OMOptim – Model-based optimization with OpenModelica

Hubert Thieriot

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OMOPTIM PRESENTATION
WHAT IS OMOPTIM?
What OMOptim intends to be?

Optimization platform designed to:
- Facilitate algorithms development
- Share optimization functions
- Apply optimization easily and efficiently

End-user oriented
Two main users

**Academics**
A platform to **develop** and test optimization methods

**Industrial**
A user-friendly tool to **perform process optimizations**
Applications

- Design optimization
- Parameters optimization
- Components selection (beta)
- Sensitivity analysis
- Optimal control
- Hybrid systems

Planned Optimization Methods

- Evolution strategies (e.g. genetic algorithms)
- Gradient based methods (e.g. SQP)
- Relaxation techniques
- Hybrid algorithms
What OMOptim can do?

**STATIC PARAMETERS**

**OPTIMIZATION**
e.g. Optimization of heat-pump parameters

- Parameters are static: constant during one simulation
- Simulation can still be dynamic
- Objective functions can consider evolution

Freedom
- Pressure levels
- Heat-exchanger area
What OMOptim can do?

STRUCTURE OPTIMIZATION
Structure optimization

- Introduction of alternative options
- Optimal choice
What OMOptim can do?

WHICH OBJECTIVES?
Multi-objectives

Pareto criteria allows several objectives simultaneously
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Scanning variables

- Configuration A
- Simulation 1
- Simulation 2
- Simulation 3
- Simulation 4
- Scanning function A
- Scanning function B
- Objective A
- Objective B

E.g.

- minimize total energy consumption over the four seasons
- minimize standard deviation of temperature related to mass flow
PROJECTS
Two energy related projects

**EDOP**
- Integration of modelization and optimization
- Dynamic optimal control of startup and load cycles

**CERES**
- Identify best energy paths within industrial processes
- Design optimization
OPTIMIZATION ALGORITHMS
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- Meta-heuristics
  - Many simulations required
  - Model as a Black-box

- Gradient based
  - Require jacobians

- Relaxation techniques
  - cf. EDOP project
Meta-heuristic algorithms implemented

- Evolutionary strategies (SPEA2, NSGA2)
- Particle Swarm Optimization
- Simulated Annealing
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PLUGIN FUNCTIONALITY
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Plugin

- Allows to implement specific functionalities
- Dynamically/Statically linked
Energy integration plugin
CERES project

• Increase heat recovery within processes
• Select best fitted utilities
• Build heat exchangers network
Energy integration - example

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Energy integration algorithms
MILP solvers

Chaudière 1
Plugin

- Why not a NMPC plugin?
- Parameter identification
FUTURE DEVELOPMENTS
First developments

- FMI compliance
- Parallelization
- Gradient based methods
Applications

- Design optimization
  - Continuous parameters
  - Components selection \( (beta) \)
- Sensitivity analysis
- Optimal control
- Hybrid systems

Planned Optimization Methods

- Evolution strategies (e.g. genetic algorithms)
- Gradient based methods (e.g. SQP)
- Relaxation techniques
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INTERESTED IN ?
• Website
  – www.openmodelica.org

• Source code
  https://openmodelica.org/svn/OpenModelica/trunk/OMOptim/

• Mail
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THANKS FOR YOUR ATTENTION
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Top-level conceptual view of OMOptim and its interfaces
To be done …

• Finalize OMOptim **structure**

• Strengthen **link** Simulation – Optimization
  – Derivative information
  – Structural change
  – Parallelization

• Organize **sharability** of optimization functions
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Modelica model

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C++, Qt

Optimization

C++, External libs

Corba

Reading/ modifying model structure

Files

Reading/ modifying variables

Open Modelica

Open Modelica, Dymola, ...

Corba

Reading Writing