phenomena in the oil-and-gas industrial sector.

Problem Motivation: Hybrid Machine Learning

ML has pervaded a vast portion of human activities with unprecedent performance, especially in the case of deep neural networks. However, even robust models tend to fail when in extrapolation mode (i.e. working outside the domain explored during the training phase) and such events become more frequent when the input space grows large. Also, lacking an explicit framework for uncertainty assessment is not suitable for industries with safety-critical and/or economically impactful issues and may prevent ML models from being fully exploited in maritime industry, O&G and renewable energy.

Hybrid Machine Learning aims to overcome some of these issues through enhancing and constraining data driven models by incorporating knowledge of the physical world using high fidelity simulators. One the one hand, data driven models have some advantages over first principle models, as they can learn statistical dependencies of unmodeled dependencies and run inferences orders of magnitude faster than the simulators. On the other hand, physical models still have several advantages in terms of robustness and transparency facilitating the use in the real world. The goal of Hybrid Machine Learning is to combine the benefits of both data driven models and physical simulators.

Tasks

- Literature review on Hybrid Machine Learning, transfer learning methods and uncertainty estimation of models
- Investigate methods for quantifying data similarity
- Implementation and evaluation of a few selected candidate algorithms
- Evaluation of the feasibility, benefits and challenges of hybrid machine learning in industrial processes.

Desired background:

- Strong programming skills (preferably Python)
- Strong understanding of statistical modelling, probability and inference
- Basic understanding of traditional ML techniques (including neural networks)
- Basic familiarity with process engineering is an advantage (not required);

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