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Shigeru Yamashita · Tetsuo Yokoyama (Eds.)

# Reversible Computation

13th International Conference, RC 2021  
Virtual Event, July 7–8, 2021  
Proceedings

*Editors*

Shigeru Yamashita   
Ritsumeikan University  
Kusatsu, Japan

Tetsuo Yokoyama   
Nanzan University  
Nagoya, Japan

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# Preface

This volume contains the papers presented at the 13th Conference on Reversible Computation (RC 2021), held online (due to the COVID-19 pandemic) during July 7–8, 2021, and hosted by Nagoya University in Japan.

The RC conference brings together researchers from computer science, mathematics, engineering, and physics to discuss new developments and directions for future research in the emerging area of Reversible Computation. This includes, for example, reversible formal models, reversible programming languages, reversible circuits, and quantum computing.

The conference received 21 submissions from authors in 13 countries. After careful deliberations, the Program Committee selected 15 papers for presentation. In addition to these papers, this volume contains the three invited talks: “How Can We Construct Reversible Turing Machines in a Very Simple Reversible Cellular Automaton?” by Kenichi Morita (Hiroshima University, Japan), “Decision Diagrams and Reversible Computation” by Shin-ichi Minato (Kyoto University, Japan), and “Variational Quantum Eigensolver and Applications to Specific Optimization Problems” by Atsushi Matsuo (IBM Research - Tokyo, Japan).

When we started planning RC 2021, we thought the conference would be held in person. Unfortunately, the COVID-19 pandemic has been having a strong impact on society, and we decided to hold the conference online as with RC 2020. Of course, an online meeting makes interaction much more difficult in general. Nevertheless, we strongly believe that this online edition contributed to the research community like previous editions of the Conference on Reversible Computation.

The conference would not have been possible without the enthusiasm of the members of the Program Committee; their professionalism and their helpfulness were exemplary. For the work of the Program Committee and the compilation of the proceedings, the extremely useful EasyChair conference management system was employed. We thank Telecom Advanced Technology Research Support Center (SCAT) for their financial support, and we also thank the Graduate School of Informatics at Nagoya University, Japan, for providing various resources. Finally, we would like to thank all the authors for their submissions, their willingness to continue improving their papers, and their wonderful presentations during RC 2021.

May 2021

Shigeru Yamashita  
Tetsuo Yokoyama

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# Decision Diagrams and Reversible Computation (Abstract of Invited Talk)

Shin-ichi Minato

Graduate School of Informatics, Kyoto University, Kyoto 606-8501, Japan

[minato@i.kyoto-u.ac.jp](mailto:minato@i.kyoto-u.ac.jp)

<http://www.lab2.kuis.kyoto-u.ac.jp/minato/>

**Abstract.** Decision diagrams have attracted a great deal of attention for thirty years in computer science and technology, because those data structures are useful to efficiently manipulate many kinds of discrete structures, which are the fundamental mathematical models for solving various practical problems. Also for reversible computation systems, decision diagrams are sometimes used as key techniques for solving problems. In this invited talk, we overview the decision diagrams related to reversible computation. First we start with BDD and ZDD as classical models of logic and set. Next we review QMDD (Quantum Multiple-valued Decision Diagrams) and DDMF (Decision Diagrams for Matrix Functions) for dealing with special logic functions computed by quantum logic circuits. We then discuss  $\pi$ DD (Permutation Decision Diagrams) for manipulating permutation, which is closely related to reversible computation. We review some previous work on reversible circuit design using  $\pi$ DDs, and also show our recent work related to reversible computation.



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