

Analysis of Patient Treatment Procedures

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Abstract. A real-life event log, taken from a Dutch Academic Hospital, provided for the BPI challenge is analyzed using process mining techniques. The log contains events related to treatment and diagnosis steps for patients diagnosed with cancer. Given the heterogeneous nature of these cases, we first demonstrate that it is possible to create more homogeneous subsets of cases (e.g., patients having a particular type of cancer that need to be treated urgently). Such preprocessing is crucial given the variation and variability found in the event log. The discovered homogeneous subsets are analyzed using state-of-the-art process mining approaches. More specifically, we report on the findings discovered using *enhanced fuzzy mining* and *trace alignment*. A dedicated preprocessing ProM plug-in was developed for this challenge. The analysis was done using recent, but pre-existing, ProM plug-ins. The high-level view of our approach is depicted in Fig. 1. Using this approach we are able to uncover many interesting findings that could be used to improve the underlying care processes.

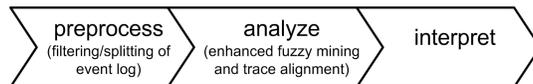


Fig. 1. Overview of the approach followed.

1 Preprocessing: Dissecting the Event Log

Process mining results are affected by the heterogeneity in event logs, e.g., the discovered control-flow models can be spaghetti-like. The event log contains rich information stored as attributes both at the event level and at the case level. We exploit this information and propose five perspectives for preprocessing that can be used in creating more homogenous subsets of cases. We mention three of the five perspectives in this paper.

- *Diagnosis Perspective:* Each case contains a few attributes that provide information on the illness the patient is diagnosed with. These attributes can be broadly classified into two categories (i) diagnosis code and (ii) diagnosis. Each case may contain up to 16 attributes of each type. One can filter the event log based on a particular value for any of the diagnosis codes or diagnosis attributes or a combination of them.
- *Organizational Perspective:* The ‘org:group’ attribute of each event captures the department/lab where the activity corresponding to the event was performed. Continuous sequence of activities executed in a department/lab can

be considered as a notion of artifacts. We propose the transformation of the original log into an *abstraction log* where the activities correspond to the organization names. Each continuous sequence of one or more events pertaining to the same organization in the process instance of the original log is replaced by a single event with the organization name as its activity. At the same time, we create one sub-log for each organization whose process instances correspond to the replaced sequence of events. The process of transformation is illustrated in Fig. 2.

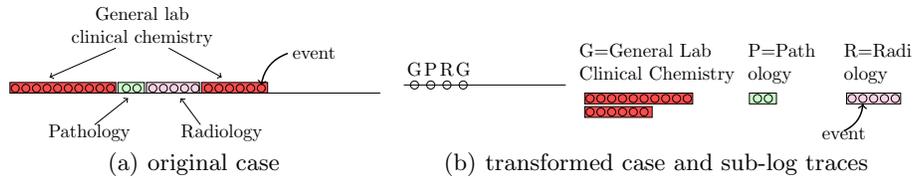


Fig. 2. Transformation of the original log into an abstraction log using the notion of artifacts on the organizational perspective.

- *Urgent and Non-Urgent Cases:* The event log contains certain activities that are classified as urgent. Ordinary counterparts to such activities also exist. This indicates that certain cases (patients) are considered as emergency cases and are treated in an expedited manner. This enables the partitioning of a log into two categories: urgent and non-urgent cases.

2 Analysis

We focus on the control-flow and process diagnostics aspects and use the *enhanced* Fuzzy Miner plugin (to mine hierarchical workflow models) for control-flow analysis, and the ‘Trace Alignment with Guide Tree’ plugin for process diagnostics. The control-flow model mined using the organizational perspective creates the flow of patients across different departments/labs. Each department can be seamlessly zoomed in to view the sub-process for that department. Our analysis revealed that the processes are in fact simple and sequential. Trace alignment enables the *inspection of event logs by grouping and aligning the traces*. Trace alignment can be used to explore the process in the early stages of analysis and to answer specific questions in later stages of analysis, e.g., are there common patterns of execution?, are there any anomalies?, are there any distinguishing aspects with respect to the treatment procedures followed among cases?, etc. Based on trace alignment, we noticed that not only are the treatment procedures simple and sequential but also the cases share a lot in common with very little deviations from the main path. The reader is referred to [1] for a comprehensive report on the approach, analysis, and results.

References

1. Bose, R.P.J.C., van der Aalst, W.M.P.: Analysis of Patient Treatment Procedures: The BPI Challenge Case Study. Technical Report BPM-11-18, BPM-Center.org (2011) <http://bpmcenter.org/wp-content/uploads/reports/2011/BPM-11-18.pdf>.