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Algorithmic Aspects of Cloud Computing

6th International Symposium, ALGOCLOUD 2021
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Revised Selected Papers

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Preface

The International Symposium on Algorithmic Aspects of Cloud Computing (ALGOCLOUD) is an annual international symposium that aims to tackle the diverse new topics in the emerging area of algorithmic aspects of computing and data management in modern cloud-based systems, interpreted broadly so as to include edge- and fog-based systems, cloudlets, cloud micro-services, virtualization environments, and decentralized systems, as well as dynamic networks.

The symposium aims at bringing together researchers, students, and practitioners to present research activities and results on topics related to the algorithmic, design, and development aspects of modern cloud-based systems. ALGOCLOUD is particularly interested in novel algorithms in the context of cloud computing and cloud architectures, as well as experimental work that evaluates contemporary cloud approaches and pertinent applications. ALGOCLOUD also welcomes demonstration manuscripts, which discuss successful system developments, as well as experience/use-case articles and high-quality survey papers.

ALGOCLOUD 2021 took place during September 6–7, 2021 as a virtual event (due to the covid-19 pandemic), although it was originally planned to take place in Lisbon, Portugal. It was part of ALGO 2021 (September 6–10, 2021), the major annual congress that combines the premier algorithmic conference "European Symposium on Algorithms" (ESA) and a number of other specialized symposiums and workshops, all related to algorithms and their applications, making ALGO the major European event for researchers, students, and practitioners in algorithms.

There was a positive response to the ALGOCLOUD 2021 call for papers. The diverse nature of papers submitted demonstrated the vitality of the algorithmic aspects of cloud computing. All submissions went through a rigorous peer-review process and were reviewed by at least three Program Committee (PC) members. The submissions were evaluated based on their quality, originality, and relevance to the symposium. Following reviewers' recommendations, the PC accepted four original research papers and one brief announcement covering a variety of topics that were presented at the symposium. We would like to thank all PC members for their significant contribution to the review process.

The program of ALGOCLOUD 2021 was complemented with a keynote talk entitled "Cloud-Assisted Peer-to-Peer Systems", which was delivered by Christian Scheideler (Paderborn University, Germany), and three tutorials entitled "Self-Adjusting Networks: Enablers, Algorithms, Complexity", "Self-healing Distributed Algorithms", and "Gaming the Decentralized Finance", which were delivered by Stefan Schmid (University of Vienna, Austria), Amitabh Trehan (Durham University, UK), and Maria Potop-Butucaru (Sorbonne Université - LIP6), respectively. We wish to express our sincere gratitude to all our esteemed invitees for their contributions.

Finally, we would like to thank all authors who submitted their research work to ALGOCLOUD and the Steering Committee for its continuous support.

We hope that these proceedings will help researchers, students, and practitioners understand and be aware of state-of-the-art algorithmic aspects of cloud computing, and that they will stimulate further research in the domain of algorithmic approaches in cloud computing in general.

November 2021

Gianlorenzo D'Angelo
Othon Michail

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Cloud-Assisted Peer-to-Peer Systems (Keynote Talk)

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Abstract. Traditional approaches for distributed systems have either followed the client-server or peer-to-peer approach. However, with the emergence of clouds, another option becomes viable: cloud-assisted peer-to-peer systems. The idea behind cloud-assisted peer-to-peer systems is to combine the best of the client-server and the peer-to-peer approaches while avoiding their disadvantages by getting the cloud involved whenever the peer-to-peer system by itself cannot guarantee a desired quality of service. While cloud-assisted peer-to-peer systems have already been investigated by the systems community for more than a decade, in particular in the area of content streaming, these systems have not yet been studied in theory. In my presentation, I propose a model for cloud-assisted peer-to-peer systems and present various simple solutions for that model. A particularly interested aspect about this model is that whenever the cloud needs to get involved, the peers need to pay for that service, so the goal is to set up a solution so that the total amount of fees that needs to be paid for the cloud services is kept as small as possible while making sure that the fees from the peers cover the costs of the cloud.

Tutorials

Self-Adjusting Networks: Enablers, Algorithms, Complexity

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Abstract. Network traffic is growing explosively, and next-generation workloads, e.g., related to (distributed) machine learning and artificial intelligence, will further increase the amount of traffic headed for and between the world's data centers. This quickly growing demand pushes today's wide-area and datacenter networks towards their capacity limits. While over the years, several interesting new network architectures have been proposed to improve the efficiency and performance of such networks, especially in the context of data centers, these networks often have in common that their topology is fixed and cannot be reconfigured to the traffic demand they serve. This tutorial discusses a different approach to operate networks: reconfigurable "self-adjusting" networks whose topology adjusts to the workload in an online manner. Reconfigurable networks are enabled by emerging optical technologies, allowing to quickly change the physical topology at runtime. This technology also introduces a vision of demand-aware networks which tap a new optimization opportunity: empirical and measurement studies show that traffic workloads feature spatial and temporal structure, which in principle could be exploited by reconfigurable networks. However, while the technology of such reconfigurable networks is evolving at a fast pace, these networks lack theoretical foundations: models, metrics, and algorithms - we have fallen behind the curve. The objective of this tutorial is to help bridge this gap, and introduce to the ALGO community a rich and potentially impactful research area, which touches many core topics of the conference. We first discuss technological enablers and report on motivating empirical studies. Our main focus in this tutorial then is on the new models and algorithmic challenges introduced by this field. In particular, we will review existing algorithms and complexity results, and highlight future research directions.

Self-healing Distributed Algorithms

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Abstract. Resilience and fault-tolerance are highly desirable properties for networks and often distributed algorithms are designed with this purpose in mind. Self-healing is one such fault-tolerance paradigm which seeks to maintain a desirable state of the system despite attack accepting only a short disruption. The concept of self-healing appears in various forms ranging from autonomic networks to practical networks to distributed algorithms. We look at the later setting formalising self-healing as a game on graphs where a powerful adversary deletes/inserts nodes and the network responds by adding/dropping edges locally in a distributed manner while seeking to maintain global invariants. This requires the network to be reconfigurable e.g. in the P2P-CONGEST model (with limited message sizes). We look at various results in this setting building up self-healing resilience by adding topological properties such as connectivity, diameter, stretch, expansion, and routing in a simultaneous manner.

Gaming the Decentralized Finance

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Abstract. Decentralized finance opens a new research field: reliable distributed economical systems that is a cross research between classical distributed systems and mathematical models for economical systems. Blockchain technology is today at the core of decentralized finance. Differently from the classical distributed systems, blockchain technology faces complex faults and behaviors including rational. Interestingly, when rational behaviors are combined with classical faults (e.g. Byzantine behaviors) established results in distributed computing need to be revisited. This talk reports several results related to robustness of distributed abstractions used in blockchain technologies to Byzantine and rational behaviors analyzed through the lens of game theory.

Contents