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New Trends in Databases and Information Systems

ADBIS 2019 Short Papers, Workshops
BBIGAP, QAUCA, SemBDM, SIMPDA, M2P, MADEISD
and Doctoral Consortium
Bled, Slovenia, September 8–11, 2019
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Preface

The European Conference on Advances in Databases and Information Systems (ADBIS) celebrated its 23rd anniversary. Previous ADBIS conferences were held in St. Petersburg (1997), Poznan (1998), Maribor (1999), Prague (2000), Vilnius (2001), Bratislava (2002), Dresden (2003), Budapest (2004), Tallinn (2005), Thessaloniki (2006), Varna (2007), Pori (2008), Riga (2009), Novi Sad (2010), Vienna (2011), Poznan (2012), Genoa (2013), Ohrid (2014), Poitiers (2015), Prague (2016), Nicosia (2017), and Budapest (2018). After 20 years the conference returned to Slovenia, and was organized in Bled.

ADBIS can be considered one of the most established and recognized conferences in Europe, in the broad field of databases and information systems. The conference aims at: (1) providing an international forum for presenting research achievements on database theory and practice, development of advanced DBMS technologies, and their applications; (2) promoting the interaction and collaboration between the database and information systems research communities from European countries and the rest of the world; (3) offering a forum for a less formal exchange of research ideas by means of affiliated workshops; and (4) activating young researchers from all over the world by means of a doctoral consortium.

ADBIS workshops have been associated with the ADBIS conference since 2005 and doctoral consortia have been associated since 2008. This long tradition continued this year. Therefore, the program of ADBIS 2019 included keynotes, research papers, thematic workshops, and a doctoral consortium (DC). The main conference, workshops, and DC had their own international Program Committees.

This volume contains 19 short research papers from the main conference, 31 workshops papers, and 5 DC papers, which were all presented at ADBIS 2019, held during September 8–11, 2019, in Bled, Slovenia.

The selected short papers span a wide spectrum of topics related to the ADBIS conference. Most of them are related to database and information systems technologies for advanced applications. Typical applications are text databases, streaming data, and graph processing. In addition, there are also papers covering the theory of databases.

The main conference received a total of 103 submissions. After a rigorous reviewing process 27 papers were accepted as full papers and 19 were selected as short papers for presentation and publication in this volume, giving an acceptance rate for short papers of 45%.

The following six workshops were run at ADBIS 2019:

- International Workshop on BI & Big Data Applications (BBIGAP), chaired by: Fadila Bentayeb (Université Lyon 2, France) and Omar Boussaid (Université Lyon 2, France)

- International Workshop on Qualitative Aspects of User-Centered Analytics (QAUCA), chaired by: Nicolas Labroche (Université de Tours, France), Patrick Marcel (Université de Tours, France), and Veronika Peralta (Université de Tours, France)
- A joint workshop Semantics in Big Data Management (SemBDM) and Data-Driven Process Discovery and Analysis (SIMPDA), chaired by: Paolo Ceravolo (Universita degli Studi di Milano, Italy), Florence Sedes (Toulouse Institute of Computer Science Research, France), Maria Teresa Gomez Lopez (University of Seville, Spain), and Maurice van Keulen (University of Twente, The Netherlands)
- Modelling is going to become Programming (M2P), chaired by: Ajantha Dahanayake (Lappeenranta University of Technology, Finland) and Bernhard Thalheim (Kiel University, Germany)
- Modern Approaches in Data Engineering and Information System Design (MADEISD), chaired by: Ivan Luković (University of Novi Sad, Serbia) and Slavica Kordić (University of Novi Sad, Serbia)

In total, 67 papers were submitted to these workshops, out of which 31 were selected for presentation and publication in this volume, giving an acceptance rate of 46%.

The ADBIS 2019 DC was a forum where PhD students had a chance to present their research ideas to the database research community, to receive inspiration from their peers and feedback from senior researchers, and to tie cooperation bounds. DC papers aim at describing the current status of the thesis research. The DC Committee accepted five papers that were presented at the DC. Two main topics emerged this year: big data integration and big data analytics.

ADBIS chairs would like to express their sincere gratitude to everyone who contributed to make ADBIS 2019 successful:

- All the organizers of the previous ADBIS workshops and conferences. They made ADBIS a valuable trademark and we are proud to continue their work.
- The authors, who submitted papers of high quality to the conference.
- The members of the international Program Committee for dedicating their time and expertise to assure a high-quality program.
- The members of ADBIS Steering Committee for proven trust and conferred organization of the conference.
- Springer for publishing these proceedings.
- Last but not least, to all the helping hands from the webmaster, programmers to technicians, and administration, without whom the organization of such a conference would not have been possible.

– Finally, we would like to express our special thanks to the local chair Lili Nemec Zlatolas for her continuous coordinating activities that ensured the success of ADBIS 2019.

July 2019

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Abstract of Invited Talk

Databases Meet Blocks, Ledgers and Contracts

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Introduction and Motivation

Considering the impact on society blockchain technology has, it is falsely to predict the technology is adequately understood. Even in professional circles, there exists the notion, that this technology is only connected with crypto currencies and finances, whereby neglecting the fact that in its core, it is a novel type of a database technology, having its specifics, which make it suitable for special use cases [8]. As it was with the NoSQL databases in the early 21st century, the public tends to perceive it as a solution for everything, while slowly realising the contrary [5]. Even though the technology is still in it early stages, it should not be neglected, as indicated also by Gartner in its top 10 strategic technology trends for 2019 report, where Blockchain is within the mesh section [3].

Furthermore, Blockchain is also the cornerstone of smart contracts as well as decentralized application. Where the latter is a novel Web technology, based on the Web3 notion, which emphasizes the decentralized and distributed nature of the new Internet [2], the former is the core of it, whereby pushing the business logic onto the data layer [4, 6].

As aforementioned, blockchain technology can be categorized as kind of a database, however, it has several specific characteristics, which consequently effects the possible use cases, making it hard to apply without thinking out of the box. Furthermore, due to its distributed nature and its focus on data integrity, it is interesting to see how it falls into the CAP theorem [1].

Breaking Down Blockchain

lockchain technology is part of the bigger family of distributed ledger technologies. Its main characteristic is storing transaction-based data into a chronological structure in multiple virtual locations simultaneously, while relying on the decentralized environment and not on a central authority to manage the process [7]. Another important characteristic is the fact that it ensures the data integrity on the highest level, even though it is operating in a distributed environment. The blockchain protocols store data into predefined size of data blocks, which stores only a limited size of

transactions-based data that is cryptographically signed. Each block is referenced with the previous one, forming an unbreakable chain of blocks, distributed throughout the network in a fully replicated manner, i.e. a digital ledger between network nodes. The data in the ledger cannot be queried as per se, whereas depending on the blockchain platform, it has to be structured or can be unstructured in some degree. The latter is the case with smart contracts, which are a collection of programmatic instruction, stored in blocks of data, which can later on reference newly added data. Smart contracts are programmable code, which is execute in a dedicated Database Management Systems, which includes a specific and dedicated virtual environment (e.g. Ethereum Virtual Machine) [4]. As such smart contracts can host the business logic, which is stored on the data layer, consequently in a distributed and decentralized environment, accessible by decentralized applications. Such feature puts blockchain on the top of the database world, where it requires much more attention from the professional community.

The focus of this work will thus be on the features, possibilities, as well as on the challenges of blockchain technology, breaking it down in terms of data structures, topology, as well as current open research topics.

References

1. Brewer, E.: CAP twelve years later: how the "rules" have changed. Computer **45**(2), 23–29 (2012). https://ieeexplore.ieee.org/document/6133253/
2. Cai, W., Wang, Z., Ernst, J.B., Hong, Z., Feng, C., Leung, V.C.M.: Decentralized applications: the blockchain-empowered software system. IEEE Access **6**, 53019–53033 (2018). https://ieeexplore.ieee.org/document/8466786/
3. Cearley, D., Burke, B.: Top 10 Strategic Technology Trends for 2019: A Gartner Trend Insight Report. Technical report, https://emtemp.gcom.cloud/ngw/globalassets/en/doc/documents/383829-top-10-strategic-technology-trends-for-2019-a-gartner-trend-insight-report.pdf
4. Chinchilla, C.: A Next-Generation Smart Contract and Decentralized Application Platform. https://github.com/ethereum/wiki/wiki/White-Paper
5. Leavitt, N.: Will NoSQL databases live up to their promise? Computer **43**(2), 12–14 (2010). http://ieeexplore.ieee.org/document/5410700/
6. Mohanta, B.K., Panda, S.S., Jena, D.: An overview of smart contract and use cases in blockchain technology. In: 2018 9th International Conference on Computing, Communication and Networking Technologies (ICCCNT), pp. 1–4. IEEE, July 2018. https://ieeexplore.ieee.org/document/8494045/
7. Suciu, G., Nadrag, C., Istrate, C., Vulpe, A., Ditu, M.C., Subea, O.: Comparative analysis of distributed ledger technologies. In: 2018 Global Wireless Summit (GWS), pp. 370–373. IEEE, November 2018. https://ieeexplore.ieee.org/document/8686563/
8. Turkanovic, M., Holbl, M., Kosic, K., Hericko, M., Kamisalic, A.: EduCTX: a blockchain-based higher education credit platform. IEEE Access **6**, 5112–5127 (2018). http://ieeexplore.ieee.org/document/8247166/

Abstract of the Invited Talk on International Workshop on Qualitative Aspects of User-Centered Analytics – QAUCA

Analytical Metadata Modeling

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Abstract. Decision-making is based on thorough analyses of the available data. However, due to the data growth and diversification, data exploration becomes a challenging and complex task. Next generation systems aim at assisting the user and facilitating this process. Complex metadata constructs sit at the core of these systems and they are the key component to automate and support data analysts tasks. In this talk, we will discuss how metadata is managed and exploited to provide strategic advantage to organizations by lowering the high-entry barriers to complex data analysis.

Keywords: Big data · Data variety · Metadata · User-centric Analysis

Introduction

Traditional Decision Support Systems (DSS) already underlined the relevance of metadata for decision making. Some approaches, such as [4], described several aspects of the data lifecycle (e.g., schemata, provenance, etc.) in terms of metadata. However, such metadata was not used to support the user in their day-by-day tasks (rather, it was used as internal information to manage the BI system). Also, the advent of Big Data emphasized the need to extract information from data sources out of our control, which typically expose unstructured or, at most, semi-structured data. As such, the Data Variety challenge [1] was coined, which claims for crossing and integrating as much relevant data, of any type, as possible. This includes text, images, video and audio. which require a pre-processing stage to extract relevant features from them prior to integrating such data with other sources. The confluence of both trends reinforced the need to annotate the processes and data generated with metadata in order to automate the data lifecycle and support the users in their analytical tasks regardless of the potentially complex data management processes in the background.

The so-called next generation BI systems (e.g., [2, 3], among others), acknowledge the wealth of data available in diverse formats and therefore, in addition, claim for expanding the use of metadata to other fields such as source discovery, data integration/crossing, recommendation, personalisation and, in general, to support the user exploiting the available data. Indeed, there is a strong common backbone in this shift. Next generation systems should automate repetitive and burdensome tasks (e.g., creating a catalog of variables available) and support and facilitate those tasks where a full automation is harder to achieve (e.g., entity resolution).

Analytical Metadata for Next Generation Systems

In this talk we will claim for a strict methodology when creating, annotating and managing metadata. We will present SM4AM [5], *a Semantic Model for Analytical Metadata* based on RDF, and jointly designed by the DTIM[1] and DAISY[2] research groups. SM4AM is grounded on ontological metamodeling, which we claim to be the proper solution to model and store metadata in these scenarios. This way, we avoid imposing a fixed universal model, which is unfeasible due to the (meta)data models heterogeneity in the current wealth of data. Further, RDF supports sharing and flexible metadata representation, which opens the door for advanced interoperability between semantic-aware systems. We will also discuss how to properly instantiate and exploit SM4AM. In this sense, metadata annotation should be a manual task but fully automatic to avoid errors and facilitate a common understanding of the RDF metamodel.

We will wrap-up this talk by presenting novel ideas about how to exploit a metadata repository compliant with SM4AM. First, we will introduce a novel way to cross data through what we call *metamodel-driven (meta)data exploration*, where SM4AM is asserted on top of existing RDF models to facilitate the automatic extraction and processing of already existing data repositories. We will compare our approach to other prominent solutions such as KBPedia[3]. Next, we will present a next generation Big Data system that uses SM4AM at its core. This system uses metadata to automatically bootstrap sources (for now, CSV, JSON, XML and relational sources), and extract and align their schemata in an automatic manner. From such information, the system is able to generate a global view of the sources in a bottom-up approach. Finally, the system provides high-level user-friendly querying mechanisms over the global view generated for non-IT people. All in all, we will show that there are nowadays solid foundations as to pave the road to build semantic-aware systems able to efficiently manage the data variety challenge while providing advanced support for data analysts.

References

1. Bean, R.: Variety, not volume, is driving big data initiatives, March 2016
2. Deng, D., et al.: The data civilizer system. In: 8th Biennial Conference on Innovative Data Systems Research CIDR 2017 (2017)
3. Nadal, S., Romero, O., Abelló, A., Vassiliadis, P., Vansummeren, S.: An integration-oriented ontology to govern evolution in big data ecosystems. Inf. Syst. (2018). https://doi.org/10.1016/j.is.2018.01.006
4. Object Management Group.: Common Warehouse Metamodel Specification 1.1. http://www.omg.org/spec/CWM/1.1/PDF/. Accessed Sep 2016
5. Varga, J., Romero, O., Pedersen, T.B., Thomsen, C.: Analytical metadata modeling for next generation BI systems. J. Syst. Softw. **144,** 240–254 (2018)

[1] http://www.essi.upc.edu/dtim/.

[2] https://www.daisy.aau.dk/.

[3] http://kbpedia.org/.

Contents

ADBIS 2019 Short Papers

Distributed Computation of Top-*k* Degrees in Hidden Bipartite Graphs 3
Panagiotis Kostoglou, Apostolos N. Papadopoulos, and Yannis Manolopoulos

Applying Differential Evolution with Threshold Mechanism for Feature Selection on a Phishing Websites Classification 11
Lucija Brezočnik, Iztok Fister Jr., and Grega Vrbančič

Document Data Modeling: A Conceptual Perspective 19
David Chaves and Elzbieta Malinowski

Towards Automated Visualisation of Scientific Literature 28
Evelina Di Corso, Stefano Proto, Tania Cerquitelli, and Silvia Chiusano

Metadata Management for Data Lakes 37
Franck Ravat and Yan Zhao

Correlation Between Students' Background and the Knowledge on Conceptual Database Modelling 45
Lili Nemec Zlatolas, Aida Kamišalić, and Muhamed Turkanović

Smart Caching for Efficient Functional Dependency Discovery 52
Anastasia Birillo and Nikita Bobrov

The Agents' Selection Methods for a Consensus-Based Investment Strategy in a Multi-agent Financial Decisions Support System 60
Marcin Hernes, Adrianna Kozierkiewicz, and Marcin Pietranik

Ratings vs. Reviews in Recommender Systems: A Case Study on the Amazon Movies Dataset 68
Maria Stratigi, Xiaozhou Li, Kostas Stefanidis, and Zheying Zhang

Solution Pattern for Anomaly Detection in Financial Data Streams 77
Maciej Zakrzewicz, Marek Wojciechowski, and Paweł Gławiński

Exploring Pattern Mining for Solving the Ontology Matching Problem 85
Hiba Belhadi, Karima Akli-Astouati, Youcef Djenouri, and Jerry Chun-Wei Lin

Systematic Creation of Cumulative Design Science Research Knowledge with a Case Study in the Field of Automatic Speech Recognition 94
Udo Bub

SLFTD: A Subjective Logic Based Framework for Truth Discovery 102
Danchen Zhang, Vladimir I. Zadorozhny, and Vladimir A. Oleshchuk

A Cellular Network Database for Fingerprint Positioning Systems 111
Donatella Gubiani, Paolo Gallo, Andrea Viel, Andrea Dalla Torre, and Angelo Montanari

Automatically Configuring Parallelism for Hybrid Layouts 120
Rana Faisal Munir, Alberto Abelló, Oscar Romero, Maik Thiele, and Wolfgang Lehner

Automated Vertical Partitioning with Deep Reinforcement Learning 126
Gabriel Campero Durand, Rufat Piriyev, Marcus Pinnecke, David Broneske, Balasubramanian Gurumurthy, and Gunter Saake

BrainFlux: An Integrated Data Warehousing Infrastructure for Dynamic Health Data 135
Jonathan Elmer, Quan Zhou, Yichi Zhang, Fan Yang, and Vladimir I. Zadorozhny

Modelling and Querying Star and Snowflake Warehouses Using Graph Databases 144
Alejandro Vaisman, Florencia Besteiro, and Maximiliano Valverde

Towards Integrating Collaborative Filtering in Visual Data Exploration Systems 153
Houssem Ben Lahmar and Melanie Herschel

ADBIS 2019 Workshop: Modelling is Going to Become Programming – M2P

Usage Models Mapped to Programs 163
András J. Molnár and Bernhard Thalheim

Phenomenological Framework for Model Enabled Enterprise Information Systems 176
Tomas Jonsson and Håkan Enquist

Query-Based Reverse Engineering of Graph Databases – From Program to Model 188
Isabelle Comyn-Wattiau and Jacky Akoka

A Model-Driven Needs Based Augmented Reality: From Model to Program 198
Manal A. Yahya and Ajantha Dahanayake

Graphical E-Commerce Values Filtering Model in Spatial Database Framework 210
Michal Kopecky and Peter Vojtas

Transforming Object-Oriented Model to a Web Interface Using XSLT. 221
Jiri Musto and Ajantha Dahanayake

Abstract Layers and Generic Elements as a Basis for Expressing Multidimensional Software Knowledge 232
Valentino Vranić and Adam Neupauer

Model Suite and Model Set in Software Development 243
Igor Fiodorov and Alexander Sotnikov

Automatic Code Generator for Screen Based Systems 253
Katerina Korenblat and Elena V. Ravve

Formalizing Requirement Specifications for Problem Solving in a Research Domain 266
Nikolay A. Skvortsov and Sergey A. Stupnikov

ADBIS 2019 Workshop: Modern Approaches in Data Engineering and Information System Design – MADEISD

Customer Value Prediction in Direct Marketing Using Hybrid Support Vector Machine Rule Extraction Method 283
Suncica Rogic and Ljiljana Kascelan

Crowd Counting á la Bourdieu: Automated Estimation of the Number of People 295
Karolina Przybylek and Illia Shkroba

A Holistic Decision Making Framework for a Vehicle Sharing System 306
Selin Ataç, Nikola Obrenović, and Michel Bierlaire

Residual MobileNets 315
Adam Brzeski, Kamil Grinholc, Kamil Nowodworski, and Adam Przybylek

A Blockchain-Based Decentralized Self-balancing Architecture for the Web of Things 325
Aleksandar Tošić, Jernej Vičič, and Michael Mrissa

A Business-Context-Based Approach for Message Standards Use - A Validation Study. 337
Elena Jelisic, Nenad Ivezic, Boonserm Kulvatunyou, Nenad Anicic, and Zoran Marjanovic

A Two-Tiered Database Design Based on Core Components Methodology 350
Elena Jelisic, Nenad Ivezic, Boonserm Kulvatunyou, Marija Jankovic, and Zoran Marjanovic

ADBIS 2019 Workshop: Semantics in Big Data Management – SemBDM and Data-Driven Process Discovery and Analysis – SIMPDA

Using Rule and Goal Based Agents to Create Metadata Profiles 365
Hiba Khalid and Esteban Zimányi

On Metadata Support for Integrating Evolving Heterogeneous Data Sources 378
Darja Solodovnikova, Laila Niedrite, and Aivars Niedritis

The Impact of Event Log Subset Selection on the Performance of Process Discovery Algorithms 391
Mohammadreza Fani Sani, Sebastiaan J. van Zelst, and Wil M. P. van der Aalst

Exploiting Event Log Event Attributes in RNN Based Prediction 405
Markku Hinkka, Teemu Lehto, and Keijo Heljanko

Design and Implementation of a Graph-Based Solution for Tracking Manufacturing Products 417
Jorge Martinez-Gil, Reinhard Stumpner, Christian Lettner, Mario Pichler, and Werner Fragner

ADBIS 2019 Workshop: International Workshop on BI and Big Data Applications – BBIGAP

An XML Interchange Format for ETL Models 427
Judith Awiti and Esteban Zimányi

Metadata Systems for Data Lakes: Models and Features. 440
Pegdwendé N. Sawadogo, Étienne Scholly, Cécile Favre, Éric Ferey, Sabine Loudcher, and Jérôme Darmont

A Metadata Framework for Data Lagoons 452
Vasileios Theodorou, Rihan Hai, and Christoph Quix

Assessing the Role of Temporal Information in Modelling Short-Term Air Pollution Effects Based on Traffic and Meteorological Conditions: A Case Study in Wrocław 463
Andrea Brunello, Joanna Kamińska, Enrico Marzano, Angelo Montanari, Guido Sciavicco, and Tomasz Turek

Extreme Climate Event Detection Through High Volume of Transactional Consumption Data 475
Hugo Alatrista-Salas, Mauro León-Payano, and Miguel Nunez-del-Prado

ADBIS 2019 Workshop: International Workshop on Qualitative Aspects of User-Centered Analytics – QAUCA

Data Quality Alerting Model for Big Data Analytics 489
Eliza Gyulgyulyan, Julien Aligon, Franck Ravat, and Hrachya Astsatryan

Framework for Assessing the Smartness Maturity Level of Villages 501
Jorge Martinez-Gil, Mario Pichler, Tina Beranič, Lucija Brezočnik, Muhamed Turkanović, Gianluca Lentini, Francesca Polettini, Alessandro Lué, Alberto Colorni Vitale, Guillaume Doukhan, and Claire Belet

GameRecs: Video Games Group Recommendations 513
Rama Hannula, Aapo Nikkilä, and Kostas Stefanidis

FIFARecs: A Recommender System for FIFA18 525
Jaka Klancar, Karsten Paulussen, and Kostas Stefanidis

ADBIS 2019 Doctoral Consortium

Algorithms and Architecture for Managing Evolving ETL Workflows 539
Judith Awiti

Data Integration of Legacy ERP System Based on Ontology Learning from SQL Scripts 546
Chuangtao Ma

Business Intelligence & Analytics Applied to Public Housing 552
Étienne Scholly

Textual Data Analysis from Data Lakes 558
Pegdwendé N. Sawadogo

A Dockerized String Analysis Workflow for Big Data 564
Maria Th. Kotouza, Fotis E. Psomopoulos, and Pericles A. Mitkas

Author Index 571