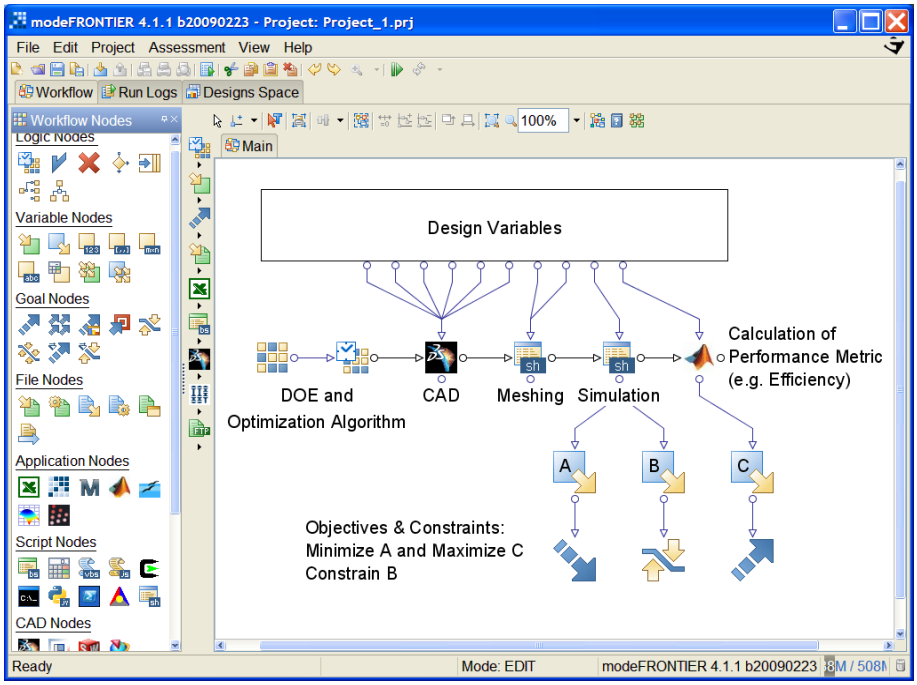
modeFRONTIER®

the multi-objective optimization and design environment

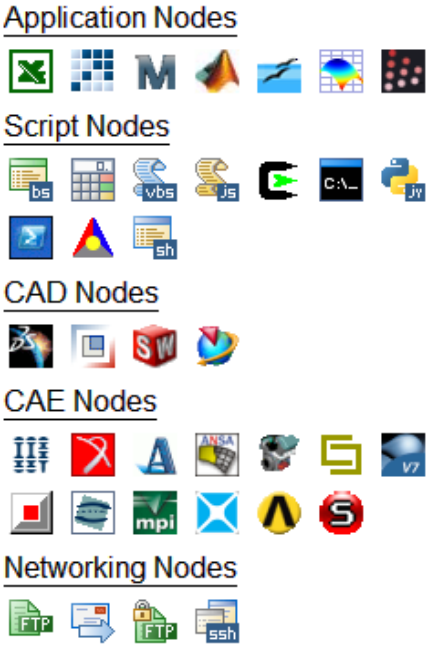
modeFRONTIER® is a multi-objective optimization and design environment which combines a comprehensive process integration platform with sophisticated, state-of-the-art, optimization algorithms, and powerful post-processing capabilities.

Process Integration

Coupling different CAE tools to create a single, integrated, environment becomes a straight-forward task when carried out with the user-friendly GUI in **modeFRONTIER**. The direct interfaces available for many of the most widely used commercial tools, such as MATLAB and EXCEL, as well as several CAD and engineering analysis programs make for seamless coupling. Even for the software for which no direct interface yet exists, **modeFRONTIER**'s generic text file interface allows the user to create a process flow which includes all components of the CAE environment, even in-house tools.



Direct Integration Nodes

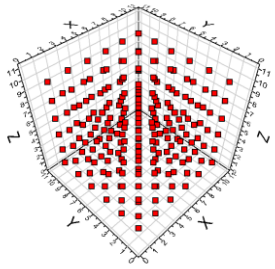


Design of Experiments (DOE)

The DOE can be used to create a starting population from which an optimization algorithm will "learn"; to design experiments, either physical or numerical, such that as much information as possible can be extracted from as few runs as possible; or to create an array of data points which can be used to train a response surface, or meta-model, which can subsequently be used for virtual optimization.

DOE Techniques in modeFRONTIER:

- Random	- Full Factorial	- Latin Hypercube Monte Carlo
- Sobol	- Reduced Factorial	- Uniform Reducer
- Uniform Latin Hypercube	- Cross Validation	- Dataset Reducer
- Incremental Space Filler	- Central Composite	- D-Optimal
- Constraint Satisfaction	- Plackett Burman	- Latin Square
- Taguchi Matrix	- Cubic Face Centered	- Box-Behnken



Optimization

modeFRONTIER has a full library of algorithms for both single- and multi-objective optimization. When faced with a true multi-objective problem (i.e. one where the objectives are in conflict) the user can apply one of the multi-objective algorithms and treat all objectives separately; such cases result in a **Trade-Off curve**, or **Pareto Frontier**, of designs, any one of which could be considered an optimum.

Optimization Algorithms in modeFRONTIER:

- MACK
- Lipschitz
- Simplex
- B-BFGS
- Levenberg-Marquardt
- Genetic Algorithms (MOGA-II and NSGA-II)
- ARMOGA
- Multi-Objective Particle Swarm
- Multi-Objective Simulated Annealing
- SQP (NLPQLP, MIPSQP, NBI-NLPQLP)
- Multi-Objective Game Theory
- Evolution Strategies (1P1-ES, DES,MMES)

Response Surface Modeling

In cases where running a full optimization is impractical due to the CPU-intensive nature of the analysis tools involved, or due to time restrictions, users can run virtual optimizations by training response surfaces.

Metamodels in modeFRONTIER

Classical:	Statistical:	Advanced:
- User Defined	- Shepard K-Nearest	- Radial Basis Function
- Polynomial SVD	- Kriging	- Neural Network
- Parametric Surfaces	- Anisotropic Kriging	- Evolutionary Design
	- Gaussian Processes	

Post Processing

Once data has been obtained, whether from an optimization or DOE, or from data importation, the user can turn to the extensive post-processing features in **modeFRONTIER** to analyze the results. The software offers a wide-ranging toolbox, allowing the user to perform sophisticated statistical analysis and data visualization.

Post-processing Features

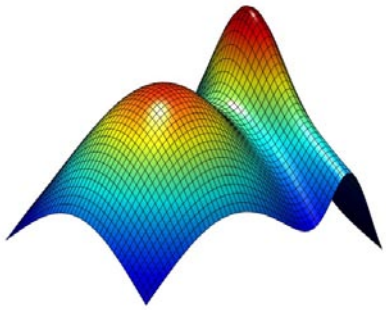
- History
- Multi-History
- Multi-History Ribbon
- Scatter
- Scatter 3D
- Bubble
- Bubble 4D
- Designs Distribution Bars
- Parallel Coordinates
- Designs Summary
- Probability Density Function
- Cumulative Distribution Function
- Box-Whiskers
- Categories Box-Whiskers
- Categories Summary
- Broken Constraints
- Quantile-Quantile Plot
- Correlation Matrix
- Scatter Matrix
- DOE Main Effects
- DOE Interaction Effects
- Effects Matrix
- Statistics Summary
- Student
- Overall Student
- Overall Student 3D
- ANOVA
- SOM Components
- Components comparison
- SOM U-Matrix
- SOM D-Matrix
- SOM P-Matrix
- SOM Response

Multi-Criteria Decision Making

This is a post-processing tool which helps the user to make selections of best designs from a family of Pareto solutions. It is extremely useful when dealing with several conflicting objectives.

Six Sigma and Robust Design Optimization

In cases where there is variation in the inputs (e.g. manufacturing tolerances), the designer may need to minimize the standard deviation of the system response. **modeFRONTIER**'s MORDO (Multi-objective Robust Design Optimization) module allows the user to assign a stochastic distribution to the input parameters, and to carry out an optimization where new objectives will be added to those of maximizing or minimizing system characteristics: to minimize the variation of those performance metrics around the nominal optimum points.



Data Importation

modeFRONTIER's Data Import Wizard allows the user to statistically analyze the results of previously run experiments, either numerical or physical, as well as to train response surfaces with the imported data.

Automatic Report Generation

modeFRONTIER offers the user the ability to create customizable reports, documenting all the important aspects of the project, from the workflow to the post-processing charts. The reports can be exported as HTML, RTF or PDF files.

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