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Knowledge Representation for Health Care

AIME 2015 International Joint Workshop, KR4HC/ProHealth 2015
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Revised Selected Papers

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Preface

Health-care organizations are facing the challenge of delivering high-quality services to their patients at affordable costs. These challenges become more prominent with the aging population with chronic diseases and the rise of health-care costs. The high degree of specialization of medical disciplines, huge amounts of medical knowledge and patient data to be consulted in order to provide evidence-based recommendations, and the need for personalized health care are prevalent trends in this information-intensive domain. The emerging situation necessitates computer-based support of health-care process and knowledge management as well as clinical decision-making.

For a third time, this workshop brought together researchers from two communities who have been addressing these challenges from different perspectives. The “Knowledge-Representation for Health-Care” (KR4HC) community, which is part of the larger medical informatics community, has been focusing on knowledge representation and reasoning to support knowledge management and clinical decision-making. This community has been developing efficient representations, technologies, and tools for integrating all the important elements that health-care providers work with: electronic medical records (EMRs) and health-care information systems, clinical practice guidelines, and standardized medical vocabularies. In turn, the “Process-Oriented Information Systems in Health-Care” (ProHealth) community, which is part of the larger business process management (BPM) community, focus on ways to adopt BPM technology in order to provide effective solutions for health-care process management. BPM technology has been successfully used in other sectors for establishing process-aware enterprise information systems (as opposed to collections of stand-alone systems for different departments in the organization). Adopting BPM technology in the health-care sector is starting to address some of the unique characteristics of health-care processes, including their high degree of flexibility, the integration with EMRs and shared semantics of health-care domain concepts, and the need for a tight cooperation and communication among medical care teams.

In 2012 and 2013, joint workshops were organized bringing together health-care knowledge representation as dealt with in previous KR4HC workshops, and health-care process support as addressed in previous ProHealth workshops, with a considerable success. Participants in the joint workshops could explore the potential and the limitations of the two approaches for supporting health-care knowledge and process management and clinical decision-making. The workshops also provided a forum wherein challenges, paradigms, and tools for optimized knowledge-based clinical process support could be debated. All the organizers and participants of the workshops coincided on the profit of the event, which encouraged us to organize a third edition of the joint workshop in 2015.

With the same objectives as the first and second workshop, the third joint workshop aimed to increase the interactions between researchers and practitioners from these different yet similar fields to improve the understanding of domain-specific

requirements, methods, theories, tools and techniques, as well as the gaps between IT support and health-care processes yet to be closed. This forum also provided an opportunity to explore how the approaches from the two communities could be better integrated.

Providing computer-based support in health care is a topic that has been picking up speed for more than two decades. We are witnessing a plethora of different workshops devoted to various topics involving computer applications for health care. In the last years, our goal has been to join forces with other communities in order to learn from each other, advance science, and create a stronger and larger community. The history of the two workshops, KR4HC and ProHealth, demonstrates the efforts that have been made in that direction so far.

The first KR4HC workshop, held in conjunction with the 12th Artificial Intelligence in Medicine Conference (AIME 2009), brought together members of two existing communities: the clinical guidelines and protocols community, who held a line of four workshops (European Workshop on Computerized Guidelines and Protocols (CPG2000, CPG2004); AI Techniques in Health Care: Evidence-Based Guidelines and Protocols 2006; Computer-Based Clinical Guidelines and Protocols 2008), and a related community, who held a series of three workshops devoted to the formalization, organization, and deployment of procedural knowledge in health care (CBMS 2007 Special Track on Machine Learning and Management of Health Care Procedural Knowledge 2007; From Medical Knowledge to Global Health Care 2007; Knowledge Management for Health Care Procedures 2008). Since then, five more KR4HC workshops have been held, in conjunction with the ECAI 2010, AIME 2011, BPM 2012, AIME13, and KR 2014 conferences.

The first ProHealth workshop took place in the context of the 5th International Conference on Business Process Management (BPM) in 2007. The next three ProHealth workshops as well as last year's workshop were also held in conjunction with BPM conferences (BPM 2008, BPM 2009, BPM 2011, and BPM 2014). The aim of ProHealth has been to bring together researchers from the BPM and the medical informatics communities. As the workshop was associated with the BPM conference that had never been attended by researchers from the medical informatics community, we had included medical informatics researchers as keynote speakers of the workshop, members of the Program Committee, and to our delight, saw a number of researchers from the medical informatics community actively participating in ProHealth workshops.

Following the keynote talk given by Manfred Reichert from the BPM community at the Artificial Intelligence in Medicine 2011 (AIME 2011) conference, where KR4HC was held, the organizers of ProHealth and KR4HC workshops showed interest in holding their workshops in conjunction with the BPM 2012 conference, which marked a landmark in the collaboration between the two communities. These efforts were continued when the second joint workshop took place as part of the AIME 2013 conference. Now, we are continuing these efforts with the Third Joint Workshop on Knowledge Representation for Healthcare and Process-Oriented Information Systems in Health Care (KR4HC/ProHealth).

The KR4HC/ProHealth 2015 workshop focused on IT support of high-quality health-care processes. It addressed topics including knowledge-driven health IT,

clinical guidelines and pathways, and health information systems and clinical data. Furthermore, the workshop included a special “MobiGuide project” track related to mobile process and decision-support, featuring six presentations from the FP7 MobiGuide project (www.mobiguide-project.eu).

The workshop received 24 papers from Italy (6), Israel (4), Spain (3), Canada (2), France (2), Germany (2), The Netherlands (2), Austria (1), Brazil (1), Chile (1), Poland (1), and the USA (1). Papers had to clearly establish their research contribution as well as their relation to health-care processes. Five full papers were selected to be presented at the workshop as full papers, according to their relevance, quality, and originality. One of these papers was finally retracted. The four other papers appear in this volume together with a paper by the keynote speaker. Five additional contributions submitted as full paper were selected for short presentation at the workshop, respecting the positive assessments provided by the expert reviewers. These five papers are also included in this volume.

In his keynote paper “Evolution and Revolution in Knowledge-Driven Health IT: A 50-Year Perspective and a Look Ahead,” Prof. Robert Greenes from the Department of Biomedical Informatics at Arizona State University, USA, analyzed the past 50 years, in terms of what the world was like, what challenges we faced, and what achievements have been accomplished in each of the five decades since the 1960s and in our current decade. He further looked at new forces impacting us. The challenges stem from disruptions in the nature of health-care delivery, its financing, and its expanded emphasis on health and wellness as well as disease treatment, and from frequent changes in technology. One of the main disruptions for clinical decision support is that we have fragmented health systems, and communication and coordination of care are not optimal for the patient. Hospital, clinic, and home/self-care are separated and are hence not well connected. We are maximizing delivery of enterprise- or practice-specific health care rather than patient-centric care. There is limited decision-support because data are limited largely to an organization. In general, we do not have a life-time patient-oriented record with views on episodes of care and patients do not control electronic health record (EHR) usage. As another challenge, both society and the public demand more patient engagement, while at the same time facing an aging population with the world of chronic and multiple diseases growing. Hence, there is a greater need for coordination as well as for managing the continuity of care, but contemporary EHR systems do not support this. Furthermore, there are other disruptions, such as regulatory ones. In addition to these societal challenges, there is the race with technology (e.g., emerging technologies such as sensors, smart phones, and distributed apps). These are affecting the expectations of consumers, and our focus changes to meet these challenges. The original challenge of providing high-quality clinical decision support remains and has not been resolved yet. There have been success stories, but owing to the changes in technology and society expectations, the systems that have been successful are sometimes proprietary and obsolete. Moreover, newly emerging knowledge-based technologies are needed to integrate data flows and workflows across venues of care, to connect patients and the health system more effectively, and to integrate analytics to optimize decision-making. These include knowledge resources that reside outside of EHR systems and can be used to orchestrate and inform the operations of apps and services on an interoperable multi-tier platform.

The first regular paper “A Patient Simulation Model Based in Decision Tables for Emergency Shocks” by Francis Real, David Riaño, and Jose-Ramon Alonso introduced a knowledge-based simulation system hinging on decision tables about patients arriving at ICUs with shock. Seven prevalent sorts of shocks were modeled. The following four papers focus on clinical guidelines and clinical pathway support. The paper entitled “META-GLARE: A Meta-Engine for Executing CIGs” by Alessio Bottrighi, Stefania Rubrichi, and Paolo Terenziani introduces the execution component of META-GLARE, a framework to acquire, consult, and execute clinical practice guidelines represented under different CIG formalisms. The paper “Identifying Evidence Quality for Updating Evidence-based Medical Guidelines” by Zhisheng Huang, Qing Hu, Annette ten Teije, and Frank van Harmelen proposes a rule-base model to identify different levels of evidence within textual guidelines. The model can estimate the level of evidence on an average of 75 %. The paper “Answer Set Programming for Temporal Conformance Analysis of Clinical Guidelines Execution” by Matteo Spiotta, Paolo Terenziani, and Daniele Theseider Dupré describes a first approach to automate conformance checking between clinical guidelines and basic medical knowledge in order to detect contractions along time. The paper “Towards a Pathway-Based Clinical Cancer Registration in Hospital Information Systems” by Michael Heß, Monika Kaczmarek, Ulrich Frank, Lars-Erik Podleska, and Georg Täger presents an approach fostering the model-based design of process-aware health-care applications. More precisely, a domain-specific language for modeling clinical pathways is enhanced with a medical data structure (i.e., an oncologic data set) in order to enable a pathway-based (i.e., process-driven) cancer documentation in hospital information systems. The paper “A Mixed-Initiative Approach to the Conciliation of Clinical Guidelines for Comorbid Patients” by Luca Piovesan and Paolo Terenziani analyzes the technologies contained in the GLARE system to help physicians manage interactions between CIGs in order to deal with comorbid patients.

The first paper in the MobiGuide track, by Erez Shalom, Yuval Shahar, Ayelet Goldstein, Elior Ariel, Moshe Sheinberger, Nick Fung, Val Jones, and Boris van Schooten, discusses the implementation of the distributed guideline-based decision support model within the patient-guidance framework of MobiGuide. The paper presents the projection and call-back mechanism between the main backend DSS and the mobile DSS. This mechanism is used to execute projections of parts of clinical guidelines that have been customized to the requirements of concrete patients on the smart phone of the corresponding patient. The second paper in the MobiGuide track tackles the data quality problem of the mobile decision support system (mDSS) and presents the Quality-of-Data Broker, which runs on the smart phone of the MobiGuide project. The paper written by Nekane Larburu, Boris van Schooten, Erez Shalom, Nick Fung, Hermie Hermens, and Val Jones is titled “A Quality Aware Mobile Decision Support System for Patients with Chronic Illnesses.” These works were presented under the context of the EU FP7 MobiGuide project.

The paper by Jens Weber, Morgan Price, and Iryna Davies addresses the problem of data quality in health information systems. Inspired by the design-by-contract approach from software engineering, the authors propose an approach for designing and monitoring systems for various quality concerns.

We would like to thank the invited speaker as well as the members of the Program Committee and the reviewers for their efforts in selecting the papers. They helped us to compile a high-quality program for the KR4HC/ProHealth 2015 workshop. We would also like to acknowledge the splendid support of the local organization and the AIME 2015 organizers.

We hope you will find the papers of the joint KR4HC/ProHealth 2015 workshop interesting and stimulating.

September 2015

Richard Lenz
Silvia Miksch
Mor Peleg
Manfred Reichert
David Riaño
Annette ten Teije

Organization

KR4HC 2014 was organized by Richard Lenz, University of Erlangen-Nuremberg, Germany, Silvia Miksch, Vienna University of Technology, Austria, Mor Peleg, University of Haifa, Israel, Manfred Reichert, University of Ulm, Germany, David Riaño, Universitat Rovira i Virgili, Spain, and Annette ten Teije, Vrije Universiteit Amsterdam, The Netherlands.

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