Applying process mining techniques to analyze clinical processes

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Abstract and Objective

In a competitive health-care market, hospitals must deliver high quality care while reducing costs. To accomplish this goal, hospital managers need a thorough understanding of the actual Care Processes (CPs). Diffusion of ICT tools within hospitals, provide huge collections of data, useful for process analysis. Process Mining (PM), describing a family of a-posteriori analysis techniques, can be used to extract process-related information from data. We applied PM to data from hospitals in the Lombardia region, to analyze differences and performance of their CPs.

Keywords:

Care process, Workflow, Process analysis, Process mining

Introduction

Health-Care Organizations (HCOs) place strong emphasis on efficiency and effectiveness, to control their health-care performance and costs. Thus, it is important to evaluate existing infrastructures and services. To this aim, it is crucial to explore and process the data collected by the HCO systems, organizing them in form of Process Logs (PL), which can be seen as the history of what happened in the HCO. PL can be helpful to gain a clear picture of the actual CP, through the use of PM techniques, to extract process-related knowledge and models. We applied PM to analyze the procedures for treating stroke patients in different hospitals of the Lombardia Region to understand how they work, to discover potential differences in the treatment of the patients, and to analyze the bottlenecks.

Methods

PM aims at discovering the gap between what is prescribed or supposed to happen, and what *actually* happens. The goal of PM is to extract information (e.g., process models) from PL, containing sequences of activities related to particular cases (i.e., patients). Each activity is associated to additional information such as the person executing or initiating the activity, the timestamp of the activity, or data recorded with the event (e.g., the dose of a drug). PM permits, among its features, to derive process models, organisational contexts, and performance indicators. This allows organisations to monitor how people, groups, or software/system components are working together, and/or to discover bottlenecks, average/variance of the total flow time or the time spent between the activities.

Results

We used the PROM tool in three directions: 1) its "heuristic miner" generated the graphical representation of the CP of each hospital (identified by codes, for privacy issues). Comparing these CPs, we observed that in hospital #1, for example, patients are treated more homogeneously than in other hospitals. However, considering the emergency phase of the CP, the lack of an early neurological evaluation delays the assessment and the application of the treatment; 2) "dottet charts" are graphical representations of the events occoured for each patient in a hospital. Focusing again on hospital #1, these charts confirm the uniformity of treatment, while showing important temporal information, such as the medium hospitalization time (0-27 days). Furthermore, most of the activities occoured in the first 4-5 days, and then few activities take place while waiting for discharge; 3) Petri nets has been used to simulate the CPs obtained at 1), to analyze performance issues. Among the results, we found that in the hospital the emergency procedures and the transfer from the emergency ward to the stroke unit take too much time, respect to other hospitals. The considerations from points 2) and 3) suggested the professionals from hospital #1 to improve the coordination between its units and to optimize the discharge procedures in the future, to improve the efficiency of the patient's management.

Conclusion

This work shows that PM techniques may be fruitfully applied to gain a better understanding of the clinical pathways adopted by hospitals. In this way different "schools" may be discovered, while organizational and performance issues can be depicted from data, as a starting point to plan improvements in the treatment of the patients.