



Towards model-based Generation and Optimization of AUTOSAR Runnable-to-Task Mapping

Thomas Wilhelm & Raphael Weber (MASE'19 @ MODELS'19, 2019-09-15, Munich)

Agenda

► **Motivation**

Deployment of runnables in the context of AUTOSAR

Use cases

AUTOSAR Configuration Generation Meta-model

Initial ECU Configuration Generation

Case study

ECU Configuration Optimization

Outlook

Motivation

Aktueller Dienstplan																
	MA.	Wst.	Ist-Std./Soll-Std.	Qualifikation	6.10	7.10	8.10	9.10	10.10	11.10	12.10	13.10	14.10	15.10	16.10	17.10
K. Wolff	2.9	38.5	47.0	Examiniert									N	N	N	N
	0.0	9.5	27.0	Examiniert				N	N	N						
	2.7	38.5	82.5	Examiniert	N	N	N		S							
	2.7	38.5	78.7	Examiniert				S	S	S	S	N	N	N	N	N
	0.0	38.5	70.7	Examiniert	N	N	N		S							
	2.5	38.5	103.0	Examiniert			S				S				S	S
	4.1	38.5	81.8	Examiniert			S					S	S		S	S
	0.0	38.5	102.0	Examiniert	S	N	S					S	S		S	S
	2.4	38.5	118.7	Examiniert	S		S	S		S	S			S		
	1.1	38.5	117.3	Examiniert	S	S	S	S	S	S	S			S		
	0.0	9.5	23.2	Examiniert		S		S	S							
	3.0	38.5	114.6	Examiniert	S	S					N	N		S	S	S
	3.6	30.0	88.8	Examiniert		S		F	F	S	S				S	S
	4.3	38.5	114.1	Examiniert	S	S		F	F	S	S		S	S		
	0.0	38.5	100.7	Examiniert	S			F	F		F	S	S	S		
	1.0	38.5	101.7	Examiniert		F	F				F	S	S		F	
	0.0	38.5	96.7	Examiniert			F			F					F	F
	1.2	38.5	123.7	Examiniert	N	N			F	F		F	F	F	F	F
	3.3	38.5	119.6	Examiniert	F	F										
	0.0	38.5	94.2	Examiniert	F	F										
	1.3	38.5	43.8	Schüler/in	N											
	2.1	38.5	79.8	Schüler/in	S											
	0.0	38.5	124.0	Examiniert	F	F										
	1.9	38.5	118.2	Schüler/in	F	F										
Frühschicht					E4/5-S1/1	E5/5-S1/1	E									
Spätschicht					E0/5-S1/1	E5/5-S1/1	E5/5-S1/1	E5/5-S0/0	E5/5-S0/0	E5/5-S1/1	E5/5-S1/1	E5/5-S1/1	E5/5-S1/1	E5/5-S0/0	E5/5-S0/0	E5/5-S0/0
Nachtschicht					E0/5-S1/1	E5/5-S1/1	E5/5-S1/1	E5/5-S0/0	E5/5-S0/0	E5/5-S1/1	E5/5-S1/1	E5/5-S1/1	E5/5-S1/1	E5/5-S1/1	E5/5-S0/0	E5/5-S0/0

Nachrichten

Pflegekraft K. Wolff arbeitet im gesamten Planungszeitraum 123.7 Stunden, soll aber nur 115.5 arbeitsen (MA: 0.2).

...

Pflegekraft K. Wolff hat zwischen diesem Nachtschichtblock (4.10 - 7.10) und dem Anfang des nächsten Nachtschichtblockes (20.10) nur 12 Tag(e) Abstand, also 4 Tag(e) zu wenig.

...

Zu Excel

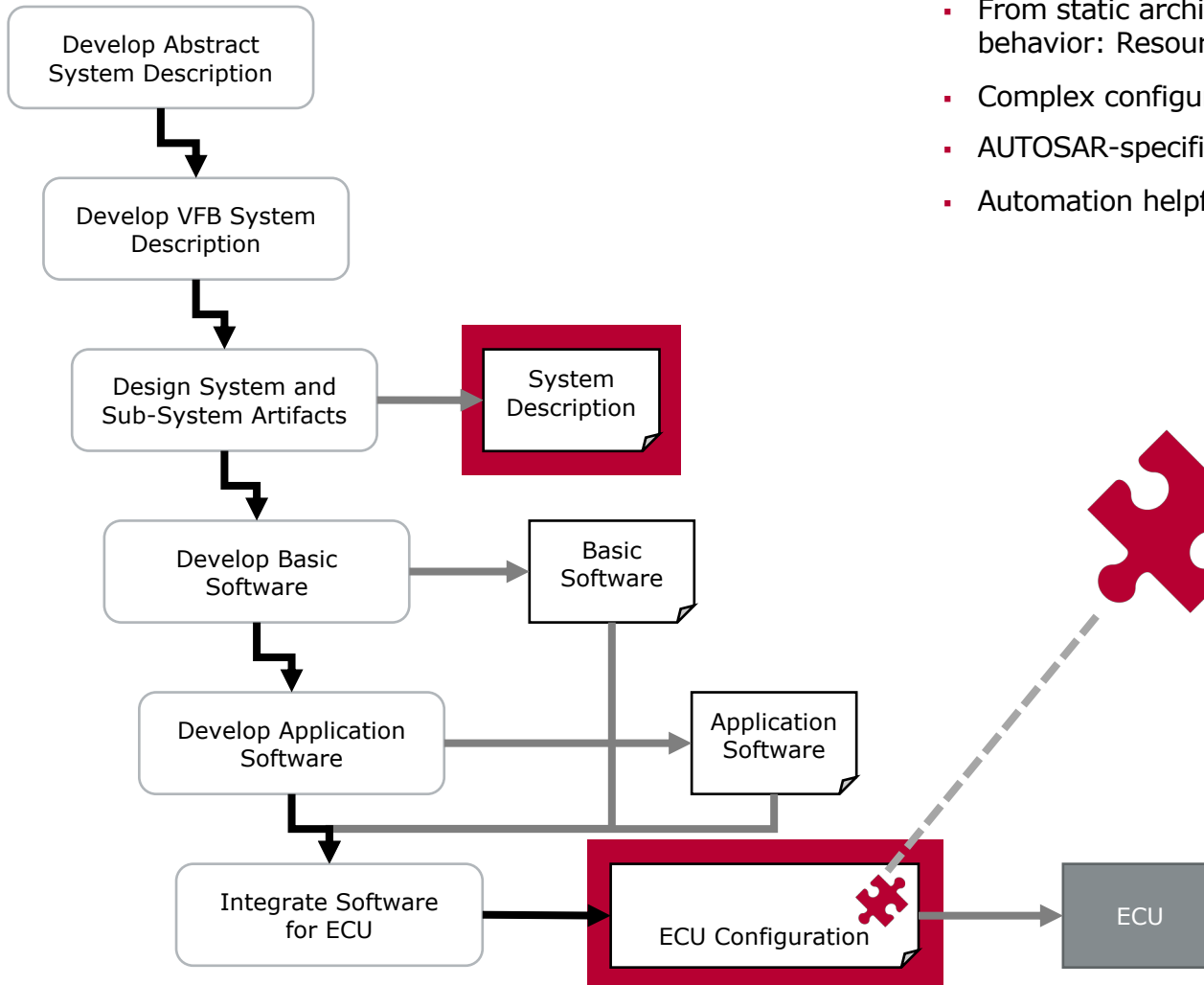
Schließen

Universität Würzburg: Wissensbasierte Dienstplanung

[<http://www.is.informatik.uni-wuerzburg.de/research-tools-download/weitere-anwendungen/dienstplanung/>]

Deployment in the context of AUTOSAR

AUTOSAR Methodology (simplified)



integration of HW and SW

- From static architecture and design to dynamic behavior: Resource sharing effects
- Complex configuration of ECU
- AUTOSAR-specific constraints
- Automation helpful and feasible

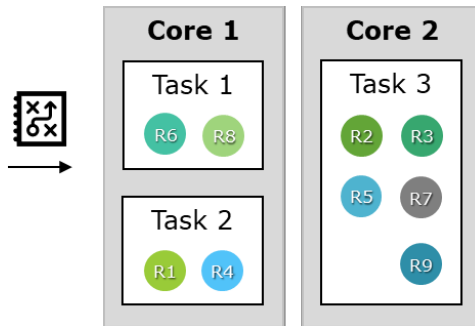
mapping of runnables to tasks

Mapping Runnable Entities to OS Tasks

create an initial configuration

use case
1A

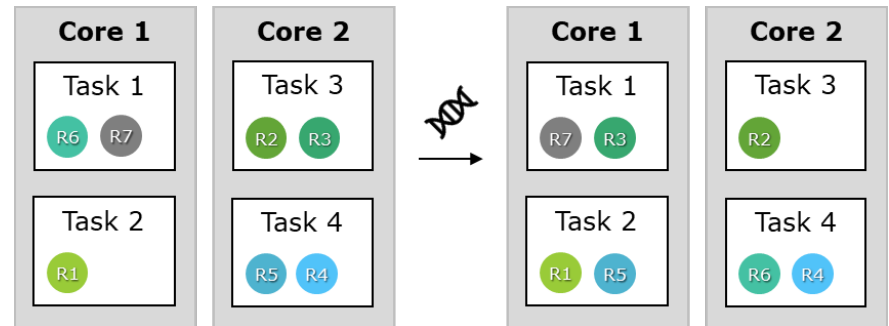
Tasks exist (and may contain runnables):
Map the runnables to these tasks.



optimize an existing configuration

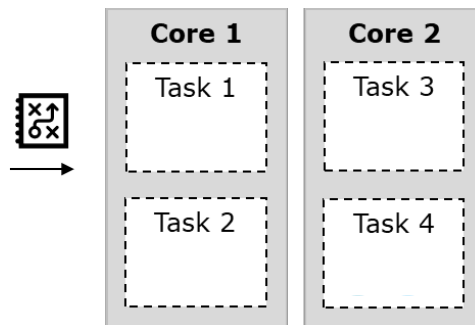
use case
2

A configuration exists:
Optimize the existing configuration
by finding a new mapping



use case
1B

Tasks do not exist:
Create suitable tasks*,
map the runnables to them



constraint programming



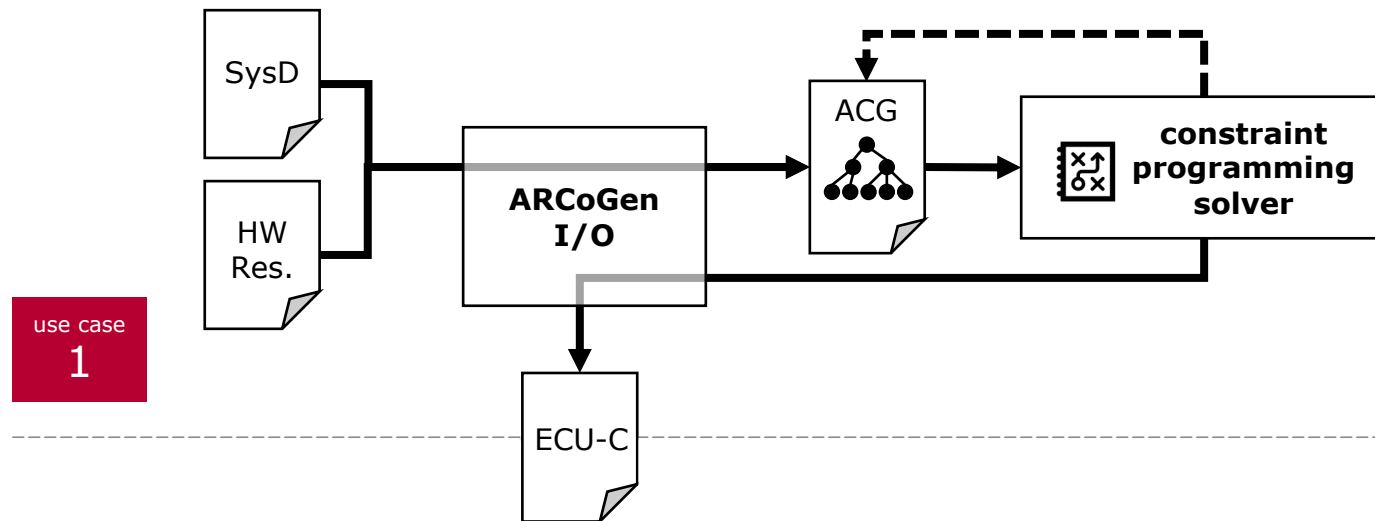
evolutionary algorithm

* Creating tasks is challenging (see Hoettger et al. (2015)) and work in progress.

AUTOSAR configuration generation meta-model

TimeSphere
level: NodeLevel safetyLevel: SafetyLevel validMappingTarget: boolean
...

Using the meta model



ACG = model instance

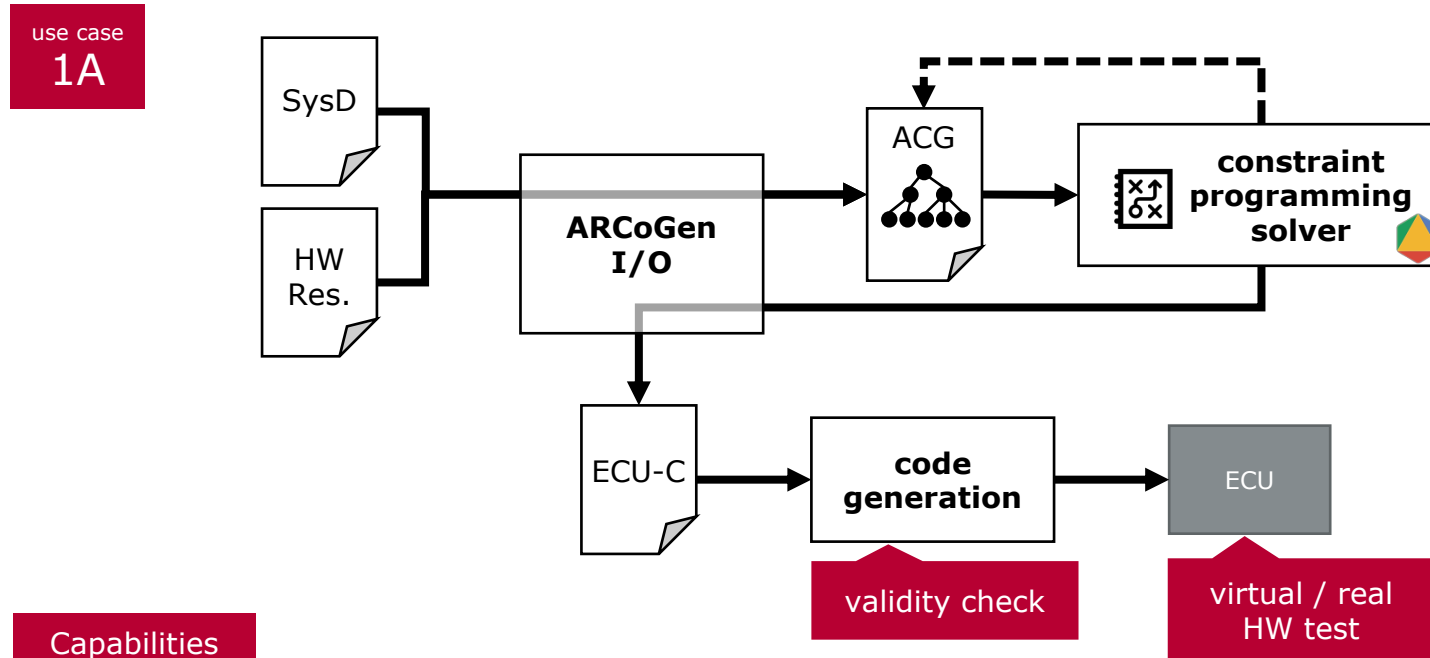
ARCoGen = AUTOSAR Configuration Generator

SysD = System Description (AUTOSAR)

HW Res. = Hardware Resource Template (AUTOSAR)

ECU-C = ECU configuration (AUTOSAR)

Approach



Capabilities

- ▶ Consider AUTOSAR-specific constraints
- ▶ Optimization goals: balanced core utilization, communication cost (in progress)
- ▶ Task synthesis (in progress)

Challenges

- ▶ Basic software
- ▶ Utilization caused by non-periodic runnables

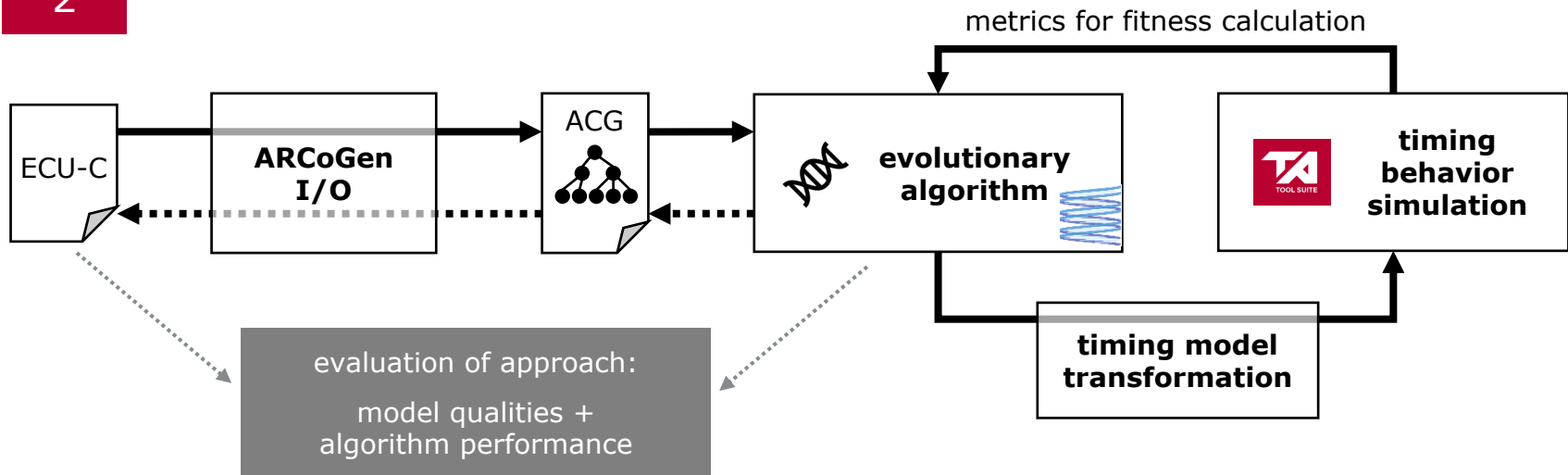
Case study

- ▶ Goal: evaluate feasibility of approach
- ▶ Input:
 - ▶ Test model with 18 SWCs, 50 runnables, 26 tasks overall
 - ▶ System description
 - ▶ HW resource template (tri-core ECU)
 - ▶ Execution times from measurement trace
- ▶ Method:
 - ▶ Use existing test model as reference
 - ▶ Generate a new mapping
 - ▶ Evaluate result using existing AUTOSAR toolchain
- ▶ Result:
 - ▶ Generated mapping is valid (DaVinci Configurator analysis + code generation)
 - ▶ Test of functionality on virtual target successful
 - ▶ Simulation to gain utilization data
 - ▶ Utilization is more balanced (see limitations)
- ▶ Limitations:
 - ▶ Utilization only considered for periodic runnables
 - ▶ Basic software is not considered
 - ▶ Security not considered in the test model

model	U of C1	U of C2	U of C3
reference	23,14%	9,97%	4,87%
generated (incl. non-periodic)	13,67%	10,26%	12,80%
generated (excl. non-periodic)	10,62%	8,13%	9,74%
delta (generated incl./excl.)	3,05%	2,13%	3,06%

Approach

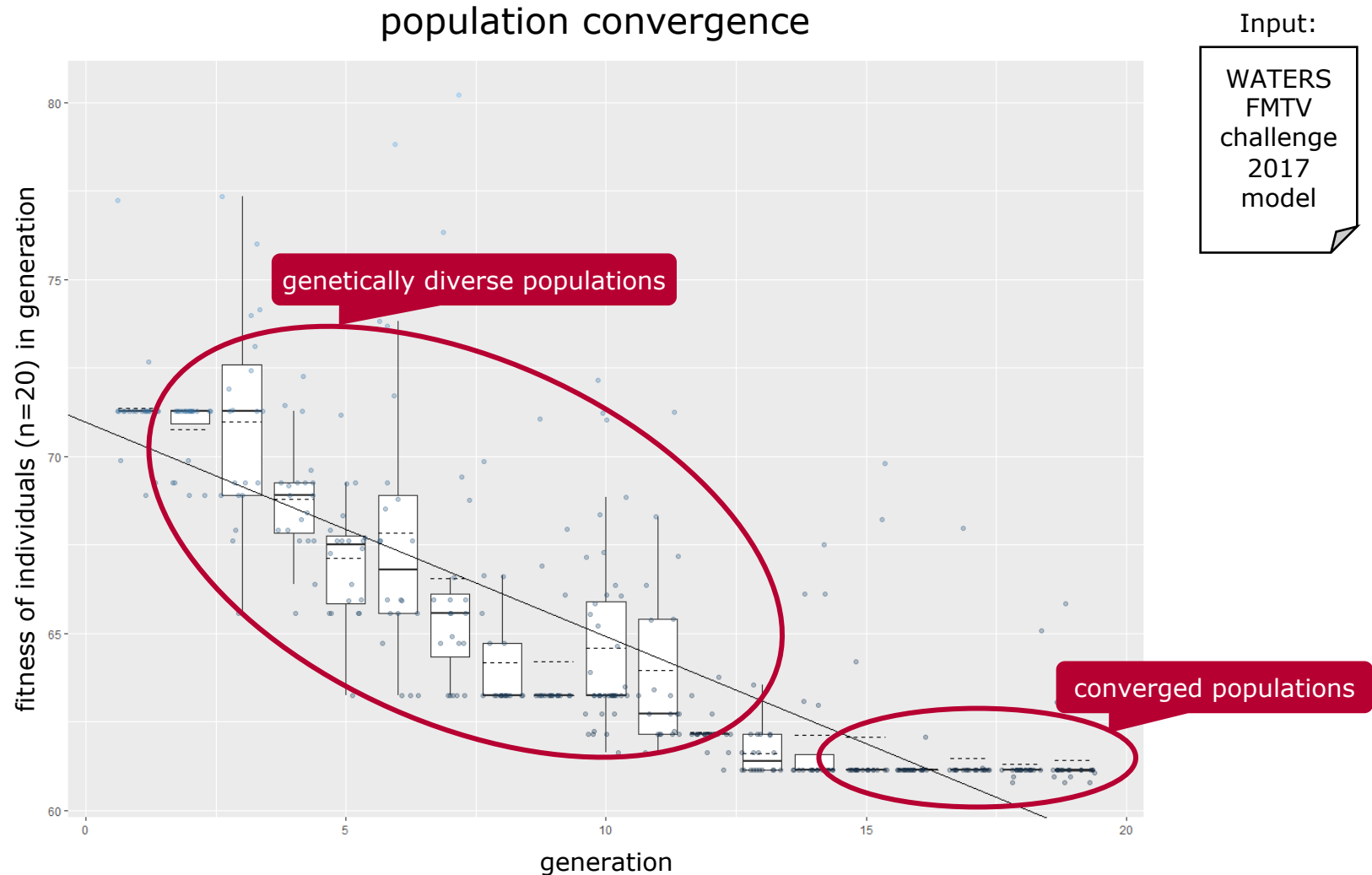
use case
2



challenges

- ▶ Locality of the problem representation
- ▶ Cost of fitness calculation
- ▶ Constraint-aware evolutionary operators (search vs. solution space)
- ▶ Evaluation of results (validity, user) and algorithm performance (duration, convergence, ...)
- ▶ Use case specific algorithm design and parameters

Algorithm performance evaluation



Outlook

Initial configuration generation:

- ▶ Communication cost as optimization goal
- ▶ Gather user feedback

Configuration optimization:

- ▶ Find operators that respect AUTOSAR constraints
- ▶ Identify common algorithm designs and parameters for problem classes (what classes are there?) using the experiment toolchain

Challenges in the wild:

- ▶ Data quality: Garbage in, garbage out
- ▶ Size of input models might be prohibitive

Your questions are welcome!

Author:
Thomas Wilhelm
Vector Germany