Implementation of OMV Machine-Learning augmented workflows to support scenario evaluations under uncertainty in DELFI

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The challenge: scenario evaluations under uncertainty

Numerical models can be conditioned to many different types of measured data, this is an ill-posed problem, a multitude of different parameter combinations can lead to acceptable agreement with the observed data.

The final model ensemble conditioned to all observed data can be used to forecast under uncertainty where changing production conditions might change non-sensitive parameters in the history to sensitive parameters in the forecast.

Optimizing field re-developments leads to increasing value ranging from 5 to 50M EUR per field. The risk of failure can be reduced from 40% to 10% by using probabilistic workflows.
OMV Machine-Learning augmented workflows

Instead of finding the best parameter combination by minimizing the mismatch, prior distributions are used for the different uncertain parameters which are then conditioned to the various observed data obeying Bayes’ updating rule.

The Random Forest Machine Learning algorithm is used to generate a large variety of parameter combinations in an acceptable agreement with the various sources of observed data, addressing also parameter interactions.
OMV Machine-Learning Workflows Digital Journey

2019: Concept from coreflood simulation study
SPE-200578-MS

2020 Q1: Method applied for water saturation initialization
SPE-203384-PA

2020 Q2-Q4: First workflow application for field studies
SPE-205188-PA & SPE-208194-MS

2021: First Co-Development of Stochastic Modelling in Delfi: Clustering & CODEC®

2022: Co-Development of Stochastic Modelling in Delfi: **ML Workflows**
Original workflow

- **Geomodels preparation**
  - Parameter Table
  - 1000-2000 Geomodels
- **Latin Hypercube**
- **Dynamic Simulator**
- **Data Analysis Toolkit**
- **Manual Sampling**
- **Dynamic Simulator**
- **Economics Toolkit**

**CODEC®**
- Include Files
- RE input preparation
- Output of simulations and LH parameters
- New Parameter Table
- 100s Geomodels
- Ensemble selection
- Table (csv-file)
- Include Files
- RE input preparation
- 1000-2000 Geomodels

**OMV GEOCLOUD**

**AZURE**

**WORKSTATION**

Parameter Table

**CODEC®**

**Parameter Table**

**1000-2000 Geomodels**

**Output of simulations and LH parameters**

**New Parameter Table**

**100s Geomodels**

**Ensemble selection**

**Table (csv-file)**
Simplified workflow

Data Science Toolkit

New parameters

100 realizations

Reservoir Engineering Workspace

1,000 realizations

OMV CODEC®

OMV CODEC®

Parametrization
Economics (csv)

Reservoir Engineering Workspace

OMV CODEC®

OMV CODEC®

Economics Toolkit

DELI Petrotechnical Suite

DELI Reservoir Engineering Workspace

DELI Data Science
Stochastic Modelling Architecture

Ensemble generation and simulation

Model management
Quick automated analysis
Key realizations

Reservoir Model DMS
OMV ML Model Conditioning Approach

1. Statement of model complexity and parameterization
2. Latin hypercube sampling
3. Falsification of prior uncertainties
4. ML based generation of statistical models to determine discrepancy based on input parameters
5. Utilization of these statistical models to define posterior parameter combinations
6. Simulation using the posterior parameter combinations in order to validate the results
Statistical models: Random Forest

The methodology allows

• Categorical, continuous geological and dynamic model parameters

• Calibration to multiple data at well and reservoir level

• Decision trees created for each observed data type (objective functions) based on the importance of variables in the regression.
Statistical models: Exploring alternative algorithms

DELFI Data Science

- Easy access and testing capabilities to various ML algorithms
- Compare different regression models, evaluate impact, and adapt the workflows
Utilization of statistical models: from concept to scripts

SPE-205188-PA • Conditioning Model Ensembles to Various Observed Data (Field and Regional Level) by Applying Machine Learning Augmented Workflows
Utilization of statistical models: to code-free dynamic workflows
Output and Validation

The use of statistical ML models ensures that non-sensitive parameter ranges are kept aligned to the prior distributions.

Fast feed-back on parameter distribution and validity of ensembles.
Co-development set up

Steering committee, governance team and project team are conformed by OMV and Schlumberger representatives

Bi-weekly sprint review meetings, every 6-month governance meetings and regular updates to the steering committee

Story map captures feedback and direction of development

Testing program based on OMV use cases

Constant dialogue with the development team
The main benefits to OMV

OMV needs a stochastic modelling workflow to condition model ensembles to multiple data at well and reservoir level for **systematic and auditable** probabilistic production forecast profiles.

With the implementation of the Machine-Learning workflow in DELFI we have achieved:

- Reduction of working environments
- Simplification of data transferring
- Full integration of disciplines
- Parallelization of geomodelling and simulation
- Improved user experience from code to interactive interface
- Access to powerful visualization tools for data science
- Easier testing and implementation of alternative algorithms
- Flexible loop back mechanisms (optimization)
- Easier deployment to field business units
Thank you!

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