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Process Support and Knowledge Representation in Health Care

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Revised Selected Papers

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Preface

Healthcare organizations are facing the challenge of delivering high quality services to their patients at affordable costs. These challenges become more prominent with the growth in the aging population, the prevalence of chronic diseases, and the rise of healthcare costs. 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 healthcare are widespread trends in this information-intensive domain. The emerging situation necessitates computer-based support for the management of healthcare processes and knowledge as well as to help clinical decision-making.

For a second time, this workshop brings together researchers from two communities who address these challenges from two different perspectives. The knowledge-representation for healthcare 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 representation methods, technologies, and tools for integrating all the important elements that health care providers work with: Electronic Medical Records (EMRs) and healthcare information systems, clinical practice guidelines, and standardized medical vocabularies. The process-oriented information systems in healthcare community, which is part of the larger business process management (BPM) community, has been studying ways to adopt BPM technology in order to provide effective solutions for healthcare process management. BPM technology has been successfully used in other sectors for establishing process-aware enterprise information systems (vs. collections of stand-alone systems for different departments in the organization). Adopting BPM technology in the healthcare sector is starting to address some of the unique characteristics of healthcare processes, including their high degree of flexibility, the integration with EMRs and shared semantics of healthcare domain concepts, and the need for tight cooperation and communication among medical care teams.

In 2012, a joint workshop was organized bringing together healthcare knowledge representation as dealt with in previous KR4HC workshops, and healthcare process support as addressed in previous ProHealth workshops, with considerable success. Participants in the joint workshop could explore the potential and the limitations of the two approaches for supporting healthcare knowledge and process management and clinical decision-making. The workshop 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 workshop agreed on the high profit of the event which encouraged us to organize a second edition of the joint workshop in 2013.

Under the same objectives of this first workshop, the new 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 and theories, tools and techniques, and the gaps between IT support and healthcare 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 healthcare 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 healthcare. In the last years, our goal has been to try 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 we have 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 (CPG 2000, CPG 2004); 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 healthcare (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, two more KR4HC workshops have been held, in conjunction with the ECAI 2010 and the AIME 2011 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 were also held in conjunction with BPM conferences (BPM 2008, BPM 2009, and BPM 2011). 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 their interest to hold their workshops in conjunction as part of the BPM 2012 conference, which marked a landmark in the collaboration between the two communities. Now, we are continuing the efforts that started then with a second joint workshop on Knowledge Representation for Healthcare and Process-Oriented Information Systems in Healthcare (KR4HC/ProHealth).

The KR4HC/ProHealth 2013 workshop focused on IT support of high-quality healthcare processes. It addressed topics including semantic interoperability in healthcare, modeling clinical guidelines, knowledge-based techniques for handling clinical data, and content aware healthcare services and guidance.

The workshop received 19 papers from Italy (4), The Netherlands (4), Israel (3), Austria (2), Canada (2), Spain (2), Germany (1), and Norway (1). Papers had to clearly establish their research contribution as well as their relation to healthcare processes. Ten full papers were selected to be presented in the workshop according to their relevance, quality, and originality. These papers appear in this volume together with a paper by the keynote speaker, Prof. Stefan Schulz from the Institut für Medizinische Informatik, Statistic und Dokumentation, at Medizinische Universität Graz, Austria.

In his keynote paper "How Ontologies can Improve Semantic Interoperability", Prof. Schulz discussed some experiences on how semantic interoperability has been addressed through the use of standard terminologies and information models and the efforts of the Network of Excellence SemanticHealthNet to construct a generalized methodology for semantic enhancement of health care resources. Semantic enhancement consists of the annotations of those resources with OWL axioms in order to provide a semantic interpretation and also to provide interoperability among healthcare IT systems and resources. In the paper entitled "SemanticCT: A Semantically-Enabled System for Clinical Trials", the authors Z. Huang, A. ten Teije, and F. van Harmelen introduce the system SemanticCT that allows semantic integration of data for clinical trials and provides several services such as semantic search for clinical trials and patient data, finding trials for a patient, and finding patients for a trial.

Three additional papers were presented on modeling clinical practice guidelines. The paper "Identifying Patient-Action Sentences Using a Heuristic-Based Information Extraction Method", by R. Wenzina, and K. Kaiser, proposes a rule-based combination of linguistic and semantic information in order to automate the detection of condition-action textual sentences in clinical practice guidelines. This work is relevant, for example, in computerizing clinical guidelines. Secondly, the paper "Supporting Computer-Interpretable Guidelines' Modeling by Automatically Classifying Clinical Actions" by A.L. Minard, and K. Kaiser provides a comparison of several rule-based and machine learning methods to categorize the clinical actions appearing in clinical guidelines. Based on support vector machine technology, the current best supervised classification process becomes a promise to reduce the workload of modeling clinical guidelines. In the third paper, "Discovering Probabilistic Structures of Healthcare Processes", A. Hommersom, S. Verwer, and P. J. F. Lucas face the problem of capturing the uncertainty of medical protocols and disease evolutions as an automata learning process. The method proposed is tested for patients with transient ischemic attack in The Netherlands, considering patients with myocardial infarction separately from patients not diagnosed with myocardial infarction.

The next three papers focus on knowledge-based techniques for handling clinical data. In their paper "Implementation of a System for Intelligent

Summarization of Longitudinal Clinical Records", A. Goldstein and Y. Shahar describe the inner working of CliniText, a software system conceived to provide verbal summaries of electronic patient records in order to help healthcare professionals to focus on the relevant issues. In the paper, the work is mainly tested on clinical numeric data registered in the electronic record of patients with cardiac problems. In "Knowledge-Based Patient Data Generation", Z. Huang, F. van Harmelen, A. ten Teije, and K. Dentler address the challenge of synthesizing large scale patient data under a knowledge-based approach. The synthesis of realistic data is achieved by the incorporation of a knowledge-base in the domain of application that can be extracted from biomedical publications or web resources. The synthesis of data has been tested in the breast cancer domain and the data exploited by the SemanticCT tool in order to check patient eligibility for clinical trials. The paper "An Ontology-Driven Personalization Framework for Designing Theory-Driven Self-Management Interventions", by S. S. R. Abidi and S. Abidi, presents a patient-centered framework to help individuals to manage themselves their chronic diseases. An ontology is presented for modeling social cognition theory (SCT) in terms of educational issues and strategies, assessment and care personalization. This ontology was tested to provide support in a self-management program for cardiac conditions.

The last three papers focus on context-aware services and guidance. In the paper entitled "Dynamic Homecare Service Provisioning: A Field Test and its Results", by A. Zarghami, M. Zarifi, M. van Sinderen, and R. Wieringa, a platform for dynamic homecare service provisioning is proposed and validated in a field test. The paper is mainly centered in the set-up of the experiments and the analysis of the results in terms of platform adaptivity, tailorability, and evolvability. In the paper "iALARM: An Intelligent Alert Language for Activation, Response, and Monitoring of Medical Alerts" by D. Klimov and Y. Shahar, the two-tier architecture iALARM is introduced. This architecture is designed for the management of clinical alerts that are expressed in a formal language which is able to capture the target population, a declarative part describing the triggering pattern, and a procedural part defining the way the alarm must be raised. M. Iannaccone, M. Esposito, and G. De Pietro, discuss "GLM-CDS: A Standards-Based Verifiable Guideline Model for Decision Support in Clinical Applications". The set of already existing languages and systems for computer-interpretable guidelines representation and exploitation is extended in this paper with a new model, the GuideLine Model for Clinical Decision Support (GLM-CDS). The different components of GLM-CDS are discussed: the control-flow model, the information model, the terminological model, and the computer-interpretable encoding system. An example of application of the model to hypertension is provided.

To conclude, we would like to thank the invited speaker, Prof. Stefan Schulz, as well as the members of the Program Committee and the reviewers for their efforts to help us select the papers. They aided us to compile a high-quality program for the KR4HC/ProHealth 2013 workshop and a second later review

for the papers to appear in this book. We would also like to acknowledge the splendid support of the local organization and the AIME 2013 workshop chairs, and the forty-three participants that registered and attended the workshop.

September 2013

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Organization

The joint international workshop KR4HC/ProHealth brought together the sixth edition of the "Workshop of Process-Oriented Information Systems in Health Care" and the fifth edition of the "Workshop on Knowledge Representation for Health Care". The edition of this book with the invited keynote and a selection of the best papers of that event was organized by David Riaño (Universitat Rovira i Virgili, Tarragona, Spain), Richard Lenz (University of Erlangen and Nuremberg, Germany), Silvia Miksch (Vienna University of Technology, Austria), Mor Peleg (University of Haifa, Israel), Manfred Reichert (University of Ulm, Germany), and Annette ten Teije (VU University Amsterdam, The Netherlands).

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