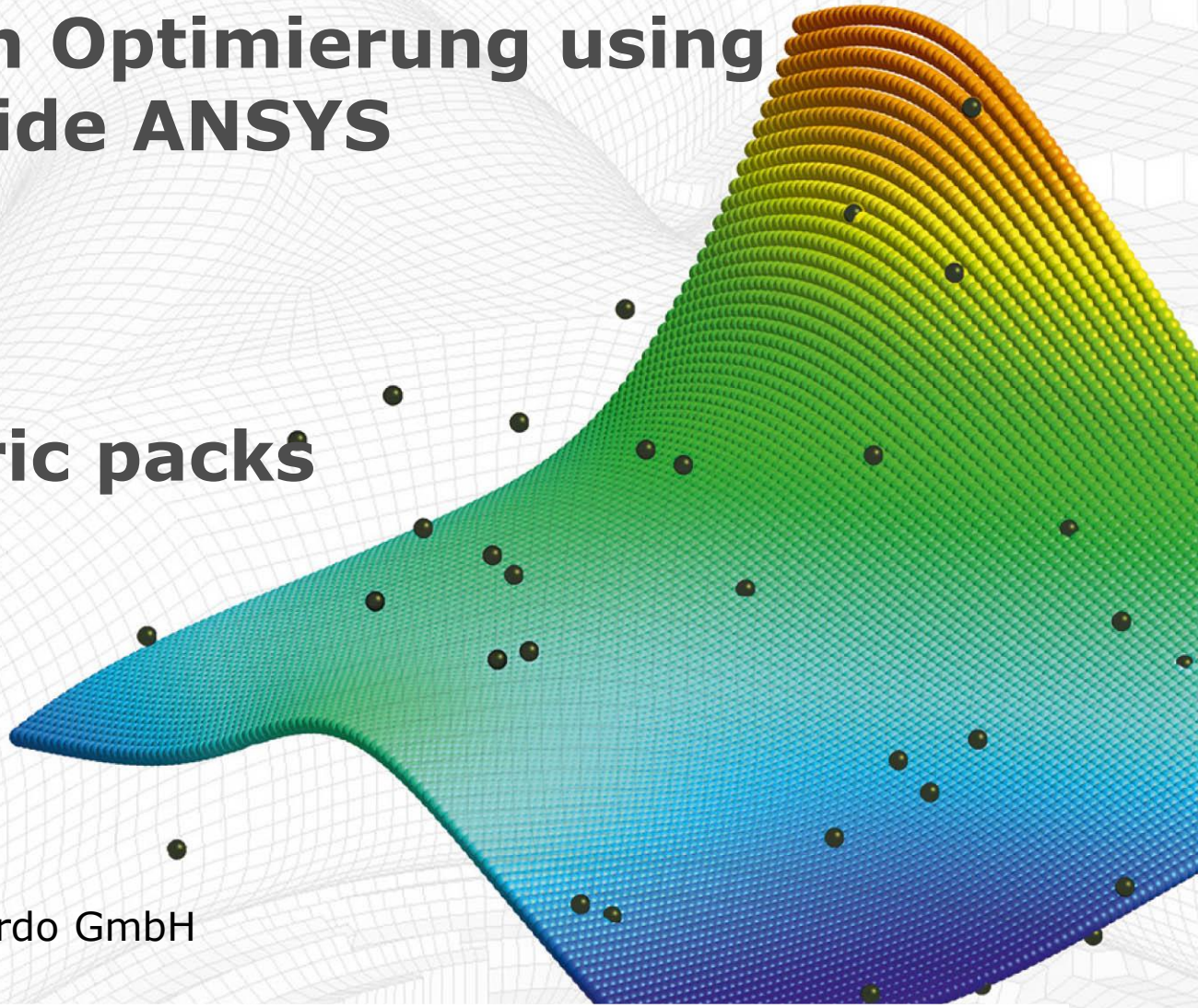
Robust Design Optimierung using optiSLang inside ANSYS Workbench

supported by HPC parametric packs

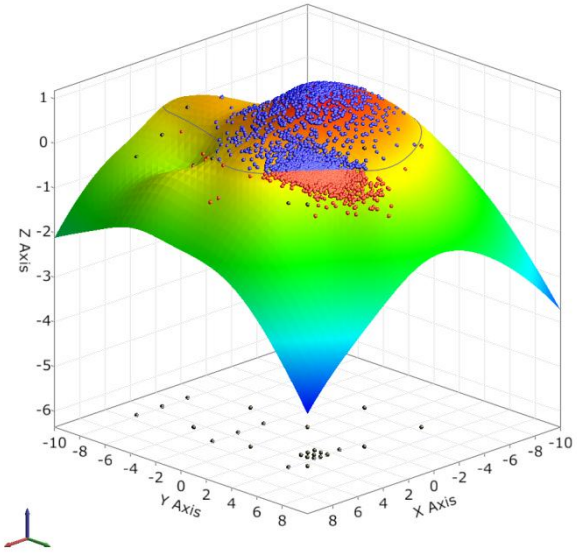


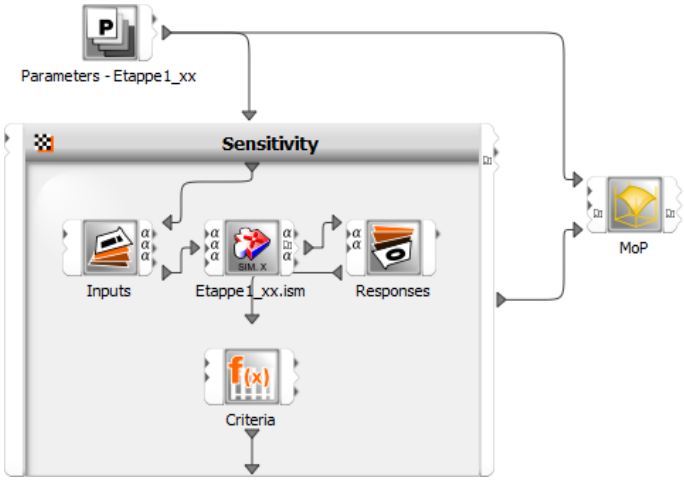
Dr.-Ing. Johannes Will

Managing director Dynardo GmbH

Excellence of optiSLang

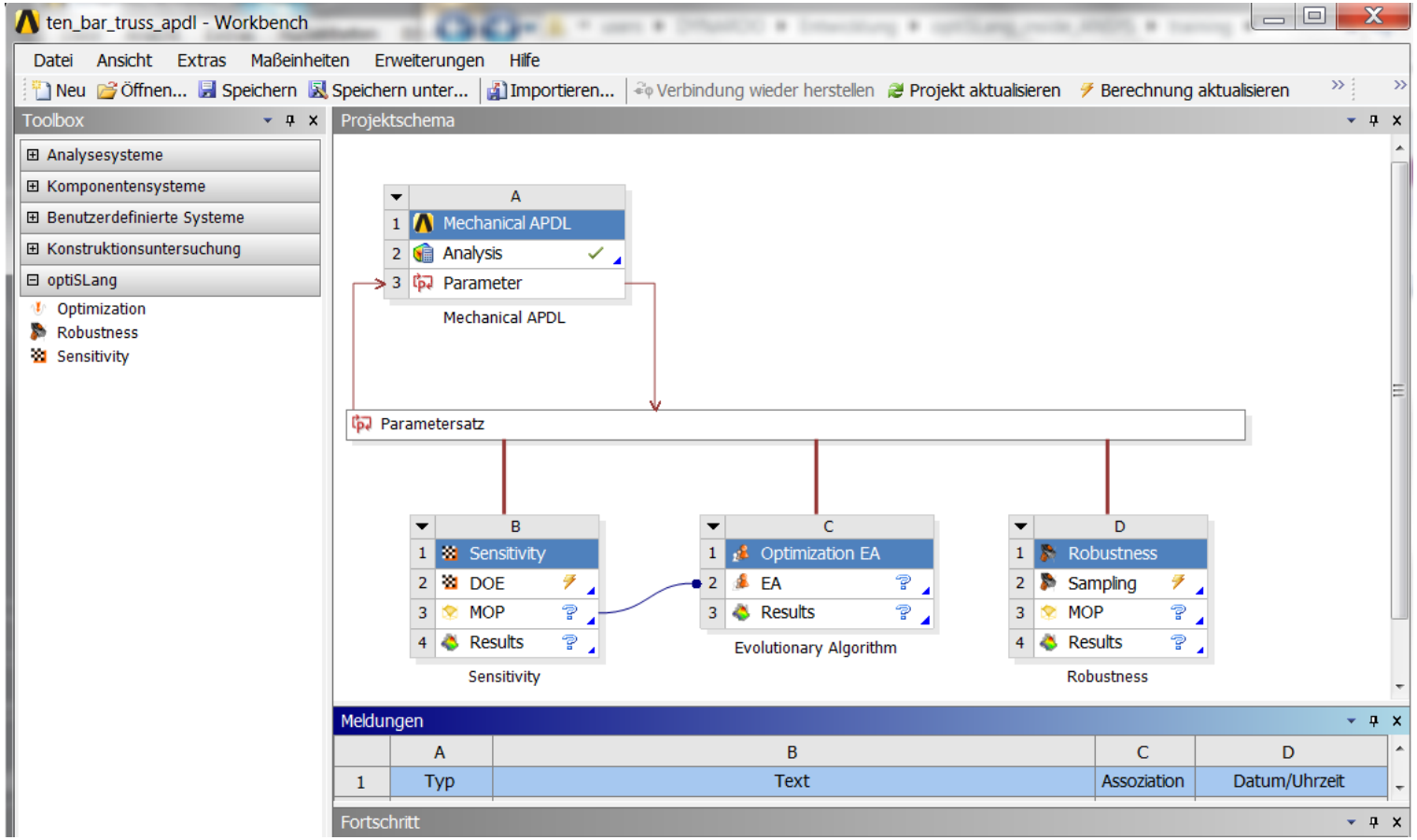
- optiSLang is an algorithmic toolbox for sensitivity analysis, optimization, robustness evaluation, reliability analysis and robust design optimization
- optiSLang is the commercial tool that has completed the necessary functionality of sensitivity analysis, optimization and stochastic analysis to run real world industrial applications in CAE-based robust design optimizations
- optiSLang offers the beginner and expert users **easy and safe to use** predefined workflows of best practice
- Since 2009 interfacing via optiPlug support ANSYS workbench-optiSLang applications





optiSLang inside ANSYS Workbench v14

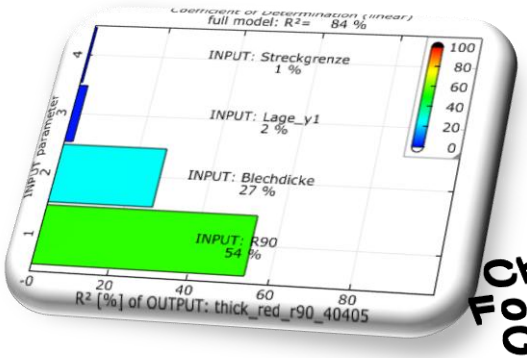
Modules Sensitivity+MOP, Optimization and Robustness+MOP provide „best practise" optiSLang functionality



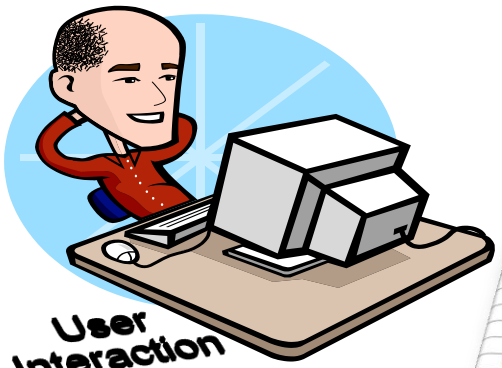
Sensitivity Analysis

(Design Exploration)

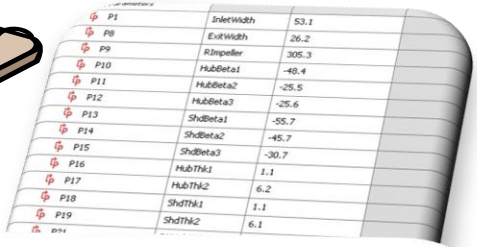
Sensitivity Analysis

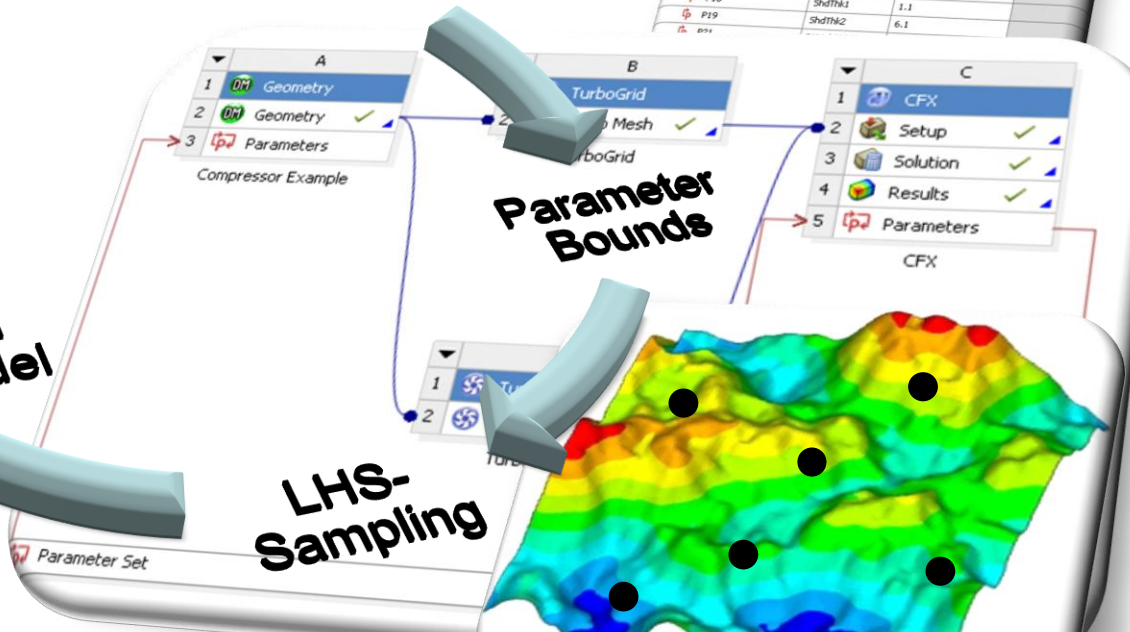


Check Forecast Quality



User Interaction

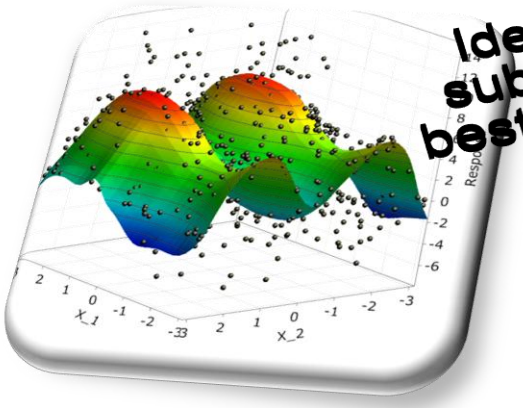




Parameter Bounds

LHS-Sampling

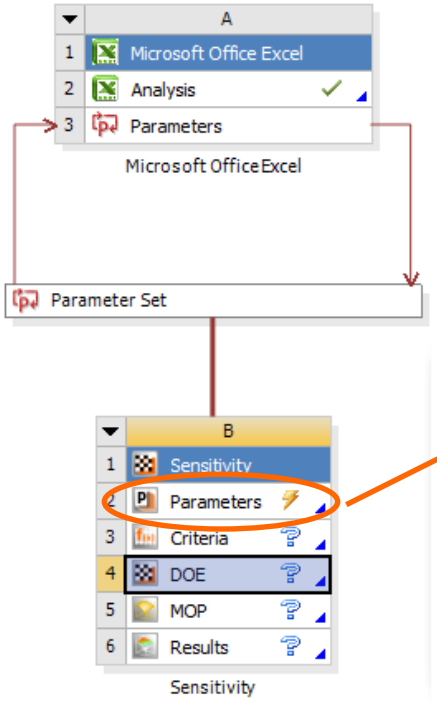
Identify best subspace and best meta model

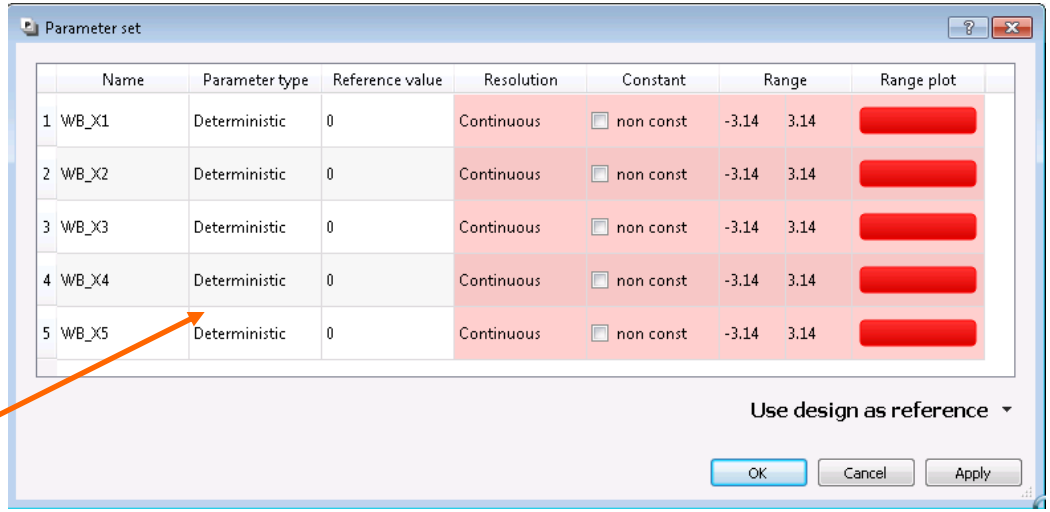


Sensitivity Module

Minimal required user input:

- Definition of parameter variation





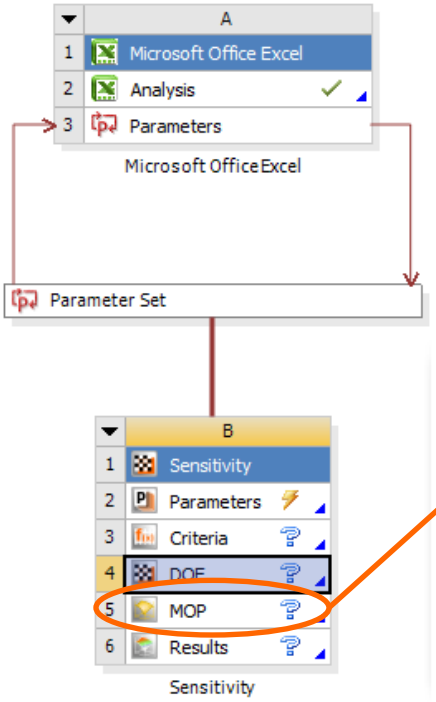
Sensitivity Module

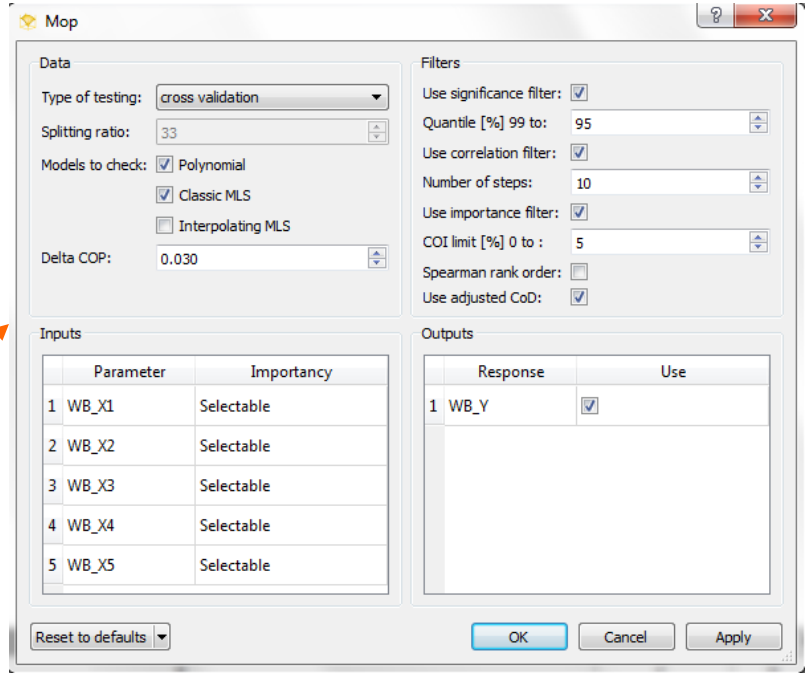
The Meta Model of optimal Prognosis (MOP) is automatically created out of the DOE-Sampling

Minimal required user input: non

Additional features:

- supports removing designs out of DOE Post Processing

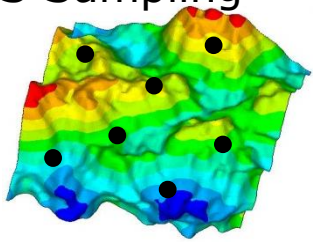




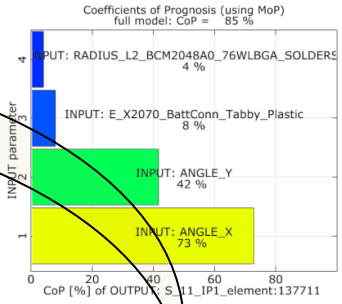
Optimization

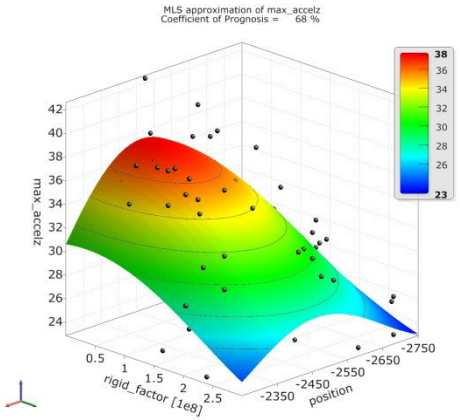
Sensitivity Analysis and Optimization

1) Start with a sensitivity study using the LHS Sampling



2) Identify the important parameters and responses
- understand the problem
- reduce the problem



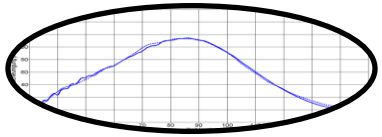


Scan the whole Design Space

Understand the Problem using CoP/MoP

optiSLang

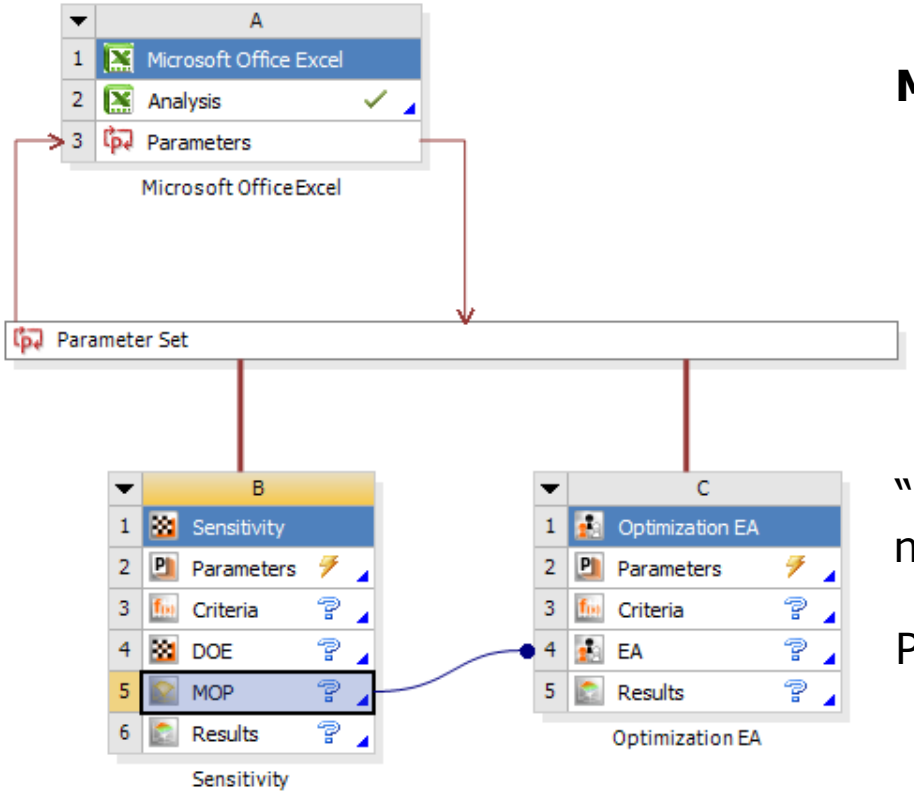
Search for Optima



3) Use MOP+gradient solver for fast Design Improvement

4) Run an ARSM, gradient based or biological based optimization Algorithms

Optimization using MOP



After sensitivity analysis optimization using MOP is supported.

Minimum required user input:

- drop the optimization module onto MOP
- defining objective and constraints

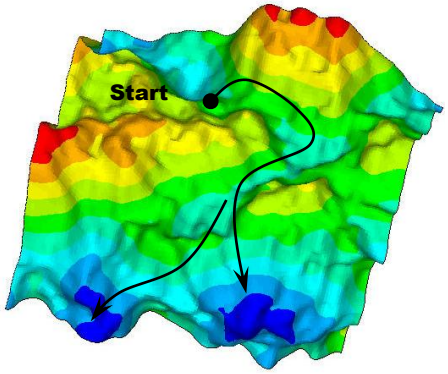
"Optima" which are based on meta models need to be verified!

Proof optima:

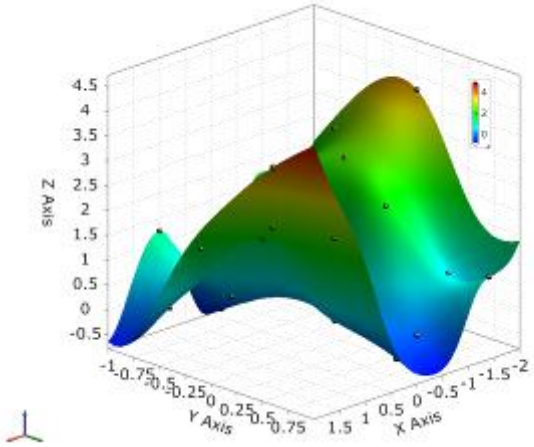
- Automatic verification with real ANSYS call
- Check differences in post processing

Optimization Algorithms

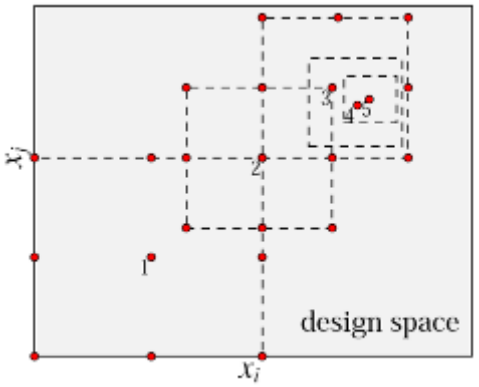
Gradient-based



Response surface method

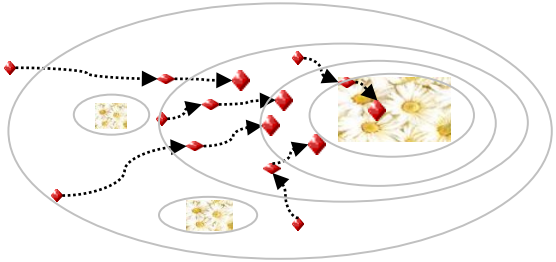


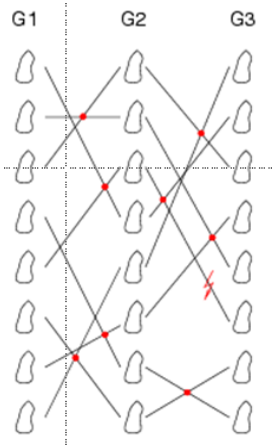
Adaptive RSM



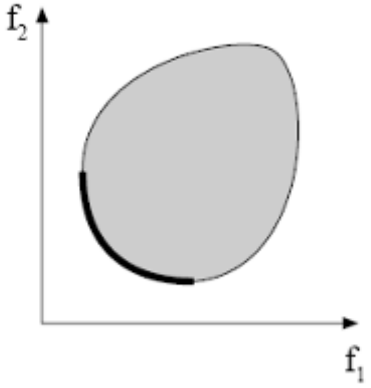
Nature inspired optimization algorithms:

- Genetic algorithms,
- Evolutionary strategies
- Particle Swarm Optimization



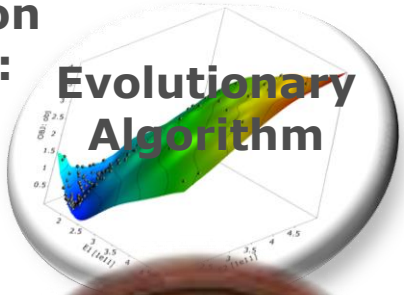


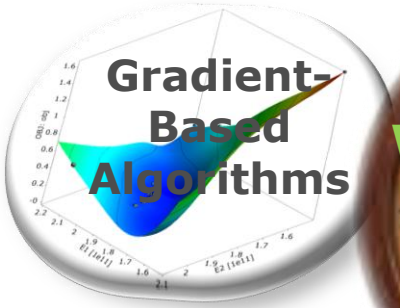
Pareto Optimization

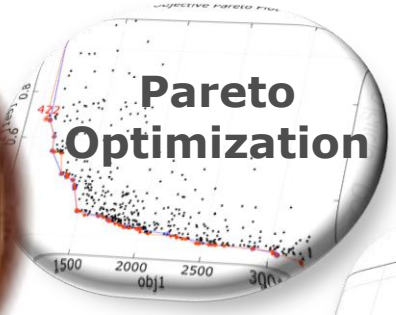


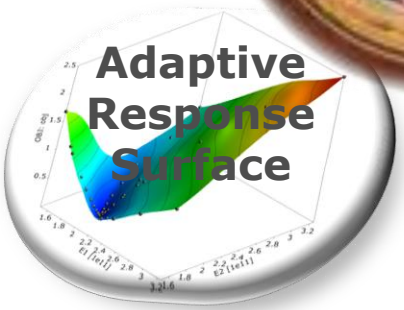
When to use which Algorithm

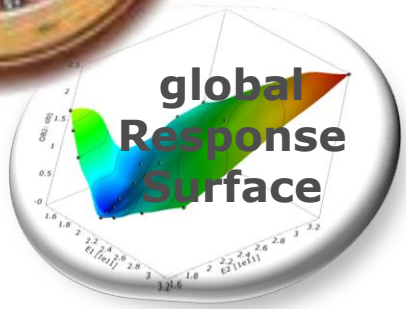
Optimization Algorithms:



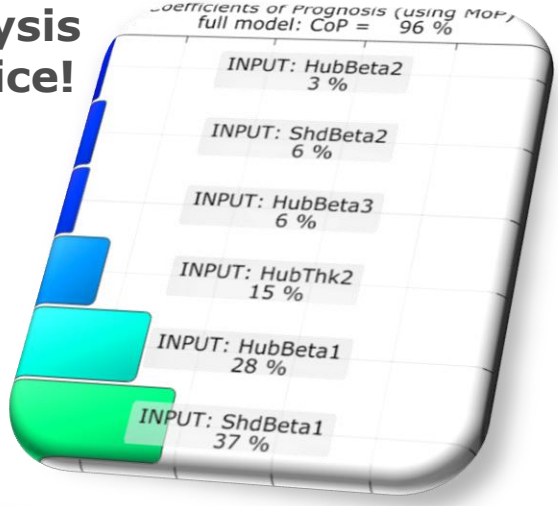


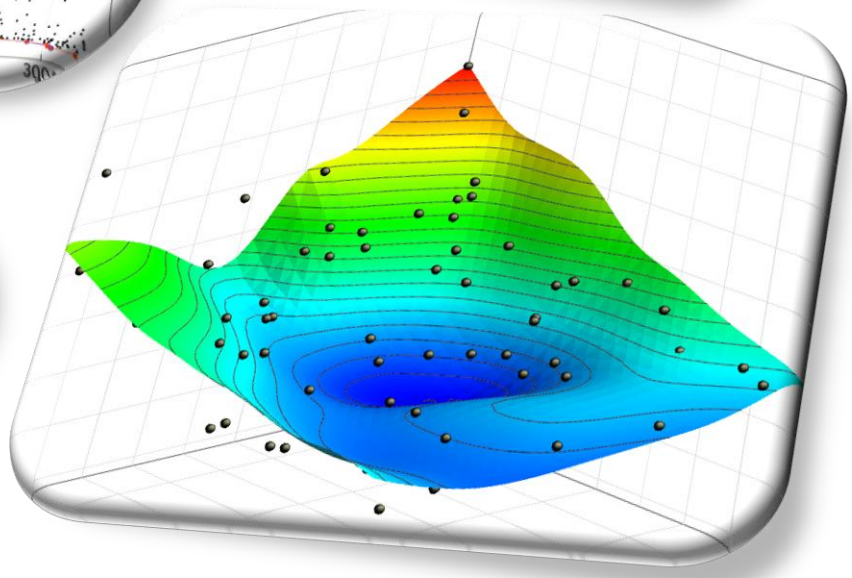






Sensitivity Analysis allows best choice!





Optimization Wizzard

optiSLang helps you to select a suitable optimization algorithm. Support the underlying (automatic) selection process with some additional information about the solver and the problem itself.

Exampel for using MOP and best_design_Sensitivity:

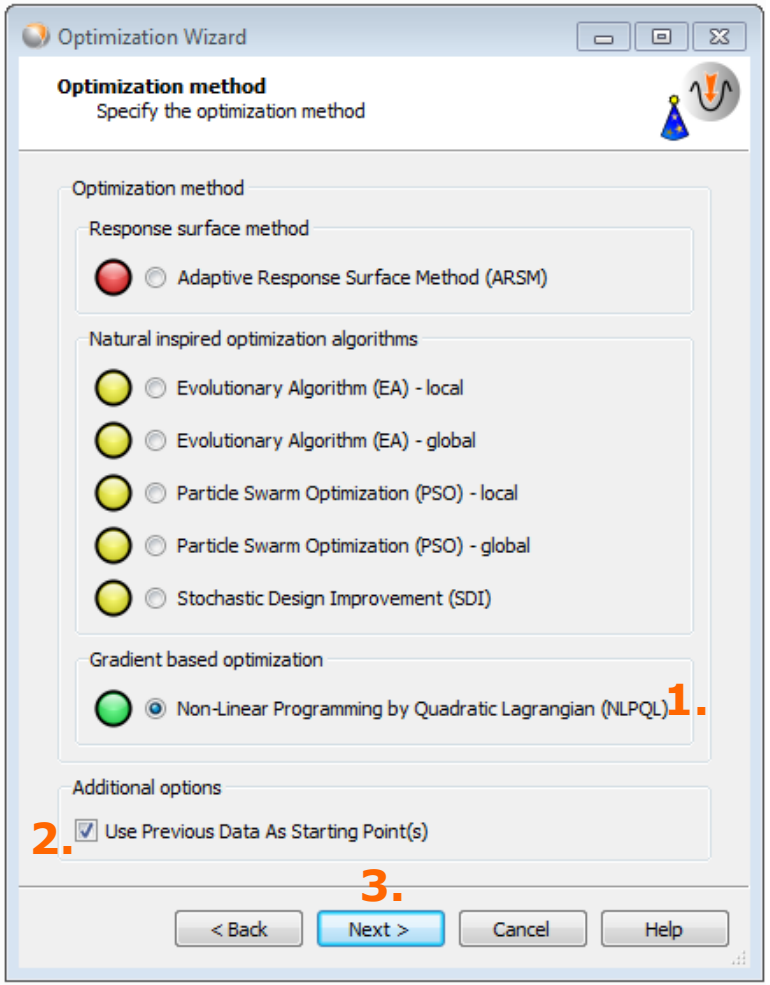
1. Set the analysis status as “Preoptimized” (best design from Sensitivity)
2. Set the constraint violations to “Seldom”
3. Set failed designs to “None” (MOP gives always response values)
4. Set solver noise to “None” (MOP gives a smooth surface)

Optimization Wizzard using MOP

Suggested algorithm is NLPQL

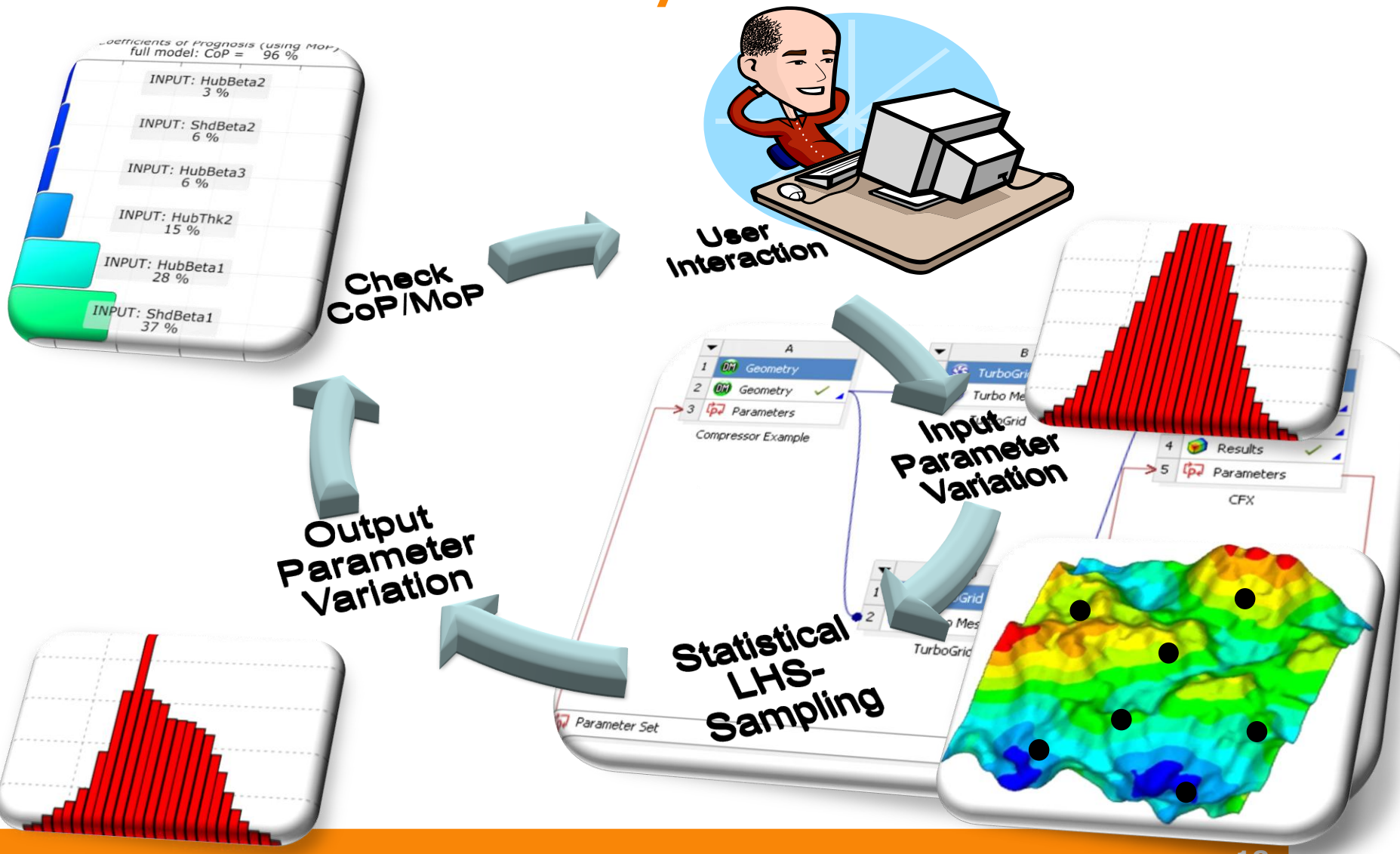
Start point is automatically selected

Press “Next”

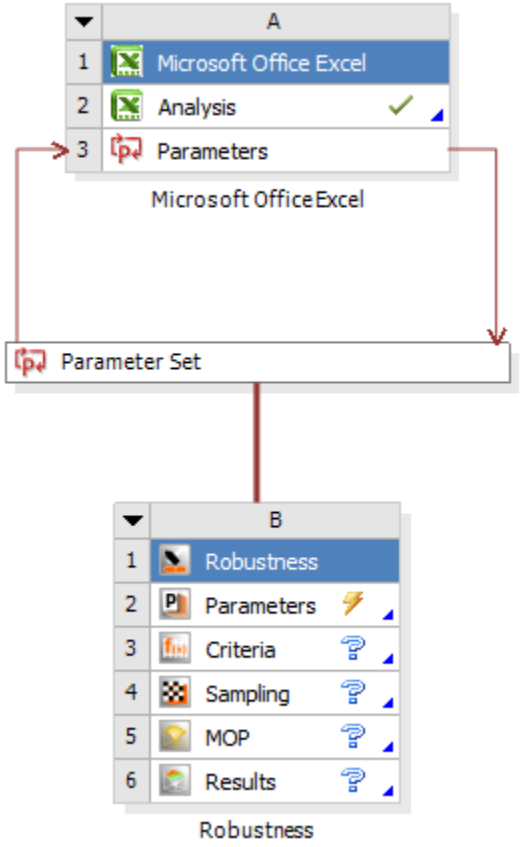


Robustness Design Optimization

Robustness = Sensitivity of Uncertainties



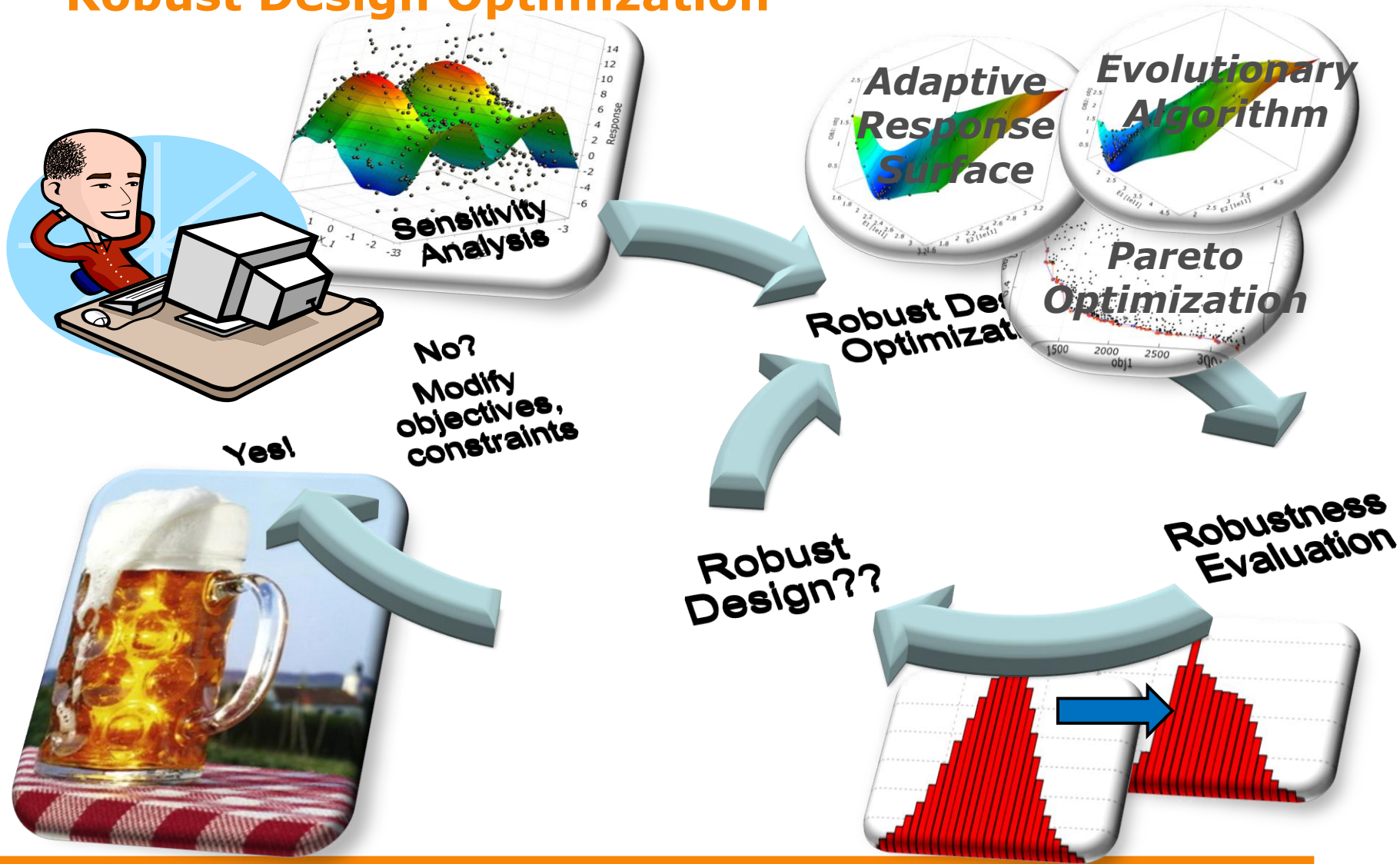
Robustness Evaluation



Minimum required user input:

- definition of input variation /scatter
- definition of robustness criteria
- number of samples for ALHS

Robust Design Optimization



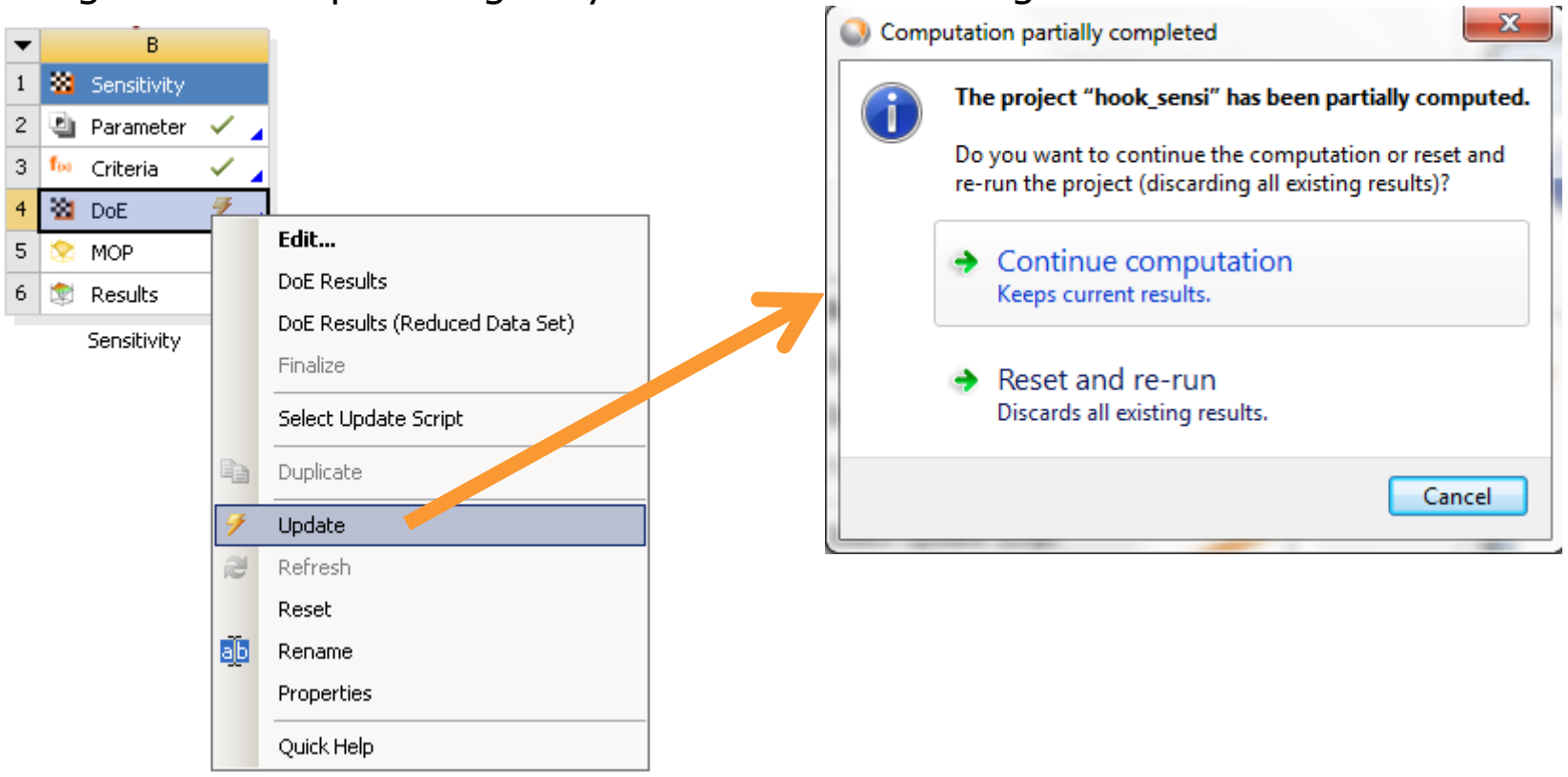
Update Functionality optiSLang inside ANSYS v14.5

Continue crashed session option inside ANSYS

optiSLang saves every design which was successfully calculated

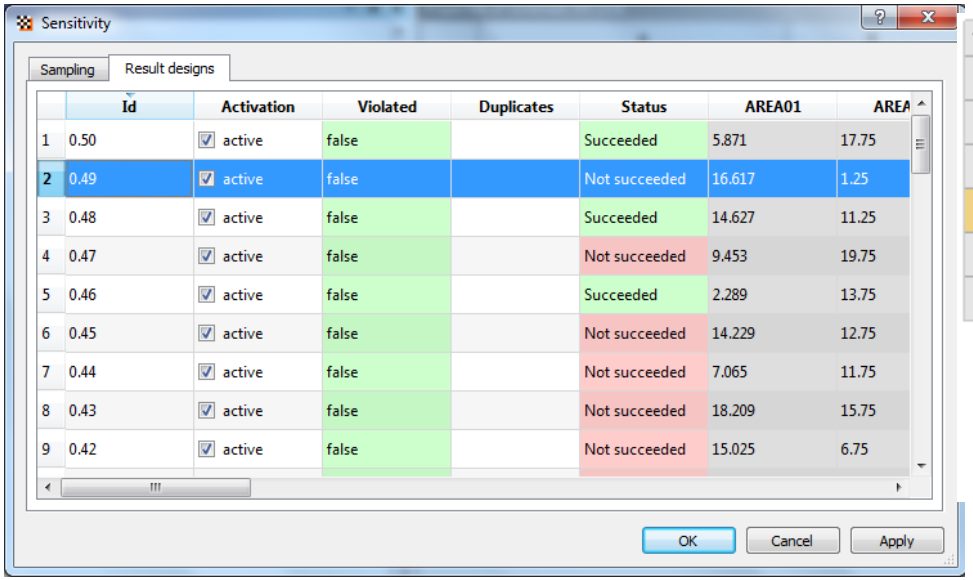
using update at optiSLang container continue or reset can be chosen

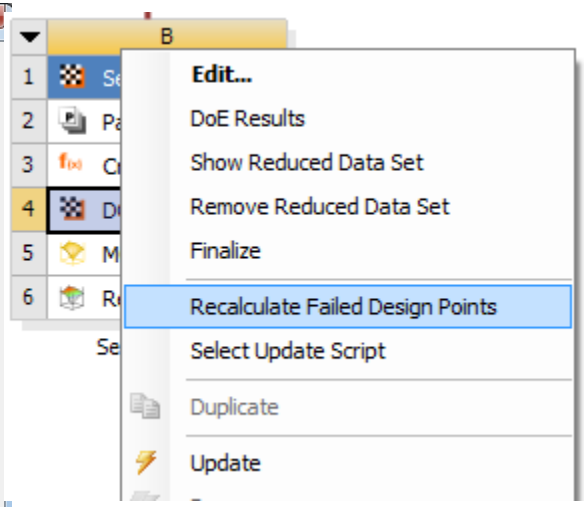
using continue optiSLang only send unsolved designs



Recalculate failed designs

- Due to different reasons design evaluations may fail
- With “Recalculate Failed Design Points” you can start them again





Update via Python scripting

- ANSYS initialize per default an update mechanism, which updates a complete ANSYS Workbench project
- Mechanism can be overridden via python file
- optiSLang provides this feature for optiSLang design evaluations
- user has full access to his ANSYS model update

Properties of Schematic B4: DoE

	A	B
1	Property	Value
2	⊟ General	
3	Component ID	DoE (optiSLang)
4	Directory Name	Sensitivity
5	Open Postprocessing during Solver Run	☐
6	Save Design Point Directories	☑
7	⊟ Update Options	
8	Run Python Script for Update	☑
9	Python Script:	C:\Users\Verwalter\Desktop\Python Scripts\update.py

Parallel evaluation using Ansys RSM

- ANSYS RSM is the powerful tool to distribute jobs
- optiSLang can fill the Workbench design table with a predefined number of designs
- ANSYS RSM organizes distribution of jobs

- If ANSYS RSM is installed you only need to:
  - Choose RSM Mode
  - Set max. number of parallel jobs

Properties of Schematic B4: DOE

	A	B
1	Property	Value
2	General	
3	Component ID	DOE (optiSLang)
4	Directory Name	Sensitivity
5	Open Postprocessing during Solver Run	☑
6	Open Postprocessing after Calculation	☐
7	Save Design Point Directories	☐
8	Update Options	
9	Use RSM Mode	☑
10	Preferred Number of Design Points in Parallel	25

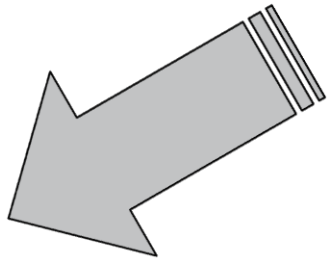
ANSYS HPC Parametric Pack
optiSLang inside Ansys Workbench v14.5

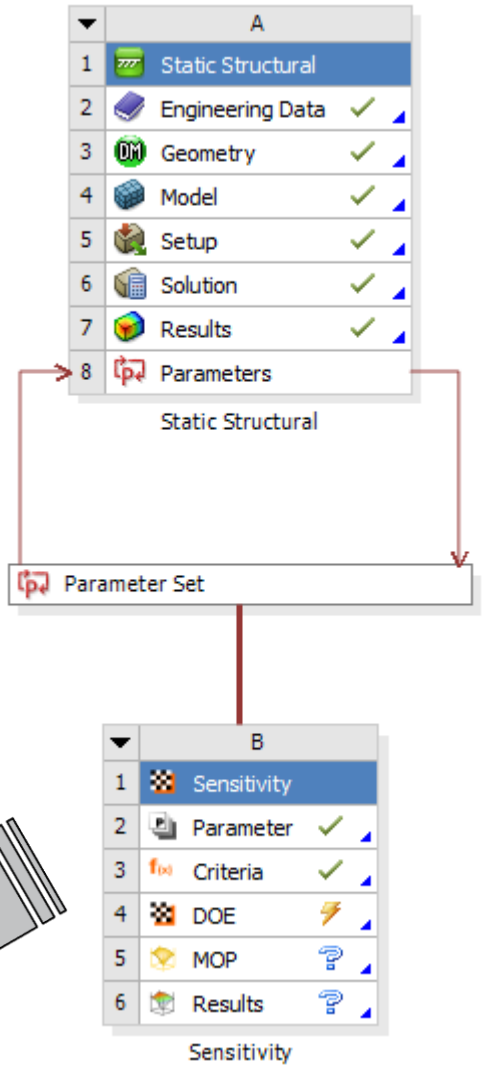
optiSLang Algorithm Settings

- Select "Use RSM Mode" to enable parallel design point submission
- Set the "Preferred Number of Design Points in Parallel" to the intended RSM job size

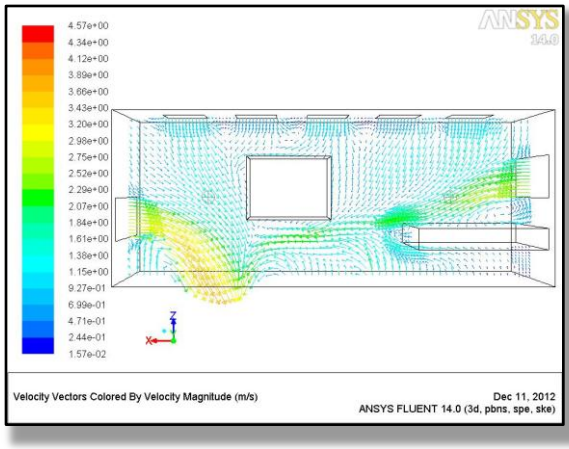
Properties of Schematic B4: DOE

	A	B
1	Property	Value
2	General	
3	Component ID	DOE (optiSLang)
4	Directory Name	Sensitivity
5	Open Postprocessing during Solver Run	☐
6	Open Postprocessing after Calculation	☐
7	Save Design Point Directories	☑
8	Notes	
9	Notes	
10	Update Options	
11	Use RSM Mode	☑
12	Preferred Number of Design Points in Parallel	4





Flow simulation of LCD manufacturing process



Problem Description

- Identify model inflow parameter to match outflow
- Identified output velocities have to be in 10% error ranges comparing with reference values
- Input parameter: 10 pressure areas (100 design points)

Detail:

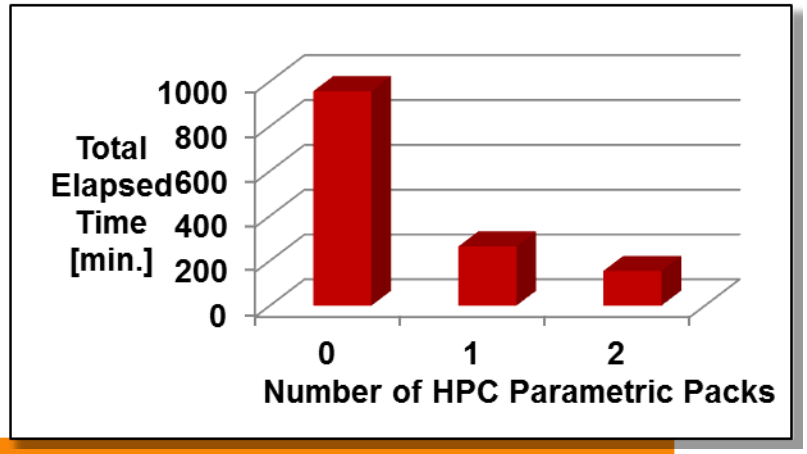
- Pressure-Based solver, K-Epsilon Model with Standard Wall Functions
- 78.800 nodes, 66.900 hexahedral elements
- Hardware: Workstation with dual Intel® Xeon® E5645 (2,4 GHz, 12 Cores), 96 GB, all jobs running 1 core

Licensing Solution

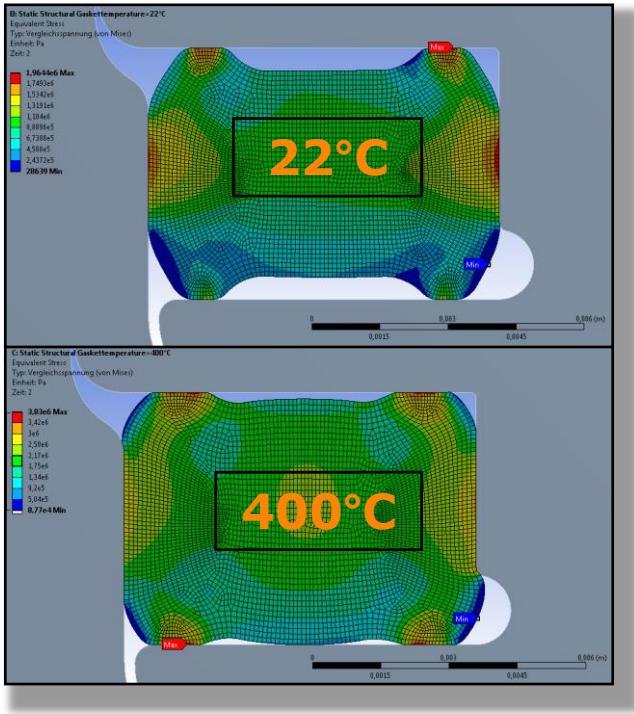
- 1 Ansys Fluent
- 2 Ansys HPC Parametric Packs

Result/Benefit

- ~6,2x speedup over sequential execution



Temperature analysis of a Seal



Problem Description

- Sensitivity study of influence of geometry variation to seal deformation
- 15 Input geometry parameter (100 design points)

Detail:

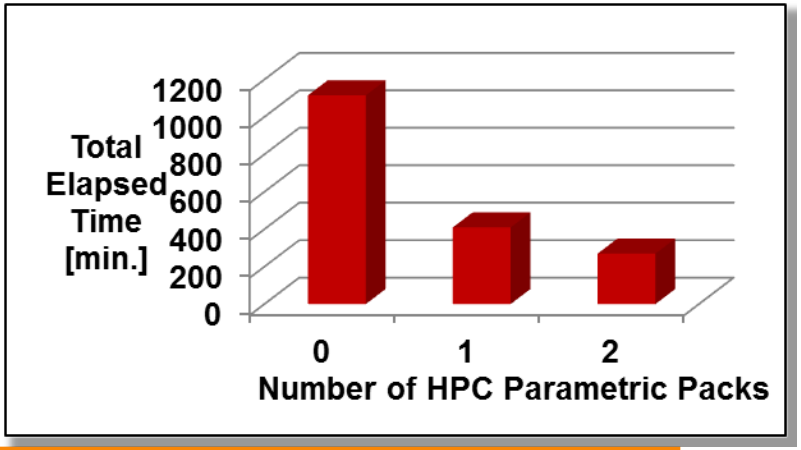
- Mechanical analysis with temperature loading
- 6.100 nodes, 5.500 elements (2D)
- Hardware: - Workstation with dual Intel® Xeon® E5645 (2,4 GHz, 12 Cores), 96 GB, all jobs running 1 core

Licensing Solution

- 1 Ansys Mechanical, 1 Ansys DesignModeler
- 2 Ansys HPC Parametric Packs

Result/Benefit

- ~4,1x speedup over sequential execution
- Easier and fully automated workflow!

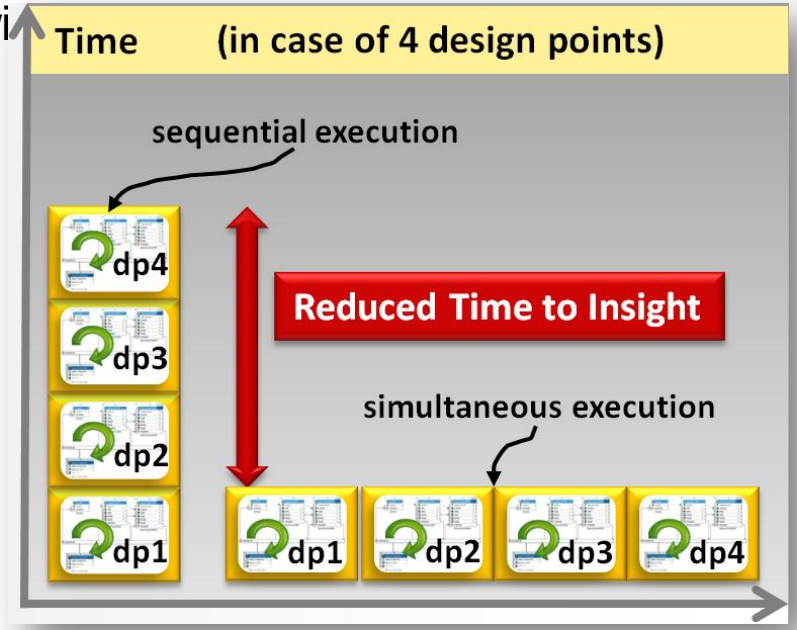


Benefit of ANSYS HPC Parametric Pack

Faster turn around time for multiple jobs

- Geometry update and Result processing wi
  be performed sequentially on local resource
- Meshing, solution, result extraction executed in parallel

Scaling factor depend on:
- time for geometry update
- time for meshing & solution
- hardware environment

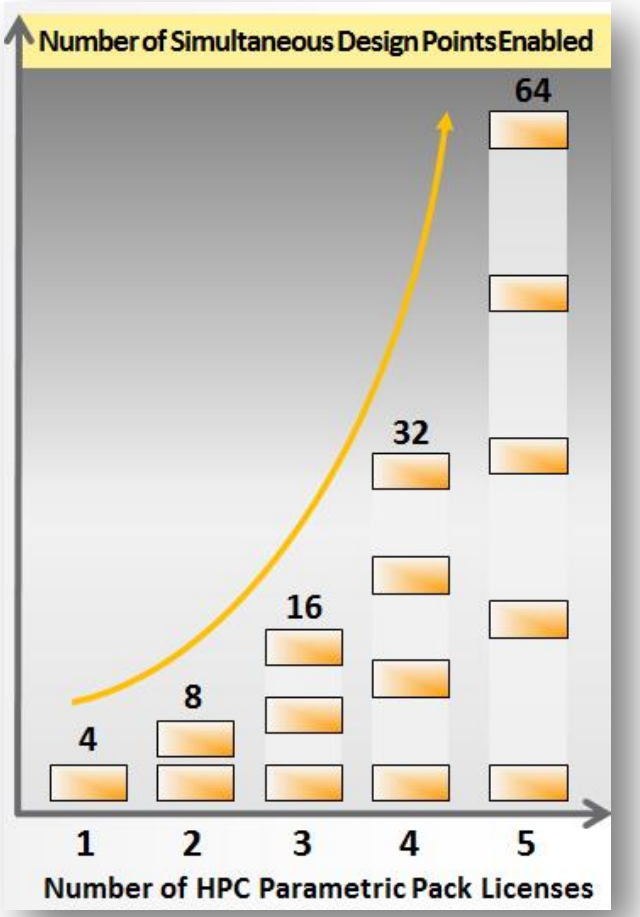


Benefit of ANSYS HPC Parametric Pack

Get ready for RDO by multiplying base licenses

One base license set can be multiplied by ANSYS HPC Parametric Packs

Now small, medium & large companies can increase significantly the number of parallel jobs!



Get ready for RDO using ANSYS HPC Parametric Pack

HPC Parametric pack is available in ANSYS workbench only

all parametric models from ANYS classic needs to be integrated in ANSYS workbench

optiSLang v4 supports integration node for ANSYS workbench including parameterization of additional responses (signals,..)

Dynardo Consulting switched to HPC Parametric Pack for all ANSYS RDO tasks Q2/2013