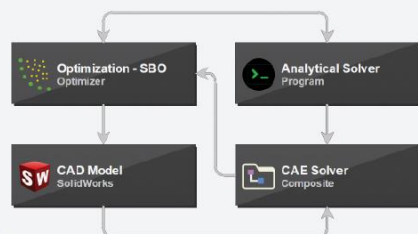
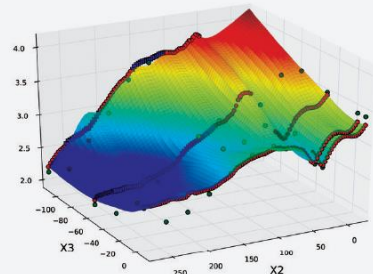




DESIGN SPACE EXPLORATION FOR EVERY EXPERTISE



What's New in pSeven 6.12-6.14

Dmitry Frolov
DATADVANCE

October, 2018

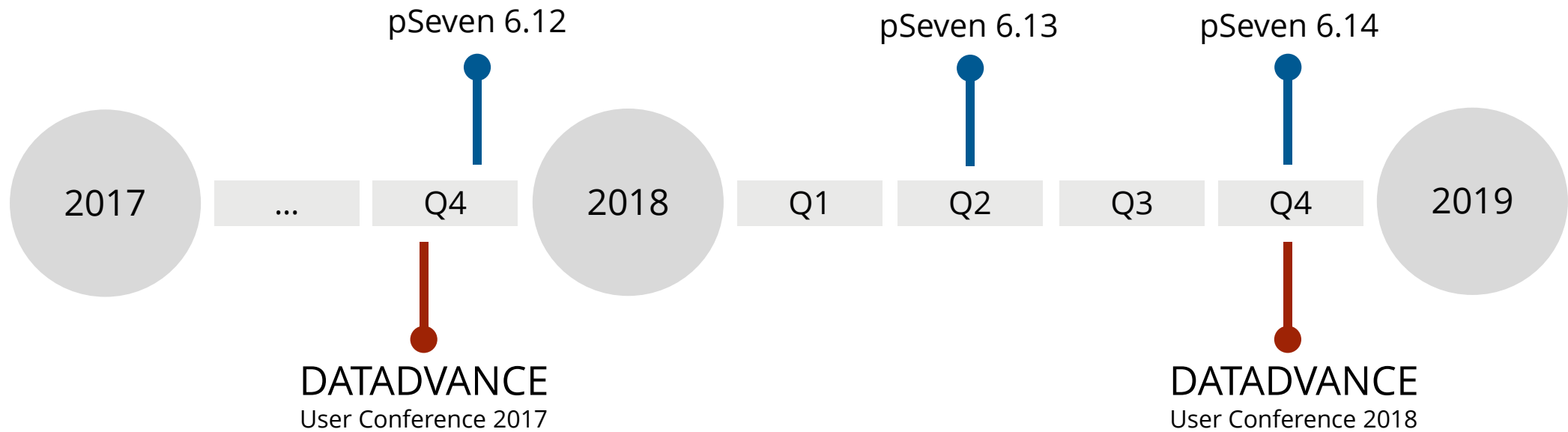


DATADVANCE



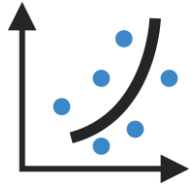
Release retrospective:

- 3 releases came out after the user conference in 2017
- Approximate release frequency is 2 per year

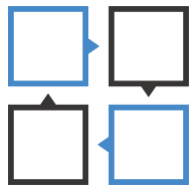




Design Space Exploration Enhancements



Predictive Modeling Enhancements



New Integration Capabilities



Appearance, Usability & Performance Improvements

Why Do Design Space Exploration?



Design Space Exploration allows engineers to:

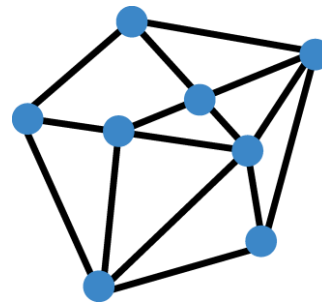
- Develop **trust** in their models
- Explore design **alternatives**
- Perform **trade-off** studies
- **Discover** bottlenecks
- **Identify** models
- Set **goals**

“Design Space Exploration is both a class of quantitative methods and a category of software tools for **systematically** and **automatically** exploring very large numbers of design alternatives and identifying **optimal** performance parameters.”

B. Jenkins, Ora Research



1. Create model



2. Apply Design Space Exploration



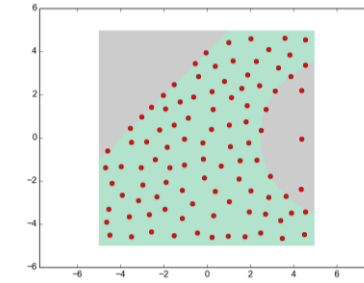
3. Make smart decisions



Adaptive Design of Experiments in 6.12:

■ Feasible domain sampling:

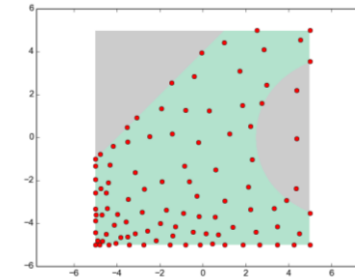
- Setup: variables and bounds, linear and non-linear constraints
- Result: uniform sample in feasible domain



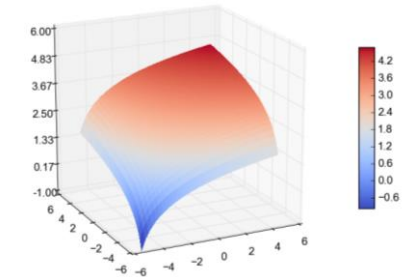
Feasible domain sampling

■ Response surface improvement:

- Setup: variables and bounds, linear and non-linear constraints, objective function
- Result: sample in feasible domain for better objective function approximation



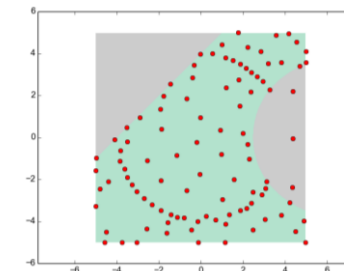
Response surface improvement



Objective function

■ Search for designs with given objective function value (Level set):

- Setup: variables and bounds, linear and non-linear constraints, objective function and its required value
- Result: sample in feasible domain with given value of objective function

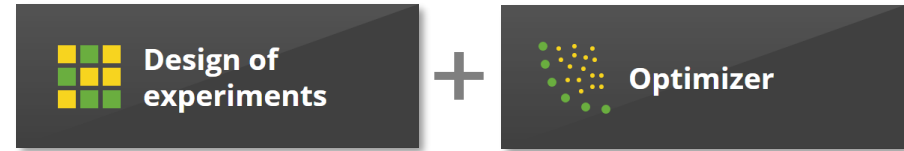


Level set



Brand new Design Space Exploration block:

- One block for all your exploration and optimization needs
- Evolution of *Design of Experiments* block combined with *Optimizer* functionality
- Unified setup for:
 - Parametric studies
 - Design of Experiments (DoE)
 - Adaptive Design of Experiments (ADoE)
 - Optimization
- *Optimizer* block is now legacy:
 - Robust and reliability-based design optimization is still conducted in *Optimizer*



The screenshot displays the 'Configure: Design space exploration' window. At the top, it shows 'Technique: Full factorial design' and 'Options: All options are default.' Below this is a 'Variables' table:

Size	Lower bound	Upper bound	Levels
1	0.0	10.0	
1			(1.0, 2.0, 3.0)
2			(A, B)

Below the table, there are sections for 'Responses' (listing F1 and F2) and 'Parallel Coordinates' (showing plots for Nozzle diameter, Nozzle angle, 1st flow velocity, 2nd flow velocity, and Pressure drop). A 'Design space exploration' block is overlaid on the left side of the interface. A red circle with the text 'New in 6.14' is positioned on the right. At the bottom, there are two plots: a scatter plot of red dots in a green-shaded region and a line plot showing a function with local and global minima.

New
in 6.14



DSX block setup:

SmartSelection mode:

- Automatically and adaptively chooses the most effective technique
- Proposes number of design points (budget)
- Now also available for DoE and ADoE
- Activated by a button

Manual setup:

- Options hierarchically grouped from basic to advanced
- Explicit choosing between:
 - Gradient-Based and Surrogate-Based Optimization
 - Globalization and local algorithms for Gradient-Based Optimization
- Filtering of Pareto-optimal designs from any study

Other DSX improvements:

New sample-based ADoE technique:

- No model needed (simulation, analytic etc.), data is enough
- Uses datasets as input and suggests the best possible new variant

Support for categorical variables

Configure: Design space exploration (Design space exploration)

Technique: **Latin hypercube sampling** Options: All options are default.

Name	Type	Size	Lower bound	Upper bound	Levels	Constant	Value
X1	Continuous	1	0.0	10.0		<input type="checkbox"/>	
X2	Continuous	1	0.0	5.0		<input type="checkbox"/>	
X3	Continuous	1	5.0	15.0		<input type="checkbox"/>	

Filter...

Number of designs: Auto Hints: +

Name	Type	Size	Lower bound	Upper bound	Value	Function	Blackbox
F1	Evaluation	1				Generic	<input checked="" type="checkbox"/>
F2	Evaluation	1				Generic	<input checked="" type="checkbox"/>

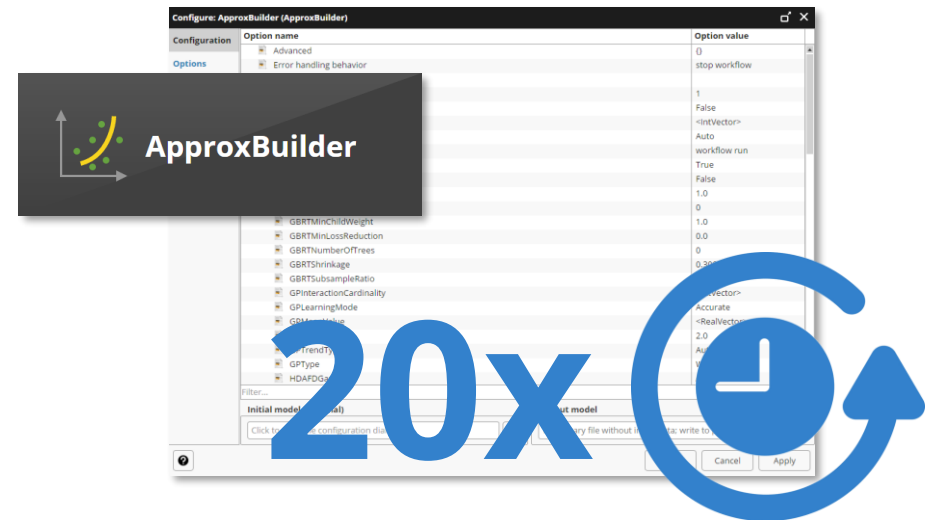
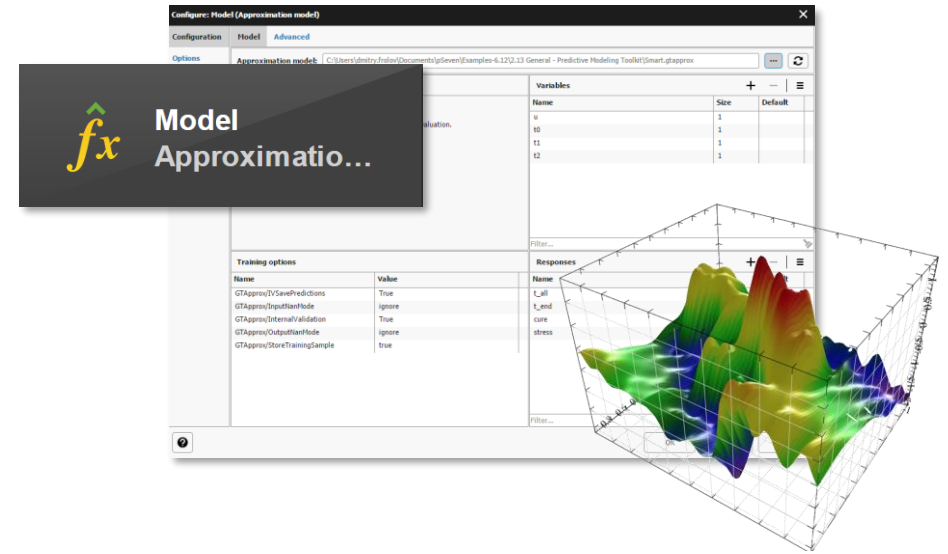
Filter...

Run options Ports and parameters OK Cancel Apply



Building and using models:

- **Approximation model:**
 - Seamless integration of approximation models into workflows
 - Automatic creation of input and output ports
 - *ApproxPlayer* is now a legacy block
- **ApproxBuilder block:**
 - Support of variables names (enhanced usability)
- **Model Builder in Analyze:**
 - Limit SmartSelection to use only specified techniques
- **20x SPEED UP for building models:**
 - Faster up to 20x times for small and big models
 - Very effective for models with big number of outputs (200+)
 - Different outputs are trained in parallel

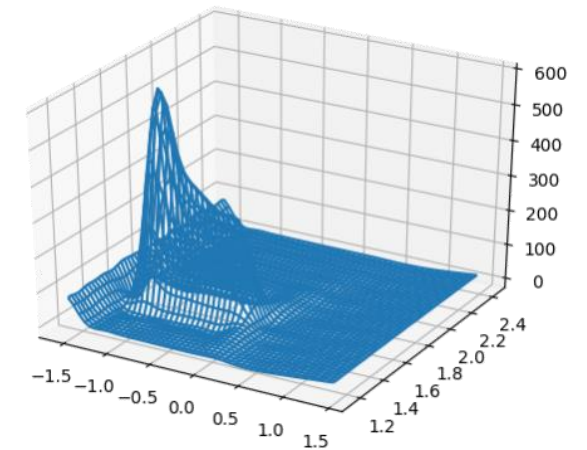
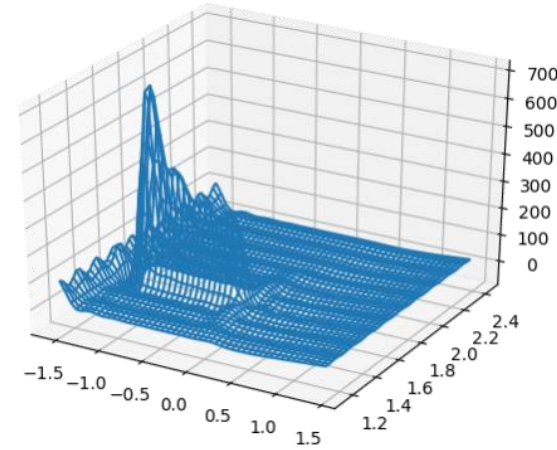




Approximation techniques improvements:

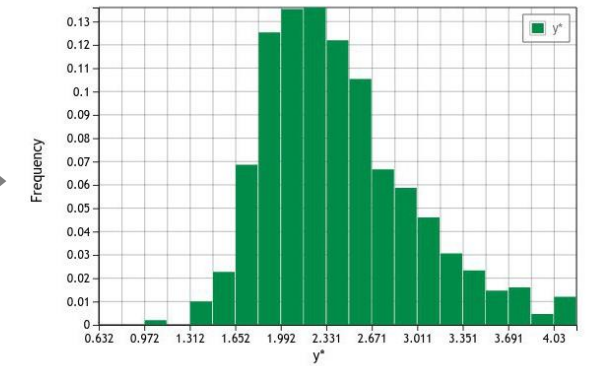
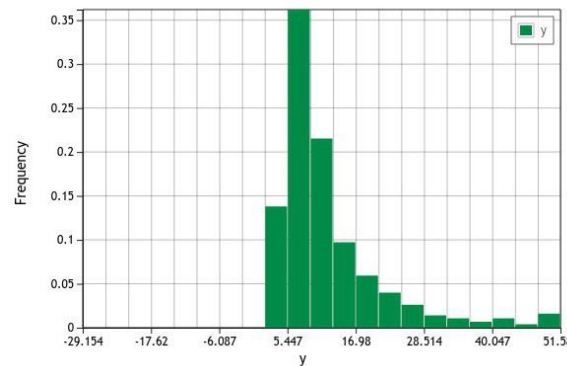
■ Model landscape analysis:

- Helps to avoid oscillations
- Chooses the best approximation technique according to the expected landscape of the model



■ Logarithm of outputs:

- Used when outputs has exponential dependency where low and high values are equally important
- Allows to build more accurate approximation models

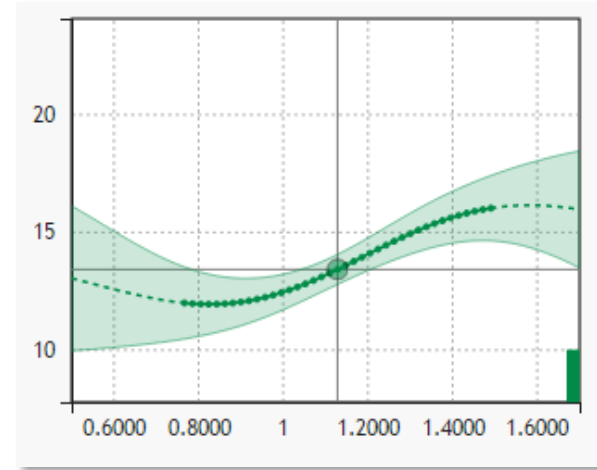




Model Explorer enhancements:

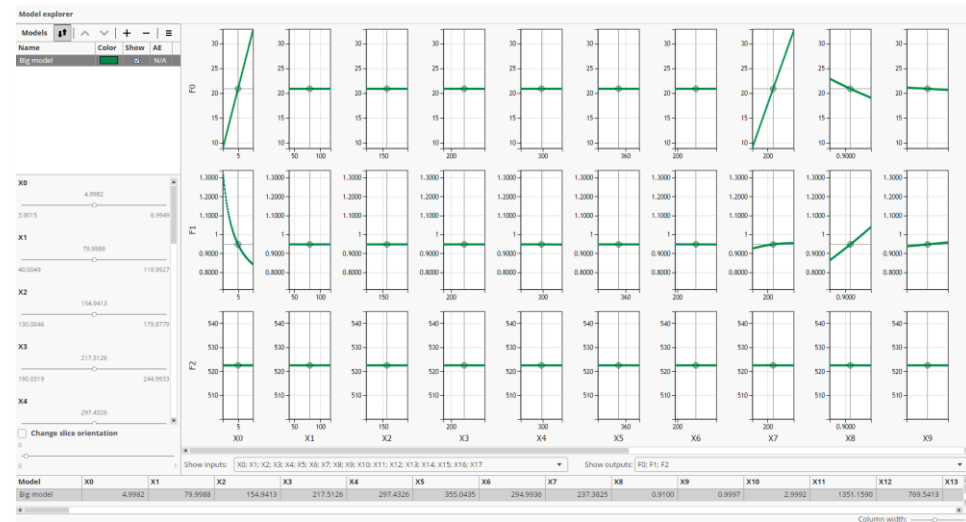
■ Extrapolation:

- Extrapolation of approximation model predictions
- Combined with accuracy estimation provides more insight into approximation model behavior



■ Usability:

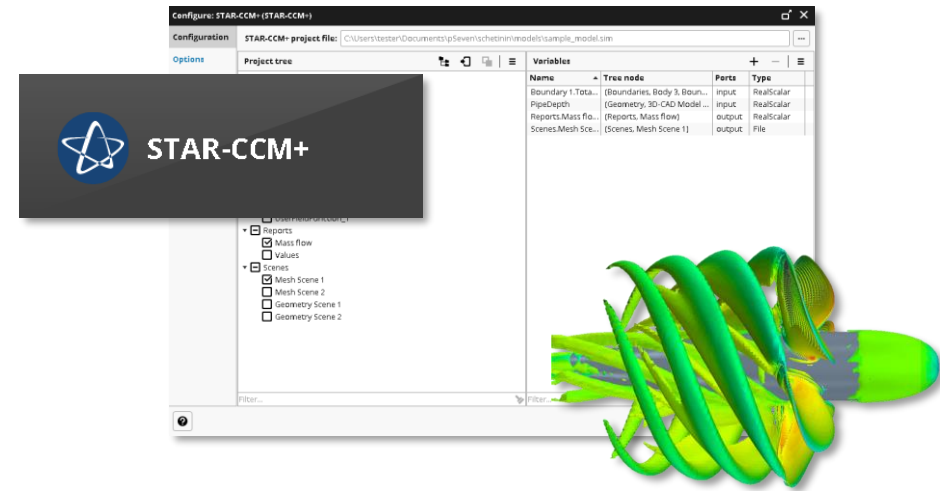
- Visualization of high-dimensional models (100+ parameters)
- Support of categorical variables
- Model reloading time is significantly reduced





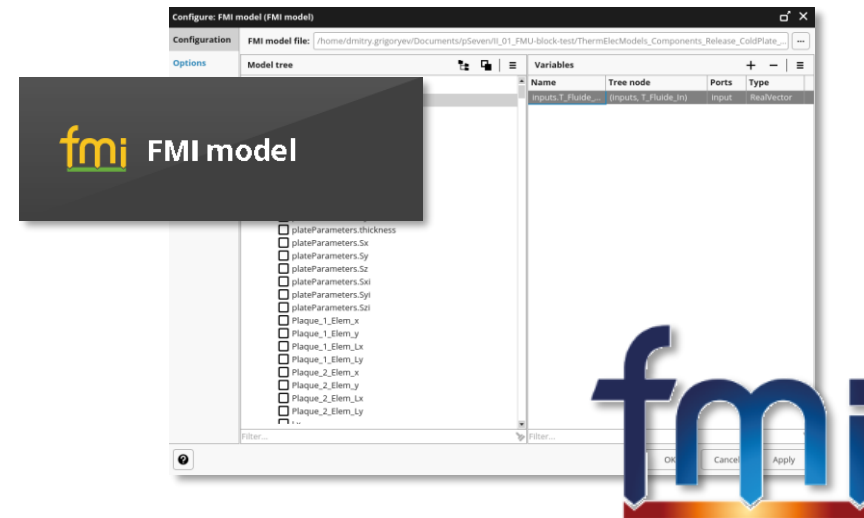
New STAR-CCM+ block:

- Direct integration with all StarCAD, CFD and Turbo Wizard (.trbw) parameters
- Supports macros and remote execution
- Thermal and stress parameters currently not supported (can be implemented by demand)



New FMI model block:

- Supports FMI Version 1.0 & 2.0
- Supports FMI for Co-Simulation only
- Smooth operation with even 10 000+ of parameters

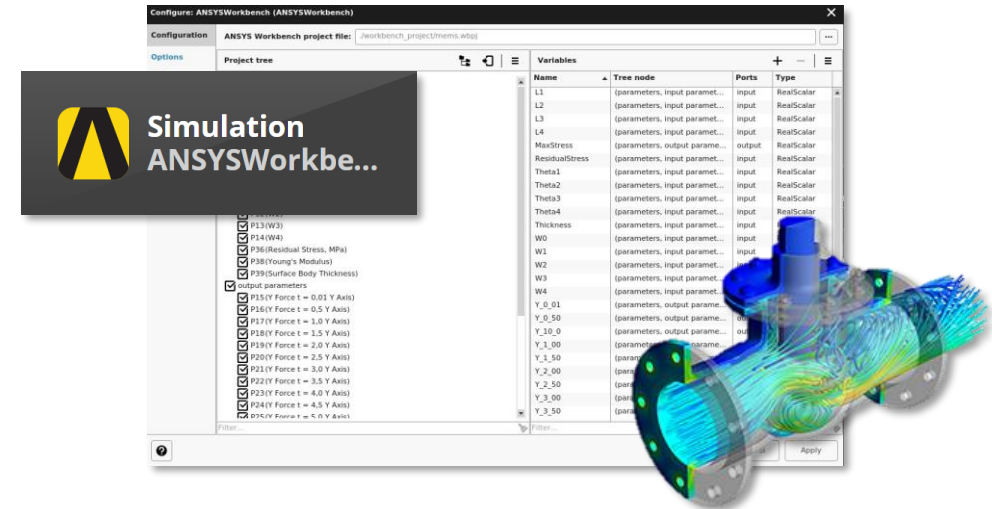




CAD/CAE blocks enhancements:

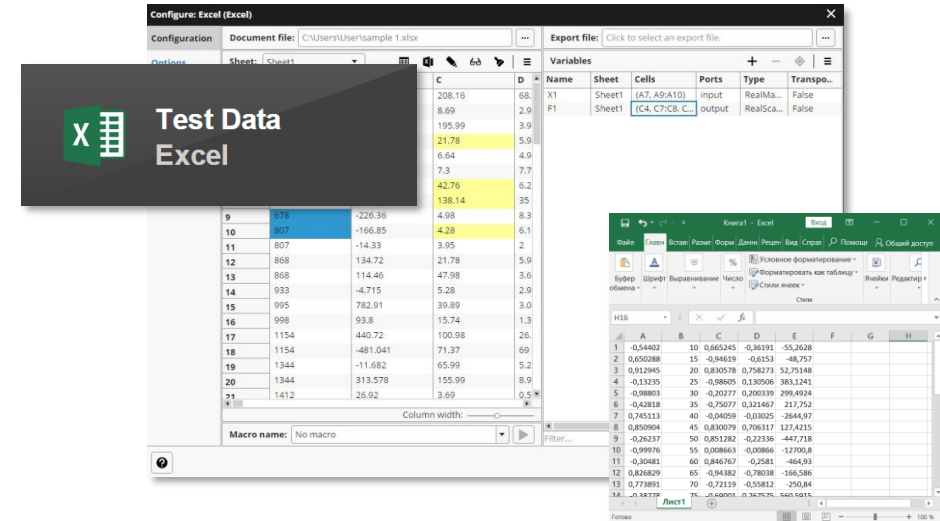
■ ANSYS Workbench:

- Capability to process batches of input parameters
- Support of *ANSYS HPC Parametric Pack* licenses
- Run several instances of the block with different projects simultaneously



■ Excel:

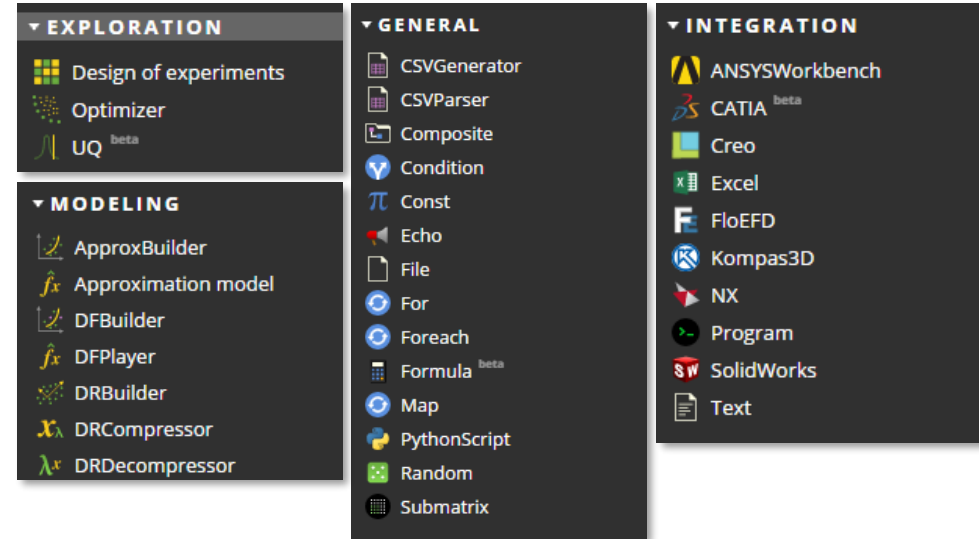
- Read values of variables from disjoint selections
- Write data from a single variable to disjoint selections
- Execute excel macros directly in block
- Due to optimization of Excel block's architecture import of big files now takes only few seconds





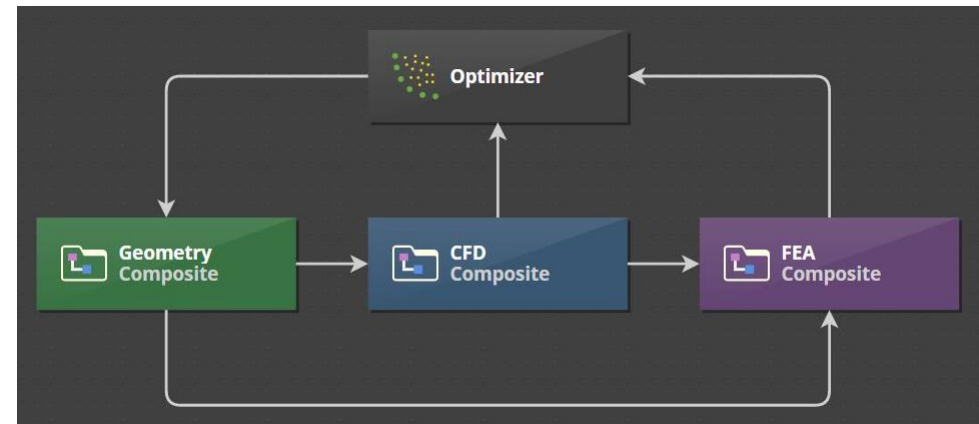
Redesigned block library:

- Added block icons
- Changed block grouping
- Added new tags
- Keyboard navigation support



Colors for Composite blocks:

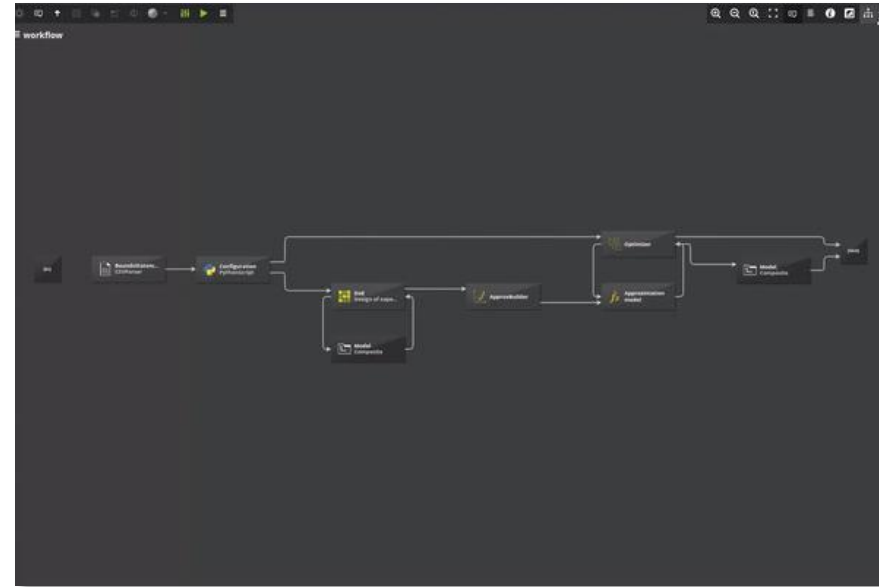
- Differentiate the functionality
- Easier navigation through the workflow





New automatic layout:

- Algorithm developed from scratch
- Neat lay out of blocks and links
- Supports horizontal, vertical or diagonal layout



Convenient work with large datasets:

- Browsing in tables is faster up to 10x times
- Preview of imported big files is also faster
- Speed is non-dependent on the dataset size

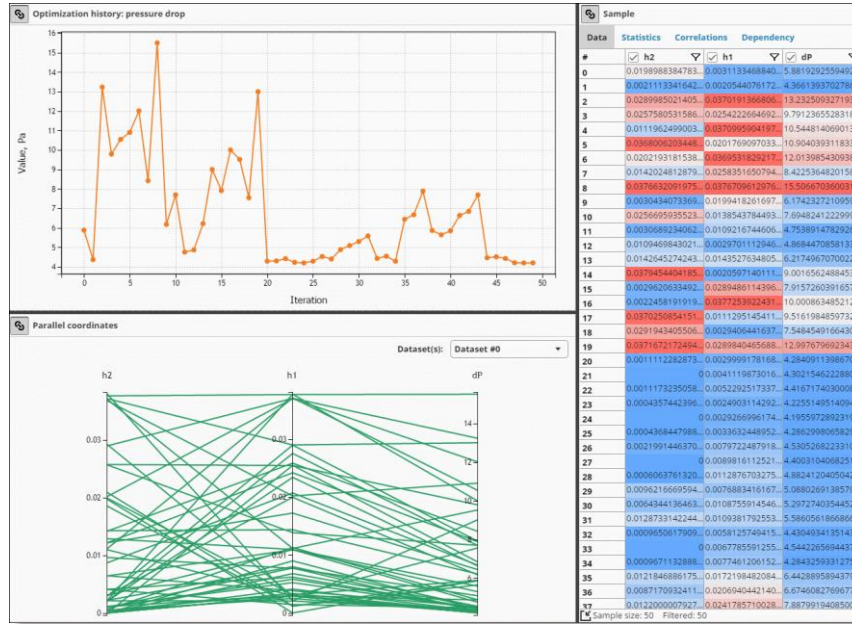
The screenshot displays a data table with a header row and multiple data rows. The table is titled 'Sample' and has columns for 'Data', 'Statistics', 'Correlations', and 'Dependency'. The data rows show numerical values for each column, with some cells highlighted in red and others in blue. The table is scrollable and includes a search bar and various icons at the top.

#	LC_xxx_s...	LC_xxx_s...	LC_xxx_s...	LC_xxx_s...	LC_xxx_s...	LC_xxx_s...	LC_xxx_s...	LC_xxx_s...	LC_xxx_s...	LC_xxx_s...
4799	15	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4800	16	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4801	17	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4802	18	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4803	19	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4804	20	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4805	21	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4806	22	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4807	23	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4808	24	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4809	25	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4810	26	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4811	27	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4812	28	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4813	29	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4814	30	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4815	31	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4816	32	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4817	33	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4818	34	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4819	35	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4820	36	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4821	37	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4822	38	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4823	39	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4824	40	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4825	41	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	
4826	42	0.39	0.03	-0.43	-0.47	-0.49	-0.25	-0.35	0.2	



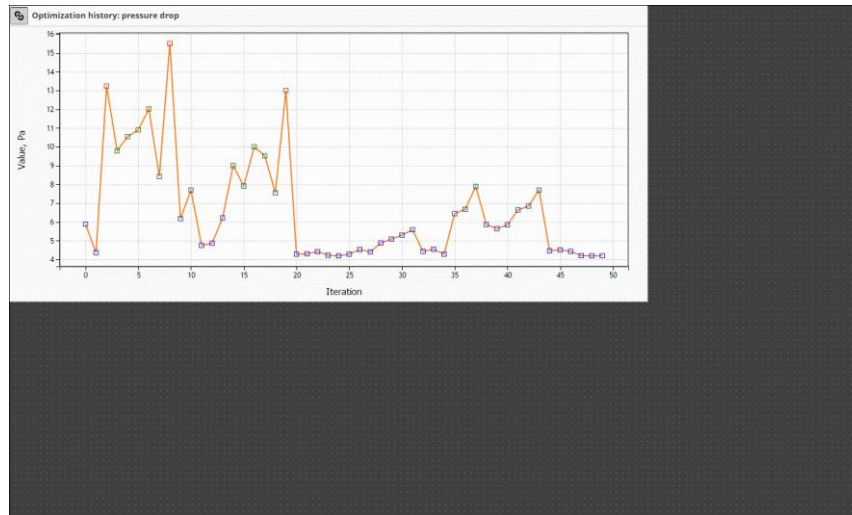
Synchronized plots:

- Simultaneously highlights the chosen datasets and points on:
 - Tables
 - 2D plots
 - Parallel coordinates
- Sync and unsync the plots manually
- Supports different groups of plots



Interactive 2D plots:

- Puts screenshots from the simulation on graphs
- Easy to visually assess the design point





High-degree parallelization:

- Support for systems with more than 64 logical processors and several processor groups:
 - Most effective for approximation

Support of network paths:

- Projects, workflows and reports can now be opened from and saved to network folders
- Blocks in workflows now support opening of files from network folders

No GUI mode:

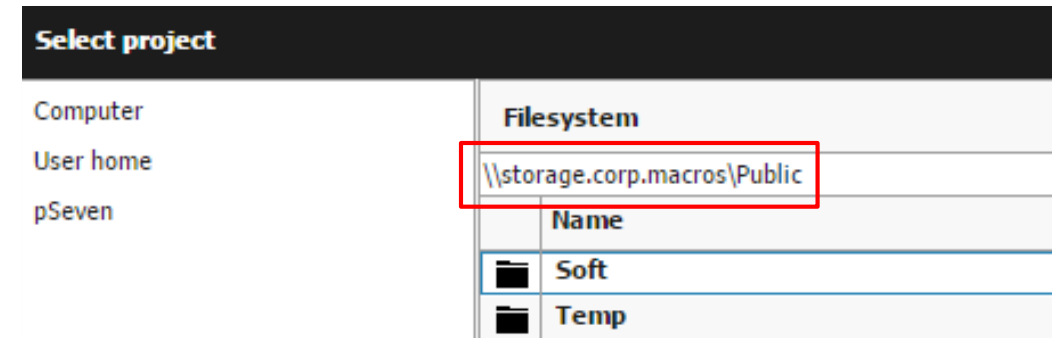
- Start pSeven workflows from command line (CMD)
- Use command "*p7batch.exe runner --help*"
- Easy integration into any simulation environment

Successful parallelization in pSeven falls under the following rule:

$$N \cdot M \leq P$$

Where:

- N – parallelization number in algorithmic block
- M – parallelization number in Composite block (if applicable)
- P – number of available processors



```
C:\Users\User\pSeven-6.14\client>p7batch.exe runner --help
[Client] DATADVANCE pSeven 6.14 (c) 2010-2018
[Client] Usage:
[Client] p7batch.exe [mode] [[argument=value] ..] --run-workflow
[Client] Arguments for mode 'runner':
[Client] --help : print mode specific help
[Client] --home : path to application home directory
[Client] --log-level : log level: debug, info, warning, error
[Client] --log-file : path to application log file (use p7batch.exe --log-file)
```




Visit us

datadvance.net

Follow us



Contact us

info@datadvance.net

42 Avenue du Général de
Crotte, 31100, Toulouse,
FRANCE
Tel.: +33 (0)6 03-84-62-92

Nauchny proezd 17,
15 floor, 117246, Moscow,
RUSSIA
Tel.: +7 (495) 669-68-15

