user story

Data-driven surrogate models and analysis for friction application using MoDS

Assessing engine performance parameters such as brake mean effective pressure (BMEP), friction mean effective pressure (FMEP) and specific fuel consumption (SFC) using virtual engineering toolkits is important during the design phase of any IC engine development programme. Furthermore, by reducing the computational expense associated with detailed predictive modelling of these engine performance parameters, the overall design cycle can be made cost- and time-effective.

THE CHALLENGE

The objective is to facilitate automated development of data-driven computational surrogates which incur low computational expense (evaluation times in ms) and quantify their predictive capability by comparison with high-fidelity, first generation detailed physics-based model data. Furthermore, the surrogates were desired to be applied over multiple types of IC engines, thus presenting a significant challenge relating to the surrogate accuracy.

THE CHALLENGE

The objective is to reduce the computational expense associated with predictive modelling of friction losses and IC engine performance in the design phase.

THE SOLUTION

Using MoDS to develop data-driven computational surrogates and to rank them based on their predictive capability across a multiple IC engine configurations.

THE RESULTS

- Multiple data-driven computational surrogates proposed
- Easy-to-use interface for quantifying model robustness with respect to blind test data
- Enhances the process of new engine design

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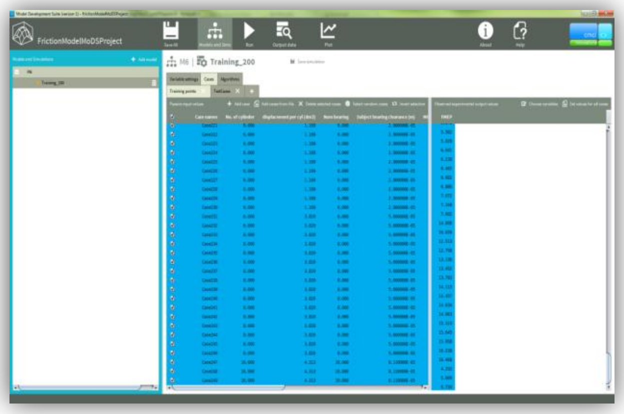
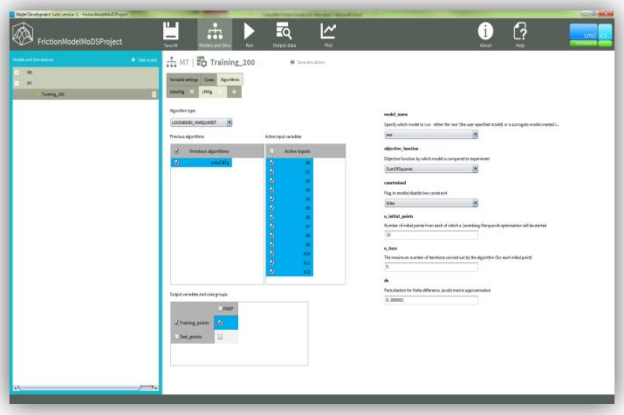




Test data querying and visualisation, followed by the specification of variable semantics and optimisation algorithms

THE SOLUTION

The main objective was to reduce the computational overhead by producing data-driven surrogate models, which are both cheap to evaluate yet, are sufficiently accurate for most usages. In order to achieve this, MoDS was employed to ease the workload. MoDS is a software package for performing general optimisation and statistical analysis on arbitrary “black-box” models, thus well-suited to the task at hand. MoDS allows users to “read” in any model, and due to the arbitrary nature of these models, MoDS is designed to perform this task swiftly and flexibly, including advanced querying capability for models which are defined in spreadsheet formats.

MoDS divided the provided data on main end and big end bearing into training and test data, calibrating the surrogate models using the training data and then assessing the robustness using the test data. With the model and corresponding data read in, it is possible to use the wide array of algorithms available in MoDS, however, in this case, it was only necessary to apply general-purpose optimisation routines to train the models. The end results allowed the collaborating OEM to decide between these models on the basis of robustness diagnostics as well as visual means created through the post-processor.

THE RESULTS

Data-driven surrogate models with evaluation times in milliseconds were formulated for evaluating FMEP.

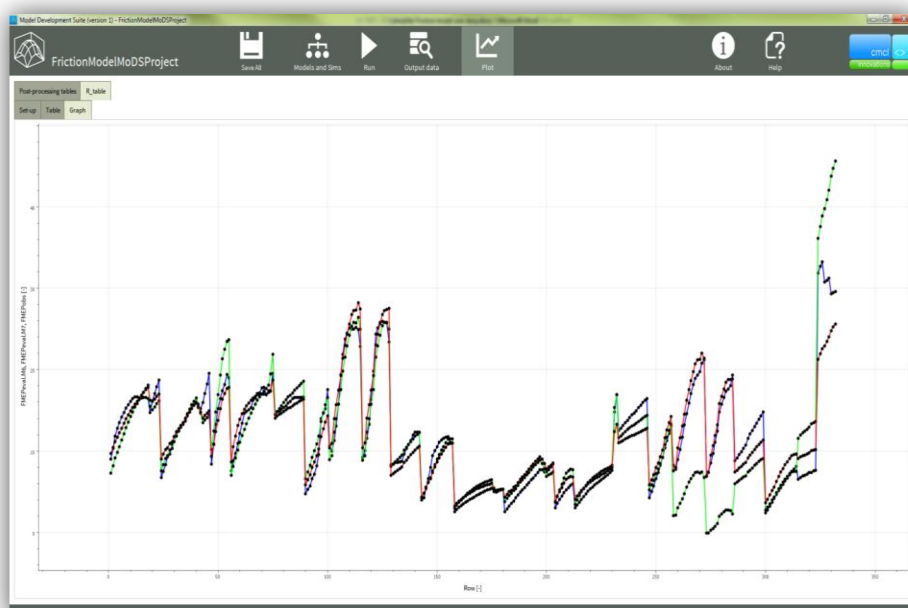
The various robustness diagnostics measures indicated which of the surrogate models were most robust to new data, and therefore most suitable for use in the design process.

APPLICATION AREAS

- Data-driven modelling
- Data querying and visualisation
- Parameter estimation
- Main and big end bearing
- Friction mean effective pressure
- Model ranking
- Optimisation

PRODUCTS USED

- MoDS



MoDS post-processor comparing the FMEP obtained from the data-driven surrogates against the high-fidelity physics-based friction model

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