Special Issue on the 14th and 15th International Conferences on Reachability Problems (RP 2020 & 2021)

Preface

This special issue of Fundamenta Informaticae journal is devoted to the 14th and 15th International Conferences on Reachability Problems (RP 2020 and RP 2021). Reachability Problems 2020 was held on October 19–21, 2020, and hosted by the Institut de Recherche en Informatique Fondamentale at Université de Paris, France. Reachability Problems 2021 was held on October 25–27, 2021, and hosted by the University of Liverpool, UK. Both conferences were arranged virtually due to COVID-19 restrictions.

The Reachability Problems conference brings together researchers from a variety of disciplines who are interested in computational aspects of reachability problems, as they appear in algebraic structures, computational models, automata and formal languages, concurrent systems, computational games, hybrid systems, automated verification, etc. One of the goals of the conference is to promote exploration of new approaches to analysing the behaviour of computational processes by combining mathematical, algorithmic, and computational techniques. The first workshop on Reachability Problems was organized in Turku, Finland in 2007. In 2018 RP was transformed into the annual International Conference on Reachability Problems and so far RP has been organized 14 times and located at: the Max Planck Institute for Software Systems (MPI-SWS) and the University of Kaiserslautern (2022), University of Liverpool - virtually - (2021), IRIF, University of Paris - virtually - (2020), Universite libre de Bruxelles (2019), ´ Aix-Marseille University (2018), Royal Holloway, University of London (2017), Aalborg University (2016), the University of Warsaw (2015), the University of Oxford (2014), Uppsala University (2013), the University of Bordeaux (2012), the University of Genoa (2011), Masaryk University Brno (2010), Ecole Polytechnique (2009), the University of Liverpool (2008), and Turku University (2007).

Reachability is a fundamental problem in the context of computational models and physical processes. In general, the reachability problem can be formulated as follows – given a state space and a collection of transition functions, decide whether a certain set of target states is reachable from a given set of initial states. Often one considers reachability problems over infinite state spaces. Transition rules are specified in numerous ways, including via rewrite rules, affine maps, and differential equations.

Algorithmic solutions to reachability problems are typically based on combinations of exploration strategies, symbolic manipulations of sets of states, decomposition properties, reduction to optimisation problems and logical decision procedures. Such algorithms also benefit from approximations, abstractions, accelerations, and extrapolation heuristics. Ad hoc solutions, as well as solutions based on general-purpose constraint solvers and deduction engines, are often combined in order to balance efficiency and flexibility.

This volume comprises four papers from the two conferences, chosen because of their quality and impact within the reachability community, and potential for future extensions in various directions.

In the paper “Absent Subsequences in Words”, M. Kosche, T. Koß, F. Manea and S. Siemer extend the notion of an absent factor of a string to absent subsequences (or scattered factors). Various results regarding combinatorial and algorithmic properties of minimal and shortest absent subsequences are given, including compact representations of the sets of such words, and efficient determination of whether a given string is a minimal or shortest absent subsequence in a word.

In “Reachability In Simple Neural Networks”, M. Sälzer and M. Lange consider the complexity of reachability problems for neural networks, i.e., the problem of determining if a neural network computes a valid output for a valid input, focusing on an NP-completeness proof, and also showing NP-hardness even for very restricted classes of neural networks. Interesting directions for future research are also given.

In “On the Complexity of Techniques That Make Transition Systems Implementable by Boolean Nets”, R. Devillers and R. Tredup consider synthesis problems for Petri nets, which aims to determine if a given labelled transition system is implementable by some class of Petri nets. If such an implementation is not possible then certain transition systems can be modified, allowing them to be implemented by a Petri net of the given class. The present paper considers the problem of limiting the number of such modifications and gives NP-completeness proofs for various problems.

The paper “Methods for Efficient Unfolding of Colored Petri Nets” by A. Bilgram, P. G. Jensen, T. Pedersen, J. Srba, and P. H. Taankvist, considers coloured Petri nets and gives two complementary methods based on static analysis to reduce the size of the unfolded traditional Petri net. Comparisons of the given unfolder to other techniques are shown.

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