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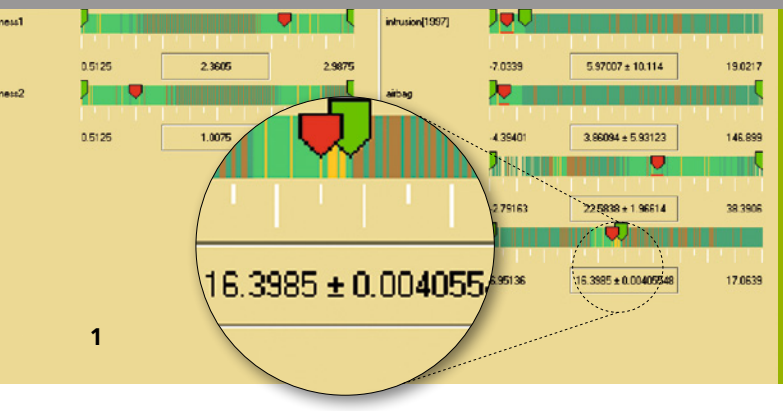

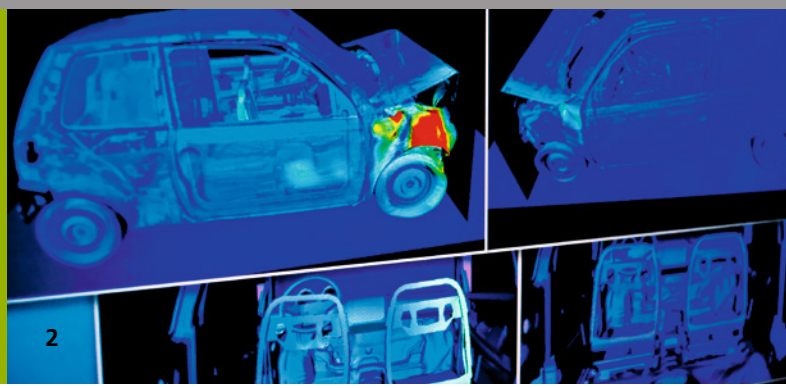

1 *DesParO GUI*
2 *Multi-disciplinary optimization of a Volkswagen Lupo model*

INTERACTIVE ENVIRONMENT FOR PARAMETER ANALYSIS AND OPTIMIZATION

Fraunhofer Institute for Algorithms and Scientific Computing SCAI

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DesParO

Design Parameters

Technical processes and products typically depend on many parameters, e.g. geometrical, material and process parameters. The user would like to adjust these parameters to obtain the best design of the product or the optimal control of the production process.

DesParO is a software toolbox enabling sensitivity analysis and robust multi-objective optimization of such parametrized production processes. As a special feature, it provides an easy–to-use GUI for the interactive exploration of design spaces based on a metamodeling approach. DesParO can be combined with all kind of simulation programs or data stemming from physical experiments. For the user's particular benefit, the software offers the possibility of obtaining almost optimal configurations with a low number of simulation runs and/or physical experiments.

This toolbox is thus particularly suited for computationally expensive simulation codes as well as pure experimental analysis of costly processes and products.

DesParO Methods

DesParO is a unique system for creating, exploring and analyzing metamodels as well as for performing robust multi-objective optimization. The metamodels are based on radial basis functions and polynomial detrending and are able to fully interpolate the data set given.

DesParO's correlation measures as well as its local tolerance and parameter sensitivity estimation are capable of handling nonlinearities efficiently.

DesParO provides the user with a global view on the design space, reveals a full set

of alternative solutions and allows the user to explore interactively the whole space of design variables and to find the optimal region with respect to multiple design objectives.

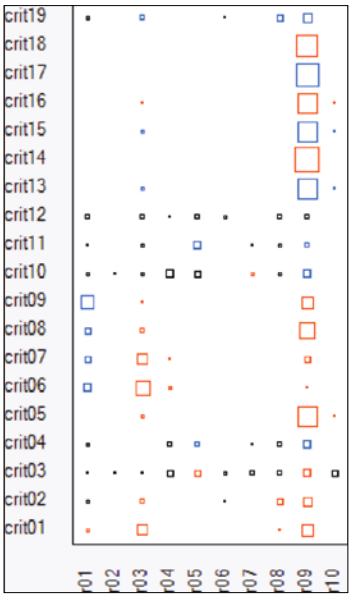
Consequently, DesParO is free of common drawbacks inherent to automatic optimization tools, such as a solution stuck in a local optimum typical for differential methods or the exhaustive numerical experimentation of Monte-Carlo-like sampling strategies.

DesParO Features

DesParO offers unique features such as:

- Innovative slider technology for both parameter and criteria fields: This allows for exploring design spaces and robust multi-objective optimization tasks fully interactively.
- Robust, local tolerance prediction: DesParO predicts not only the value of the design objective, but also local tolerance limits. For noisy objectives this allows to satisfy constraints in a safe manner.
- Global nonlinear correlation analysis: DesParO automatically recognizes a pattern of interdependencies between the optimization criteria and design variables and represents it as an easily readable colour-coded diagram. This enables, for instance, global parameter-importance ranking.
- Parameter sensitivity analysis: DesParO offers a fully local nonlinear sensitivity analysis and corresponding dynamic matrix representation, allowing for detailed parameter studies.
- Interpolation of simulation results: DesParO provides interpolation of simulation results to the values of design variables specified by the user. This allows to visualize a full solution immediately and to inspect in detail the obtained optimal design. The list of formats supported is extended continuously. Ask for your format!
- Innovative optimization strategies: Optimize interactively via the graphical user's interface (GUI), or employ DesParO's batch facilities.
- Adaptive metamodel refinement: DesParO's novel refinement methods provide an adaptive, hierarchical modelling and allow for improving accuracy of predictions iteratively – step by step in order to keep costs minimal.

3 *Correlation matrix*



DesParO Versions

DesParO is available as a stand-alone application (GUI and batch) for Windows and Linux platforms or as a documented software development kit (SDK) for the integration into workflow tools, other optimizers, customer's software, or simulators.

DesParO Applications

DesParO's metamodeling and robust optimization approach has successfully been tested on a number of real-life multi-dimensional problems in

- automotive design: for instance in crash, metal forming, casting, NVH
- product analysis, configuration and/or optimization: for instance, for the configuration of catalysts or the optimization of tube joints
- process analysis and optimization in microelectronics, chemistry, CFD etc.
- model calibration, parameter fitting, history matching: for instance, in oil reservoir simulation and molecular dynamics, or for setting up material models for the integration into simulation software via DesParO's SDK libraries

Performance

New metamodels are created both very quickly and accurately. Metamodels can be explored truly interactively. In particular, the real-time calculation of the local tolerances and sensitivities is unique. In addition, large simulation results corresponding to the data sets (parameter combinations along with design objectives) at hand are interpolated very efficiently in terms of computing time and memory requirements.

Integration into workflow management tools, optimizers, and simulators

DesParO can be integrated into workflow tools or other optimization software, including OPTIMUS, for instance. Use DesParO's batch model evaluation instead of a simulator, or integrate the DesParO SDK!

Additional support for OPTIMUS includes workflow and optimization setup for specific tasks. Model evaluation output files are easily readable by means of standard office or visualization software.

DesParO's SDK and batch versions can easily be integrated into other software tools and scripts. They allow for tailoring the process steps you need: model setup, model evaluation including local tolerances, local or global parameter sensitivity analysis, and optimization. For instance, a material model calibrated by means of DesParO can be added to a simulator or a product configurator can be set up by means of DesParO's metamodeling approach and integrated into customer's software via the SDK.