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Frederica Darema · Erik Blasch ·
Sai Ravela · Alex Aved (Eds.)

Dynamic Data Driven Applications Systems

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Editors
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Bethesda, MD, USA

Erik Blasch
Air Force Office of Scientific Research
Arlington, VA, USA

Sai Ravela
Massachusetts Institute of Technology
Cambridge, MA, USA

Alex Aved
Air Force Research Laboratories
Rome, NY, USA

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Preface

The Dynamic Data Driven Applications Systems (DDDAS 2020) conference showcases scientific research advances and technology capabilities stemming from the DDDAS paradigm, whereby instrumentation data are dynamically integrated into an executing application model, and in reverse, the executing model controls the instrumentation.

DDDAS/InfoSymbiotics[1] plays a key role in advancing capabilities in many application areas; driving innovation in a great many methodological areas ranging from *foundational methods* such as filtering, estimation, and uncertainty quantification to *applications approaches;* and coordinating system-level design, including representation models, network control, and sensor management. DDDAS incorporates comprehensive principle- and physics-based models, instrumentation (including sensing and actuation), planning and control methods, as well as theory involving models' convergence properties, uncertainty quantification, observation, and sampling. Over the last two decades, the DDDAS paradigm has shown the ability to engender new capabilities in aerospace, materials sciences, biosciences, geosciences and space sciences, resilient security, and cyber systems for critical infrastructures such as power-grids. The scope of application areas ranges from the nano-scale to the extra-terra-scale.

DDDAS permeates a great many areas: statistical estimation, machine learning, informative planning, decision support, network analysis, and big data. DDDAS also emphasizes foundational aspects in systems thinking with an overarching objective and the ability to judiciously structure, dynamically adapt, and optimally exploit resources. The DDDAS paradigm has influenced the extension of existing methods such as data assimilation and the digital twin, which have evolved to incorporate the adaptive aspects of DDDAS into their definitions. Other recent techniques such as generative adversarial networks (GANs) resemble the DDDAS paradigm by generating data from models and discriminating the information for enhanced system performance. For test and evaluation, DDDAS creates capabilities for lifetime assessment and optimization of the performance of components and systems. Also, a number of recent and emerging algorithms in machine learning, and other methods and approaches, such as informative sensing, informative estimation, informative planning, targeted observation, active learning, relevance feedback, recommender systems, stochastic modeling, reinforcement learning, and feature selection – applying and/or adopting the essence of the DDDAS paradigm, which includes high-dimensional simulation/modeling in order to facilitate data-driven exploitation and decision making dynamically, adaptively, and in real-time. Moreover, in addition to the homonymous DDDAS-based agencies sponsored initiatives and programs (which started in 2000), other initiatives such as

[1] InfoSymbiotic Systems or InfoSymbiotics are terms introduced to denote DDDAS.

cyber-physical systems (which started in 2006 by the embedded systems community) can benefit from the more comprehensive approaches of the DDDAS paradigm.

The DDDAS/InfoSymbiotics conference series is a forum that presents novel directions, reports innovative solutions, and documents advanced opportunities over a wide set of scientific and engineering application areas. A consequence of the growing interest, activities, and advances in DDDAS, the DDDAS2020 conference showcases 21 peer-reviewed plenary presentations, 14 peer-reviewed posters, 5 keynote presentations, and 3 panels from experts in academia, industry, and government sectors. The proceedings include the keynotes' overview papers, the panels' abstracts, and the accepted papers. All presentation slides are posted at the DDDAS website (www.1dddas.org).

DDDAS 2020 follows from past DDDAS conferences and workshops, starting with the March 2000 National Science Foundation (NSF) DDDAS Workshop and subsequent DDDAS conferences, and DDDAS workshops in conjunction with conferences since 2003. Starting in 2018, efforts and results over the years are also discussed more extensively in a series of Springer handbooks on DDDAS.

We are thankful to all the contributors of this conference, including the keynote speakers and panelists, those who submitted abstracts and papers for their research work and authoring the papers included in these proceedings, and to the reviewers of the two-stage papers selection process.

August 2020

Frederica Darema
Erik Blasch
Alex Aved
Sai Ravela

The original version of the book was revised: The typo in the main title was corrected. The correction to the book is available at https://doi.org/10.1007/978-3-030-61725-7_44

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