Grußworte

Liebe Fachgruppenmitglieder,


1) Bereits veröffentlichte Beiträge, die im Rahmen des Fachgruppentreffens vorgestellt werden. Hier waren die Originalartikel und Konferenzpapiere einzureichen.

2) Beiträge von jungen Forschern, die noch dabei sind, ihr Forschungsthema zu entwickeln. Hier war ein Forschungsproposal einzureichen.

Für beide Typen von Einreichungen wurden zudem Kurzbeiträge von 4 Seiten im LNI-Format gesammelt. Alle diese Beiträge sind elektronisch bei CEUR publiziert und zusätzlich im diesem Heft des EMISA Forums abgedruckt. Ergänzend zum Programm des Fachgruppentreffens sind wir stolz, dass wir Keynote-Vorträge von Prof. Dr. Hajo A. Reijers (VU Amsterdam) und Prof. Dr. Jan vom Brocke (Uni Liechtenstein) im Programm hatten.

Für das kommende Jahr können Sie bereits die Woche vom 12. Juni 2017 vormerken. Dann wird das EMISA-Fachgruppentreffen am Rande der CAISE Conference in Essen stattfinden. Wir freuen uns, dass Michael Fellmann und Matthias Weidlich die Leitung übernehmen werden!

Wir hoffen, dass Sie gleichermaßen viel Freude an dieser neuen Ausgabe des EMISA FORUMs als auch am neuen Format des Fachgruppentreffens haben!

Mit herzlichen Grüßen,

Jan Mendling
(EMISA-Sprecher)
10 Principles of Good Business Process Management

Abstract: Will Business Process Management still be present in five years time? Many organizations have been disappointed with the results BPM projects have delivered. New concepts are already on the horizon, such as business innovation, business transformation, and alike. Will these concepts replace BPM? This would be massive loss, considering the 20 to 30 years of research and practice in the field. Are we starting over again learning the foundations of new concepts even though these concepts also strongly relate to processes? Business process management has established as a matured discipline. It provides well-proven methods that build the core to master contemporary and future challenges in management. However, BPM has to develop, and it is often reduced to originating areas such as process modeling and workflow management systems. We believe that BPM failure is largely founded in the fact that the view on BPM is too limited and that essential principles of good process management are not considered. We therefore set out identifying principles of good BPM. We suggest that following basic principles, BPM is more likely to be successful. Considering these principles, BPM can provide a solid set of capabilities essential to master contemporary and future challenges, including business innovation and transformation as mentioned above. For academia, these principles are essential to further shape BPM as an academic discipline and to prove its value for economy and society.

Bio: Jan vom Brocke is head of the BPM group in Liechtenstein. He is Professor of Information Systems, the Hilti Endowed Chair of Business Process Management, Director of the Institute of Information Systems, Founder and Co-Director of the International Master Program in IT and Business Process Management, Director of the PhD Program in Information and Process Management, and Vice President Research and Innovation at the University of Liechtenstein. Jan has conducted over 300 studies in the area of IT and BPM, published in renowned outlets, including MIS Quarterly (MISQ), the Journal of Management Information Systems (JMIS), the European Journal of Information Systems (EJIS), Information Systems Journal (ISJ), and the Business Process Management Journal (BPMJ). He has authored and edited 29 books, including the International Handbook on Business Process Management, BPM: Driving Innovation in a Digital World and Green BPM: Towards the Sustainable Enterprise. Jan is an invited speaker and trusted advisor on BPM serving many organizations around the world. See Jan’s website for more information: www.janvombrocke.com
Keynote 2

Hajo A. Reijers (VU Amsterdam)

Measuring the Organizational Impact of IT Innovations

Abstract: The rate at which new IT solutions appear is unprecedented. Still, while they may be impressive from a technological perspective, it is often less clear what their bottom-line contribution is to the improvement of organizational performance. In this research keynote, I will explain an entirely new method to approach this issue and actually measure the impact. This method embraces simulation as a technique to neutralize the effects of developments that take place in parallel to the introduction of a new IT solution within a certain organizational context. I will illustrate how this method works through a study on workflow management systems, which was carried out for a period of over a decade. The illustration also shows the importance of additional, follow-up analyses that are more qualitative in nature. The talk should be of interest to any researcher who is concerned with demonstrating the value of organization-wide IT innovations.

Bio: Hajo Reijers is a full-time professor in Business Informatics at the Vrije Universiteit Amsterdam. He also holds a part-time, full professorship in Business Process Technologies at the Technische Universiteit Eindhoven and teaches at the TIAS Business School in the Operational Excellence program. He is interested in both the organizational and technological sides of BPM topics, such as process modeling, workflow technology, process mining, and BPR. On these topics, he published over 150 scientific papers, chapters in edited books, and articles in professional journals. More information can be found on www.reijers.com. Hajo Reijers can be followed as @profBPM on Twitter.
Impressionen von der EMISA 2016
Call for Contributions

8th International Workshop on
Enterprise Modelling and Information Systems Architectures (EMISA’17)
co-located with the 29th International Conference on Advanced Information Systems Engineering (CAiSE)
June 12-13, 2017 — Essen, Germany
https://hu.berlin/emisa17

Objectives

The strategic importance of enterprise modelling has been recognized by an increasing number of companies and public agencies. Enterprise modelling delivers the ‘blueprints’ for co-designing and aligning business and enterprise information systems such that they complement each other in an optimal way. As example consider the support of business processes by process-aware information systems. Achieving such interplay requires a multi-perspective approach taking organizational, economic, and technical aspects into account. In a world of cloud, social and big data, additional challenges for enterprise modelling and the design of information systems architectures are introduced, e.g., in respect to the design of data-driven processes or processes enabling cross-enterprise collaboration. To deal with these challenges, a close cooperation of researchers from different disciplines such as information systems, business informatics, and computer science will be required.

EMISA 2017 is the eighth international workshop in a series that provides a key forum for researchers and practitioners in the fields of enterprise modelling and the design of information systems architectures. The workshop series emphasizes a holistic view on these fields, fostering integrated approaches that address and relate business processes, business people and information technology. The workshop is open for a broad range of subjects. Possible topics include, but are not limited to:

- Enterprise modelling: languages, methods, tools
- Patterns for enterprise modelling
- Patterns for information systems architectures
- Model life cycle management
- Model evolution
- Model configuration and model variants
- Model quality: metrics, case studies, and experiments
- Process modelling and process-aware information systems
- Collaborative enterprise modelling
- Model-driven architectures
- Model-driven IS development
- Component- and service-oriented software architectures
- Service engineering and evolution
- Service composition, orchestration and choreography
- Complex event processing and event-driven architectures
- Human aspects in enterprise modelling
- Modelling social information and innovation networks
- Information systems in the cloud
- Mobile enterprise services
**Submissions**

EMISA 2017 calls for submissions in the following categories:

1) **PhD Research Proposals:** EMISA 2017 invites PhD students to submit research proposals. There will be a dedicated slot in the program to discuss PhD research proposals including the current status and the further plan of the research work. PhD research proposals shall be submitted as a short paper of 5 pages.

2) **Current Research Talk Proposals:** EMISA 2017 invites proposals for scientific talks of international excellence. Eligible are proposal submissions that are based on published or accepted papers from international conferences or journals. Proposals for research talks shall be submitted as an extended abstract of 2 pages.

3) **Novel Directions Talk Proposals:** EMISA 2017 invites proposals for talks that motivate a novel research direction, outline the research gaps to address, and carve out major challenges. These talks shall serve as a stimulus for discussions as part of a dedicated slot in the workshop program. Novel directions talk proposals shall be submitted as a short paper of 5 pages.

Proposals can be submitted according to instructions on the EMISA 2017 website: https://hu.berlin/emisa17

All submissions have to strictly follow the formatting guidelines of LNI. Template and explanations can be found at https://www.gi.de/service/publikationen/LNI/autorenrichtlinien.html. Submissions have to be made via easychair.org.

All accepted submissions (PhD Research, Current Research, Novel Directions) will be published in the next print edition of EMISA Forum. The short papers proposing PhD Research or a Novel Directions Talk will also be published as an electronic CEUR proceedings volume.

**Organization**

The workshop is organized by the GI Special Interest Group on Design Methods for Information Systems (GI-SIG EMISA, www.emisa.org), which provides a forum for researchers from various disciplines who develop and apply methods to support the analysis and design of information systems. EMISA 2017 will take place in Essen, Germany, co-located with the 29th International Conference on Advanced Information Systems Engineering (CAiSE).

**Important Dates**

Submission of proposals: March 24, 2017
Notification of acceptance: April 15, 2017
Final paper version: May 1, 2017

**Program Committee Co-Chairs**

Michael Fellmann, Universität Rostock, Germany
Matthias Weidlich, Humboldt-Universität zu Berlin, Germany
Call for Papers

ZEUS focuses on the discussion of fresh ideas, the presentation of work in progress, and the establishment of a scientific network between young researchers in the region.

Important Dates

Submission: January 6, 2017
Notification: January 27, 2017
Camera ready (pre-proceedings) version: February 5, 2017
Registration: February 5, 2017
Workshop: February 13-14, 2017
Post-workshop proceedings version: March 14, 2017

Topics

The topics of the ZEUS workshop are centered around service composition and related technologies, techniques and tools. Contributions focused on the analysis or synthesis of all kinds of services are as welcome as practical evaluations, use case-driven feasibility studies, or technology adoption models. ZEUS also calls for contributions in the field of Cloud computing, RESTful services, and microservices.

Topics include, but are not limited to:

• Service lifecycle: analysis, specification, modelling, testing, deployment, execution, monitoring, adaptation
• Patterns, languages, reference models, and model extensions
• Multi-view and multi-perspective engineering (SOA, choreographies, collaborations, conversations, artifact-centric systems)
• Formal methods, models, simulation, and verification
• System architectures for service composition
• RESTful Web services (design aspects, hypermedia, linked data, mashups, conversations)
• Microservices and Nanoservices (architecture, lifecycle, deployment, composition)
• Workflows and business processes
• Complex event processing (correlation, aggregation, transformation, monitoring, extraction)
• Security, compliance, and non-functional requirements and properties
• Cloud-enabled applications, migration to/from the Cloud, Cloud Integration
• Composable Big Data Analytics Pipelines
• Applications, frameworks, methods, tool demonstrations, and case studies
Submission

All papers must be submitted following the instructions at the ZEUS 2017 submission site, handled by EasyChair.

Results can be presented in talks or tool demonstrations. Submissions will be reviewed by at least three reviewers each in order to assure general fitness regarding content, readability and scope and to give first feedback to the authors. Depending on innovation, technical soundness and presentation clarity, papers may be rejected or accepted as position, workshop or tool demonstration papers.

Workshop papers

Workshop papers are regular contributions that describe original solutions in field of ZEUS. These papers must not exceed 6 pages (LNCS style). Workshop papers are reviewed according to the Call for Papers. Accepted papers shall be included in the proceedings and presented at the workshop.

Positions papers

Position papers should draft a new idea and put it up for discussion at the workshop. Position papers should only be an extended abstract and must not exceed 3 pages (LNCS style). Position papers are briefly reviewed according to the Call for Papers. The main idea and the relation to existing work should be contained. Accepted papers shall be included in the proceedings.

Position papers have been introduced based on the experiences gained from the last editions of the workshop. They allow authors to get early feedback during the workshop, but should not disallow extending the paper to a full paper submitted to a first class conference – even if the position paper is referenced and the delta is explained properly.

Tool demonstrations

ZEUS also offers a forum to demonstrate implementations of techniques and algorithms in the area of the aforementioned topics to get early feedback and provide interesting insights for the audience. Tool demonstrators are asked to submit a demo script of no more than 3 pages (LNCS style) which states how the tool is linked to the Call for Papers and what to expect during the demonstration.

The ZEUS workshop series is indexed in DBLP.

Organization

The workshop is hosted by the Architecture, Design and Web Information Systems Engineering group at the USI Faculty of Informatics in Lugano, Switzerland

Local Organizers

The organization of the workshop on site is coordinated by:
Cesare Pautasso, USI Lugano, Switzerland

You can reach the local organizers:

**Prof. Dr. Cesare Pautasso**
**USI Faculty of Informatics**
via Buffi 13
6900 Lugano, Switzerland
+41 058 66 4311
+41 058 666 4536

**Steering Committee**

- Oliver Kopp, University of Stuttgart, Germany
- Jörg Lenhard, University of Karlstad, Sweden

**Program Committee (To Be Confirmed)**

- Saimir Bala, Vienna University of Economics and Business
- Anne Baumgrass, Synfioo - 360° Transportation Monitoring
- Domenico Bianculli, University of Luxembourg
- Daniele Bonetta, Oracle Labs
- Richard Braun, TU Dresden
- Dirk Fahland, Eindhoven University of Technology
- Alessio Gambi, Saarland University
- Georg Grossmann, University of South Australia
- Nico Herzberg, Hasso Plattner Institute at the University of Potsdam
- Christoph Hochreiner, TU Wien
- Conrad Indiono, University of Vienna
- Meiko Jensen, Independent Centre for Privacy Protection Schleswig-Holstein
- Oliver Kopp, University of Stuttgart
- Agnes Koschmider, Karlsruhe Institute of Technology
- Philipp Leitner, University of Zurich
- Joerg Lenhard, University of Karlstad
- Henrik Leopold, VU University Amsterdam
- Jürgen Mangler, University of Vienna
- Stephan Reiff-Marganiec, University of Leicester
- Andreas Schoenberger, Siemens AG
• Stefan Schulte, TU Wien
• Jan Sürmerli, Humboldt University of Berlin
• Matthias Weidlich, Humboldt University of Berlin
Special Issue on Integrating Process-oriented and Event-based Systems

Process-oriented information systems (POIS) control operations by coordinating the execution of elementary activities. Recently, there has been a significant uptake of POIS in transportation, logistics, and medical infrastructures – domains that impose new challenges in terms of system reactivity and adaptability. Here, trends such as sensing of data and advancing system integration represent opportunities to strengthen the event-perspective in process-oriented systems in order to achieve more flexible and comprehensive process control.

Event-based systems (EBS), in turn, have been put forward to integrate heterogeneous systems in a flexible and scalable manner by separating communication from application logic. EBS have found their way into many applications where event generation is relatively deterministic and follows structured behaviour, i.e., events are created by processes. Exploiting the process-perspective promises to lead to advancements in the design, analysis, and optimisation of event-based systems.

The increasing overlap of application scenarios that involve concepts and techniques of process-oriented as well as event-based systems, however, is only marginally supported by exchange and convergence of the related research fields. Despite the manifold opportunities for cross-fertilisation as highlighted by a recent Dagstuhl Seminar (http://www.dagstuhl.de/16341/), only a small amount of research has been conducted on how process-oriented systems and event-based systems can be integrated. Given this background, this special issue invites submissions focusing on various aspects of the interplay of process-oriented and event-based systems. We welcome both theoretical contributions as well as papers describing interesting applications. Topics include, but are not limited to:

- Process-driven distribution of event processing
- Process-driven handling of event data quality issues
- Process-driven definition of complex events
- Process-driven optimisation of event processing
- Event semantics in processes
• Process-event correlation
• Events for flexible and adaptive process management
• Events in inter-process correlation
• Event-driven choreographies
• Applications of event-driven process management
• Benchmarks and evaluation of event-driven process management

Important Dates
Submission: 15th December, 2016
First Round Notification: 1st March, 2017
First Round Revisions: 1st May, 2017
Second Round Notification: 1st July, 2017
Final Submission: 1st September, 2017
Publication: 1st December, 2017

Guest Editors
David Eyers, University of Otago, New Zealand
Avigdor Gal, Technion - Israel Institute of Technology, Israel
Hans-Arno Jacobsen, Technische Universität München, Germany
Matthias Weidlich, Humboldt-Universität zu Berlin, Germany

Submission: http://www.elsevier.com/locate/infosys
Für Sie gesurft – Neue (und alte) Tipps aus dem WWW

EMISA-Edition, Folge 34

Gottfried Vossen, Universität Münster

Heute präsentiere ich Ihnen die 34. Folge dieser Kolumne. Wie immer stelle ich Ihnen Websites, Apps und Dienste vor, die mir (und anderen) in letzter Zeit aufgefallen sind. Und nicht überraschend geht es einmal mehr um das Thema Big Data und vieles, was sich darum rankt.

Ich beginne mit einer Seite, über die ich beim Vorbereiten eines Vortrags gestolpert bin: Wir wissen ja schon lange, dass Google, Apple, Facebook und Amazon (zusammen auch bereits GAFA genannt) mit unseren Daten Geld verdienen, aber Handshake macht es möglich, an seinen Daten mit zu verdienen: „Handshake is an app and a website that allows you to negotiate a price for your personal data directly with the companies that want to buy it. It cuts out the middle man and has been specifically designed for people who recognise their personal data has serious value. ... Companies will ask you what you feel, think or intend to do. Whatever it may be, they will offer you financial reward at the same time as they send you their request. They will choose you anonymously based on your Handshake profile; the information you store securely with us about who you are and what you're into. If you do want to engage, you can either accept their offer or try to negotiate a price that seems fair to you. If you don't get the price you want, they don't get what they want. On the flip side, when you strike a deal, it’s a win-win for both of you. Negotiating significantly increases your chances of striking a deal you're happy with.”

http://handshake.uk.com/hs/index.html

Handshake ist zwar noch in der Beta-Phase, verspricht aber, eine interessante und absolut zeitgemässe Idee zu verwirklichen.
Wer nun von sich glaubt, nicht genügend Daten zu erzeugen, um daraus Kapitel zu schlagen, der kann leicht Abhilfe schaffen; dazu stöbere er (oder sie) einmal durch „The Big List of Twitter Tools: 93 Free Twitter Tools and Apps to Fit Any Need“, zu finden unter https://blog.bufferapp.com/free-twitter-tools.

Ich bleibe noch beim Thema Daten, und zwar den „dunklen“. Laut Lattice sind dies unstrukturierte Daten, wie z. B. Texte oder Bilder, aus denen Lattice, das aus dem Stanford-Projekt DeepDive hervorgegangen ist, strukturierte Daten macht.

https://lattice.io/

Meine nächsten beiden Hinweise sind eher als Warnung zu verstehen: Shodan ist eine Suchmaschine für das Internet of Things (IoT), über die Anfang dieses Jahres bei CNBC zu lesen war „Spying through strangers’ webcams just got easier“ und weiter: „Shodan — a company that describes itself as a search engine for Internet-connected devices — launched a tool last year that lets users access publicly available webcams all over the world. Recently, the company added freeze-framed images from those webcams, making browsing through people’s public and private lives as easy as clicking through a Netflix catalog. An American toddler in daycare? Check. Sleeping couch potato in Hong Kong? You got it. Or perhaps you’re into a specific street corner in Guangzhou China? Plus who knows what else. Full access to over 1,000 webcams — pointed at public and private spaces around the world — requires a one-time membership fee of $49. Of course, tech-savvy spies have always been able to tap into unsecured webcams or hack into poorly protected devices, but the new feature on Shodan makes it easier than ever for anyone to browse a library of webcams that have not been password protected.“ Und, in den Worten des Gründers John Matherly: ““Shodan wants to provide a complete view of the Internet which includes control systems, printers, servers, databases, tea kettles and of course webcams,”
In fast die gleiche Kerbe schlägt Censys: “Censys is a search engine that enables researchers to ask questions about the hosts and networks that compose the Internet. Censys collects data on hosts and websites through daily ZMap and ZGrab scans of the IPv4 address space, in turn maintaining a database of how hosts and websites are configured. Researchers can interact with this data through a search interface, report builder, and SQL engine. ... Censys is a community effort similar to an open source project. If you want to see new protocols scanned, help implement them in ZGrab. We'll add them to the roster and provide data back to you and the community. Know how to tag a device? Send us a ZTag pull request and your new annotation will automatically get applied to our next scan.” Die Entwickler von Censys haben ein Paper mit dem Titel "A Search Engine Backed by Internet-Wide Scanning" geschrieben, das in der 22nd ACM Conference on Computer and Communications Security 2015 erschienen ist und in welchem sie die technischen Grundlagen erläutern.

https://www.shodan.io/

https://censys.io/

Auf meine vollkommen willkürliche Eingabe der IP-Adresse 24.151.13.5 antwortet Censys wie folgt:
Man sollte also selbst einmal ausprobieren, welche Server auf diese Weise erreichbar sind; es bleibt mit Shodan und Censys nicht mehr viel verborgen!

Zu den positiven Seiten des IoT gehört aus meiner Sicht, dass allmählich in vielen Bereichen Konnektivität Wirklichkeit wird, die seit Jahren angekündigt war. Ein Beispiel liefert IoTool: „Mobile sensor solutions are a hit these days – everyone has their own solution for IoT, M2M or just monitoring sport activities and health related problems. There are a lot of mobile applications for different mobile sensors on the market, but all are made to work exclusively with specific sensors or use cases. Our IoTool helps connect any type of sensor (more than 100 sensors already supported) via any interface to smartphone. The collected data is encrypted, stored, displayed, processed and synced to the Cloud (IoTool servers with your full access, available in 16 datacenters around the World). An API is available to include all modules to your solution. Connect your own sensors, learn, teach, research with full control!”

https://iotool.io

Ebenso um Konnektivität bemüht ist Omnity; den Gründern geht es um das Schaffen von Verbindungen zwischen dem Wissen in den Bereichen Wissenschaft, Medizin, Ingenieurwesen, Recht und Finanzen. Für den Bereich Research schreibt Omnity auf ihrer Webseite: “More than 2,500 scientific papers and 2,200 patent applications are published every day. Just the last five years of most scientific and engineering fields have produced on the scale of 100,000 documents. Reading these one an hour would take 50 years, a professional lifetime. Pair-wise comparison of these documents at three minutes per comparison would take more than 9,000 years, nearly the length of recorded human civilization. It is impossible to stay current in any field, much less the boundaries between two or more different fields, where most innovation occurs. Omnity enables research and
development professionals in all fields to rapidly and efficiently detect otherwise hidden patterns of relevant document interconnections. Whether for basic research or advanced product development, Omnity allows real-time insight into complex document sets, enabling research and development professionals to efficiently and systematically answer a wide range of questions.

Sogar die Washington Post schrieb euphorisch im Mai 2016: “This new search engine could be way smarter than Google” und weiter: “Search engines that aren’t Google rarely have much that’s interesting to offer to the average consumer. But Omnity, a new search engine aimed at researchers — or even just students doing their homework — offers some glimmers of something new that make it worth taking notice. Search, as we know it, is ripe for some sort of change, after all. Google is certainly working to bake search more fully into our cars, phones and other devices. Specialized search engines — for flights, places to stay, even .gifs — are going strong. And then there are those AI bots being promised by Google, Facebook, Microsoft and others. What are they but high-powered, repackaged search engines? Omnity stands out by offering results that best match for any given search term and also how those results relate to each other. So if you’re about to start a research project on a topic you know little about, you can quickly see who is getting cited the most, whose research is the most influential or which university is leading the pack on that subject. It draws from a number of data sets, including SEC filings, public news organization reports, scientific journals, financial reports and legal histories.

https://www.omnity.io/,


Viele Leser meiner Kolumne werden Reddit kennen: „Reddit bridges communities and individuals with ideas, the latest digital trends, and breaking news (...okay, and maybe cats). Our mission is to help people discover places where they can be their true selves, and empower our community to flourish.“ Reddit bezeichnet sich selbst auch als „the front page of the Internet.“ Witzigerweise scheint jedoch nicht alles Hand und Fuß zu haben, was dort publiziert wird, den im Technology Review ging es kürzlich darum, dort Intelligenz zu finden: „Is it possible that the secret to building machine intelligence lies in spending endless hours reading Reddit? That’s one question a team of researchers at OpenAI, a nonprofit backed by several Silicon Valley luminaries, hopes to answer with a new kind of supercomputer developed by chipmaker Nvidia. The researchers are also training robots do the dishes through experimentation, and they are building algorithms capable of learning to play a wide variety of different computer games.” Den ganzen Artikel findet man hier: [https://www.technologyreview.com/s/602153/this-supercomputer-will-try-to-find-intelligence-on-reddit/](https://www.technologyreview.com/s/602153/this-supercomputer-will-try-to-find-intelligence-on-reddit/)

Für die Freunde der Virtuellen Realität ist die HTC Vive sicher eine von mehreren Optionen für 3D-Spiele, aber über SoundStage kann man damit jetzt auch virtuell Musik machen: SoundStage „is a VR music application that lets you arrange synthesizers, drums, speakers, and other equipment within the boundaries of your room, so you have a custom-built studio to make your own tunes.“ Interessenten sei das Video empfohlen, dass in folgendem Artikel verlinkt ist: [http://www.theverge.com/circuitbreaker/2016/8/18/12532264/soundstage-review-vr-music-production-vive](http://www.theverge.com/circuitbreaker/2016/8/18/12532264/soundstage-review-vr-music-production-vive)

Jetzt etwas Kniffiges mit sehr ernstem Hintergrund: Man weiß ja inzwischen, dass das Problem zu entscheiden, ob ein fahrerloses Auto im Falle einer Fehlfunktion oder Notsituation, in welches es nur eine von zwei Entscheidungen treffen kann, die aber beide
fatale Folgen haben, nicht lösbar ist, jedenfalls nicht so, dass das Ergebnis zufriedenstellend ist. Es gibt hier sogar einen engen Bezug zum Halteproblem für Turingmaschinen! Am MIT wurde ein Tool entwickelt, mit welchem man selbst testen kann, wie man in derartigen Situationen entscheiden würde. Es handelt sich um die Moral Machine:

http://moralmachine.mit.edu/

Die Entwickler schreiben dazu: “From self-driving cars on public roads to self-piloting reusable rockets landing on self-sailing ships, machine intelligence is supporting or entirely taking over ever more complex human activities at an ever increasing pace. The greater autonomy given machine intelligence in these roles can result in situations where they have to make autonomous choices involving human life and limb. This calls for not just a clearer understanding of how humans make such choices, but also a clearer understanding of how humans perceive machine intelligence making such choices. Recent scientific studies on machine ethics have raised awareness about the topic in the media and public discourse. This website aims to take the discussion further, by providing a platform for 1) building a crowd-sourced picture of human opinion on how machines should make decisions when faced with moral dilemmas, and 2) crowd-sourcing assembly and discussion of potential scenarios of moral consequence.” Unter den Szenarien, die man selbst beurteilen kann, findet man etwa das folgende:
Ein voll besetztes Auto fährt auf eine Personengruppe zu und kann diese überfahren oder in einen Betonklotz auf der anderen Straßenseite krachen. Wie würden Sie entscheiden?

Zum Schluss noch einmal zurück zum Thema Daten und Preise: Wer seine Haushaltskasse besser unter Kontrolle halten will, für den (oder die) gibt es jetzt Crtlio:

https://ctrl.io/

Wer noch neue Apps zur Begleitung des persönlichen Work-Out sucht, sehe hier nach: http://techcrunch.com/2016/05/31/get-fit-for-summer-with-these-workout-apps/


https://www.breitbandmessung.de/
Und wer einmal eine etwas andere Tagung als immer nur Fachkonferenzen (oder TEDx irgendwo) erleben möchte, dem rate ich, sich unter http://sas.summit.co/ für den nächsten (oder übernächsten) „Summit at Sea“ zu bewerben.

Wie immer weise ich darauf hin, dass die Inhalte sämtlicher hier beschriebenen Webseiten urheberrechtlich geschützt sind, allerdings ist nach einschlägiger Meinung das Copyright nur relevant für die Verwendung in anderen Webseiten bzw. wenn Gestaltungselemente für andere Designs übernommen würden, was beides nicht der Fall ist. Insofern betrachte ich das Beschreiben von Seiten in der hier vorgenommenen Form weiterhin als Werbung für diese.
Creating a Domain Specific Modelling Method for Ambient Assistance (Extended Abstract)

Judith Michael1 and Heinrich C. Mayr1

Abstract: Designing and applying a domain specific modelling language appears to be quite simple: invent appropriate modelling elements and connectors, define their semantics in a legend and use them. The talk will show, that there are more aspects to consider and more steps to perform, and that it is necessary to deeply immerse into the domain in question. But the result is worth the effort. The work summarized in this extended abstract has been published in the ICTer 2015 proceedings by IEEE [MM2015].

Keywords: Enterprise Modelling Languages and Methods, Domain Specific Modelling Languages, Modelling Tools, Process for Modelling Method Creation

1 Motivation

There is an on-going discussion about the pros and cons of domain specific Modelling languages in comparison to the traditional generic languages like, for example, the Unified Modelling Language UML or the Business Process Model Notation BPMN. Certainly, generic languages have high merits due to their versatility in arbitrary domains as well as a broad body of experience and knowledge that has emerged from intensive use and research. On the other hand, such languages tend to follow the “law of logistic growth” by being continuously extended up to the point where complexity and lack of concept orthogonality corrupts transparency and makes the language hardly manageable for practical use. As an example, today’s 17 (standard) and 8 additional UML 2.0 diagrams may lead to misunderstandings and user demotivation.

In contrast to that a Domain Specific Modelling Language (DSML) is designed for exclusive use in a certain domain and there-in for specific purposes. Consequently it comes (a) with a lean set of modelling concepts and explicit constraints that are tailored for the particular domain and purposes and (b) with lexical/graphical notations that are familiar and/or easy to understand by the users in that domain.

To use a DSML in practice requires, however, to embed it into a Domain Specific Modelling Method (DSMM), which features the procedure of how to apply the language as well as appropriate mechanisms to be used in such procedure. We present a guideline for how to create such a DSMM following [MM15], where we illustrated the process steps

1 Alpen-Adria-Universität Klagenfurt, Institut für Angewandte Informatik, Universitätsstraße 65-67, 9020 Klagenfurt, Österreich. judith.michael@aau.at and heinrich.mayr@aau.at
by using the Human Cognitive Modelling Language (HCM-L)\textsuperscript{2} as a running example\textsuperscript{3}. But the approach is generic enough to be transferred to other domains, in particular when (1) intuitive and thus easy understandability by model consumers is required, like by a country doctor about the processes in his practice, or a lawyer about his clients’ processes, or (2) individual human preferences in business processes, organizational or topological (e.g. buildings and rooms) structures have to be modeled. The talk will therefore focus on the DSMM process in general and touch some ideas for enterprise modelling. This summary only lists references that are not cited in the original paper; for all other sources, for an in-depth description, and for a comparison of our approach with that of Ulrich Frank, from which we started our considerations, please see [MM15].

### 2 The DSMM-Process

We propose to divide the DSMM creation process in five main phases (see Fig.1) which usually will have to be gone through iteratively: Preparation, Modelling Language, Modelling Process, Modelling Tool and Evaluation.

![Fig. 1: The main steps of the DSMM creation process](image)

#### Phase 1: Preparation

This phase ensures, that the relevant facts of the Universe of Discourse are known and well defined. This is important for informing the subsequent phases with the relevant knowledge about the intended domain. We distinguish the following preparation steps:

a) **Clarification of Scope and Purpose of the Language**: the scope determines what should be a part of DSML’s meta-model or not, who are the future users, and for whom the textual/graphical notation should be readable.

\textsuperscript{2} HCM-L was developed for Modelling purposes in the domain of Ambient Assistance, and in particular within the framework of the Human Behavior Monitoring and Support (HBMS) project, where it serves to represent and reproduce episodic knowledge of a certain person without any loss.

\textsuperscript{3} This work was funded by the Klaus Tschira Stiftung gGmbH, Heidelberg
b) Requirements Analysis: to reveal in detail all focal aspects to be potentially modeled. Domain specific standards, relevant literature and stakeholder know-how are important sources for this analysis; the results could be summarized in, e.g., usage scenarios or exemplary diagrams as part of the specification.

c) Context Analysis: the domain specific context of the afore-mentioned focal aspects is usually relevant for a comprehensive capture of a domain. Therefore, all relevant contextual information should be collected and reflected regarding their possible usage in the model and typical use cases. As an example, it might be desirable in enterprise modelling to add business goals and requirements to enterprise architecture models [En11].

Phase 2: Modelling Language

This phase concentrates on the language design and definition:

a) Selection of a Base Modelling Language: there are many powerful (generic) modelling languages “on the market”; selecting one of these as a basis for deriving the modeling concepts of the intended DSML may reduce the overall effort.

b) Language Specification: developing a meta-model by defining the syntax and semantics of the intended DSML. Relevant parts of the base modelling language could be included, irrelevant parts removed.

c) Design of the Notation: based on the meta-model, an appropriate notation has to be defined. Mostly, this will be a graphical one for which Moody’s nine principles of designing cognitively effective visual notations should be observed. Experiments with stakeholders help to improve the notation’s readability. For enterprise modelling, e.g., [MRR10] recommend on the styles of labels, [KFS15] present an overview of the visual design of process model element labels.

Phase 3: Modelling Process

Defines the process of using the DSML systematically for creating models by providing a stepwise procedure of how to act for modelers, e.g., what aspects should be modeled first, if there is more than one diagram type, with which one should be started.

Phase 4: Modelling Tool

A modelling language without tool is useless in practice. No matter if such a tool will be created from scratch or by adopting a meta-modelling framework, several steps have to be performed in order to end up with an appropriate solution:

a) Tool Requirements Definition: regarding categories like methodology support, general software characteristics or documentation.

b) Framework and Meta-Modelling Language Selection: the implementation of a modelling tool from scratch for an incrementally changing modelling language leads to challenges in the development process. Thus, adopting a meta-modelling
framework is a more efficient choice which, however, inevitably includes the selection of the meta-modelling language to be used.

c) **View Definition:** complex domains lead to complex models. For enabling users to manage such complexity, appropriate measures have to be provided. Usually this challenge is solved by providing various views on the complex content.

d) **Tool Implementation:** the meta-model of the DSML is formulated using the meta-modelling language of the selected framework. The implementation is based on the tool requirements specified in step a).

e) **Framework Dependent Add-Ons:** additional functionalities of a given framework should be checked with regard to the requirements, e.g., coupling to external frameworks, simulation or analysis functions.

**Phase 5: Evaluation**

The evaluation of the created DSML and DSMM has to be carried out against the goals and requirements revealed in phase 1 in cooperation with the relevant stakeholders. Additionally, the quality issues (both, instances and meta-model) have to be evaluated. In the case of a DSML for enterprise modelling, Business Process Compliance (BPC) [RTD08] should also be evaluated in this step and, if needed, changes implemented.

**3 Outlook**

The presented approach to systematically developing a DSML/DSMM is based on our experiences made in the course of the HBMS project. We would like to discuss it with the EMISA community in order to further sharpen and improve the particular steps.

**References**


Requirements Catalog for Business Process Modeling Recommender Systems (Extended Abstract)

Michael Fellmann\textsuperscript{1}, Novica Zarvic\textsuperscript{2}, Dirk Metzger\textsuperscript{3}, Agnes Koschmider\textsuperscript{4}

Abstract: The manual construction of business process models is a time-consuming and error-prone task. While recommendation systems are widely used and auto-completion functions are a standard feature of programming tools, such techniques are rarely applied in commercial BPM tools although implementation strategies have already been suggested. Therefore, this paper collects requirements from different perspectives (literature and empirical studies) of how to effectively and efficiently assist process modelers in their modeling task. The condensation of requirements leads to a catalog, which provides a solid foundation to implement Process Modeling Recommender Systems (PMRSs). The contents in this paper represent a shortened version of the full paper. The original work summarized in this extended abstract has been published in [Fe15].

Keywords: Business Process Modeling, Recommender Systems, Requirements.

1 Introduction

Business process modeling and reorganization are still among the top-ten of relevant topics of today’s CIOs [Lu13]. However, the construction of semi-formal process models is even today, after two decades of research on business process modeling, a highly manual task that can be challenging, especially for unexperienced modelers. It might not be easy to figure out where to start and stop modeling and on which abstraction level to model [Wi10, Ni113] since guidance in modeling is largely missing in current tools. These barriers call for process modeling support features, which assist users during process modeling and make suggestions how to complete a currently being edited process model. Such assistance functions are common features in programming environments or e-commerce systems (e.g., amazon.com). Although it has been demonstrated that assistance functions are beneficial in these domains, assistance functions are rarely considered in commercial BPM tools. Therefore, it should be a priority to offer assistance functions in process modeling tools. However, it seems that auto-completion of programming snippets is easier than auto-completion of graphical process models. This may be caused by a variety of attributes and characteristics such as syntactic consistency, semantic

\textsuperscript{1} University of Rostock, Institute of Computer Science, Albert-Einstein-Str. 22, 18057 Rostock, Germany
michael.fellmann@uni-rostock.de
\textsuperscript{2} Osnabrück University, Information Management and Information Systems, Germany
novica.zarvic@uni-osnabrueck.de
\textsuperscript{3} Osnabrück University, Information Management and Information Systems, Germany
dirk.metzger@uni-osnabrueck.de
\textsuperscript{4} Karlsruhe Institute of Technology (KIT), Germany
agnes.koschmider@kit.edu
validity, completeness and readability that influence the decision for an appropriate subsequent fragment. Since giving recommendations in modeling is not straightforward, we elicit and present a requirements catalog for Process Modeling Recommender Systems (PMRSs). This is not a trivial task and it should be noted that the elicitation and specification of requirements are considered to represent quite difficult processes in the area of requirements engineering [La02]. In this way, we expect that our contribution will fertilize the discussion and development of assistance functionality in process modeling, which already has been identified as useful [KHO11].

2 Research Method

The goal of the paper that is summarized here is to provide a holistic view on requirements for PMRSs. For achieving this, relevant scientific works were inspected conducting a systematic literature review as well as different empirical studies were carried out within two years. With regard to the latter, we performed three studies, namely (i) a short online-survey about modeling support functionality, (ii) a case study, and (iii) a survey at a major fair that was based on a live-demonstration of a prototypical implementation. The first and the last of the mentioned case studies also largely involved business users (especially the last one, a live-demonstration and survey at a major fair, CeBIT). Summing up, the research process followed can be characterized to be exploratory in nature [SLP09], where the results from literature as well as from users gradually consolidate the set of requirements, which are finally synthesized into a structured collection. Our research process is depicted in Fig. 1.

![Fig. 1: Research method](image-url)
3 Results

In order to provide a catalog of requirements, we consolidated the plethora of requirements that were elicited according to the procedure sketched in Section 2. For a detailed description of the elicited requirements from the literature (RL), the survey (RS), the case study (RC) and the prototype (RP), we refer to the original article [Fe15]. During this consolidation process, we at first combined redundant requirements and then detected and consolidated requirements that are subsumed by others. Finally, we further classified the requirements as being functional (FUNC), non-functional (NFNC), architectural (ARCH) or data-related requirements (DATA). We decided for these categories for the following reasons. The distinction between functional and non-functional requirements is well known in systems and software engineering. However, we additionally distinguish between requirements concerning the data since these are an important precondition of a PMRS as well as requirements concerning the architectural perspective. The latter ones are relevant in respect to the provisioning of the system. Table 1 shows the integrated results.

<table>
<thead>
<tr>
<th>Req. No.</th>
<th>Name of the consolidated requirement</th>
<th>Source-requirement</th>
<th>FUNC</th>
<th>NFNC</th>
<th>ARCH</th>
<th>DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>R01</td>
<td>Recommendation of basic constructs</td>
<td>RL1</td>
<td>■</td>
<td>■</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R02</td>
<td>Recommendation of additional objects</td>
<td>RL2, RP1-2</td>
<td>■</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R03</td>
<td>Innovative and intelligent recommendations</td>
<td>RC2, RP7</td>
<td></td>
<td></td>
<td></td>
<td>■</td>
</tr>
<tr>
<td>R04</td>
<td>Provision of context and meta-information</td>
<td>RL3-4, RC1, RS2, RP8</td>
<td></td>
<td>■</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R05</td>
<td>Quality and relevance of recommendations</td>
<td>RL5, RL10</td>
<td>■</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R06</td>
<td>Easy handling of the recommendations</td>
<td>RL6, RL8-9, RS3-4, RC6</td>
<td></td>
<td></td>
<td></td>
<td>■</td>
</tr>
<tr>
<td>R07</td>
<td>Personalized recommendations</td>
<td>RL7</td>
<td>■</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R08</td>
<td>Knowledge base management and evolution</td>
<td>RL11, RP3, RC3</td>
<td></td>
<td>■</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R09</td>
<td>Advanced features</td>
<td>RC4-5</td>
<td></td>
<td></td>
<td></td>
<td>■</td>
</tr>
<tr>
<td>R10</td>
<td>Multiple interfaces and platforms</td>
<td>RL12, RP4-6, RS1</td>
<td>■</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tab. 1: Consolidated PMRS requirements catalog

What can be seen when looking at Table 4 is that the distribution of source requirements according to their type being one of RC, RL, RP or RS is not equal. One requirement was detected exclusively by analyzing the case study and three exclusively by the literature analysis. Seven requirements were detected by two or more types of source requirements. Only one requirement was detected by all four types. It thus can be concluded, that the derivation of requirements from different sources such as the literature analysis and the survey, the case study and the prototype presentation in fact is valuable and leads to a more holistic elicitation of requirements.
4 Conclusion

Although sophisticated modeling tools exist, guidance in process modeling in terms of auto-completion and recommendation features is largely missing even in today’s tools. In the contribution [Fe15] that is summarized by the paper at hand, we therefore systematically collected requirements for such features as a first step towards the stepwise iterative development of PMRSs guiding the modeler in modeling. We derived the requirements deductively from literature as well as inductively by three empirical studies conducted within two years that involved both practitioners and students. We hope that our requirements catalog may be useful and serve as a point of reference both for researchers and the industry engaged with the development of PMRSs.

References


Evaluating Wiki Collaborative Features in Ontology Authoring (Extended abstract)

Chiara Di Francescomarino  Chiara Ghidini  Marco Rospocher

Abstract: This extended abstract summarizes a rigorous investigation about the effectiveness of the impact of wiki collaborative functionalities on the collaborative ontology authoring. The work summarized in this extended abstract has been published in [DGR14].

Context. This extended abstract summarizes a rigorous investigation about the impact of wiki collaborative functionalities on ontology modelling, presented in:

Evaluating Wiki Collaborative Features in Ontology Authoring
Di Francescomarino, C.; Ghidini, C.; Rospocher, M.;
IEEE Transaction on Knowledge and Data Engineering, 26 (12): 2997-3011, 2014.

Good quality ontology modelling often demands for multiple competencies and skills, which are difficult to find in a single person. This results in the need of involving more actors, possibly with different roles and expertise, collaborating towards the ontology construction. Collaborative ontology authoring has been recently widely investigated in the literature [Su02, Tu10, Di08, Ro14, RTM14]. These studies show that the collaboration among the different involved actors needs to be fostered by taking into account two important requirements.

A first requirement deals with the collaboration between who knows the domain that is going to be modelled, i.e., the Domain Expert (DE) and who has the technical skills to formalize the domain modelling, i.e., the Knowledge Engineer (KE). Traditional methodologies and tools were mainly based on the idea that knowledge engineers should drive the modelling process (producing ontologies in a formalism which is usually not understandable for domain experts) and domain experts should only report to KEs their knowledge of the domain. However, these methodologies often create an unnecessary extra layer of indirectness, an imbalance between the two roles and the impossibility for the domain experts to understand the modelled ontology. DEs should be actively involved in the ontology modelling process rather than only provide domain knowledge to KEs.

A second important requirement deals with the support of distributed teams of actors. Independently of their geographical position or their role, team members should be made aware about the collaborative development of the modelled artefacts, should be supported in the communication of modeling choices, as well as in the work coordination.

Wiki tools for the ontology authoring offer an appealing option for tackling these collaborative aspects. Indeed wikis usually provide collaborative features (wiki collaborative

1Fondazione Bruno Kessler, Via Sommarive, 18, 38123 Trento, dfmchiara|ghidini|rospocher@fbk.eu
features) useful for supporting ontology authoring, such as (i) easily customizable interfaces for the ontology editing; and (ii) functionalities for discussing ideas, commenting decisions, notifying and tracking changes.

This extended abstract summarizes the work described in detail in [DGR14, DGR12]. Purpose of the work is offering a rigorous investigation, based on a theoretical and empirical evaluation, of the effectiveness of the impact of wiki functionalities on the collaborative ontology authoring. The results show that wiki collaborative features, by actively involving domain experts in the authoring process and reducing the interaction effort of modellers, support and affect the process of collaborative ontology authoring, as well as the lifecycle of the built ontology entities.

Wiki Collaborative Features. Wiki systems, originally created for unstructured content like the Wikipedia pages, have been evolved towards wiki tools supporting the collaborative authoring of structured content, including ontologies [ADR06, GRS12]. In this work we focus on the following collaborative functionalities.

- **Multi-mode access to content**: interfaces for accessing or editing content can be easily customized according to roles and users;
- **Discussion mechanism**: wikis provide mechanisms to enable users to communicate, offering support for the creation of discussion threads, sections and replies;
- **Watchlist**: wikis allow users to monitor the evolution of pages of interest;
- **Notification mechanism**: wikis allow for notification services to the users in case of changes in the pages of interest;
- **Revision history**: wikis offer the complete tracking of any change and comment.

Theoretical Evaluation. It is based on a framework for the analysis of collaboration features in process modelling tools [MRW12]. The framework evaluates the technical support provided by tools with respect to the five levels of social interaction [MC94]: awareness, communication, coordination, group decision making and team-building.

By applying the framework to the wiki collaborative features of a wiki tool [GRS12] and investigating their support to each of the interaction aspects, we found that each of the features contributes to support one or more of the social interaction aspects and that all the five levels are actually covered by these features:

- **Awareness** ← Revision history, Watchlist, Notification mechanism, Multi-mode access to content, (Shared workspace);
- **Communication** ← Multi-mode access to content, Discussion mechanism, (Shared workspace);
- **Coordination** ← Revision history, Watchlist, Notification mechanism;
- **Decision Making** ← Discussion mechanism, Notification mechanism;
- **Team Building** ← Multi-mode access to content, (Shared workspace).
Empirical Evaluation. For a rigorous evaluation of the impact of the wiki collaborative features on the collaborative ontology authoring, we carefully designed the empirical evaluation. Specifically, we focused on the evaluation of (i) the effectiveness of the wiki collaborative features in the process of ontology modelling; (ii) the impact of collaborative features on the collaborative ontology modelling and on the (ontology) entity lifecycle. For each of these aspects we further refined the analysis by defining specific research questions. In detail, for the first aspect we looked at the effectiveness of the features based on three different factors, i.e., DEs involvement (RQ1), required effort (RQ2) and designers’ perception (RQ3). Concerning the impact of the collaborative features, we separately focused on the ontology modelling process (RQ4) and on the entity lifecycle process (RQ5).

The empirical study carried out for answering the research questions involved four teams, each composed of a DE and two KEs. Each team was asked to collaboratively model ontologies for two domains from the pedagogical field. To this end, all the teams members were provided with a modelling tool [GRS12], as well as with chat and email support. Specifically, each team was asked to model the ontology of one of the domains with the modelling tool enhanced with the wiki collaborative features (CMT- Collaborative Modelling Tool), and the ontology related to the other domain with the same modelling tool in which the wiki collaborative features were removed (NCMT- Non-Collaborative Modelling Tool). The four teams carried out the modelling task on the two domains in two laboratory sessions, one with CMT and the other with NCMT according to a balanced design [Wo00]. Moreover, each session was divided in 5 different phases: the first four phases aimed at simulating an asynchronous collaboration, i.e., DEs and the KE working in different (alternate) phases; the last phase was instead focused on the synchronous collaboration, i.e., all the three team members working together.

From the analysis of the results we found that the wiki collaborative features actually increase the involvement of DEs in the ontology editing (RQ1). Indeed, when CMT is used, the DEs average number of edited axioms and of editing operations is statistically significantly greater than when NCMT is used. An inverse pattern occurs instead for KEs, i.e., the KEs average number of edited axioms and of editing operations with CMT is statistically significantly lower than with CMT. Concerning RQ2, the results confirm that the wiki collaborative features reduce the effort required by team members to communicate. Indeed, the length of the (chat and email) conversations carried out with CMT is statistically significantly lower than with NCMT. Overall modellers showed a (statistically significant) positive evaluation about the perceived overall effectiveness and ease of use of the wiki collaborative functionalities, while they were a bit more skeptical with respect to the effectiveness of the features in addressing some of the five interaction levels, i.e., support for coordination and team building (RQ3). The obtained results also show that the collaborative functionalities have an impact on the ontology modelling process (RQ4). Specifically, it comes out that the process of ontology authoring carried out with CMT is less rigid and encourages more agile interactions among team members than the one carried out with NCMT. By further inspecting this result, we were able to (statistically) confirm that a high usage of the wiki collaborative functionalities correspond to a high dynamism in the typology of activities carried out. Finally, also the created ontology entity lifecycle seems to be affected by the usage of the collaborative functionalities (RQ5). Qualitative differences
between the lifecycle of CMT and NCMT ontology entities seems to reveal that CMT entities are built according to a process more structured than the one used for NCMT entities, thus suggesting a possibly higher quality of the resulting CMT entities.

References


A Visual Language for Modeling Multiple Perspectives of Business Process Compliance Rules (Extended Abstract)

David Knuplesch¹ und Manfred Reichert¹

Abstract: A fundamental challenge for enterprises is to ensure compliance of their business processes with imposed compliance rules stemming from various sources, e.g., corporate guidelines, best practices, standards, and laws. In general, a compliance rule may refer to multiple process perspectives including control flow, time, data, resources, and interactions with business partners. On one hand, compliance rules should be comprehensible for domain experts who must define, verify and apply them. On the other, these rules should have a precise semantics to avoid ambiguities and enable their automated processing. Providing a visual language is advantageous in this context as it allows hiding formal details and offering an intuitive way of modeling the compliance rules. However, existing visual languages for compliance rule modeling have focused on the control flow perspective so far, but lack proper support for the other process perspectives. To remedy this drawback, we introduce the extended Compliance Rule Graph language, which enables the visual modeling of compliance rules with the support of multiple perspectives. Overall, this language will foster the modeling and verification of compliance rules in practice.

The work summarized in this extended abstract has been published in [KR16]

Keywords: business process compliance, extended compliance rule graphs, business process modeling, smart processes

1 Motivation

During the last decades a variety of techniques for verifying the correctness of business process models were proposed. While early approaches focused on issues related to structural and behavioral model correctness (e.g., absence of deadlocks and livelocks) [vdA97], the semantic correctness of process models with respect to imposed compliance rules (i.e., business process compliance) has been subject to recent works [GMS06, LRD08, AWW09, Kn10]. Compliance rules constrain the execution order (i.e. control flow) of tasks and may originate, for example, from security constraints, domain-specific guidelines, corporate standards, and legal regulations. Besides the control flow perspective, other fundamental perspectives relevant in the context of business process compliance refer to time, data, and resources as well as the interactions a business process has with partner processes [CRRC10, Ra12, Kn13a].

¹ Ulm University, Institute of Database and Information Systems, James-Franck-Ring, 89081 Ulm, Germany, {david.knuplesch,manfred.reichert}@uni-ulm.de
Problem Statement and Contribution

In practice, compliance rules are represented in a rather verbose and ambiguous way. To enable the computer-based verification of business process compliance, i.e., to verify that a particular business process meets imposed compliance rules, subject matter experts and business analysts should provide unambiguous descriptions of compliance rules, which then can be translated into a machine-readable representation by IT experts. For the latter purpose, several approaches for the formal specification of compliance rules exist, e.g. applying linear temporal logics (LTL) [GK07] or using the formal contract language (FCL) [GS09]. As formal rule languages would be too intricate for subject matter experts and business analysts, rule patterns hiding formal details and providing informal explanations were suggested [DAC98, Tu12, Ra13]. Although few approaches exist that not only consider the control flow perspective, but also the data, time and resource perspectives, these approaches only support a pre-specified set of rule patterns.

Empirical studies show that business process modeling as well as compliance rule description languages, which both employ visual notations, offer advantages compared to purely text-based specifications [Ot12, HZ14]. Examples of visual notations for compliance rules include Compliance Rule Graphs [LRMD10], BPMN-Q [ADW08], and BPSL [LMX07]. Like visual process modeling languages, theses approaches combine an intuitive notation with the advantages of a formal language. Existing visual compliance rule languages, however, lack a comprehensive support of the time, data, resource, and interaction perspectives of a business processes, which hinders their use in more sophisticated scenarios.

To remedy this drawback, we provide an approach for the visual modeling of compliance rules in [KR16] referring to these perspectives as well as to the interactions a business process may have with partner processes. In particular, we show how the various perspectives can be visually represented with the extended Compliance Rule Graph (eCRG) language. For this purpose, [KR16] introduces all elements of the eCRG language step-by-step and along various examples. We evaluate the expressiveness of the eCRG language based on well-known patterns and its application to a real-world healthcare scenario. Furthermore, understandability issues are considered in an empirical study that confirms that Management Scientists are able to understand eCRGs and that their eCRG understanding can reach a level not largely differing from the one of Computer Scientists. Finally, [KR16] presents two proof-of-concept prototypes, which support the modeling of eCRGs as well as their verification against process logs.

Altogether, the eCRG language allows domain experts to capture compliance requirements at both an abstract and a visual level, while enabling the specification of verifiable compliance rules that consider the various perspectives. Note that [KR16] significantly extends previous work, which introduced fundamentals of the eCRG language [Kn13b, SKR14]. In addition to these preliminary works, [KR16] provides the first detailed presentation of the eCRG elements and an empirical study on the understandability of the eCRG language. Furthermore, [KR16] introduces a proof-of-concept prototype, which comprises a modeling environment, as well as an eCRG com-
pliance checker verifying the compliance of given process execution logs with a set of eCRGs, and provides a more profound discussion of related work.

3 Outlook

Our overall aim is to ensure multi-perspective compliance for all phases of the process life cycle. Hence, there is ongoing work applying the extended Compliance Rule Graph (eCRG) language for runtime compliance monitoring [KRK15] as well as for compliance checking in the context of process changes [Kn15]. Furthermore, we plan to compare the eCRG language with pattern- and logic-based approaches in another empirical study.

Literatur


Detecting Flight Trajectory Anomalies and Predicting Diversions in Freight Transportation (Extended Abstract)

Claudio Di Ciccio¹, Han van der Aa², Cristina Cabanillas², Jan Mendling², Johannes Prescher²

Abstract: Timely identifying flight diversions is a crucial aspect of efficient multi-modal transportation. When an airplane diverts, logistics providers must promptly adapt their transportation plans in order to ensure proper delivery despite such an unexpected event. In practice, the different parties in a logistics chain do not exchange real-time information related to flights. This calls for a means to detect diversions that just requires publicly available data, thus being independent of the communication between different parties. The dependence on public data results in a challenge to detect anomalous behavior without knowing the planned flight trajectory. Our work addresses this challenge by introducing a prediction model that just requires information on an airplane’s position, velocity, and intended destination. This information is used to distinguish between regular and anomalous behavior. When an airplane displays anomalous behavior for an extended period of time, the model predicts a diversion. A quantitative evaluation shows that this approach is able to detect diverting airplanes with excellent precision and recall even without knowing planned trajectories as required by related research. By utilizing the proposed prediction model, logistics companies gain a significant amount of response time for these cases. The work summarized in this extended abstract has been published in [Di16].

Keywords: Air transportation, Airplane trajectory, Logistics, Machine learning, Prediction methods

1 Introduction

The growth of inter-continental trade has led to a notable increase in multi-modal transport. Multi-modal transport involves at least two modes of transportation on two consecutive transportation legs, which have to be synchronized. This is, for instance, the case when air freight cargo is unloaded at airports in order to be distributed into the hinterland by trucks, or sea ship cargo being redistributed at sea ports. Because multi-modal transport faces increasing challenges in terms of efficiency, describing and planning such sequential dependencies is a common concern. A crucial problem in this context is that different parties involved in a transportation chain hardly exchange real-time information related to individual deliveries. This makes it difficult for a receiving party to respond in a timely way to unexpected events that occur earlier on in the transportation.

The impact of such unexpected events is especially prominent in supply chains that involve cargo airplanes. In case an airplane has to land in an airport that is not the intended destination (i.e. the flight is diverted), re-planning and adaptation mechanisms must be triggered
so that other parties involved in the chain can continue with the delivery of the cargo. Although diversions are relatively rare, their impact on the logistic chain is significant. To recognize the impact of a diversion on costs and CO₂ emissions, it must be considered that the freight of an airplane is, on average, loaded onto 30 trucks.³ If the airplane diverts to a different destination airport, the logistics service provider has to cancel (or reroute) the trucks that have been sent to the expected destination, and in parallel arrange for new transportation means to pick up the cargo in the actual landing airport. Therefore, this requires a rerouting of up to 60 trucks for a single airplane. Optimization of scheduling around such unexpected events is therefore recognized as one of the most important fleet management decisions. In order for these corrective actions to be effective, it is crucial that the logistics service provider becomes aware of the airplane diversion as soon as possible [Bu13]. Unfortunately, the communication between logistics service providers and cargo airlines is in practice not as prompt as required. In fact, logistics service providers do not receive real-time information and are generally even only notified once an airplane has already landed at another airport. Therefore, it is desirable to identify an anomalous flight behavior without depending on such information completeness.

In this paper, we address the problem of alerting receiving parties, e.g. trucking companies, in case a delivering airplane is diverted. Based on real scenarios, we make use of event data that is semi-publicly available. More specifically, our contribution is a prediction model that detects flight trajectory anomalies based on minimal input data. We implemented the model as a prototype and tested it on a sample of flights yielding a high predictive accuracy. The prediction model provides considerable gains in response time.

To the best of our knowledge, our research work is the first that addresses the issue of predicting the diversions of flights. We also remark here that our approach operates under the requirements that trajectories are not known a priori, and that there is no limited geographical area that is specifically meant to be put under analysis. Previous techniques have challenged related issues in the area of monitoring aircraft routes based on flight data [Kr02, GSF11, Gu14]. Nevertheless, not only they pursue different goals, but also their operating conditions change in terms of information they require: The need of planned flight trajectories as input, the circumscription of the geographical area in scope, or the higher number of factors used to detect anomalous behavior.

2 Automated Flight Diversion Detection

This section describes the proposed prediction model for the automated detection of diverting airplanes. During a flight, an airplane transmits updates on its (i) position, (ii) velocity, (iii) and altitude. We refer to these updates as flight track events. Whenever our model receives a flight track event, it predicts whether the airplane is diverting or whether it is still heading towards its intended destination. To make this prediction, the model performs three subsequent steps. (1) Given the receipt of a flight track event, the prediction model combines the received information with the previous gathered events within a given time

³ According to a major logistics service provider that we have collaborated with in this research project.
interval. The length of the time interval $L$ is customizable. Such a combination leads to the generation of five features, based upon the framework of [Ca14]: (i) Distance completed from the origin airport, (ii) distance gained towards the destination, (iii) velocity deviation, (iv) altitude deviation, and (v) phase, namely the covered fraction of the distance from the origin to the destination. (2) The second step uses a one-class classifier to process the treated data. Given the aforementioned features as input, it determines whether the behavior in the time interval should be considered as normal or anomalous. In our implementation, we resort on one-class Support Vector Machines (SVMs) with Gaussian kernel as the classifiers [CV95]. We opted for one-class SVMs because they can be trained on behavior observed in regular flights. It is a valuable advantage in our setting, since the diversions are rare. (3) Finally, we augment the classification of the behavior with the classifications of the airplane’s prior intervals. If the number of consecutive anomalous intervals in the flight history surpasses a certain threshold $t$, our model predicts a diversion.

3 Evaluation

We have evaluated the prediction accuracy and response time gains achieved by using our model on real flight data, acquired from FlightRadar24 and FlightStats for a period ranging from 10/07/2013 to 16/07/2013, and from 14/07/2013 to 11/08/2013, respectively. The data sets contained labeled data both of regular and diverted data, mainly related to routes over the United States and Europe. We have first conducted a grid search in the training and validation phase to tune the best configuration of the parameters (the SVM-specific parameters, the length of the time intervals $L$, and the number of consecutive anomalies that lead to a diversion alert $t$). Our final objective was to maximize the F-score, recall and precision of predictions [Mi97], keeping the time needed for a diversion prediction $L \cdot t$ as low as possible. To this end, we adopted a K-fold cross-validation approach with $K = 5$ [Ko95] on approximately the 80% of the flight data. Once the best performing parameters combinations were collected, we proceeded with the test phase on the remaining 20% of data. Gathered test results turned out to be in line with the validation phase, thus showing that the classifiers do not suffer from overfitting with respect to the training data. The minimum and maximum F-score respectively amounted to 0.76 and 0.82. The corresponding values for precision and recall floated in the range 0.78–0.96, and 0.68–0.79. The best classifiers raised a diversion alert after processing consecutive events for 12 to 16 minutes.

To assess the response time gain, we have considered two separate metrics: (i) the time-gain w.r.t. planned arrival time, namely the response time gained to cancel or redirect road transportation assigned to pick up cargo at the original arrival airport, and (ii) the time-gain w.r.t. actual arrival time, i.e., the response time gained to arrange road transportation to pick up cargo at the new arrival airport. Using the configuration that performed best in terms of highest F-score, our approach is on average able to predict a diversion 120 minutes before the originally scheduled landing time, and 62 minutes before the actual landing occurs. This gives logistic service providers more than one hour to react to a probable diversion. This is a significant gain in comparison to the case where logistic service providers have to wait for a notification of the diversion, which often occurs up to two hours past the actual landing time.
4 Conclusion

In this paper we tackle synchronization problems in multi-modal transport and the challenge to timely react to unexpected behavior. Our contribution is a model for the prediction of flight diversions based on the automated detection of anomalous behavior. In contrast to prior research, our technique does not require information on planned flight paths. We model the flight trajectory as a sequence of positional updates that describe flight’s location, altitude and velocity. Such data is transformed into relevant features that characterize the behavior of an airplane during a time interval, which are processed by a one-class classifier. We evaluated our technique on an extensive set of real-world data demonstrating its accuracy in terms of the F-measure and a substantial time-to-prediction gain.

We plan to extend our work in several ways in the future. Firstly, we intend to expand the approach such that it not only predicts the occurrence of diversions, but also computes to which airport the airplane will most likely divert. Also, knowing how diversions can be predicted for airplanes, we intend to investigate the prediction of breakdowns and diversions in other transportation contexts, e.g. road, inland waterway or railway transportation, such that the model can be used in any multi-modal logistics scenario.

Acknowledgement. The research work has received funding from the European Union’s Seventh Framework Programme under grant agreement 318275 (GET Service).

References


[Di16] Di Ciccio, Claudio; van der Aa, Han; Cabanillas, Cristina; Mendling, Jan; Prescher, Johannes: Detecting flight trajectory anomalies and predicting diversions in freight transportation. Decision Support Systems, 88:1 – 17, August 2016.


State-of-the-Art of Business Process Compliance Approaches: A Survey (Extended Abstract)

Michael Fellmann$^1$, Andrea Zasada$^1$

Abstract: Compliance means to adhere to laws, regulations and guidelines. It has become an integral part of business process management since the financial crisis revealed the dimension of legal offences and violated business rules. Even though Business Process Compliance (BPC) has reached a mature state, studies imply that practice still struggles with the documentation and automated control of compliance requirements. Moreover, due to the plethora of approaches, it is hard to gain an overview on existing works. This paper thus gives a short overview on BPC approaches. The work summarized in this extended abstract has been published in [FZ14].

Keywords: Business Process, Compliance, Validation, Verification, Review Article.

1 Introduction

As enterprises increasingly rely on business process models and execution environments to manage and automate their business processes, approaches to ensure compliance in business process modelling and execution are of utmost importance [Aw08, RW12]. Research can contribute to these efforts by addressing the needs of enterprises to automate compliance checks and enhance visibility of operational risks [Mi15]. However, due to the plethora of approaches, it is hard to compare and select from among them. In [FZ14], we therefore provide an overview guided by the following research questions:

RQ1: What is the scope of compliance approaches?
RQ2: Which phases of the process lifecycle are targeted by compliance approaches?
RQ3: What kind of research dominates compliance research?
RQ4: What is the contribution of compliance research works?
RQ5: What are trends regarding compliance research?

The review is based on the suggestions from Webster and Watson [WW02] and vom Brocke et al. [Vb09] who describe best practices of a systematic literature review. It included five scientific databases. The literature search revealed 430 hits from which 84 were considered relevant for the classification (cf. [FZ14] for a detailed description). The remainder of the paper is structured as follows. Section 2 introduces our classification of compliance approaches that is also used to answer RQ1–4 in the original paper. In Section 3, we apply the classification to important research works. In Section 4, research trends are sketched (RQ5) and Section 5 provides a conclusion.

$^1$University of Rostock, Institute of Computer Science, Albert-Einstein-Str. 22, 18057 Rostock, Germany
{michael.fellmann | andrea.zasada}@uni-rostock.de
2 Classification of Compliance Approaches

In the original paper [FZ14], a faceted classification is developed and subsequently applied to characterize research works. The classification contains the four dimensions (facets) Scope, Lifecycle phase, Formality and Contribution type of compliance approaches along with their attributes (cf. Figure 1). For example, the attribute Order and occurrence of the Scope dimension refers to the fact that every process is determined by events which trigger subsequent process steps. The execution of processes in turn requires detailed Information, which has to be either extracted from regulations or can be defined by the company as indicated by the attributes Resource, Time or Location.

Fig. 1: Dimensions for compliance checking

3 Classification of Important Compliance Works

In our original paper, we selected the top 20 articles (a complete list can be found here: http://tinyurl.com/compliance-list) according to the citation rate measured with Google Scholar (as of 2013, when the original article was written). We then provided a visual map (cf. Figure 2) where approaches are classified according to three dimensions of our classification: Formality, Scope and Contribution type. Regarding formality (y-axis), we slightly extended this dimension to comprise additional levels of formality in order to provide for a more suitable graphical representation. The extended levels are: Highly formal (e.g. using mathematical analyses), Formalized approaches with end-user orientation (e.g. presenting an algorithm with a user interface), Management-oriented partly formal approaches (e.g. descriptions of tools or procedures) and Management-
oriented frameworks or methods (e.g. architectures or strategies). Regarding the Scope (x-axis), we used the attributes of our classification. Regarding Contribution type, we extended the criteria Other and replaced it by the two more specific attributes No specific contribution type and Technical artefact and method. With these extensions, we can provide the map that is shown in Figure 2 (references to the articles in the map are contained in the original publication [FZ14]).

![Classification of important compliance works](image)

**Fig. 2: Classification of important compliance works**

4 Research Trends

Regarding the subject of research, it can be noticed that compliance research has been driven by the increasing requirements of businesses to comply with given
laws, regulations, best practices and contracts that have been existent since the beginning of the century. Research on the topic reached its climax (regarding the publication rates) in 2009. Many of the research works propose formal methods or frameworks to approach compliance. Future research may thus be concerned with the applicability of the developed approaches in terms of intuitive tool support, cognitive efficient user interfaces and ergonomic and usable languages for compliance rule specification or generation from natural language text as well as with organizational aspects and “the human in the loop”.

5 Conclusion

With our review that we summarized here and that is presented in detail in [FZ14], we want to serve the research community by showing the landscape of research in terms of what the literature is focused on (scope), which phase of the process lifecycle are addressed (design, execution, after execution), from which perspective (business-oriented or more formal, computer-science-related work) as well as which contribution type (technical artefact, method or other) is provided. We hope that our contribution is useful and may both serve as a starting point for new researchers and as an overview of the work for more experienced researchers in the business process compliance field.

References


Plausibility Checking of Formal Business Process Specifications in Linear Temporal Logic
(Extended Abstract)\(^1\)

Christoph Czepa, Huy Tran, Uwe Zdun\(^2\),
Thanh Tran Thi Kim, Erhard Weiss, Christoph Ruhsam\(^3\)

Abstract: Many approaches for keeping business processes in line with constraints stemming from various sources (such as laws, standards, internal policies, best practices, etc.) are based on Linear Temporal Logic (LTL). Creating LTL specifications is an error-prone task, which entails the risk that the formula does not match the intention of its creator. Manual testing is time-consuming and usually limited to a small amount of test cases. This paper proposes a semi-automatic plausibility checking approach for LTL-based specifications. Additionally to the LTL formula, the user specifies the desired behavior of the LTL specification in several smaller parts, namely by an initial truth value and one or more temporal queries (TQs). TQs change the truth value once a specific pattern of events occurred in an event trace. By this approach, a large set of test cases for the LTL specification can be created automatically. The work summarized in this extended abstract has been published in [Cz16].

Keywords: Linear Temporal Logic, Testing, Plausibility Check, Business Process Management

1 Introduction

Linear Temporal Logic (LTL) has become a de facto standard for defining system specifications due to its extensive use in model checking (cf. e.g., [Ro11]) and the possibility to automatically translate LTL formulas to nondeterministic finite automata (NFA) for runtime verification on finite traces (cf. e.g., [DGDM14]). In business process management, LTL plays an important role in the verification of business processes. Elgammal et al. [El14] propose a compliance request language (CRL) with underlying LTL representations. Pesic & van der Aalst [PvdA06] suggest ConDec, a graphical language for the definition of declarative workflows with mappings to LTL formulas.

The creation of LTL formulas is a challenging and error-prone task that requires considerable knowledge and experience. It is hardly surprising that higher levels of abstraction, such as CRL and ConDec, are often preferred to creating LTL formulas from scratch. However, there are two major issues when solely trying to rely on a pattern-based approach. Firstly, formal patterns that precisely match the intention of the user might not be available. Hence, manually defining a new formula by modifying or combining existing

\(^1\)The research leading to these results has received funding from the FFG project CACAO, no. 843461 and the WWTF Grant No. ICT12-001. This paper contains an image licensed under CC [Wi]

\(^2\)University of Vienna, Faculty of Computer Science, Software Architecture Research Group, Währingerstraße 29, 1090 Vienna, Austria, firstname.lastname@univie.ac.at

\(^3\)Isis Papyrus Europe AG, Alter Wienerweg 12, 2344 Maria Enzersdorf, Austria, firstname.lastname@isis-papyrus.com
patterns or by creating a new specialized LTL formula might be required. Secondly, if an existing candidate pattern has been identified, it remains unclear whether the intention of the creator is really met. Either the meaning of the pattern could be misinterpreted or the LTL formula might contain errors.

To the best of our knowledge, finding errors in LTL formulas has not yet been investigated sufficiently. Salamah et al. [Sa05] propose to use a set of manually created test cases to check the plausibility of pattern-generated LTL formulas. However, this involves the user in the generation process of all the sample traces and the expected truth values at the end of these traces. This results usually in a small number of test cases since the manual specification of test cases is time-consuming.

2 Approach

The proposed plausibility checking approach aims at supporting users during the creation of LTL formulas. Figure 1 provides an approach overview.

Whenever an LTL formula is created or modified, the user also creates a plausibility specification which is used to encode the desired behavior of the LTL formula. The plausibility specification consists of an initial truth value (either temporarily satisfied or temporarily violated) and one or more temporal queries (TQs) which describe truth value changes. A TQ consists of a temporal expression that uses a subset of EPL (Event Processing Language) [Esa], more specifically the operators every (\(\forall\)), until (\(\mathcal{U}\)), leads-to (\(\mathcal{X}\)), not (\(\neg\)), and (\(\land\)), or (\(\lor\)), and a truth value to which the reference truth value is changed to once the temporal expression is matched by a given trace. A temporal query is of the form \(e \Rightarrow r\) where \(e\) is an temporal expression and \(r\) is a truth value. The expression formed by the operator \(\Rightarrow\) implies that there is a change of the truth value caused by the temporal ex-
pression and the resulting truth value is \( r \) (\( \bot \) for temporarily violated, \( \top \) for temporarily satisfied, \( \bot \) for permanently violated, \( \top \) for permanently satisfied).

The temporal expression of a TQ is enacted as a statement by the CEP (Complex Event Processing) engine Esper [Esb] which fires a listener that turns the reference truth value to the defined truth value once the statement is matched. The LTL formula is transformed into a nondeterministic finite automaton (NFA) by the LTL2NFA algorithm [DGDM14]. Both the NFA and CEP receive as inputs the elements of finite traces. These inputs lead to changes of both the truth value, which reflects the current state of the automaton, and the reference truth value determined by the CEP engine. In order to achieve a positive plausibility checking result, there must not be any deviation between the truth value (determined by NFA) and the reference truth value (determined by CEP) for all inputs. In case of a deviation, a counterexample trace and the truth values of both the LTL formula and the plausibility specification are being made available as a starting point for correction.

Since the reference truth value is determined by the plausibility specification, manually assigning a truth value to a trace is no longer necessary. Consequently, a large number of test cases can be generated automatically based on the plausibility specification.

3 Discussion of Applicability in the Context of Specification Patterns

In 1999, Dwyer et al. publish a paper entitled “Patterns in property specifications for finite-state verification” [DAC99] alongside with a constraint pattern collection called “Property Specification Patterns” which is available online\(^3\). In the FAQs, the following information is stated: “Mappings were validated primarily by peer review amongst the project members, with assistance from several other people on selected pattern mappings. Some of the mappings also underwent testing by running existing FSV\(^4\) tools to analyze small finite-state transition systems which encode (un)satisfying sequences of states/events.” Consequently, we cannot assume the correctness of a pattern representation. As an example for an LTL formula that does not match our understanding of the corresponding pattern, we are now going to discuss the Precedence After pattern (after a: b precedes c) and its LTL representation \( G(\neg a) \lor F(a \land (\neg c \mathcal{U} b)) \). We formulate a single TQ \( a \rightarrow \neg b \mathcal{U} c \rightarrow \bot \) which causes the truth value to switch to permanently violated once there has been an a but thereafter no b until c occurs. Plausibility checking notifies us of the counterexample \([a, c, a]\) where the LTL formula is satisfied. According to the pattern scopes defined by Dwyer et al. [DAC99], the after scope after a starts at the first occurrence of a. Thus, with the occurrence of the trace \([a, c]\) the pattern becomes permanently violated because b should have happened in between the first occurrence of a and the occurrence of c. Consequently, every suffix of \([a, c]\) must not cause any further change of the truth value of the pattern, so there must be something wrong with the LTL formula. The reason why the LTL formula is incorrect becomes obvious when we substitute the weak until by one of its equivalences. Then the modified formula is given as \( G(\neg a) \lor F(a \land (\neg c \mathcal{U} b) \lor G(\neg c)) \). The trace \([a, c, a]\) meets the LTL formula by satisfying the subformula \( F(a \land G(\neg c)) \) through the

\(^3\)http://patterns.projects.cis.ksu.edu
\(^4\)Finite State Verification
second occurrence of $a$ because the trace ends there and $c$ is not present after this $a$. From our point of view, a correct LTL formula for this pattern is $(\forall \neg a) \lor (\neg a \mathcal{U} (a \land (\neg c \mathcal{W} b)))$ because here it is ensured that only the first $a$ starts the scope.

4 Conclusion

This paper discusses a plausibility checking approach which requires the user to specify the desired behavior of the LTL specification in several smaller parts, namely by an initial truth value and temporal queries. This enables the evaluation of LTL formulas against a large set of automatically generated test cases that are based on the provided plausibility specification. Existing pattern-based approaches, such as CRL and ConDec, may benefit from this approach whenever it becomes necessary to extend the set of supported constraints.

References

[Cz16] Czepa, Christoph; Tran, Huy; Zdun, Uwe; Tran, Thanh; Weiss, Erhard; Ruhsam, Christoph: Plausibility Checking of Formal Business Process Specifications in Linear Temporal Logic. In: 28th International Conference on Advanced Information Systems Engineering (CAiSE’16), Forum Track. June 2016.


A Framework for Efficiently Mining the Organisational Perspective of Business Processes (Extended Abstract)

Stefan Schöning¹ Cristina Cabanillas² Stefan Jablonski³ Jan Mendling⁴

Abstract: Process mining aims at discovering processes by extracting knowledge from event logs. Such knowledge may refer to different business process perspectives. The organisational perspective deals, among other things, with the assignment of human resources to process activities. Information about the resources that are involved in process activities can be mined from event logs in order to discover resource assignment conditions, which is valuable for process analysis and redesign. Prior process mining approaches in this context present one of the following issues: (i) they are limited to discovering a restricted set of resource assignment conditions; (ii) they do not aim at providing efficient solutions; or (iii) the discovered process models are difficult to read due to the number of assignment conditions included. In this paper we address these problems and develop an efficient and effective process mining framework that provides extensive support for the discovery of patterns related to resource assignment. The framework is validated in terms of performance and applicability. The work summarized in this extended abstract has been published in [Sc16].

Keywords: Business process management, declarative process mining, event log analysis, organisational perspective, resource perspective

1 Introduction

Business Process Management is a well accepted method for structuring the activities carried out in an organisation, analysing them for efficiency and effectiveness, and identifying potential for improvement [Du13]. Processes are not always explicitly defined when the process models are designed. Actual process executions may constitute a valuable input for improving process design. Process mining provides methods for automatic process analysis, among others for discovering processes by extracting knowledge from event logs in form of a process model. Various algorithms are available to discover models capturing the control-flow of a process, related to the behavioural perspective of the process [vdA11, DM15]. For perspectives like the organisational perspective, which manages the involvement of human resources in processes, only partial solutions for mining have been developed despite the importance of resource information not only for performance but also for compliance analysis [Le12].

The need to better support the organisational perspective was evidenced by previous approaches that mined this perspective [SvdA08, NvdA10]. Prior work in this area focused on discovering specific aspects of the organisational perspective such as role models,

¹University of Bayreuth, Institute for Computer Science, Bayreuth, Germany, stefan.schoenig@uni-bayreuth.de
²Vienna University of Economics and Business, Vienna, Austria, cristina.cabanillas@wu.ac.at
³University of Bayreuth, Institute for Computer Science, Bayreuth, Germany, stefan.jablonski@uni-bayreuth.de
⁴Vienna University of Economics and Business, Vienna, Austria, jan.mendling@wu.ac.at
separation of duty or social networks. However, comprehensive and integrated support for the well-established workflow resource patterns, and specifically in this context for the so-called creation patterns [Ru05], was missing. Furthermore, the close interplay between the organisational and the behavioural perspectives was disregarded. In [Sc15] we addressed these gaps by developing a declarative process mining approach for the organisational perspective, which supports all the creation patterns as well as what we called cross-organisational patterns, which discover how the involvement of resources influences the control-flow of the process.

The research reported in this paper extends our prior work towards an efficient and effective mining framework. As illustrated in Figure 1, the framework is divided into an event log pre-processing phase, a phase for integrated resource mining including cross-perspective patterns, and a model post-processing phase. We evaluate our approach with an implementation of the three phases; with simulation experiments for measuring performance; and with the application of the approach on a real-life event log for checking its effectiveness.

This research extends our previous work [Sc15] as follows: (i) the developed pre-processing method increases the efficiency of the approach; (ii) the developed post-processing techniques increase the understandability of the results; (iii) a prototype of the entire framework has been implemented using Drools; and (iv) the approach has been extensively validated. In addition, the mining approach is explained in more detail. With our work, we complement research on process mining with an extensive support of the organisational perspective.

This is an extended abstract of the article [Sc16] published in the Decision Support Systems Journal.

2 Extracted Patterns and Target Language

The well-known workflow resource patterns [Ru05] capture the various ways in which resources are represented and utilised in business processes. Of specific interest for our approach are the creation patterns that describe the different ways in which resources can be assigned to activities. Furthermore, it has been identified that the process control-flow is intertwined with dependencies upon resource characteristics. For instance, sometimes an
activity must be executed eventually before another one for specific resources but not for others. A specific collection of such cross-perspective patterns capturing these situations has not been defined. They can be defined by combining the aforementioned organisational patterns with control-flow patterns. The organisational and the cross-perspective patterns constitute the set of patterns to be discovered by our framework.

Next, we shortly describe the target language we use for representing the mining results. Current procedural languages like BPMN put a strong emphasis on control-flow and assume other perspectives to be specified separately. Cross-perspective patterns cannot be readily modelled. Declarative process modelling does not limit the number of perspectives involved in the constraints defined. We use DPIL [ZSJ14] for modelling the output of the mining because it supports multiple perspectives including the behavioural and the organisational perspectives, as well as the interplay between them. Nonetheless, the concepts of our approach are generic such that other declarative languages could also be used as long as they provided support for the modelling of our target patterns.

### 3 Mining Framework

We shortly describe our framework to discover organisational and cross-perspective patterns. Declarative process modelling languages like DPIL are based on so-called rule templates. A rule template captures frequently needed relations and defines a particular type of rules. Unlike concrete rules, a rule template consists of placeholders, i.e., typed variables. In declarative process mining, rule templates are used for querying the provided event log to find solutions for the placeholders. First, rule candidates need to be constructed by instantiating the given set of rule templates with all possible combinations of occurring process elements provided in the event log. The resulting candidates are subsequently checked w.r.t. the log. This provides for every candidate the number of instances, i.e., the traces in the event log where it non-vacuously holds. Based on these values rules are classified and separated into non-valid and valid ones.

Since DPIL builds upon a flexible organisational meta model, it is possible to define rule templates that describe many aspects of the organisation. By instantiating these rule templates with all possible parameter combinations of defined resources, groups and relation types, it is possible to generate rule candidates that focus on the organisational perspective of the process to be analysed. These candidates can then be checked under consideration of the event log and the organisational model. We define rule templates for our target set of patterns. Here, we distinguish between templates for organisational patterns and templates for cross-perspective patterns. The former are divided into two groups: rule templates related to a single task and rule templates related to more than one task. We provide representative examples for each group of rule templates that cover frequently needed organisational information. Note that besides the templates described next, further templates could be defined individually to cover the analyst’s needs.

Real-life event logs and organisational models potentially contain a big set of distinct tasks, resources and groups. This leads to a potentially big number of rule candidates to
be checked. Although many of these parameter combinations never occur together in the same trace, the corresponding rules need to be checked. We use the well-known Apriori algorithm to pre-process the log and to extract task-resource and task-group combinations that frequently occur together. In this way, it is possible to reduce the number of organisational rule candidates by ignoring infrequent parameter combinations.

The mining method extracts all the assignment rules related to each task. However, when several rules are extracted for one single task, not all of them might be strictly necessary to understand the process. Some rules may be implied by stronger rules because they are less restrictive and do not provide any value to the current resource assignment expression of a task. Those rules complicate the understandability of discovered models. We identified two pruning approaches to eliminate unnecessary rules: (i) pruning based on organisational rule hierarchies and (ii) pruning based on transitive reduction. The requirement for all pruning operations is that they do not change the meaning of the generated model.

Literaturverzeichnis


Conformance Checking and Performance Improvement in Scheduled Processes: A Queueing-Network Perspective (Extended Abstract)

Arik Senderovich\textsuperscript{1} Matthias Weidlich\textsuperscript{2} Liron Yedidsion\textsuperscript{3} Avigdor Gal\textsuperscript{4} Avishai Mandelbaum\textsuperscript{5} Sarah Kadish\textsuperscript{6} Craig A. Bunnell\textsuperscript{7}

Abstract: Conceptual models of service processes enable operational analysis and may be constructed automatically from event logs containing recorded traces of process execution. In this work, we target the analysis of resource-driven, scheduled processes based on event logs. Specifically, we approach the questions of conformance checking (how to assess the conformance of the schedule and the actual process execution) and performance improvement (how to improve the operational process performance). The first question is addressed based on a comparative analysis of queueing networks for both the schedule and the actual process execution. These results of this analysis are used to improve the operational performance of a process: we suggest adaptations of the scheduling policy of the service process to decrease the tardiness (non-punctuality) and lower the flow time. The work summarized in this extended abstract has been published in [Se16].

1 Operational Analysis of Scheduled Processes

Service systems play a fundamental role in domains such as transportation and the health sector. Services are provisioned by a service process [Du13, Da11], broadly defined by a set of activities that are executed by a service provider to serve particular clients. We focus on service processes that are multi-stage and scheduled. The former means that there is a series of interactions between a client and a service provider, or specific resources at a provider’s end. Scheduled processes, in turn, are structured such that the arrival of clients as well as the basic activities of handling their requests are largely known in advance.

In this work, we target operational analysis of such multi-stage scheduled service processes. Specifically, we elaborate on methods to answer the following two questions: how to assess the conformance of a pre-defined schedule of a service process to its actual execution? and how to improve operational performance of the scheduled process?

We address the above questions with a model-driven approach, exploiting a specific type of queueing networks. This choice is motivated by the need to capture the key actors of service

\textsuperscript{1} Technion - Israel Institute of Technology, Haifa, Israel, sarks@tx.technion.ac.il
\textsuperscript{2} Humboldt-Universität zu Berlin, Germany, matthias.weidlich@hu-berlin.de
\textsuperscript{3} Technion - Israel Institute of Technology, Haifa, Israel, lirony@ie.technion.ac.il
\textsuperscript{4} Technion - Israel Institute of Technology, Haifa, Israel, avigal@ie.technion.ac.il
\textsuperscript{5} Technion - Israel Institute of Technology, Haifa, Israel, avim@ie.technion.ac.il
\textsuperscript{6} Dana-Farber Cancer Institute, Boston, Massachusetts, United States, sarah_kadish@dfci.harvard.edu
\textsuperscript{7} Dana-Farber Cancer Institute, Boston, Massachusetts, United States, craig_bunnell@dfci.harvard.edu
processes (clients and providers), their interactions, and the dependencies of different stages of the service process, including parallel processing of activities [Bo06]. Against this background, we rely on Fork/Join networks [AG89], which serve as the foundation for analysis of parallel queueing systems [AMZ12].

2 Conformance Checking & Process Improvement

To address the question of conformance, we present a method that is grounded in queueing networks that are discovered for both the schedule and the actual process execution. We then apply statistical inference (hypotheses testing) and similarity assessment to validate the scheduling assumptions of the process. As outlined in Figure 1, the conformance checking step yields diagnostics on operational deviations between the schedule and the execution of the process. The identified deviations then guide the efforts to answer the question of how to improve the operational performance of a process. In particular, we target improvements in terms of decreased tardiness (lateness with respect to due dates) and lower flow time by adapting the scheduling policy. Our contributions can be summarized as follows:

Conformance Checking: Following the existing theory for validating (simulation-based) operational models against execution data [Sa11], we decompose the conformance checking problem along two dimensions, namely conceptual and operational. Conceptual conformance checks the assumptions and theories that underlie the schedule. To assess this type of conformance, we compare the schedule and the event log indirectly by means of Fork/Join networks that are discovered for both. These networks are compared through the lenses of their corresponding components: structure, routing, and server dynamics, which enables general insights beyond the level of instance-based conformance checking. Operational conformance checks the ‘predictive power’ of a schedule with respect to various performance measures (e.g., delay predictions). To this end, we measure deviations between the observed and the scheduled performance indicators.

Process Improvement: Conformance checking detects parts of the process that fail to conform (conceptually or operationally) to a given schedule. We handle lack of conformance by combining data-driven analysis via the Fork/Join model, and principles from scheduling research [Pi12]. Specifically, we target local improvement of service policy, whenever conformance is lacking. By default, scheduled processes often operate under the Earliest-Due Date first (EDD) service policy per node, thus ‘optimizing’ schedule-related performance measures (e.g., non-punctuality). Assuming that all cases are available at the beginning of the scheduling horizon, it is indeed optimal to use the EDD policy. However, when cases
arrive into the system at different times (according to schedule), we show that the EDD policy can be improved to achieve lower tardiness. Moreover, we show that without losing punctuality, our algorithms also improve other performance measures such as flow time.

3 Discussion

This work presents methods for conformance checking and performance improvement of scheduled multi-stage service processes, as they are observed in such domains as healthcare and transportation. We explore the value of the proposed approach by a two-step evaluation. First, we apply the conformance checking techniques to RTLS-based data from a real-world use-case of a large outpatient oncology clinic namely, the Dana-Farber Cancer Institute. Our experiments demonstrate the usefulness of the validation method for detection of operational deviations and identification of root causes of deviations. As a second step, we evaluate the proposed process improvement technique by means of simulation and show that tardiness and flow time can be reduced by more than 20% using our scheduling policy.

Acknowledgement. We are grateful to the SEELab members, Dr. Valery Trofimov, Igor Gavako and especially Ella Nadjarov, for their help with the statistical analysis. We also thank Kristen Camuso, from Dana-Faber Cancer Institute for the insightful data discussions.

References


[Sc16] Senderovich, Arik; Weidlich, Matthias; Yedidsion, Liron; Gal, Avidgor; Mandelbaum, Avishai; Kadish, Sarah; Bunnell, Craig A.: Conformance checking and performance improvement in scheduled processes: A queueing-network perspective. Information Systems, 2016. DOI: http://dx.doi.org/10.1016/j.is.2016.01.002

http://www.dana-farber.org/
Process Innovation as Creative Problem-Solving: An Experimental Study of Textual Descriptions and Diagrams (extended abstract)

Kathrin Figl1, Jan Recker2

Abstract: Supporting business and systems analysts with process models in idea generation tasks has been a longstanding topic of interest. In the study we summarize in this extended abstract, we examined how process models support process re-design tasks where analysts attempt to generate ideas about novel ways in which organizational processes can be executed. Through an experiment we compared how two types of models about organizational processes – textual and diagrammatical – assist novice analysts in developing innovative solutions to process redesign tasks. The results from our study indicate that diagrams are superior to textual process descriptions regarding the appropriateness of process redesign ideas and tend to produce ideas with higher originality and impact, while the sheer amount of ideas does not vary significantly. Process diagrams also change the focus of the redesign ideas - ideas related to information systems improvements increase, while ideas related to data flow enhancements in a process decrease. The work summarized in this extended abstract has been published in [FR16].

Keywords: Process Innovation, Business Process Models, Business Process Reengineering, Creative Problem-Solving, Diagrams

1 Introduction

The complexity of contemporary information systems draws much attention to how their analysis and design can be supported by appropriate methods and tools. Much of this attention has traditionally focused on techniques that support the modeling of requirements of information systems in terms of data or processes [Pa02]. We examine process models and study how individuals use domain understanding developed through the use of process models in developing new, improved models for how these business processes could be enacted. This is an important area of study. Nowadays analysts often rely on process models to document and analyze current organizational operations, to help business personnel understand the work domain and identify improvement opportunities related to the business processes and involved information systems [De01]. The exercise of improving technical or organizational processes typically involves the development of so-called “as-is” process models that capture the current organizational reality, which are then provided to analysts in hope that they would stimulate creative ideas about how the current processes can be changed to yield the desired business

1 WU - Vienna University of Economics and Business, Institute for Information Systems and New Media, Welthandelsplatz 1, Vienna, Austria, kathrin.figl@wu.ac.at
2 Queensland University of Technology, QUT Business School, Brisbane, Australia, j.recker@qut.edu.au
outcomes. The question that unfolds, however, is whether process models are actually assisting analysts in finding innovative new solutions for “to-be” processes, or whether they limit them to narrow current ways of thinking. For example, process modeling has been argued to focus mainly on the shortcomings of an existing solution, with the consequence that model-based process innovation concentrates on overcoming existing problems rather than achieving inspirational new goals [Ro06]. Other studies, however, suggest that good process models are an important determinant to process improvement success [Ko09].

2 Research Model

Figure 1 shows the research model that framed our experimental study: We were interested in the influence of the type of process representation on the creativity and type of the process-redesign solutions. Based on findings in the literature on how individual characteristics relate to creative problem-solving processes, the model also acknowledges the relevance of the individual as a creative person by using creative competence [Cr05] and creative attitude as control variables.

![Research Model Diagram](image)

Figure 1. Research Model (adapted from [FR16]).

3 Design

We conducted an experiment to investigate the impact of type of process representation (textual versus diagrammatic) on creative redesign while controlling for other factors. We asked participants to analyze and redesign a business process for a pizza-delivery service business process in three different improvement tasks [Ob13]. We employed two
categories of dependent variables. First, we measured the solutions’ creativity in terms of fluency (number of ideas), appropriateness, and originality, as is common in the creativity literature, and in terms of their impact [Pi12]. We added the impact dimension in order to relate creative problem-solving solutions back to the original business objective of changing a process (thus to differentiate process redesign solutions that are truly relevant to the business from other creative solutions). Second, we used a measure we developed for the type of solutions in terms of the locus of change, that is, as affecting the control flow, information systems, or the organizational, technological, or the data component of a business process. Three research assistants coded the creativity of process redesign ideas. The answer “Webcam in the kitchen with livestream. Pizzas get name cards and can be observed while baking.” was for instance rated high, the answer “Tell them to set an alarm clock.” was rated low in originality for the task “The pizza-delivery service wants to improve its processes, so that customers know at all times when their pizza will arrive. How can the process be changed to implement this improvement?” Additionally we measured creative competence with a standardized instrument, the Abbreviated Torrance Test for Adults [GT02].

For the experiment, we recruited 120 university students from a business school as proxies for future end-users of process representations who have at least some knowledge about business domains and business-process management.

4 Results

To identify differences between the main experimental groups, we performed analysis of covariance for repeated measures tests, with the treatment (text or diagram) as the independent variable for each dependent variable (fluency, appropriateness, originality, and impact of a future process; number of control flow-/ information system-/ data-/ technological resources-related ideas) in all three creativity tasks. We used creative competence as a covariate.

In summary, we found three major results: First, the “diagram” group generated ideas that were more appropriate than those of the “text” group. They also produced ideas of greater originality and impact, although these results were not significant at the p<0.05 level. Most of the results were in line with our expectations, but the number of ideas produced was similar between the two groups. The findings confirm a commonly held notion that diagrammatic process models are a useful aid to process analysts in designing future processes. While these results demonstrate that diagrammatic models do not make analysts more creative per se or lead to a higher number of ideas, the redesign solutions offered appear to be beneficial in terms of dimensions like appropriateness and type of idea. Our findings do not support the argument that process models evoke fixation and hinder the generation of creative, appropriate ideas.

Second, the individual creative competence factor affected the number of ideas produced, confirming the widely held assumption that participants with higher creativity
produce more ideas.

Third, participants in the diagram group produced more ideas related to information systems and fewer ideas related to data than the text group did. Diagram users also produced more control flow ideas but fewer organizational resource ideas, but neither difference was significant. In sum, the type of process representation influenced some but not all types of process-redesign ideas. One useful interpretation of our findings is that managers can, at least to some extent, guide the development of future processes by selecting a process representation format that is more or less conducive to producing changes to the control flow, data, resource, or technology components of a business process.

References

Modeling Test Cases in BPMN for Behavior-Driven Development (Extended Abstract)

Daniel Lübke\textsuperscript{1} Tammo van Lessen\textsuperscript{2}

\textbf{Abstract:} Validating analytical business processes and testing executable ones are difficult tasks in process development projects. Within the project Terravis, which builds a process hub for enabling fully digitalized mortgage processes between Swiss land registries, banks, notaries and other parties, these tasks became problematic. For improving stakeholder communication and extending the test scope, behavior-driven development was adapted to BPMN and business processes. This technique was introduced and very well received within the project, leading to better process documentation and better tests.

\textbf{Keywords:} BPMN, Process Elicitation, Business Process Modeling, Scenarios, Model-Driven Testing, Behavior-Driven Development

1 Introduction

Business Process Modeling is a challenge in practice: Many stakeholders need to be interviewed and their opposing views integrated into one target solution. The project Terravis [BLM14] faced this problem heavily when it started to build a process integration platform for all land registry-based business throughout Switzerland. Prior to this project, there was no overall process description on how mortgage-related business processes, e.g. increasing an existing mortgage because a bank customer wants to increase his/her loan for repairing the roof, are executed. Cantonal laws differ so that there was and still is no Swiss-wide homogeneous solution, banks and involved notaries conducted business differently and non-standardized. The financial crisis increased the pressure on the banks to operate more cost-efficiently in 2009. One possibility was to digitalize the business that was completely paper-based before.

Digitizing business processes meant to first understand the different variations of the same business process especially taking into account the cantonal legislature and different notary systems. The second step was to standardize the processes and used documents as much as possible before they were implemented in the Terravis Process Hub. Such an endeavor meant designing and especially validating the new business processes with all stakeholders that up to this point were not confronted with any BPM-related project nor had prior knowledge of BPMN.

\textsuperscript{1} innoQ Schweiz GmbH, Gewerberstr. 11, CH-6330 Cham, daniel.luebke@innoq.com
\textsuperscript{2} innoQ Deutschland GmbH, Krischerstr. 100, D-40789 Monheim am Rhein, tammo.van-lessen@innoq.com
The Process Hub consists of a central BPMS running executable business processes and a Web application that can be used to start and control running processes. Alternatively, all stakeholders can integrate via SOAP services.

This extended abstract will summarize the original paper [LvL16] describing the Behavior-Driven Development (BDD) Approach to find a practical way to validate new business processes and build executable test cases for Terravis efficiently.

2 Motivation

Terravis was in production for 3 years before first problems required a new approach to process modeling and testing. The platform grew and processes got more complex [Lü15]. Feature Requests came in via email and were not documented in appropriate quality in the existing process models. Also the impact of these changes were more and more unclear because very often stakeholders did not express enough constraints and clear business rules for the change scope. The communication between process stakeholders and the development team got interrupted, which is a common problem [SR16].

One essential change in Terravis’ environment led to a new approach to process validation and testing because it significantly increased the number of test cases:

Banks started to integrate their core systems to enable process integration with Terravis. However, two standard-banking-solution providers supported only an older version of the service interfaces. This in turn led to two new huge-impact features.

The first feature was multi-version support. When a new service version became available, external systems might use either the new or the old version. However, not all the necessary components could be tested with the Web application before because it supports only the newest service version. So, system tests conducted through the Web application cannot catch defects in the version transformation component.

The other requested feature was multi-channel capability. The banks realized they could not rely only on their systems’ capabilities. In order to access new features that are only available via the new service versions, they had to use the Web application. This meant that processes can be started via either the Web application or the integrated system and are “sticky”, i.e. all messages for that process instance are routed to the initiating system. However, the multichannel feature also could not be tested with the Web application alone.

The new approach needed to enable the testing of the new architectural features, provide test automation and increase process documentation quality as well the ability of the project to validate business process descriptions.

3 Approach

We decided to use a modified Behavior-Driven Development (BDD) approach. BDD [No06] is an evolution of Test-Driven Development (TDD) [Be03] that also integrates elements
from Domain-Driven Design (DDD) [Ev03]. While the roots are for sure in the field of software development, the approach is well-suited for business process design and modelling. Instead of the traditional Given-When-Then-structure for describing system behavior, the modified approach uses BPMN [SR09] scenarios.

A scenario is a completely sequential and deterministic business process model. Collapsed pools represent the process or the system to be described/tested and all process participants are modeled as pools exchanging messages with the test subject. A sample test case is shown in figure 1.

Test Data and Assertions from a business point of view, which are also useful for discussing and validating the business process with stakeholders, are added as documentation to the BPMN elements.

The free text is not completely free, but must conform to templates. These templates are defined according to the needs of the scenarios by the process developers. The same is done for the assertions. Finally, the pools and messages are mapped to WSDL the WSDL constructs Services, Porttypes, and Operations.

These mappings are used by a generator for generating an executable BPELUnit test suite [Lü07]. BPELUnit is the framework already used for unit testing all processes and using it for other SOAP-based tests was a natural choice. However, the conceptual approach is independent of BPELUnit and even WSDL & SOAP.

The project has adopted the new approach and modeled test cases for the 10 most frequently used process variants. Because the test cases are independent of any technical details, the test cases can be used with other technical mappings for different service versions. They are successfully integrated into the nightly build and test the current process implementations together with the current service and infrastructure implementations (e.g. ESB, digital archive, document generation, ...).
4 Conclusions & Outlook

The BPMN-based BDD approach uses scenarios modeled in BPMN with text-based descriptions of exchanged messages and assertions. It was very well received in the project Terravis and really allows BPMN to serve as a “lingua franca”: BPMN is not only to used for formulating an analytical model that is further refined into an executable model but it is also used for describing easy to understand scenarios that are also executable test cases.

Besides the technical motivation of developing well-understood test cases, the scenarios serve a validation and documentation purpose: The process documentation is made understandable for non-BPMN people and can be used in workshops to discuss process steps and variants. The project now establishes more and more test cases for existing processes.

All new processes are documented with scenarios for getting an analytical validation from all stakeholders before they are transformed into executable test cases by the development team. All test cases are executed daily as part of the nightly build.

We have received feedback to this approach by both industry and academia. Further formalization and conceptual support for other integration technologies like REST services are the next possible research steps.

The work summarized in this extended abstract has been published in [LvL16].

References


Towards Predictive Behavior Analysis for Smart Environments

Agnes Koschmider¹, Stefanie Speidel²

Abstract: Predictive behavior analysis allows prediction of the (human) behavior based on the analysis of historical data. Efficient approaches for predictive behavior analysis are available for scenarios with structured processes (e.g., based on ERP systems). The prediction of behavior becomes an obstacle when unstructured (decision making) processes underlie the scenario. Scenarios with unstructured processes can be found in smart environments logging sensor (event) streams such as e.g., Smart Home or Connected Cars. No efficient solutions exist to identify abnormal behavior (anomalies) in such smart environments. To provide a solution for anomaly detection in unstructured processes we suggest crossing process engineering with deep learning. Methods from process engineering allow identifying deviations while deep learning improves the robustness of anomaly detection and prediction. This conjunction is a promising approach in order to find an efficient solution.

Keywords: data, process mining, behavior analysis, deep learning

1 Introduction

Predictive behavior analysis allows prediction of the (human) behavior based on the analysis of historical data [Bi55]. Particularly, predictive behavior analysis intends finding patterns, which allow to identify deviations of human behavior and to give predictions how likely it is that activities occur in the future. Efficient approaches for predictive behavior are available for scenarios with structured processes. Blue Yonder³ is the leading predictive application for structured processes (i.e., they evaluate operating SCM, ERP or HR systems). The forecasts of Blue Yonder are highly robust because it is assumed that human behavior only rarely changes. The prediction of behavior becomes an obstacle when unstructured (decision making) processes underlie the scenario. Unstructured processes are characterized by activities that take place spontaneously and thus the prediction of an appropriate order of activities is hampered. Scenarios with unstructured processes can be found in smart environments logging sensor (event) streams such as e.g., Smart Home or Connected Cars. No efficient solutions exist to

¹ Karlsruhe Institute of Technology, Institute AIFB, 76128 Karlsruhe, agnes.koschmider@kit.edu
² Karlsruhe Institute of Technology, Institute AIFB, 76128 Karlsruhe, stefanie.speidel@kit.edu
³ http://www.blue-yonder.com/
identify abnormal behavior (anomalies) in such smart environments. For instance, a human-being does not necessarily show an abnormal behavior when leaving home directly after getting up while leaving home the day before after breakfast. Predictive behavior analysis might be beneficial for the following scenarios:

- **Smart Home**: Activities of daily life can be supported by techniques of Ambient Assisted Living. The Smart Home is equipped with numerous sensors (e.g., motion, temperature, heating) in order to provide assistance. Predictive behavior analysis for Ambient Assisted Living might determine the probability of falls or the change of care levels.

- **Connected Cars**: Are surrounded by sensors, which track every movement of the driver. Predictive behavior analysis allows an individual communication with the driver warning him/her about personal perilous situations (e.g., feeling uncomfortable when crossing a bridge).

- **Industry 4.0 / Industrial Internet**: Predictive behavior analysis might improve techniques for predictive maintenance (determining the default risk of machines), which are mainly based on heuristics.

The variety of systems helping decision makings of human-beings in smart environments are devoted to a situation-aware assistance. For instance, a Smart Watch that saves biometric profiles and gives recommendations to rest in case that an abnormal blood pressure arises. These approaches are mainly rule-based.

A prerequisite to provide a solution for anomaly detection in unstructured processes is the understanding how unstructured processes are generated from smart environments as shown in Fig. 1. The unstructured (personal) process is derived from traces using process mining algorithms.

![Diagram](image)

**Fig. 1.** From sensor streams to unstructured processes

Identifying anomalies in unstructured processes (called spaghetti processes) is not
feasible. It has been shown that multiple graph comparison (a process is a directed, bipartite graph) is an NP-complete problem [Co77]. Therefore, usually the heuristic miner is used to understand the process, which abstracts from exception behavior [WeRi11]. Due to the reduced consideration of exceptional activities, the heuristic miner is therefore not suitable for our purpose. Also a multiple comparison of traces is a NP-complete problem [WaJi94]. Therefore algorithms for pairwise sequence comparison have been proposed in the bio-informatics. The approach of [BoAa12] applies such algorithm in order to detect deviations between traces. With this approach missing or additional activities can be found (e.g., with regard to Smart Home it can be found that a person did not leave home at present day). The identification of missing or additional activities is not enough to identify anomalies. More sophisticated approaches are necessary.

2 Approach

Our approach is based on the crossing of interfield knowledge. Particularly, domain knowledge from process engineering is crossed with deep learning. First, sensor data must be accessible and must be processed in order to derive activities, e.g., moving at home, leaving home. We have access to a large data set of sensors of 50 households that was tracked for a period of one year. Additionally, minutes were taken about the state of the persons (how did they feel). We intend to implement an activity generator allowing to abstract activities from the data / event streams and to create the gold standard. Subsequently, approaches from process engineering and deep learning are applied in order to find anomalies.

- Process engineering methods contribute to the preparation of the trace in a way that also structural changes in the behavior of activities can be detected. Changes in the execution of activities allow to identify e.g., activities that are performed in sequence while they have been executed in parallel in the past indicating a performance reduction of the human-being. Abnormal process fragments could be simulated in order to identify temporal changes (e.g., the time to perform a task increases continuously). The view on the problem from a process engineering angle also allows to apply graph matching algorithms in order to detect anomalies in short process fragments (e.g., the behavior before and after jogging).

- Deep learning / machine learning approaches enable the detection of anomalies and the prediction of behaviour based on historical data. A specific challenge here are time series with heterogenous data that have to be analyzed. Deep Learning, especially recurrent neural networks like long short-term memory (LSTM) is a promising technique for predictive analysis of such data. The advantage of such
networks is the ability to process time series with an arbitrary length and the ability to remember relationships in different points in time. It can either be applied on low-level sensor information or on activities derived from sensor data.

3 Challenges

An appropriate crossing of methods from both domains remains a challenge of our approach. Furthermore, a solution for predictive behavior analysis in unstructured processes has to deal with challenges such as (1) Obtaining the gold standard, which shows the intended behavior, (2) Obtaining activities from (sensor) data. Initial solutions have been suggested [SRGM16], (3) Integration of sensor data (e.g., temperature) and activities (moving in the kitchen) during simulation, (4) Obtaining enough data for machine learning approaches, (5) Consideration of (external) environmental influences (e.g., delays of public transportation), (6) Consideration of personal (daily) purposes.

Acknowledgement: The idea of the project has been elaborated together with Melanie Herschel from the University of Stuttgart.

4 References


Repeated Use of Process Models: The Impact of Artifact, Technological and Individual Factors (Extended Abstract)

Alexander Nolte\textsuperscript{1}, Eike Bernhard\textsuperscript{2}, Jan Recker\textsuperscript{2}, Fabian Pittke\textsuperscript{3}, Jan Mendling\textsuperscript{3}

Abstract: Business process modeling has received a lot of attention from practitioners and researchers alike. Organizations make significant investments into process modeling in terms of training, tools and resources. Yet, having invested into creating large process model collections, process models often fall into disuse, provoking the impression that the initial investment has been lost. In this paper we present a summary of a study on factors that facilitate or hinder the repeated use of process models by individual users. Results from that study indicate the importance of quality and ease of understanding of process models to repeated use, alongside individual factors, such as motivation and individual expertise. We also identified means that support organizations in promoting repeated process model use. The work summarized in this extended abstract has been published in [No16].

Keywords: Process Modeling, Repeated Use, Value of Process Modeling, Intentions for Repeated Use, Survey

1 Introduction

In this paper we present summarized results from a study on factors that influence an individuals’ intention to repeatedly use process models and on means to foster repeated use. These results were reported in an article for the Decision Support Systems journal in June 2016. This paper provides a short overview of the approach as well as the results. For a full account of the research we would like to encourage the reader to refer to the respective journal paper [No16].

Studying factors that influence an individuals’ intention to repeatedly use process models is of relevance for research and practice alike since many organizations commit ongoing investments in creating large process model collections [Ra06]. Afterwards organizations are oftentimes faced with the problem that models fall into disuse which means that investments taken to create them are at the risk of being lost. Repeated use has been identified as a key challenge in order for process modeling to be beneficial [In09]. We subsequently conducted a study aiming at identifying antecedents of individual repeated use behavior.

There is a substantial body of literature that focusses on technical aspects of process

\textsuperscript{1} Ruhr-University Bochum, Bochum, Germany, nolte@iaw.ruhr-uni-bochum.de
\textsuperscript{2} Queensland University of Technology, Brisbane, Australia, e.bernhard@hdr.qut.edu.au, j.recker@qut.edu.au
\textsuperscript{3} Vienna University of Economics and Business, Vienna, Austria, fabian.pittke@wu.ac.at, jan.mendling@wu.ac.at
model re-use. In this field however re-use is understood as applying some fragments of a model or an entire existing model [Ko14] in the creation of a new or revised model. Discussions include, for instance, various types of re-use patterns [Th08]. Behavioral aspects of repeated process model use however have not been studies so far. In particular, questions of when and why a particular act of repeated model use is happening remain unanswered.

In order to close this gap we first developed a theoretical model of factors that might impact and individuals’ intention to repeatedly use a process model (section 2). Based on this model we created a questionnaire using established measures from literature, conducted a pretest and ran a study in one large representative organization (section 3). Results from this research are reported in section 4.

2 Theoretical model and background

We started our conceptualization by first defining our phenomenon of interest – repeated process models use – as “the extent to which a process model is employed again by an individual user to perform a task” [No13]. Repeated use in this context thus describes a knowledge seeking behavior rather an actual modeling task.

Based on this conceptualization we conducted an analysis of existing literature in order to identify factors that could potentially promote or hinder an individual’s intention to repeatedly use a process model. Due to the lack of empirical research on repeated process model use we extended our review to information artifacts and information seeking behavior. This included literature on knowledge re-use as well as more technologically centered scenarios such as software re-use, code re-use and database query re-use. We also considered literature concerned with factors that influence re-purchase intentions which have extensively been studied in the field of marketing. In total we identified the following groups of factors to have a direct positive effect on an individuals’ intention to repeatedly use a process model:

- **Artifact factors:** Repeated use will depend on the properties of the process model that is being repeatedly used. These properties include the fit of the process model to a task the user is aiming at repeatedly using it for, a users’ perception about the quality of the process model, her perception of the usefulness of a process model, her perception about how easy it is for her to interpret this process model and finally her previous satisfaction when using process models.

- **Individual factors:** We perceive repeated process model use as an individual knowledge seeking behavior and it is thus reasonable to include individual factors in our analysis. These factors include an individuals’ motivation as well as her modeling expertise. The latter is relevant for this context since extracting information from models requires the ability to read and understand them.
• **Technological factors:** Organizations usually have software tools in place in which models are stored and through which they are accessed. We thus included technological factors such as the perceived usefulness of a software, its perceived ease of use and the overall accessibility of process models into our analysis.

3 Study

In order to study the impact of the aforementioned factors on an individual's intention to repeatedly use a process model, we conducted a cross-sectional survey in one large representative organization. We selected a particular large European bank since process models are an important aspect of their work and using process models is a well-established practice there. That organization has a repository containing thousands of process models. We invited 406 people to participate and received 121 completed and 107 incomplete responses, which we excluded from further analysis.

For the survey we relied on established measures for each of the aforementioned factors and included questions that would allow us to gain a deeper understanding about the organizational context as well as the individual itself. These questions covered age and gender of a person as well as measures of the time an individual has been a member of the organization and which organizational unit the person belongs to. We also included questions about the purpose for which an individual generally uses process models during her work and we developed a scale aiming at identifying intentions for repeated use based on the definition described in the previous section (c.f. section 2). Finally, we included open ended questions which focused on the organizational context as well as on ideas of people on how to improve process models and process model access. The full questionnaire can be found in the appendix of our DSS paper [No16].

4 Analysis and results

After data cleansing which included removing inappropriate responses as well as responses by participants that had not used process models before we ended up at 86 usable data points for our analysis. We conducted a quantitative analysis starting with descriptive statistics and simple correlations before conducting a structural model estimation using PLS as well as a supplementary qualitative analysis. Due to page limitations we will only report on the most significant findings here.

The structural model analysis revealed the following factors to have a direct and positive effect on repeated process models use, in descending order of importance:

- The **perceived ease of use** of a process model,
- the **perceived usefulness** of a process model,
The analysis also revealed that satisfaction has no direct effect on repeated use intentions despite being influenced by the same factors that influence intentions for repeated use. Furthermore, satisfaction was also influenced by the perceived semantic quality of a process model.

These findings were supported by our subsequent qualitative analysis since most participants stated that models should be "short and simple but with enough details to understand them". The qualitative analysis also revealed that models are mainly used repeatedly to gain or regain knowledge about a process the respective participant is involved in. We also found enquiries by external stakeholders such as people from other departments and external partners to be a reason for repeated process model use. We could however not identify a fit between the original task a model was developed for and the task it was subsequently repeatedly used for to be a promoting factors for repeated process model use.

Finally, we also analyzed suggestions by participants on how to improve the repeated use of process models. There we found that most participants perceived models to be useless due to a number of different reasons such as a lack of appreciation for people who use models and devote time to keeping them up to date. Other reasons for this perception were the perception of models to be outdated and the perception that only a subset of existing processes are documented. In order to overcome this perception, some participants suggested that management support could increase the significance of process model use. Suggestion into that direction ranged from providing resources to use process models to expert support for people that are not capable of understanding process models on their own. Participants also mentioned that process models sometimes were hard to find in the corporate process model repository and subsequently suggested to invest in better search functionality.

5 Conclusion

Based on the aforementioned analysis we subsequently arrived at the conclusion that properties of the artifact as well as an individuals’ motivation and the accessibility of process models are the main factors influencing and individuals’ intention to repeatedly use a process model. The main influencing factors on individual intentions to repeatedly use process models however are the perceived ease of interpretation and the perceived usefulness of a process model. The perceived semantic quality of a process model did not influence intentions for repeated process model use which leads us to the conclusion that companies should focus on creating models that are easy to understand rather than overly complex. In order to foster repeated use, companies should also give their employees more time to use process models and provide them with means to easily access and explore them.
References


Alignment-based Metrics in Conformance Checking (summary)

B.F. van Dongen¹ and J. Carmona² and T. Chatain³

Abstract: The holy grail in process mining is a process discovery algorithm that, given an event log, produces fitting, precise, properly generalizing and simple process models. Within the field of process mining, conformance checking is considered to be anything where observed behaviour, e.g., in the form of event logs or event streams, needs to be related to already modelled behaviour.

In the conformance checking domain, the relation between an event log and a model is typically quantified using fitness, precision and generalization. In this paper, we present metrics for fitness, precision and generalization, based on alignments and the newer concept named anti-alignments. The work summarized here is presented in detail in [vdAA vD12, vDCC16].

Keywords: alignments, process mining, quality metrics, fitness, precision, generalization

1 Quality Metrics in Process Mining

The holy grail in process mining is a process discovery algorithm that, given an event log, produces fitting, precise, properly generalizing and simple process models. Event logs are generally considered to be accurate representations of the behaviour of a system in such a way that each event refers to an activity that was executed in the context of a case. By deriving a process model from such an event log, process discovery algorithms give insights into the underlying system. There has been always a discussion on how to interpret process discovery results, i.e. how does the produced model relate to the actual, but unknown, system in four quality dimensions [BvDvdA14]:

Fitness quantifies how much of the observed behaviour is captured by the model,
Generalization quantifies how well the model explains unobserved system behaviour,
Precision quantifies how much behavior exists in the model that was not observed, and
Simplicity quantifies the complexity of the model and is not considered in this paper.

Consider an example event log in Table 1, together with several process models as depicted in Figure 1 to 4. The model in Figure 1 shows the “ideal” process discovery result, i.e. the model that is fitting, fairly precise and properly generalizing. Models 2 and 3 are chosen such that they score poorly on at least one of the dimensions precision or generalization, while model 4 scores around 0.5 in both dimensions.

Tab. 1: An example event log

<table>
<thead>
<tr>
<th>Trace</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>⟨A,B,D,E,I⟩</td>
<td>1207</td>
</tr>
<tr>
<td>⟨A,C,D,G,H,F,I⟩</td>
<td>145</td>
</tr>
<tr>
<td>⟨A,C,G,D,H,F,I⟩</td>
<td>56</td>
</tr>
<tr>
<td>⟨A,C,B,D,F,I⟩</td>
<td>23</td>
</tr>
<tr>
<td>⟨A,C,D,H,F,I⟩</td>
<td>28</td>
</tr>
</tbody>
</table>

¹ b.f.v.dongen@tue.nl, Eindhoven University of Technology, Eindhoven (The Netherlands)
² jcarmona@cs.upc.edu, Universitat Politècnica de Catalunya, Barcelona (Spain)
³ chatain@lsv.ens-cachan.fr, LSV, ENS Cachan, CNRS, INRIA, Université Paris-Saclay, Cachan (France)
Table 2 contains our conformance metrics for fitness (F), proposed in [Ad14, vdAAvD12] and for precision (P) and generalization (G) proposed in [vDCC16] for the models in Figure 1 to Figure 4. In this paper, we explain the intuition behind these three metrics and we refer to literature for further details.

Alignment based Fitness. A model fits a log if all traces in the log can be replayed by the model. A fitness metric quantifies the fit of a log in a model. Several different measures exist for this quality dimension [BvDvdA14, Ad14, vdAAvD12, and references therein]. The most recent and robust technique uses a cost-based alignment between the traces in the event log and the most optimal execution of the process model [Ad14].

An alignment is a sequence of pairs that refer to an event from a trace and a transition in the model, or \( \gg \) elements indicating deviations. The projection of these pairs onto the first element yields the trace from the log and the projection onto the second elements yields a firing sequence in the model. Each pair in an alignment is called a move. If both parts of the pair are equally labelled, we call such a pair a synchronous move. A model move is a pair \( (a, \gg) \), i.e. a transition is fired, but no corresponding event appeared in the log and a log move is a pair \( (\gg, t) \), i.e. an event appears in the log, but there is no corresponding transition to be fired in the model.

Consider for example the trace \( \langle A, C, H, D, F, I \rangle \) and model 2. The optimal alignment for this trace in that model is \( \langle A \gg A, C \gg C, H \gg H, D \gg D, F \gg F, I \rangle \) with 5 deviations and a fitness of \( 1 - \frac{5}{11} = 0.55 \).

Typically, a cost function is used to compute so-called optimal alignments, such that the number of model moves, i.e. pairs \( (a, \gg) \), and log moves, i.e. pairs \( (\gg, t) \) in the alignment is minimized. Then, using an optimal alignment, i.e. an alignment with minimal cost,
for each trace fitness is calculated by adding all penalties for log and model moves and dividing that by the worst-case costs, i.e. the costs of an alignment with only log and model moves. For more details on fitness, we refer to [BvDvdA14, Ad14, vdAAvD12].

**Anti-alignment based Precision.** A model is considered *precise* if the behaviour the model allows for that was not observed in the event log is small. In this section, we present the precision metric proposed in [vDCC16], which uses anti-alignments as introduced in [CC16]. An *anti-alignment* is a firing sequence of a model which differs (according to some distance metric) sufficiently from all the observed traces in a log\(^4\).

Consider the log in Table 1 and model 4. A maximal anti-alignment of length 10 is the firing sequence \(\langle A, C, G, G, D, G, G, G, F, I \rangle\) with minimal edit distance \(\frac{4}{10} = 0.4\). In contrast, model 1 has only one anti-alignment, namely \(\langle A, C, G, H, D, F, I \rangle\) with length 7 and distance \(\frac{4}{7}\) and model 2 and 3 do not have anti-alignments.

In [vDCC16], we suggest a fresh view on precision, using anti-alignments\(^5\). The intuition behind our metric is as follows. A very precise process model allows for exactly the observed traces to be executed and not more. Hence, if one trace is removed from the log, this trace becomes the anti-alignment for the remaining log as it is the only execution of the model that is not in the log. We use this property to estimate precision. For each trace in the log, we compute a maximal anti-alignment for the model and the log without that trace. This anti-alignment is guaranteed to reach the final marking. Then, we compute the distance between the removed trace and the anti-alignment found which we average over the log, *not* taking into account the relative frequencies of the traces in the log. If the language of the model equals the log, then the anti-alignments will be equal to each removed trace, hence the precision is 1. If for every trace, an anti-alignment can be produced which has maximal distance from that trace, the precision is 0.

Frequencies of traces are not considered as the comparison is between the language of the model and the observed traces. Observing one trace more frequently than another should not influence the precision of the model as the unobserved behaviour does not change.

In trace-based precision, the length of the anti-alignment considered is bounded by the length of the removed trace. This guarantees that an anti-alignment exists in the log without that trace, but also limits the possibility to see imprecise executions of the model that are much longer than the lengths of the observed traces. Therefore, we also defined a log-based precision metric, which uses an anti-alignment of the model with respect to the entire log of a much greater length than the longest trace observed in the log. The log-based precision metric uses a single anti-alignment of considerable maximum length to determine the amount of behaviour allowed by the model, but not observed in the event log. Our final precision metric is a weighted sum of log- and trace-based precision.

**Anti-alignment based Generalization.** In contrast to precision, which relates the log and the model, *generalization* relates some unknown system to the log and the model as it rea-

\(^4\) We refer to [http://www.lsv.ens-cachan.fr/~chatain/darksider/](http://www.lsv.ens-cachan.fr/~chatain/darksider/) for the anti-alignment tool.  
\(^5\) This approach is implemented in the ProM package “anti-alignments” [http://www.promtools.org/](http://www.promtools.org/).
sons over expected future behaviour. Generalization aims to estimate the extent to which unobserved, but likely possible behaviour, is explained by the model.

In order to quantify generalizations, we consider not only the sequential behaviour that is actually allowed by the model, but we also quantify how different this behaviour is when considering the state space of the model. (Structured) loops and parallel structures, which are most commonly used to achieve generalization when modelling a system, have introduce new traces while introducing fewer new states. Therefore, in our generalization metric, we consider the notion of a recovery distance for an anti-alignment.

Like for precision, we first consider trace-based generalization following the same leave-one-out procedure. This way, the model is guaranteed to contain an anti-alignment of some distance (i.e. the removed trace). Not using trace-based generalization would lead us to consider all models non-generalizing if the log equals the language of the model. In contrast to precision, generalization depends on the frequency of the traces and once again, using the average over trace-based and log-based generalization we get one metric.

2 Conclusions and Future Challenges

In this paper we presented three metrics for fitness [vdAAvD12], precision [vDCC16] and generalization [vDCC16] based on alignments and anti-alignments. The future challenges in the domain of conformance checking are in scalability, i.e. dealing with volume and velocity and variability of input data; approximation, i.e. balancing computation time with accuracy of alignments; understandability, i.e. providing explanations of the root causes between observed and modelled behaviour; multi-perspective conformance, i.e. considering data, resources and time; measurability, i.e. providing a better understanding of the different conformance dimensions and solid metrics having a formal interpretation.

References


In Log and Model We Trust? (extended abstract)

Andreas Rogge-Solti, Arik Senderovich, Matthias Weidlich, Jan Mendling, and Avigdor Gal

Abstract: While models and event logs are readily available in modern organizations, their quality can seldom be trusted. Raw event recordings are often noisy, incomplete, and contain erroneous recordings. The quality of process models, both conceptual and data-driven, heavily depends on the inputs and parameters that shape these models, such as domain expertise of the modelers and the quality of execution data. The mentioned quality issues are specifically a challenge for conformance checking. Conformance checking is the process mining task that aims at coping with low model or log quality by comparing the model against the corresponding log, or vice versa. The prevalent assumption in the literature is that at least one of the two can be fully trusted. In this work, we propose a generalized conformance checking framework that caters for the common case, when one does neither fully trust the log nor the model. In our experiments we show that our proposed framework balances the trust in model and log as a generalization of state-of-the-art conformance checking techniques.

Keywords: process mining, conformance checking, model repair, log repair

1 Introduction

Business process management plays an important role in modern organizations that aim at improving the effectiveness and efficiency of their processes. To assist in reaching this goal, the research area of process mining offers multitude of techniques to analyze event logs that carry data from business processes. Process mining investigates the interplay among reality (system), its reported observations (event log), and a corresponding process model [BvDvdA14]. While reality is typically unknown, we are left with the need to reconcile the event log and the process model, where evidence of a certain behavior may only be present in one but not in the other.

Current conformance checking techniques are not capable of defining levels of trust for model and log to cater for uncertainty. Therefore, we consider the problem of optimally reconciling an event log with a process model, given an input event log and a model (if such exist) and our degree of trust in each. In this extended abstract we present the results of our work in [Ro16], where we outline that various process mining tasks can actually be regarded as special cases of this generic problem formulation. The problem formulation goes beyond locating misalignments between a process model and an event log by

1 Wirtschaftsuniversität Wien, Vienna, Austria, firstname.lastname@wu.ac.at
2 Technion–Israel Institute of Technology, Haifa, Israel sariks@tx.technion.ac.il
3 Humboldt University of Berlin, Germany firstname.lastname@hu-berlin.de
4 Wirtschaftsuniversität Wien, Vienna, Austria, firstname.lastname@wu.ac.at
5 Technion–Israel Institute of Technology, Haifa, Israel avigal@ie.technion.ac.il
providing explanations of misalignments and categorizing them as one of a) anomalies in an event log, b) modeling errors, and c) unresolvable inconsistencies. This generalized conformance checking problem can be seen as the unification of conformance checking, model repair, and anomaly detection.

2 The Generalized Conformance Checking Problem

We consider the setting that next to the given input event log $L$ and input process model $M$, we also have a trust level for the model $\pi_M$ and a trust level for the log $\pi_L$. Latter reflect for instance the trust in the event recording mechanism, or the trust in the abilities of the modeler. In this setting, we are interested in finding the optimal (repaired) log $L^*$ and (repaired) model $M^*$ pair that best fit the input log $L$ and model $M$, and also fit each other best according a distance measure (e.g., replay fitness).

To solve this problem, we propose a two-step divide-and-conquer approach. The main idea of this approach is to avoid the inherent complexity induced by the freedom to change the model or the log by sequentialization: first identifying changes in the model, before turning to changes applied to the log.

Our approach is outlined in Figure 1. We lift the problem into the model space by mining a model $M(L)$ by representing event logs as their discovered counterparts. Then, we approximate $M^*$ by applying a greedy heuristic search in the space between the input model $M$ and the mined model $M(L)$. If we strongly trust our input model, then, we respect that by not allowing to move too far away from the input model. If we do not trust our input model at all, we would end up with the mined model $M(L)$.

After approximating the optimal model $M^*$, we align the input log $L$ to it using techniques like [vdAAvD12], and see which deviations remain. These misalignments then need to be classified into errors in the log, and remaining non-conformance between event log and model. Here, we use the trust in the log to determine the the share that will be corrected in the log. For example, if we trust our log to be correct entirely (trustlevel 1), we do not
Classical Process Discovery finds a model that best fits to the entire event log, e.g., the alpha algorithm [vdA WM04].

Heuristic Process Discovery algorithms apply preprocessing to the event log by discarding infrequent patterns [GvdA07, WvdADM06].

Model Repair fixes deficient models due to e.g., a change in the system that is reflected in the log. For example [FvdA15].

Conformance Checking. This task tries to find misalignments between event log and model. Example works include [RvdA08, vdaA vD12, Se16].

Log Repair. Given a trusted model and a noisy log, we modify the log until it conforms to the model [Ro13, RSK14, Wa15].

“Happy Path” Simulation is complementary to heuristic process discovery. It is a theoretical use case where we do not trust infrequent parts of the model [MSS15].

Process Simulation is complementary to process discovery, where we are given an untrustworthy empty log and a fully trustworthy model.

Garbage In, Garbage Out. When both the model and the log are untrustworthy, the best log and model tuple that fits them is any pair of model and log that fits each other, including an empty log and an empty model.

Generalized Conformance Checking is the focus of this paper. Instead of only detecting the misalignments, as in conformance checking, we also provide, where the model would best be adopted, and where the log would best be adopted for a better overall fit.

<table>
<thead>
<tr>
<th>Process mining task</th>
<th>Log Trust</th>
<th>Model Trust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classical Process Discovery</td>
<td>$\pi_L = 1$</td>
<td>$\pi_M = 0$</td>
</tr>
<tr>
<td>Heuristic Process Discovery</td>
<td>$0 &lt; \pi_L &lt; 1$</td>
<td>$\pi_M = 0$</td>
</tr>
<tr>
<td>Model Repair</td>
<td>$\pi_L = 1$</td>
<td>$0 &lt; \pi_M &lt; 1$</td>
</tr>
<tr>
<td>Conformance Checking</td>
<td>$\pi_L = 1$</td>
<td>$\pi_M = 1$</td>
</tr>
<tr>
<td>Log Repair</td>
<td>$0 &lt; \pi_L &lt; 1$</td>
<td>$\pi_M = 1$</td>
</tr>
<tr>
<td>“Happy Path” Simulation</td>
<td>$\pi_L = 0$</td>
<td>$0 &lt; \pi_M &lt; 1$</td>
</tr>
<tr>
<td>Process Simulation</td>
<td>$\pi_L = 0$</td>
<td>$\pi_M = 1$</td>
</tr>
<tr>
<td>Garbage In, Garbage Out</td>
<td>$\pi_L = 0$</td>
<td>$\pi_M = 0$</td>
</tr>
<tr>
<td>Generalized Conformance Checking</td>
<td>$0 &lt; \pi_L$</td>
<td>$0 &lt; \pi_M$</td>
</tr>
</tbody>
</table>

Table 1: Some process mining tasks cast as problem instances. [Ro16]

repair the log at all. If our trust in the input log is less (because it is based on noisy sensors for instance), then we repair a corresponding share of the misalignments in the event log.

Table 1 characterizes different areas of process mining and business intelligence that this generalized framework covers for different trust levels.

### 3 Conclusion

In this work, we presented a generalization of the conformance checking problem. It strives for a balance between two independent input parameters: the trust in the log quality, and the trust in the model quality. Specifically, when presented with an event log and a process model, generalized conformance checking attempts at repairing both according to
the initial trust levels, and returns an improved log-model pair. Generalized conformance checking is comparable to state-of-the-art model repair techniques in model quality measures. The full formalisation, evaluation results, and further details can be found in the original conference paper [Ro16].

References


Lessons Learned in Aligning Data and Model Evolution in Collaborative Information Systems (Extended Abstract)

Thomas Reschenhofer¹, Manoj Bhat¹, Adrian Hernandez-Mendez¹ und Florian Matthes¹

Abstract: Today’s enterprises have to align their information systems continuously with their dynamic business and IT environment. Collaborative information systems address this challenge by involving diverse users in managing the application’s data as well as its conceptual model. In this sense, both the data and the model co-evolve. There are different approaches for aligning data and model evolution, wherein either the data is aligned to the model, or vice versa.

In this work, we present a hybrid approach supporting both strategies and elaborate on our experiences of applying the approach in projects for over five years. Thereby, we discuss challenges and issues faced in those projects. We formulate those issues and respective solutions as lessons learned, which not only hold for the concrete system which was applied in those projects, but which should guide the design and implementation of all software systems supporting the co-evolution of data and model.

The work summarized in this extended abstract has been published in [Re16].

Keywords: Lessons learned, best practices, model evolution, data evolution, collaborative information systems, semantic wiki

1 Introduction

The demand and requirements for information systems are changing continuously due to an increasingly turbulent business environment, technology innovations, and legal regulations. Adaptive information systems enable enterprises to adapt their software systems to meet the demands of such a dynamic business and IT environment.

One aspect of an information systems that is subject to frequent changes is its conceptual model – also referred to as the user-model [MK15]. The reasons for the user-model changes are manifold and range from the correction of mistakes to the adaption to new laws and regulations. If the information system is not able to adapt to the changing environment, the quality of the system’s support for its business will decrease over time [vWv06]. Therefore, meta-model based information systems that allow users to dynamically update and evolve their user-models in order to meet the demands of the changing business needs are becoming popular. In a collaborative environment, this approach implies at least two different co-existing user roles for managing the user-model and its application data [SDW08] namely model designers who are responsible

¹ Technical University of Munich (TUM), Department of Informatics, Boltzmannstr 3, 85748 Garching. {thomas.reschenhofer, manoj.mahabaleshwar, adrian.hernandez}@tum.de, matthes@in.tum.de
for user-model changes, and end-users or data owners performing data changes.

Achieving such a collaborative environment that supports the evolution of both the user-model and its data in a coherent and consistent manner is a non-trivial task. Matthes et al. [MNS11] tackle this challenge with the so-called Hybrid Wiki approach. Thereby, the application data is initially represented by the unstructured wiki pages which can be structured incrementally and collaboratively by attaching types, attributes, and integrity rules. At the same time, model designers can define and adapt the user-model which imposes certain constraints on the underlying wiki pages and thus induces a schema on the application data.

Our experiences related to the application of a collaborative information system (CIS) that implements the Hybrid Wiki approach in a variety of use-cases and domains revealed a couple of challenges and issues which are not only related to the Hybrid Wiki approach in particular, but to collaborative approaches for the co-evolution of user-models and data in general. In this paper, we discuss our experiences of applying the Hybrid Wiki approach in industrial and research projects, and the consequences for the redesign of this approach.

2 Hybrid Wikis

The goal of the Hybrid Wiki approach is to empower non-expert users to collaboratively gather and consolidate information in a knowledge-based information system [MNS11]. It tries to reduce the complexities involved in using semantic wikis and their corresponding technologies including the markup language and the query language. The term “hybrid” refers to wiki pages which integrate a subset of semantic wiki features into classical wiki software.

The Hybrid Wiki approach enables data owners to iteratively structure initially unstructured data by adding attributes to wiki pages. Additionally, users can annotate wiki pages with type tags which enable the system to identify similarities between wiki pages. Furthermore, model designers can define type tag definitions, attribute definitions, and validators in order to specify constraints on the data. In this way, the model designer defines the user-model and urges the data owners to capture data corresponding to the user-model. It should be noted that in the Hybrid Wiki approach data owners are not restrained by strict integrity constraints while capturing information in wiki pages and their attributes, i.e., a value violating integrity constraints as defined in the user-model can still be stored in the CIS [MNS11].

The Hybrid Wiki approach was applied in several industrial and research projects in the domains Enterprise Architecture Management (EAM), Collaborative Product Development (CPD), and Collaborative Content Management (CCM) for more than five years [MN11], [RRS14].
3 Lessons Learned in Aligning Data and Model Evolution

Patton [Pa01] defines lessons learned as the knowledge which is derived from the screening of a situation and which can be applied in similar situations in the future. In the context of this paper, a lesson learned represents an issue we faced in the application of the Hybrid Wiki approach and the consequential redesign and reimplementation of our Hybrid Wiki system.

3.1 Relevance of Terminology

The starting point for defining the terminology of the Hybrid Wiki meta-model were wikis and wiki pages. However, these terms already refer to a certain form of representation and content creation, while the Hybrid Wiki approach was not only applied as a means for traditional knowledge management but also as a user-driven and model-based repository. Consequently, the stakeholders in the respective cases refer to their information objects using more general terms, e.g., *Entities* or *Workspaces*. In order to foster the adoption of the Hybrid Wiki approach in the future projects, we applied those implicitly proposed terminology changes to the Hybrid Wiki meta-model.

3.2 Simplicity vs. Expressiveness

Originally, the Hybrid Wiki meta-model allowed to assign multiple types (type tags) to one entity (wiki page). However, this seemed to be too complicated for the majority of users. As a consequence, we redesigned the meta-model accordingly, i.e., entities can only be assigned to a single type. On the other hand, the meta-model was extended by additional constraints to differentiate between additional types of attributes, e.g., dates or Booleans.

3.3 Configurability of Modeling Approach

Depending on the degree of maturity of the model, either a flexible data-first or a more restrictive model-first approach is desirable. Consequently, means for seamlessly changing the modeling approach in order to align it to the current needs are required, e.g., by activating or deactivating so-called free attributes (attributes which are not defined by the user model), or by configuring the strictness of constraints.

3.4 Searchable Inconsistencies

While inconsistencies between data and model are inevitable, users have to be supported in identifying and resolving them. This implies the need for facilities enabling the search for inconsistencies and to create data consolidation views.
4 Conclusion

There are three main conclusions which we draw from our experiences from the applications of the Hybrid Wiki approach. First, finding the right balance between data- and model-first approaches is decisive. The practical applications of the Hybrid Wiki approach revealed that in early stages of the user-model design, a focus on the data-first approach enables model designers to harness collective intelligence among the system’s users and to utilize each individual’s domain-specific knowledge. As soon as the user-model reaches a certain degree of maturity, the design space should be restricted in order to enforce a convergence of the user-model. Second, the co-evolution of both the user-model and its data yields to inconsistencies between them. One important success factor of software systems is the integration of adequate data consolidation tools and techniques. Third, a conceptual model enabling the co-evolution of user-model and data must have the right balance between simplicity and expressiveness. The basic concepts of a pragmatic approach to model and data co-evolution should be usable and understandable by a broad spectrum of both data owners and model designers.

5 Bibliography


Discovering Interacting Artifacts from ERP Systems
(Extended Abstract)\(^3\)

D. Fahland\(^1\), X. Lu\(^1\), Marijn Nagelkerke\(^2\), Dennis van de Wiel\(^2\)

**Abstract:** Enterprise Resource Planning (ERP) systems are widely used to manage business documents along a business processes and allow very detailed recording of event data of past process executions and involved documents. This recorded event data is the basis for auditing and detecting unusual flows. Process mining techniques can analyze event data of processes stored in linear event logs to discover a process model that reveals unusual executions. Existing techniques assume a linear event log that use a single case identifier to which all behavior can be related. However, in ERP systems processes such as Order to Cash operate on multiple interrelated business objects, each having their own case identifier, their own behavior, and interact with each other. Forcing these into a single case creates ambiguous dependencies caused by data convergence and divergence which obscures unusual flows in the resulting process model. We present a new semi-automatic, end-to-end approach for analyzing event data in a plain database of an ERP system for unusual executions. We identify an artifact-centric process model describing the business objects, their life-cycles, and how the various objects interact along their life-cycles. The technique was validated in two case studies and reliably revealed unusual flows later confirmed by domain experts. The work summarized in this extended abstract has been published in [Lu15].

**Keywords:** Process Mining, ERP-System, Artifact-Centric Model, Object Life-Cycle, Interaction Discovery

1 Introduction and Problem Description

Information systems (IS) not only store and process data in an organization but also record event data about how and when information changed. This “historical event data” can be used to analyze, for instance, whether information processing in the past conformed to the prescribed processes or to compliance requirements. Process mining [Aa11] offers automated techniques for this task. In particular exploring visual models discovered from event data allows to identify unusual flows and their circumstances; based on which concrete measures for process improvement can be devised [Ec15]. Prerequisite to this analysis is a process event log that holds events about information changes with the assumption that each event belong to one specific execution of a specific process.

In general, information access is not tied to a particular process execution; rather the same information can be accessed and changed from various processes and applications. For

\(^{1}\) d.fahland@tue.nl, Eindhoven University of Technology, The Netherlands

\(^{2}\) KPMG IT Advisory N.V., Eindhoven, The Netherlands

\(^{3}\) This article summarizes problem, approach, and selected findings of a study published as Xixi Lu, Marijn Nagelkerke, Dennis van de Wiel, and Dirk Fahland. Discovering Interacting Artifacts from ERP Systems. Services Computing, IEEE Transactions on, 8(6), 2015 doi: 10.1109/TSC.2015.2474358 [Lu15].
instance, in Enterprise Resource Planning (ERP) systems (such as SAP and Oracle Enterprise), information is stored in business objects or documents which are linked via one-to-many and many-to-many relations, typically in the relational database. The objects themselves are encapsulated in services [AMZ00] which are invoked by high-level end-to-end business processes; each invocation is called a transactions which is logged in the data object itself.

Fig. 1 shows a simplified example of the transactional data of an Order to Cash (OTC) process supported by SAP systems; Fig. 2(a) visualizes the events of Fig. 1 that are related to document creation. There are two sales orders S1 and S2; creation of S1 is followed by creation of a delivery document D1, an invoice B1, another delivery document D2, and another invoice B2 which also contains billing information about S2. Creation of S2 is also followed by creation of another delivery document D3. Further, there is a return order S3 related to S1 with its own return delivery document D4. The many-to-many relations between documents surface in the transactional data of Fig. 1: a sales document can be related to multiple delivery documents (S1 is related to B1 and B2) and a billing document can be related to multiple sales document (B2 is related to S1 and S2). This behavior already contains an unusual flow: delivery documents were created twice before the billing document (main flow), but once the order was reversed (B2 before D3).

When applying classical process mining techniques, one first has to extract an event log based on a single case identifier to which all event data can be related. Choosing SD id in Fig. 1 leads to the two sequences of events shown in Fig. 2(a). Process discovery on
this log yields the model of Fig. 2(b) which is wrong: two invoices are created before their deliveries instead of one, and three invoices are created instead of two (known as divergence and convergence, respectively) [Pi11].

2 Approach: Discovering Artifact-Centric Models

We propose to approach the problem under the “conceptual lens” of artifact-centric models [CH09]. An artifact is a data object over an information model; each artifact instance exposes services that allow changing its informational contents; a life-cycle model governs when which service of the artifact can be invoked; the invocation of a service in one artifact may trigger the invocation of another service in another artifact. Information models of different artifacts can be in one-to-many and many-to-many relations allowing to describe behavior over complex data in terms of multiple objects interacting via service invocations. Under this lens, each document of an ERP system can be seen as an artifact; a transaction on a document is a service call on the artifact; behavioral dependencies between transactions of documents can be seen as life-cycle behavior and dependencies of service calls. Describing the transactional data of Fig. 1 with artifact-centric concepts yields the model of Fig. 2(c); it visualizes the order in which objects are created and also highlights the unusual flow of invoice B2 being created before delivery D2.

The problem of discovering an artifact-centric process model from relational ERP data decomposes into two sub-problems. (1) Given a relational data source, identify a set of artifacts, extract for each artifact an event log, and discover a model of its life-cycle. (2) Given a set of artifacts and their data source, identify interactions between the artifacts, between their instances, between their event types and between their events. Figure 3 shows the overview of our approach. (1.1) We use the data schema of the data source to discover artifact types which detail all stamped columns related to a particular business object. (1.2) For each artifact we then extract a classical event log [Aa11], each case describes all events related to one instance of the artifact. (1.3) Existing process discovery algorithms allow discovering a life-cycle model of the artifact. In parallel, (2.1) we discover interactions between artifacts from foreign key relations in the data source; (2.2) during log extraction, each case of an artifact is annotated with references to cases of other artifacts this case interacts with. (2.3) The case references are refined into interactions between activities of different artifact life-cycles. Fig. 3: An overview on our approach.
3 Results

We implemented our approach based on [NvDF12] and conducted two case studies. By separating data into artifacts along one-to-many relations, we eliminated divergence and convergence, the *interaction flows* discovered from one-to-many relations were meaningful to business users, and unusual flows were detected.

Fig. 4 shows models obtained from 2 months data of an SAP Order-to-Cash process (11 document header tables, 134,826 records of 5–49 attributes); the model at the top was obtained with a classical approach (only 29 of 77 edges are correct); the model at the bottom was obtained using our approach. In both case studies the discovered process models were assessed as accurate graphical representations of the source data by domain experts; all edges including outlier edges were assessed as correct and traced back to the source data together with domain experts. These insights could be obtained exploratively and much faster than with existing best practices.

References


Workflow Management Principles for Interactions Between Petri Net-Based Agents (Extended Abstract)

Thomas Wagner¹ Daniel Moldt¹

Abstract: Agents provide suitable mechanisms for modelling complex interactions in distributed systems. In some cases, though, classical agents interactions may exhibit issues of complexity and rigidness. These issues can lead to cumbersome and inefficient implementations. Introducing workflow and especially task principles into agents interactions extends the mechanisms available to agent modellers. With these improved mechanisms it is possible to avoid issues found in classical agents interactions. This contribution describes a Petri net-based approach on this topic. The work summarised in this extended abstract has been published in [WM15b].

Keywords: Workflows, Agents, Integration, Interaction, Communication, Petri Nets

1 Introduction

Agents interactions provide the means to design, model and implement complex relations between components (i.e. agents) in distributed systems. Agents interaction patterns are usually highly complex and describe which agents are exchanging what data at what precise point in their execution. The ability to model this complexity is beneficial for most scenarios. However, the strict association of specific agents or roles of agents to particular data and/or functionality also contains an inherent rigidity. Especially in an open system, agents with capabilities unknown beforehand may be available. Incorporating these agents into a system is challenging, due to the rigidly defined interactions.

One approach to solve and avoid these kinds of issues originates from the field of workflow management. Agents interacting to provide the functionality within a system are conceptually very similar to humans doing work facilitated by a workflow. Both, agents and humans, serve as resources to a set of related processes. These processes consist of tasks that need to be accomplished in order for the process to finish. For agents as resources, these tasks are usually implicit within their behaviour. At some point during execution they receive a message and react to it by performing the pre-defined behaviour. Another difference is that there is no separate and explicit workflow or workflow engine(s) present in an agent system. Instead, the agents themselves serve as the engines whenever they request work from other agents. Altogether, this means that agents serve as both workflow resources and workflow engines within an agent system considered in workflow terms. The approach described in this abstract implements this idea to improve agents interactions.

This extended abstract is structured as follows: After this introduction the overall approach is presented in Section 2, a prototype in Section 3 and the abstract concludes in Section 4.

¹University of Hamburg, Department of Informatics, http://www.informatik.uni-hamburg.de/TGI/
2 Approach

The general approach takes the perspective that an agent system is a workflow system with a specialised form and categorisation of components. The behaviour of and between agents is considered in the form of workflow processes modelled as workflow Petri nets [vdA97]. These processes partition the functionality within the behaviour into explicitly modelled tasks. Tasks are intended to be executed by any agent that features the required functionality. The interface to the tasks is kept as generic as possible, simply requiring the form of input and output/result data. Task parameters describe the required functionality for the task as well as data formats. The understanding of the task concept follows the idea of the task transition [Ja02] for reference Petri nets [Ku02].

Figure 1 gives an overview of the approach. Some agents initiate, control and manage parts of the behaviour (i.e. the workflow processes) of a system. In workflow terms these agents act as workflow engines. Whenever a task becomes available, the information about it is sent to the so-called intermediary system. The intermediary system is a subsystem of agents providing standardised functionality. In workflow terms the intermediary system serves a function similar to a workflow enactment service (cf. [Ho95]). It gathers the information about available tasks from all engines and forwards it to the appropriate resources. Any agent of the system is a potential resource and registers itself and its capabilities with the intermediary system. The intermediary system filters available tasks for resources according to their capabilities. Resources can decide to request the tasks offered to them. When that happens the request is routed via the intermediary system to the engine. Note, that all communication between engines and resources happens with the involvement of or via the intermediary system. The engine has autonomous control over its workflows and can decide whether to agree to the request or not.

![Fig. 1: Overview of the Approach (Edited from WM15b)](image-url)
If it agrees, the request transitions in all three components fire (conceptually\(^2\)) synchronised (upper part of Figure 1). The resource then uses its internal functionality to execute the work associated with the task. If at any point the engine or the resource decide to cancel the task execution, the cancel transition in all three components is synchronised. If the resource is finished, it informs the engine of the result, but the engine has control whether or not to accept the result (or to cancel the task). Accepting the result confirms the task and fires and synchronises the corresponding confirm transitions in all three components.

The main effect of the approach is a decoupling of agents as interaction partners. Engines do not need to know beforehand which other agent is capable of and available to execute their requests. Agents simply send the task information to the intermediary system, which forwards it to all eligible resources. In cases of high workload the intermediary system may (in e.g. an open system) consider alternative resources and evaluate their functionality for a task. The benefits of the decoupling are increased flexibility and efficiency. There are also some disadvantages, especially w.r.t. the centralised nature of the intermediary system. These issues can mostly be solved in the implementation.

3 **WORKBROKER-Prototype**

The approach described above has been implemented in the WORKBROKER-prototype. The WORKBROKER realises an intermediary system using MULAN (Multi-Agent Nets, [Rö04]) and CAPA (Concurrent Agent Platform Architecture, [DMR03]) agents. It is integrated as a proof of concept into our software development support system (SDCC) for the PAOSE approach (Petri net based, Agent- and Organization-oriented Software Engineering\(^3\)). Agents (as engines) representing development teams execute development workflows. Tasks are e.g. requests for other development teams to fix bugs, change a common interface or clarify design choices. The engines create these tasks and send the information to the WORKBROKER intermediary system, which forwards them to the affected other development team agents. These agents then serve as the resources for the tasks with the WORKBROKER handling communication and management of the interactions.

4 **Conclusion**

In conclusion, the approach presented in this abstract enhances the way agents interact and cooperate. Utilising the idea of agents as engines as well as resources and considering interactions as (parts of) tasks and workflows allows modellers to exploit the advantages of workflows regarding behaviour modelling. It does not limit or prohibit any options regarding classical agents interactions and is thus a straightforward extension of capabilities for modellers. One can flexibly choose the best mechanism for each interaction.

In fact, the approach brings the concepts agents and workflows closer together. It is part of larger, ongoing work to combine and integrate the concepts of agent and workflow on the

---

\(^2\) Actual implementations would only enact a pseudo-synchronisation within distributed settings.

\(^3\) see [http://www.paose.de](http://www.paose.de)
abstract level. Through such an integration, the strengths of both, agents and workflows, can be made available to system modelling. Introducing workflow principles into agent behaviour is an important step for this integration. More information about the overall work on the integration can be found in [WM15a].

Applying the agent/workflow approach to our own SDCC provides relevant insights into the complex but powerful mechanisms: Currently, a new version of the WORKBROKER is being implemented in the prototype for the overall integration of agents and workflows. This new WORKBROKER realises an intermediary system between entities that can dynamically act and be regarded as agents, workflows or both. These entities are used for modelling systems in which structural and behavioural modelling abstractions are considered equally. The new prototype not only considers agents interactions in workflow terms, but instead the entirety of the agent. Using these integrated entities makes it easier and more directly possible to exploit workflow principles for agents. The effects are currently being researched, but are, from a modelling point of view, very promising.

Literaturverzeichnis


Automating Data Exchange in Process Choreographies (Extended Abstract)³

D. Fahland¹, Andreas Meyer, Luise Pufahl, Kimon Batoulis, Mathias Weske²

Abstract: Communication between organizations is formalized as process choreographies in daily business. While the correct ordering of exchanged messages can be modeled and enacted with current choreography techniques, no approach exists to describe and automate the exchange of data between processes in a choreography using messages. This paper describes an entirely model-driven approach for BPMN introducing a few concepts that suffice to model data retrieval, data transformation, message exchange, and correlation – four aspects of data exchange. For automation, this work utilizes a recent concept to enact data dependencies in internal processes. We present a modeling guideline to derive local process models from a given choreography; their operational semantics allows to correctly enact the entire choreography from the derived models only including the exchange of data. Targeting on successful interactions, we discuss means to ensure correct process choreography modeling. Finally, we implemented our approach by extending the camunda BPM platform with our approach and show its feasibility by realizing all service interaction patterns using only model-based concepts. The work summarized in this extended abstract has been published in [Me15].

Keywords: Process Modeling, Data Modeling, Process Choreography, Data Exchange, BPMN, SQL

1 Introduction and Problem Description

In daily business, organizations interact with each other, e.g., concluding contracts or exchanging information. Fig. 1(left) describes an interaction between a customer and a supplier with respect to a request for a quote. The customer sends the request to a chosen supplier which internally processes it and sends the resulting quote as response which then is handled internally by the customer. An interaction between business processes of multiple organizations via message exchange is called process choreography. In BPMN (Business Process Model and Notation), a choreography diagram describes the order of message exchanges between multiple participants from a global view (global choreography model). A collaboration diagram describes message exchanges are realized via send and receive activities, distributed over the different participants (local choreography model).

This paper considers how to implement local choreography models that adhere to a global agreement; we focus on a top-down approach where all participants jointly agree on a

¹d.fahland@tue.nl, Eindhoven University of Technology, The Netherlands
²andreas.meyer@hpi.de, luise.pufahl@hpi.de, kimon.batoulis@hpi.de, mathias.weske@hpi.de, Hasso Plattner Institute at the University of Potsdam, Germany
Fig. 1: Implementing a given global collaboration diagram (left) in a private process model (right)

Fig. 2: Modeling Guideline for deriving local process models from a global choreography model.

global data exchange and collaboration model to which each participant’s local process and data models either must adhere or are required to be changed accordingly [vdAW01]. Deriving a local choreography from a global one is a non-trivial step; various techniques are required [DW11] including locally enforcing the order of globally specified message exchanges. In general, both control-flow (order of message exchange) and data-flow (actual message contents) need to be addressed when transitioning from global to local models. The paper contributes an approach to for integrating control-flow and data-flow in message exchange; we present a few syntactic extensions to BPMN together with operational semantics that allow to model and realize the intended global interaction using model-based concepts only.

2 Approach

We combine several existing approaches to automate data exchange in process choreographies entirely model-driven as follows; these approaches are used along the general guideline shown in Fig. 2. (1) All participants agree on a global choreography model expressed in BPMN as shown in Fig. 1(left); BPMN will also be used for the local choreography models.
(2) In addition, we introduce that all participants globally agree to specific data exchange formats used in the collaboration modeled in UML: Fig 4(top) shows the global data model. (3) For mapping the control-flow of a global choreography model into local ones, we utilize the Public-to-Private approach [vdAW01] unchanged; Fig. 1(right) and Fig. 3 show the two local process models obtained from the choreography of Fig. 1(left).

(4) Next, we map the data perspective of the global choreography to each local process model by defining a straightforward attribute-level data schema mapping between global and local data models. When exchanging messages local data is translated from the local data model of the sender to the globally agreed on data model, and then translated by the recipient to its local data model. This way heterogeneous local data models are isolated from each other and are synchronized. By marking specific attributes of the global data model as correlation identifiers (e.g., Global_Request.r_id in Fig. 1(left)) we obtain locally usable correlation keys through the above mentioned data schema mapping; these local correlation identifiers can then be used as proposed in the BPMN standard to associate an incoming message to the right process instance.

(5) To process (create and store) messages in a model-driven fashion, we apply (and slightly extend) the approach in [Me13] for automatically deriving SQL queries from BPMN data objects to enact complex data-dependencies. Thereby, we utilize the notion of dedicated (multi-instance) case objects for subprocesses from to realize 1:n communication with a set of participants. Fig. 5 illustrates the syntax and the operational semantics we provided with this extension. 1.) To send Global Quote message, activity Send Quote first automatically derives SQL queries based on the annotations to its input data objects [Me13] (a Quote object related to the quote instance, a Request and several Article object related to the quote). 2.) The retrieved local data is transformed into a message carrying a data object of the global data model by an XQuery generated from the data schema mapping of Fig. 4. 3.+4.) The message is sent and received using standard communication protocols. 5.) The recipient correlates the received message through the designated correlation key Global Request.r_id; technically, we identify the process instance of the Customer that holds a Quote object with attribute r_id having the same value as the message;
this query is generated automatically. 6.+7.) The received message is transformed into local data objects (using the data schema mapping) which are then stored in the database of the Customer, again using queries derived from the output data objects of task Receive Quote [Me13].

3 Results

We integrated several existing, isolated techniques for fully model-based definition and enactment of choreographies. We provided a few minor syntactic extensions of BPMN with complimentary operational semantics that translates model features into executable, platform-independent code [Me15]; we implemented our approach based on the Camunda BPM engine; see http://bpt.hpi.uni-potsdam.de/Public/BPMNData. Using this engine, we created fully model-driven implementations of all service interaction patterns [BDtH05] including patterns on 1:n message exchange with multiple participants using identical/different correlation identifiers, and referral of correlation identifiers.

References


Gameful Business Process Modeling

Nicolas Pflanzl

Abstract: Gamification is a recent trend concerned with the use of game design elements in non-game applications. This PhD research proposal discusses the use of gamification for business process modeling in participative BPM scenarios. To that extent, a modeling tool allowing users to earn points and badges and compare themselves with others on a leaderboard is described. A discussion of initial, mixed results is provided.

Keywords: Gamification, Social BPM, Business Process Modeling, Modeling Software

1 Introduction

Gamification is a relatively novel phenomenon that denotes the use of game design elements in other, non-game contexts [De11] such as education, training, health, and work [HKS14]. While originally an industry-driven trend, gamification has recently become a well-embedded constituent of the academic discussion in fields such as Computer Science, Human-Computer Interaction and Information Systems. Empirical studies have repeatedly shown that it can deliver a diverse range of benefits, including an improved motivation, engagement, enjoyment, and learning of the “gamified” systems’ users, as well as behavioral changes [SF15]. The goal of the outlined PhD research project lies in an examination of the impacts of gamification through its implementation in a commercial business process modeling tool. The motivation for this endeavor is grounded in the expectation that Business Process Management (BPM) and its related activities will increasingly be democratized, thus transcending the domain of a small number of experts and coming into the area of influence of a much larger, heterogeneous number of potential participants [PV14]. An indicator for this is the emergence of Social BPM, i.e., an approach to BPM based on the principles of social software, including bottom-up self-organization, egalitarianism, and social production [Er10]. The main goals of Social BPM lie in improving the acceptance of business processes by including all relevant stakeholders in their conceptualization, as well as leveraging the ideas for process improvement and innovation of process end-users. However, such an approach comes with its own challenges, such as engaging and motivating employees to actually participate, educating and training BPM novices, and providing them with tools they can actually work with to create high-quality process models [PV14]. Gamification is envisioned as a tool that can help overcome these challenges and thus enrich BPM in democratized settings. The research endeavor follows the Design Science Research Process proposed by Peffers et al. [Pe07] and is currently in the evaluation stage of its first iteration. The remainder of this proposal consists of a description of a gamification concept in Section 2 and a prototypical implementation in Section 3, a discussion of initial evaluation results in Section 4, and a conclusion and outlook.
2 Concept

This concept outlines how the reported benefits of gamification can be leveraged to address some of the challenges that participative approaches to BPM entail. To that extent, gamification functionality shall be integrated into a business process modeling tool to support the goals of Social BPM and the goals of participating users. There is an understanding that the use of software tools holds considerable benefits for BPM projects [IEH99, Re12]. In particular, such tools can provide features complementary to the underlying modeling grammar that enrich working with the latter [Re12]. Following that logic, gamification can be instantiated as such a complementary modeling feature. The set of possible game design elements for gamified applications is vast, and as of yet there is no formal, validated approach that helps with their selection and composition. However, a set of three elements can be found in the overwhelming majority of implementations [HKS14, SF15]: points, badges, and leaderboards. Points represent a virtual currency that users can earn for the quantity and quality of work they perform. Badges are special distinctions users may earn for particularly remarkable behavior that are prominently featured on user profiles. Lastly, leaderboards present a ranking of users according to the points they have accumulated and are intended to stimulate competitive behavior. To gamify business process modeling, the activity must be reconceptualized as a gameful activity. Formally, a game can be defined as “a rule-based, formal system with variable and quantifiable outcomes, where different outcomes are assigned different values [and] the player exerts effort in order to influence the outcome [...]” [Ju11, pp.7-8]. Similarly, in business process modeling rules are imposed, e.g., by the modeling language, different outcomes are alternative solutions for a particular modeling task, different values are the qualities of the respective models, and the players are modelers who exert effort to create the best-possible model. This results in the notion of gameful business process modeling as an activity in which the performance of the modeler is constantly evaluated by measuring the quality of the current process model, rewards such as points and badges can be earned for the work that is done, and a leaderboard allows for a comparison with other modelers. Through this, the following positive effects can be expected: Firstly, the availability of points and badges increases the engagement and motivation of users to participate in Social BPM. Secondly, the availability of real-time modeling feedback coupled with rewards will both enable and motivate modelers to create high-quality process models. Lastly, the combination of these two factors will allow modelers to develop good modeling habits and practices over time. It must be noted that this concept is focused on short-term, extrinsic motivation, which is appropriate for initial implementations, but may not be able to reap the full potentials of gamification.

3 Implementation

To demonstrate the feasibility of the concept, points, badges and a leaderboard were incorporated into a business process modeling tool as a prototypical implementation. The interface of this implementation is depicted in Figure 1, with the central dotted box labeled C (Canvas) representing the modeling area. Central to the gamified modeling experience is box F (Feedback) which provides information about the quality of the current model in
real-time. Based on relevant literature (cf., e.g., [Pu02, Me08]), the prototype provides an experimental set of quality metrics addressing aspects of the readability, understandability and completeness of process models. In general, a user can earn 10 points per quality metric. With every change to the model, quality metrics that are affected are instantly updated, and thus it becomes possible for modelers to directly see the effects of their actions. Upon saving, a notification about the obtained points is shown to the user in the status panel (box S). Users can also unlock badges for reaching certain modeling milestones or performing particular actions, such as having created 10 process models, removed 100 edge crossings, or having written 10,000 characters of textual descriptions. The total number of badges earned by a user so far is also displayed in the status panel (box S) and a notification is displayed when a new achievement is unlocked. The implementation also consists of additional help features (boxes H1, H2) that provide further details and information about quality metrics to novice modelers. These are only peripheral to the gamification functionality, but can support learning. Also provided, but not depicted here, are user profiles as records of achievement, and a leaderboard for competition with others.

4 Evaluation

The prototype has been applied in a field study (n = 173) and a controlled experiment (n = 58) with Bachelor-level Information Systems students at the University of Münster. In the former, students were working on a process modeling case study over the course of a semester, whereas the latter consisted of a 45-minutes mock exam. In both, students were randomly distributed between working with/without gamification. The evaluation is still ongoing and has presented initial, mixed results. In the field study, students using gamification have engaged with the tool more as measured by the average number of logins.
Furthermore, they exhibited a more positive attitude towards the tool. Interestingly, with
the exception of “completeness” (i.e., providing as much metadata about process elements
as possible), the quality of the resulting process models were equal for both groups. Re-
sults are comparable for the controlled experiment: model qualities were almost identical,
but students using gamification made a smaller number of technical modeling errors. Ad-
ditionally, they were less confident about the quality of their results, which may be due to
negative effects of the real-time quality feedback on overconfidence. Lastly, they reported
a higher perceived usefulness of the tool and intention to use it again in the future. Some
of these results are unexpected and require a more in-depth examination in the future.

5 Conclusion

This paper has presented a gamification-based approach for enriching Social BPM. It has
described a concept based on points, badges, and leaderboards to turn business process
modeling into a gameful activity and discussed its prototypical implementation in a com-
mercial tool. Initial results from a field study and experiment paint a mixed picture, which
may lead to a refinement of the gamification concept in the future.

References

[De11] Deterding, Sebastian; Dixon, Dan; Khaled, Rilla; Nacke, Lennart: From Game Design
Elements to Gamefulness: Defining Gamification. In: 15th International Academic
[Er10] Erol, Selim; Granitzer, Michael; Happ, Simone; Jantunen, Sami; Jennings, Ben; Johan-
nesson, Paul; Koschmider, Agnes; Nurcan, Selmin; Rossi, Davide; Schmidt, Rainer: Com-
bining BPM and Social Software: Contradiction or Chance? Journal of Software Mainte-
[HKS14] Hamari, Juho; Koivisto, Jonna; Sarsa, Harri: Does Gamification Work? A Literature Re-
view of Empirical Studies on Gamification. In: 47th Hawaii International Conference on
[IEH99] Im, Il; El Sawy, Omar A; Hars, Alexander: Competence and Impact of Tools for BPR.
[Pe07] Peffers, Ken; Tuunanen, Tuure; Rothenberger, Marcus A.; Chatterjee, Samir: A Design
Science Research Methodology for Information Systems Research. Journal of Manage-
In: 47th Hawaii International Conference on System Sciences. 2014.
[Re12] Recker, Jan: Modeling With Tools is Easier, Believe Me - The Effects of Tool Function-
[SF15] Seaborn, Katie; Fels, Deborah L.: Gamification in Theory and Action: A Survey. Interna-
A Game Theoretic Perspective on Business Processes

Alexander Herwix

Abstract: It has been recognized that in times of digitalization and rapidly changing business environments business process management will need to question and evolve its core ideas to stay innovative and relevant. Thus, the presented research project aims to synthesize existing theoretical perspectives on business processes into a novel and unified conceptualization of business processes inspired by game theory. This may help to integrate the diverse fields of “process-related” research into a common framework. Initial theoretical considerations are presented.

Keywords: Business Process Management, Game Theory, Institutions, Organizational Routines

1 Introduction

Business process management (BPM) is “a body of methods, techniques and tools to discover, analyze, redesign, execute and monitor business processes” [Du13]. Traditionally, this has implied a focus on business processes that are relatively stable, core to the business and, thus, can reasonably be made explicit [vdAtHW03]. However, more recently BPM has been evolving towards a more embracing perspective, considering “all work as process work” [Ha15a] and subsuming activities that cannot easily be made explicit, for example, non-routine creativity- or knowledge-intensive activities [SR08, vdAWG05, Se15] under the umbrella of business processes. Consequently, Dumas et al. [Du13] define a business process very broadly as “a collection of inter-related events, activities and decision points that involve a number of actors and objects, and that collectively lead to an outcome that is of value to at least one customer” (p. 5).

As this shift in perspective is occurring there has been a recognition that existing BPM methods, techniques and tools are not easily transferable to this broader definition of business processes [SR08, vdAWG05, SRH12, HJ09]. Thus, it has been argued that BPM will need to strengthen and evolve its core ideas to stay innovative and relevant [Re14], especially in times of digitalization and rapidly changing business environments.

Existing BPM research has tackled this challenge in a variety of ways. A non-exhaustive list could include, for example, examining the flexibility of process-aware information systems [RW12], developing the case-metaphor into a new paradigm for business process support [vdAWG05] or investigating declarative approaches to business process modelling [Zu13]. While all of these approaches provide useful and interesting insights, they remain mostly practical and are seldom embedded in an encompassing and grounded theoretical perspective of business processes in their organizational context. A shared underlying

1 University of Cologne, Professorship of Integrated Information Systems, Pohligstr. 1, 50969 Cologne, herwix@wiso.uni-koeln.de
conceptualization of what a business process is or is not still remains elusive and poses a barrier to integrative research across "process-related" fields [Re14].

This research project aims to help address this challenge by investigating the following basic research question: How should business processes be conceptualized? In particular, the focus is set on developing a theoretical perspective that allows for the analysis and design of not only well-defined and established but also emerging, complex, non-routine, creativity- or knowledge-intensive business processes and supporting methods, techniques and tools. Towards this end, the research project pursues a two-staged research design. In the first stage of the research project a narrative literature review [BCK14] and case study research [Yi09] are employed to develop and initially evaluate a theory of business processes (i.e., theory type IV. [Gr06]). In the second stage a design science research (DSR) project is planned with the intention of evaluating the practical utility of this new understanding of business processes as kernel theory in the development of a design theory (i.e., theory type V. [Gr06]) for BPM systems. Consequently, the research project is expected to make meaningful theoretical as well as practical contributions.

2 Theoretical Background

A core theme underlying traditional BPM methods is the attempt to control the flow of work and optimize the division of labor and the associated effects of differentiation and integration of work practices in the context of business processes [Du13, Ha15a, Ha15b]. However, this mindset becomes severely challenged when creativity-, knowledge-intensive or simply non-routine activities are considered, where the predictability of inputs, resources or outputs is low [SR08, vdAWG05, SRH12, HJ09, Li03]. When work is increasingly unpredictable, simply the act of accomplishing it successfully becomes a major challenge and the main objective [Li03]. Optimizations regarding the control flow become less durable and quickly turn into possible sources of conflict and waste [HJ09, Li03]. Accordingly, existing BPM research has proposed to conceptualize business processes including such activities as consisting of well-structured sub-processes as well as pockets of creativity, which in turn can again be decomposed into multiple levels of abstraction [SMWR10].

A key insight not address by this perspective is that the routineness or creativity-intensity of business processes is not static but a dynamic relation between the environment and the resources (i.e., workers, machines, etc.) of any given business process [Li03]. Business processes evolve; non-routine can become routine and established routine or standard processes can turn non-routine or even chaotic as the environment or resources change [Li03]. A deeper understanding of what business processes are and how they emerge and evolve will be critical in today’s times of ever quicker changing business environments and increasing competitive pressures [Ba08, Te07, Pi14].

Most BPM research, however, has focused on investigating innovative technical and practical approaches to deal with non-routine business processes (e.g., [RW12, Zu13, Pe07, VBB13, Mu11, AW14]) and generally neglected to provide or build a coherent theoretical perspective of businesses and their processes [Re14, Di13]. Enterprise engineering (EE)
on the other hand, is an emerging discipline that has focused on building a comprehensive and integrated set of theories which aim to provide a solid foundation for the systematic engineering of organizations. EE builds on the language action paradigm and conceptualizes business processes as transaction types that consist of steps through a universal pattern of communicative acts between two actor roles (sic., one initiator and one executor role) [Di06]. Business processes where multiple actor roles are required to work together to deliver a service or a product are represented as a tree of causally related and nested transaction types [Di06] (p. 99-103). Although there is no doubt that EE is a well-grounded discipline, it has to be noted that even EE's conceptualization of business processes does not explicitly address their evolving nature. Several open questions remain, for example: How and why do business processes emerge and evolve? How are non-routine and routine business processes related? How can non-routine business process be effectively supported?

The emerging literature on the dynamics of organizational routines started to address similar questions [Fe16, FP03, Pe12, PF05, PH15]. In this literature stream business processes are viewed as emergent sociomaterial phenomena that can be conceptualized as patterns or networks of action [Fe16]. Viewed through this lens business processes evolve “in the form of a recursive cycle of performative aspects (specific performances in specific times and places) and ostensive aspects (enacted patterns)” [Fe16] (p.506) which can be manifested in the form of artifacts [PF05]. Mathematical modelling and simulation of patterns of actions has demonstrated that retention, variation and selection of actions seem to be the necessary and sufficient conditions that enable the emergence of four major dynamic properties also observed in business processes, namely, formation, inertia, endogenous change and learning curves [Pe12]. However, how this retention, variation and selection of actions comes about remains outside of the scope of current theoretical models in this research area.

Building on game theory, Aoki [Ao10] develops a conceptualization of corporations as institutions that emerge and evolve quasi-endogenously from the recursive play of linked and, thus, coevolving games in different (e.g., social or economic) domains (p. 132-143). In his work, institutions and individual agents are conceptualized as actors who interact in emergent quasi-environments that consist of multiple linked, thus, coevolving games across different domains. The strategies of actors then jointly construct an emergent state of play which manifests itself in salient public indicators that are perceivable by actors and shape their beliefs which in turn may lead to the adjustment of their strategies. To escape the inherent problem of infinite regress, he argues for the need to acknowledge the historical past and, thus, the evolutionary process (p. 121).

2 In essence, game theory posits that any interaction involving two or more actors can be viewed as a game. The rules of the game and the actions taken by the actors determine the outcome of a game. The set of actions selected by an actor is called his strategy. A central idea of game theory is the Nash equilibrium. A Nash equilibrium is a point where all actors' strategies are best responses given the rules of the game and the choices of the other actors. [YZ14]
3 Research Design

The research project aims to synthesize the aforementioned research streams into a comprehensive theoretical perspective of business processes as evolutionary phenomena that is rooted in game theory. More specifically, it is designed to develop the hypothesis that *business processes are meaningfully conceptualized as emergent phenomena that evolve as pattern representations of the recursive play of coevolving games in different domains* into a useful theory of business processes. Recognizing the underlying epistemological implications of this hypothesis, this project follows a generally design-oriented research approach.

In the first stage, which is currently ongoing, the research hypothesis is being developed into an initial theory of business processes. A narrative literature review [BCK14] is being conducted to identify and synthesize literature streams that provide different perspectives on how business processes are best conceptualized. Moreover, case study research [Yi09] is employed to juxtapose and refine theoretical considerations synthesized from the literature with empirical observations in the field. At the moment, a single, embedded case study design [Yi09] is planned. The unit of analysis is BPM system use in organizational units within the critical case of an enterprise with a strong record of BPM adoption. This design will ensure at least initial empirical validation for the emerging theory.

In the second stage, the emerging theory will be used to derive design guidelines for BPM systems. These guidelines are planned be instantiated in the form of IT artifacts that may be evaluated experimentally or in the context of action design research [Se11]. Although theory development is still on going, an intriguing initial design proposition can already be formulated: *If a business process can reasonably be conceptualized as the outcome of the recursive play of coevolving games, should BPM not focus on the general notion of providing methods, techniques and tools that support process stakeholders in their quest towards (hopefully Pareto-efficient) evolutionary stable equilibria?*

4 Expected Outcomes

Existing BPM research has neglected to integrate their mostly practically oriented endeavors into a comprehensive theoretical perspective of business processes. For example, there is no consensus on what a business process is or is not [Re14]. The research project is expected to provide a novel theoretical contribution in the form of an emerging theory of business processes rooted in game theory that aims to provide a coherent explanation of how and why business processes evolve as a consequence of the recursive play of linked and coevolving games in different domains. If successful, this would strengthen the core of BPM and could help to integrate the diverse field of "process-related" research into a common framework [Gi07]. Expected practical contributions include new insights in the form of theory derived and empirically evaluated design guidelines for BPM systems.
References


[Di13] Dietz, Jan L. G.; Hoogervorst, Jan A. P.; Albani, Antonia; Aveiro, David; Babkin, Eduard; Barjis, Joseph; Caetano, Artur; Huysmans, Philip; Iijima, Junichi; Kervel, Steven J. H. Van; Mulder, Hans; Op, Martin; Land, t; Proper, Henderik A.; Sanz, Jorge; Terlouw, Linda; Tribollet, Jose; Verelst, Jan; Winter, Robert: The discipline of enterprise engineering. International Journal of Organisational Design and Engineering, 3(1):86, 2013.


Elastic Process Optimization and Scheduling in the Cloud

Philipp Waibel

Abstract: Business processes in today’s industry are getting more complex and resource-intensive from day to day. Cloud computing offers methods and technologies that can help managing this steadily increase of complexity in the business process executions. A new class of Business Process Management Systems (BPMS), called elastic BPMS (eBPMS), is using Cloud computing resources for the enactment of so-called Elastic Processes (EP). Those eBPMS are combining traditional BPMS with Cloud controllers and are thus able to use Cloud resources for the EP enactment in an ad hoc manner. This paper focuses on our current work on a research eBPMS called ViePEP and discusses open research questions in the field of eBPMS.

Keywords: Elastic Processes, Elastic BPMS, ViePEP, Business Process, Cloud Computing

1 Introduction

The focus of Business Process Management (BPM) is the management and optimization of companies’ business processes. The daily work with business processes is supported by so-called Business Process Management Systems (BPMS). Such a BPMS supports the customer during the complete BPM lifecycle, including the definition of a business process and its enactment [We12]. A business process is a composition of several human tasks as well as software tasks that have to be executed on computational resources. Furthermore, the design of a business process can range from simple sequential executed process steps to more complex processes with loops, splits or choices [va03]. A special case of business processes, called workflows, are processes that only consist of software services [Ho15].

Workflow execution requests may occur in a regular interval, as well as in an ad hoc manner. Especially in the latter case, the rapidly changing resource requirements can lead to a suboptimal usage of the available computational resources (e.g., CPU or RAM). This may lead to over-provisioning, where more resources than needed are available, or to under-provisioning, where less resources than needed are available and the system may not be able to fulfill the request in time [Sc15].

Cloud computing offers a promising solution for the optimal usage of computational resources. By using well-known basic principles of Cloud computing, like leasing and releasing computational resources on-demand, BPMS are able to elastically react to rapidly changing resource requirements. A BPMS that is using Cloud resources to execute workflows is called an elastic BPMS (eBPMS) and the corresponding business processes are called elastic processes (EPs) [Du11]. Besides the management of the process lifecycle, an eBPMS is also a Cloud controller that leases and release Cloud resources, deploys services on them, and starts the services execution according to a schedule [Ho16].

1 TU Wien, Distributed Systems Group, Argentinierstrasse 8, 1040 Wien, p.waibel@infosys.tuwien.ac.at
This work-in-progress paper aims at presenting our former work on an eBPMS called ViePEP and discusses further open research questions in the field of eBPMS.

2 Vienna Platform for Elastic Processes

ViePEP (Vienna Platform for Elastic Processes) is a state-of-the-art eBPMS solution that combines the functionalities of a traditional BPMS with a Cloud controller that is able to enact software services on Cloud resources in a cost-efficient way [Sc13a]. This is done by continuous monitoring, optimization and scheduling of the available Cloud resources, in form of Virtual Machines (VMs), and service enactment while considering predefined Service Level Agreements (SLAs) to guarantee a certain level of Quality of Service (QoS).

As can be seen in the Figure 1, ViePEP consists of five top level entities. The first entity, the Client, is responsible for the modeling of the business process, the definition of optional SLAs and the issuing of business process enactment requests. The second entity, called BPMS VM, is the core of ViePEP. It is responsible for the enactment of the process and the optimization of the Cloud resources by solving an optimization problem in continuous intervals. The BPMS VM is also responsible for the leasing and releasing of VMs on Cloud resources and the execution of Backend VMs on them. Those Backend VMs are then responsible for the execution of services that represent the process steps. Finally, the Message Queue is used by the Backend VMs to send monitoring information to the BPMS VM. The Service Repository hosts the services that can be deployed on Backend VMs.

Due to space constraints we can not discuss each entity in greater detail, but the interested reader can find a more detailed description in [Sc13a].

3 Research Questions

Our former work on ViePEP raises several research questions, which are discussed in the following.

In the recent years the concept of Dockers significantly gained popularity. Compared to a traditional VM, Docker is a more light-weight system, which can be used to execute services that need less additional computational resources by surpassing the need of an
own operating system and is thus cheaper to execute than a VM. At the current status, ViePEP executes services on VMs. By updating the used optimization problem to allow Docker-based service enactment, the overall execution costs can be reduced even further.

To be able to optimize the usage of the Cloud resources as cost-efficient as possible while considering predefined SLAs, ViePEP analyzes the workflow including the process steps that are not yet executed. During this analysis, ViePEP tries to predict and schedule the execution of the upcoming process steps. This analysis raises two new research questions: The first question concerns the execution duration of a process step. Currently ViePEP uses Ordinary Least Squares Linear Regression, a 2-dimensional regression, to predict the execution duration of a process step. However, for many real-world services, this prediction mechanism is not sufficient and a multi-dimensional resource prediction is needed. The second question concerns the execution of a workflow. For a sequential workflow, the scheduling is straightforward. However, real-world workflows can be more complex and include XOR-gates and loops. In the first case, an analyzing software cannot predict which route the actual execution will take. Here, ViePEP considers the route with the longest execution duration and schedules according to these times, i.e., ViePEP applies a worst-case approach. Furthermore, if the process model contains loops, ViePEP cannot predict how often this loop will be taken. At the current state, ViePEP considers a predefined amount of loop rounds. By using stochastic analyzes both solutions can be enhanced. This means that a “smart” BPMS can learn from previous process executions and with this information, predict how often the loop will be executed or which branch of the XOR-gate will be taken.

Finally, the architecture of ViePEP can be extended by changing the central component BPMS VM (see Section 2) into a decentralized component. This adds the possibility to distribute the load, which is currently processed at one instance of the BPMS VM, onto several BPMS VM instances, so the BPMS VM does not become a bottleneck.

4 Related Work

To the best of our knowledge, relatively little research has been done in the field of eBPMS, as well as scheduling and resource usage of EPs. Besides our own work [Ho16, Sc13a, Ho13, Sc13b, HSD13], the work of Cai et al. [CLG13], Wei and Blake [WB14] and Bessai et al. [Be13] are worth mentioning. For a full discussion of the related work, we refer to [Sc15, Ho16].

Similar to ViePEP, in the work of Cai et al. [CLG13] the authors define an optimization model that provides a cost-efficient Cloud resource usage for EPs. However, their work only considers single processes. Therefore, their approach is not able to share resources among different processes like it is done by ViePEP. Bessai et al. also provide algorithms for cost- and time-efficient scheduling of business processes in Cloud computing environments [Be13]. In the work of Wei and Blake [WB14], the authors also provide algorithms for using Cloud resources for the execution of business processes. In comparison to the work of Bessai et al., they also allow QoS constraints. However, in comparison to ViePEP, they do not consider deadline constraints.
Acknowledgment

This work is partially supported by the Commission of the European Union within the CREMA H2020-RIA project (Grant agreement no. 637066).

References


[Ho15] Hoenisch, Philipp; Hochreiner, Christoph; Schuller, Dieter; Schulte, Stefan; Mendling, Jan; Dustdar, Schahram: Cost-efficient scheduling of elastic processes in hybrid clouds. In: 8th Int. Conf. on Cloud Computing. IEEE, pp. 17–24, 2015.


Towards Detecting Misalignment Symptoms: An Alignment Perspective-Driven Architecture-Matching Framework (Extended Abstract)

Dóra Óri

Abstract: When assessing the harmony between business and information systems, most of traditional studies deal with the presence and the achievement of strategic alignment. On the contrary, exiguous attention is paid to the phenomenon of strategic misalignment, which means the absence or difficulties of business-IT alignment. This paper deals with strategic misalignment between business and information systems. It proposes an enterprise architecture (EA)-based framework to detect the symptoms of misalignment in enterprise architecture models. It collects typical misalignment symptoms along the traditional alignment perspectives and connects them to relevant EA analysis types. The paper discusses the typical signs of strategic misalignment in different EA domain matches. Suitable EA analysis types are recommended to the detected signs of misalignment. The work summarized in this extended abstract has been published in Dóra Óri: Towards Detecting Misalignment Symptoms: An Alignment Perspective-Driven Architecture-Matching Framework. Enterprise and Organizational Modeling and Simulation. Lecture Notes in Business Information Processing, Vol 231. Springer Berlin Heidelberg, 2015.

Keywords: Strategic Alignment Perspectives, Enterprise Architecture Alignment, Misalignment Symptoms, Enterprise Architecture Analysis.

1 Introduction

One of the most important issues on information systems (IS) research is the need to align business with information systems. Since information systems facilitate the success of business strategies, the importance of business-IT (or strategic) alignment is unquestionable. While organizations are continually trying to achieve alignment, they are suffering from difficulties which encumber the achievement of alignment [Ca08]. Most of traditional alignment studies deal with alignment achievement [He93], while misalignment issues are scarcely covered in the literature. Besides the low attention on misalignment, existing literature on the topic suffers from another shortage. The innate ability of the enterprise architecture (EA) concept [Za87] to support alignment assessment is also scantily addressed in the literature (for exceptions see e.g. [Ca12], [Pe05] and [So05]).

This paper aims to present a framework to address the above illustrated concerns. The paper discusses strategic misalignment between the business dimension and the

1 Corvinus University of Budapest, Department of Information Systems, Fővám tér 13-15, H-1093 Budapest, DOri@informatika.uni-corvinus.hu
information systems (IS) dimension. It addresses misalignment analysis by proposing an EA-based framework to detect the typical symptoms of misalignment in an organization. The specific contribution of the paper lies in connecting typical misalignment symptoms to relevant EA analysis types.

2 Related Work – Excerpt

The theoretical foundation of the paper consists of two main parts. The first part deals with theoretical background: 1) Strategic Alignment, 2) Misalignment and 3) Enterprise Architecture. The second part of the section deals with specific works: Different EA analysis types as well as EA alignment methods are presented.

3 Framework Building for EA-Based Misalignment Assessment – Excerpt

The research model deals with enterprise architecture-based misalignment assessment. In this section an introduction is given on the components of the proposed framework. 1) Meta-methodology is used as a supportive research concept to build the framework. 2) Alignment perspectives are decomposed into perspective components according to the necessary SAM domain matches. 3) Typical misalignment symptoms are collected to every traditional alignment perspective. 4) Subsequently, suitable EA analysis types are recommended to the misalignment symptoms. Figure 1 shows the research model of the proposed framework. The original paper contains the above mentioned collections.

Fig. 1: The construction of Enterprise Architecture-Based Misalignment Assessment Framework
4 Operation of the Framework: An Example

This section provides the operation results of the proposed EA-based misalignment assessment framework. A detailed analysis is given on misalignment symptoms and relevant EA analysis types via matching alignment domains along the four traditional alignment perspectives (Strategy Execution, Technology Transformation, Competitive Potential and Service Level). As a first step typical misalignment symptoms are introduced to each alignment perspective. As a second step suitable EA analysis types are recommended which are able to detect the corresponding misalignment symptom. The results of the proposed framework are introduced in a well-structured manner.

As an example, the analysis of Strategic Execution Perspective is given. Table 1 shows typical misalignment symptoms as well as suitable EA analysis types to the perspective components of Strategy Execution perspective.

<table>
<thead>
<tr>
<th>Perspective Component</th>
<th>Misalignment Symptom</th>
<th>EA Analysis Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.1.1 Business Strategy and Business Structure matching</td>
<td>S.01 Undefined organizational mission, strategy and goals</td>
<td>A.03 Coverage analysis</td>
</tr>
<tr>
<td></td>
<td>S.02 Undefined business process goals, business process owners</td>
<td>A.03 Coverage analysis</td>
</tr>
<tr>
<td></td>
<td>S.03 Lack of relation between process goals and organizational goals</td>
<td>A.01 Dependency analysis, A.02 Network analysis, A.03 Coverage analysis</td>
</tr>
<tr>
<td></td>
<td>S.04 Undefined business roles or responsibilities</td>
<td>A.03 Coverage analysis</td>
</tr>
<tr>
<td>P.1.2 Business Structure and IT Structure matching</td>
<td>S.06 Application functionality does not support at least one business process activity</td>
<td>A.01 Dependency analysis, A.03 Coverage analysis, A.08 Heterogeneity analysis</td>
</tr>
<tr>
<td></td>
<td>S.07 Business process task supported by more than one application</td>
<td>A.01 Dependency analysis, A.03 Coverage analysis, A.08 Heterogeneity analysis</td>
</tr>
<tr>
<td></td>
<td>S.08 Critical business process does not depend on scalable and available applications</td>
<td>A.01 Dependency analysis, A.03 Coverage analysis</td>
</tr>
</tbody>
</table>

Table 1: Analysis of Strategy Execution perspective – Excerpt
5 Conclusion and Future Work

This paper dealt with EA-based misalignment assessment. After introducing theoretical context and related work, a framework was proposed on architecture matching-driven misalignment symptom detection. It was followed by an analysis: the framework was used to connect typical misalignment symptoms with traditional alignment perspectives. After collecting typical misalignment symptoms, relevant EA analysis types were recommended which were able to identify the misalignment symptoms in question. The main contribution of the paper was that it connected typical misalignment symptoms to relevant EA analysis types along the perspectives of the SAM model.

Presenting typical misalignment symptoms and recommending suitable EA analysis types along the four traditional alignment perspectives provided us with several insights regarding the nature of misalignment assessment. In the original paper 1 out of 4 perspective-based analysis – the Technology Transformation perspective – is evaluated in detail. The justification of the choices is based on the operation of the proposed framework.

As part of future work the approach will be evaluated against some set of testable criteria. In addition, the proposed framework will be tested and validated in real-life situations. Furthermore, containing EA models will be added to the framework. Finally, additional examination methods will be established in order to approach EA-based misalignment assessment from different perspectives.

References


Learning from Quality Issues of BPMN Models from Industry (Extended Abstract)

Henrik Leopold¹ Jan Mendling² Oliver Günther³

Abstract: Many organizations use business process models for documenting their business operations. In recent years, the Business Process Model and Notation (BPMN) evolved into the leading standard for process modeling. However, BPMN is complex: the specification offers a huge variety of different elements and often several representational choices for the same semantics. This raises the question of how well modelers can deal with these choices. Empirical insights into BPMN usage from the perspective of practitioners are still missing. We close this gap by analyzing a large set of BPMN 2.0 process models from practice. We found that particularly representational choices for splits and joins, the correct use of message flow, the proper decomposition of models, and the consistent labeling appear to be connected with quality issues. Based on our findings we give five recommendations how these issues can be avoided in the future. The work summarized in this extended abstract has been published in [LMG16].

Keywords: Process Model Quality, BPMN Modeling Guidelines, Modeling Recommendations

1 Introduction

Business process models play an important role for documenting business operations and for formalizing business requirements in software engineering. In recent years, the Business Process Model and Notation (BPMN) has become de-facto standard for process modeling. A major challenge of BPMN in practice concerns its complexity resulting from the considerable number of elements it offers, its sophisticated semantics, and its representational choices.

While the uptake of BPMN in practice has triggered the research community to study its usage, empirical studies on how BPMN is actually used are scarce [zMR08, MH08, Re10]. The scope of most contributions is restricted to language properties, e.g. [Re11, FMS13], instead of actual usage.

With this paper, we aim to shed light on the actual usage of BPMN, and conducted a study with six companies from industry. This way, we wanted to understand if quality issues arise and how they can be prevented. The participating companies provided us access to a total of 585 BPMN process models. We implemented an automatic guideline checker that covers rules described in BPMN textbooks [Al09, Si11, WM08]. The results helped us to learn about the frequency of different classes of modeling problems and to suggest a set of measures to overcome them.

¹ VU Amsterdam, De Boelelaan 1081, 1081 HV Amsterdam, The Netherlands, h.leopold@vu.nl
² WU Vienna, Welt handelsplatz 1, 1020 Vienna, Austria, jan.mendling@wu.ac.at
³ Universität Potsdam, Am Neuen Palais 10, 14469 Potsdam, Germany
2 A Study on BPMN Use in Industry

For our study, we collected a total of 585 BPMN 2.0 process models from six companies. The companies came from different industries and varied in size as well as in their degree of modeling experience. Using a variety of automated techniques, we developed a tool for checking a set of 35 well-known BPMN guidelines and correctness rules. This set covers in particular the guidelines proposed by Silver [Si11] and Allweyer [Al09] as well as the recommendations by White and Miers [WM08].

Figure 1 gives an overview of the 15 most frequent quality issues\(^3\). As indicated by the different bar colors, the quality issues can be subdivided into the three categories *structure*, *layout*, and *labeling*.

![Violations of modeling guidelines in practice](image)

*Fig. 1: Violation of modeling guidelines in practice*

The *structure* category refers to the consistent and correct use of modeling elements such as activities, gateways, events, pools, and flow connectors. For this category, our study yielded mixed results. On the positive side, we found that about 99% of the investigated models are free from any syntactical errors. On the negative side, we observe that 22% of the models contain deadlocks and 42% contain multi merges. The biggest problem, however, is caused by the inconsistent association of main and sub processes. In 86% of all models containing sub processes, the roles of the sub process do not match the corresponding role of the main process.

The *layout* category is concerned with the proper positioning of the process model elements in terms of cognitive effectiveness. Hence, it is the goal of the rules and guidelines of this category to guarantee that a model can be easily read and understood. Our study shows that only a few models suffer from issues such as inappropriate spacing, arcs flow-

\(^3\) Note that there are no overlaps among the quality issues.
ing into the wrong direction, or inconsistent incoming and outgoing behavior. Neverthe-
less, not all aspects are respected and implemented to the same degree. The biggest layout
issue concerns models of extensive size. About 47% of all models exceed the maximum
diagram size, i.e., they do not fit on a DIN A3 page.

The labeling category refers to the proper use of natural language in the process model.
Our empirical results show that between 40% and 47% of the labels follow syntactic pat-
terns that are potentially ambiguous and hence may negatively affect the understanding of
the model [MRR10]. Moreover, glossaries are used by a fraction of modelers only. About
72% of all roles and 77% of all data objects are not linked to a glossary. As a result, an
inconsistent usage of roles and data objects can be expected.

3 Five Measures for Improved BPMN Modeling

The results show that many quality and correctness criteria are well respected in the inves-
tigated organizations. However, we also observed that many advanced structural concepts,
such as consistency among process models, process model size as well as the labeling of
process model elements, appear to be connected with quality issues. Apparently, the avail-
able modeling recommendations and guidelines are not sufficiently clear. In the following,
we discuss the five major problem areas we identified and give specific recommendations
on how to avoid them.

1. Avoid implicit splits and joins: Implicit splits and joins via multiple outgoing and
incoming arcs are the major cause for deadlocks and multi merges. This problem is
caused by BPMN offering several options to represent such semantics. We therefore
recommend prohibiting the use of multiple arcs. The semantics of splits and joins
can be clearly and unambiguously defined using gateways.

2. Provide tool support for proper model decomposition: Our empirical results show
that modelers may struggle with the proper decomposition of their models. Either
the models are too big, or they are not fully consistent. Since both problems can be
effectively enforced by a modeling tool, we recommend implementing respective
mechanisms.

3. Omit the throwing message event: Our study suggests that message flow arcs may
cause several problems. Particularly the throwing message event appeared to cause
confusion. We hence recommend removing the throwing message event from the
symbol set. It is easy to use activities for throwing events instead.

4. Establish centrally maintained glossary: The consistent reuse of central concepts
such as roles and data objects is an important requirement for a sound process ar-
chitecture. Thus, we propose to introduce a centrally defined glossary that either
automatically monitors and imports new terms or is regularly updated by a dedi-
cated glossary manager.

5. Provide tool support for applying linguistic checks during the modeling process:
Achieving consistency with respect to the structural use of natural language seems
to be difficult. The most effective measure seems to communicate such inconsistencies already during the modeling process. Modeling tools could use techniques such as refactoring to automatically suggest a correct version of a non-compliant label [LSM12].

A closer look at our recommendation list reveals that particularly recommendations 1 and 3 can be traced back to the representational choices of BPMN. The modelers from the investigated organizations struggled with correctly dealing with these choices and incorporated errors that should be avoided. Our recommendations have the advantage that they do not restrict the expressive power of BPMN. Instead, they help the modeler to select a preferable representation when a specific pattern of behavior needs to be expressed. Recommendations 2, 4, and 5 refer to quality issues that may also occur in other process notations such as Event-driven Process Chains or UML activity diagrams. Still, our study demonstrates that also BPMN models may suffer from these problems. Hence, also these recommendations contribute to a consistent process architecture.

References


### Sprecher der mit der EMISA assoziierten Arbeitskreise und Fachgruppen

<table>
<thead>
<tr>
<th>Name</th>
<th>Funktion</th>
<th>Institution</th>
<th>Adresse</th>
<th>Telefonnummer</th>
<th>E-Mail</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prof. Dr. Michael Fellmann</strong></td>
<td>AK Semantische Technologien im Geschäftsprozessmanagement</td>
<td>Universität Rostock</td>
<td>Albert-Einstein-Str. 22, 18057 Rostock</td>
<td>+49 - 0381 498-7440</td>
<td><a href="mailto:michael.fellmann@uni-rostock.de">michael.fellmann@uni-rostock.de</a></td>
</tr>
<tr>
<td><strong>Prof. Dr. Stefan Strecker</strong></td>
<td>FG Modellierung betriebl. Informationssysteme</td>
<td>FernUniversität in Hagen</td>
<td>Fakultät für Wirtschaftswissenschaft</td>
<td>+49 2331 987-4431</td>
<td><a href="mailto:stefan.strecker@fernuni-hagen.de">stefan.strecker@fernuni-hagen.de</a></td>
</tr>
<tr>
<td><strong>Horst Kremers</strong></td>
<td>Committee on Data for Science and Technology</td>
<td>FernUniversität in Hagen</td>
<td>Albert-Einstein-Str. 22, 18057 Rostock</td>
<td>+49 - 0381 498-7440</td>
<td><a href="mailto:michael.fellmann@uni-rostock.de">michael.fellmann@uni-rostock.de</a></td>
</tr>
<tr>
<td><strong>Dr. Daniel Moldt</strong></td>
<td>FG Petrinetze und verwandte Systemmodelle</td>
<td>Universität Hamburg</td>
<td>Fachbereich Informatik</td>
<td>+49 – 40 428 83 2247</td>
<td><a href="mailto:moldt@informatik.uni-hamburg.de">moldt@informatik.uni-hamburg.de</a></td>
</tr>
<tr>
<td><strong>Prof. Dr. Markus Nüttgens</strong></td>
<td>AK Geschäftsprozessmanagement mit Ereignisgesteuerten Prozessketten</td>
<td>Universität Hamburg</td>
<td>WISO Fakultät, Wirtschaftsinformatik</td>
<td>+49 - 40 428 83 2247</td>
<td><a href="mailto:markus.nuettgens@wiso.uni-hamburg.de">markus.nuettgens@wiso.uni-hamburg.de</a></td>
</tr>
</tbody>
</table>
## Fachexperten der EMISA

<table>
<thead>
<tr>
<th>Prof. Dr. Jörg Desel</th>
<th>Prof. Dr. Drhc. Heinrich Mayr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fachbereich Softwaretechnik und Theorie der Programmierung</td>
<td>Universität Klagenfurt</td>
</tr>
<tr>
<td>FernUniversität in Hagen</td>
<td>Institut für Angewandte Informatik</td>
</tr>
<tr>
<td>D-58084 Hagen</td>
<td>Universitätsstraße 65-67</td>
</tr>
<tr>
<td>Tel: +49 - 2331-987 2609</td>
<td>A-9020 Klagenfurt am Wörthersee</td>
</tr>
<tr>
<td>E-Mail: <a href="mailto:joerg.desel@fernuni-hagen.de">joerg.desel@fernuni-hagen.de</a></td>
<td>Tel: +43 - 463 2700 3732</td>
</tr>
<tr>
<td></td>
<td>E-Mail: <a href="mailto:Heinrich.Mayr@aau.at">Heinrich.Mayr@aau.at</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prof. Dr. Gottfried Vossen</th>
<th>Prof. Dr. Andreas Oberweis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universität Münster</td>
<td>Karlsruher Institut für Technologie</td>
</tr>
<tr>
<td>Lehrstuhl für Informatik</td>
<td>Institut für Angewandte Informatik und Formale Beschreibungsverfahren (AIFB)</td>
</tr>
<tr>
<td>Leonardo-Campus 3</td>
<td>Kaiserstraße 89</td>
</tr>
<tr>
<td>D-48149 Münster</td>
<td>D-76133 Karlsruhe</td>
</tr>
<tr>
<td>Tel. +49- 251 83-38151</td>
<td>Tel.: +49 - 721 608 44516</td>
</tr>
<tr>
<td>E-Mail: <a href="mailto:vossen@uni-muenster.de">vossen@uni-muenster.de</a></td>
<td>E-Mail: <a href="mailto:oberweis@kit.edu">oberweis@kit.edu</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prof. Dr. Mathias Weske</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Universität Potsdam</td>
<td></td>
</tr>
<tr>
<td>Hasso-Plattner-Institut für Softwaresystemtechnik</td>
<td></td>
</tr>
<tr>
<td>Prof. Dr. Helmert-Str. 2-3</td>
<td></td>
</tr>
<tr>
<td>D-14482 Potsdam</td>
<td></td>
</tr>
<tr>
<td>Tel: +49 (0)331-5509191</td>
<td></td>
</tr>
<tr>
<td>E-Mail: <a href="mailto:mathias.weske@hpi.uni-potsdam.de">mathias.weske@hpi.uni-potsdam.de</a></td>
<td></td>
</tr>
</tbody>
</table>
EMISA-Leitungsgremium

Das im September 2012 gewählte EMISA-Leitungsgremium besteht aus den Sprechern der assoziierten Arbeitskreise und Fachgruppen (siehe vorige Seite) sowie folgenden gewählten Mitgliedern:

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prof. Dr. Jan Mendling</strong></td>
<td>(Sprecher des Leitungsgremiums)</td>
</tr>
<tr>
<td></td>
<td>Wirtschaftsuniversität Wien</td>
</tr>
<tr>
<td></td>
<td>Department of Information Systems &amp; Operations</td>
</tr>
<tr>
<td></td>
<td>Institute for Information Business</td>
</tr>
<tr>
<td></td>
<td>Welthandelsplatz 1</td>
</tr>
<tr>
<td></td>
<td>A-1020 Wien</td>
</tr>
<tr>
<td></td>
<td>Tel: +43-1-31336 5200</td>
</tr>
<tr>
<td></td>
<td>E-Mail: <a href="mailto:jan.mendling@wu.ac.at">jan.mendling@wu.ac.at</a></td>
</tr>
<tr>
<td><strong>Prof. Dr. Stefanie Rinderle-Ma</strong></td>
<td>(Stellv. Sprecherin, Redaktion EMISA FORUM)</td>
</tr>
<tr>
<td></td>
<td>Universität Wien, Fakultät für Informatik</td>
</tr>
<tr>
<td></td>
<td>Workflow Systems and Technology</td>
</tr>
<tr>
<td></td>
<td>Rathausstraße 19/9</td>
</tr>
<tr>
<td></td>
<td>A - 1010 Wien</td>
</tr>
<tr>
<td></td>
<td>Tel. : +43-1-4277 39517</td>
</tr>
<tr>
<td></td>
<td>E-mail: <a href="mailto:stefanie.rinderle-ma@univie.ac.at">stefanie.rinderle-ma@univie.ac.at</a></td>
</tr>
<tr>
<td><strong>Dr. Dirk Fahland</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TU Eindhoven</td>
</tr>
<tr>
<td></td>
<td>Architecture of Information Systems Group</td>
</tr>
<tr>
<td></td>
<td>NL-5600 MB Eindhoven</td>
</tr>
<tr>
<td></td>
<td>Tel. +31 40 2474804</td>
</tr>
<tr>
<td></td>
<td>E-Mail: <a href="mailto:d.fahland@tue.nl">d.fahland@tue.nl</a></td>
</tr>
<tr>
<td><strong>Dr. Agnes Koschmider</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Karlsruher Institut für Technologie (KIT)</td>
</tr>
<tr>
<td></td>
<td>Institut für Angewandte Informatik und Formale Beschreibungsverfahren (AIFB)</td>
</tr>
<tr>
<td></td>
<td>Kaiserstr. 89</td>
</tr>
<tr>
<td></td>
<td>D-76133 Karlsruhe</td>
</tr>
<tr>
<td></td>
<td>Tel: +49-721-608 44514</td>
</tr>
<tr>
<td></td>
<td>E-Mail: <a href="mailto:agnes.koschmider@kit.edu">agnes.koschmider@kit.edu</a></td>
</tr>
<tr>
<td><strong>Dr. Henrik Leopold</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>VU University Amsterdam</td>
</tr>
<tr>
<td></td>
<td>Department of Computer Science</td>
</tr>
<tr>
<td></td>
<td>De Boelelaan 1081</td>
</tr>
<tr>
<td></td>
<td>NL-1081 HV Amsterdam</td>
</tr>
<tr>
<td></td>
<td>Tel: +31 20 59 87767</td>
</tr>
<tr>
<td></td>
<td>E-Mail: <a href="mailto:h.leopold@vu.nl">h.leopold@vu.nl</a></td>
</tr>
<tr>
<td><strong>Dr.-Ing. Hansjürgen Paul</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Institut Arbeit und Technik</td>
</tr>
<tr>
<td></td>
<td>Forschungsschwerpunkt WISDOM</td>
</tr>
<tr>
<td></td>
<td>Munscheidstraße 14</td>
</tr>
<tr>
<td></td>
<td>D-45886 Gelsenkirchen</td>
</tr>
<tr>
<td></td>
<td>Tel. +49-209-1707229</td>
</tr>
<tr>
<td></td>
<td>E-Mail: <a href="mailto:paul@iat.eu">paul@iat.eu</a></td>
</tr>
<tr>
<td><strong>Prof. Dr. Eric Proper</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Luxembourg Institute of Science and Technology</td>
</tr>
<tr>
<td></td>
<td>IT for Innovative Services department</td>
</tr>
<tr>
<td></td>
<td>5, avenue des Hauts-Fourneaux</td>
</tr>
<tr>
<td></td>
<td>L-4362 Esch-sur-Alzette</td>
</tr>
<tr>
<td></td>
<td>Tel: +352 275 888 1</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:e.proper@acm.org">e.proper@acm.org</a></td>
</tr>
<tr>
<td><strong>Prof. Dr. Ulrich Reimer</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FHS St. Gallen</td>
</tr>
<tr>
<td></td>
<td>Hochschule für Angewandte Wissenschaften</td>
</tr>
<tr>
<td></td>
<td>Institut für Informations- und Prozess-Mgmt.</td>
</tr>
<tr>
<td></td>
<td>Rosenbergstrasse 59</td>
</tr>
<tr>
<td></td>
<td>CH-9000 St. Gallen</td>
</tr>
<tr>
<td></td>
<td>Tel. +41-71 226 17 46</td>
</tr>
<tr>
<td></td>
<td>E-Mail: <a href="mailto:ulrich.reimer@fhs.g.ch">ulrich.reimer@fhs.g.ch</a></td>
</tr>
<tr>
<td><strong>Prof. Dr. Manfred Reichert</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Universität Ulm</td>
</tr>
<tr>
<td></td>
<td>Fakultät f. Ingenieurwissenschaften u. Informatik</td>
</tr>
<tr>
<td></td>
<td>Institut für Datenbanken und Informationssysteme</td>
</tr>
<tr>
<td></td>
<td>James-Franck-Ring, Geb. O27</td>
</tr>
<tr>
<td></td>
<td>D-89069 Ulm</td>
</tr>
<tr>
<td></td>
<td>Tel: +49-731-5024135</td>
</tr>
<tr>
<td></td>
<td>E-Mail: <a href="mailto:manfred.reichert@uni-ulm.de">manfred.reichert@uni-ulm.de</a></td>
</tr>
<tr>
<td><strong>Prof. Dr. Matthias Weidlich</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Humboldt-Universität zu Berlin</td>
</tr>
<tr>
<td></td>
<td>Department of Computer Science</td>
</tr>
<tr>
<td></td>
<td>Rudower Chaussee 25,</td>
</tr>
<tr>
<td></td>
<td>D-12489 Berlin</td>
</tr>
<tr>
<td></td>
<td>Tel: +49 (0)30 2093 3143</td>
</tr>
<tr>
<td></td>
<td>E-Mail: matthias.weidlich @hu-berlin.de</td>
</tr>
</tbody>
</table>
Impressum


• Fachbeiträge
• Berichte aus der Praxis
• Projektberichte (auch über laufende Projekte)
• Aktuelle Schlagwörter
• Vorstellung von Arbeitsgruppen
• Buchbesprechungen
• Aktuelle Publikationen, Dissertationen, Habilitationen
• Tagungsberichte
• Call for Papers, Einladungen, Programme
• Leserbriefe, E-Mail-Zuschriften


Herausgeber: Leitungsgremium der Fachgruppe EMISA
Auflage: 500
Redaktion: Univ.-Prof. Dr. Stefanie Rinderle-Ma
Universität Wien
Forschungsgruppe Workflow Systems and Technology
Fakultät für Informatik
Währingerstraße 29,
A-1090 Wien

Tel: +43-1-4277-79110
E-Mail: stefanie.rinderle-ma@univie.ac.at

Redaktionsschluss für das nächste Heft: 1. Oktober 2017