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# Beyond Databases, Architectures and Structures

## Paving the Road to Smart Data Processing and Analysis

15th International Conference, BDAS 2019  
Ustroń, Poland, May 28–31, 2019  
Proceedings


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# Preface

Collecting, processing, and analyzing data have become important branches of computer science. Many areas of our existence generate a wealth of information that must be stored in a structured manner and processed appropriately in order to gain knowledge from the inside. Databases have become a ubiquitous way of collecting and storing data. They are used to hold data describing many areas of human life and activity, and as a consequence, they are also present in almost every IT system. Today's databases and data stores have to face the problem of data proliferation and growing variety. More efficient methods for data processing are needed more than ever. New areas of interests that deliver data require innovative algorithms for data analysis.

Beyond Databases, Architectures and Structures (BDAS) is a series of conferences located in Central Europe and are significant for this geographic region. The conference intends to give the state of the research that satisfies the needs of modern, widely understood database systems, architectures, models, structures, and algorithms focused on processing various types of data. The conference aims to reflect the most recent developments of databases and allied techniques used for solving problems in a variety of areas related to database systems or even go one step forward – beyond the horizon of existing databases, architectures, and data structures.

The 15th International BDAS Scientific Conference (BDAS 2019), held in Ustroń Poland during May 28–31, 2019, was a continuation of the highly successful BDAS conference series started in 2005. For many years BDAS was organized under the technical co-sponsorship of the Institute of Electrical and Electronics Engineers (IEEE). The 14th edition of the BDAS conference (BDAS 2018) was organized under the technical co-sponsorship of the International Federation for Information Processing (IFIP) within the IFIP World Computer Congress (IFIP WCC 2018), which attracted hundreds of participants. For many years, BDAS has attracted thousands of researchers and professionals working in the field of databases and data analysis. Among the attendees at our conference were scientists and representatives of IT companies. Several editions of BDAS were supported by our commercial, world-renowned partners, developing solutions for the database domain, such as IBM, Microsoft, Sybase, Oracle, and others. BDAS annual meetings have become an arena for exchanging information on the widely understood database systems and data processing algorithms.

BDAS 2019 was the 15th edition of the conference, organized under the technical co-sponsorship of the IEEE Poland Section. We also continued our successful cooperation with Springer, which resulted in the publication of this book. The conference attracted participants from 15 countries, who made this conference a successful and memorable event. There were several keynotes and invited talks given during BDAS by leading scientists. The keynote speeches, tutorials, and plenary sessions allowed participants to gain insight into new areas of data analysis and data processing.

BDAS is intended to have a broad scope related to collecting, storing, processing, and analyzing data. Proceedings of the conference were published in this book and the *Studia Informatica* journal. Both books reflect fairly well the broad span of research presented at BDAS 2019. This volume consists of 26 carefully selected papers that are assigned to seven thematic groups:

- Big Data and Cloud Computing
- Architectures, Structures, and Algorithms for Efficient Data Processing and Analysis
- Artificial Intelligence, Data Mining, and Knowledge Discovery
- Image Analysis and Multimedia Mining
- Bioinformatics and Biomedical Data Analysis
- Industrial Applications
- Networks and Security

The first group, containing four papers, is devoted to big data and cloud computing. Papers in this group discuss hot topics of diffused data processing and using big data technologies and scalable computing platforms in seismic signal analysis, monitoring people with IoT devices, generation of power in coal-fired power plants.

The second group contains four papers devoted to various database architectures and models, data structures, and algorithms used for efficient data processing. Papers in this group discuss data serialization and performance of various NoSQL data stores, integrity constraints, and schema decomposition in relational databases.

The third group contains six papers devoted to various methods used in data mining, knowledge discovery, and knowledge representation. Papers assembled in this group show a broad spectrum of applications of various exploration techniques, including decision rules, fuzzy and rough sets, clustering and classification algorithms, to solve many real problems.

The fourth group consists of three papers devoted to image analysis and processing. These papers discuss problems of face recognition, increasing image spatial resolution, and compression of medical images. The fifth group consists of three papers devoted to bioinformatics and biological data analysis. Papers in this group focus on protein structure comparison, clinical data annotation, and sports data preprocessing.

The sixth group consists of three papers proposing applications of data analysis to trading rules based on FOREX EUR/USD quotations, spatial data processing, and fuzzy modeling of the methane hazard rate. The last, seventh, group consists of three papers devoted to networks and security, including network protocol for synchronization of seismic data, SQLite-based e-mail servers, and building a security evaluation laboratory.

We hope that the broad scope of topics related to databases covered in this proceedings volume will help the reader to understand that databases have become an essential element of nearly every branch of computer science.

We would like to thank all Program Committee members and additional reviewers for their effort in reviewing the papers. Special thanks to Piotr Kuźniacki, builder and for 15 years administrator of our website [bdas.polsl.pl](http://bdas.polsl.pl), and Paweł Benecki and Mateusz Gołosz, new members of our team and copyeditors of this book.

The conference organization would not have been possible without the technical staff:  
Dorota Huget and Jacek Pietraszuk.

April 2019

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