Data-Driven Process Discovery and Analysis

This book constitutes the thoroughly refereed proceedings of the Third International Symposium on Data-Driven Process Discovery and Analysis held in Riva del Garda, Italy, in August 2013. The six revised full papers were carefully selected from 18 submissions. Following the event, authors were given the opportunity to improve their papers with the insights they gained from the symposium. The
selected papers cover theoretical issues related to process representation, discovery and analysis or provide practical and operational experiences in process discovery and analysis.

Business Process Management Workshops This book introduces readers to the field of conformance checking as a whole and outlines the fundamental relation between modelled and recorded behaviour. Conformance checking interrelates the modelled and recorded behaviour of a given process and provides techniques and methods for comparing and analysing observed instances of a process in the presence of a model, independent of the model’s origin. Its goal is to provide an overview of the essential techniques and methods in this field at an intuitive level, together with precise formalisations of its underlying principles. The book is divided into three parts, that are meant to cover different perspectives of the field of conformance checking. Part I presents a comprehensive yet accessible overview of the essential concepts used to interrelate modelled and recorded behaviour. It also serves as a reference for assessing how conformance checking efforts could be applied in specific domains. Next, Part II provides readers with detailed insights into algorithms for conformance checking, including the most commonly used formal notions and their instantiation for specific analysis questions. Lastly, Part III highlights applications that help to make sense of conformance checking results, thereby providing a necessary next step to increase the value of a given process model. They help to interpret the outcomes of conformance checking and incorporate them by means of enhancement and repair techniques. Providing the core building blocks of conformance checking and describing its main applications, this book mainly addresses students specializing in business process management, researchers entering process mining and conformance checking for the first time, and advanced professionals whose work involves process evaluation, modelling and optimization.

Healthcare Pathway Discovery, Conformance, and Enrichment This is the second edition of Wil van der Aalst’s seminal book on process mining, which now discusses the field also in the broader context of data science and big data approaches. It includes several additions and updates, e.g. on inductive mining techniques, the notion of alignments, a considerably
expanded section on software tools and a completely new chapter of process mining in the large. It is self-contained, while at the same time covering the entire process-mining spectrum from process discovery to predictive analytics. After a general introduction to data science and process mining in Part I, Part II provides the basics of business process modeling and data mining necessary to understand the remainder of the book. Next, Part III focuses on process discovery as the most important process mining task, while Part IV moves beyond discovering the control flow of processes, highlighting conformance checking, and organizational and time perspectives. Part V offers a guide to successfully applying process mining in practice, including an introduction to the widely used open-source tool ProM and several commercial products. Lastly, Part VI takes a step back, reflecting on the material presented and the key open challenges. Overall, this book provides a comprehensive overview of the state of the art in process mining. It is intended for business process analysts, business consultants, process managers, graduate students, and BPM researchers.

Process Mining Using Convex Polytopes Traditional data mining techniques have been extensively applied to find interesting patterns, build descriptive and predictive models from large volumes of data accumulated through the use of different information systems. The results of data mining can be used for getting a better understanding of the underlying educational processes, for generating recommendations and advice to students, for improving management of learning objects, etc. However, most of the traditional data mining techniques focus on data dependencies or simple patterns and do not provide a visual representation of the complete educational (assessment) process ready to be analyzed. To allow for these types of analysis (in which the process plays the central role), a new line of data-mining research, called "process mining", has been initiated. Process mining focuses on the development of a set of intelligent tools and techniques aimed at extracting process-related knowledge from event logs recorded by an information system. In this paper we demonstrate the applicability of process mining, and the ProM framework in particular, to educational data mining context. We analyze assessment data from recently organized online multiple choice tests and demonstrate the use of process discovery, conformance checking and performance
analysis techniques. (Contains 6 figures and 4 footnotes.) [Funding was provided by the Dutch Science Foundation (NWO). For the complete proceedings, "Proceedings of the International Conference on Educational Data Mining (EDM) (2nd, Cordoba, Spain, July 1-3, 2009)," see ED539041.].

2019 International Conference on Process Mining (ICPM) This book constitutes the refereed proceedings of the 22nd International Conference on Concurrency Theory, CONCUR 2011, held in Aachen, Germany, September 5-10, 2011. The 32 revised full papers were carefully reviewed and selected from 94 submissions. The papers are organized in topics such as real-time systems, probabilistic systems, automata, separation logic, \(\mu\)-calculus, Petri nets, process algebra and modeling, verification, games, and bisimulation.

Fundamental Approaches to Software Engineering This book constitutes the proceedings of the First Asia Pacific Conference on Business Process Management held in Beijing, China, in August 2013. In all, 19 contributions from seven countries were submitted. Following an extensive review process by an international Program Committee, seven full papers and one short paper were accepted for publication in this book and presentation at the conference. In addition, a keynote by Wil van der Aalst is also included.

Asia Pacific Business Process Management This book analyses state-of-the-art techniques in business process management as drivers of advanced entrepreneurship, financial management, supply chain management, and sustainability management. The role of management in a rapidly-changing environment and the use of innovative methods and techniques to address and solve key management problems are also explored.

Process Mining More and more information about business processes is recorded by information systems in the form of so-called “event logs”. Despite the omnipresence of such data, most organizations diagnose problems based on fiction rather than facts. Process mining is an emerging discipline based on process model-driven approaches and data mining. It not only
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allows organizations to fully benefit from the information stored in their systems, but it can also be used to check the conformance of processes, detect bottlenecks, and predict execution problems. Wil van der Aalst delivers the first book on process mining. It aims to be self-contained while covering the entire process mining spectrum from process discovery to operational support. In Part I, the author provides the basics of business process modeling and data mining necessary to understand the remainder of the book. Part II focuses on process discovery as the most important process mining task. Part III moves beyond discovering the control flow of processes and highlights conformance checking, and organizational and time perspectives. Part IV guides the reader in successfully applying process mining in practice, including an introduction to the widely used open-source tool ProM. Finally, Part V takes a step back, reflecting on the material presented and the key open challenges. Overall, this book provides a comprehensive overview of the state of the art in process mining. It is intended for business process analysts, business consultants, process managers, graduate students, and BPM researchers.

Interactive Process Mining in Healthcare The field of Business Process Management (BPM) is marred by a seemingly endless sequence of (proposed) industry standards. Contrary to other fields (e.g., civil or electronic engineering), these standards are not the result of a widely supported consolidation of well-understood and well-established concepts and practices. In the BPM domain, it is frequently the case that BPM vendors opportunistically become involved in the creation of proposed standards to exert or maintain their influence and interests in the field. Despite the initial fervor associated with such standardization activities, it is no less frequent that vendors either choose to drop their support for standards that they earlier championed on an opportunistic basis or elect only to partially support them in their commercial offerings. Moreover, the results of the standardization processes themselves are a concern. BPM standards tend to deal with complex concepts, yet they are never properly defined and all-too-often not informed by established research. The result is a plethora of languages and tools, with no consensus on concepts and their implementation. They also fail to provide clear direction in the way in which BPM standards should evolve. One can also observe
a dichotomy between the “business” side of BPM and its “technical” side. While it is clear that the application of BPM will fail if not placed in a proper business context, it is equally clear that its application will go nowhere if it remains merely a motivational exercise with schemas of business processes hanging on the wall gathering dust.

Conformance Checking and Diagnosis in Process Mining This book discusses the impact of information and communication technologies (ICTs) on organizations and on society as a whole. Specifically, it examines how such technologies improve our life and work, making them more inclusive through smart enterprises. The book focuses on how actors understand Industry 4.0 as well as the potential of ICTs to support organizational and societal activities, and how they adopt and adapt these technologies to achieve their goals. Gathering papers from various areas of organizational strategy, such as new business models, competitive strategies and knowledge management, the book covers a number of topics, including how innovative technologies improve the life of the individuals, organizations, and societies; how social media can drive fundamental business changes, as their innovative nature allows for interactive communication between customers and businesses; and how developing countries can use these technologies in an innovative way. It also explores the impact of organizations on society through sustainable development and social responsibility, and how ICTs use social media networks in the process of value co-creation, addressing these issues from both private and public sector perspectives and on national and international levels, mainly in the context of technology innovations.

E-Commerce and Web Technologies Transactions on Petri Nets and Other Models of Concurrency (ToPNoC) II These Transactions publish archival papers in the broad area of Petri nets and other models of concurrency, ranging from theoretical work to tool support and industrial applications. ToPNoC issues are published as LNCS volumes, and hence are widely distributed and indexed. This Journal has its own Editorial Board which selects papers based on a rigorous two-stage refereeing process. ToPNoC contains: - Revised versions of a selection of the best papers from workshops and tutorials at the annual Petri net conferences - Special
sections/issues within particular subareas (similar to those published in the Advances in Petri Nets series) - Other papers invited for publication in ToPNoC - Papers submitted directly to ToPNoC by their authors The second volume of ToPNoC focuses on Concurrency in Process-Aware Information Systems. Although the topic of business process management using information technology has been addressed by consultants and software developers in depth, more fundamental approaches towards such Process-Aware Information Systems (PAISs) have been rather uncommon. It wasn't until the 1990s that researchers started to work on the foundations of PAISs. Clearly, concurrency theory is an essential ingredient in these foundations as business processes are highly concurrent involving all types of routing logic and resource allocation mechanisms. The 16 papers in this special issue of ToPNoC cover topics ranging from the formal (mostly Petri-net based) foundations of PAISs to more applied topics such as flexibility and process mining. Thus, this volume gives a good overview of the state of the art in PAIS research.

Intellectual Capital, Smart Technologies and Digitalization A unifying foundation to design and implement process-aware information systems This publication takes on the formidable task of establishing a unifying foundation and set of common underlying principles to effectively model, design, and implement process-aware information systems. Authored by leading authorities and pioneers in the field, Process-Aware Information Systems helps readers gain a thorough understanding of major concepts, languages, and techniques for building process-aware applications, including: * UML and EPCs: two of the most widely used notations for business process modeling * Concrete techniques for process design and analysis * Process execution standards: WfMC and BPEL * Representative commercial tools: ARIS, TIBCO Staffware, and FLOWer Each chapter begins with a description of the problem domain and then progressively unveils relevant concepts and techniques. Examples and illustrations are used extensively to clarify and simplify complex material. Each chapter ends with a set of exercises, ranging from simple questions to thought-provoking assignments. Sample solutions for many of the exercises are available on the companion Web site. Armed with a new and deeper understanding, readers are better positioned to make their own contributions to the field and evaluate various
approaches to a particular task or problem. This publication is recommended as a textbook for graduate and advanced undergraduate students in computer science and information systems, as well as for professionals involved in workflow and business process management, groupware and teamwork, enterprise application integration, and business-to-business integration. A Solution's Manual is available online. An Instructor Support FTP site is also available.

On the Move to Meaningful Internet Systems This book contains the refereed proceedings of the 14th International Conference on Business Process Modeling, Development and Support (BPMDS 2013) and the 18th International Conference on Exploring Modeling Methods for Systems Analysis and Design (EMMSAD 2013), held together with the 25th International Conference on Advanced Information Systems Engineering (CAiSE 2013) in Valencia, Spain, in June 2013. The 15 full papers, two experience reports, and three idea papers accepted for BPMDS were selected from 54 submissions and cover a wide spectrum of issues related to business process development, modeling, and support. They are grouped into sections on innovative representations for knowledge-intensive processes; business process management in practice; analysis of business process models; model-based business process analysis; flexible business process management; improvement and change patterns; and process model repositories. The 10 full and 2 short papers accepted for EMMSAD were chosen from 27 submissions and focus on exploring, evaluating, and enhancing current information modeling methods and methodologies. They are grouped in sections on advanced modeling; capturing design knowledge; method engineering; modeling process; specialized modeling; and modeling experiences.

Enterprise, Business-Process and Information Systems Modeling More and more information about business processes is recorded by information systems in the form of so-called “event logs”. Despite the omnipresence of such data, most organizations diagnose problems based on fiction rather than facts. Process mining is an emerging discipline based on process model-driven approaches and data mining. It not only allows organizations to fully benefit from the information stored in their systems, but it can also be used to check the conformance of processes, detect bottlenecks, and predict execution problems. Wil van der Aalst delivers the
first book on process mining. It aims to be self-contained while covering the entire process mining spectrum from process discovery to operational support. In Part I, the author provides the basics of business process modeling and data mining necessary to understand the remainder of the book. Part II focuses on process discovery as the most important process mining task. Part III moves beyond discovering the control flow of processes and highlights conformance checking, and organizational and time perspectives. Part IV guides the reader in successfully applying process mining in practice, including an introduction to the widely used open-source tool ProM. Finally, Part V takes a step back, reflecting on the material presented and the key open challenges. Overall, this book provides a comprehensive overview of the state of the art in process mining. It is intended for business process analysts, business consultants, process managers, graduate students, and BPM researchers.

Fundamental Approaches to Software Engineering

Modern Business Process Automation This book constitutes the refereed proceedings of the 12th International Conference on Electronic Commerce and Web Technologies (EC-Web) held in Toulouse, France, in August/September 2011. The 25 papers accepted for EC-Web, selected from 60 submissions, are organized into eight topical sections on semantic services, business processes and services, context-aware recommender systems, intelligent agents and e-negotiation systems, collaborative filtering and preference learning, social recommender systems, agent interaction and trust management, and innovative strategies for preference elicitation and profiling.

Process Mining Techniques in Business Environments This book constitues the thoroughly refereed proceedings of the Second International Symposium on Data-Driven Process Discovery and Analysis held in Campione d'Italia, Italy, in June 2012. The six revised full papers were carefully selected from 17 submissions. To improve the quality of the contributions the symposium fostered the discussion during the presentation, giving authors the opportunity to improve their work extending the presented results. The selected papers cover topics spanning
from theoretical issues related to process representation, discovery and analysis to practical and operational experiences in process discovery and analysis.

Modeling Business Processes This book describes process mining use cases and business impact along the value chain, from corporate to local applications, representing the state of the art in domain know-how. Providing a set of industrial case studies and best practices, it complements academic publications on the topic. Further the book reveals the challenges and failures in order to offer readers practical insights and guidance on how to avoid the pitfalls and ensure successful operational deployment. The book is divided into three parts: Part I provides an introduction to the topic from fundamental principles to key success factors, and an overview of operational use cases. As a holistic description of process mining in a business environment, this part is particularly useful for readers not yet familiar with the topic. Part II presents detailed use cases written by contributors from a variety of functions and industries. Lastly, Part III provides a brief overview of the future of process mining, both from academic and operational perspectives. Based on a solid academic foundation, process mining has received increasing interest from operational businesses, with many companies already reaping the benefits. As the first book to present an overview of successful industrial applications, it is of particular interest to professionals who want to learn more about the possibilities and opportunities this new technology offers. It is also a valuable resource for researchers looking for empirical results when considering requirements for enhancements and further developments.

Business Intelligence This book constitutes the thoroughly refereed proceedings of the First International Symposium on Data-Driven Process Discovery and Analysis held in Campione d'Italia, Italy, in June/July 2011. The 11 revised full papers were carefully selected from 31 submissions. In addition to the thorough review process, the lively discussions at the event itself also helped the authors to improve their papers and to foster interesting extensions. The selected papers cover a wide range of topics spanning from theoretical issues related to process representation to practical experience in process discovery and analysis.
CONCUR 2011 -- Concurrency Theory As the age of Big Data emerges, it becomes necessary to take the five dimensions of Big Data—volume, variety, velocity, volatility, and veracity—and focus these dimensions towards one critical emphasis—value. The Encyclopedia of Business Analytics and Optimization confronts the challenges of information retrieval in the age of Big Data by exploring recent advances in the areas of knowledge management, data visualization, interdisciplinary communication, and others. Through its critical approach and practical application, this book will be a must-have reference for any professional, leader, analyst, or manager interested in making the most of the knowledge resources at their disposal.

BPM - Driving Innovation in a Digital World This book constitutes the proceedings of the Second Asia Pacific Conference on Business Process Management held in Brisbane, QLD, Australia, in July 2014. In all, 33 contributions from 12 countries were submitted. After each submission was reviewed by at least three Program Committee members, nine full papers were accepted for publication in this volume. These nine papers cover various topics that can be categorized under four main research focuses in BPM: process mining, process modeling and repositories, process model comparison, and process analysis.

Process-Aware Information Systems To large organizations, business intelligence (BI) promises the capability of collecting and analyzing internal and external data to generate knowledge and value, thus providing decision support at the strategic, tactical, and operational levels. BI is now impacted by the “Big Data” phenomena and the evolution of society and users. In particular, BI applications must cope with additional heterogeneous (often Web-based) sources, e.g., from social networks, blogs, competitors', suppliers', or distributors' data, governmental or NGO-based analysis and papers, or from research publications. In addition, they must be able to provide their results also on mobile devices, taking into account location-based or time-based environmental data. The lectures held at the Third European Business Intelligence Summer School (eBISS), which are presented here in an extended and refined format, cover not only established BI and BPM technologies, but extend into
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innovative aspects that are important in this new environment and for novel applications, e.g., pattern and process mining, business semantics, Linked Open Data, and large-scale data management and analysis. Combining papers by leading researchers in the field, this volume equips the reader with the state-of-the-art background necessary for creating the future of BI. It also provides the reader with an excellent basis and many pointers for further research in this growing field.


Encyclopedia of Business Analytics and Optimization This book shows how business process management (BPM), as a management discipline at the intersection of IT and Business, can help organizations to master digital innovations and transformations. At the same time, it discusses how BPM needs to be further developed to successfully act as a driver for innovation in a digital world. In recent decades, BPM has proven extremely successful in managing both continuous and radical improvements in many sectors and business areas. While
the digital age brings tremendous new opportunities, it also brings the specific challenge of correctly positioning and scoping BPM in organizations. This book shows how to leverage BPM to drive business innovation in the digital age. It brings together the views of the world’s leading experts on BPM and also presents a number of practical cases. It addresses managers as well as academics who share an interest in digital innovation and business process management. The book covers topics such as BPM and big data, BPM and the Internet of Things, and BPM and social media. While these technological and methodological aspects are key to BPM, process experts are also aware that further nontechnical organizational capabilities are required for successful innovation. The ideas presented in this book have helped us a lot while implementing process innovations in our global Logistics Service Center. Joachim Gantner, Director IT Services, Swarovski AG Managing Processes – everyone talks about it, very few really know how to make it work in today’s agile and competitive world. It is good to see so many leading experts taking on the challenge in this book. Cornelius Clauser, Chief Process Officer, SAP SE This book provides worthwhile readings on new developments in advanced process analytics and process modelling including practical applications – food for thought how to succeed in the digital age. Ralf Diekmann, Head of Business Excellence, Hilti AG This book is as an important step towards process innovation systems. I very much like to congratulate the editors and authors for presenting such an impressive scope of ideas for how to address the challenging, but very rewarding marriage of BPM and innovation. Professor Michael Rosemann, Queensland University of Technology


Process Mining in Action

Process Mining A comprehensive guide to well-known workflow patterns: recurrent, generic business process constructs, described from the control-flow, data, and resource perspectives. The study of business processes has emerged as a highly effective approach to coordinating an organization's complex service- and knowledge-based activities. The growing field of business process management (BPM) focuses on methods and tools for designing, enacting, and analyzing business processes. This volume offers a definitive guide to the use of patterns, which synthesize the wide range of approaches to modeling business processes. It provides a unique and comprehensive introduction to the well-known workflow patterns collection—recurrent, generic constructs describing common business process modeling and execution scenarios, presented in the form of problem-solution dialectics. The underlying principles of the patterns approach ensure that they are independent of any specific enabling technology, representational formalism, or modeling approach, and thus broadly applicable across the business process modeling and business process technology domains. The authors, drawing on extensive research done by the Workflow Patterns Initiative, offer a detailed introduction to the fundamentals of business process modeling and management; describe three major pattern catalogs, presented from control-flow, data, and resource perspectives; and survey related BPM patterns. The book, a companion to the authoritative Workflow Patterns
Process Mining Online Assessment Data This book contains the refereed proceedings of the 18th International Conference on Business Information Systems, BIS 2015, held in Poznań, Poland, in June 2015. The BIS conference series follows trends in academic and business research; thus, the theme of the BIS 2015 conference was “Making Big Data Smarter.” Big data is now a fairly mature concept, recognized and widely used by professionals in both research and industry. Together, they work on developing more adequate and efficient tools for data processing and analyzing, thus turning "big data" into "smart data." The 26 revised full papers were carefully reviewed and selected from 70 submissions. In addition, two invited papers are included in this book. They are grouped into sections on big and smart data, semantic technologies, content retrieval and filtering, business process management and mining, collaboration, enterprise architecture and business-IT alignment, specific BIS applications, and open data for BIS.

Asia Pacific Business Process Management Process mining is an innovative research field which focuses on extracting business process insights from transactional data commonly recorded by IT systems, with the ultimate goal of analyzing and improving organizational productivity along performance dimensions such as efficiency, quality, compliance and risk. By relying on data rather than perceptions gained from interviews and workshops, process mining shifts the way of thinking from confidence based to evidence-based business process management. Thus, process mining distinguishes itself within the information systems domain by its fundamental, evidence-based focus on understanding, analyzing, and improving business processes.

Conformance Checking Process mining techniques can be used to discover, analyze and improve real processes, by extracting models from observed behavior. The aim of this book is conformance checking, one of the main areas of process mining. In conformance checking, existing process models are compared with actual observations of the process in order to
assess their quality. Conformance checking techniques are a way to visualize the differences between assumed process represented in the model and the real process in the event log, pinpointing possible problems to address, and the business process management results that rely on these models. This book combines both application and research perspectives. It provides concrete use cases that illustrate the problems addressed by the techniques in the book, but at the same time, it contains complete conceptualization and formalization of the problem and the techniques, and through evaluations on the quality and the performance of the proposed techniques. Hence, this book brings the opportunity for business analysts willing to improve their organization processes, and also data scientists interested on the topic of process-oriented data science.

Data-Driven Process Discovery and Analysis Healthcare pathways define the execution sequence of clinical activities as patients move through a treatment process, and they are critical for maintaining quality of care and improving health outcome for all patients. Past studies show that there is potential for informative healthcare pathways to be extracted from hospital health records, but there is currently no consensus on a systematic healthcare pathway mining method that supports explicit design and conformance analysis of concise and comprehensible healthcare pathway models. This study investigates the utilization of business process modelling methods to design a process mining pipeline for healthcare pathway discovery, conformance analysis and enrichment using hospital records. The process mining pipeline is designed with emphasis on producing pathway models that are concise and easy to interpret for clinicians without a sufficient background in process mining. The proposed process mining pipeline is applied to an appendicitis and cholecystitis case study as an example of a simple pathway, and an ambulatory cardiac care case study as an example of a complex pathway. Results from the two case studies indicate that the proposed pipeline designed with business process mining tools is effective for healthcare pathways of different levels of complexity. The produced healthcare pathway models are easy for clinical interpretation and provide an unbiased overview of real patient movements through the treatment process. Preliminary analysis on building machine learning models to predict post-
operation length of stay in hospital, using information extracted by the process mining pipeline, is showing promising results. This means that the proposed mining pipeline also has the potential to support the development of machine learning models to further relate healthcare pathways to performance indicators such as readmission rates and mortality rates. This study establishes the use of business process modelling methods for the improvement of healthcare pathway mining methods, and there is value in investigating the capabilities of other business process mining tools for healthcare pathway mining purposes.

ICT for an Inclusive World This book constitutes the refereed proceedings of the 15th International Conference on Fundamental Approaches to Software Engineering, FASE 2012, held in Tallinn, Estonia, in March/April 2012, as part of ETAPS 2012, the European Joint Conferences on Theory and Practice of Software. The 33 full papers presented together with one full length invited talk were carefully reviewed and selected from 134 submissions. The papers are organized in topical sections on software architecture and components, services, verification and monitoring, intermodelling and model transformations, modelling and adaptation, product lines and feature-oriented programming, development process, verification and synthesis, testing and maintenance, and slicing and refactoring.

Robust Process Mining with Guarantees Process Mining is a relatively young field of study that highlights the difficulty to infer models of processes from which to extract enough information to make predictions about its behaviour, find bottlenecks and causality relationships so as to be able to answer as many questions as one can make about them. In this context, a process may be understood as any activity performed by humans or computers or the result between the interaction of the two. Research on this topic has provided many different solutions focused on "process discovery", "conformance checking" and "model extension" and some of them led to the development of commercial software. However, most of the solutions research on "process discovery" has provided are not suitable to handle industrial cases. In this document we present a new approach to do Process Mining focusing on "process discovery": using convex polytopes.
Process Mining in Healthcare What are the possibilities for process mining in hospitals? In this book the authors provide an answer to this question by presenting a healthcare reference model that outlines all the different classes of data that are potentially available for process mining in healthcare and the relationships between them. Subsequently, based on this reference model, they explain the application opportunities for process mining in this domain and discuss the various kinds of analyses that can be performed. They focus on organizational healthcare processes rather than medical treatment processes. The combination of event data and process mining techniques allows them to analyze the operational processes within a hospital based on facts, thus providing a solid basis for managing and improving processes within hospitals. To this end, they also explicitly elaborate on data quality issues that are relevant for the data aspects of the healthcare reference model. This book mainly targets advanced professionals involved in areas related to business process management, business intelligence, data mining, and business process redesign for healthcare systems as well as graduate students specializing in healthcare information systems and process analysis.

Workflow Patterns After a brief presentation of the state of the art of process-mining techniques, Andrea Burratin proposes different scenarios for the deployment of process-mining projects, and in particular a characterization of companies in terms of their process awareness. The approaches proposed in this book belong to two different computational paradigms: first to classic "batch process mining," and second to more recent "online process mining." The book encompasses a revised version of the author's PhD thesis, which won the "Best Process Mining Dissertation Award" in 2014, awarded by the IEEE Task Force on Process Mining.

Data-Driven Process Discovery and Analysis This book provides a practically applicable guide to the methodologies and technologies for the application of interactive process mining paradigm. Case studies are presented where this paradigm has been successfully applied in emergency medicine, surgery processes, human behavior modelling, strokes and outpatients' services, enabling the reader to develop a deep understanding of how to apply process mining...
technologies in healthcare to support them in inferring new knowledge from past actions, and providing accurate and personalized knowledge to improve their future clinical decision-making. Interactive Process Mining in Healthcare comprehensively covers how machine learning algorithms can be utilized to create real scientific evidence to improve daily healthcare protocols, and is a valuable resource for a variety of health professionals seeking to develop new methods to improve their clinical decision-making.

Innovation in Sustainable Management and Entrepreneurship This book constitutes the refereed proceedings of the 4th International Conference on Fundamental Approaches to Software Engineering, FASE 2001, held in Genova, Italy in April 2001. The 22 revised full papers presented were carefully reviewed and selected from a total of 74 submissions. The papers are organized in topical sections on metamodeling, distributed components, UML, testing, formal methods, and case studies.

Business Information Systems This book presents techniques for process discovery, conformance checking and enhancement. For process discovery, it introduces the Inductive Miner framework: a recursive skeleton for discovery techniques that in itself provides several guarantees. The framework is instantiated in several concrete discovery techniques, each of which targets a specific challenge of process discovery, such as incompleteness of information or noisy behavior. For conformance checking, it introduces the Projected Conformance Checking framework, which focuses on speed, but nevertheless provides several guarantees, such as that for certain classes of models, it can decide language equivalence. For enhancement, it introduces the Inductive visual Miner, a well-polished end-user focused tool that includes process discovery, conformance checking and that can visualize performance on a discovered model, all without any user input.

Transactions on Petri Nets and Other Models of Concurrency II An introduction to the modeling of business information systems, with processes formally modeled using Petri nets. This comprehensive introduction to modeling business-information systems focuses on business
processes. It describes and demonstrates the formal modeling of processes in terms of Petri nets, using a well-established theory for capturing and analyzing models with concurrency. The precise semantics of this formal method offers a distinct advantage for modeling processes over the industrial modeling languages found in other books on the subject. Moreover, the simplicity and expressiveness of the Petri nets concept make it an ideal language for explaining foundational concepts and constructing exercises. After an overview of business information systems, the book introduces the modeling of processes in terms of classical Petri nets. This is then extended with data, time, and hierarchy to model all aspects of a process. Finally, the book explores analysis of Petri net models to detect design flaws and errors in the design process. The text, accessible to a broad audience of professionals and students, keeps technicalities to a minimum and offers numerous examples to illustrate the concepts covered. Exercises at different levels of difficulty make the book ideal for independent study or classroom use.

Business Process Management This book constitutes the proceedings of the 10th International Conference on Business Process Management, BPM 2012, held in Tallinn, Estonia, in September 2012. The 17 regular papers and 7 short papers included in this volume were carefully reviewed and selected from 126 submissions. The book also features two keynote lectures which were given at the conference. The papers are organized in topical sections named: process quality; conformance and compliance; BPM applications; process model analysis; BPM and the cloud; requirements and performance; process mining; and refactoring and optimization.