DESIGN SPACE EXPLORATION FOR EVERY EXPERTISE

What's New in pSeven 6.12-6.14

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Release retrospective:

- 3 releases came out after the user conference in 2017
- Approximate release frequency is 2 per year
What's New? - Agenda

- 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
Design Space Exploration Enhancements

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

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

- **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
Design Space Exploration Enhancements

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*
Design Space Exploration Enhancements

**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**
Predictive Modeling Enhancements

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
Predictive Modeling Enhancements

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
Predictive Modeling Enhancements

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 Integration Capabilities

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
New Integration Capabilities

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
Appearance Improvements

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
Usability Improvements

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 in non-dependent on the dataset size
Usability Improvements

**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
Performance Improvements

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