

Special issue of the 25th RCRA International Workshop on Experimental Evaluation of Algorithms for Solving Problems with Combinatorial Explosion

Preface

This special issue of *Fundamenta Informaticae* publishes extended and revised versions of the best papers presented at RCRA 2018, the 25th Workshop of the RCRA working group (Rappresentazione della conoscenza e Ragionamento Automatico, Knowledge representation and automated reasoning) of the Italian Association for Artificial Intelligence (AI*IA).¹ This event continues the series of the RCRA annual meetings held since 1994 and becoming international in 2007.

RCRA 2018 was held in Oxford, United Kingdom, on the 13th of July 2018 as a Workshop of the Federated Logic Conference 2018 (FLoC 2018). The success of the RCRA event series shows that the RCRA workshop is nowadays established as a major forum for exchanging ideas and proposing experimentation methodologies for algorithms in Artificial Intelligence.

The majority of problems afforded by Artificial Intelligence (AI) techniques have a combinatorial nature, showing an exponential explosion of the search space. Such problems are often addressed with algorithms that have a common goal: the effective exploration of huge state spaces. Solving these problems with reasonable performance is often both a challenging and a crucial task, because feasible or optimal decisions often depend on a non-trivial combination of various factors. Moreover, algorithms developed in a research area for some problem may often also be applicable (with necessary modifications and adjustments) to other problems, or can be hybridised with techniques in other areas to improve the performance of problem solving. Cross-fertilising areas, so to merge the viewpoints of different communities that try to solve similar problems, can result in faster development of effective solutions.

Over recent years, research in AI has increasingly focused on experimental evaluation of algorithms, on the development of suitable methodologies for experimentation and analysis, on the study of representation languages, and on the implementation of effective systems for the specification and solution of real world problems. The aim of the RCRA workshop is fostering the cross-fertilisation of ideas stemming from different areas, proposing benchmarks for new challenging problems, comparing models and algorithms from an experimental viewpoint, and, in general, comparing different approaches with respect to efficiency, problem modelling, and ease of development.

¹<http://rcra.aixia.it/rcra-2018>

Since the 2005 edition, the RCRA workshops have focused on the theme of algorithms in AI, proposing benchmarks to compare them and study their efficiency through experimental evaluation. These meetings have reached the objective to gather researchers coming from AI fields as diverse as constraint satisfaction, machine learning, logic languages, (quantified) satisfiability solving, or planning and scheduling, just to name a few. The event has gained more and more interest, first from the Italian community, then from the international one.

RCRA 2008 (Udine, Italy) was co-located with the International Conference on Logic Programming (ICLP 2008). RCRA 2009 (Reggio Emilia, Italy) was a workshop of the 11th Conference of the Italian Association for Artificial Intelligence (AI*IA 2009). RCRA 2010 (Bologna, Italy) was in association with the 7th International Conference on Integration of Artificial Intelligence and Operations Research Techniques in Constraint Programming (CPAIOR 2010). RCRA 2011 (Barcelona, Spain) was a workshop of the 22nd International Joint Conference on Artificial Intelligence (IJCAI 2011). RCRA 2012 (Rome, Italy) was held in association with the 12th AI*IA Symposium on Artificial Intelligence (AI*IA 2012). RCRA 2013 was held in Rome, Italy as an autonomous event. RCRA 2014 was held in Vienna, Austria, as a workshop of the Federated Logic Conference (FLoC 2014) and part of the Vienna Summer of Logic (VSL). RCRA 2015 (Ferrara, Italy) was held in association with the 14th AI*IA International Conference on Artificial Intelligence (AI*IA 2015). RCRA 2016 (Genova, Italy) was held in association with the 15th AI*IA International Conference on Artificial Intelligence (AI*IA 2016). Finally, RCRA 2017 (Bari, Italy) was again held in association with the 16th AI*IA International Conference on Artificial Intelligence (AI*IA 2017).

During the years, the success of the workshop series have led RCRA to become a major forum for exchanging ideas and proposing experimentation methodologies for algorithms in AI.

Starting from 2007, after each workshop edition, a special issue of a major International journal is published with extended and revised versions of the best papers, with a second round of fresh reviews involving additional reviewers having the goal of meeting the standard of journal publications and accepting only the best submissions.

Concerning the 2018 edition, twelve papers were presented at RCRA 2018. After the workshop, the authors had the possibility to submit extended versions of their papers for possible publication in this special issue. After two further rounds of reviews, the following five papers were selected:

- *An Experimental Comparison of Algebraic Crossover Operators for Permutation Problems.*
by Marco Bairoletti, Gabriele Di Bari, Alfredo Milani and Valentino Santucci.
This work introduces 34 crossover operators divided in three families. Crossover operators are very important components in Evolutionary Computation, and the presented empirical analysis indicates that the newly introduced operators are valid and effective alternatives to the classical existing ones.
- *MILP, Pseudo-Boolean, and OMT Solvers for Optimal Fault-Tolerant Placements of Relay Nodes in Mission Critical Wireless Networks.*
by Quian Matteo Chen, Alberto Finzi, Toni Mancini, Igor Melatti and Enrico Tronci.
The authors design and empirically evaluate a MILP-based approach for addressing the problem of deploying relay nodes that minimises the network deployment cost, while guaranteeing the operability of the network when some of the relay nodes become faulty.
- *Analyzing Heuristic-based Randomized Search Strategies for the Quantum Circuit Compilation Problem* by Angelo Oddi and Riccardo Rasconi.

This paper proposes a greedy random search heuristic to solve the quantum circuit compilation problem, where the objective is essentially to synthesise a quantum gate execution plan characterised by a minimum makespan. The presented empirical analysis demonstrates the effectiveness of the approach, and highlights potential for combining it with other state-of-the-art techniques.

- *Optimal Personalised Treatment Computation through In Silico Clinical Trials on Patient Digital Twins.*

by Stefano Sinisi, Vadim Alimguzhin, Toni Mancini, Enrico Tronci, Federico Mari and Brigitte Leeners.

In Silico Clinical Trials hold the promise to decrease time and cost for the safety and efficacy assessment of pharmacological treatments, reduce the need for animal and human testing, and enable precision medicine. This paper presents methods and an algorithm that, by means of extensive in silico clinical trials, guided by intelligent search, optimise a personalised pharmacological treatment for a patient.

- *Partial (Neighbourhood) Singleton Arc Consistency for Constraint Satisfaction Problems.*

by Richard Wallace.

Algorithms based on singleton arc consistency (SAC) show considerable promise for improving backtrack search algorithms for constraint satisfaction problems. Neighbourhood singleton arc consistency (NSAC) is a limited form of SAC-based reasoning that can be as effective as SAC, while requiring less CPU-time. In this work, Wallace introduces various forms of SAC and NSAC, and empirically demonstrates the effectiveness of the proposed techniques.

Acknowledgements. We would like to thank the authors who submitted articles to this special issue. The submissions were impressive both in quantity and quality. Our sincere appreciation goes to the anonymous reviewers for thoughtfully evaluating the submitted manuscripts in two rounds of review. We also would like to express our deep gratitude to Damian Niwinski, Editor-in-Chief of *Fundamenta Informaticae*, for making this special issue possible, and we thank him and Bartek Klin for their support throughout the whole process. Finally, we are very grateful to the members of the program committee and the external anonymous reviewers of RCRA 2018 for their work, as well as to all participants of the workshop.

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