

## Intelligent Data Analysis

This open access book constitutes the proceedings of the 18th International Conference on Intelligent Data Analysis, IDA 2020, held in Konstanz, Germany, in April 2020. The 45 full papers presented in this volume were carefully reviewed and selected from 114 submissions. Advancing Intelligent Data Analysis requires novel, potentially game-changing ideas. IDA's mission is to promote ideas over performance: a solid motivation can be as convincing as exhaustive empirical evaluation.

This book constitutes the refereed proceedings of the 9th International Conference on Intelligent Data Analysis, IDA 2010, held in Tucson, AZ, USA in May 2010. The 21 revised papers presented together with 2 invited papers were carefully reviewed and selected from more than 40 submissions. All current aspects of intelligent data analysis are addressed, particularly intelligent support for modeling and analyzing complex, dynamical systems. Topics covered are end-to-end software systems; modeling complex systems such as gene regulatory networks, economic systems, ecological systems, resources such as water, and dynamical social systems such as online communities; and robustness, scaling properties and other usability issues.

This book constitutes the refereed conference proceedings of the 15th International Conference on Intelligent Data Analysis, which was held in October 2016 in Stockholm, Sweden. The 36 revised full papers presented were carefully reviewed and selected from 75 submissions. The traditional focus of the IDA symposium series is on end-to-end intelligent support for data analysis. The symposium aims to provide a forum for inspiring research contributions that might be considered preliminary in other leading conferences and journals, but that have a potentially dramatic impact.

With the recent and enormous increase in the amount of available data sets of all kinds, applying effective and efficient techniques for analyzing and extracting information from that data has become a crucial task. Intelligent Data Analysis for Real-Life Applications: Theory and Practice investigates the application of Intelligent Data Analysis (IDA) to these data sets through the design and development of algorithms and techniques to extract knowledge from databases. This pivotal reference explores practical applications of IDA, and it is essential for academic and research libraries as well as students, researchers, and educators in data analysis, application development, and database management.

This volume of Advances in Intelligent Systems and Computing contains accepted papers presented in the main track of ECC 2015, the Second Euro-China Conference on Intelligent Data Analysis and Applications. The aim of ECC is to provide an internationally respected forum for scientific research in the broad area of intelligent data analysis, computational intelligence, signal processing, and all associated applications of AIs. The second edition of ECC was organized jointly by VSB - Technical University of Ostrava, Czech Republic, and Fujian University of Technology, Fuzhou, China. The conference, organized under the patronage of Mr. Miroslav Novak, President of the Moravian-Silesian Region, took place in late June and early July 2015 in the Campus of the VSB - Technical University of Ostrava, Czech Republic.

This book constitutes the refereed proceedings of the Second International Symposium on Intelligent Data Analysis, IDA-97, held in London, UK, in August 1997. The volume presents 50 revised full papers selected from a total of 107 submissions. Also included

is a keynote, *Intelligent Data Analysis: Issues and Opportunities*, by David J. Hand. The papers are organized in sections on exploratory data analysis, preprocessing and tools; classification and feature selection; medical applications; soft computing; knowledge discovery and data mining; estimation and clustering; data quality; qualitative models. This book constitutes the refereed proceedings of the 11th International Conference on Intelligent Data Analysis, IDA 2012, held in Helsinki, Finland, in October 2012. The 32 revised full papers presented together with 3 invited papers were carefully reviewed and selected from 88 submissions. All current aspects of intelligent data analysis are addressed, including intelligent support for modeling and analyzing data from complex, dynamical systems. The papers focus on novel applications of IDA techniques to, e.g., networked digital information systems; novel modes of data acquisition and the associated issues; robustness and scalability issues of intelligent data analysis techniques; and visualization and dissemination results.

This book constitutes the conference proceedings of the 16th International Symposium on Intelligent Data Analysis, which was held in October 2017 in London, UK. The 28 full papers presented in this book were carefully reviewed and selected from 66 submissions. The traditional focus of the IDA symposium series is on end-to-end intelligent support for data analysis. IDA solicits papers on all aspects of intelligent data analysis, including papers on intelligent support for modelling and analyzing data from complex, dynamical systems.

This book constitutes the refereed proceedings of the 10th International Conference on Intelligent Data Analysis, IDA 2011, held in Porto, Portugal, in October 2011. The 19 revised full papers and 16 revised poster papers presented together with 3 invited papers were carefully reviewed and selected from 73 submissions. All current aspects of intelligent data analysis are addressed, particularly intelligent support for modeling and analyzing complex, dynamical systems. The papers offer intelligent support for understanding evolving scientific and social systems including data collection and acquisition, such as crowd sourcing; data cleaning, semantics and markup; searching for data and assembling datasets from multiple sources; data processing, including workflows, mixed-initiative data analysis, and planning; data and information fusion; incremental, mixed-initiative model development, testing and revision; and visualization and dissemination of results; etc.

This book constitutes the proceedings of the 19th International Symposium on Intelligent Data Analysis, IDA 2021, which was planned to take place in Porto, Portugal. Due to the COVID-19 pandemic the conference was held online during April 26-28, 2021. The 35 papers included in this book were carefully reviewed and selected from 113 submissions. The papers were organized in topical sections named: modeling with neural networks; modeling with statistical learning; modeling language and graphs; and modeling special data formats.

Going beyond performing simple analyses, researchers involved in the highly dynamic field of computational intelligent data analysis design algorithms that solve increasingly complex data problems in changing environments, including economic, environmental, and social data.

Computational Intelligent Data Analysis for Sustainable Development present

This book constitutes the refereed proceedings of the 5th International Conference on Intelligent Data Analysis, IDA 2003, held in Berlin, Germany in August 2003. The 56 revised papers presented were carefully reviewed and selected from 180 submissions. The papers are organized in topical sections on machine learning, probability and topology, classification and pattern recognition, clustering, applications, modeling, and data processing.

Making use of data is not anymore a niche project but central to almost every project. With access to massive compute resources and vast amounts of data, it seems at least in principle

possible to solve any problem. However, successful data science projects result from the intelligent application of: human intuition in combination with computational power; sound background knowledge with computer-aided modelling; and critical reflection of the obtained insights and results. Substantially updating the previous edition, then entitled Guide to Intelligent Data Analysis, this core textbook continues to provide a hands-on instructional approach to many data science techniques, and explains how these are used to solve real world problems. The work balances the practical aspects of applying and using data science techniques with the theoretical and algorithmic underpinnings from mathematics and statistics. Major updates on techniques and subject coverage (including deep learning) are included. Topics and features: guides the reader through the process of data science, following the interdependent steps of project understanding, data understanding, data blending and transformation, modeling, as well as deployment and monitoring; includes numerous examples using the open source KNIME Analytics Platform, together with an introductory appendix; provides a review of the basics of classical statistics that support and justify many data analysis methods, and a glossary of statistical terms; integrates illustrations and case-study-style examples to support pedagogical exposition; supplies further tools and information at an associated website. This practical and systematic textbook/reference is a “need-to-have” tool for graduate and advanced undergraduate students and essential reading for all professionals who face data science problems. Moreover, it is a “need to use, need to keep” resource following one's exploration of the subject.

Pattern Recognition has a long history of applications to data analysis in business, military and social economic activities. While the aim of pattern recognition is to discover the pattern of a data set, the size of the data set is closely related to the methodology one adopts for analysis. Intelligent Data Analysis: Developing New Methodologies Through Pattern Discovery and Recovery tackles those data sets and covers a variety of issues in relation to intelligent data analysis so that patterns from frequent or rare events in spatial or temporal spaces can be revealed. This book brings together current research, results, problems, and applications from both theoretical and practical approaches.

This book constitutes the refereed proceedings of the 8th International Conference on Intelligent Data Analysis, IDA 2009, held in Lyon, France, August 31 – September 2, 2009. The 33 revised papers, 18 full oral presentations and 15 poster and short oral presentations, presented were carefully reviewed and selected from almost 80 submissions. All current aspects of this interdisciplinary field are addressed; for example interactive tools to guide and support data analysis in complex scenarios, increasing availability of automatically collected data, tools that intelligently support and assist human analysts, how to control clustering results and isotonic classification trees. In general the areas covered include statistics, machine learning, data mining, classification and pattern recognition, clustering, applications, modeling, and interactive dynamic data visualization.

This book constitutes the refereed conference proceedings of the 12th International Conference on Intelligent Data Analysis, which was held in October 2013 in London, UK. The 36 revised full papers together with 3 invited papers were carefully reviewed and selected from 84 submissions handling all kinds of modeling and analysis methods, irrespective of discipline. The papers cover all aspects of intelligent data analysis, including papers on intelligent support for modeling and analyzing data from complex, dynamical systems.

This book focuses on methods and tools for intelligent data analysis, aimed at narrowing the increasing gap between data gathering and data comprehension, and emphasis will also be given to solving of problems which result from automated data collection, such as analysis of computer-based patient records, data warehousing tools, intelligent alarming, effective and efficient monitoring, and so on. This book aims to

describe the different approaches of Intelligent Data Analysis from a practical point of view: solving common life problems with data analysis tools.

This book constitutes the refereed proceedings of the 7th International Conference on Intelligent Data Analysis, IDA 2007, held in Ljubljana, Slovenia, September 6-8, 2007. The 33 revised papers presented were carefully reviewed and selected from almost 100 submissions. All current aspects of this interdisciplinary field are addressed; the areas covered include statistics, machine learning, data mining, classification and pattern recognition, clustering, applications, modeling, and interactive dynamic data visualization.

Intelligent data analysis, data mining and knowledge discovery in databases have recently gained the attention of a large number of researchers and practitioners. This is witnessed by the rapidly increasing number of submissions and participants at related conferences and workshops, by the emergence of new journals in this area (e.g., *Data Mining and Knowledge Discovery*, *Intelligent Data Analysis*, etc.), and by the increasing number of new applications in this field. In our view, the awareness of these challenging research fields and emerging technologies has been much larger in industry than in medicine and pharmacology. The main purpose of this book is to present the various techniques and methods that are available for intelligent data analysis in medicine and pharmacology, and to present case studies of their application. *Intelligent Data Analysis in Medicine and Pharmacology* consists of selected (and thoroughly revised) papers presented at the First International Workshop on Intelligent Data Analysis in Medicine and Pharmacology (IDAMAP-96) held in Budapest in August 1996 as part of the 12th European Conference on Artificial Intelligence (ECAI-96). IDAMAP-96 was organized with the motivation to gather scientists and practitioners interested in computational data analysis methods applied to medicine and pharmacology, aimed at narrowing the increasing gap between excessive amounts of data stored in medical and pharmacological databases on the one hand, and the interpretation, understanding and effective use of stored data on the other hand. Besides the revised Workshop papers, the book contains a selection of contributions by invited authors. The expected readership of the book is researchers and practitioners interested in intelligent data analysis, data mining, and knowledge discovery in databases, particularly those who are interested in using these technologies in medicine and pharmacology. Researchers and students in artificial intelligence and statistics should find this book of interest as well. Finally, much of the presented material will be interesting to physicians and pharmacologists challenged by new computational technologies, or simply in need of effectively utilizing the overwhelming volumes of data collected as a result of improved computer support in their daily professional practice.

In recent years there has been a growing interest to extend classical methods for data analysis. The aim is to allow a more flexible modeling of phenomena such as uncertainty, imprecision or ignorance. Such extensions of classical probability theory and statistics are useful in many real-life situations, since uncertainties in data are not only present in the form of randomness --- various types of incomplete or subjective information have to be handled. About twelve years ago the idea of strengthening the dialogue between the various research communities in the field of data analysis was born and resulted in the International Conference Series on Soft Methods in Probability and Statistics (SMPS). This book gathers contributions presented at the SMPS'2012

held in Konstanz, Germany. Its aim is to present recent results illustrating new trends in intelligent data analysis. It gives a comprehensive overview of current research into the fusion of soft computing methods with probability and statistics. Synergies of both fields might improve intelligent data analysis methods in terms of robustness to noise and applicability to larger datasets, while being able to efficiently obtain understandable solutions of real-world problems.

This book highlights recent advances in intelligent data analysis, computational intelligence, signal processing, and all associated applications of artificial intelligence. It gathers papers presented at the ECC 2017, the Fourth Euro-China Conference on Intelligent Data Analysis and Applications. The aim of the ECC was to provide an internationally respected forum for scientific research in the broad areas of intelligent data analysis, computational intelligence, signal processing, and all associated applications of artificial intelligence (AI). The fourth installment of the ECC was jointly organized by the University of Málaga, Spain; the VŠB - Technical University of Ostrava, Czech Republic; and Fujian University of Technology, Fuzhou, China. The conference took place in Málaga, Spain on October 9–11, 2017.

Each passing year bears witness to the development of ever more powerful computers, increasingly fast and cheap storage media, and even higher bandwidth data connections. This makes it easy to believe that we can now – at least in principle – solve any problem we are faced with so long as we only have enough data. Yet this is not the case. Although large databases allow us to retrieve many different single pieces of information and to compute simple aggregations, general patterns and regularities often go undetected. Furthermore, it is exactly these patterns, regularities and trends that are often most valuable. To avoid the danger of “drowning in information, but starving for knowledge” the branch of research known as data analysis has emerged, and a considerable number of methods and software tools have been developed. However, it is not these tools alone but the intelligent application of human intuition in combination with computational power, of sound background knowledge with computer-aided modeling, and of critical reflection with convenient automatic model construction, that results in successful intelligent data analysis projects. *Guide to Intelligent Data Analysis* provides a hands-on instructional approach to many basic data analysis techniques, and explains how these are used to solve data analysis problems. Topics and features: guides the reader through the process of data analysis, following the interdependent steps of project understanding, data understanding, data preparation, modeling, and deployment and monitoring; equips the reader with the necessary information in order to obtain hands-on experience of the topics under discussion; provides a review of the basics of classical statistics that support and justify many data analysis methods, and a glossary of statistical terms; includes numerous examples using R and KNIME, together with appendices introducing the open source software; integrates illustrations and case-study-style examples to support pedagogical exposition. This practical and systematic textbook/reference for graduate and advanced undergraduate students is also essential reading for all professionals who face data analysis problems. Moreover, it is a book to be used following one’s exploration of it. Dr. Michael R. Berthold is Nycomed-Professor of Bioinformatics and Information Mining at the University of Konstanz, Germany. Dr. Christian Borgelt is Principal Researcher at the Intelligent Data Analysis and Graphical Models Research Unit of the European

Centre for Soft Computing, Spain. Dr. Frank Höppner is Professor of Information Systems at Ostfalia University of Applied Sciences, Germany. Dr. Frank Klawonn is a Professor in the Department of Computer Science and Head of the Data Analysis and Pattern Recognition Laboratory at Ostfalia University of Applied Sciences, Germany. He is also Head of the Bioinformatics and Statistics group at the Helmholtz Centre for Infection Research, Braunschweig, Germany.

This book constitutes the refereed conference proceedings of the 13th International Conference on Intelligent Data Analysis, which was held in October/November 2014 in Leuven, Belgium. The 33 revised full papers together with 3 invited papers were carefully reviewed and selected from 70 submissions handling all kinds of modeling and analysis methods, irrespective of discipline. The papers cover all aspects of intelligent data analysis, including papers on intelligent support for modeling and analyzing data from complex, dynamical systems.

This book gathers papers presented at the ECC 2016, the Third Euro-China Conference on Intelligent Data Analysis and Applications, which was held in Fuzhou City, China from November 7 to 9, 2016. The aim of the ECC is to provide an internationally respected forum for scientific research in the broad areas of intelligent data analysis, computational intelligence, signal processing, and all associated applications of artificial intelligence (AI). The third installment of the ECC was jointly organized by Fujian University of Technology, China, and VSB-Technical University of Ostrava, Czech Republic. The conference was co-sponsored by Taiwan Association for Web Intelligence Consortium, and Immersion Co., Ltd.

Intelligent Data Analysis for Biomedical Applications: Challenges and Solutions presents specialized statistical, pattern recognition, machine learning, data abstraction and visualization tools for the analysis of data and discovery of mechanisms that create data. It provides computational methods and tools for intelligent data analysis, with an emphasis on problem-solving relating to automated data collection, such as computer-based patient records, data warehousing tools, intelligent alarming, effective and efficient monitoring, and more. This book provides useful references for educational institutions, industry professionals, researchers, scientists, engineers and practitioners interested in intelligent data analysis, knowledge discovery, and decision support in databases. Provides the methods and tools necessary for intelligent data analysis and gives solutions to problems resulting from automated data collection Contains an analysis of medical databases to provide diagnostic expert systems Addresses the integration of intelligent data analysis techniques within biomedical information systems

This book constitutes the conference proceedings of the 17th International Symposium on Intelligent Data Analysis, which was held in October 2018 in 's-Hertogenbosch, the Netherlands. The traditional focus of the IDA symposium series is on end-to-end intelligent support for data analysis. The 29 full papers presented in this book were carefully reviewed and selected from 65 submissions. The papers cover all aspects of intelligent data analysis, including papers on intelligent support for modeling and analyzing data from complex, dynamical systems.

This book embodies principles and applications of advanced soft computing approaches in engineering, healthcare and allied domains directed toward the researchers aspiring to learn and apply intelligent data analytics techniques. The first part covers AI, machine learning and data analytics tools and techniques and their applications to the class of several hospital and health real-life problems. In the later part, the applications of AI, ML and data analytics shall be covered over the wide variety of applications in hospital, health, engineering and/or applied

sciences such as the clinical services, medical image analysis, management support, quality analysis, bioinformatics, device analysis and operations. The book presents knowledge of experts in the form of chapters with the objective to introduce the theme of intelligent data analytics and discusses associated theoretical applications. At last, it presents simulation codes for the problems included in the book for better understanding for beginners.

This book constitutes the refereed conference proceedings of the 14th International Conference on Intelligent Data Analysis, which was held in October 2015 in Saint Étienne, France. The 29 revised full papers were carefully reviewed and selected from 65 submissions. The traditional focus of the IDA symposium series is on end-to-end intelligent support for data analysis. The symposium aims to provide a forum for inspiring research contributions that might be considered preliminary in other leading conferences and journals, but that have a potentially dramatic impact. To facilitate this, IDA 2015 will feature two tracks: a regular "Proceedings" track, as well as a "Horizon" track for early-stage research of potentially ground-breaking nature.

These papers on Intelligent Data Analysis and Management (IDAM) examine issues related to the research and applications of Artificial Intelligence techniques in data analysis and management across a variety of disciplines. The papers derive from the 2013 IDAM conference in Kaohsiung, Taiwan. It is an interdisciplinary research field involving academic researchers in information technologies, computer science, public policy, bioinformatics, medical informatics, and social and behavior studies, etc. The techniques studied include (but are not limited to): data visualization, data pre-processing, data engineering, database mining techniques, tools and applications, evolutionary algorithms, machine learning, neural nets, fuzzy logic, statistical pattern recognition, knowledge filtering, and post-processing, etc.

This comprehensive book highlights soft computing and geostatistics applications in hydrocarbon exploration and production, combining practical and theoretical aspects. It spans a wide spectrum of applications in the oil industry, crossing many discipline boundaries such as geophysics, geology, petrophysics and reservoir engineering. It is complemented by several tutorial chapters on fuzzy logic, neural networks and genetic algorithms and geostatistics to introduce these concepts to the uninitiated. The application areas include prediction of reservoir properties (porosity, sand thickness, lithology, fluid), seismic processing, seismic and bio stratigraphy, time lapse seismic and core analysis. There is a good balance between introducing soft computing and geostatistics methodologies that are not routinely used in the petroleum industry and various applications areas. The book can be used by many practitioners such as processing geophysicists, seismic interpreters, geologists, reservoir engineers, petrophysicist, geostatisticians, asset managers and technology application professionals. It will also be of interest to academics to assess the importance of, and contribute to, R&D efforts in relevant areas.

This volume presents the proceedings of the First Euro-China Conference on Intelligent Data Analysis and Applications (ECC 2014), which was hosted by Shenzhen Graduate School of Harbin Institute of Technology and was held in Shenzhen City on June 13-15, 2014. ECC 2014 was technically co-sponsored by Shenzhen Municipal People's Government, IEEE Signal Processing Society, Machine Intelligence Research Labs, VSB-Technical University of Ostrava (Czech Republic), National Kaohsiung University of Applied Sciences (Taiwan), and Secure E-commerce Transactions (Shenzhen) Engineering Laboratory of Shenzhen Institute of Standards and Technology.

This book presents intelligent data analysis as a tool to fight against COVID-19 pandemic. The intelligent data analysis includes machine learning, natural language processing, and computer vision applications to teach computers to use big data-based models for pattern recognition, explanation, and prediction. These functions are discussed in detail in the book to recognize (diagnose), predict, and explain (treat) COVID-19 infections, and help manage socio-economic

impacts. It also discusses primary warnings and alerts; tracking and prediction; data dashboards; diagnosis and prognosis; treatments and cures; and social control by the use of intelligent data analysis. It provides analysis reports, solutions using real-time data, and solution through web applications details.

This is a detailed introductory presentation of the key classes of intelligent data analysis (IDA) methods. The first part of the book discusses classical statistical issues. The following chapters concentrate on machine learning and artificial intelligence and provide introductions to the topics of rule induction methods, neural networks, fuzzy logic, and stochastic search methods. The book concludes with a higher level overview of the IDA process and illustrations of its application.

This book constitutes the Proceeding of the Sixth International Conference on Intelligent Data Analysis and Applications, October 15–18, 2019, Arad, Romania. This edition is technically co-sponsored by “Aurel Vlaicu” University of Arad, Romania, Southwest Jiaotong University, Fujian University of Technology, Chang’an University, Shandong University of Science and Technology, Fujian Provincial Key Lab of Big Data Mining and Applications, and National Demonstration Center for Experimental Electronic Information and Electrical Technology Education (Fujian University of Technology), China, Romanian Academy, and General Association of Engineers in Romania - Arad Section. The book covers a range of topics: Machine Learning, Intelligent Control, Pattern Recognition, Computational Intelligence, Signal Analysis, Modeling and Visualization, Multimedia Sensing and Sensory Systems, Signal control, Imaging and Processing, Information System Security, Cryptography and Cryptanalysis, Databases and Data Mining, Information Hiding, Cloud Computing, Information Retrieval and Integration, Robotics, Control, Agents, Command, Control, Communication and Computers (C4), Swarming Technology, Sensor Technology, Smart cities. The book offers a timely, board snapshot of new development including trends and challenges that are yielding recent research directions in different areas of intelligent data analysis and applications. The book provides useful information to professors, researchers, and graduated students in area of intelligent data analysis and applications.

This volume of *Advances in Intelligent Systems and Computing* highlights papers presented at the Fifth Euro-China Conference on Intelligent Data Analysis and Applications (ECC2018), held in Xi’an, China from October 12 to 14 2018. The conference was co-sponsored by Springer, Xi’an University of Posts and Telecommunications, VSB Technical University of Ostrava (Czech Republic), Fujian University of Technology, Fujian Provincial Key Laboratory of Digital Equipment, Fujian Provincial Key Lab of Big Data Mining and Applications, and Shandong University of Science and Technology in China. The conference was intended as an international forum for researchers and professionals engaged in all areas of computational intelligence, intelligent control, intelligent data analysis, pattern recognition, intelligent information processing, and applications.

This book constitutes the refereed proceedings of the 6th International Conference on Intelligent Data Analysis, IDA 2005, held in Madrid, Spain in September 2005. The 46 revised papers presented together with two tutorials and two invited talks were carefully reviewed and selected from 184 submissions. All current aspects of this interdisciplinary field are addressed; the areas covered include statistics, machine learning, data mining, classification and pattern recognition, clustering, applications, modeling, and interactive dynamic data visualization.

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