Ex-Post Identification of Task Models With Causally Ordered User Interface Logs (Extended Abstract)

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Abstract

Identifying adequate back-office tasks to automate is a significant problem in adopting robotic process automation. Task mining on user interface logs enables departments to detect the underlying task model, but creating these logs is time and resource-consuming. Furthermore, contrary to process mining logs that can be extracted in an ex-post fashion from ERP systems, user interface logs require definitions prior to the recording: abstract activities and mapping to lower-level user interface interactions need to be specified beforehand. To this end, the presented research project proposes a new framework for desktop activity mining that enables interaction recording prior to defining tasks and activities to be mined.

Keywords

task mining, causal logs, object-centric UI log

1. Introduction and Motivation

Through the advent of Robotic Process Automation, the boundaries of automation-capable business processes have shifted [1]. Robotic Process Automation operates on the user interface of enterprise software. Therefore, integrating systems through the existing user interface eliminates the need for separate integration APIs. Furthermore, the visual modelling environment provided by RPA providers enabled departments to start their automation projects without the involvement of the IT department or professional programmers. Moreover, recent advances in artificial intelligence expanded the scope of tasks a computer can take over.

While visual modelling tools enable departments to build custom RPA bots, the technical feasibility assessment poses a significant challenge. The difficulty arises from a lack of experience and technical background compared to dedicated automation experts in IT departments. On the other hand, automation experts do not know the department's daily tasks and, therefore, can not propose feasible tasks by themselves. Ultimately, tasks to automate can only be found through intensive exchange between both departments, which requires time and resources.

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2. Problem statement and state-of-the-art

The research field around Robotic Process Automation recognises this problem of identifying adequate tasks for automation. From the managerial perspective, researchers propose quantified measurements to compare potential candidates in terms of automation-capability and profitability [2, 3]. Whereas the works of [4, 5, 6, 7, 8] leverage insights from process mining to discover potential task models from user interface logs.

Unfortunately, much information about the task executions (or cases) is not directly available in real live scenarios [6]. However, this information is necessary to calculate the previously proposed measurements and apply the process mining algorithms. One way to get around this limitation is to have employees estimate the values of essential criteria, such as the number of exceptional cases or the execution time.

Another possibility is recording user interface interactions and manually enriching the log. For example, in [4] and [8], the log is segmented implicitly into traces by the user when he starts and stops the recording. Additionally, the user abstracts events to activities with tool support.

The approach in [5] solves the segmentation task by building a dominator tree from the directly-follows-graph (DFG). An integral part of the DFG approach is the automated mapping of events to more abstract activities through additional UI information, such as the button name or application-specific parameters. For this, the solution requires application-specific add-ons and the log to contain only events from one task.

In conclusion, the automatic identification and segmentation of task executions from real-life logs remain one of the leading research challenges [6, 9].

3. Proposed approach and methodology

Therefore, this research project proposes a new approach to recording user interaction events in advance without the knowledge of any potential task candidate. This way, an employee can record all interactions of his/her daily tasks into one log. This log can then be used afterwards to mine models of tasks contained within the log. This is different to current works, where each log is recorded explicitly to mine one specific task model.

This project builds upon the work of [5] to leverage additional UI element properties for automatically mapping events to activities. However, instead of recording events within the applications through add-ons, the author proposes using the application-generic Microsoft User Interface Automation API (MS-UIA), which offers many insightful properties. Furthermore, to tackle the problem of a proper case distinction, the author proposes to transfer the object-centric approach from process mining to UI logs [10] as user interaction events may be related to UI elements and data objects.

The first part of this project will include recognising different instantiations of UI elements and data objects. Next, these objects are mapped to more abstract classes of objects by utilising properties provided by the MS-UIA, like the UI element name or the unique *AutomationID*.

As an extension to the reference model for UI logs presented in [11], this work provides

semantically enriched relations between interaction events and UI objects, such as *creates*, *requires*, *changes*, *destroys*. The semantics will create precedence order relations between events independent of the user's fixed but arbitrary chronological order, thereby revealing the half order prescribed by the application. This half-order over events simplifies the detection of recurrent patterns in the log since the relations can be interpreted as causal connections.

The next part is concerned with good algorithms for log clipping. *log clipping* is a new step in task mining projects concerned with the proper outline of events relevant to the task of interest. The author proposes using minimal domain knowledge in an iterative procedure to dissociate events. The algorithm leverages that events of one task are likely to form a connected component with respect to the causal relations mentioned above. Accordingly, the domain knowledge needs only to specify one distinctive event of the task. Then, a traversal through the causal relationships provides the remaining relevant events.

The final model discovery will apply state-of-the-art object-centric DFG algorithms to extract the underlying task model [12]. Developing a specialised mining algorithm for the new type of UI log is not part of this project.

The solution approach mentioned above can be broken down into three main research questions:

- How can the information provided by the user interface be leveraged to identify UI element objects and data objects
- What information can be exploited to automatically map instantiations of UI element objects to more abstract object classes
- How can user interactions be correlated to the objects they create, require, change or destroy

An evaluation measures the UI log generation's feasibility, effectiveness and robustness. This includes a quantitative assessment of precision and recall of interactions against hand-created task models. During prototyping, the author will generate logs, replaying commonly used automation tasks from the existing literature (like transferring data from a spreadsheet to a web form [8]).

For robustness in real-life scenarios, a case study within a medium-sized company should confirm the results from the continuous evaluation on self-created logs. This final assessment could be enriched with a qualitative assessment of the usability, understandability and effectiveness of the models/logs from the employees through semi-structured interviews.

4. Preliminary Results & Future Work

Preliminary prototype results reveal that the MS-UIA can be queried to extract relevant information about the UI elements. A temporal analysis of the UI state changes with the respective human interactions shows which of these are responsible for creating and deleting other UI elements. For a test data set, the approach has shown to be highly

resilient to noise from pop-ups, context changes or task changes since these relate to other objects.

The next work package will target the detection of data objects via common input values or clipboard usage. These objects will connect events from different applications within the log. After this, the test data can be enlarged by replaying tasks used in current literature that is mostly comprised of two applications [13, 5]. The common tasks are then recorded in one log containing many more tasks and noisy activities. This log should reflect the more realistic setting when the task for mining is not known at recording time. At last, applying the two current state-of-the-art task mining tools on the realistic log should compare the strengths and weaknesses of these approaches to the presented approach.

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