

OptiY 4.5

Breakthrough-Technology for Meta-Modeling

Fast, Stable and Ease-of-Use

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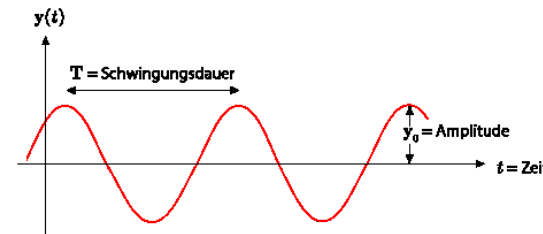
Extended and enhanced Libraries for Gaussian process

$$\begin{pmatrix} Y_0 \\ \mathbf{Y}^n \end{pmatrix} \approx N_{n+1} \left[\begin{pmatrix} \mathbf{f}_0^r \\ \mathbf{F} \end{pmatrix} \boldsymbol{\beta}, \sigma_x^2 \begin{pmatrix} 1 & \mathbf{r}_0^r \\ \mathbf{r}_0 & \mathbf{R} \end{pmatrix} \right]$$

Values	
Weight [0..1]	1
Approximation	Gaussian Process
Covariance Function	Best Covariance
Polynomial Type	Best Covariance
Optimization Goal	Square Exponential
Last Value	Exponential
	Gamma-Exponential
	Matérn Class 3/2
	Matérn Class 5/2
	Rational Quadratic
	Periodic

- **Numerical stable Model-Libraries (new Algorithms)**
- **New Covariance for periodic Systems as Vibrations**

$$R(x_1 - x_2) = \exp(-w^2 \cdot \sin^2(\pi \frac{|x_1 - x_2|}{\lambda}))$$

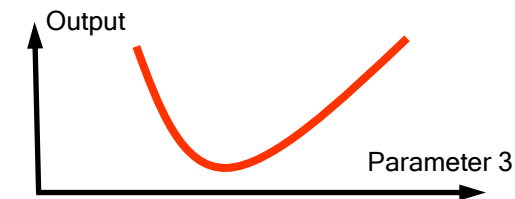
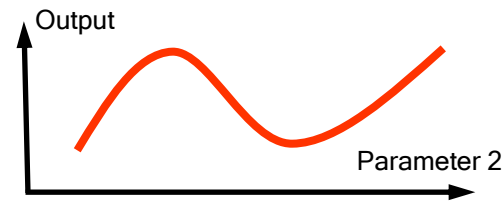
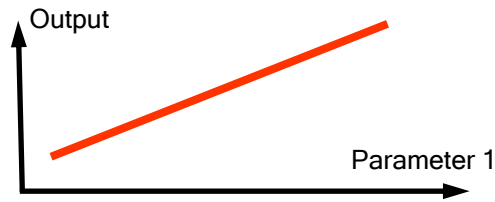


Extended Polynomial Regression

$$y = \beta_0 + \sum_{i=1}^n \sum_{k=1}^{Order} \beta_{ik} \cdot x_i^k + \sum_{i=1}^{n-1} \sum_{j=i+1}^n \beta_{ij} \cdot x_i \cdot x_j$$

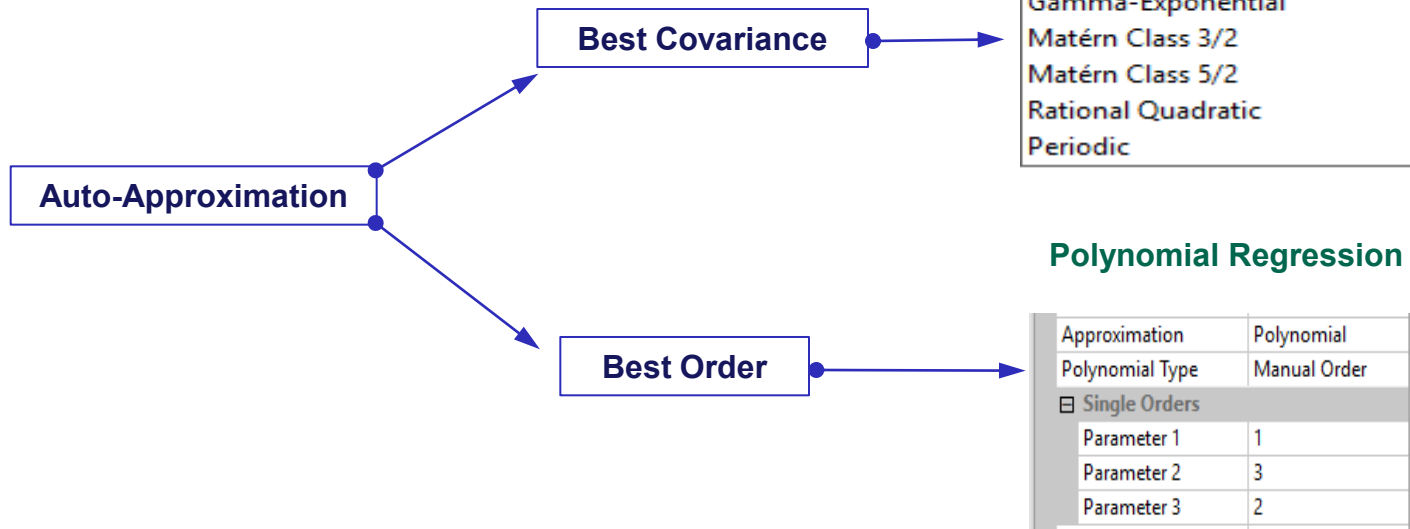
Different Polynomial Orders for different nonlinear Parameters in Design Space

Approximation	Polynomial
Polynomial Type	Manual Order
☐ Single Orders	
Parameter 1	1
Parameter 2	3
Parameter 3	2



Ease-of-Use

Internally Automatic Calculation for Choosing the best Meta-Model



Gaussian Process

Best Covariance
Square Exponential
Exponential
Gamma-Exponential
Matérn Class 3/2
Matérn Class 5/2
Rational Quadratic
Periodic

Polynomial Regression

Approximation	Polynomial
Polynomial Type	Manual Order
<input type="checkbox"/> Single Orders	
Parameter 1	1
Parameter 2	3
Parameter 3	2

Combination: Gaussian Process + Polynomial regression

Approximation	Gaussian Process
Covariance Function	Best Covariance
Polynomial Type	Best Order

Powerful and Fit most Engineering Problems

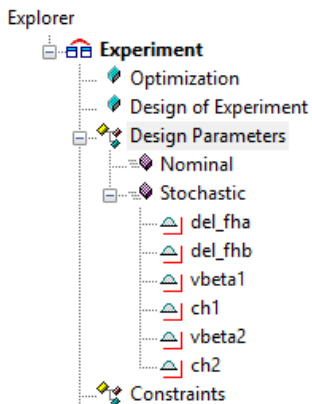
Fast Solver and Stable Meta-Models

New Solver for Training of the Gaussian Meta-Models (Finding optimal Hyper-Parameters)

- Gradient Based Optimization:
 - Fast
 - Independent on number of parameters,
 - No Parallel-Computing
- Evolution Strategies:
 - Robust
 - Parallel-Computing

Design of Experiment	
Method	Standard
Response Surface	
Adaptive Design	False
Training Data [%]	70
Default Parameters	False
Gaussian Process	
Check Redundant Data	True
Suggested Points	2
Best Covariance	Some Covariances
Optimization Method	Gradient Based
Training Data	
Extreme Points	Evolution Strategies
Selection Method	Uniformly

Huge Number of Parameters



Huge Size of DOE - Data

No	del_fha	del_fhb	Status
6035	12	10	Ok
6036	12	10	Ok
6037	12	10	Ok
6038	12	10	Ok
6039	12	10	Ok
6040	12	10	Ok
6041	12	10	Ok
6042	12	10	Ok
6043	12	10	Ok
6044	12	10	Ok
6045	12	10	Ok
6046	12	10	Ok

Benchmark Test Comparison

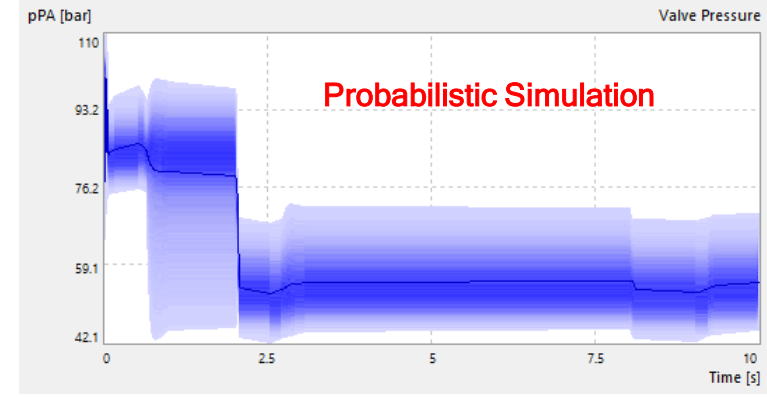
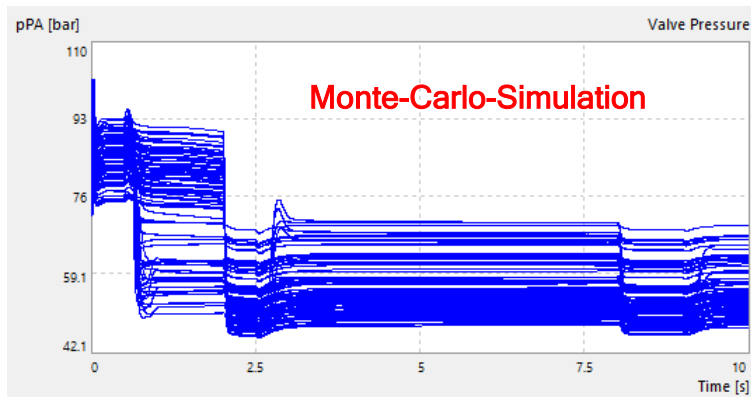
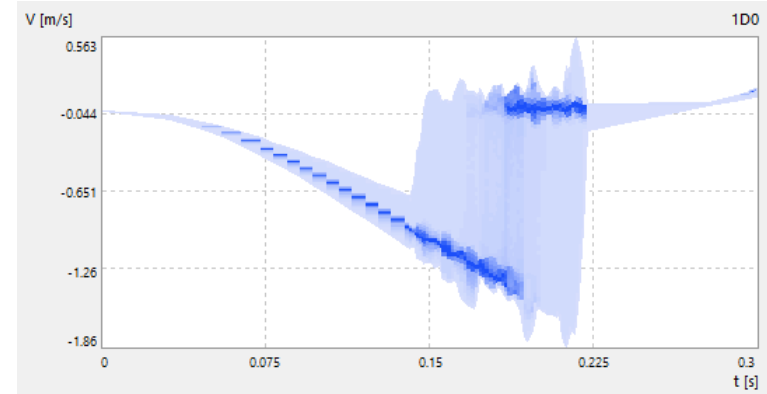
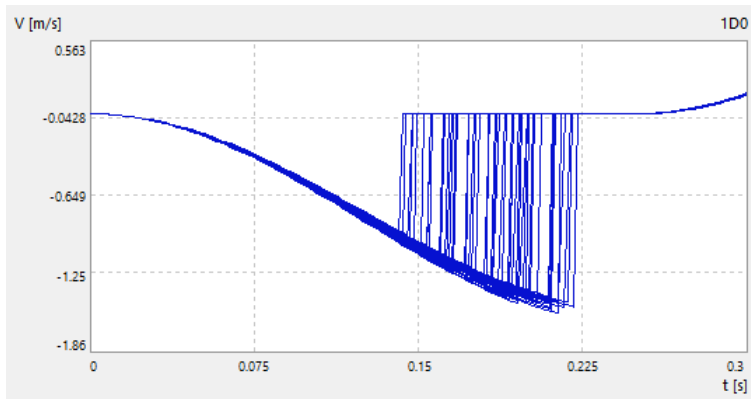
(6 Parameters, 1.000 Training-Data, 5.000 Test-Data, Gaussian Process with Best Covariance)

- OptiY 4.4: Computing Time 14 min, MSE (Quality) 9,32
- OptiY 4.5: Computing Time 9 Min, MSE (Quality) 3,63
- **Computing Time: 35% Faster**
- **Model-Quality: 61% Better**

Fast Probabilistic Dynamic Simulation

- Automatic Step Control
- Strong Nonlinearity (Contact Simulation)
- High Accuracy

Values	
Output Value	Constraints
Boundary	Total X-Axis
X-Step Control	Automatic
1D-Approximation	Component-Approximation
Noise Level [0..100]	0.5
Approximation	Gaussian Process
Covariance Function	Square Exponential
Polynomial Type	Uniform Order
Polynomial Order	0



Parallel-Computing in SimulationX

- Copy the original Model Copied to different Models
- Load all copied Models into SimulationX
- Start Simulation parallel at the same time
- Only one License SimulationX required

