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**Project Title:** Smart Proxy Models for Reservoir Simulation

**Long Description**

**Background**

Traditional reservoir simulation starts with building a geological model of the reservoir from static data followed by adding fluid flow principles to arrive at a dynamic reservoir model. The dynamic reservoir model is then calibrated using the production history and used for field development in order to improve the recovery. However, the real-time measurements of rates, pressures, and temperatures is changing this routine. The massive computational footprint of numerical simulation models limits their application for detailed analyses, uncertainty quantification, and optimization. In data-driven reservoir modeling, instead of a model which is built based on our understandings, data will be the main building block of the models. These models are built much faster than numerical simulation models.

**Goal of the project**

The shortcoming of the data-driven reservoir model is that it only applies to brown fields where reasonable amount of data is accessible. Also, it is valid just until the physics of the problem is not changed. For example, when an enhanced oil recovery (EOR) method is applied after the primary recovery, the model is not valid anymore and should be trained again. In such cases, the database is constructed from the numerical reservoir simulation data and the model is called a Smart Proxy Model (SPM). SPM is therefore a replica of a reservoir simulation model that runs in real-time. SPM is developed utilizing the pattern recognition capabilities of artificial intelligence and machine learning and is trained to adaptively learn fluid flow from a complex reservoir simulation model. It provide results such as well pressure and production profiles or pressure and saturation distribution throughout the reservoir in real-time.

One of the objectives of the proposed project is improving the fundamental understanding of data-driven modeling that is replacing the traditional reservoir modeling. Modelling fluid flow is of high interest in many industries and can obviously benefit from smart proxy modelling. The final goal of this project is the application of smart proxy modeling in reservoir simulation. Selected field data will be used for training the SPM in order to mature the methods and applications. This needs extensive research, verification, and testing. The approach combines numerical simulation and data-driven techniques. Using SPM, models may be updated in real-time, creating realistic opportunities for real-time reservoir management in smart fields. The fact that thousands of SPM runs can be performed in seconds makes uncertainty analysis a practical task. This allows the uncertainty associated with any decisions to be identified quickly. We intend to build proxies of numerical reservoir simulation models that run quickly and reproduce highly accurate pressure and saturation changes at the gridblock level for fast history matching and field development planning. Proxy models can be further extended for application in:

- Well test analysis, instead of using well test sector models and local grid refinement. The objective here will be to apply machine learning techniques and proxy models to interpret flow rate, pressure and temperature data from permanent downhole gauges in real-time
- EOR processes or the cases with significant physics change
- Multi-scale simulation and upscaling.

**Motivation**

Advances in computing methods promote use of cluster computing and automation, and computer-assisted methods are gaining popularity. This will allow for greater interactions and improvements in understanding reservoir uncertainties for optimized field development. The current project aims at
digitization and optimization of the production for real-time reservoir management. This will increase hydrocarbon production efficiency, and will unlock reserves in existing fields. The research will address fundamental studies of a modeling approach not yet fully developed and contributes to find a novel method that will replace the traditional reservoir simulation.

The project leader will hire a PhD candidate soon to work closely with several master students (and other PhD candidates) on this topic. This Postdoc position will collaborate with them for a mutual benefit and more interaction and extension of the research group of the project leader. Additionally, it provides the opportunity to publish the results and obtain a thorough peer validation of the results, models and methods proposed. The candidate and the project leader will actively seek broad dissemination of the results through peer-reviewed journals. The published project results may also become available to students as a part of additional teaching material (research-based teaching) or be used in supervision of master students interested in the topic.

This Postdoc project will hopefully promote collaboration with BRU21 (Better Resource Utilization in the 21st Century) project in the field of reservoir modelling and simulation to identify the potential for improving efficiency, with the aim of reducing costs. Multidisciplinary collaboration across NTNU is promoted, as interaction with several departments involved in BRU21 (such as ITK) will be established. The research and innovation program in Digital and Automation Solutions for O&G provides a bridge between petroleum engineering & digital and automation. This project will also exchange ideas with PoreLab (SSF) that focuses on the fundamental studies regarding the physics of porous media using experimental, theoretical and computational methods. This is vital for implementing the appropriate fluid flow in the models at different scales, and especially in the case of EOR processes with complex physics involved.

Based on the new findings, future project proposals for increased funding and activity (PhD and Postdoc positions) can be prepared in order to establish collaborative environment between academia and industry and attract external funding. An example can be an ERC Starter application to be submitted after the completion of this project. The intended collaboration with other research groups and participation in multidisciplinary initiatives outside the applicant’s research group can help to get involved in applying for joint funding and establishing research centers in the future.

References


