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Volume 926

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The series "Advances in Intelligent Systems and Computing" contains publications on theory, applications, and design methods of Intelligent Systems and Intelligent Computing. Virtually all disciplines such as engineering, natural sciences, computer and information science, ICT, economics, business, e-commerce, environment, healthcare, life science are covered. The list of topics spans all the areas of modern intelligent systems and computing such as: computational intelligence, soft computing including neural networks, fuzzy systems, evolutionary computing and the fusion of these paradigms, social intelligence, ambient intelligence, computational neuroscience, artificial life, virtual worlds and society, cognitive science and systems, Perception and Vision, DNA and immune based systems, self-organizing and adaptive systems, e-Learning and teaching, human-centered and human-centric computing, recommender systems, intelligent control, robotics and mechatronics including human-machine teaming, knowledge-based paradigms, learning paradigms, machine ethics, intelligent data analysis, knowledge management, intelligent agents, intelligent decision making and support, intelligent network security, trust management, interactive entertainment, Web intelligence and multimedia.

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Advanced Information Networking and Applications

Proceedings of the 33rd International Conference on Advanced Information Networking and Applications (AINA-2019)

Springer

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Welcome Message from AINA-2019 Steering Committee Co-chairs

Welcome to the 33rd International Conference on Advanced Information Networking and Applications (AINA-2019). It is our great pleasure and honor to hold AINA-2019 at Kunibiki Messe, Matsue, Japan, from March 27 to March 29, 2019. On behalf of the AINA Steering Committee and AINA-2019 Organizing Committee, we would like to express to all participants our cordial welcome and high respect.

AINA is an international forum, where scientists and researchers from academia and industry working in various scientific and technical areas of networking and distributed computing systems can demonstrate new ideas and solutions in distributed computing systems.

AINA was born in Asia, but it is now an international conference with high quality thanks to the great help and cooperation of many international friendly volunteers. AINA is a very open society and is always welcoming international volunteers from any country and any area in the world. In conjunction with AINA-2019 main conference, we have also 14 international workshops.

An international conference can be organized by support and great voluntary efforts of many people and organizations. Our main responsibility is to coordinate various tasks carried out with other willing and talented volunteers.

We would like to thank AINA-2019 general co-chairs, PC co-chairs, workshops' co-chairs, track area chairs, PC members, and workshops' organizers for their great efforts to make AINA-2019 a very successful event. We have special thanks to the finance chair and web administrator co-chairs.

We would like to take opportunity to thank all members of the Organization Committee and Program Committee as well as all reviewers for their hard work to make the reviews on time and authors for submitting the papers. We would like to thank Local Arrangement Team for the technical support and good local arrangement for the conference.

Finally, we would like to thank: Matsue City, Shimane Prefecture, The Telecommunications Advancement Foundation (TAF), Japan, for their financial support.

We do hope that you will have a great time in Matsue, Japan.

Makoto Takizawa
Leonard Barolli
AINA Steering Committee Co-chairs

Welcome Message from AINA-2019 General Co-chairs

It is our great pleasure to welcome you all at the 33rd International Conference on Advanced Information Networking and Applications (AINA-2019), which will be held at Kunibiki Messe, Matsue, Japan, from March 27 to March 29, 2019.

AINA International Conference is a forum for sharing ideas and research work in the emerging areas of information networking and their applications. The area of advanced networking has grown very rapidly, and the applications around it have experienced an explosive growth especially in the area of pervasive and mobile applications, sensor networks, ad hoc networks, vehicular networks, multimedia computing and social networking, semantic collaborative systems, as well as grid, P2P, IoT, and cloud computing. This advanced networking revolution is transforming the way people live, work, and interact with each other and is impacting the way business, education, entertainment, and health care are operating. The papers included in the proceedings cover theory, design, and application of computer networks, distributed computing, and information systems.

Each year AINA receives a lot of paper submissions from all around the world. It has maintained high-quality accepted papers and is aspiring to be one of the main international conferences on the information networking in the world. In conjunction with AINA-2019 conference, there are 14 workshops, which also accepted good-quality papers.

An international conference of this size requires the support and help of many people. A lot of people have helped and worked hard to produce a successful AINA-2019 technical program and conference proceedings. First, we would like to thank all authors for submitting their papers, the session chairs, and distinguished keynote speakers. We are indebted to program area chairs, Program Committee members, and reviewers, who carried out the most difficult work of carefully evaluating the submitted papers.

We would like to give our special thanks to Prof. Makoto Takizawa and Prof. Leonard Barolli, the co-chairs of the Steering Committee, for their strong encouragement, guidance, and insights, and for spending a lot of energy for conference organization and shaping the conference program. We would like to thank PC co-chairs and workshops' co-chairs of AINA-2019 for their great contribution to

the success of the conference. Our special thanks go to the finance chair and web administrator co-chairs.

Finally, we would like to thank the Local Arrangement Team for the support and good local arrangement for the conference. We do hope that you will have a great time in Matsue, Japan.

Tomoya Enokido
Farookh Hussain
Alireza Shahrabi
AINA-2019 General Co-chairs

Welcome Message from AINA-2019 Program Committee Co-chairs

Welcome to the 33rd International Conference on Advanced Information Networking and Applications (AINA-2019), which will be held at Kunibiki Messe, Matsue, Japan, from March 27 to March 29, 2019.

The purpose of AINA conference is to bring together researchers, developers, and industrial experts to share new ideas and recent research results in the emerging areas of information networking and their applications. The papers included in the proceedings cover all aspects of theory, design, and application of computer networks and distributed computing systems. Most of the papers deal with new trends in information networking, such as wireless sensor networks, ad hoc networks, cloud computing, peer-to-peer systems, grid computing, pervasive and ubiquitous systems, multimedia systems, security, multi-agent systems, IoT, and web-based systems.

This edition AINA received many paper submissions from all over the world. Each submission was peer-reviewed by Program Committee members and invited external reviewers. Finally, the Program Committee accepted 112 papers (about 25% acceptance ratio), which will be presented during the conference days. Unfortunately, many interesting and good papers could not be accepted in AINA-2019 due to the limited number of time slots allocated for presentations at the conference.

We are very proud and honored to have two distinguished keynote talks by Dr. Markus Aleksy, ABB AG, Germany, and Naohiro Hayashibara, Kyoto Sangyo University, Japan, who will present their recent work and will give new insights and ideas to the conference participants.

Organizing an international conference of this size is of course a team effort. Therefore, we gladly admit that we had the help of many very professional people. First of all, we would like to thank all the authors for their interesting contributions since they shape the program and make it interesting for the audience. Moreover, we would like to express our thankfulness to all program vice chairs for their great efforts. Additionally, we would like to thank all Program Committee members and reviewers who carried out the most important work to evaluate the submitted papers. We also thank the workshops' co-chairs for organizing many excellent

workshops and symposiums, which enrich the conference and provide additional opportunities for discussions and future co-operations.

The great success of the AINA conference series would not be possible without the enormous commitment and support of the Steering Committee co-chairs Prof. Makoto Takizawa and Prof. Leonard Barolli. Therefore, we would like to thank them for their strong encouragement and guidance.

The general coordination of an event such as AINA conference requires a lot of coordination effort as well as many other activities related to the conference organization. Here, we thank the general co-chairs for their great support and invaluable suggestions. We give special thanks to the finance chair and web administrator co-chairs for their great efforts and efficient work to deal with many conference matters.

We hope you will enjoy the conference and readings and have a great time in Matsue, Japan.

Akimitsu Kanzaki
Flora Amato
Omar Hussain
AINA-2019 Program Committee Co-chairs

Welcome Message from AINA-2019 Workshops' Co-chairs

Welcome to AINA-2019 workshops to be held in conjunction with the 33rd International Conference on Advanced Information Networking and Applications (AINA-2019) at Kunibiki Messe, Matsue, Japan, from March 27 to March 29, 2019. The goal of AINA workshops is to provide a forum for international researchers and practitioners to exchange and share their new ideas, research results, and ongoing work on leading-edge topics in the different fields of information networks and their applications. Some of the accepted workshops deal with topics that open up perspectives beyond the ordinary, thus enriching the topics usually addressed by the AINA conference.

For this edition, the following 14 symposiums and workshops will be held with AINA-2019.

1. The 15th International Symposium on Frontiers of Information Systems and Network Applications (FINA-2019)
2. The 15th International Workshop on Heterogeneous Wireless Networks (HWISE-2019)
3. The 12th International Symposium on Mining and Web (MAW-2019)
4. The 12th International Workshop on Bio and Intelligent Computing (BICom-2019)
5. The 12th International Workshop on Telecommunication Networking, Applications and Systems (TeNAS-2019)
6. The 10th International Workshop on Disaster and Emergency Information Network Systems (IWDENS-2019)
7. The 7th International Workshop on Collaborative Emerging Systems (COLLABES-2019)
8. The 6th International Workshop on Security Intricacies in Cyber-Physical Systems and Services (INTRICATE-SEC-2019)
9. The 5th International Workshop on Engineering Energy Efficient InternetWorked Smart seNsors (E3WSN-2019)

10. The 4th International Workshop on Innovative Technologies in Informatics and Networking (WITIN-2019)
11. The 4th International Workshop on Big Data Processing in Online Social Network (BOSON-2019)
12. The 2nd International Workshop on Internet of Everything and Machine Learning Applications (IOEMLA-2019)
13. The 1st International Workshop on Multi-Clouds and Mobile Edge Computing (M2EC-2019)
14. The 1st Workshop on Artificial Intelligence and Machine Learning (AIMAL-2019)

We would like to thank the community for their great response to AINA-2019 workshops. The excellent technical program of the workshops was the result of a professional work from workshop chairs, workshop program committees, reviewers, and authors.

We would like to give our special thanks to Prof. Makoto Takizawa and Prof. Leonard Barolli, the Steering Committee chairs of AINA International Conference, for their strong encouragement and guidance to organize the AINA-2019 workshops and symposiums. We would like to thank AINA-2019 general co-chairs for their advices to make possible organization of AINA-2019 workshops and symposiums. We are thankful to AINA-2019 program co-chairs for their support and help to prepare the technical program of AINA-2019 workshops and symposiums.

We wish all of you entertaining and rewarding experience in all workshops and AINA-2019 International Conference.

Hui-Huang Hsu
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AINA-2019 Keynote Talks

Utilizing Wireless Communication to Enable New Types of Industrial Applications

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Abstract. The recent progress in the development of wireless communication technologies enables new types of industrial applications. Traditional industrial systems usually rely on wired communication technologies to connect sensors and actuators. However, these type of communication needs to be replaced by wireless technologies in future to address new developments, such as mixed reality applications, automated guided vehicles, moving robots and drones or achieving higher flexibility required by increasing demand for highly customized products and adaptable production facilities. In this talk, we will address and discuss representative use cases and concepts focusing on the usage of wireless technologies in an industrial setting. Moreover, we will present the related challenges and requirements of communication networks in such environments and discuss the applicability of 5th generation wireless communication systems.

Lévy Walk on Graphs: Message Dissemination and Uninformed Search

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Abstract. Random walks play an important role in computer science, spreading a wide range of topics in theory and practice, including networking, distributed systems, and optimization. Particularly, Lévy walk, a family of random walks, has attracted attention in recent years in the context of mobile ad-hoc networks, delay-tolerant networks, opportunistic communication, and global optimization problems. It is also used as a model of various things not only in informatics but also in biology and environmental science. Lévy walk is a mathematical fractal which is characterized by long segments followed by shorter hops in random directions. More precisely, the step distance obeys the power law distribution. The pattern has been found by Paul Lévy, but the similar pattern has also been evolved as a naturally selected strategy that gives animals and insects an edge in the search for sparse targets to survive. In fact, this movement pattern has been observed in the molecular machinery operating in cells, bacteria, the behavior of honeybees, mussels, mud snails, wandering albatross and shearwaters. In the area of computer science, it is most likely to be used as the mobility model in mobile ad-hoc networks because of the statistical similarity of human mobility. Most of the research work, however, assumes a continuous plane and hardly any results on graphs are available. The goal of this keynote is introducing Lévy walk and its variants and presenting the challenge on Geometric graphs, especially Unit disk graphs, regarding message dissemination and uninformed search by using Lévy walk. The results on both message dissemination and uninformed search show that Lévy walk is quite efficient compared to random walks because of its ballistic trajectory. They also clarify the relationship between the efficiency of message dissemination and uninformed search, and the average degree/the diameter of the graphs.

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