Process Mining on Blockchain Data (Extended Abstract)

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Abstract

Process Mining has been applied to several domains and IT systems in previous years. This extended abstract describes an approach to process mining on blockchain data.

Keywords

Process Mining, blockchain, monitoring, software logging

1. Motivation

Business processes are at the heart of every enterprise and are decisive for their success [1]. With the rise of information technology, processes were increasingly managed digitally in specialized information systems for business environments. The execution of the processes in information systems generates data. To improve the processes, the execution data can be computationally analyzed with a set of techniques called process mining [2]. Process mining experienced increasing popularity in research as well as in the industry across domains. Vital remained the access to process execution data. Similar to traditional enterprise information systems, blockchains can also serve as process execution platforms and are already used as such for various applications. As a cross-organizational platform, blockchains have the potential to substitute trustworthy mediator entities in an otherwise trustless environment thanks to their technological properties [3]. These properties include blockchains to be an append-only data-storage [4, p. 5] in which process execution data can be stored. Here process mining techniques might be a valuable addition to generate insights from the execution data. That includes benefits seen in other technological domains, but encompasses blockchain-specific benefits, e.g., security analysis. The opportunities for research are outlined in the following chapters.

2. Research Contribution and Plan

The dissertation will aim at providing an approach to process mining on blockchain data. Initially, the usefulness and suitability of process mining on blockchain application data obtained with existing extraction tools will be examined in case studies [5] to establish two base assumptions:

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1) Smart contract code can represent a meaningful process that can be executed, and: 2) Process execution data of smart contract code can be extracted from a blockchain and its analysis with process mining techniques can be valuable. Would these assumptions not hold, process mining on blockchain data would not be possible. That results in the research question: *RQ1) Is applying process mining techniques to blockchain application data feasible and useful?* To achieve that, we will make event data available by extracting it from the blockchain, for which queries and third party solutions already exist. In a second step, we intend to answer: *RQ2) How can existing tools for extracting event data from blockchains be extended benefiting event log quality?* Foremost, existing solutions currently are limited to smart contracts with known addresses, while it is an open challenge to identify temporarily invoked contracts and extract data they logged. For logging, these temporary nested contracts go unnoticed. Primary suspect for the identification of invoked contracts is the transaction receipt that is stored on-chain to log called contract's addresses. Open to research remains extracting the contract code and specifying which event data shall be logged automatically - a task that so far has been manual. Tied to nested logging, is the logging format. In a nested logging scenario, a clear separation of traces, vital for logging in XES format, may not be suitable. Hence, we plan to explore shifting to OCEL or event knowledge graphs to better accommodate documenting blockchain application event logs. Based on RQ1 and RQ2, we will move from a post-mortem (historic) analysis of event logs into an online-setting in *RQ3) What does a process monitoring solution for blockchain applications look like that benefits application designers and users?* We will conceptualize a process monitoring approach tailored to the blockchain environment. The approach will be designed with respect to the following design challenges: event streaming in a blockchain environment, blockchain-specific process KPIs, and technical blockchain peculiarities, e.g., block inclusion for ledgers with different consensus protocols.

Generally, this dissertation will be written in the spirit of Design Science Research, taking into account the design guidelines [6]. Our research endeavors will mostly be viewed as problems that can be solved by designing and developing solutions which need to be demonstrated and evaluated. The approaches will be implemented and evaluated using existing technologies such as [7, 8]. The evaluations will take into account previously defined requirements against which the implementations are checked.

3. Related Work

Several prior contributions with related content have been published in the past and will be contextualized briefly. **Data Extraction.** Process execution data of blockchain-based applications that is stored on-chain can generally be accessed through native APIs or language-specific API wrappers. The extraction of the data and its provision in an event log, however, is not an easy task [9] and was subject to prior research [10]. Most notably the tool *Ethereum Logging Framework* (ELF) offers a configurable logging solution for the Ethereum blockchain [11, 8]. **Utilizing blockchain application data.** Extracted blockchain data has been put to use for validating smart contracts on Hyperledger Fabric [12], auditing blockchain applications on the Ethereum [13], analyzing transactions on Ethereum without focusing on specific DApps [14], and using process mining on blockchain-wide data [15] but no single process in particular.

Case studies. The suitability of process mining for data from classic data sources (ERP, CRM, etc.) has been covered in various case studies across industries [16]. In these industries process mining was applied to analyze processes from different perspectives including control flow, conformance, drifts, and performance [17]. A study showing value in process mining on blockchain data has been added only recently as part of the dissertation [18]. **Monitoring solutions.** Monitoring of processes is based on the analysis of process execution data. Process monitoring is widely considered to be based on process mining techniques and divided in offline and online monitoring [1, p. 413]. Online monitoring requires event streaming [19] which has been subject of research [20]. An example of monitoring a choreography of process participants based on message-flow was provided by [21]. Furthermore, potential and challenges for monitoring business processes have been sketched previously [22].

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