ESTECO
USERS' MEETING
NORTH AMERICA

um 2025

modeFRONTIER Product Update

Streamlined process automation for AI data-driven modeling

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Product Manager

Agenda

ESTECO
USERS' MEETING
NORTH AMERICA

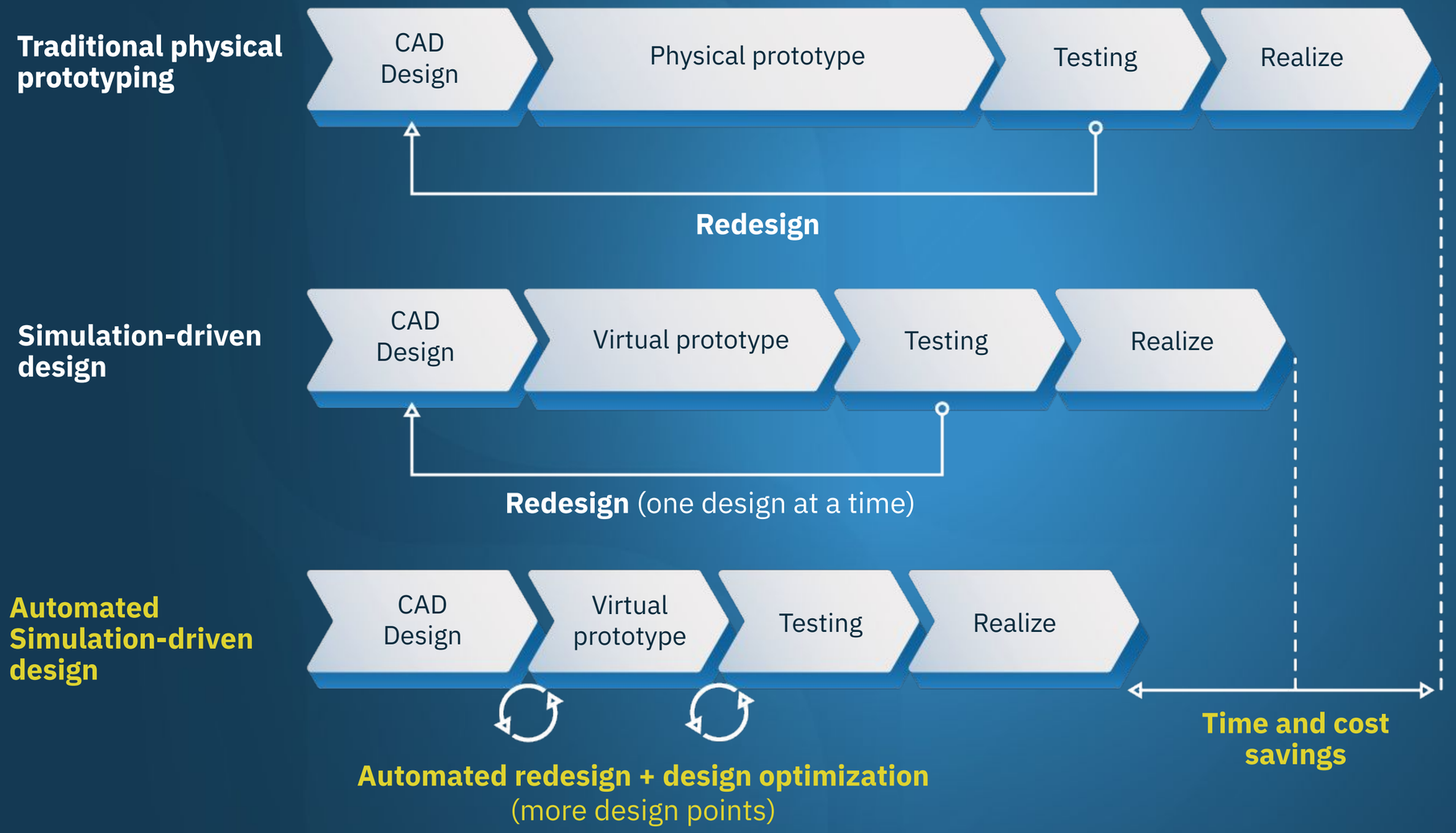
Streamlined operations with process automation and system integration

Enabling data-driven modeling with modeFRONTIER evolved process automation and integration

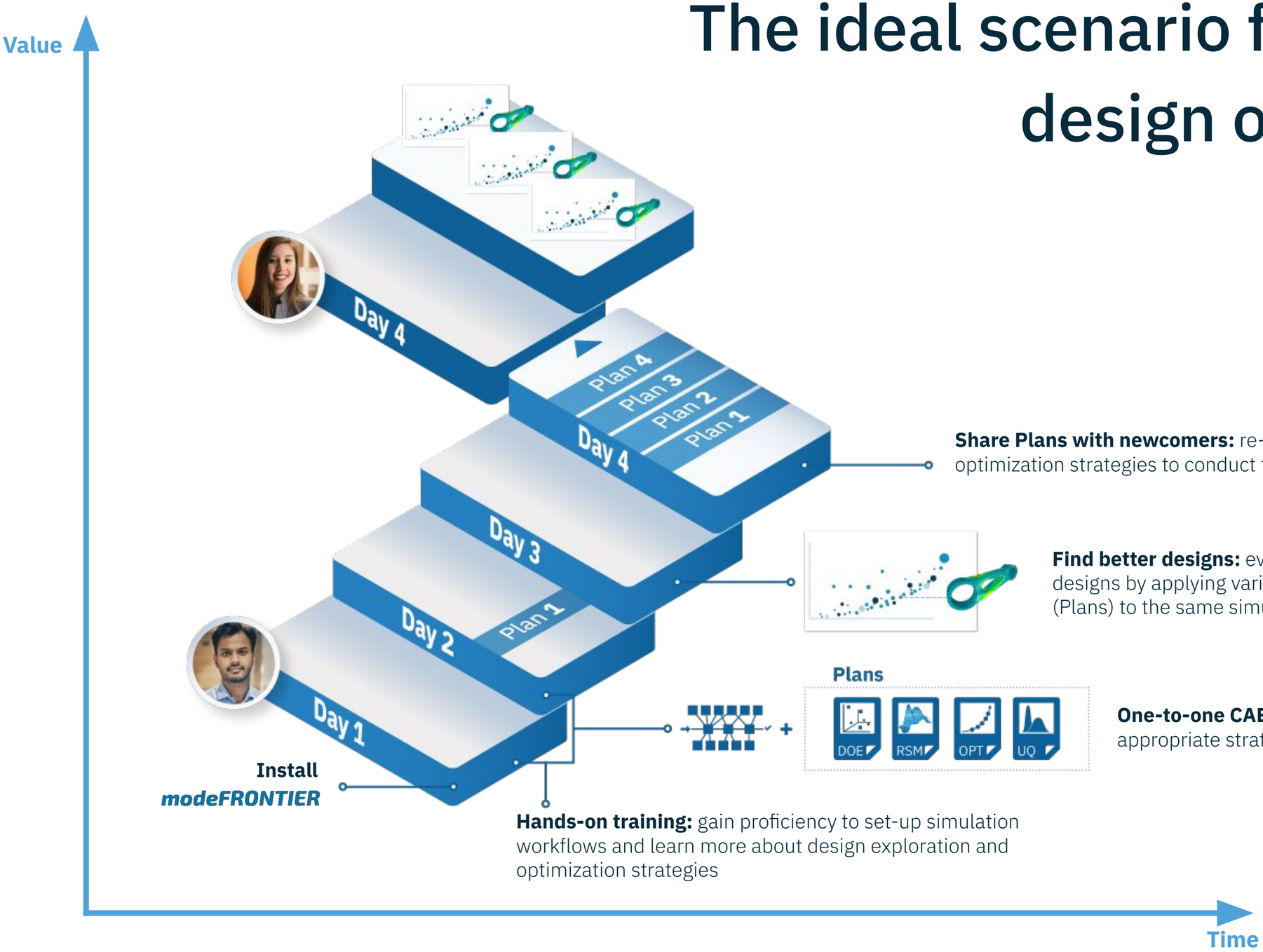
modeFRONTIER roadmap 2026/2027

Streamlined operations with process automation and system integration

Business challenge: time and cost savings



The ideal scenario for effective design optimization



Share Plans with newcomers: re-use design exploration and optimization strategies to conduct further analysis

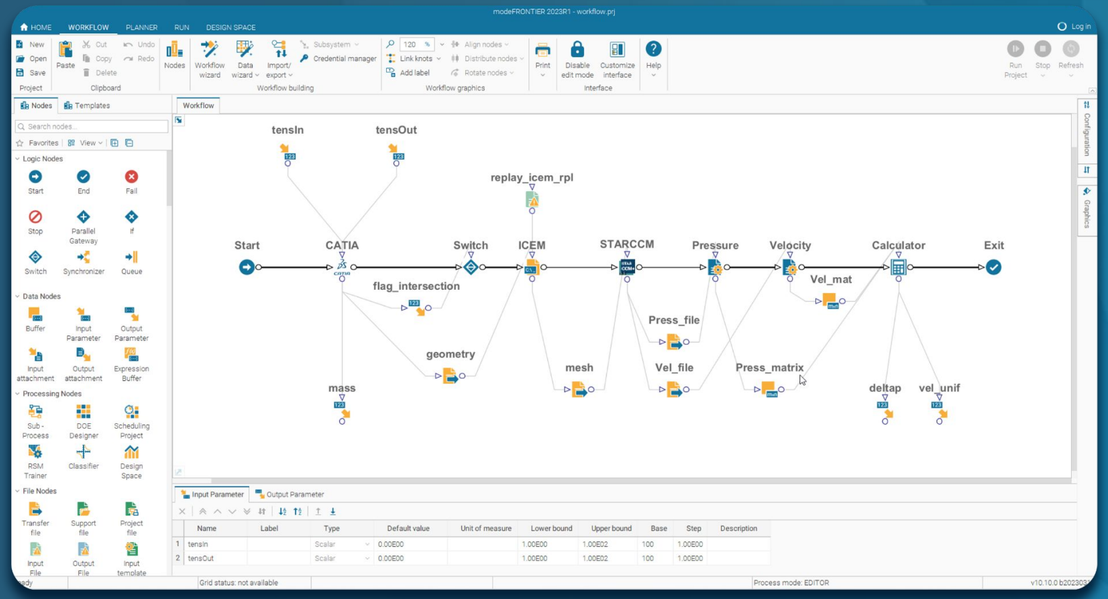
Find better designs: evaluate thousand of designs by applying various run configurations (Plans) to the same simulation workflow

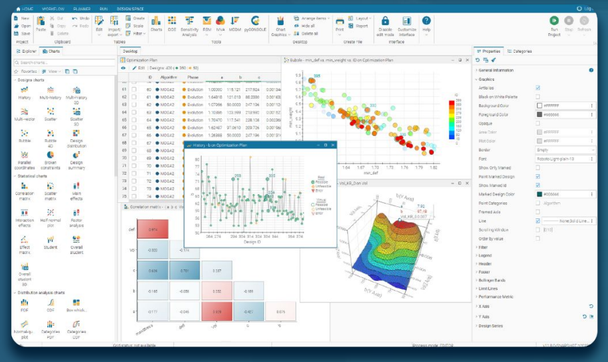
One-to-one CAE support: apply the most appropriate strategy for your design challenge

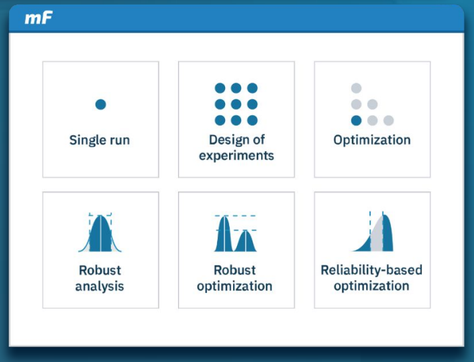
Hands-on training: gain proficiency to set-up simulation workflows and learn more about design exploration and optimization strategies

modeFRONTIER

The vendor agnostic software for process automation and design optimization.

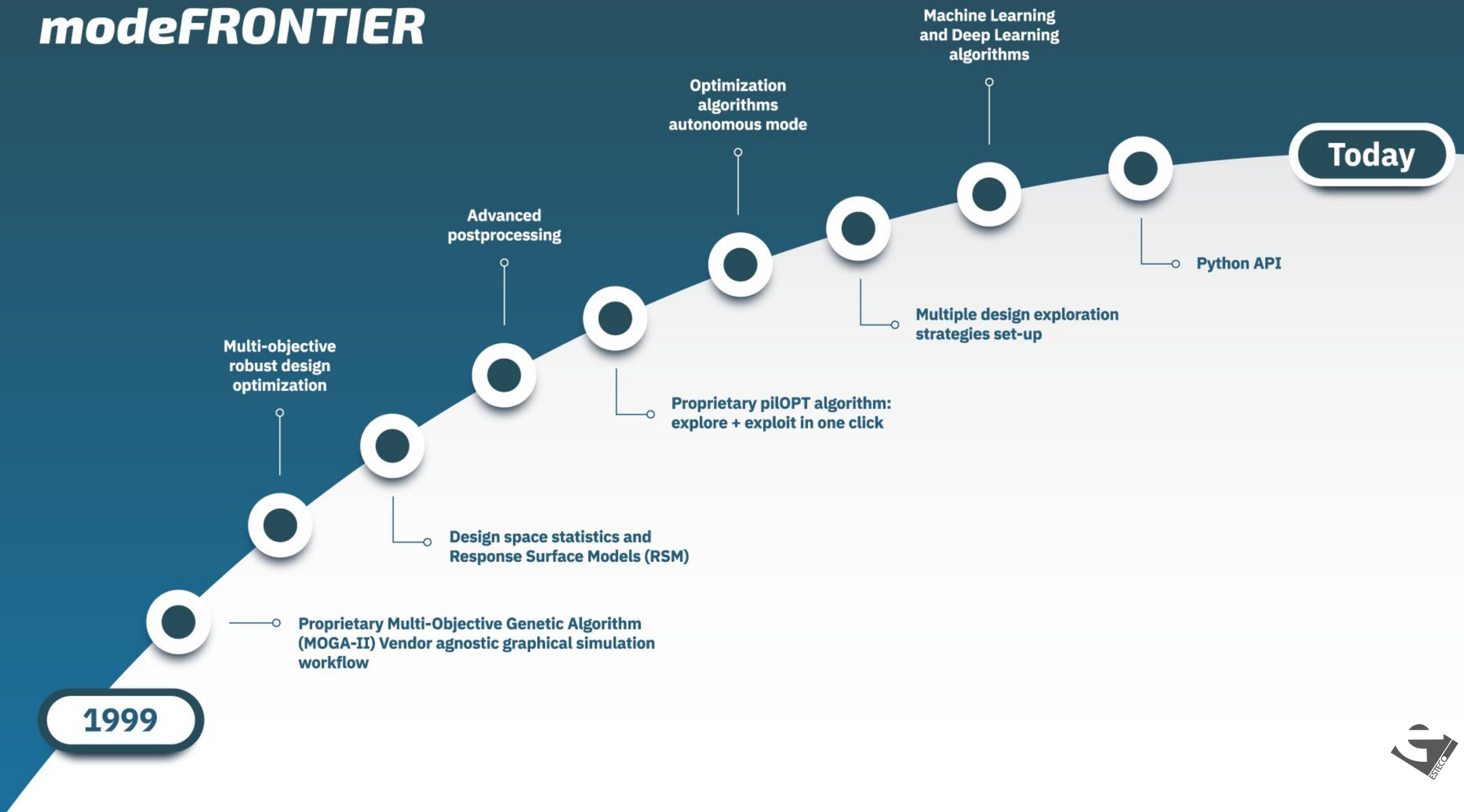


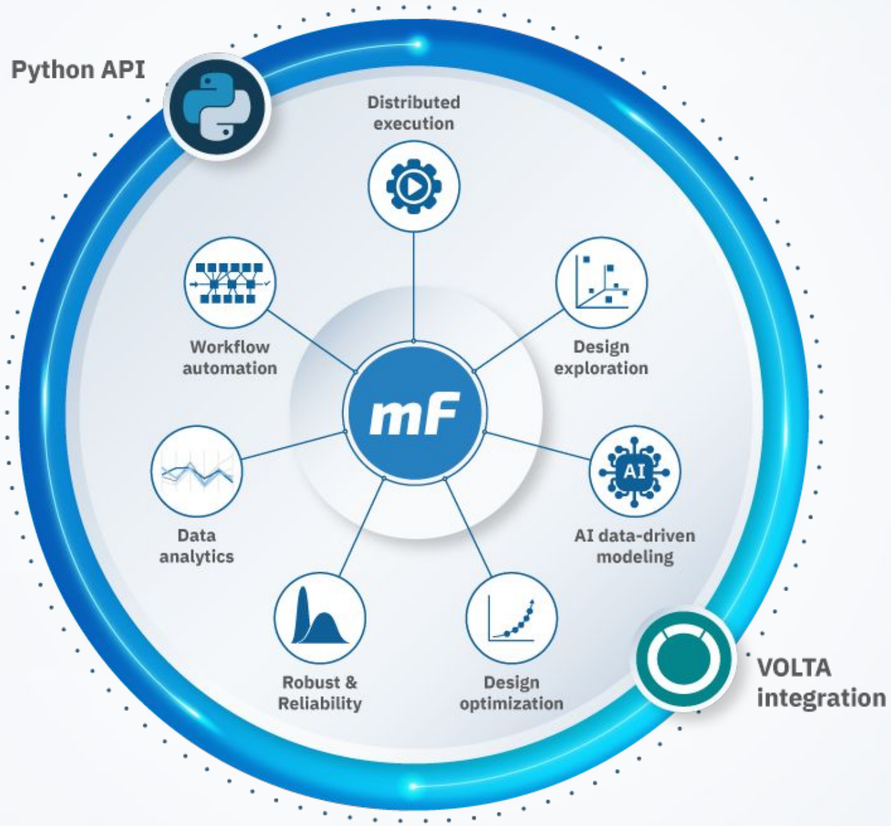




Automatically explore the design space with AI-enabled methods and accelerate product development.

modeFRONTIER





- Usability: workflow and Planner environment
- Enhanced integration with engineering applications

Enabling data-driven modeling with modeFRONTIER evolved process automation and integration

The modeFRONTIER process flow

Problem definition
Inputs, outputs, optimization objectives and constraints.

Execution at scale
Smart use of computational resources.

Democratization
Connect to ESTECO VOLTA digital engineering platform.

Process automation
Simulation integration and data exchange management.

Evaluation strategy
Design exploration or optimization studies.

Insights
AI-data driven modeling and visualization.

The concept behind the modeFRONTIER workflow

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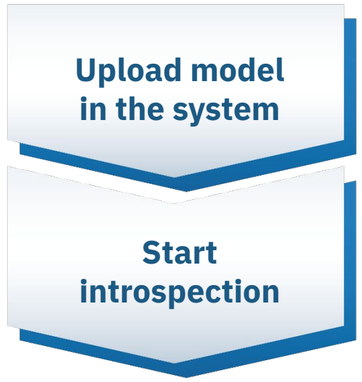
The concept behind the modeFRONTIER workflow

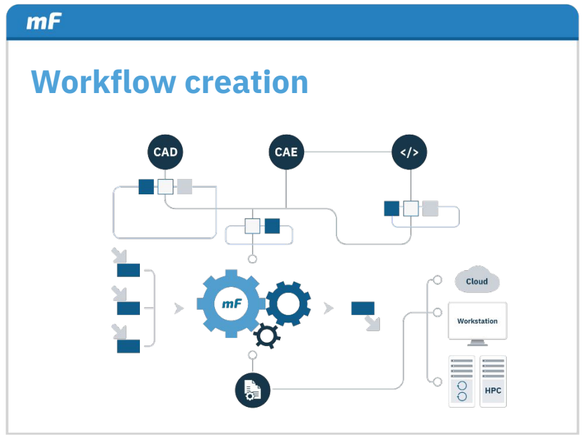


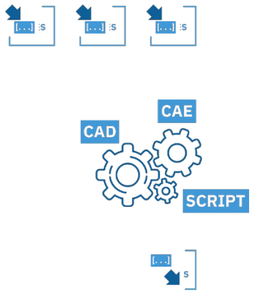
The concept behind the modeFRONTIER workflow

Upload model in the system

Start introspection

Choose parameters for workflow creation





Input variables
Define the design space

Black box
Compute outputs based on inputs

Output variables
Response of the system

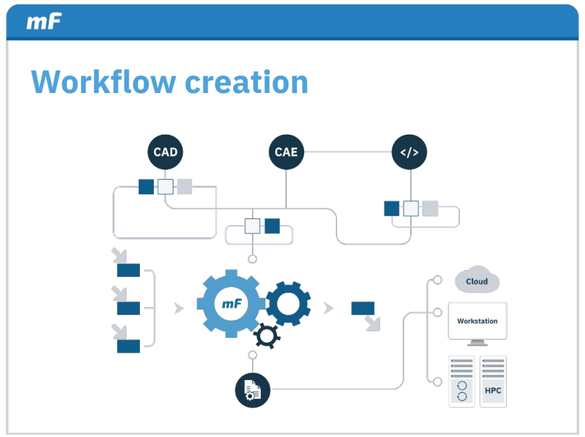
The concept behind the modeFRONTIER workflow

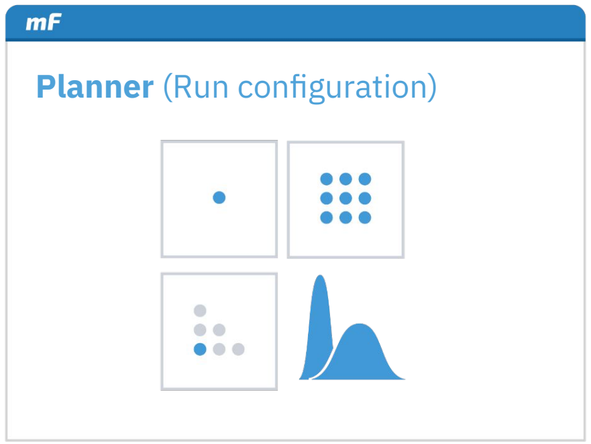
Upload model in the system

Start introspection

Choose parameters for workflow creation

Add objectives and constraints





Input variables
Define the design space

Black box
Compute outputs based on inputs

Output variables
Response of the system

Evaluation strategy
Single run, DOE, Design Optimization, or Robust and Reliability analysis

Objectives
A quantity you want to minimize or maximize

Constraints
A limit you want to respect

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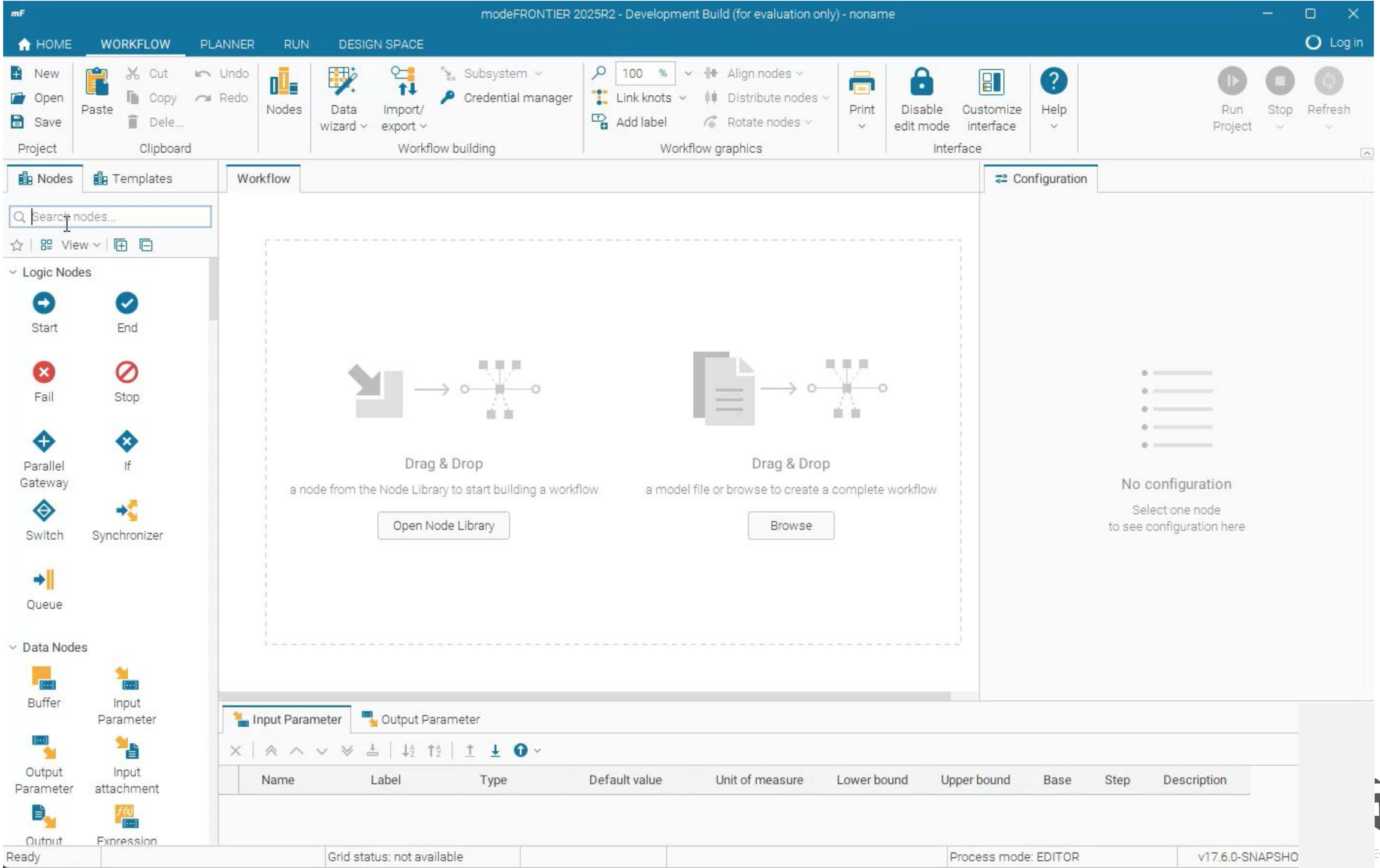
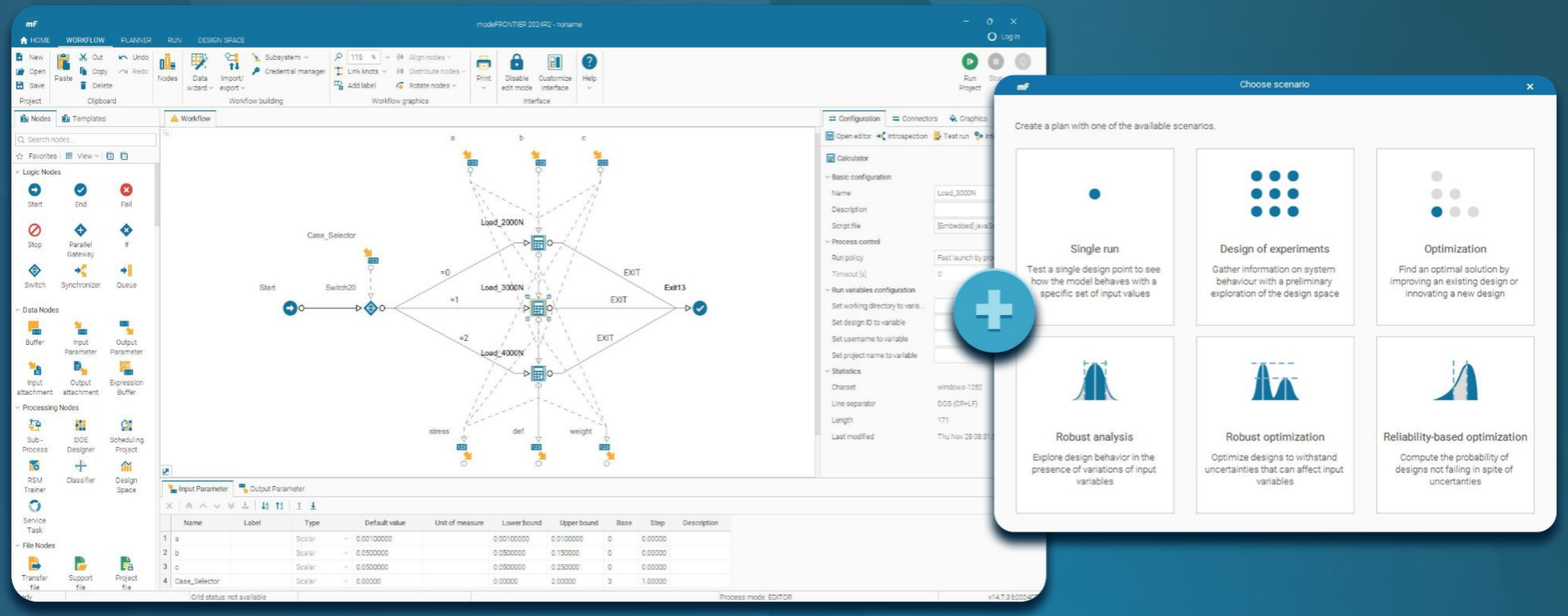

modeFRONTIER 2025R2 - Development Build (for evaluation only) - noname
HOME
WORKFLOW
PLANNER
RUN
DESIGN SPACE
Log in
New
Open
Save
Project
Paste
Cut
Copy
Dele...
Undo
Redo
Clipboard
Nodes
Data wizard
Import/ export
Subsystem
Credential manager
Workflow building
100 %
Link knots
Add label
Align nodes
Distribute nodes
Rotate nodes
Workflow graphics
Print
Disable edit mode
Customize interface
Interface
Help
Run Project
Stop
Refresh
Nodes
Templates
Search nodes...
View
Logic Nodes
Start
End
Fail
Stop
Parallel Gateway
If
Switch
Synchronizer
Queue
Data Nodes
Buffer
Input Parameter
Output Parameter
Input attachment
Output
Expression
Workflow
Drag & Drop
a node from the Node Library to start building a workflow
Open Node Library
Drag & Drop
a model file or browse to create a complete workflow
Browse
Configuration
No configuration
Select one node
to see configuration here
Input Parameter
Output Parameter
Name
Label
Type
Default value
Unit of measure
Lower bound
Upper bound
Base
Step
Description
Ready
Grid status: not available
Process mode: EDITOR
v17.6.0-SNAPSHO



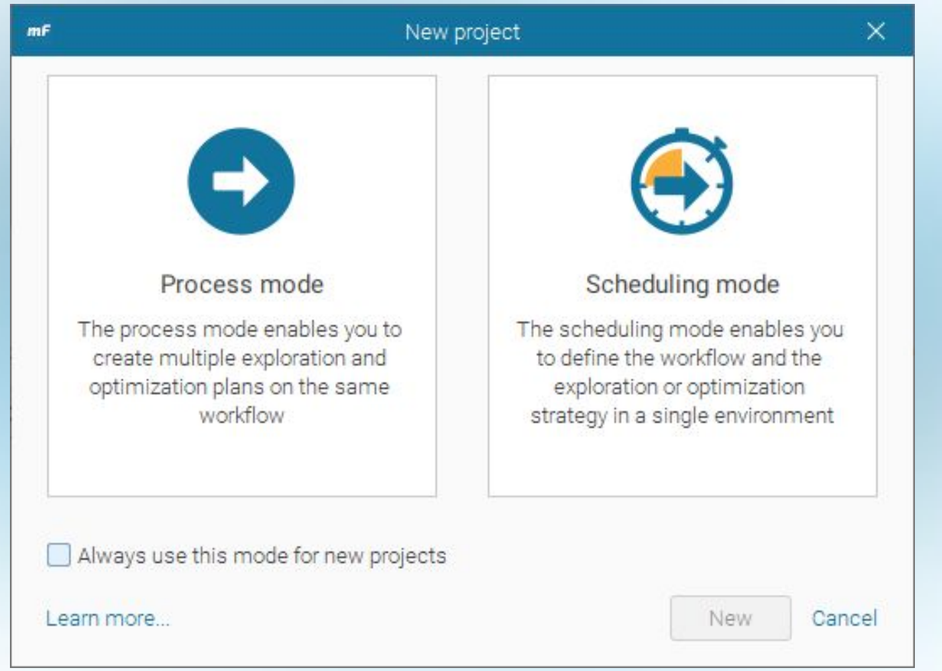
Usability: workflow and Planner environment

- Improved Planner functionality (Process mode vs Scheduling node)
- Plan services
- Service task node

Process node vs Scheduling node

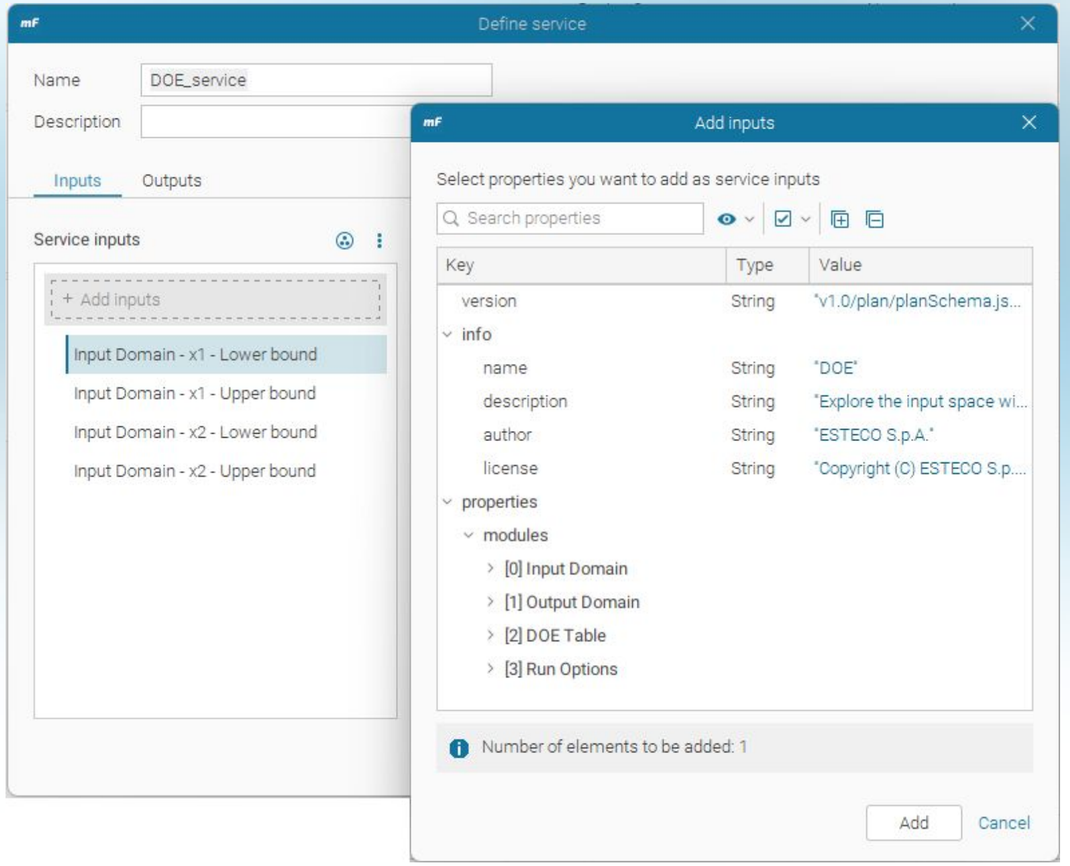
Process node
Make it easy to reuse and compare different plans for the same process.

Scheduling node
For those who want detailed control over every aspect of the process.



Plan services

modeFRONTIER Plan Services are subsets of plan elements that allow nesting and running multiple projects within a single workflow.



Reduced complexity

Projets can have many inputs/outputs, sometimes making them difficult to manage. Services can focus on a limited set chosen by the creator.

Fully parametric

Services can include properties of inputs (bounds, defaults), outputs, objectives/constraints (expressions, types), and algorithm settings.

Service task node

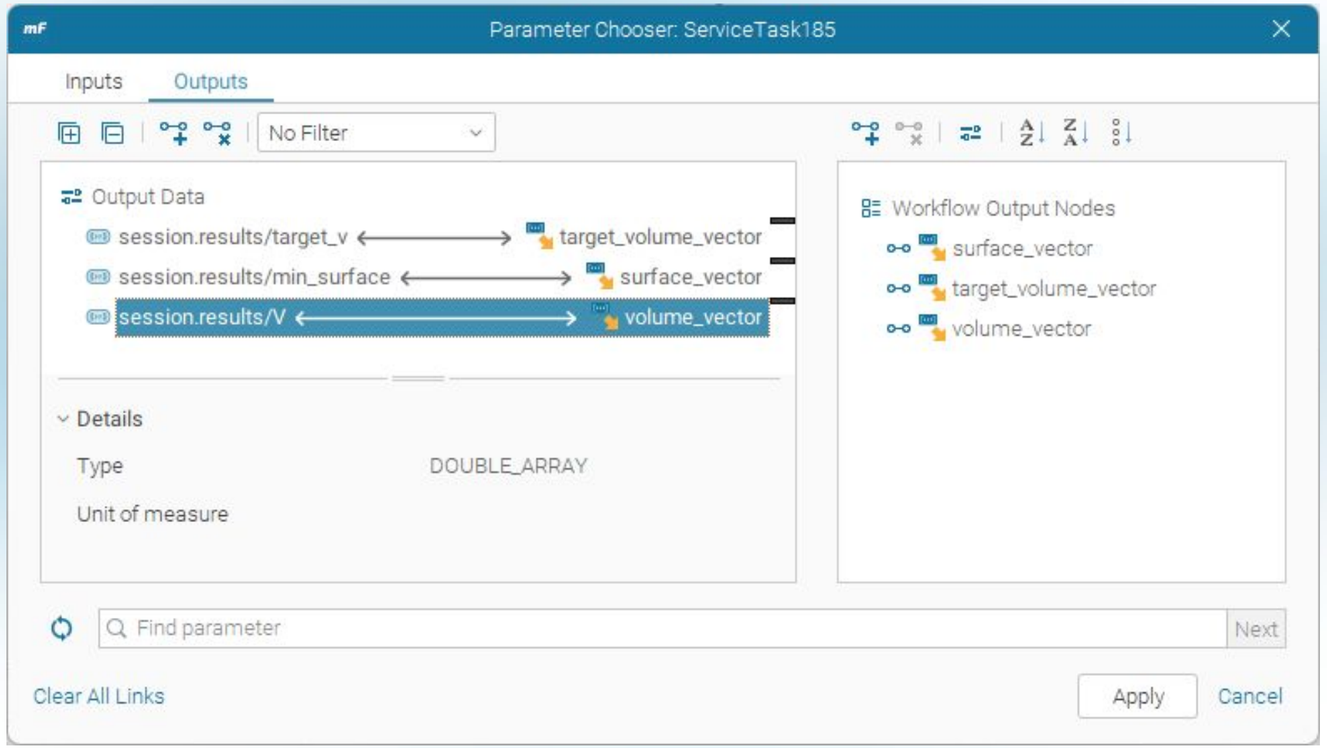
It lets you run a smaller project (service) within a larger project (main).

Service Task Parameters

Service properties become parameters in the Service Task node's Parameter Chooser.

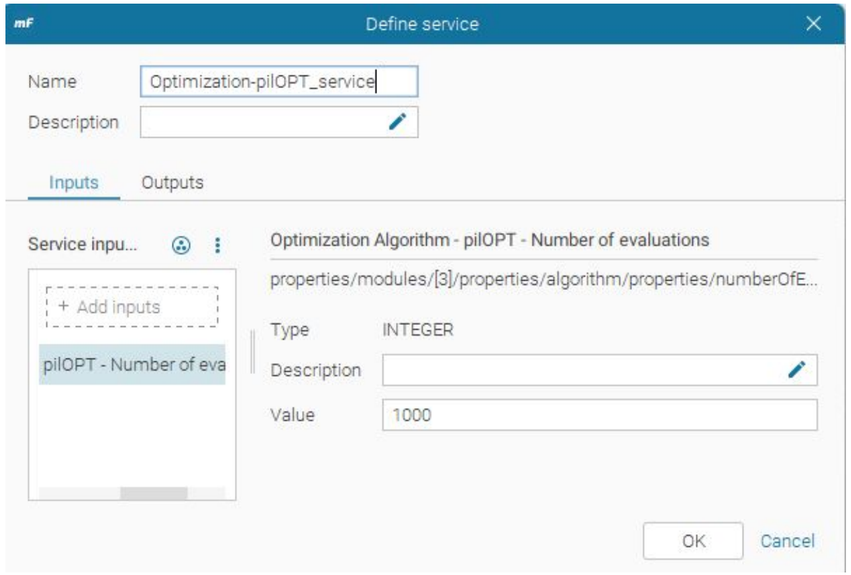
Data handling

The main project parses data and handles data exchange with the inner service.



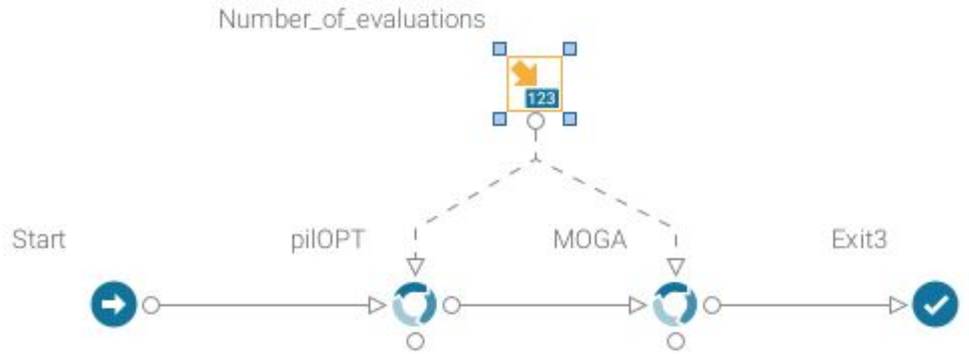
Example: run modeFRONTIER projects in batches

You can easily configure and run different optimization strategies on the same workflow.



Step 1

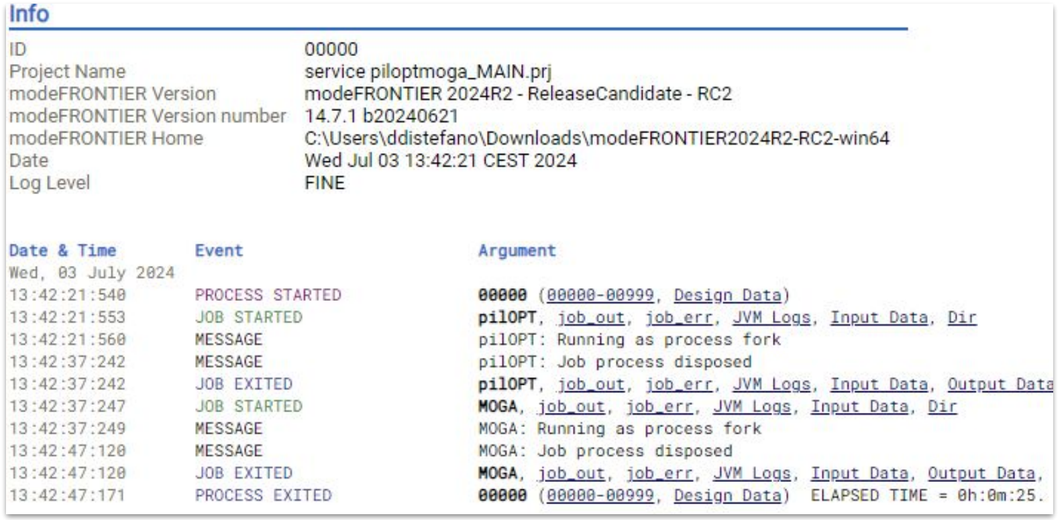
Define two services that expose the number of evaluations for pilOPT and MOGA-II, both in self-initializing mode.



Step 2

Create the main workflow using two service task nodes.

Example: run modeFRONTIER projects in batches



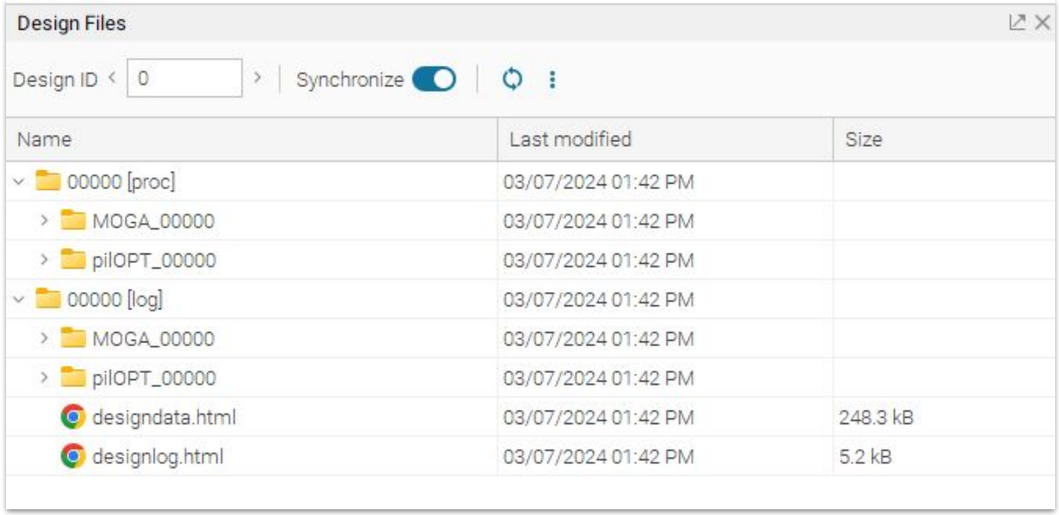
Info

ID	00000
Project Name	service piloptmoga_MAIN.prj
modeFRONTIER Version	modeFRONTIER 2024R2 - ReleaseCandidate - RC2
modeFRONTIER Version number	14.7.1 b20240621
modeFRONTIER Home	C:\Users\ddistefano\Downloads\modeFRONTIER2024R2-RC2-win64
Date	Wed Jul 03 13:42:21 CEST 2024
Log Level	FINE

Date & Time	Event	Argument
Wed, 03 July 2024		
13:42:21:540	PROCESS STARTED	**00000** (00000-00999, Design Data)
13:42:21:553	JOB STARTED	**pilOPT**, job_out, job_err, JVM Logs, Input Data, Dir
13:42:21:560	MESSAGE	pilOPT: Running as process fork
13:42:37:242	MESSAGE	pilOPT: Job process disposed
13:42:37:242	JOB EXITED	**pilOPT**, job_out, job_err, JVM Logs, Input Data, Output Data
13:42:37:247	JOB STARTED	**MOGA**, job_out, job_err, JVM Logs, Input Data, Dir
13:42:37:249	MESSAGE	MOGA: Running as process fork
13:42:47:120	MESSAGE	MOGA: Job process disposed
13:42:47:120	JOB EXITED	**MOGA**, job_out, job_err, JVM Logs, Input Data, Output Data,
13:42:47:171	PROCESS EXITED	**00000** (00000-00999, Design Data) ELAPSED TIME = 0h:0m:25.

Step 3

Run the main workflow.



Design Files

Design ID 0 Synchronize

Name	Last modified	Size
00000 [proc]	03/07/2024 01:42 PM	
MOGA_00000	03/07/2024 01:42 PM	
pilOPT_00000	03/07/2024 01:42 PM	
00000 [log]	03/07/2024 01:42 PM	
MOGA_00000	03/07/2024 01:42 PM	
pilOPT_00000	03/07/2024 01:42 PM	
designdata.html	03/07/2024 01:42 PM	248.3 kB
designlog.html	03/07/2024 01:42 PM	5.2 kB

Step 4

Full results of both sessions are available in dedicated folders.

Enhanced integration with engineering applications


Abaqus FEA


Adams/Car


Adams/View


Ansa


ANSYS Workbench


ASMI


AVL AST


CATIA


COMSOL


CREO Elements/Pro


CST Microwave


Dymola

ESI


Excel


FMI


Grasshopper


GT-Suite


Hypermesh


JMAG designer


Keysight ADS


Keysight empro


LightTools


Madymo


Maplesim


Mathcad Prime


MATLAB


Metapost


MSC Nastran


Python


Romax Designer


ROMbox ESTECO


SFE Concept


Simcenter 3D


Simcenter Amesim


Simcenter Flowmaster


Simcenter StarCCM+


SimulationX


SolidWorks


SolidWorks flowsimulation

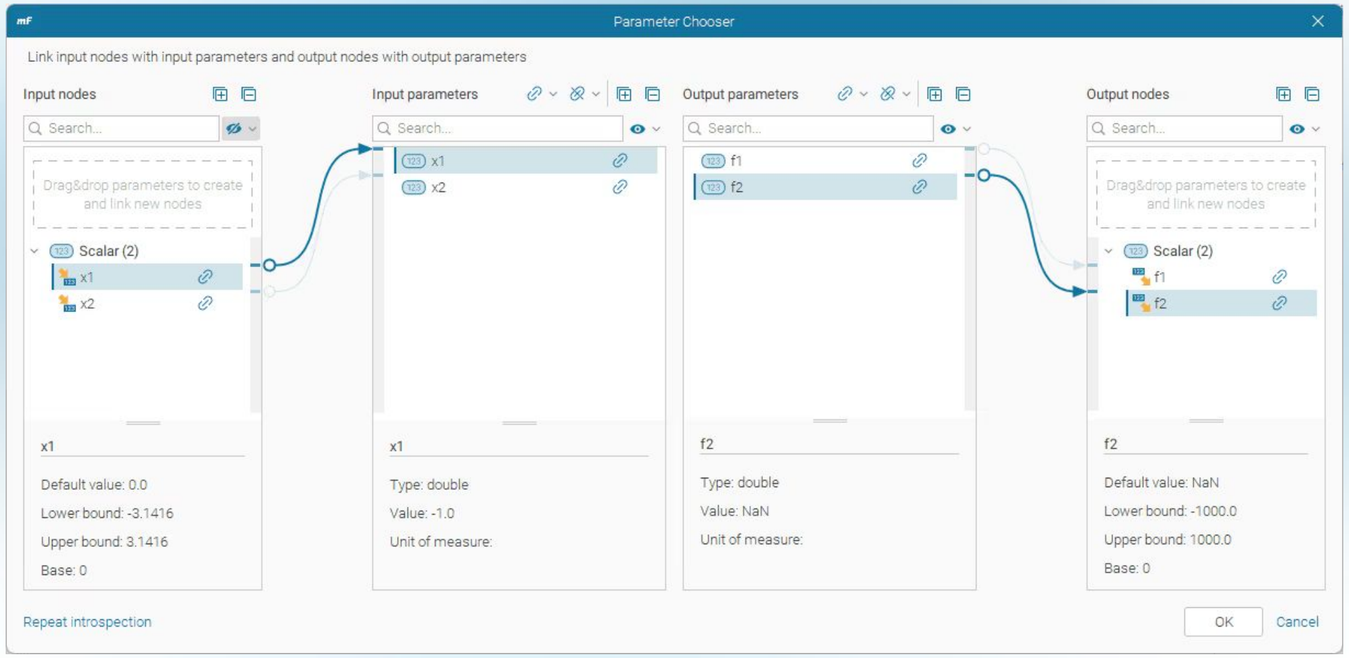

SpaceClaim


Wave


VOLTA ESTECO

New parameter chooser

Gain efficiency and control in linking your model parameters to the modeFRONTIER workflow.

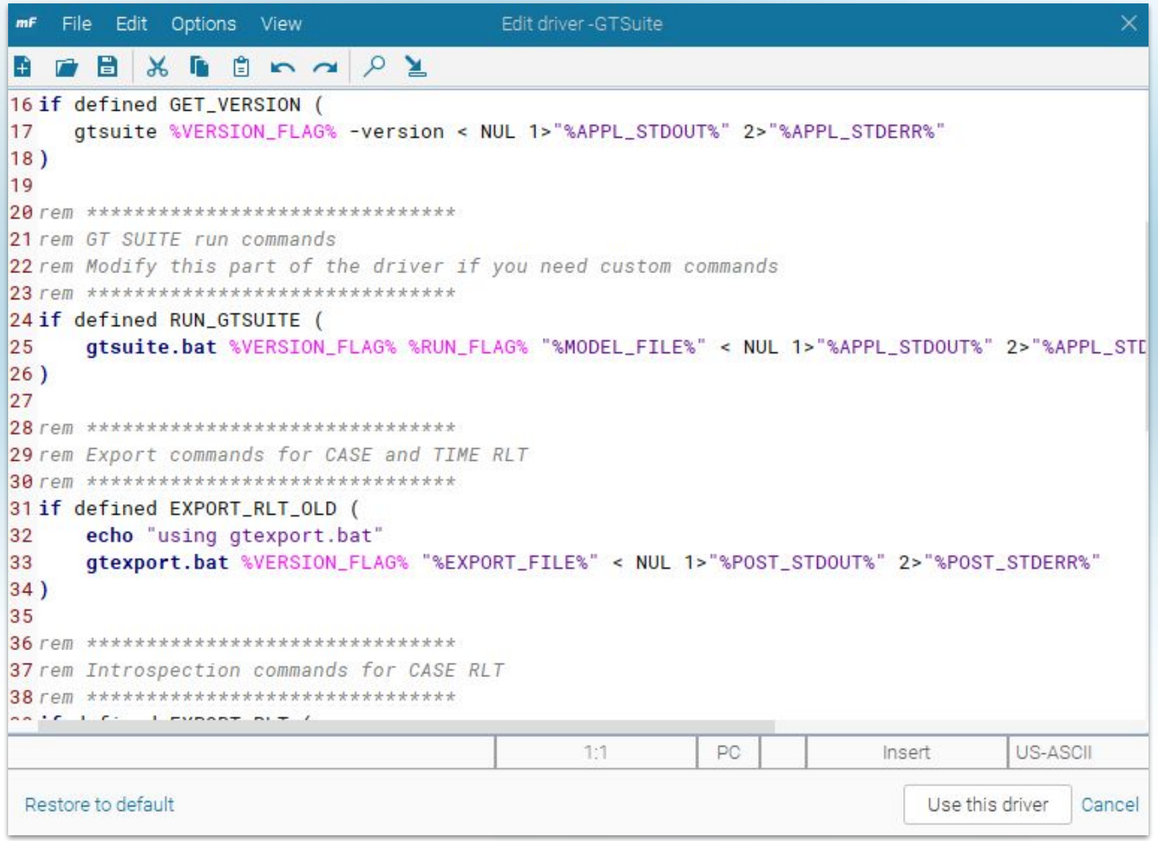


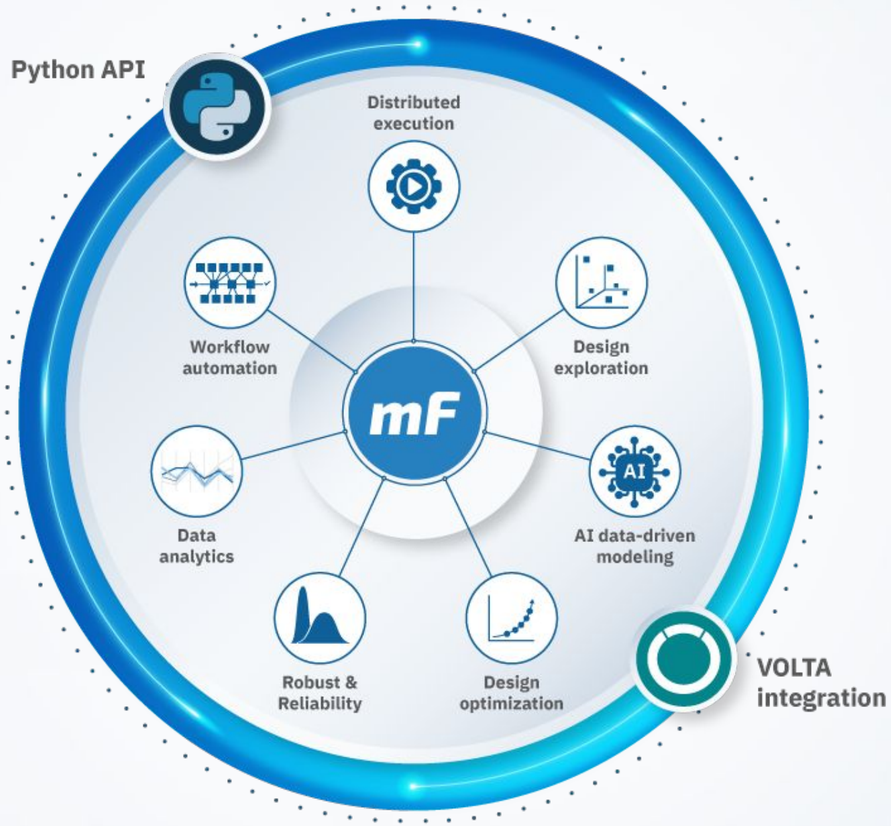
- Side-by-side visualization: easily compare inputs and outputs.
- Flexible workflow building: view and link any data node in the workflow.
- Streamlined navigation and filtering: quickly find and connect nodes and parameters.
- Automatic linking of parameters and nodes: reduce time and effort.
- Enhanced visualization of linked items.

Test run feature extended to CAD/CAE connectors

Verifying integrated software communication and custom driver by running a design with default/custom values and validating outputs.

- **Abaqus FE**
- **Adams/Car**
- **Adams/View**
- **Ansa**
- **ANSYS Workbench**
- **AVL AST**
- **CATIA**
- **CST Microwave**
- **GT-Suite**
- **Metapost**
- **Simcenter Amesim**

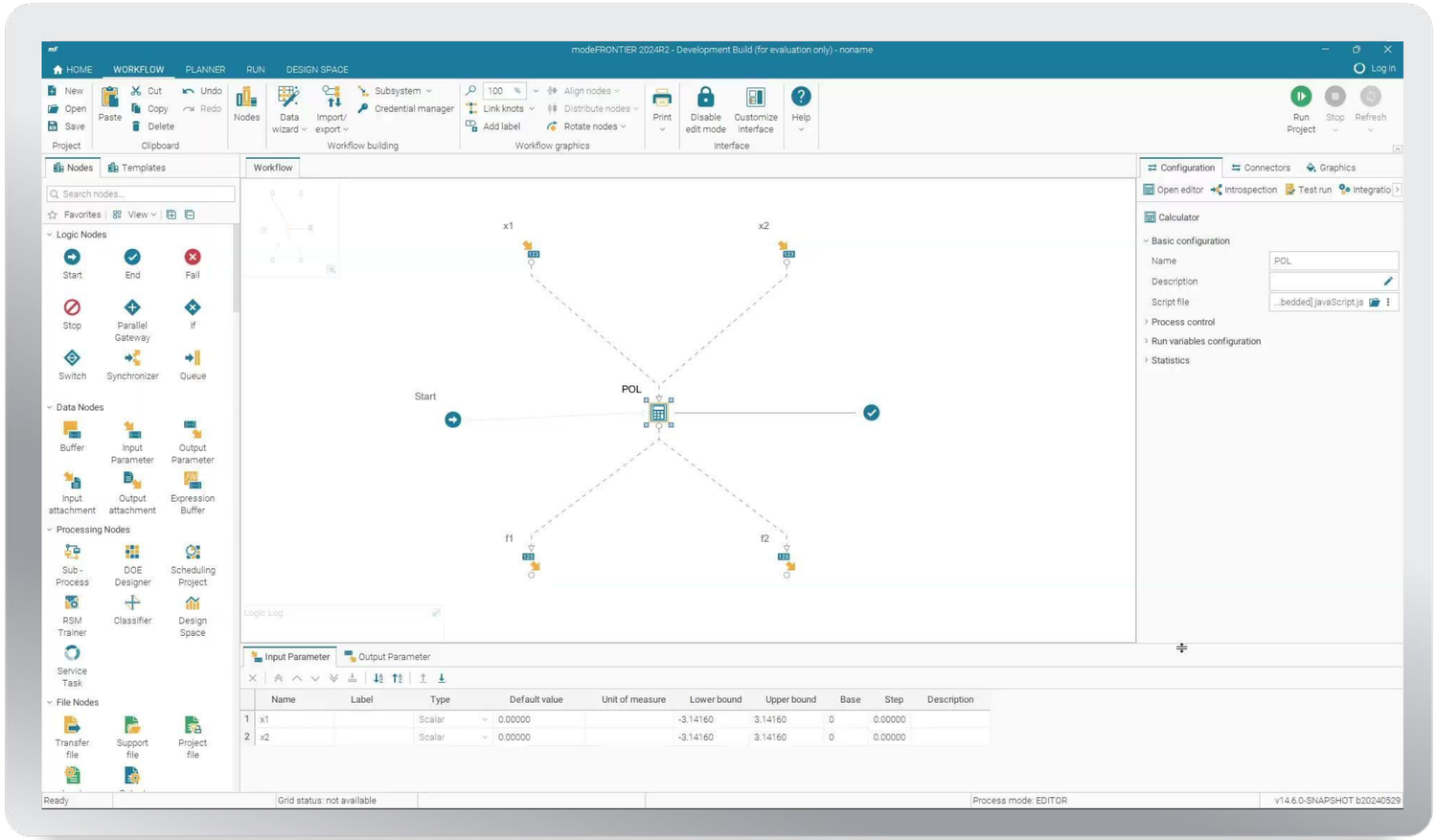




Deeper python integration (pyFRONTIER, pyCONSOLE, pyDOE, pyRSM and pySCHEDULER) for scripting and customization.

pyFRONTIER

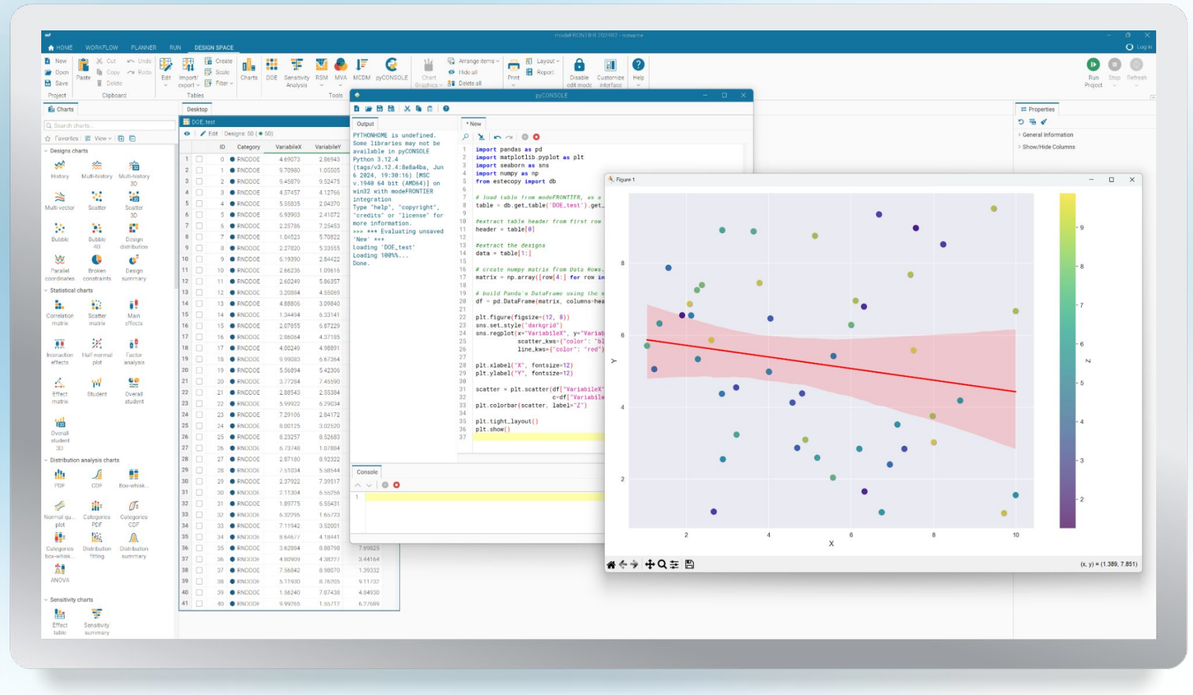
Interactive access to modeFRONTIER from an external Python interpreter (IDE or external solver) through a dedicated set of Python APIs.



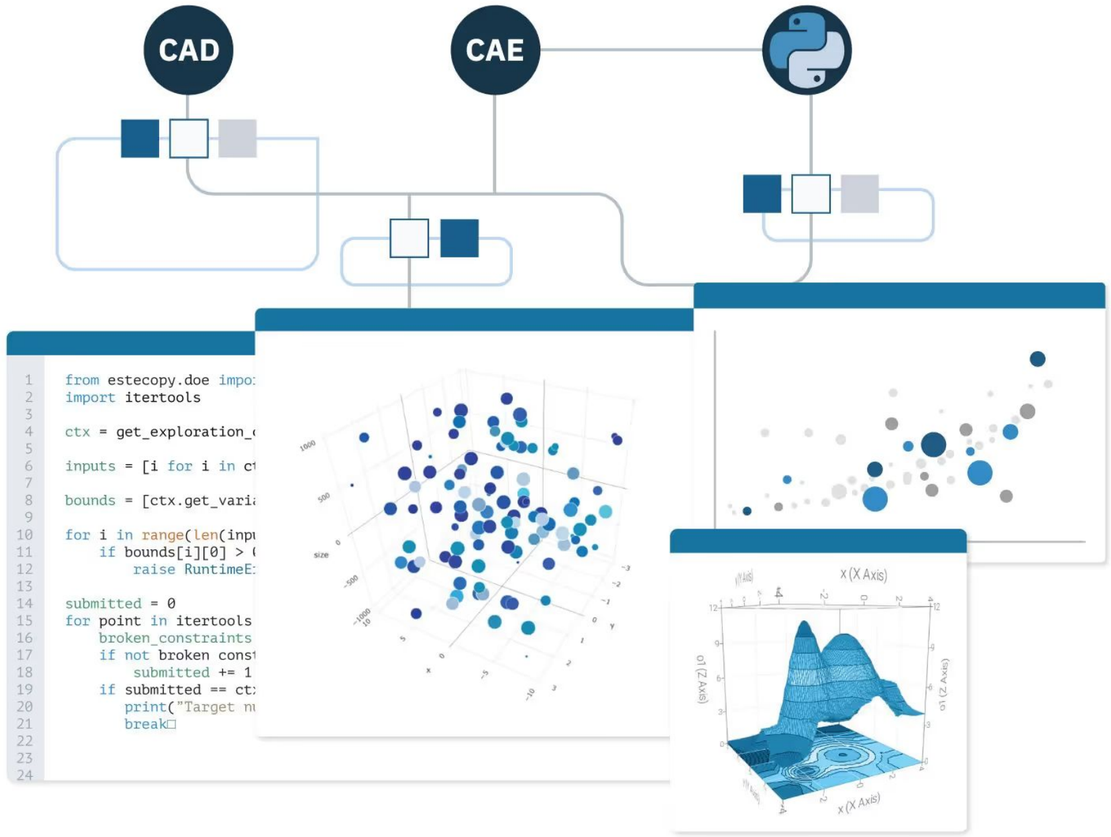
pyCONSOLE

It extends modeFRONTIER’s capabilities, adding the power of Python for more flexible and efficient design exploration.

- Seamlessly integrated Python shell within modeFRONTIER's design space, for direct access to design variables, objectives, and constraints
- Enabling real-time data manipulation and analysis, by leveraging Python's extensive libraries for enhanced functionality
- Ideal for quick prototyping and debugging



Import and train your Python algorithms

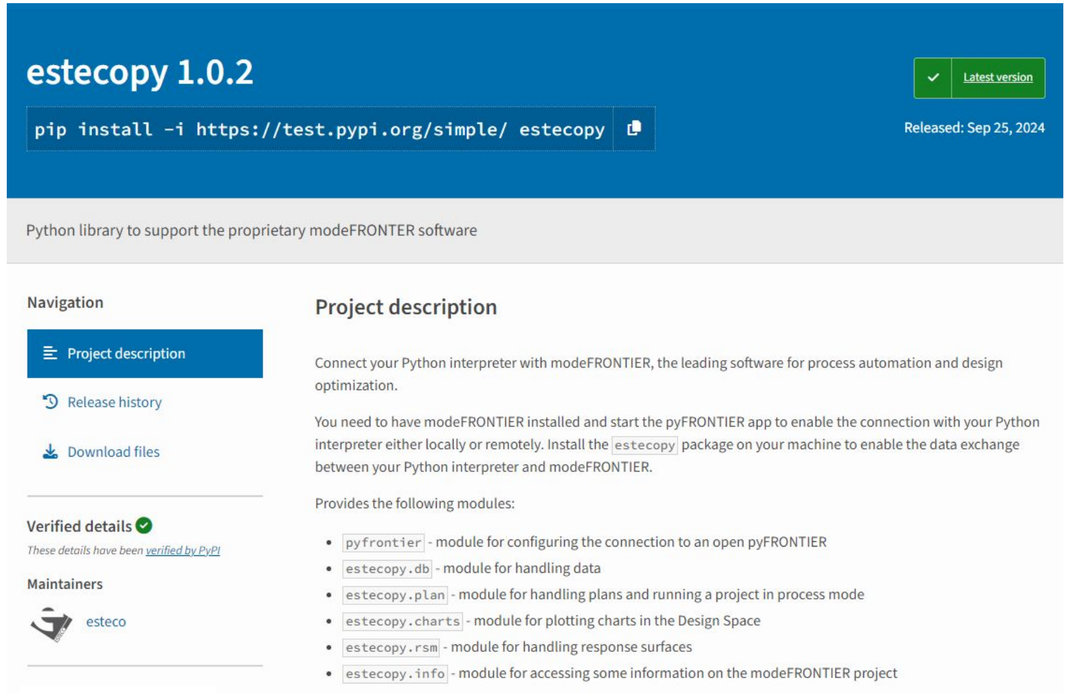


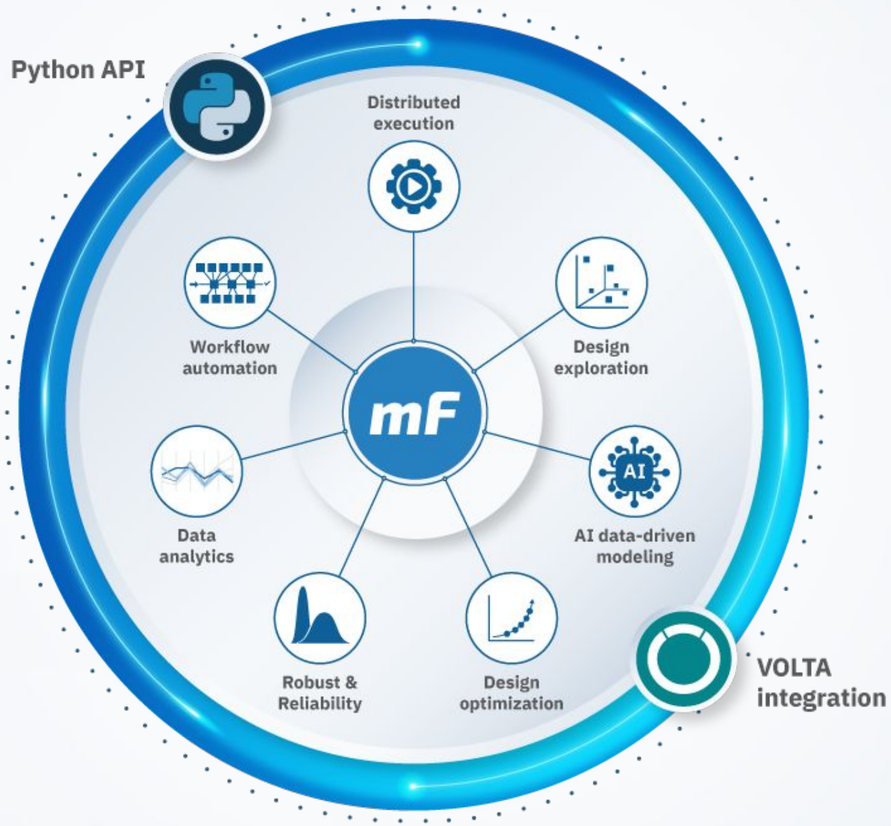
- **pyDOE**: write your own or use built-in Python algorithms to create a set of DOE design configurations
- **pyRSM**: use external Python ML libraries (i.e. scikit-learn) to perform RSM analyses
- **pySCHEDULER**: leverage external Python Scientific and ML libraries (i.e. SciPy optimize) to perform design optimization

Enhanced accessibility with estecopy on pip

The estecopy library is now accessible on pip, the Python package manager. This makes it easier for you to install and use the library.

- Increased accessibility: easily access and utilize the **estecopy** library.
- Improved efficiency: the simplified integration process allows for quicker and more efficient interaction with modeFRONTIER.



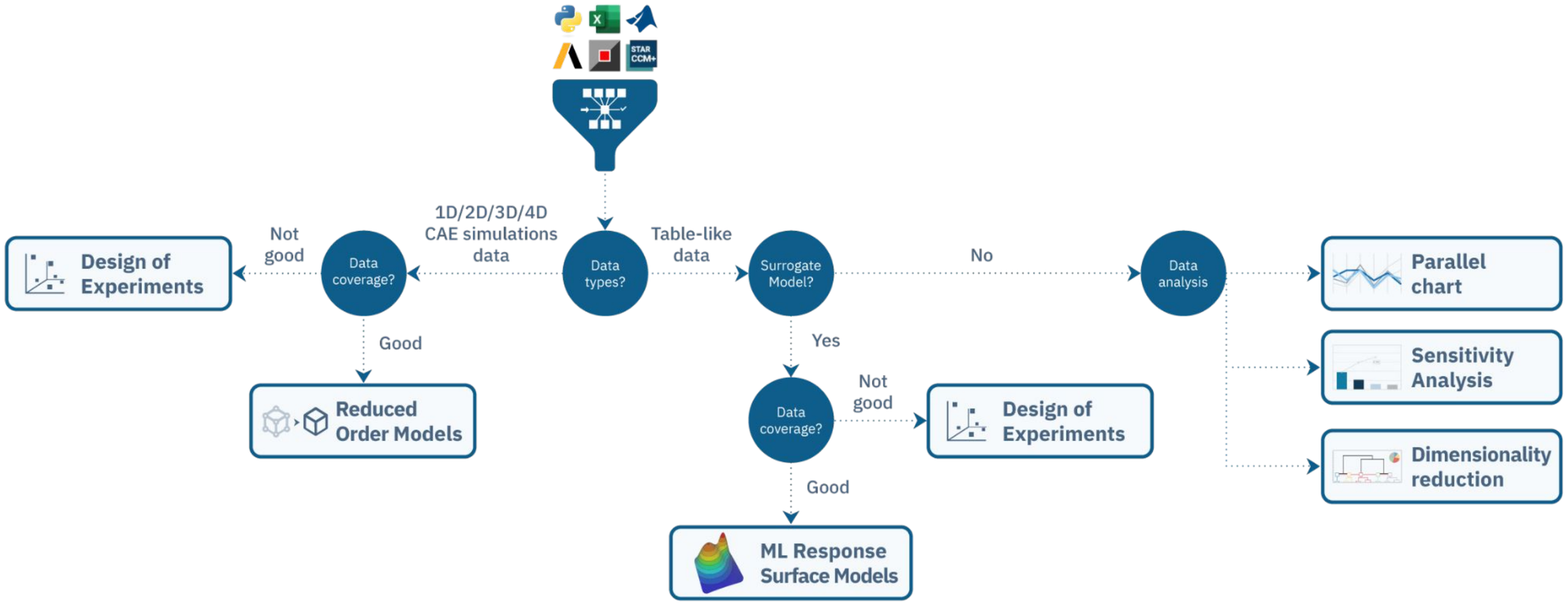


- Reduced Order Models (ROM) capabilities

- New algorithms: Multi-fidelity RSM and MUSA optimizer

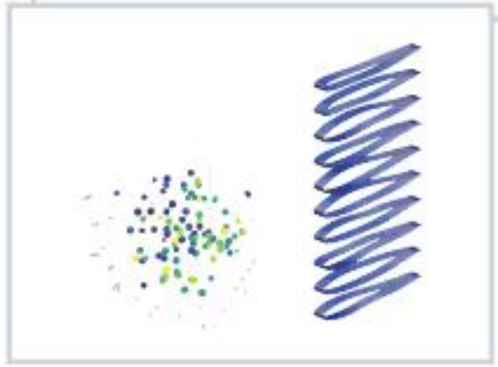
The modeFRONTIER AI/ML process data flow

Enabling the development of computationally efficient surrogate models that expedite the exploration of complex designs spaces.



Explainable AI for Reduced Order Models (ROM)

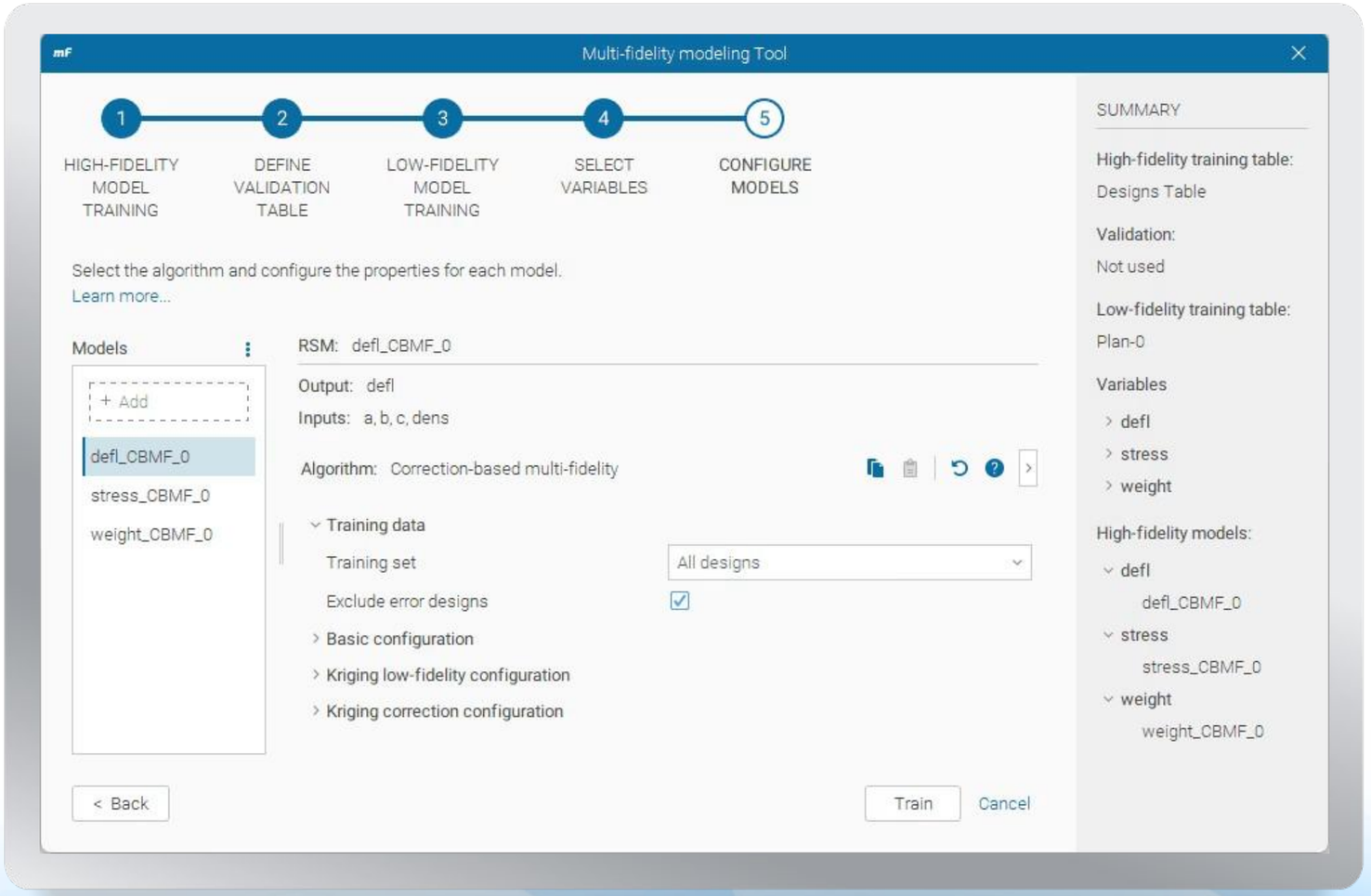
Build CAE datasets and automate ROM training with modeFRONTIER.



CAE datasets

New Multi-fidelity RSM algorithm

Bridge the gap between rapid computation and high accuracy. Integrate knowledge extracted from high-fidelity simulations with low-fidelity data.



Real-world impact

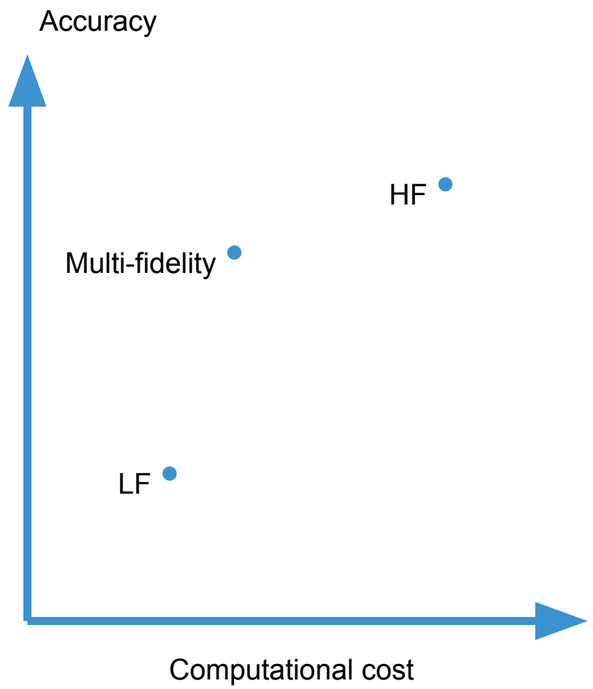
Benefits and applications in real design problems.

Benefits:

- Overall affordable computational cost.
- Improved accuracy over LF alone.
- Better coverage than HF alone.

Applications:

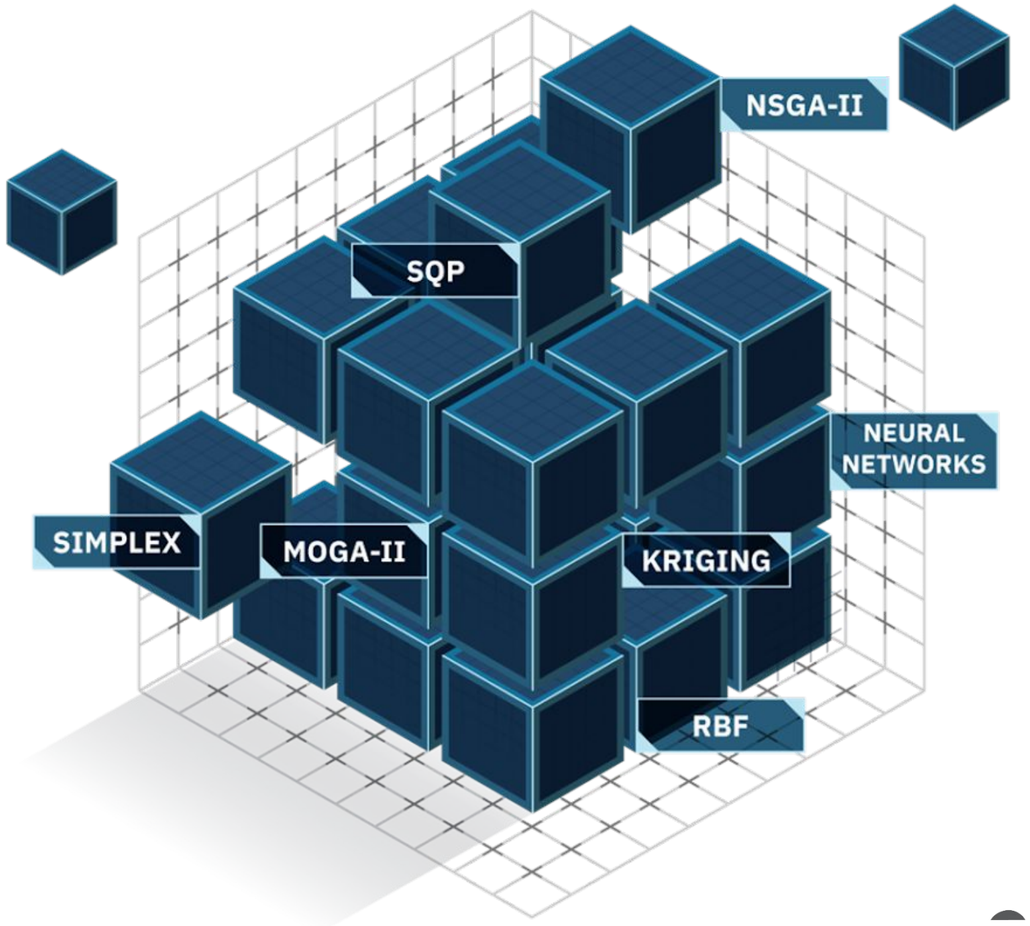
- Aerodynamic design optimization.
- Structural analysis.
- Any field with expensive simulations.



A new optimization algorithm: MUSA

Unique island-based architecture
MUSA enhances population diversity, reduces computational time, and supports both continuous and discrete variables.

Leveraging RSM-based optimization
MUSA integrates global search algorithms (MOGA-II/NSGA-II) with local refinement techniques (Simplex/AFilterSQP/NBI-AFSQP), delivering robust performance in complex design spaces.



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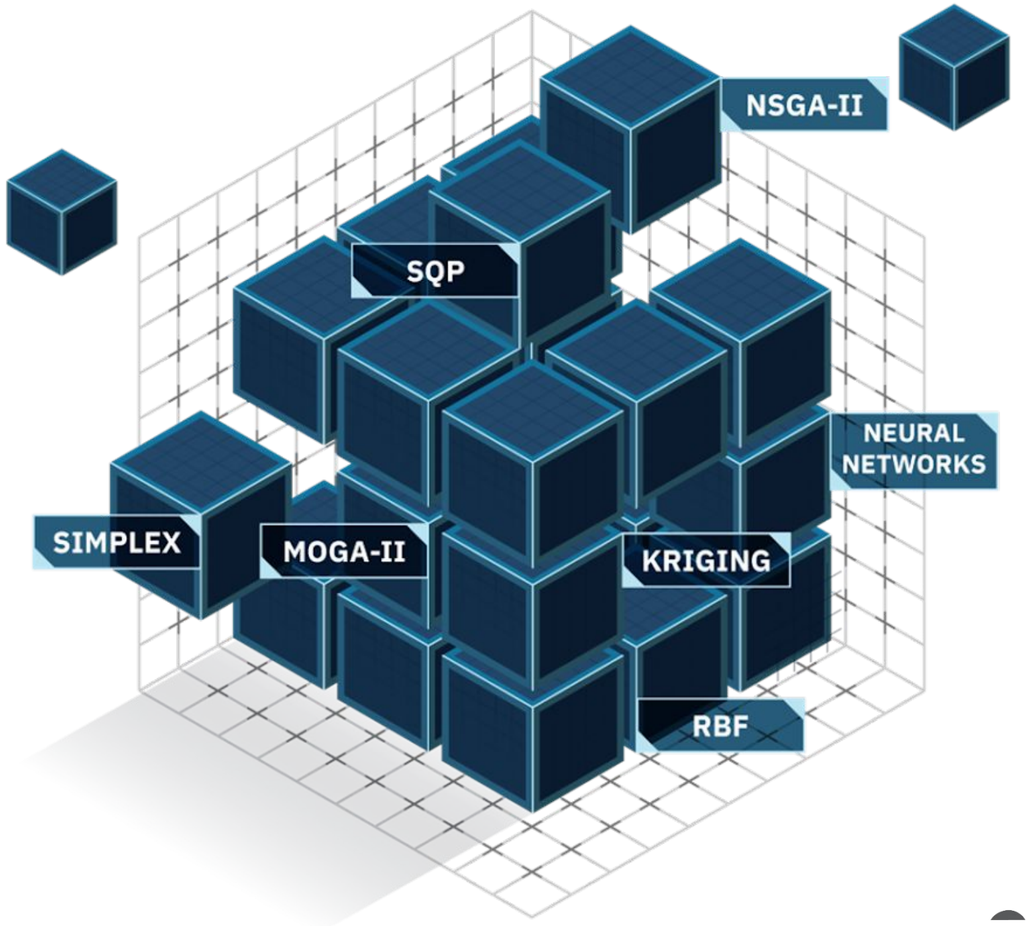
MUSA: how it works

1. Hybrid Global-Local Search Architecture

MUSA integrates MOGA-II/NSGA-II for global exploration with Simplex/AFilterSQP/NBI-AFSQP for local refinement, balancing exploration (diverse solutions) and exploitation (precision).

2. Island-based parallelism

By partitioning populations into semi-isolated “islands”, MUSA enables parallel computation, each island operating independently.



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MUSA: how it works

3. Dynamic RSM competition

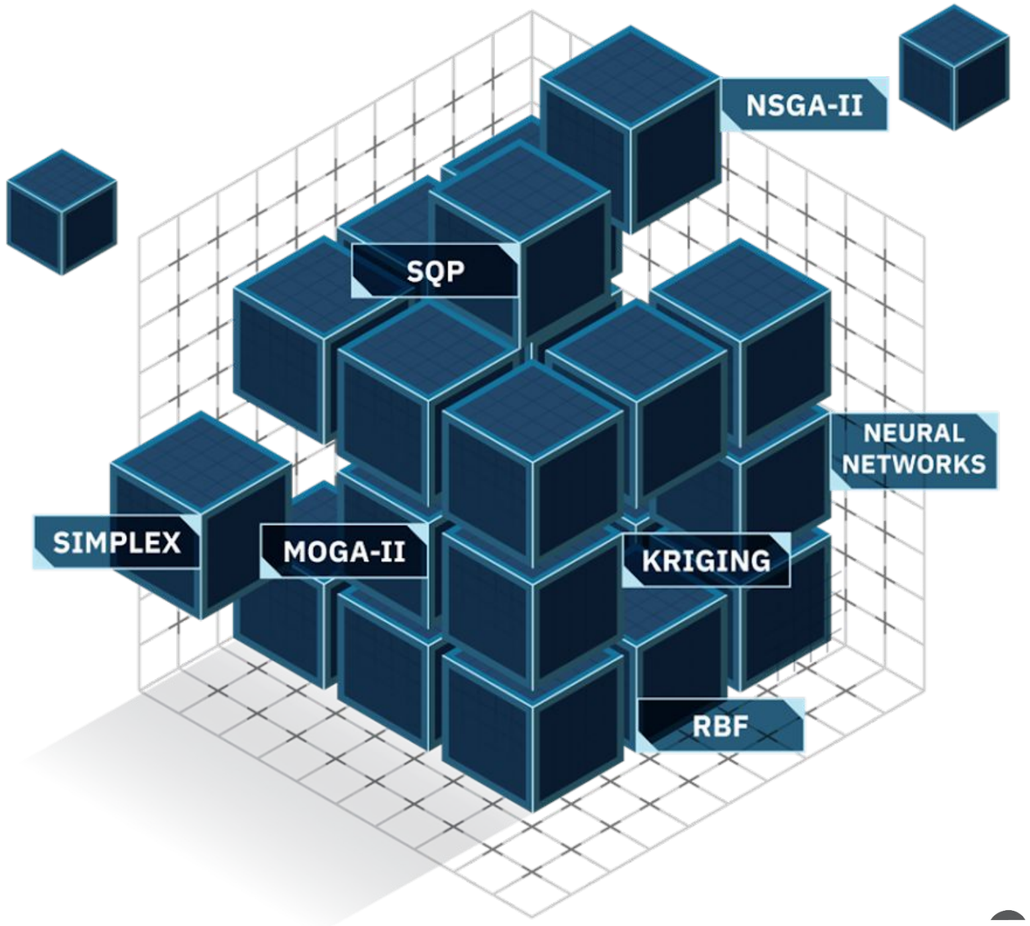
MUSA simultaneously trains RSM (Kriging, RBF, etc.) and selects the most accurate model per iteration.

4. Constraints Handling

Native support for gradient-based constraints.

5. Parameters

MUSA dynamically adapts to user-defined probabilities for: global/local search ratio, virtual optimization probability, RSM training set.



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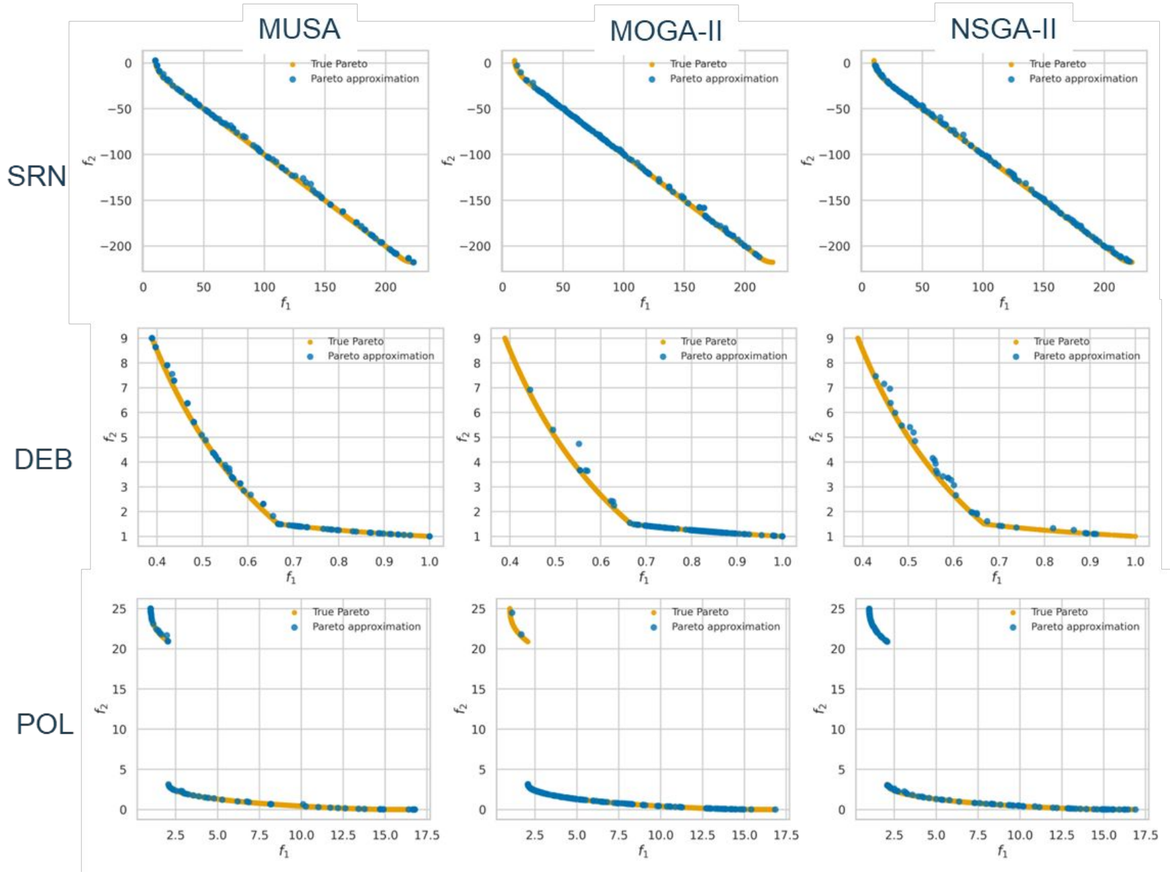
MUSA: 2-dim problem with 2 objectives

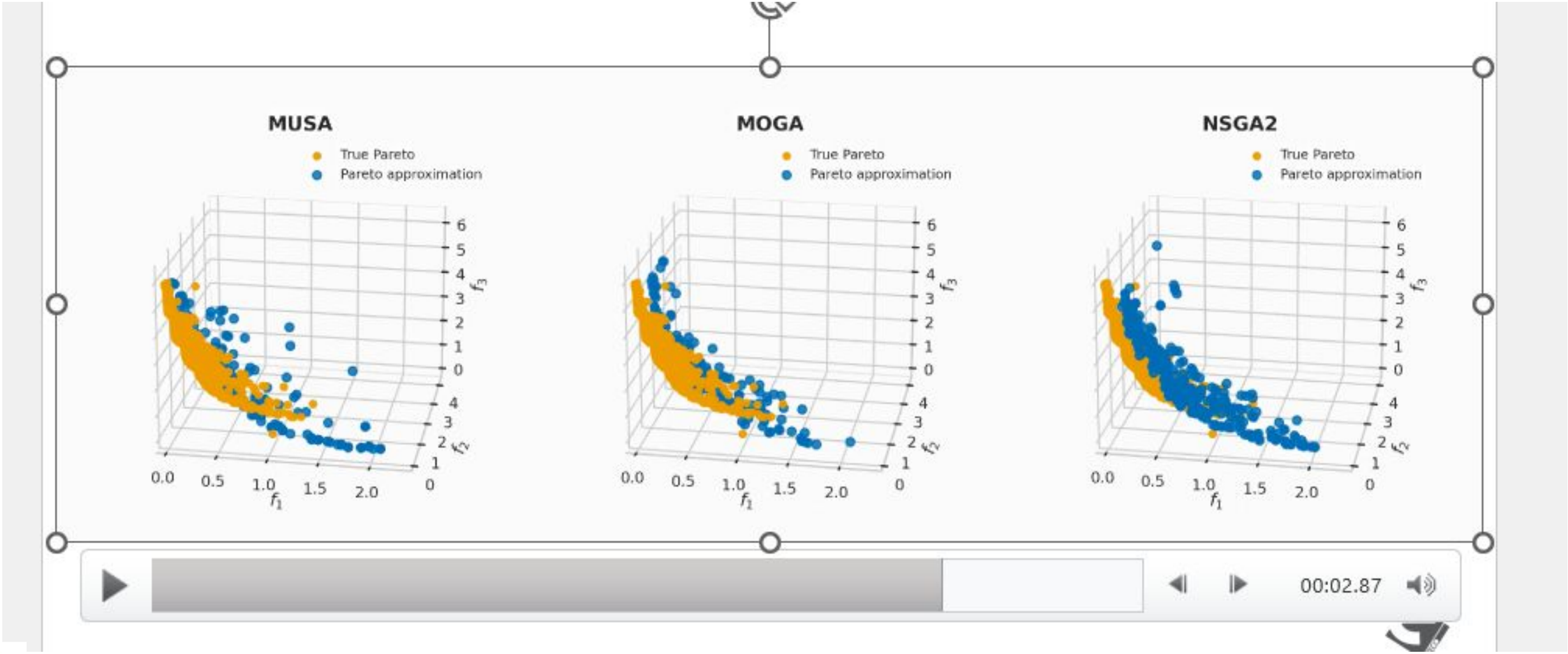
MUSA is able to leverage the best behaviors from both MOGA-II and NSGA-II at the same time.



DEB: Kalyanmoy Deb et al. “A fast and elitist multiobjective genetic algorithm: NSGA-II”. In: IEEE transactions on evolutionary computation 6.2 (2002), pp. 182–197
SRN: N Srinivasan and K Deb. “Multi-objective function optimisation using non-dominated sorting genetic algorithm”. In: Evolutionary Comp 2.3 (1994), pp. 221–248
POL: Carlo Poloni et al. “Hybrid ga for multi objective aerodynamic shape optimisation”. In: Genetic algorithms in engineering and computer science. John Wiley & Sons Ltd, 1995, pp. 397–415

MUSA: 2-dim problem with 3 objectives

This capability is even more evident in high-dimensional problems.



modeFRONTIER Roadmap 2026/2027

TODO

Multi-fidelity RSM export
Python and FMU

Parameters in Session tables
Visualize parameters in post processing

Error and exception events in the wf
Workflow-level events management

DOING

myRSM
Save, distribute and reuse your Python RSMs inside modeFRONTIER

ROM Training module
Train ROM from modeFRONTIER tables

DONE

Automated tagging for script nodes
Matlab and Octave

RSM training in the Planner
Schedule RSM training in your Plan

Connectors manager
Create your own direct interfaces

Multi-fidelity RSM export
Excel

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