*e*Health Personalization in the Next Generation RPM Systems

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Abstract

In this work we present a possible next generation Remote patient management (RPM) system that enables personalization of educational content and its delivery to patients and introduce a generic methodology for personalization emphasizing the role of knowledge discovery.[1]

1 Introduction

In order to maintain and improve quality of care without exploding costs, healthcare systems are undergoing paradigm shift from patient care in the hospital to patient care at home. Remote patient management (RPM) systems offer a great potential in reducing hospitalization costs and worsening of symptoms for patients with chronic diseases, e.g., heart failure, and diabetes.

Recent clinical studies show that education and coaching tailored toward the patient is a promising approach to increase adherence to the treatment and potentially improve clinical outcomes.Although the large volumes of data collected by RPM systems provide an opportunity for personalizing information services, there is a limited understanding of the necessary architecture, methodology, and tailoring criteria to facilitate personalization of the content. In this paper we tackle these challenges by presenting a possible architecture of the personalized RPM systems. Currently, pre-authored adaptation prevails data driven approaches despite of the many developments in data mining, including applications to user modeling. We consider the process of knowledge discovery (KDD) from RPM data that leads to identification of potentially useful features and patterns for patient modeling and construction of adaptation rules.

2 Next Generation Adaptive RPM Systems

A general architecture of an personalized RPM system, which follows general principles of personalization in e-Learning systems with KDD process, is presented in Fig 1. The key components of the system that facilitate personalization and adaptation include: patient (user) model, domain model, adaptation rules, adaptation engine, and KDD process. Further, there are authoring and management tools allowing medical experts and professionals to monitor, control and manage patient and domain models and adaptation rules.

Personalization can be organized using individual and group (or stereotype) user modeling. For each patient the patient model template is instantiated into a (personal) patient model which is stored in the *patient models* database and updated regularly, e.g., when relevant information (e.g. from user-system interaction data) becomes available. The *adaptation engine* executes firing adaptation rules that link patient and domain models, and generates personalized educational, instructional, motivational, or alerting content to be presented at the patient's feedback device, e.g., TV, a smart phone, or a computer and/or at the medical professional side (alerting). The *KDD process* is essential for discovering relevant actionable patterns contributing to patient modeling and construction of adaptation rules.

[1]This is an extended abstract of the full paper presented at the 22nd IEEE Symposium on Computer-Based Medical Systems [2]).

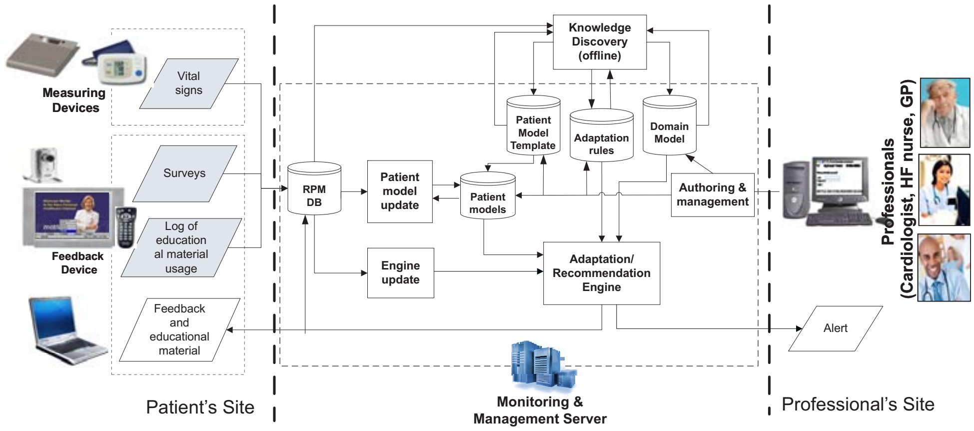

Figure 1: A high level view of the next generation RPM system

3 Knowledge discovery for patient modeling

In our work we consider knowledge discovery steps using historical data available from an existing RPM database containing data from a completed clinical trial [1].

The main steps of the (highly iterative and interactive) KDD process are shown in Fig. 2. *Relevant data selection* is done using explorative statistical data analysis, outlier detection, and data cleaning approaches. With this, basic data preprocessing and selection of a subset of relevant data is performed. *Feature extraction and construction* is done using visual data exploration, namely event- and time-series analysis that help to get a better understanding of what features and relations between them may potentially describe patient current state and its short-term and long-term dynamics. As a result, different data views can be constructed, which serve as input for the next step of the process. *Pattern discovery* gives us a full set of predictive and descriptive patterns that potentially can be used for patient modelling and adaptation rules construction. *Actionable patterns selection* is an effort of a domain expert to identify a set of relevant actionable patterns.

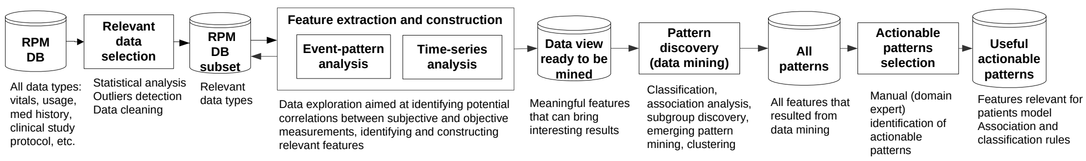

Figure 2: Knowledge discovery process

4 Further work

In this work we concentrated on so-called off-line process of discovering useful actionable knowledge for adaptation. However, since some of the patterns are inherently changing over time, it is important to investigate the the potential of online learning, concept drift handling mechanisms, discovery and use of re-occurring contexts for the so-called second order adaptation. This is one of the directions of our further work which we started to approach in [3].

RPM system are becoming also more interactive and therefore there is a natural need in development of other types of feedback personalization mechanisms in RPM systems. Other technologies including e.g. avatars, personalized information retrieval, and open corpus adaptation may become important. Integration of these technologies in the presented architecture is among the major directions of our further work.

References

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