Learn More

Dakota

CAESES® has direct and smooth access to [Dakota](), the free optimization toolkit provided by Sandia National Laboratories. There is no further installation of Dakota required; everything is readily available through an add-on in the pro edition of CAESES® (note that the Dakota interface is not included in CAESES® Free).

The entire method set of Dakota can be employed in CAESES® by using the Dakota *design engine* from the CAESES® optimization menu. As a highlight, experienced Dakota users can also define their own Dakota input files with their method setups, and fully customize the CAESES® GUI for this template.

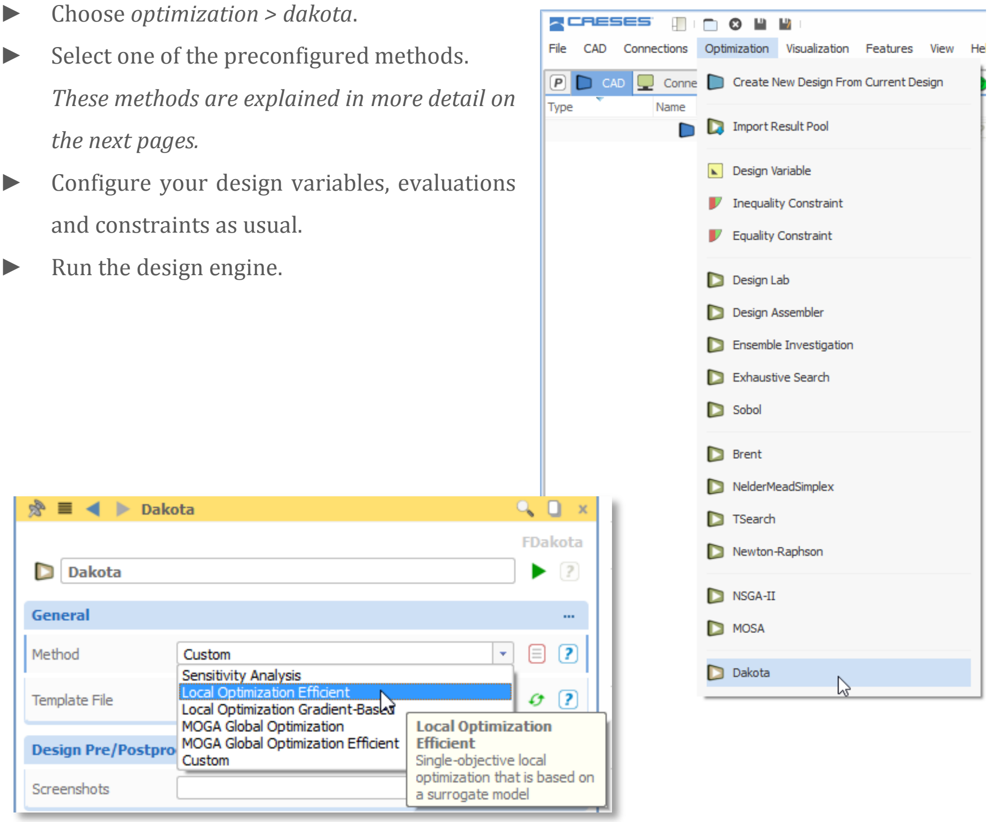
This tutorial gives a brief overview about these topics, and we hope you'll like this great symbiosis of the two tools!

1 Getting Started

CAESES® comes with a set of preconfigured Dakota input files that can be readily used. The following steps outline how you can immediately run these Dakota methods from within your CAESES® project:

- Choose *optimization > dakota*.
- Select one of the preconfigured methods.

  These methods are explained in more detail on the next pages.
- Configure your design variables, evaluations and constraints as usual.
- Run the design engine.



2

Preconfigured Methods

The preconfigured input templates for Dakota complement the existing optimization strategies of CAESES®. Here is a brief overview:

Sensitivity Analysis

- This is a Latin Hypercube Sampling. Use it for parameter studies and for finding correlations and trends. For instance, get a first idea of which design variables have the strongest effect on your objectives.

Local Optimization Efficient

- Internally, this method creates a surrogate model (response surface) and conducts a local optimization on this model. For the initial surrogate model, existing point data can be used e.g. from a previous sensitivity analysis. During the run, the surrogate model is iteratively fine-tuned: the optimum design from the local search is evaluated and the information is added to the surrogate model – which step by step increases the quality of the model.

Local Optimization Gradient-Based

- This method conducts a local search and involves gradient information. It can be used for problems with rather smooth functions where, typically, the evaluation of your objectives is not too expensive (because of the calculation of the derivatives).

MOGA Global Optimization

- Multi-Objective Genetic Algorithm. Can be used for global optimization tasks. Note that, in general, these genetic algorithms need plenty of evaluations. This makes this method suitable for problems where the evaluation is not too expensive.

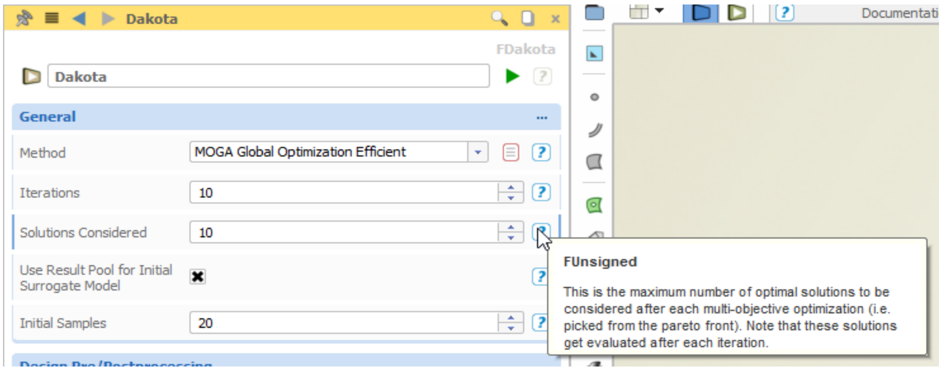
MOGA Global Optimization Efficient

- In this method, a MOGA is conducted on a surrogate model that is iteratively built-up. For the initial model, data from a previous run (e.g. sensitivity analysis) can be recycled as well. With this approach, the method might be suitable even for rather expensive evaluations.

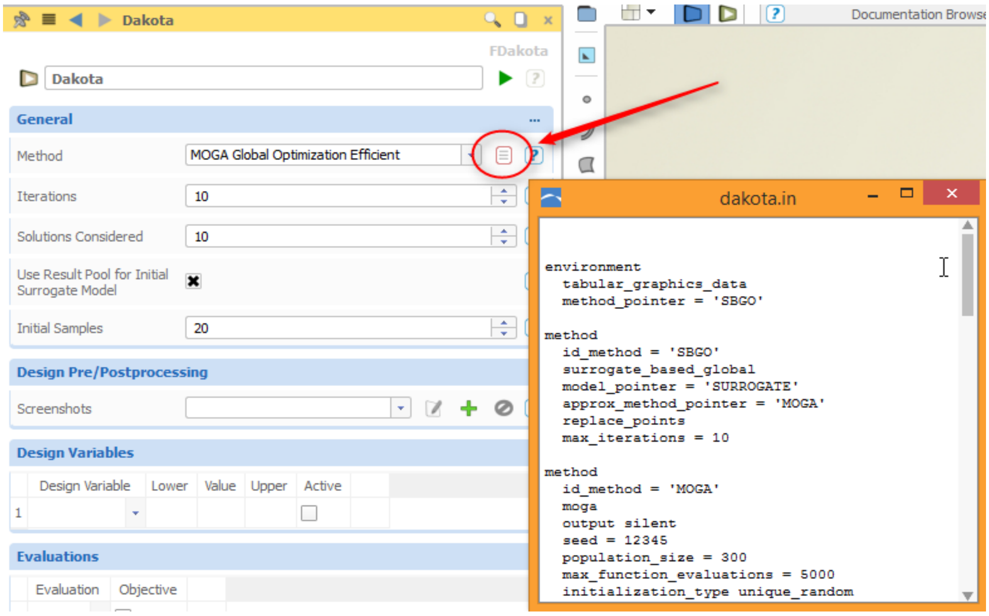
3 More Information

The brief summary from the previous page does not really cover all the method details. How can you find out more? Check this out:

- Click on the help icon (“?”) for more information about the single attribute.



- Click on the template icon in order to have a look at the input file for Dakota.

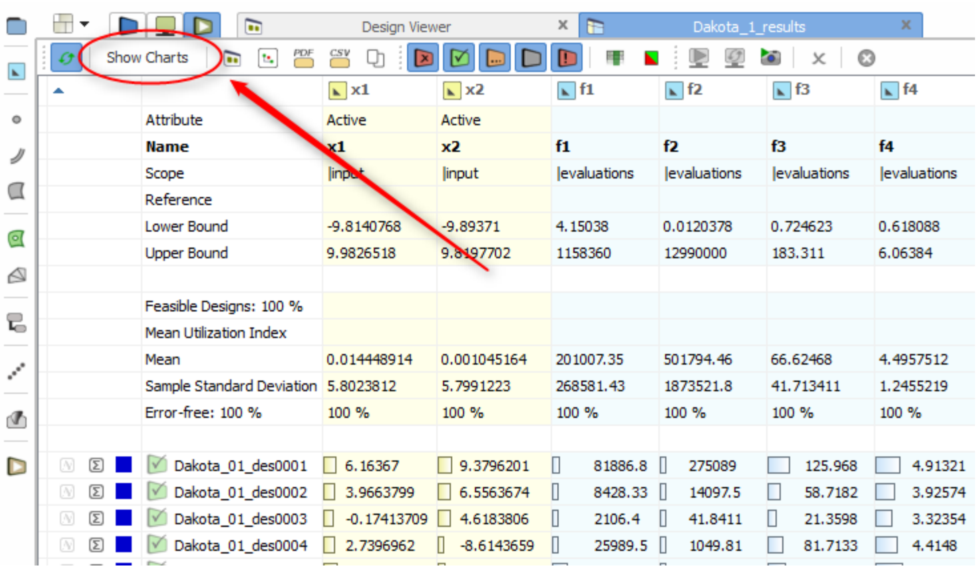


- Check out the Dakota user’s manual that is also shipped with CAESES®. See the installation folder *FRIENDSHIP SYSTEMS > CAESES > etc > dakota* where you’ll find the PDF document.
- And finally, we recommend to check out the Dakota website: **https://dakota.sandia.gov/**

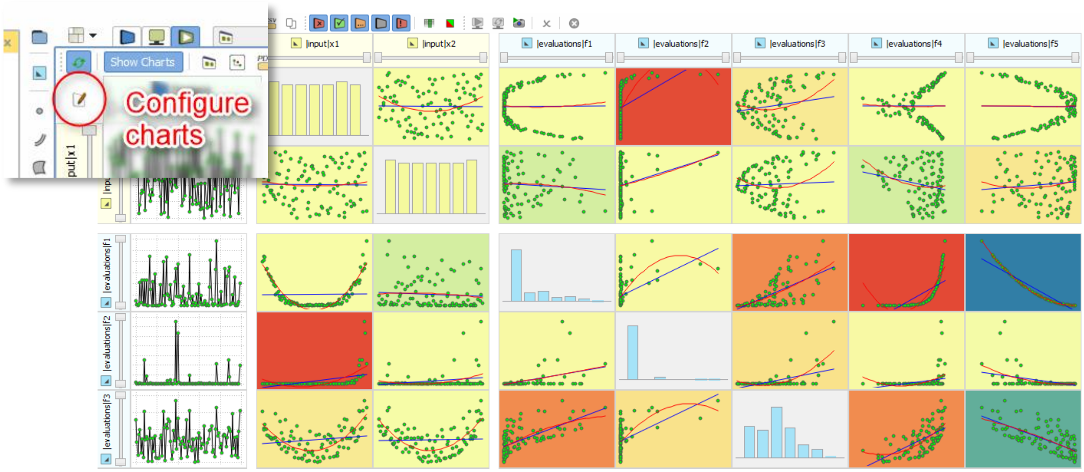
4 Charts

All design engines – including the Dakota engine – generate interactive charts. You can click on single designs to select them.

- ▶ You can access them at the top of the result table.



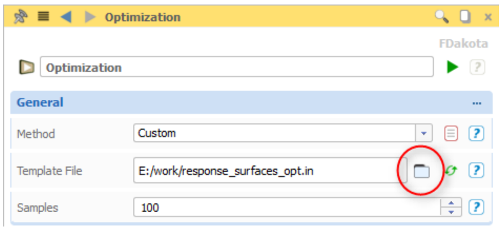
- ▶ Correlations: For a sensitivity analysis, the red colored fields indicate a positive correlation (example: if the variable value increases, the objective will increase as well), while blue-colored fields indicate a negative correlation. Don't forget to visually check the charts for non-linear correlations – only linear correlations are covered in these charts.



5 Custom Templates

You can also set up your own Dakota input file (to make use of the entire Dakota method set) and hand it over to the Dakota design engine.

- As a start, check out the preconfigured input files that are presented in this tutorial. See the installation folder *FRIENDSHIP SYSTEMS > CAESES > etc > dakota*. There you will find these files (*.in) for Dakota that are used by CAESES®. Make a copy of one of them, and modify it.
- For the *method* attribute, select "Custom" and choose your input file.



CAESES® Keywords

- In the *etc > dakota* folder, you will also find a file called "template_definitions.txt". This gives you an overview of the CAESES® keywords that you need to involve for setting up your own template. For instance, CAESES® automatically writes the number of objectives into the Dakota input file, for which a CAESES® keyword `eval_count_objective` needs to be used.

Customizing the CAESES® GUI

- When you write your own method setup for Dakota, you can also configure the user interface. This means that you can control what is transferred to the interface and what's hidden (e.g. when the default value doesn't need to be changed). Finally, you can even add documentation to a Dakota attribute. Here is a snippet where the Dakota keyword "samples" has been wrapped by the CAESES® user interface.

```
method
  sampling
  sample_type lhs
  <samples, unsigned, 100, Samples, number of samples>
  seed = 12345
```