

# Summary of the 11th International Workshop on Models@run.time

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**Abstract**—After last years anniversary, this year the 11th edition of the workshop Models@run.time was held at the 19th International Conference on Model Driven Engineering Languages and Systems. The workshop took place in the city of Saint Malo, France, on the 4th of October 2016. The workshop was organized by Sebastian Götz, Nelly Bencomo, Kirstie Bellman and Gordon Blair. Here, we present a summary of the discussions at the workshop and a synopsis of the topics discussed and highlighted during the workshop.

## I. INTRODUCTION

Since the first edition of the workshop, it has served as a podium for various topics focusing on the fundamentals and applications of run-time models. The main goal of the workshop has been to promote cross-fertilization between researchers from different communities, including core research areas such as model-driven software engineering, software architecture, computational reflection, adaptive systems, autonomic and self-healing systems, and requirements engineering, but also application-centric research areas such as cyber-physical systems, Internet of Things, and Big Data.

In consequence, this year the workshop was attended by at least thirty (30) researchers from different communities throughout the day.

This year, seven (7) out of twelve (12) submitted papers were accepted and presented, resulting in an acceptance rate of 58%. They are published in this post-workshop proceedings. As can be seen in Table I, the interest of the research community in models@run.time remains high.

A particularly interesting observation of this year's edition of the workshop was the lack of focus on self-adaptive systems, which shows that the models@run.time paradigm is being applied to a broader domain.

Year	Attendees	Submissions	Accepted (Long+Short)
2008	44	20	6+6
2009	49	16	4+2
2010	35	15	4+6
2011	26	10	4+2
2012	48	18	11
2013	25	20	7+2
2014	27	8	5
2015	36	13	8
2016	30	12	7

TABLE I

KEY NUMBERS OF THE MRT WORKSHOP SERIES

## II. WORKSHOP FORMAT AND SESSION SUMMARIES

The workshop comprised four (4) sessions, which were structured into: a session capturing the application of runtime models to cyber-physical systems and the domain of ambient assisted living, a session on the application of runtime models to self-optimizing systems and model checking, a session on infrastructures for models@run.time systems and, finally, a session discussing how to go beyond the current state of the art of the models@run.time community.

We aimed for lively discussions at the workshop and, hence, decided to divide the 90min of each session into two 30min paper presentations and a 30min panel, where the two presenters were jointly questioned by the audience. The session chairs drove the discussions to discuss the presented papers in the context of the sessions' theme. This new format turned out to be very effective. The last session captured one paper presentation followed by a 60min open discussion on the future of models@run.time.

### A. Models@run.time for Cyber-Physical Systems and AAL

In this session, after a short workshop opening, Erik Burger presented his paper entitled "View-based and Model-driven Outage Management for the Smart Grid". The approach covered in the paper, called VITRUVIUS, aimed at keeping models of different standards consistent with each other and was exemplified by 3 standardized metamodels from the smart grid domain being composed with each other. The approach made use of runtime models at the architectural level and included structural as well as physical-related runtime models. The purpose of using runtime models was to keep multiple models consistent with each other.

The second talk was given by Luis Hernan Garcia Paucar, who presented the paper entitled "Runtime Models Based on Dynamic Decision Networks: Enhancing the Decision-making in the Domain of Ambient Assisted Living Applications". The principle idea was to keep a dynamic decision network update to date with the system it captures. The approach was applied to an ambient assisted living example. In contrast to the first paper of this session, the runtime models were used at the level of requirements, i.e., quality runtime models were used to support better-informed decision making.

During the panel at the end of this session several questions were raised, which should be investigated in future work. The question brought up by the audience were:

- Do we need fundamentally different runtime models for software and the physical world?
- How do we know, when a model is to be updated and how do we know if a decision was based on an up-to-date model?
- How to handle the different types of uncertainty present in runtime models?
- Can we make use of our knowledge about the real world for the synchronization mechanism?
- Can we compose different types of uncertainty measures?

### B. Models@run.time for Model Checking and Optimization

The second session started with a talk by Hiroyuki Nakagawa, who presented his paper entitled “Caching Strategies for Run-time Probabilistic Model Checking”. The goal of the presented approach was to enable efficient runtime verification. For this, the authors extended Antonio Filieri’s runtime verification approach to allow for structural model changes at runtime. Interestingly, in this work, the runtime models were used at the level of processes, i.e., runtime process models were used for assurance by model checking. The approach has been applied to an example from the robotics domain.

The subsequent talk was given by Rene Schöne, who presented his paper entitled “Incremental Runtime-generation of Optimization Problems using RAG-controlled Rewriting”. The goal of the presented approach was to reduce the regeneration time of a model-to-text transformation using a frequently changing runtime model as input. The approach used structural runtime models at an architectural level and was applied to an example from the energy efficiency domain.

The discussion in panel of this session focused in three topics. First, the audience debated whether applying techniques from MDSD to model checking and compiler construction and vice versa is beneficial. As both papers presented in this session showed good examples of such benefits, the audience generally agreed. The second topic discussed with the need for different layers to fix wrong or out of date runtime models depending on how wrong or out of date the model is. In this context, the idea of applying the concept of reflexes to react on small deviations came up. Third and finally, the concept of trust in runtime model composition was subject to the discussion.

### C. Models@run.time Infrastructures

In contrast to the first two sessions, the third session captured fundamental approaches for Models@run.time. Namely, the question how to realize the causal connection between the system and its runtime model(s) was targeted.

The first talk was given by Lorena Arcega, who presented here paper entitled “An Infrastructure for Generating Run-time Model Traces for Maintenance Tasks”. The principle idea of the approach was to observe running java code in order to create and update a corresponding runtime model. This allows to keep a structural runtime model at the architectural level of the system up-to-date. The approach was shown to

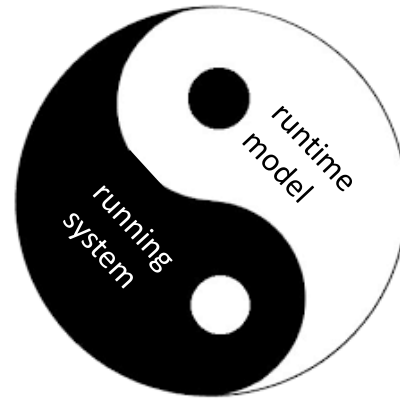


Fig. 1. Logo for Models@run.time

be feasible by in example from the home automation domain (smart hotel).

Subsequently, Hassan Gomaa presented his paper entitled “DeSARM: A Decentralized Mechanism for Discovering Software Architecture Models at Runtime in Distributed Systems”. This work focused on learning the architecture of a distributed system by observing the message flow between its individual applications. The approach was discussed using an example from the emergency domain.

The panel of this session mainly captured the question what infrastructures for models@run.time actually are? Several possibilities have been brought up by the audience, ranging from metamodels and DSLs, over a causal connection facility to a general middleware for models@run.time.

### D. Beyond Models@run.time

The last session was opened with a talk given by Chris Landauer and Kirstie Bellman, who presented their paper entitled “Self-modeling Systems Need Models at Run Time”. The paper points out two general problems, which are both about the fact that reflective systems eventually get stuck. Firstly, such systems will increase in size until they inevitably get stuck. Secondly, such systems will eventually be over-constrained and, thus, get stuck as well. Four possible approaches to address these problems were outlined:

- behavior mining to introduce new “shortcuts” and by this ease computation
- model deficiency analysis to assess how well a runtime model fulfills its purpose and, by this, to take counteraction and improve the fulfillment
- approaches to restructure system knowledge and, by this, reducing the size of the system
- constructive forgetting to reduce the size and or number of constraints of the system

In the following open discussion, two topics have been discussed. First, the need for common use cases and benchmarks for the models@run.time community as already identified in previous editions of the workshop [2]. Second, whether the workshop series should be continued or not. All present participants agreed on the need to keep the workshop running.

Finally, to open the general discussion, each of the four organizers had to answer three questions: 1) What did you like the most today? 2) What do you want to see next year? 3) Do you like the new logo?

We, as organizers, liked the fact that the workshop showed fundamental work on models@run.time and not just applications, the discussions on other topics than self-adaptive systems was very welcome and the mathematical maturity of the presented approaches was a key evolution of the workshop. For next year, we wish to see more fundamental work, more work on requirements at runtime and more work on reflection in particular. Finally, all organizers agreed about how well the new logo of the workshop conveys the essence and nature of the models@run.time paradigm (Figure 1).

### III. CONCLUSION

The eleventh edition of the international workshop on models@run.time was again very well visited (30+ participants).

The trend of submissions remained the same as in comparison to the last 2 years. Notably, although only few papers were submitted (12), as a set they presented high quality, which allowed us to accept seven (7) papers.

Since the first edition of the workshop, it was constantly co-located to the MODELS conference and, consequently, mainly attracted participants from the modeling community.

However, this year we also ran a separate edition of models@run.time at ICAC [1] to attract people from self-aware and autonomous computing. We plan to continue both editions next year, i.e., a second workshop on models@run.time for self-aware computing systems at ICAC and a 12th workshop on models@run.time at MODELS.

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