



Optimization Suite

Optimization and Fitting



Optimization Suite

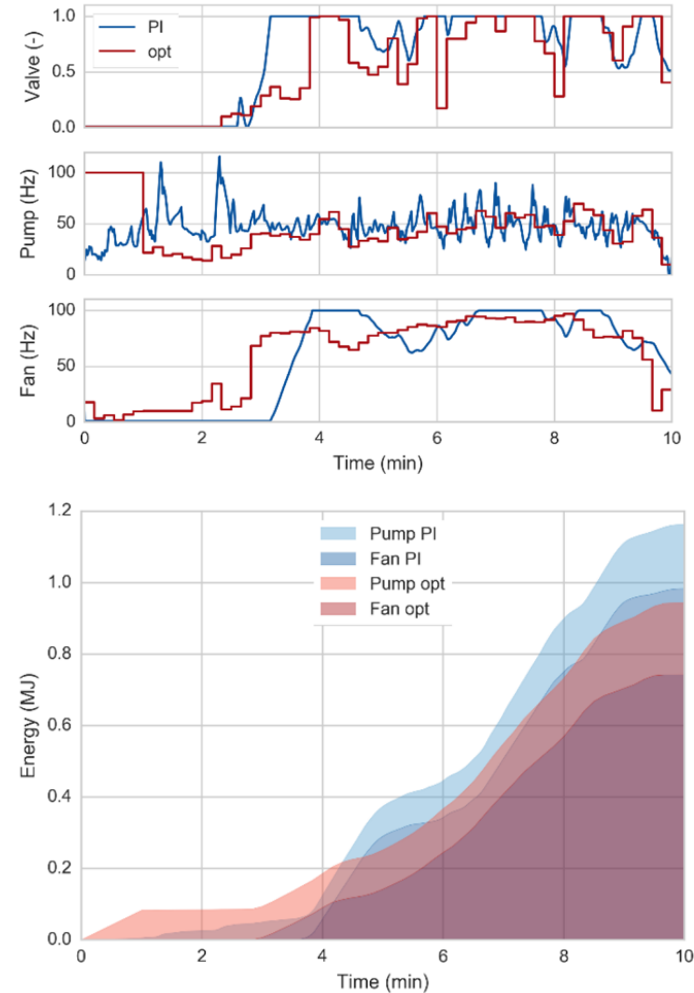
Highlights

- Separation of simulation and optimization techniques: Complex models can be simulated by suiting, well tested solvers.
- Robust transient and steady-state simulation techniques, especially for thermal systems (ODE, DAE, algebraic solvers)
- Integration in TLK's or user's toolchains for model management, visualization, evaluation, parallelization and automation
- Support of various kinds of models: FMU (Co-Simulation and Model-Exchange), Dymola models, TISC interface
- Use of open-source (e.g. SciPy) and commercial optimizers as well as TLK algorithms (e.g. Nelder-Mead algorithm including globalization)

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Optimization Problems

- **Stationary Optimization Problem:** Parameter optimization, often used for design optimization
- **Dynamic Optimization Problem:** Parameter optimization for systems that are defined by transient behavior
- **Optimal Control Problem:** Trajectory optimization of actuating variables
- **Stationary Fitting Problem:** Fitting model parameters to sets of stationary measurements
- **Dynamic Fitting Problem:** Fitting model parameters to measurement curves

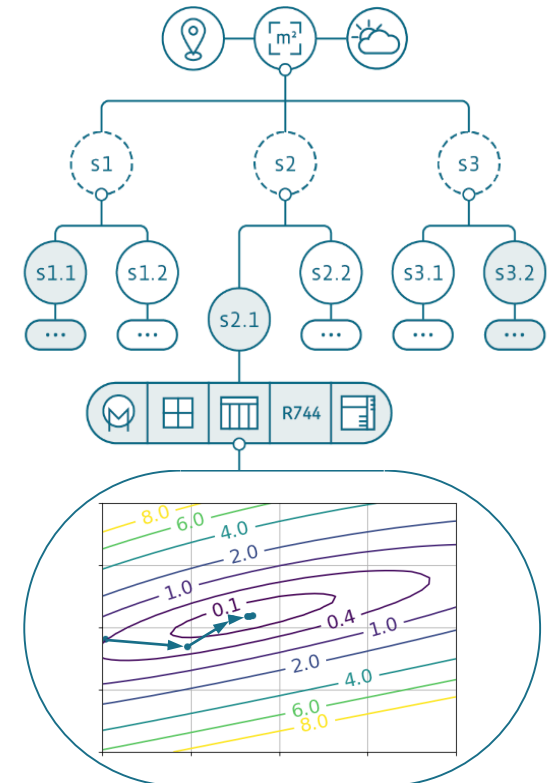


Optimal control

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Successful Applications

- Design of energy-optimal heat pump and cooling cycles
- Structural design optimization of an electric vehicle battery cooling plate
- Optimal control of a heat pump dryer
- Automated control parameter optimization for varying boundary conditions
- Automated parameter fitting of a large number of compressors



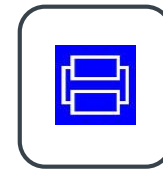
Dynamic optimization of different refrigerant cycles topologies.

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Optimization Problems

1. Stationary optimization problem
2. Dynamic optimization problem
3. Stationary fitting problem
4. Dynamic fitting problem
5. Optimal control

Supported Model Formats



Dymola
Model



FMU

Optimization Methods

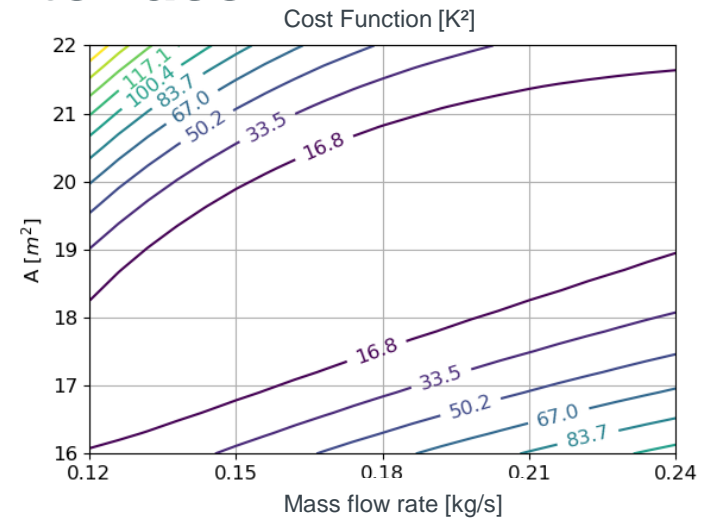
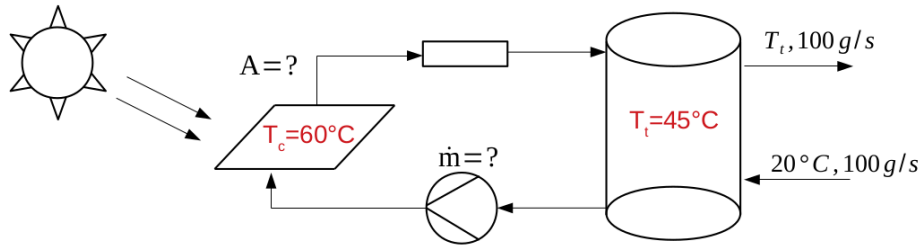
- TLK Nelder-Mead
- SLSQP
- COBYLA
- IpOpt
- Least Squares / Levenberg-Marquardt
- All others with Python interface

User Interfaces

- Python
- MoBA Automation
- ModelFitter (Excel)
- ...

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Simple Example Code of Python Interface



```

2 from OptimizationProblem import SteadyStateOptimizationProblem
3 from scipy.optimize import minimize
4
5 sop = SteadyStateOptimizationProblem()
6 sop.loadModel("SteadyStateOptimization_D.fmu")
7
8 sop.addCostFunctionVariable_LSQ(name='T_t', LSQtarget=(273.15+45.0))
9 sop.addCostFunctionVariable_LSQ(name='T_c', LSQtarget=(273.15+60.0))
10 sop.addOptimizationParameter(name='mDot', lowerBound=0., nominalValue=.01, initialValue=0.05)
11 sop.addOptimizationParameter(name='A', lowerBound=0., nominalValue=1., initialValue=6.)
12
13 res = minimize(sop.getCostFunctionValue,
14               x0=sop.getOptimizationParameterInitialValues(),
15               method="SLSQP",
16               bounds=sop.getOptimizationParameterBounds(),
17               options={'eps': 0.01, 'disp': True, 'maxiter': 200})

```

Thank You



If you have any questions,
please don't hesitate to contact us at
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