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Advanced Information Systems Engineering

28th International Conference, CAiSE 2016 Ljubljana, Slovenia, June 13–17, 2016 Proceedings

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Preface

This volume of the LNCS series contains the papers accepted for presentation at the 28th International Conference on Advanced Information Systems Engineering (CAiSE 2016), held in Ljubljana, Slovenia, during June 13–17, 2016. CAiSE has established itself as a leading venue on information systems engineering. It serves as a forum for the exchange of ideas for researchers, practitioners, and students, where the most recent results in the domain are presented and discussed. In addition, it is a place to learn, meet the community, start new projects, and identify future trends.

Information systems are developed by people and for people. The CAiSE 2016 theme was "Information Systems for Connecting People," emphasizing the wish to satisfy the needs and requirements of people, both as individuals and as parts of organizations, which are socio-technical systems. In particular, this theme emphasized the role of information systems in communication among individuals, organizational units, and organizations themselves. It could also imply knowledge building and knowledge sharing, all kinds of decision making, negotiating and reaching agreements, bridging differences and distances among various points of view, perspectives, positions, and/or cultures.

Following this theme, the scientific program of CAiSE 2016, whose papers appear in this volume, included "traditional" topics associated with information systems engineering, as well as more contemporary topics and ones specifically related to the theme. The program included the following paper sessions:

- Collaboration
- Innovation, gamification
- Cloud and services
- Open source software
- Requirements engineering
- Business process modelling
- Business process management
- Variability and configuration
- Process mining
- Mining and business process performance
- Mining and decision support
- Conceptual modelling

CAiSE 2016 received 211 full-paper submissions from all over the world: papers were submitted from 48 countries in all five continents. After a rigorous reviewing process, involving the CAiSE Program Committee and Program Board, 35 high-quality papers were selected for presentation at the conference (acceptance rate of 16.5 %). Notably, the papers accepted for publication in the conference include representatives of all five continents, demonstrating how international CAiSE is.

The scientific program also included three keynotes and four tutorials, whose abstracts appear in this volume. The keynotes are: “Three Projects and a Projection” by Jonathan Grudin, “Making Your Users and You Tick” by Igor Benko, and “Processes and Quality of Data” by Barbara Pernici. The tutorials are: “Sustainability in Information Systems Engineering and Research” by Sergio España, Patricia Lago, and Sjaak Brinkkemper; “Quality of Business Process Models” by John Krogstie; “ICT-Based Creativity and Innovation” by Michele Missikoff; “Capability-Driven Development for Building Sustainable Information Systems” by Janis Stirna, Jelena Zdravkovic, and Hrvoje Simic.

In addition, the conference featured a variety of workshops, three attached working conferences, an industry track, a doctoral consortium, and a forum devoted to fresh research ideas. Separate proceedings have been published for all these events.

As editors of this volume, we would like to thank all the members of the Program Board and of the Program Committee, as well as external reviewers for their dedication in providing thorough and fair evaluations. Our deepest thanks to Richard van de Stadt, who helped us with the CyberChairPRO conference management system in an extremely effective way. We also warmly thank the local organization team and the CAiSE webmaster, publicity chairs, workshop organization chairs, forum chairs, tutorial and panel chairs, doctoral consortium chairs, publication chair, and industry chairs. Last but not least, we thank the general chairs, Marko Bajec and Johann Eder, who helped us with patience and dedication, combining experience with enthusiasm, to deliver a program that we are sure the community found interesting and inspiring.

April 2016

Selmin Nurcan
Pnina Soffer

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Keynotes

Three Projects and a Projection

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Abstract. Thirty years ago, working as a software engineer, I was asked to help develop information systems for connecting people—a range of communication and collaboration support applications and features. It proved difficult to develop systems that people wanted to use. To understand why I gravitated to research, continuing to work with developers and HCI practitioners when opportunities arise. In this talk I will discuss three favorite projects in recent years that had directly applied goals. The goals were fully realized in one case, partly realized in a second, and the third is a favorite because of what we learned. The project areas were an enterprise email system extension, an enterprise 'serious game' platform, and K-12 (primary and secondary) education. I will then step back to describe changes over thirty years that seem salient, and some of the challenges and opportunities confronting us today.

Making Your Users and You Tick

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Abstract. A successful system delights its users, makers, and operators. Making such a system requires melding of different disciplines, practices, a good timing, perseverance, social responsibility, risk management, and some luck. The challenge amplifies when the system targets users across continents and vastly different cultures. In this talk we will illustrate some of the challenges with lessons from Google Search and Google Maps. In particular, we will look into features that help connecting people and that help connect people to the issues they care about. As examples we will use My Maps that connect people over social issues. We will also look at experimental features in Google Search where we enabled interactions between people and cultural moments, and where we enabled American presidential candidates post content directly to Google Search.

Processes and Quality of Data

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Abstract. While a great emphasis has been given in the literature on modeling and analyzing the structure of processes, data being processed and managed within processes are often considered with less attention. In the talk, the importance of data in processes will be analyzed mainly from the point of view of its quality. The data being considered include both the ones directly managed by the process and also the ones that are available in the process execution environment, providing information about its context of execution. In particular the presentation will discuss the issues and possible techniques that can be adopted for evaluating the impact of poor data quality on processes, for assessing the importance of different data quality dimensions, such as, for instance, accuracy, consistency, and completeness, for improving processes adding data quality controls, for repairing processes when failures due to poor data quality occur during execution. Finally, future directions for research considering the opportunities and issues arising from the larger and larger amounts of data available in process environments from different sources will analyzed and discussed.

Tutorials

CAiSE 2016 Tutorials

This section contains the abstracts of the tutorials accepted for presentation at the 28th International Conference on Advanced Information Systems Engineering (CAiSE 2016), held in Ljubljana, Slovenia, from the 13th to the 17th of June, 2016.

The objective of the tutorials is offering new insights, knowledge and skills to managers, teachers, researchers, and students seeking to gain a better understanding of the state-of-the-art in Information Systems engineering. They are a good way to get a broad overview of a topic beyond a current paper presentation.

This year, 9 tutorial proposals were submitted for consideration at CAiSE 2016. The tutorials were evaluated according to several criteria: relevance to CAiSE, structure and contents of the proposal, attractiveness, novelty of the topic, perceived importance in the field, methodology for the presentation, background of the speaker(s) and past experience.

As a result, 4 tutorials were selected for presentation at the conference: "Sustainability in Information Systems Engineering and Research", by Sergio España, Patricia Lago and Sjaak Brinkkemper; "Quality of Business Process Models", by John Krogstie; "ICT-based Creativity and Innovation", by Michele Missikoff; "Capability Driven Development for Building Sustainable Information Systems", by Janis Stirna, Jelena Zdravkovic and Hrvoje Simic. All the tutorials were assigned 90 minutes for presentation and were included in the main conference program.

We would like to thank all the people involved in the organization of the event: the CAiSE 2016 Program Chairs, Selmin Nurcan and Pnina Soffer; the CAiSE 2016 General Chairs, Marko Bajec and Johann Eder; and all the colleagues who submitted their tutorial proposal for consideration to the conference.

Barcelona/Geneva, March 2016

Xavier Franch, Universitat Politècnica de Catalunya, Spain
Jolita Ralyté, University of Geneva, Switzerland

Sustainability in Information Systems Engineering and Research

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Abstract. Academic and industrial interest in sustainability-related topics is increasing. There is a growing awareness that, when it comes to improving the impact in our surroundings, every little helps. This tutorial provides an overview of sustainability in the realm of information systems, both from a research perspective and from the point of view of industry practitioners. Starting from the basics of sustainability and its relation with information technology, we then review methods and technologies applicable to this domain. Moreover, we will discuss the current challenges in sustainable information systems research and development. Interlarded with examples and interactions with the participants, our ultimate goal is to motivate you to take part in this interesting area with a strong societal impact.

Keywords: Sustainability · Green IT · Information systems · Responsible software · Responsible enterprise · Socio-environmental impact · Tutorial

1 ICT Sustainability Is Not Only a Hot Topic, but also Necessary

The behaviour of enterprises and citizens has an impact on the sustainability of the economic, social and environmental systems [1]. Responsible enterprises and well-informed citizens are agents of change towards a better world. Given the great challenges to be faced, their efforts need to be supported by the appropriate information and communication technology (ICT).

The impressive advances in ICT over the last few decades have brought big threats and opportunities. Among the threats, data centres serving the ever-growing demand for information are now responsible for around 2 % of greenhouse gas emissions, a similar share to aviation [2]. Advances in energy-efficient hardware and software are expected to alleviate this problem [3]. Among the opportunities, the emerging second wave of sustainable ICT is becoming more externally focused and service-oriented, applying technology not only to exploit enterprise and customer opportunities but also to address broader societal problems [4]. In this promising landscape there are many opportunities for successful innovations to be applied in sectors such as agriculture, construction, power, consumer services, manufacturing or transportation.

2 Overview of the Tutorial: From Basics to Challenges

The tutorial aims to raise awareness on the role that advanced information systems research and engineering can have in creating a more sustainable world. It is a call for participation in a growing movement to save the planet and its people, while keeping profit in mind. The main intended learning outcomes of the tutorial are the following:

- Know the basics of sustainability from the economic, social and environment points of view (a.k.a. triple bottom line).
- Understand the role played by information systems research and engineering in technical sustainability.
- Be aware of the relevant toolset of methods and technologies applicable to this research domain.
- Be able to outline past and current trends on sustainable software, as well as the open challenges of the area.

The tutorial provides a bird's eye view on sustainable information systems engineering and research. It intends to produce insights in the audience on how they can contribute to a more sustainable world as researchers and as individuals, presenting the necessary methods and tools to do so.

Eventually, we intend to motivate you to participate in improving our world: practitioners will learn what they can do to improve the responsibility of their enterprises (well-established practices and tools); researchers will learn how they can expand the frontiers of knowledge on sustainable software (relevant theories, research methods and challenges).

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Quality of Business Process Models

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Abstract. The goal of the tutorial was to discuss issues of quality of business process models, and how the SEQUAL framework on quality of models and modeling languages can be used in practice to assess and evaluate a business process model. Based on the tutorial and accompanying material, the participants should be able to use the framework in their own work. The expected audience of the tutorial was people with intermediate or advanced background in (process) modeling, although anyone with some familiarity with modeling, and in particular business process modelling should be able to benefit from the tutorial.

Keywords: Business process modelling · Quality of models · Modeling languages

Tutorial Details

Business processes is at the core of organizational activities. A (business) process is a collection of related, structured tasks that produce a specific service or product to address a certain (organizational) goal for a particular actor or set of actors. The management of business processes receives increasing interest [2]. An important area in this regard is the modelling of processes - Business Process Modelling. Although a lot of work is done in this area, we still have not developed a common agreement relative to central notions such as:

- Quality of business process models so they can be used to achieve their purpose.
- Appropriate modelling formalisms and extensions of modelling formalisms and approaches to support achieving and maintaining model quality.
- Needs for tools and methods to support process modelling.

Within process modeling we have found the move towards standardization, e.g. to the use of BPMN, but it can be argued that BPMN do not address all the goals of modeling [1]. To understand the issues of quality of conceptual models we have for many years worked with SEQUAL, a framework for understanding the quality of models and modeling languages, which we have seen can subsume all main aspects relative to quality of models. SEQUAL builds on early work on quality of model [7], but has been extended based on theoretical results [8, 9, 10] and practical experiences [3, 4, 6, 11] with the original framework.

SEQUAL has three unique properties compared to other frameworks for quality of models:

- It distinguishes between quality characteristics (goals) and means to potentially achieve these goals.
- It is closely linked to linguistic and semiotic concepts. In particular, the core of the framework including the discussion on syntax, semantics, and pragmatics is parallel to the use of these terms in the semiotic theory of Morris.
- It is based on a constructivistic world-view, recognizing that models are usually created as part of a dialogue between those involved in modeling, whose knowledge of the modeling domain changes as modeling takes place.

Work to specialize SEQUAL for investigating the quality of business process models is the topic of an upcoming book [5] and is the basis for this tutorial which contains the following parts:

1. Characteristics of business process models
2. Quality of models relative to different goals of business process modeling
3. Overall presentation of the SEQUAL framework
4. Exemplifying the different aspects of the framework
5. Extensive examples of how the framework has been used in industrial settings
6. Summary with a quiz and take home lessons

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ICT-Based Creativity and Innovation

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1 Framing Innovation

Innovation is a key factor to relaunch the EU industrial system. In particular SMEs, that represent the 99 % of the enterprises active in Europe, need to systematically adopt innovation as part of their everyday business (see: *continuous innovation* [1]). To this end, SMEs need to rethink their culture, organization and, overall, their strategies in adopting advanced ICT infrastructures. Hence, ICT plays a central role in carrying out successful innovation; in particular, there is a new generation of ICT-based socio-technical platforms that are proving to be very effective in supporting the challenging activities of an innovation project.

This tutorial illustrates some of the key competences necessary to carry out a successful innovation project. Some of them are directly derived from the experience in Information Systems Engineering, but need to be revisited in the light of the advent of a new breed of socio-technical systems, aimed at supporting innovation in networked organizations (i.e., SMEs, but also large highly decentralised corporations, public institutions, etc.).

Carrying out an innovation project is not an easily job for a single enterprise, then it is really a challenge for a network of enterprise, having the problem of achieving the necessary coordination and synergy in a distributed, multi-player operational and decisional context. Managing an innovation project requires approaches, methods and tools inherently different from those used in 'traditional' Project Management. It is necessary a deep rethinking of existing tools and methods and, at the same time, new tools and methods need to be developed. The BIVEE (Business Innovation in Virtual Enterprise Environment) platform, developed by an European project (that received the European Excellence Award), represents a valid example [2].

2 Objectives of the Tutorial

The objectives of this tutorial is to illustrate the opportunities that advanced ICT solutions can offer to improve the innovation capacity of complex organizations, in particular SMEs organized in virtual (networked) enterprises. To this end, the tutorial starts with a reflection on the nature of Innovation, since this term represents a rich and

articulated domain, often addressed without the awareness of its complexity. Then, the tutorial proceeds addressing the following topics.

- Nature and essence of Innovation.
- Different types of innovation and the main approaches that can be used to address them.
- Focusing on selected topics, e.g., how to improve creativity, by using game-based technique, how to promote divergent thinking and serendipity in innovation.
- ICT methods and tools able to support the various activities found in the different phases of the lifecycle of Innovation: from its inception (e.g., Creativity phase) to its conclusion (e.g., Engineering and transfer to production).
- Practical issues to be considered when developing an ICT-based platform for innovation support and management, starting from a specific case: the European project BIVEE.
- Sharing conclusions on how to starting and carrying out an Innovation project.

The core of the presentation will be based on the 5-dimensional Open Innovation Space. The 5 dimensions are: *(i) key supporting disciplines* (from Economics to Design Science, from Art and Creativity to Engineering)*, (ii) enterprise facets* (Process, Product, Service, Organization, Market, Technology)*, (iii) digital enablers* (from Collaboration platform to Knowledge Management, from Big Data Analytics to Decision Support Systems)*, (iv) application domains* (see below)*, (v) enterprise innovation lifecycle* (where the core is represented by the BIVEE Innovation Waves: *Creativity, Feasibility, Prototyping, Engineering*).

It is important to remark once more that the approach and the addressed topics are positioned at a meta-level, therefore the presentation is not concerned with innovation in a specific application domain, such as automotive, health, agro-food, or aerospace. We concentrate on innovation as a discipline per se, addressing it in a sufficiently general fashion to seize the commonalities, principles, guidelines, but also methods and tools, that are valid for a large variety of enterprises operating in different application domains. But, naturally, the tutorial does not pretend to be exhaustive over all the problems and solutions connected to innovation (that include, e.g., from change management to HR, from organizational issues to business models); similarly, despite the generality of the adopted approach and the proposed solutions, when such solutions are actually applied to a concrete situation, a number of refinements, integrations and customization need to be carried out.

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Capability Driven Development for Building Sustainable Information Systems

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Abstract. The notion of capability has emerged in information system (IS) engineering as the means to support development of context dependent organizational solutions and supporting IS applications. To this end a Capability Driven Development (CDD) has been proposed. The CDD methodology supports IS development and designing as well as running applications that need to be adjusted according to changes in the context. This tutorial presents the methodology, demonstrates the tool support for CDD, as well as summarizes our experiences of using CDD in four companies.

Keywords: Enterprise modeling · Capability design · Capability development

Introduction

A significant objective of today's enterprise Information Systems (IS) is to be sustainable, which entails producing value to their stakeholders over time. A major concern is how IS can successfully support constant variations in business conditions originating, for instance, from changes in customers' demand, environmental aspects, regulations, etc. A key challenge is the need to adjust according to change at runtime.

Capability as a concept originates from competence-based management and military frameworks. It offers a complement to traditional Enterprise Modeling (EM) approaches by representing organizational knowledge from a result-based perspective. Lately, the notion has emerged in IS engineering as an instrument to context-dependent business and application design. To ensure the needs of business stakeholders for the variety of business contexts that an enterprise faces and thus facilitate sustainable application delivery, we see the capability notion as the central concept to enable a holistic approach to model-oriented IS development that integrates both the business and technological development perspectives. Capability is seen as *the ability and capacity that enable an enterprise to achieve a business goal in a certain context* [1]. It is operationalized in a capability-oriented approach that integrates organizational development with IS development taking into account changes in the application context of the solution. This is referred to as Capability Driven Development (CDD). It requires a number of organizational concepts to be modeled, such as business goals,

processes, resources, Key Performance Indicators (KPIs), as well as the parameters for describing business environmental contexts for organizations capabilities. CDD consists of the following method components:

- *Capability Design* for design, evaluation and development of capabilities by using process models, goal models and other types of models.
- *Enterprise Modeling* is included in CDD for the creation of enterprise models that are used as input for capability design.
- *Context Modeling* for analyzing the capability context, and the variations needed to deal with variations.
- *Reuse of Capability Design* for elicitation and documentation of patterns for capability design.
- *Run-time Delivery Adjustment* for defining capability adjustments at runtime.

The CDD methodology is supported by the CDD environment consisting of the following key components:

- *Capability Design Tool (CDT):* a graphical modelling tool for supporting the creation of models according to the capability meta-model. The CDT will provide the developers with a suitable notation for EM and capability design.
- *Capability Navigation Application (CNA):* an application that uses the models created in the CDT to monitor relevant context and handle run-time capability adjustments.
- *Capability Context Platform (CCP):* the context platform supports capturing and distributing context information to the CNA.
- *Capability Delivery Application (CDA):* the business application that are used to support the capability delivery. This can be a custom-made IS, or a configured IS such as an ERP. The CNA communicates, or configures the CDA to adjust for changing contexts during capability design and delivery.

CDD been applied in the following cases: SIV AG (Germany) for standard business processes execution capability; FreshTL Ltd (UK) for maritime compliance capability; CLMS Ltd (UK) for collaborative IS development using the MDD technology; Everis (Spain) for service promotion capability, marriage registration capability, and SOA platform capability.

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