

SOFTWARE

# ClearVu Intelligence

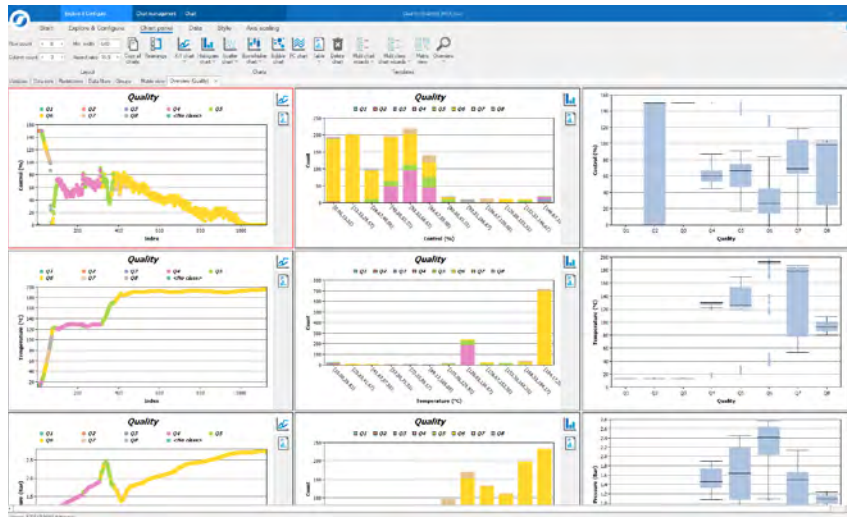
*BeyondAnalytics*

Efficient data analysis,  
modeling, prediction and  
optimization

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# ClearVu Intelligence



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# CLEARVU INTELLIGENCE

ClearVu Intelligence is a software for automatic machine learning (so-called AutoML), predictive analytics and optimization. ClearVu Intelligence was developed by divis intelligent solutions GmbH to enable the automatic creation of predictive models, the cross-validation and hyperparameter optimization of these models, and the automatic selection and deployment of the best model for all users.

ClearVu Intelligence makes it easy for you to analyze data and create predictive models that you can use for optimization and forecasting.

With ClearVu Intelligence, you can develop and optimize products faster, analyze process data, and open up new application areas such as quality and maintenance optimization.

## Benefits and functions:

- Innovative methods for automatic machine learning
- Integrated cross-validation, hyperparameter optimization and statistical tests
- Optimal model, secured by validation procedure
- Quantitative confidence measure for all model forecasts
- Measures of influence and sensitivity of input parameters
- Extensive methods for the creation of experimental designs
- Diverse possibilities of explorative data analysis and model analysis
- Interactive sensitivity analysis for models
- Stable basis for further optimization steps through the model provided
- Single and multi-criteria global optimization procedure

# The main modules of ClearVu Intelligence

ClearVu Intelligence has a comfortable graphical user interface that allows you to use all functions in an intuitive way and to visualize and analyze the data and models. Due to the flexible design of the software, all functions can also be used in command line mode and thus integrated into your own process chains.



## Explore and Configure

for the initial visualization of the data and its exploration and pre-processing



## Design of Experiments

for the automatic generation of test data for the execution of experiments, if no data are available yet



## Models and Modeling

for automatic modeling of the data with machine learning, hyperparameter optimization, cross-validation and model selection



## Optimization

for single- or multi-objective optimization using previously learned prediction models



## Interactive Sensitivity

for the interactive sensitivity and robustness analysis of the models

# CASE STUDY

## IOI OLEO GMBH

### The task

At the Witten site, IOI Oleo GmbH has commissioned us for a previously unsolved issue in connection with the production process for an important product. This product is manufactured in a batch process and is subject to the highest quality requirements. The problem was to identify essential process influences on the product quality and to derive statements how to control the process parameters in order to consistently obtain a product of ideal quality. We refer to this setting as the "golden batch".

### The solution

For this purpose, we analyzed the data on 29 batches, each as multivariate time series with 9 sensor signals recorded at 20s intervals, using our machine learning methods. On this basis, prediction models for product quality were created and the main influencing parameters and their dependencies were identified. From the models, it was thus possible to identify the main factors influencing product quality and their optimal settings. The results of the project will now be implemented in technical applications in a second phase.

### Testimonial

»We are now implementing the decisive step for the optimization of this product through the AI experts at divis. We are more than impressed with the results of this project and have found the divis team to be highly competent, efficient, and very pleasant to work with. We are currently in the process of implementing this approach for other IOI Oleochemicals products, look forward to further collaboration, and are very happy to recommend divis as a competent partner. In addition to the high level of technical expertise of Prof. Bäck's team, we were also impressed by their ability to focus on the customer's technical process question and to apply the AI methods fully in line with the task at hand.«

*Thomas Kummer, COO of IOI Oleo GmbH*



**IOI OLEOCHEMICAL**

#### DAS COMPANY:

- is one of the leading European suppliers of oleochemical specialties and medium-chain triglycerides (MCT)
- German production sites at the locations Wittenberge and Witten
- Headquarters in Hamburg, Germany

#### APPLICATION AREAS:

- Production of active ingredients and excipients for the pharmaceutical industry, emollients, emulsifiers, texturizers and a wide range of multifunctional ingredients for the cosmetics industry
- Production of special esters and additives for products in the food segment
- Process auxiliaries and lubricants for technical applications and basic oleochemicals (e.g. polyunsaturated fatty acids)

# The functions of ClearVu Intelligence

## Explore and Configure

This module is used to assess data quality, pre-process and clean of the data, and perform an initial exploration of the data. A variety of graphical visualizations such as scatter charts, histograms, box-whisker charts and correlation charts are available for this exploration of the data. All charts can be easily configured and customized and exported for further use.

In addition, you have insight into the statistics and can use all this information to create data filters and clean the data. You can also add custom restrictions and use the automatic outlier detection. The statistics and charts also reveal dependencies between variables, providing insight into the existing task.

## Design of Experiments

ClearVu Intelligence can also be used to generate experimental designs to run either real experiments or simulation runs. After evaluating all experiments, modeling of the data can then be performed.

This module offers common algorithms such as factorial experimental designs, Box-Behnken, Plackett-Burmann or D-optimal designs as well as more complex algorithms like Latin Hyper Squares or space-filling designs. You have the possibility to add restrictions so that the experimental designs are generated only in the valid range. Finally, you can copy or export the experimental designs to Excel, evaluate them and re-import them into ClearVu Intelligence to start the analysis.

## Models and Modeling

The modeling module provides the core functionality of ClearVu Intelligence by enabling a fully automated generation of models through automatic machine learning.

ClearVu Intelligence offers a variety of modeling algorithms. These include linear models, fuzzy models, support vector machines, decision trees, random forests, neural networks and Gaussian processes. In the context of automatic machine learning, the parameters of the modeling algorithms, also called hyperparameters, are optimized for all model types. In order to guarantee the generalization ability of the models, cross-validation is also performed. The best model is determined by the minimum validation error and a statistical test.

The models also provide the influence and sensitivity of the input parameters, which makes it possible to determine the most important influencing parameters. In addition, a confidence measure for the forecast quality is also provided for a forecast.

The best model can then be used for predictions, optimization, and sensitivity analysis.

## Optimization

Models created from the data, for example for product quality characteristics, process yield, stability of formulations, to name just a few possibilities, can also be used for optimization. ClearVu Intelligence allows you to define objectives such as "quality increase" or "cost minimization". These objective functions are then used for optimization in the optimization module.

For optimization, several of these objectives can be considered simultaneously. The result is a set of Pareto-optimal solutions representing the trade-offs between conflicting requirements (e.g., quality and cost).

The optimization procedure is based on a self-adaptive evolution strategy for multi-objective optimization.

Figure 1:  
Multiple, freely configurable graphical representations in the Explore and Configure module for exploratory data analysis.

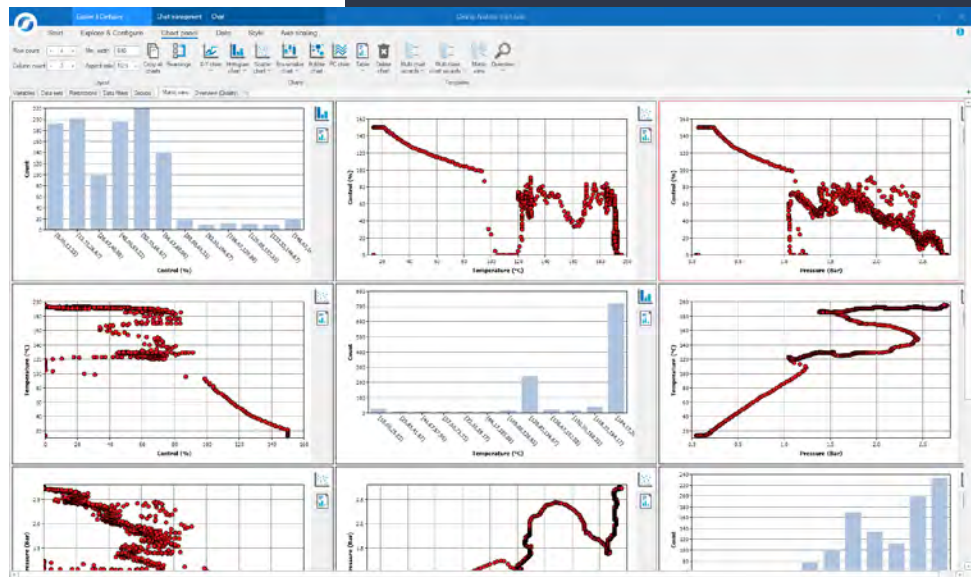


Figure 2:  
Overview of the trained models and their quality measures in the module "Models and Modeling".

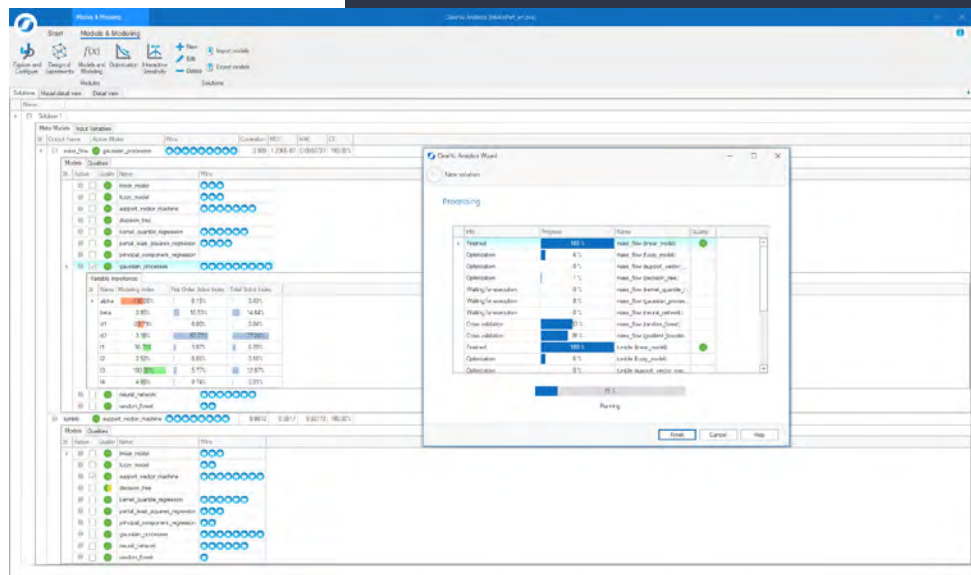
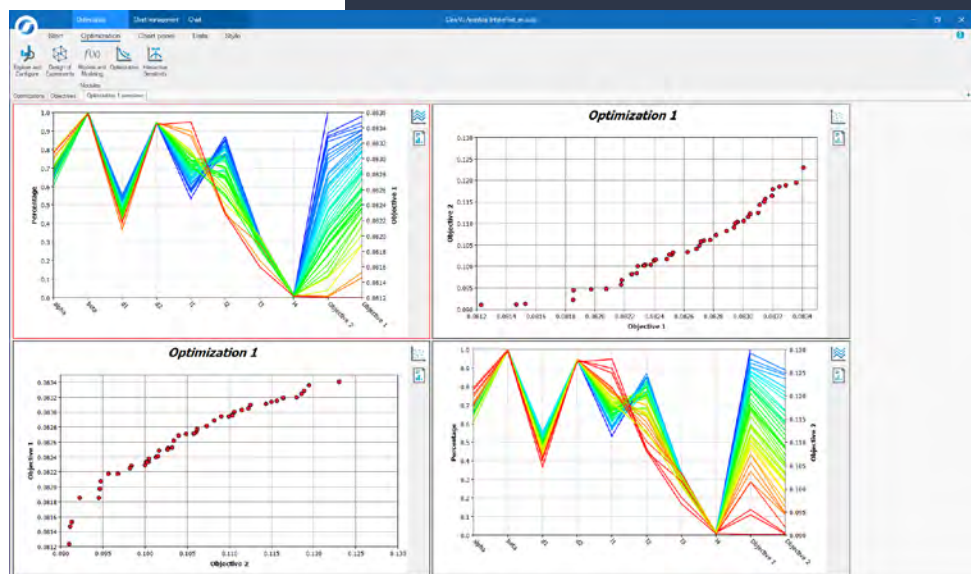


Figure 3:  
Illustration of the Pareto front and all influence parameters for multi-objective optimization in module "Optimization".



## Interactive Sensitivity

A model trained on the data can be visualized as a 3-D graph as well as a contour graph using the interactive sensitivity analysis. For this purpose, a parameter setting, for example the optimum found with the optimization, is used as a starting point. Using sliders, users can change parameter settings and thus interactively observe the change in the target variable.

This functionality mainly helps to analyze the sensitivity of the optimum with respect to individual parameters and thus find those parameters that are particularly critical near the optimum.

## Command line usage

In addition to the graphical user interface, ClearVu Intelligence also provides a command line-based programming interface. It allows the execution of time-consuming tasks such as automatic modeling with machine learning and hyperparameter optimization through distributed computing on other computers. It also enables the integration of ClearVu Intelligence functionality into custom process chains.

This functionality is available for Windows and Linux operating systems. The tasks are controlled by XML files with the necessary information, which are generated automatically. The results of the calculations can be later imported into the graphical user interface.

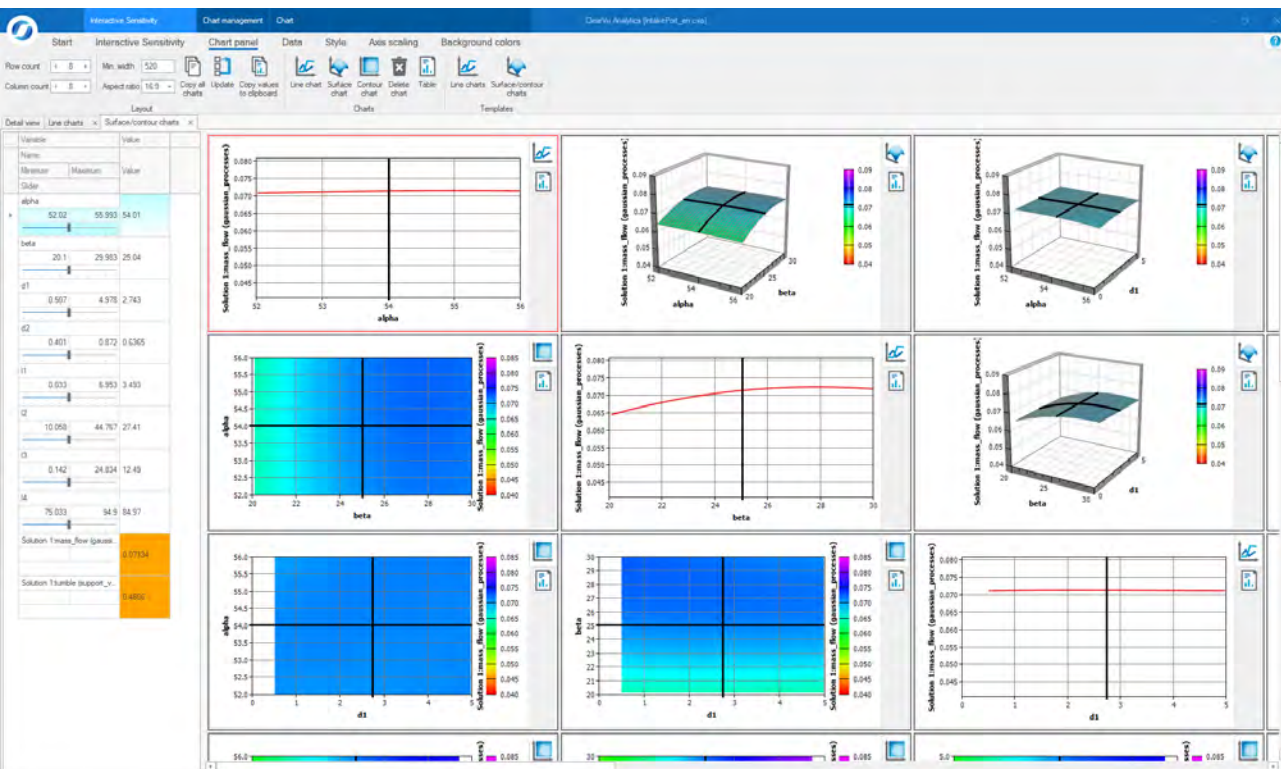
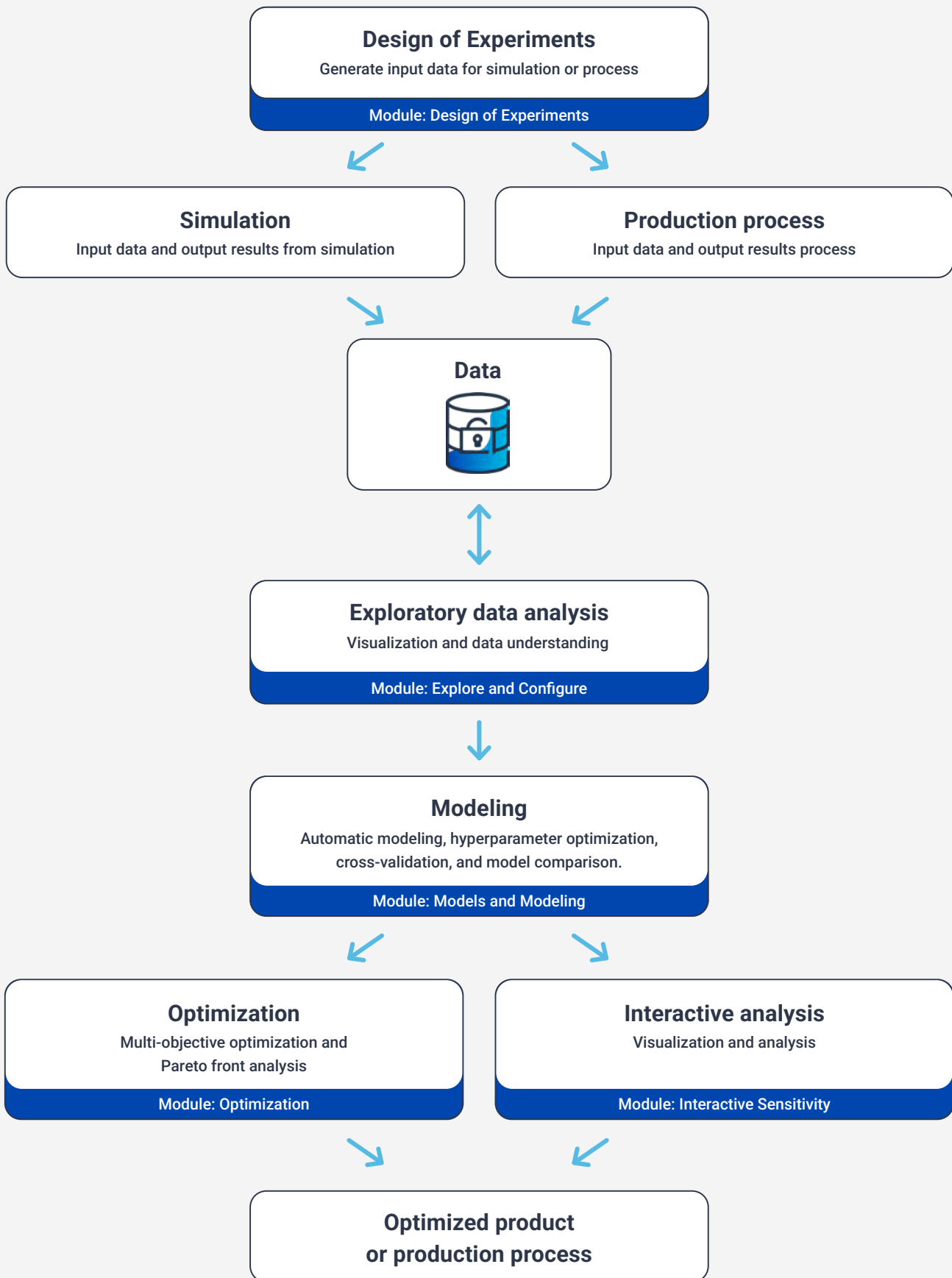


Figure 4:  
3-D representations and contour graphs of the model near a given point, for example an optimum. Parameter variations can be analyzed interactively.

# The Workflow of ClearVu Intelligence



# divis intelligent solutions GmbH

We are specialists in optimizing processes and products, implementing predictive maintenance and predictive quality, and achieving significant improvements and savings for our customers. Our company philosophy "beyond analytics" is an expression of our unconventional problem-solving approach by making state-of-the-art methods of artificial intelligence and machine learning applicable for our customers. We successfully implemented numerous applications in the automotive, chemical and consumer goods industries, among others.

In addition to our in-house developed software, we also offer our customers scalable and personalized solutions for integration into their production processes - from consulting projects to data analysis. In doing so, we always follow current innovations and technologies under the professional guidance and expertise of the managing director Prof. Dr. Thomas Bäck (head of the Natural Computing research group at the Leiden Institute of Advanced Computer Science at Leiden University).

In addition, we continuously improve our ISMS in accordance with TISAX and our QMS in accordance with ISO 9001.



## EXCERPT FROM OUR REFERENCE LIST

- Honda Research Institute Europe GmbH
- BMW Group
- Beiersdorf AG
- Chemetall GmbH
- DLR – Deutsches Zentrum für Luft- und Raumfahrt
- Daimler AG
- Hyundai Motor Company
- ThyssenKrupp Industrial Solutions AG
- 3M Deutschland GmbH
- Johnson & Johnson Deutschland
- IOI Oleo GmbH
- Dr. Ing. h.c. F. Porsche AG
- Metzeler Schaum GmbH
- Schüco Polymer Technologies KG
- Covestro AG
- Evonik Technology & Infrastructure GmbH
- S. C. Johnson & Son, Inc.
- Mercedes-Benz AG
- Norce Norwegian Research Centre AS

## WEITERE SOFTWARE



### ClearVu Design Space

WEB [divis-gmbh.de/cvss-en](https://divis-gmbh.de/cvss-en)

ClearVu Design Space supports you in the design of systems and components in the automotive industry. There are many restrictions to comply with and ClearVu Design Space provides optimal flexibility for the identification of design variants.



### ClearVu Intelligence Python Pro

WEB [divis-gmbh.de/python-en](https://divis-gmbh.de/python-en)

ClearVu Intelligence Python Pro provides the functionality of ClearVu Intelligence in Python. This makes Automated Machine Learning usable in Python without further training - fast, automatic, and powerful.



### ClearVu Intelligence Excel Add-In

WEB [divis-gmbh.de/excel-en](https://divis-gmbh.de/excel-en)

The Excel Add-In provides Automated Machine Learning directly in Excel with just a few clicks to generate forecast models for your data sets. The resulting forecast model can be used as a cell function directly in Excel for forecasting and the model itself can be analyzed and visualized.

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