Introduction to the Joint Workshop: Fifth International Workshop on Process-oriented Informations Systems in Healthcare (ProHealth 2012) / Fourth International Workshop on Knowledge Representation for Health Care (KRH4C 2012)

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 with 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 prevalent trends in this information-intensive domain. The emerging situation necessitates computer-based support of healthcare process & knowledge management as well as clinical decision-making.

This workshop brings together researchers from two communities who have been addressing 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 efficient representations, 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.

This joint workshop brings together two approaches: healthcare process support, as addressed in previous ProHealth workshops, and healthcare knowledge representation as dealt with in previous KR4HC workshops. The workshop shall elaborate both the potential and the limitations of the two approaches for supporting healthcare process & healthcare knowledge management as well as clinical decision-making. It shall further provide a forum wherein challenges, paradigms, and tools for optimized knowledge-based clinical process support can be debated. We want to bring together 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 provides 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. 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 done in that direction so far, reaching this year, a joint workshop between communities who have been actively holding such workshops since the year 2000.

The first KR4HC workshop, held in conjunction with the 12th Artificial Intelligence in Medicine conference (AIME'09), 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 / special tracks devoted to the formalization, organization, and deployment of procedural knowledge in healthcare (CBMS'07 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'10 and the AIME'11 conferences.

The first ProHealth workshop took place in the context of the 5th Int'l Conference on Business Process Management (BPM) in 2007. The next three ProHealth Workshops were also held in conjunction with BPM conferences (BPM'08, BPM'09, and BPM'11). 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'11) conference, where KR4HC was held, the organizers of ProHealth and KR4HC workshops have shown their interest to hold their workshops in conjunction as part of the BPM'12 conference, which marks a landmark in the collaboration between the two communities. We are continuing the efforts that started three years ago by members of the Software Engineering in Health Care (SEHC) community to strengthen the collaboration between the ProHealth and SEHC communities.

The ProHealth 2012 workshop focused on IT support of high-quality healthcare processes. It addressed topics including modeling and enactment of clinical guidelines and summarization, archetypes and semantic integration, process mining and temporal analysis,

The workshop received 19 papers from Spain (6), Germany (3), Israel (3), The Netherlands (3), Brazil (1), Italy (1), and Australia (1), and a paper with authors from the France, Germany, Switzerland, and the UK. Papers had to clearly establish their research contribution as well as their relation to healthcare processes. Nine 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 and two invited contributions.

In his keynote paper "The Elicitation, Representation, Application, and Automated Discovery of Time-Oriented Declarative Clinical Knowledge: The Hidden Aspect of Supporting the Automated Application of Procedural Medical Knowledge", Prof. Yuval Shahar from the

Information Systems Engineering Department and Ben-Gurion University, Israel, discussed how to represent, apply, and discover declarative knowledge. Declarative knowledge is used to define temporal concept abstractions in terms of structural, functional, logical and probabilistic relationships. Such concept abstractions are found in plan entry and transition conditions that govern execution of procedural care plans. He argued that one cannot apply procedural knowledge without first representing declarative knowledge that is required to interpret patient data. Declarative knowledge is vital for supporting tasks such as therapy, monitoring and diagnosis, quality assessment, and discovery of new knowledge from patterns found in the data.

The following three papers focus on clinical guidelines and summarization. The paper entitled "Rule-based Combination of Comorbid Treatments for Chronic Diseases Applied to Hypertension, Diabetes Mellitus, and Heart Failure" by Joan Albert Lopez-Vallverdu, David Riaño and Antoni Collado proposes a method for detection of drug interaction problems concerning comorbid patients and suggests an alternative to solve drug-drug interactions and/or drug-disease interactions. After acquisition of the interaction knowledge, a set of minimal combination rules in constructed. They developed a rule execution engine for those combination rules such that alternative drugs can be proposed that avoids the undesired drug interactions for comorbid patients. They show their approach in a realistic case study with three chronic diseases: hypertension, heart failure and diabetes mellitus.

The paper "Knowledge-driven Adaptive Execution of Care Pathways Based on Continuous Planning Techniques" by Gonzalo Milla-Millán, Juan Fdez-Olivares, Inmaculada Sánchez-Garzón, David Prior and Luis Castillo contributes to the problem how to adapt the guideline (pathways) to the dynamic environment. Their approach is based on temporal HTN planning process, and modelling both the normal flow and exceptional flow. They compare the expected effects with the real effects and based on the deviation a pathway is dynamically generated. This method guaranteed adherence to clinical guidelines. Their experiment is with the guideline for Hodgin's disease.

The paper "Towards a realistic clinical-guidelines application framework: Desiderata, Applications, and lessons learned" by Erez Shalom, Iliya Fridman, Yuval Shahar, Avner Hatsek and Eitan Lunenfeld introduces a a component based guideline application architecture called PICARD-DSS framework. The authors classify different realistic guideline application contexts and derive requirements for guideline applications in real world environments. Usage of the framework is illustrated with practical examples. Experiences are summarized to highlight some important aspects that should be considered when implementing and evaluating guideline applications.

The next four papers focus on semantic integration and cooperation. In their paper "Data Integration for Clinical Decision Support Based on openEHR Archetypes and HL7 Virtual Medical Record", Arturo González-Ferrer, Mor Peleg, Bert Verhees, Jan-Marc Verlinden and Carlos Marcos propose the use of openEHR archetypes to integrate different source patient data for exploitation with a clinical decision support system. The work is presented under the context of the EU FP7 MobiGuide project.

In their paper "Semantic Integration of Patient Data and Quality Indicators based on openEHR Archetypes", Kathrin Dentler, Annette ten Teije, Ronald Cornet and Nicolette de Keizer face the problem of representing clinical quality indicators with openEHR archetypes and using these archetypes to semantically check these indicators against patient data. Their evaluation on three indicators of gastrointestinal cancer surgery suggests that the semantic integration of patient data and clinical quality indicators is possible.

In the paper entitled "A Study of Semantic Proximity between Archetype Terms based on SNOMED CT Relationships", Jose Luis Allones, David Penas, María Taboada, Diego

Martinez and Serafín Tellado presents a novel approach to automate the binding between OpenEHR archetype terms and SNOMED CT terminology as a means to achieve interoperability between clinical systems.

The paper "Distributed Ad Hoc Cooperation in Healthcare" by [Christoph P. Neumann](#) and Richard Lenz describes an approach for distributed process coordination based on active documents called α-Docs. An α-Docs is a distributed case file that synchronizes its contents among various cooperating parties. The approach is fully decentralized and does not require any preinstalled execution environment. Instead, α-Docs carry their own execution environment, thereby enabling ad hoc cooperation by a simple file transfer.

The last four papers focus on process mining and temporal analysis. In the paper entitled "Embedding Conformance Checking in a Process Intelligence System in Hospital Environments", by Kathrin Kirchner, Nico Herzberg, Andreas Rogge-Solti and Mathias Weske, a method to conformance checking is proposed, which uses incomplete information from event logs to enable process monitoring and analysis. The basic idea is to find a best possible alignment between an existing process model and the events observed in various heterogeneous IT-systems.

In the paper "Process Mining in Healthcare: What Data is Available and Which Questions can be Solved?" by Ronny Mans, Wil Van Der Aalst, Rob Vanwersch and Arnold Moleman, typical types of event data in Hospital Information Systems are characterized. The authors analyze whether and how these typical event log entries are suitable to answer typical questions asked in clinical Process Mining projects.

Stefania Montani, Giorgio Leonardi, Alessio Bottrighi, Luigi Portinale and Paolo Terenziani, discuss Flexible and Effcient Retrieval of Haemodialysis Time Series. Medical data are often collected in the form of time series, so time series retrieval is particularly interesting for applications in healthcare. Here, the authors provide an efficient framework for time series retrieval, which uses multi-level temporal abstractions to decrease dimensionality and improve query flexibility. The approach is discussed on the example of an application in the hemodialysis domain.

Finally, Inmaculada Sánchez-Garzón, Juan Fernández-Olivares and Luis Castillo discuss an Approach for Representing and Managing Medical Exceptions in Care Pathways based on Temporal Hierarchical Planning Techniques. The authors use a task network that describes how compound tasks are decomposed into atomic tasks in order to model clinical guidelines as well as exceptional situations. Their goal is to be able to detect exceptional situations by comparing the expected health conditions of a patient represented in the model with the real status as documented in the patients medical record.

We hope you will find the papers of the joint ProHealth/KR4HC 2012 workshop interesting and stimulating.

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