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Holger Hermanns (Ed.)

Measurement, Modelling and Evaluation of Computing Systems

20th International GI/ITG Conference, MMB 2020
Saarbrücken, Germany, March 16–18, 2020
Proceedings

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Preface

This volume contains the proceedings of the 20th International GI/ITG Conference on Measurement, Modelling and Evaluation of Computing Systems (MMB 2020), which was held during March 16–18, 2020, at Saarland Informatics Campus in Saarbrücken, Germany, hosted by Universität des Saarlandes.

The biennial MMB conference is the major German forum covering all scientific aspects of measurement, modeling, and evaluation of computing systems. It started in the early 1980s to address quantitative system aspects. Over the decades, this topic has gained dramatically in importance and has embraced technology areas including computer architectures, communication networks, distributed systems and software, autonomous systems, workflow systems, cyber-physical systems and networks, Internet of Things, as well as highly dependable, highly performant, and highly secure systems.

This year we received 32 submissions. The technical program was composed by the Program Committee in a thorough single-blind reviewing procedure involving at least three reviewers, after intensive discussion and a careful selection process. All in all, 16 papers were selected representing the broad spectrum of methodological and applied work very well. The program was framed by three distinguished invited keynotes, providing insights into striking foundational advances, latest technological trends, and major application fields:

- "Interference Networks" by François Baccelli, Simons Chair in Mathematics and ECE at The University of Texas at Austin, USA
- "Safety Certification of Deep Learning" by Xioawei Huang, Department of Computer Science at The University of Liverpool, UK
- "Predictable Latency in Softwarized Networks" by Wolfgang Kellerer, Chair of Communication Networks at Technische Universität München, Germany

The technical program additionally offered five sessions of regular papers, covering Learning and Optimization, Networks, Performance Analytics, Markov Modelling, and Model-based Analysis, as well as a PhD presentation session. As in previous MMB conferences, two satellite workshops were organized covering highly relevant research topics:

- 5th Workshop on Network Calculus (WoNeCa5) organized by Steffen Bonndorf, Universität Bochum, Germany, and Amr Rizk, Universität Ulm, Germany
- 2020 ROCKS Workshop on Rigorous Dependability Analysis using Model Checking Techniques for Stochastic Systems, organized by Erika Ábrahám, RWTH Aachen, Germany, and Arnd Hartmanns, Universiteit Twente, The Netherlands

At the beginning of the conference, three invited tutorials were presented to the audience:

- "Modelling and Analysing Dependability with BDMP and KB3" by Marc Bouissou, Électricité de France, France
- "Clusters of Exceedances of Stochastic Processes and Their Application to Traffic Modeling and Identification Problems" by Natalia M. Markovich, Russian Academy of Sciences, Russia
- "Spreading Dynamics in Complex Networks" by Verena Wolf and Gerrit Großmann, Universität des Saarlandes, Germany

The conference was organized by the Center for Perspicuous Computing (CPEC) TRR 248, a Transregional Collaborative Research Centre of the Deutsche Forschungsgemeinschaft (grant 389792660).

As program chair and general chair, we would like to express our gratitude to all members of the Program Committee and all external reviewers for their dedicated service, for the timely provision of their valuable reviews, for maintaining the quality objectives of the conference, and for the intensive and constructive discussion. We express our sincere appreciation to Universität des Saarlandes as the conference host, to CPEC as the conference organizer, and to all members of the Local Organizing Committee of MMB 2020 for their great efforts devoted to the success of the conference. This pertains in particular to Felix Freiberger, Sabine Nermerich, Kristina Scherbaum, and Florian Schießl. We thank all the authors for their submitted contributions, all the speakers for their lively presentations, and all the participants for their contributions to interesting discussions. Finally, it is our hope that readers will enjoy these MMB 2020 proceedings and refer to them in their future research.

February 2020

Holger Hermanns
Verena Wolf

Organization

MMB 2020 was a joint event of the German "Gesellschaft für Informatik" (GI) and the "Informationstechnische Gesellschaft im VDE" (ITG), Technical Committees MMB on Measurement, Modelling and Evaluation of Computing Systems. It was organized by CPEC, the Center for Perspicuous Computing TRR 248, a Transregional Collaborative Research Centre of the Deutsche Forschungsgemeinschaft (grant 389792660) at Saarland Informatics Campus in Saarbrücken, Germany, hosted by Universität des Saarlandes.

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Abstracts of Invited Talks

Interference Networks

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Abstract. This invited talk features networks of coupled processor sharing queues in the Euclidean space, where customers arrive according to independent Poisson point processes at every queue, are served, and then leave the network. The coupling is through service rates. In any given queue, this rate is inversely proportional the interference seen by this queue, which is determined by the load in neighboring queues, attenuated by some distance-based path-loss function.

The model is a discrete version of a spatial birth and death process where customers arrive to the Euclidean space according to Poisson rain and leave it when they have transferred an exponential file, assuming that the instantaneous rate of each transfer is determined through information theory by the signal to interference and noise ratio experienced by the user.

The discrete and the continuous models will be discussed, both in finite and infinite domains. The stability condition is identified. The minimal stationary regime is built using coupling from the past techniques.

The mean queue size of this minimal stationary regime is determined in closed form using the rate conservation principle of Palm calculus. Some bounds on the tail of latency will be discussed.

In infinite domains, when the stability condition holds, for all bounded initial conditions, there is weak convergence to this minimal stationary regime; however, there exist initial conditions for which all queue sizes converge to infinity.

Joint work with Sergey Foss and Abishek Sankararaman.

Safety Certification of Deep Learning

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Abstract. Deep learning techniques have been shown successful in a number of tasks such as image classification, robotic control, and natural language processing, etc. This motivates their application to broader industrial sectors, including safety critical sectors – such as automotive sector, healthcare sector, and avionic sector, etc. – and business critical sectors – such as financial services sector. There is an urgent need to certify the safety of learning-enabled systems, i.e., systems with (deep) learning components, when such systems are increasingly deployed and interact with human operators. This talk will review some recent progresses on formal verification and coverage-guided testing, and discuss whether and how they can be utilised to support the certification of deep learning. Existing formal verification techniques – including layer-wise refinement, reduction to global optimisation, reduction to constraint-solving, etc. – are able to provide provable guarantees to the results, but may be subject to the scalability problem. Coverage-guided testing, on the other hand, is able to intensively test deep learning models with a large number of test cases generated under the guidance of coverage metrics. But research is needed to determine the relation between coverage metrics and the safety risks of deep learning. While both verification and testing can provide evidence to low-level claims, such as the robustness of a neural network for a given input, it is desirable to know how to utilise these low-level evidence to support high-level safety claims of deep learning such as the rate of failure within a number of new inputs.

Predictable Latency in Softwarized Networks

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Abstract. The trend towards softwarized networks provides ample opportunities and hence a high degree of flexibility in the way to plan and operate your communication networks [1]. Such flexibility supports the realization of novel applications with largely varying requirements. Many emerging applications pose stringent dependability requirements such as industrial communication, autonomous vehicles, telepresence and teleoperation in healthcare. In particular, ongoing research on 5G networks focuses on predictable low latency communication [2]. This raises the question to what extent softwarized networks also enable such more predictable networks. As network performance relies on the underlying switches, we have a closer look at Software-Defined Networking infrastructure and SDN switches, in particular, as enablers of softwarized networks. This work presents an empirical study of the predictability of SDN switches with a focus on latency and addresses the question of modeling of network latency with SDN switches based on Network Calculus. Therefore, we benchmark seven hardware OpenFlow switches in a first step [3]. Our measurement results reveal several unexpected and unpredictable behaviors and performance In particular, we observe unpredictable behaviors related to flow management and buffer management. We further uncover unexpected overhead introduced with conventional quality-of-service mechanisms such as priority queueing, which can lead to violations of latency guarantees. In a second step, we extend our empirical investigations to small networks with a comprehensive measurement campaign of low cost, low capacity SDN hardware switches [4]. We propose a novel measurement-based methodology that uses deterministic network calculus to derive a reliable performance model of a given switch. Our experiments with the Zodiac FX switch show that the derived models are accurate enough to actually provide deterministic end-to-end guarantees with low-cost softwarized network devices.

Keywords: Softwarized networks • Software-defined networking • SDN • Programmable switches • Measurements • Switch modeling • Latency • Predictability • Guarantees

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