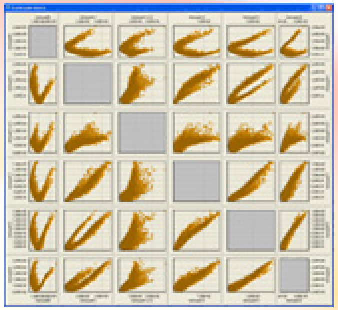
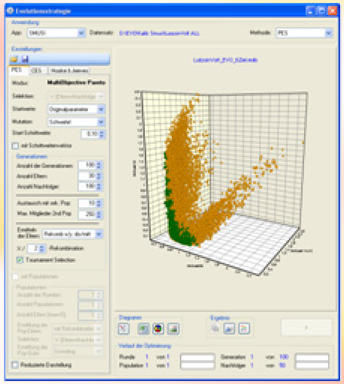
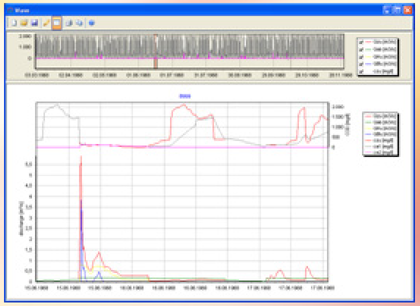
BlueM.Opt - a generic framework for simulation based optimization







International Stormwater and Urban Water Systems Modeling Conference

Toronto, Canada
19 02 2009

D. Muschalla, F. Froehlich, S. Heusch, C. Hübner, D. Kerber, F. Reussner and M. Ostrowski

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Overview

- Introduction
- Problem statement
- Methodology
  - Design goals
  - Integration of optimization algorithms
  - Integration of simulation engines
  - Supporting tools
- Application
- Conclusion and remarks

Introduction

- Engineers and scientists are frequently faced with complex optimization problems

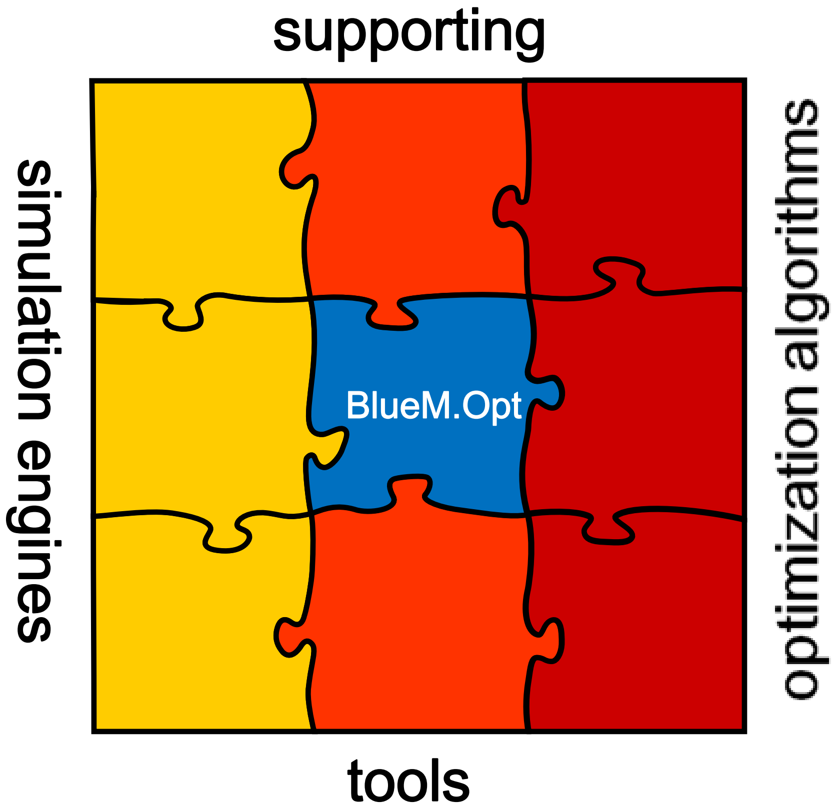
- Numerous optimization algorithms have been published
- Computer-based simulation models are accepted tools
- Application of models to a growing range of complex problems

Problem statement

- No single model/simulator can fit all applications
- No single optimization method is suitable for all problems

➢ Development of a generic framework that facilitates a problem driven coupling of appropriate models and optimization algorithms

Methodology
Design goals



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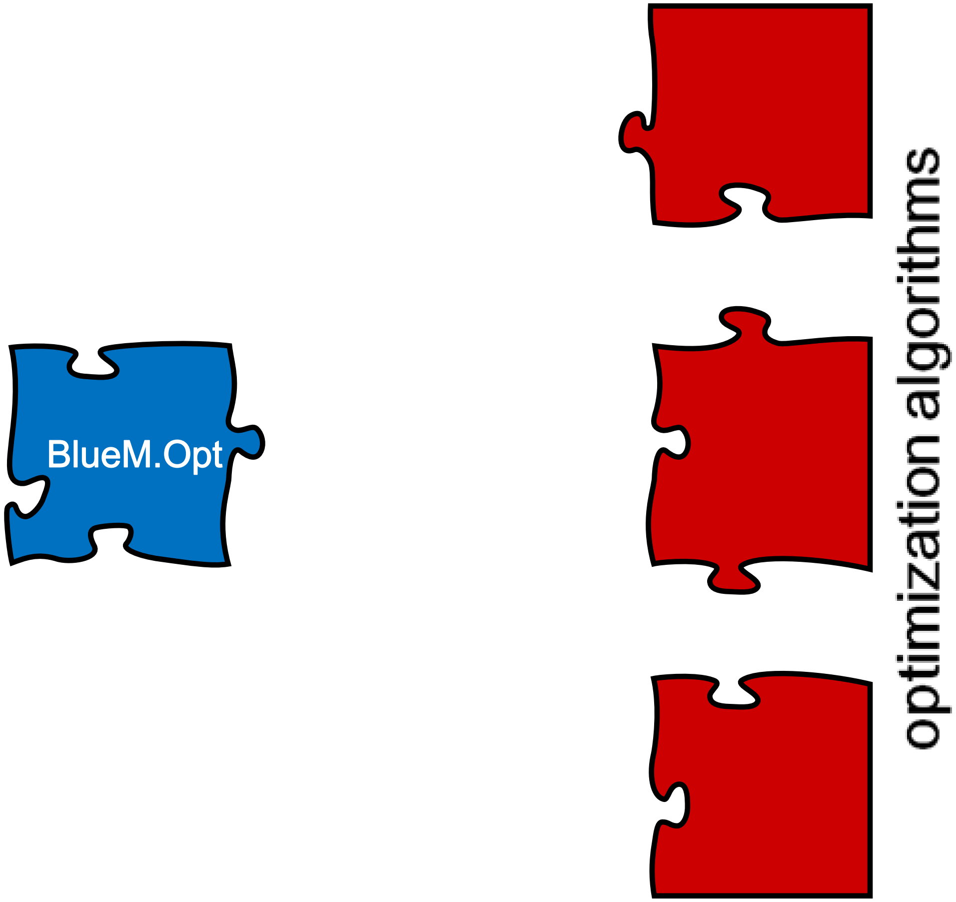
Methodology

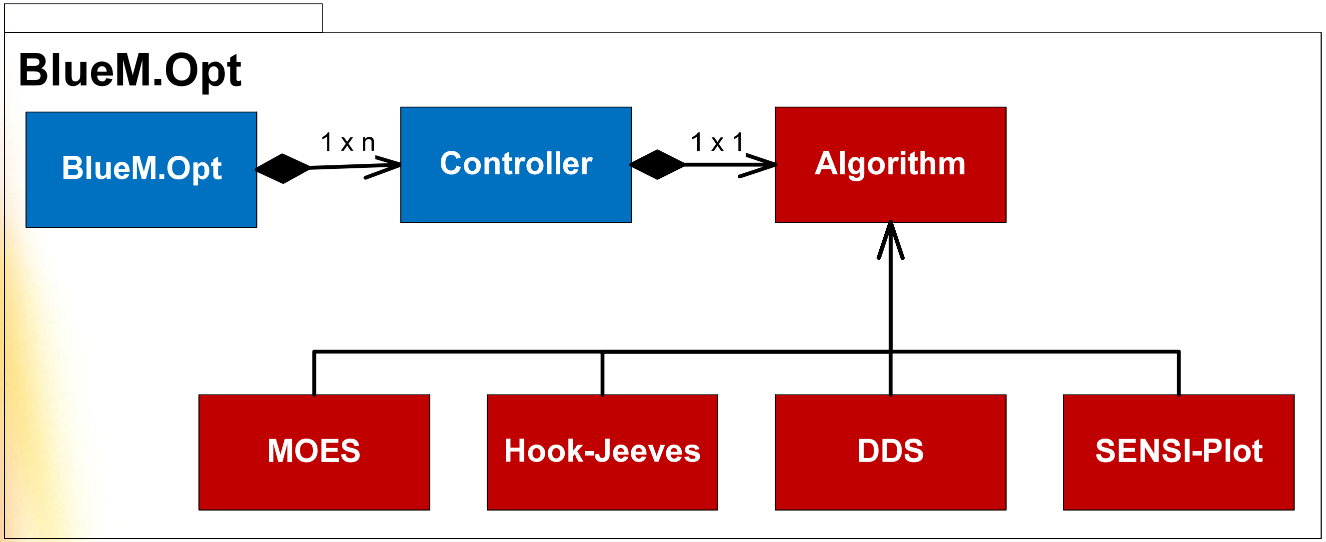
Integration of optimization algorithms



Methodology

Integration of optimization algorithms 1/3

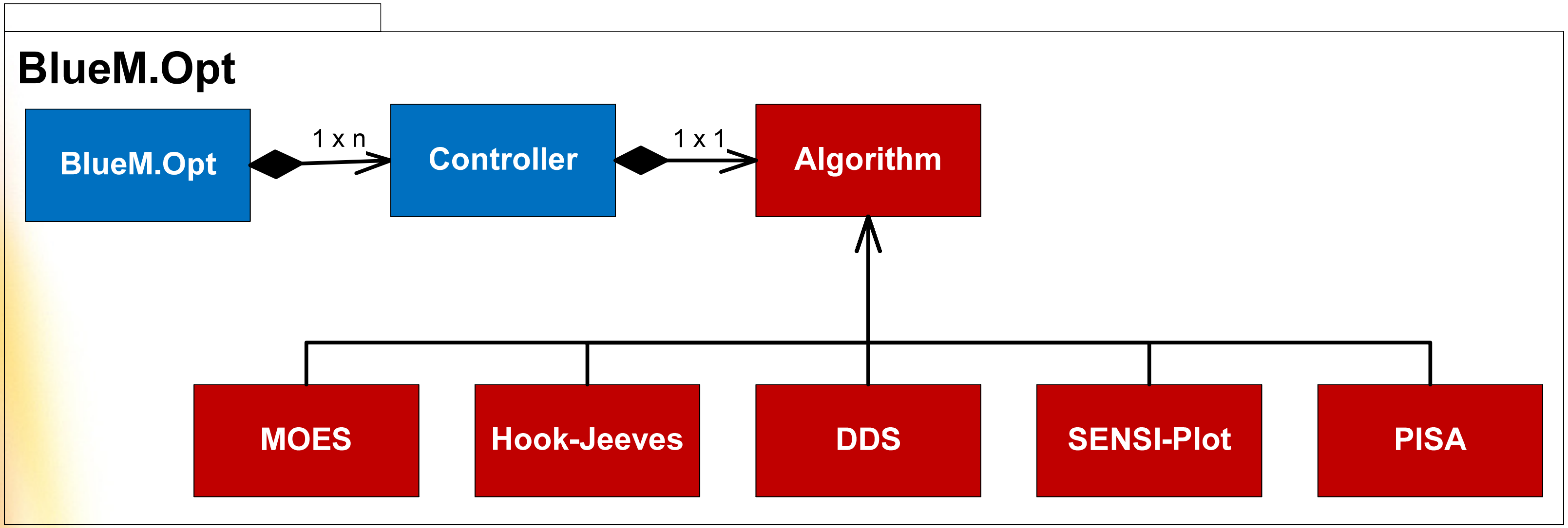
- Direct implementation via «Strategy pattern»



Methodology

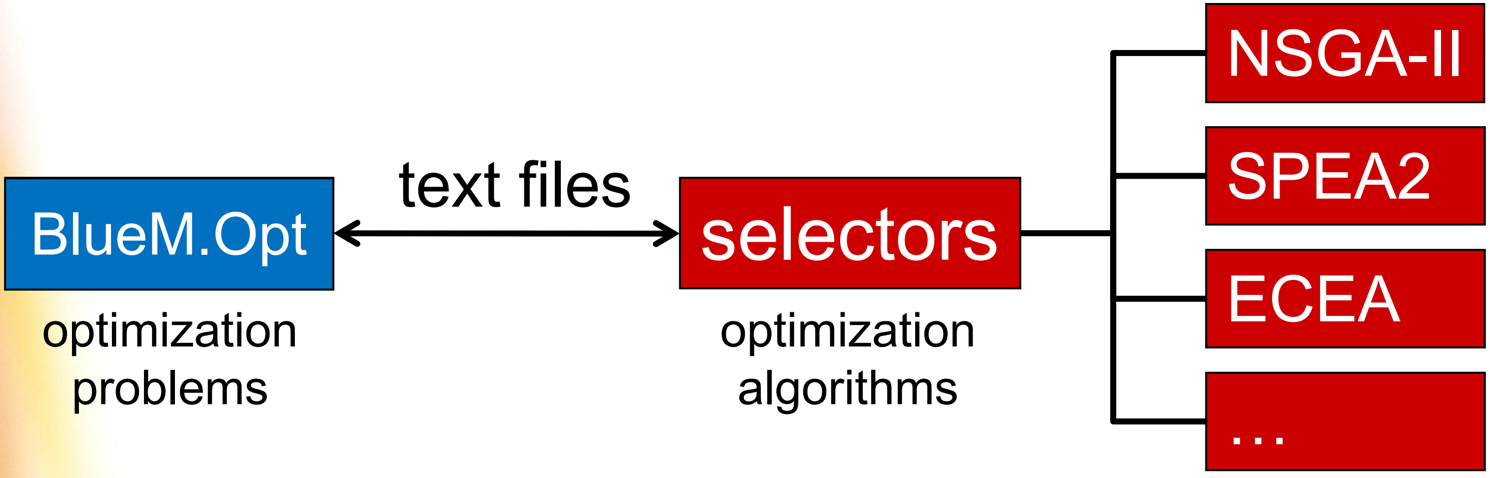
Integration of optimization algorithms 2/3

- Supporting «PISA standard»

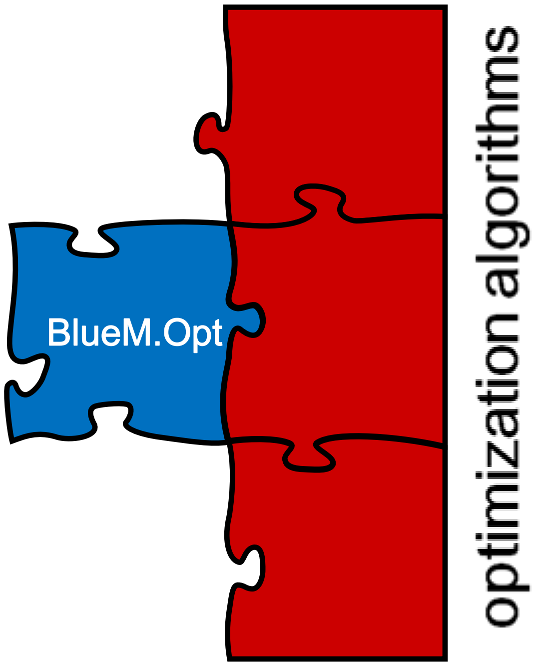


Methodology
Integration of optimization algorithms 3/3

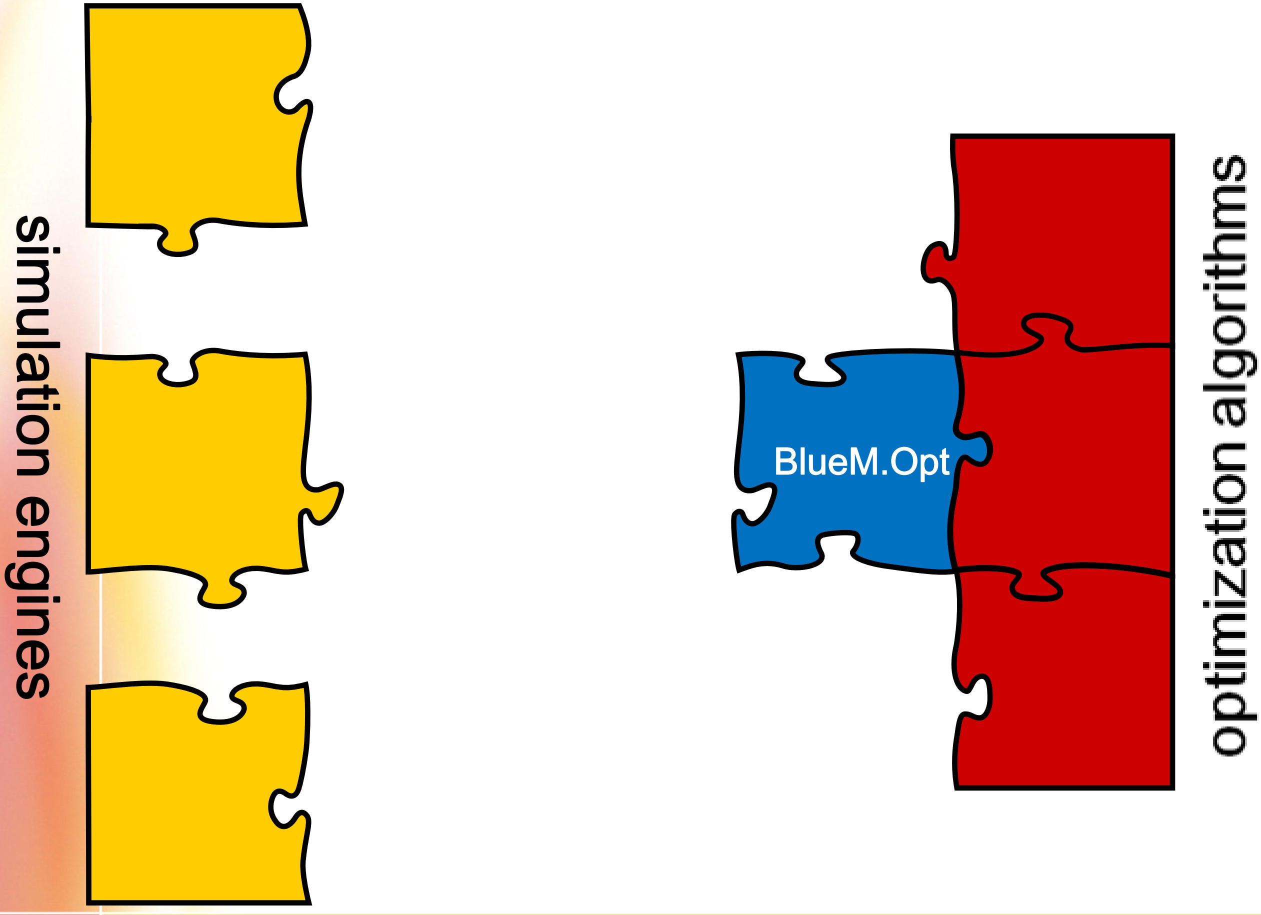
- Supporting «PISA standard»



Methodology
Integration of optimization algorithms

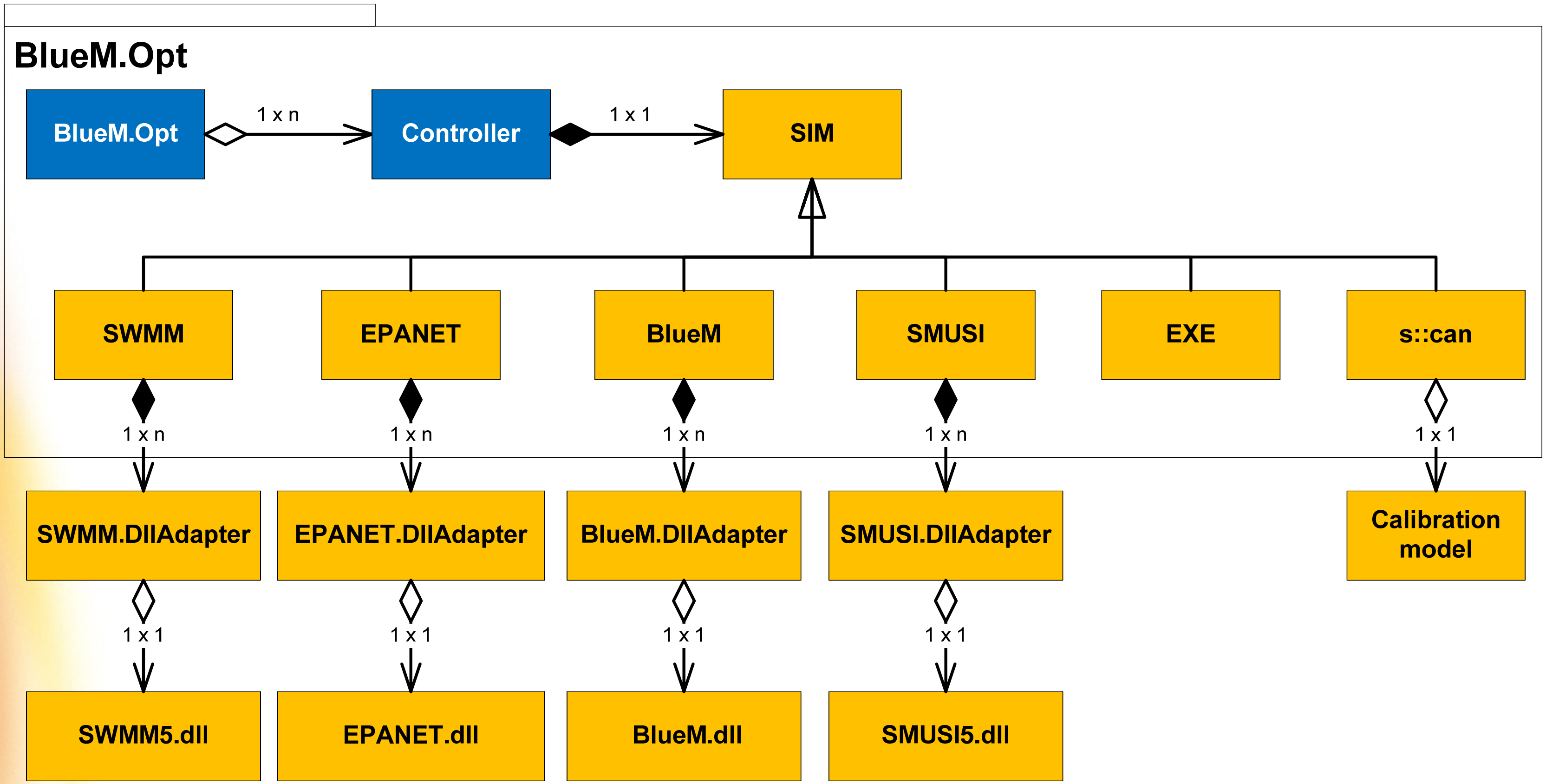


Methodology
Integration of simulation engines



Methodology

Integration of simulation engines



Methodology

Integration of simulation engines

- Input-files
  - *.opt-file: decision variables
  - *.mod-file: model parameters to be modified
  - *.zie-file : objectives
  - *.con-file: constraints

*Optimierungsparameter

Bezeichnung	Einh.	Anfangsw.	Min	Max	Beziehung
PSI	[illegible]	[illegible]	0.1	0.9	
RetKonstV	-	1	0.1	10	
RetKonst1	-	1	0.1	10	>
RetKonst2	-	1	0.1	10	>

*ModellParameter

OptParameter	Bezeichnung	Einh.	Datei	Elem. /o	Zeile	von	bis	Faktor
PSI	A01_psi	-	EZG	3201	10	110	114	1
PSI	A02_psi	-	EZG	3201	11	110	114	1
RetKonst	A01_K1	-	EZG	3201	10	143	148	10
RetKonst	A02_K1	-	EZG	3201	11	143	148	10

*OptimierungsZiele

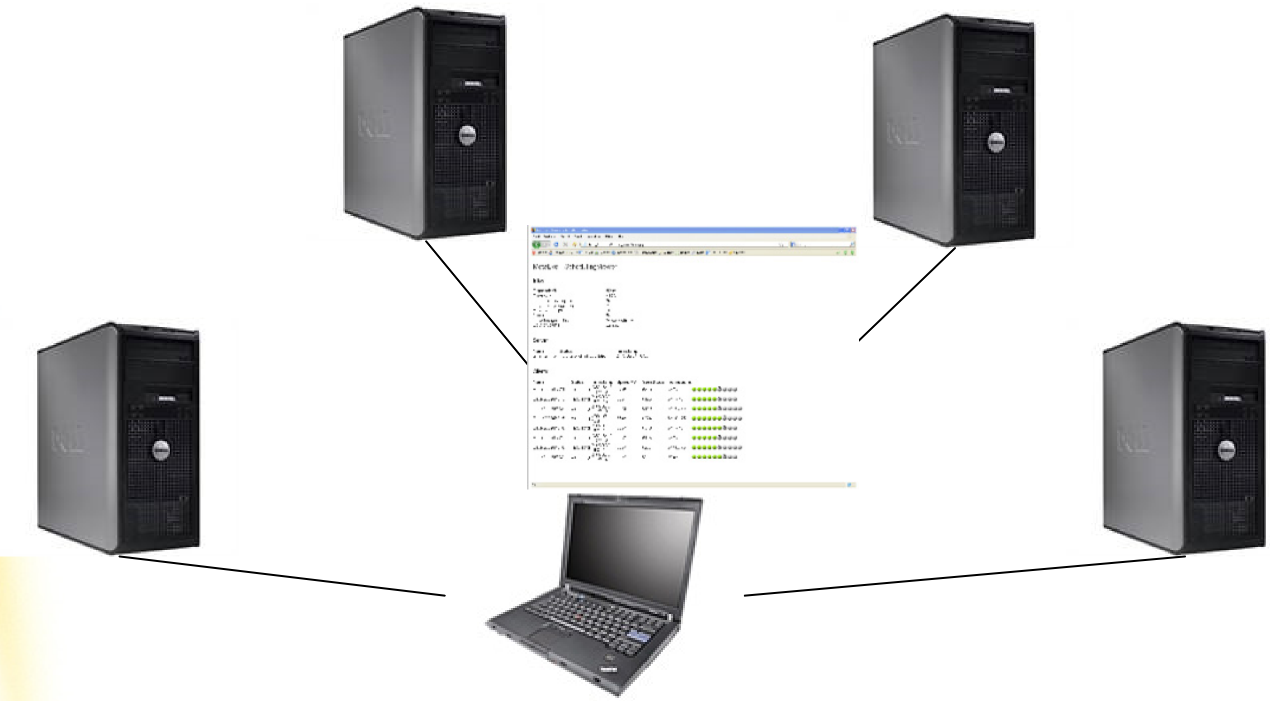
Opt	Bezeichnung	Gruppe	Ri	Op Fak	ZielTyp	Datei	SimGröße	ZielFkt	EvalZeitraum Start	EvalZeitraum Ende	Referenzwert WertTyp	Referenzwert RefWert	Referenzreihe RefGröße	Referenzreihe Datei	IstWert
P	SummeQmax	SummeQmax													
S	SE16_Q_ab	SummeQmax		+	Wert	WEL	SE16_1AB	Diff			MaxWert	0			
S	SE10_Q_ab	SummeQmax		3	Wert	WEL	SE10_1AB	Diff			MaxWert	0			
S	SE01_Q_ab	SummeQmax		[illegible]	Wert	WEL	SE01_1AB	Diff			MaxWert	0			

*Constraints

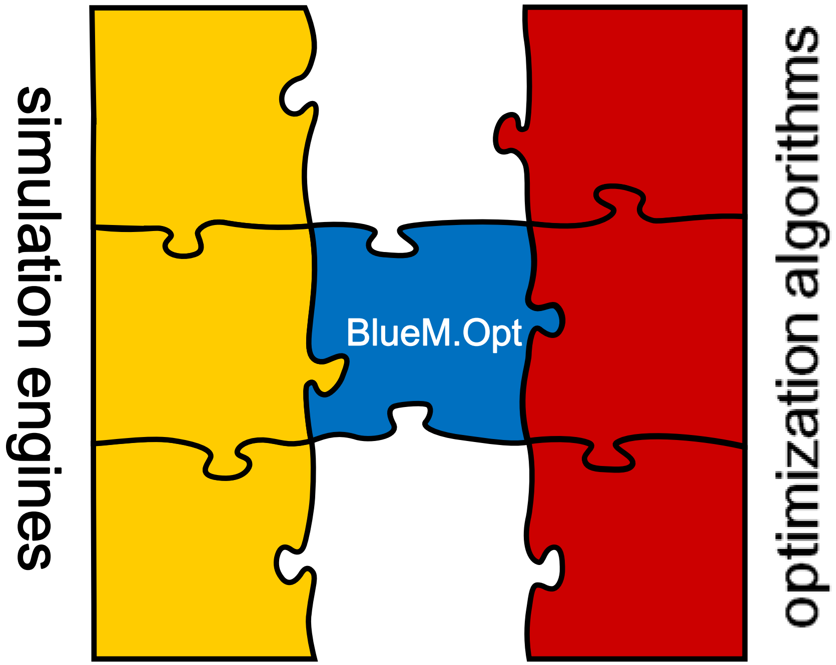
Bezeichnung	GrenzTyp	Datei	SimGröße	Oben/Unten	Grenzwert WertTyp	Grenzwert Grenzwert	Grenzreihe Grenzgröße	Grenzreihe Datei
Überlauf	Wert	WEL	TOLF_QH2	Obergrenze	MinWert	0		
HWSRaum	Reihe	WEL	TOLF_VOL	Obergrenze			HWSR	HWSR.wel

Methodology
Integration of simulation engines

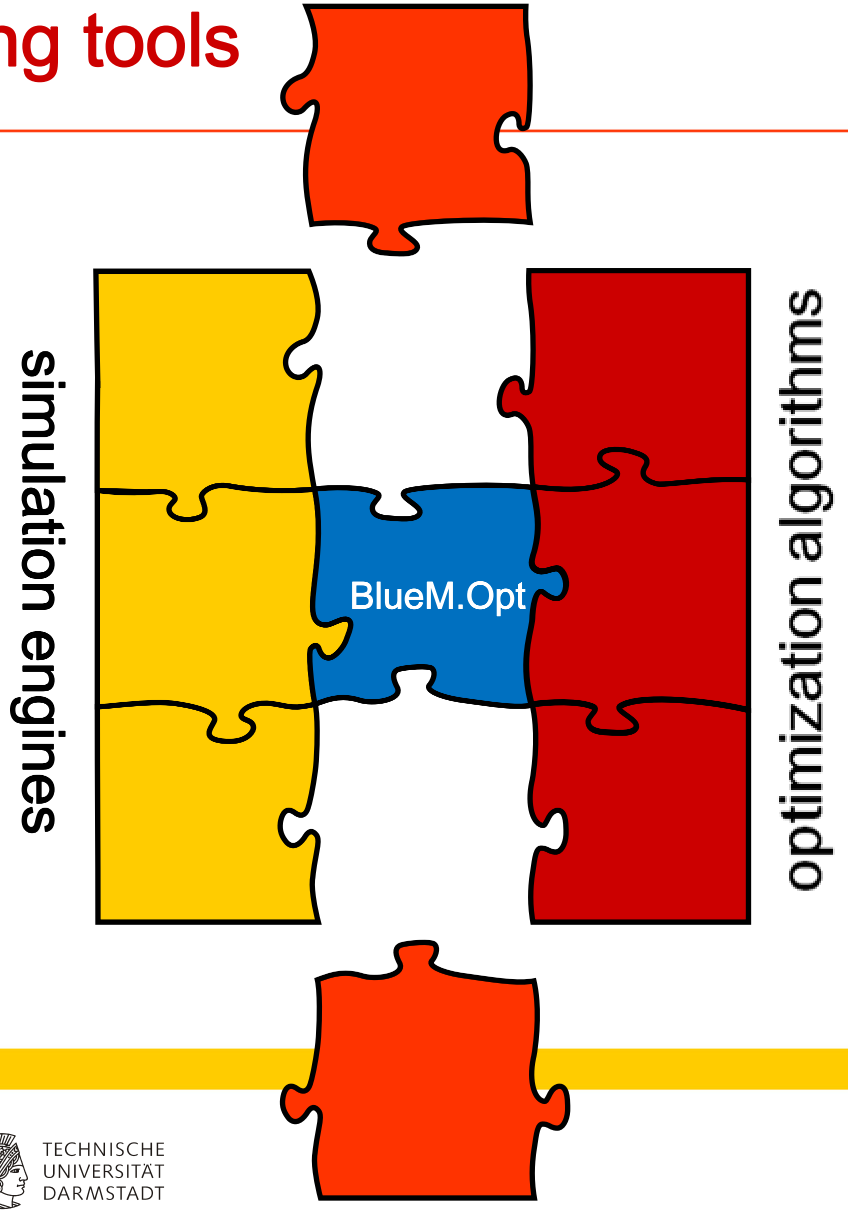
- Scheduling tool for heterogeneous PC cluster



Methodology
Integration of simulation engines



Methodology
Supporting tools



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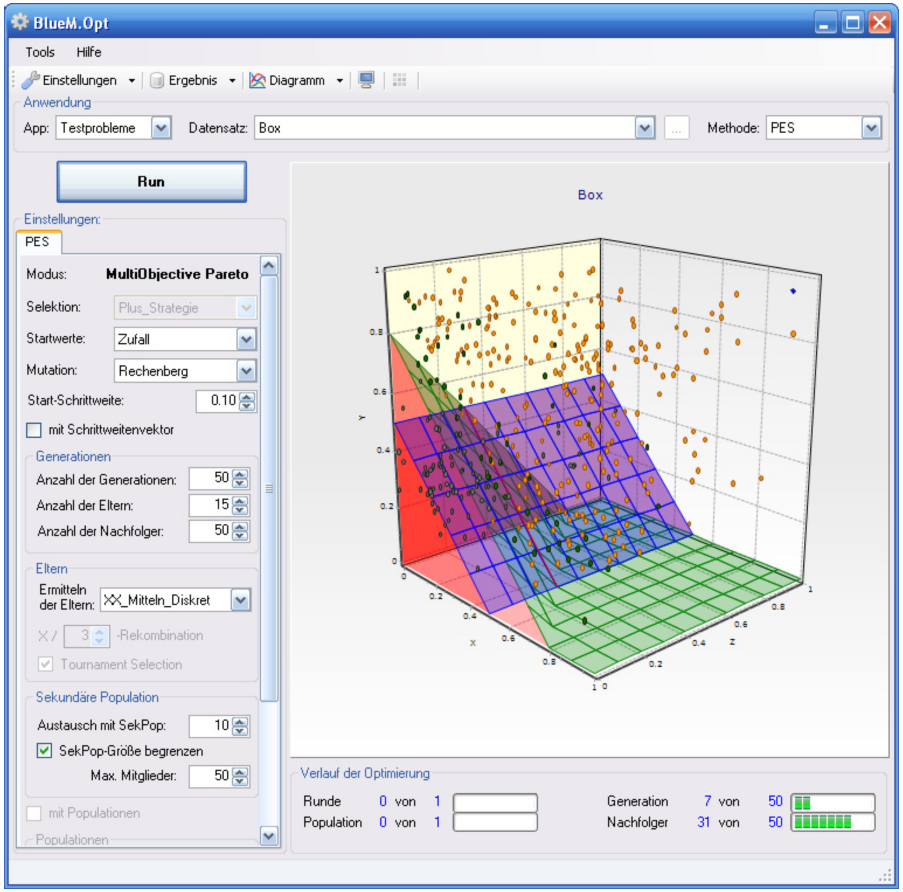
Methodology

Supporting tools

- Advanced GUI
  - Control optimization
  - Monitor progress
  - Analyze results



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Methodology
Supporting tools

- Advanced GUI
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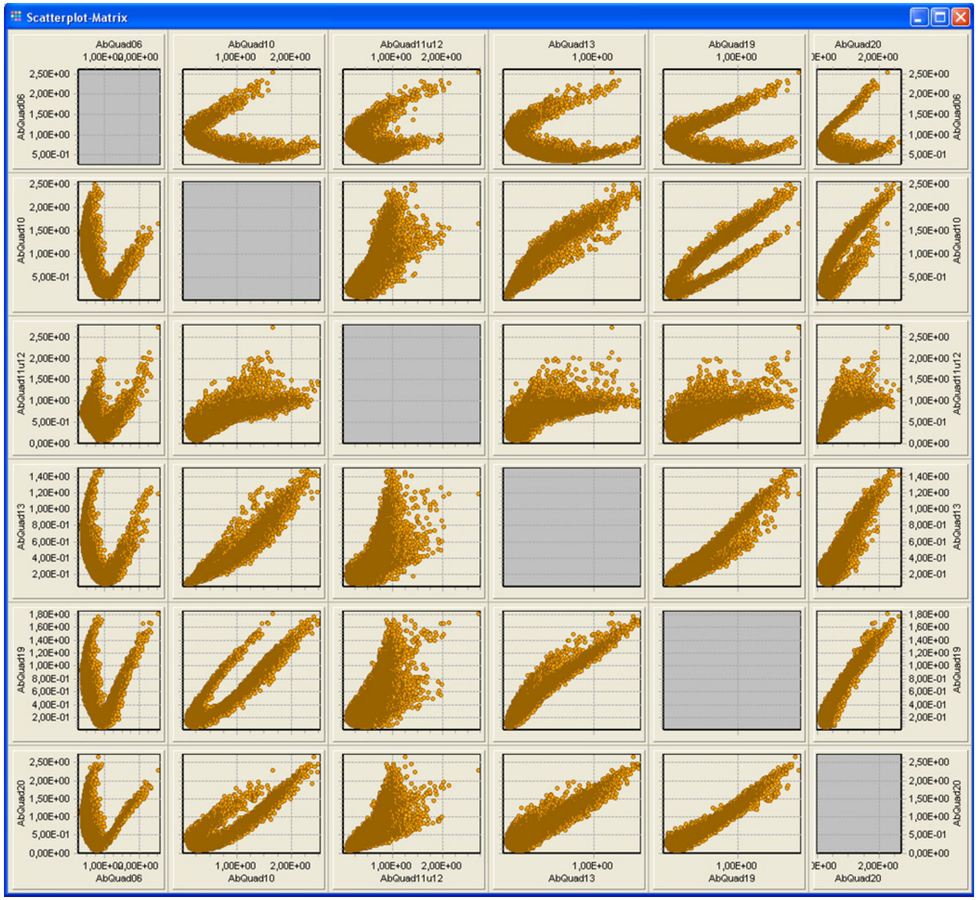
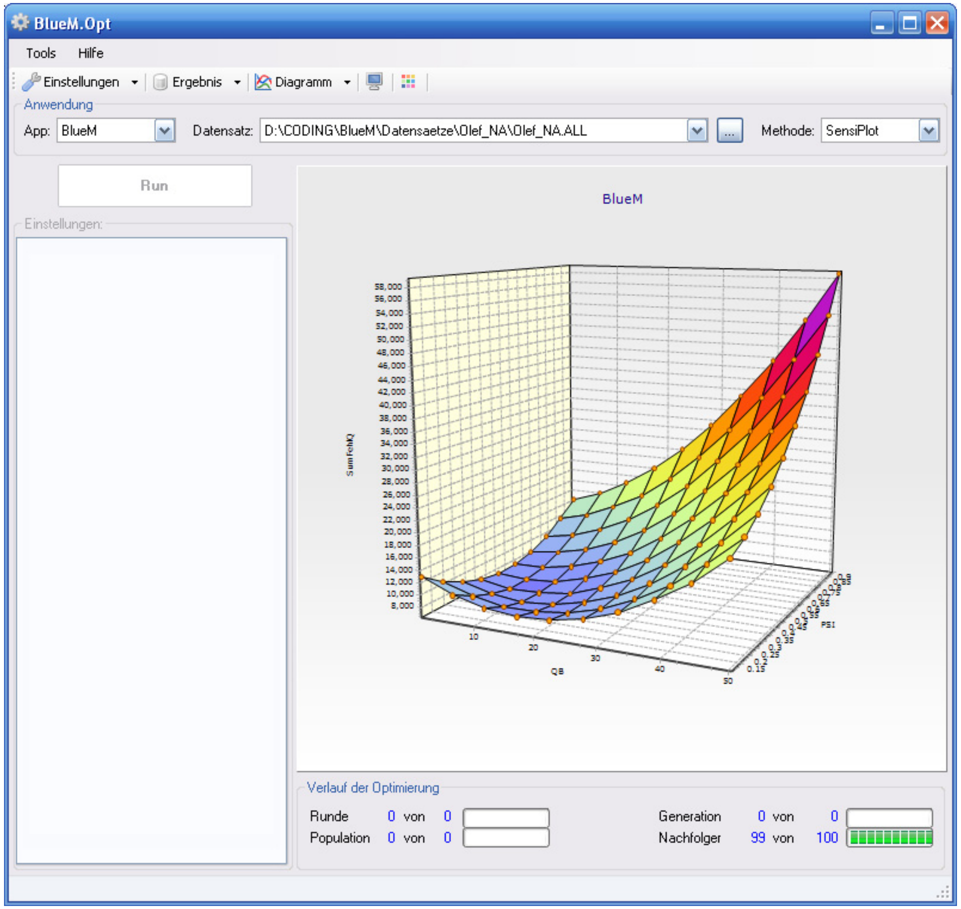


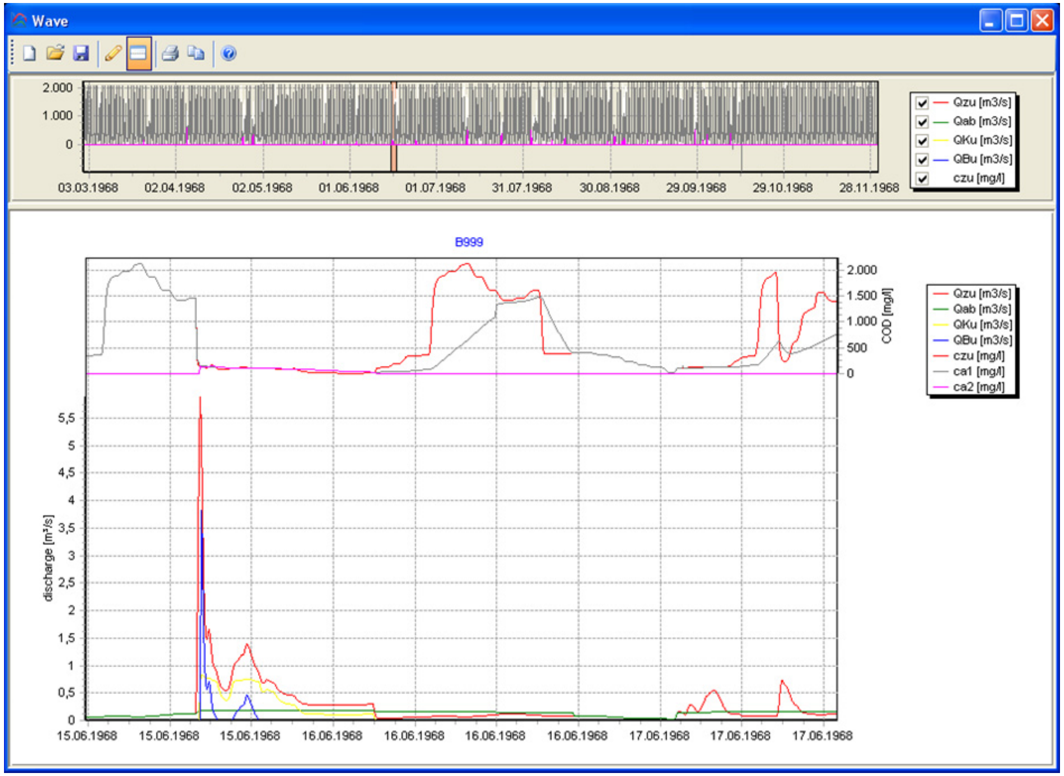
Methodology
Supporting tools

- Multidimensional response surface analysis



Methodology
Supporting tools

- Time series analysis



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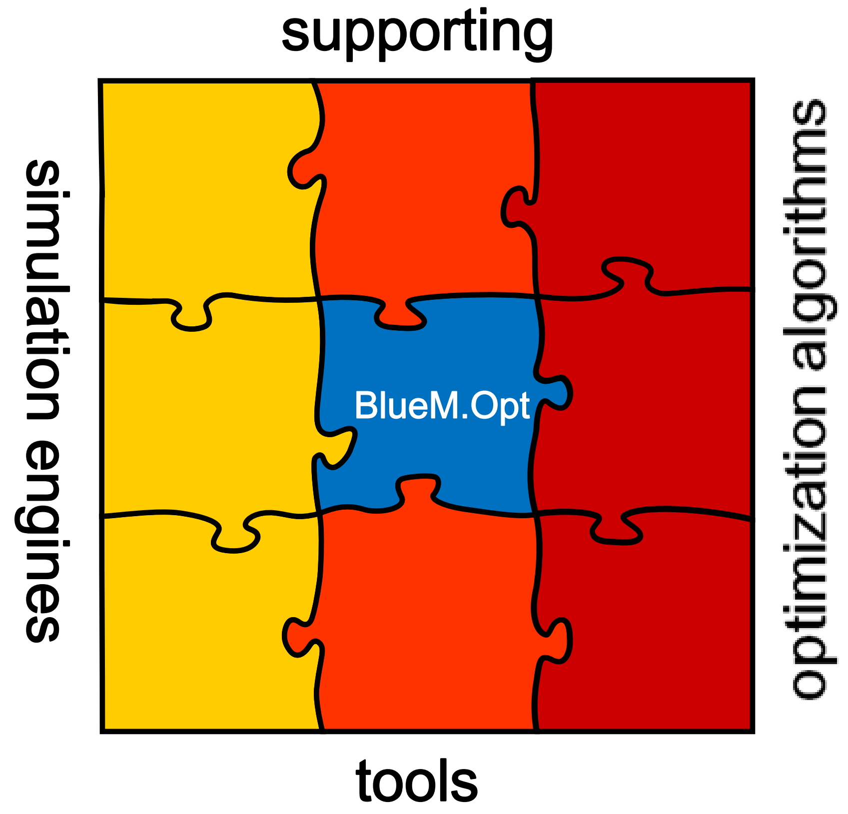
Methodology
Supporting tools

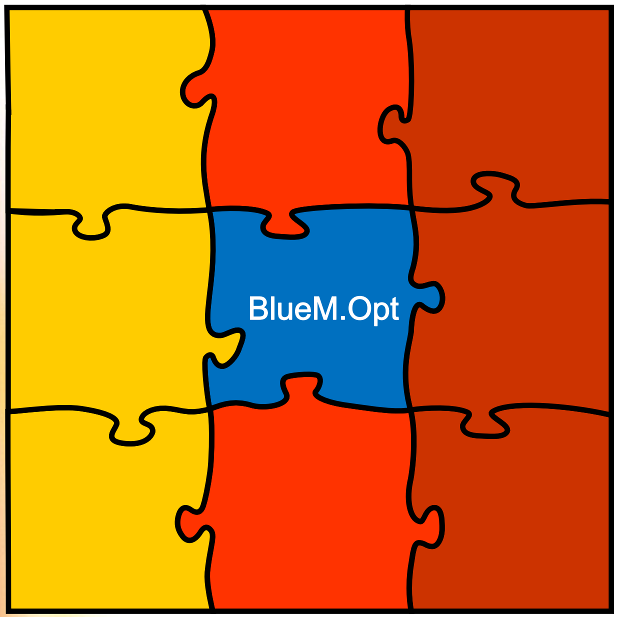


Applications

- Water quality oriented optimization of urban wastewater systems
- Optimization of rule-based control of urban drainage systems
- Single and multi objective auto calibration of sewer (quantity and quality) and rainfall runoff models
- Optimization of reservoir operating rules regarding ecological performance, water supply and flood retention capacity
- Optimization of flood control strategies regarding location, type and retention capacity of measures
- …

Conclusion and Remarks

- A generic framework has been developed that facilitates a problem driven coupling of
  - appropriate models and
  - optimization algorithms
- The framework supports all simulators that use text based input files
- BlueM.Opt is freeware
- Source code available for research cooperation



Thank you!

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