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SimuBridge: Discovery and Management of Process Simulation Scenarios

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Abstract

Business process simulation enables testing and improving redesigned versions of business processes in a secure environment. By utilizing process simulators, the effects (e.g., the resource utilization) of process changes can be studied prior to real-world implementation. With the growing availability of process execution data, techniques have emerged to extract process simulation models from event logs. This enables a faster, more evidence-driven approach instead of manually creating simulation models. However, event logs may contain noise and lack specific information, such as resource availability, for a comprehensive simulation model. This demo presents a parameterization tool for simulation models that allows users to improve discovered models by human input or external data and develop different redesign scenarios — a user-friendly interface between existing discovery techniques and process simulators.

Keywords

Business Process Simulation, Parameter, Process Mining, Human-in-the-loop

1. Introduction

Organizations run business processes to deliver products and services successfully. Regular changes in the business process environment, such as increased demand or the availability of new technology, require improving and adapting the business processes frequently [1]. Process simulation enables organizations to safely test different redesign scenarios in an imitated virtual environment and observe their implications before applying them in the real world [1]. Multiple process simulators, such as BIMP [2] and Scylla [3], take as input a BPMN (Business Process Model and Notation) process diagram extended with different additional parameters (e.g., task duration, arrival time) necessary to simulate the dynamic behavior of the process. These form the process simulation model and the resource information. Both must be of very high quality so that the simulated process behavior allows for accurate reasoning on how the process would proceed in reality. Based on the simulation model and the resource information representing


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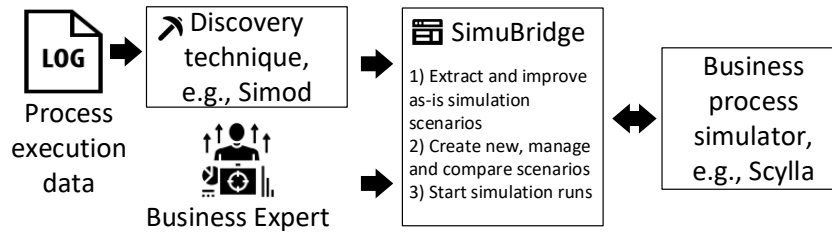


Figure 1: Main functions of SimuBridge

the real world, new process simulation scenarios can be created to test the impact of 1) possible changes in the process environment, e.g., an increase in customers, or 2) new redesign ideas, e.g., changing the order of certain activities or the automation of activities.

As more and more execution data of business processes is available in IT systems, it becomes increasingly feasible to apply process mining to the discovery of process simulation models [4] – a faster and more evidenced-based approach in contrast to creating a simulation model manually. A tool that integrates different components, such as control flow, activity duration, and role mining, is Simod [5]. Simod also provides accuracy optimization to discover simulation-ready models from execution logs. However, process execution data might not be complete or include data quality issues [6], so human input or external data might be necessary for refining and augmenting the simulation model or resource information. For example, the cost per hour of the different human resources might not be available in an event log; it needs to be extracted from a human resource database. Furthermore, the management of different scenarios for a business process simulation, the easy creation of new ones, and their comparison are not well-supported by open-access process simulation tools.

In this demo, we present SimuBridge, a tool that connects simulation discovery, human input, and process simulators and offers management of process scenarios and their comparison (cf. Figure 1). In the remaining sections, we present the tool features and architecture, then give insights into application use cases and future developments.

2. Tool Description

In the following, we first describe the main features of SimuBridge and then its technical structure. Its source code repository, including also a screencast and a tutorial, can be found at <https://github.com/INSM-TUM/SimuBridge>.

2.1. Features

As shown in Figure 1, SimuBridge supports several features explained in this subsection.

1) *Extract and improve as-is scenarios.* Using Simod, SimuBridge allows users to extract as-is process simulation models and resource information from event logs. The logs can be provided by business users. The simulation model discovered by Simod and its parameters are visualized in the user interface (UI). In addition, the UI shows scenario-related parameters (e.g., number of to-be simulated instances), process model-related parameters (e.g., activity duration and their distributions), and resource-related parameters (e.g., roles and timetables). Thus,

business experts have an initial simulation model with parameters available and can check their plausibility, adapt parameters where needed, and add the missing information. SimuBridge also allows manually creating simulation models and resource information.

2) *Create new, manage, and compare scenarios.* Usually, business experts want specific simulation parameters to be changed while keeping the rest of the parameters as in the as-is model. To support this, SimuBridge allows the creation of new scenarios based on existing ones. Additionally, scenarios can be configured from scratch without the need for process mining. Scenarios can also be deleted. Lastly, to see the differences between scenarios, two scenarios can also be compared to each other, and the differences between them are highlighted.

3) *Start simulation runs.* Finally, users can simulate the scenario without having to manually translate it into the specific input formats of a process simulator. Thus, the tool transforms the selected scenario of a user into files needed for the open-source simulator Scylla and provides the simulation output files for download.

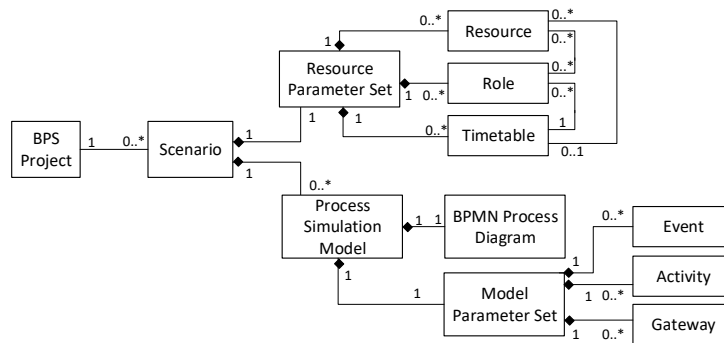


Figure 2: Internal data schema of SimuBridge.

2.2. Tool structure

SimuBridge is a web application. As illustrated in Figure 3, its UI comprises various interconnected pages that interact with an internal data storage system, which is based on the browser-side IndexedDB API¹ for client-side storage of large structured data.

SimuBridge internally stores the scenario data in a purpose-built data format. Figure 2 provides a high-level overview of this format. It was designed by analyzing the data formats of different research process simulators like BIMP and Scylla and process mining tools like Simod, and based on an analysis and overview provided in [4]. Using an intermediate format between those provided by the process mining and simulation tools allowed for design and operation independent of the other tools' specifications. Further, in the future, it allows researchers to easily add connectors to other process mining and simulation tools by translating the SimuBridge format into theirs.

To organize several process simulation scenarios, they are grouped into a BPS (Business Process Simulation) project. Each scenario includes a resource parameter set and zero or multiple process simulation models. Some process simulators, such as Scylla, can simultaneously simulate multiple business processes. The resource parameter set contains information about the resources responsible for carrying out the activities specified in the process models. These

¹See https://developer.mozilla.org/en-US/docs/Web/API/IndexedDB_API [Accessed: 15/06/23]

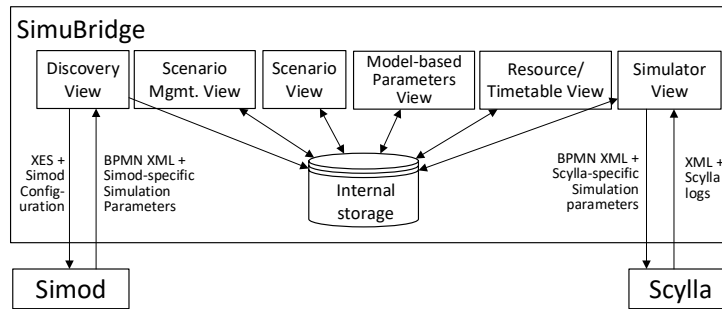


Figure 3: Architecture of SimuBridge

resources can be assigned to roles that serve as a mechanism to group resources with similar capabilities and responsibilities. Each role is assigned a default timetable to determine when resources for this role are available. Additionally, resources can have their individual timetables.

A process simulation model consists of a BPMN process diagram in the form of an XML file and the model parameter set. This set describes the execution dynamics of individual process model elements, including activities, events, and gateways. For each activity in a process model, the following details need to be provided: execution duration along with its distribution, activity costs, and the required role(s). An inter-arrival time distribution determines the occurrence of catching events. In the case of XOR and OR gateways, the execution probabilities for the outgoing sequence flows must be defined.

SimuBridge’s UI is structured as follows. The *discovery view* interacts with Simod to start process mining runs. Along with the user-given event log, in the form of an XES file, it passes a pre-defined Simod configuration. This configuration specifies aspects such as that Simod should discover resource roles, which we can then import to SimuBridge.

Simod [5] returns different BPMN XML files together with respective simulation configurations in JSON format. SimuBridge allows the user to select which of the discovered BPMN and simulation configuration files to use for the simulation scenario creation. The selected output files are then transformed by a dedicated internal Simod converter into SimuBridge’s data format and stored in the internal storage. Such a converter mainly translates one data format into another. More complex translation logic is needed, e.g., when translating unsupported distribution types into supported ones.

The *scenario management view* shows all existing scenarios, allows creating new ones based on existing ones, and comparing and deleting them. The *scenario view* provides an overview of all parameters of an individual scenario and allows general editing information of that scenario, such as its name.

Additionally, in the *model-based parameters view*, the BPMN diagram is shown. Users can review and parameterize the individual process model elements, such as activities and gateway. The *resource/timetable view* allows reviewing the existing resources, their assignment to roles, and the timetables of the availability of roles and resources. Finally, the *simulator view* allows starting a simulation run for a scenario in the open-source business process simulator Scylla. For this, the *simulator view* transforms the internal structure into the Scylla-specific files for the simulation parameters. As soon as the simulation has terminated, the output of Scylla can be downloaded.

3. Demonstration and Future Work

We evaluated our tool with three different publicly available event logs: The Disco tutorial purchasing example², the ProM tutorial repair example³, and the BPI challenge 2012 dataset [7]. SimuBridge successfully discovered, imported, and executed simulation models for each log, providing a significant improvement compared to manually translating configuration files and validating them based on plain XML/JSON code.

To validate our idea from a business perspective, we presented SimuBridge to two business experts with strong business process management and modeling expertise. They confirmed the value of comparing multiple scenarios and emphasized the usefulness of scenario management. They also agreed that a tool with automatic simulation scenario creation greatly simplifies the simulation process because it is difficult to enter hundreds of parameters manually. While acknowledging data imperfections, they still stressed the importance of being able to edit the data manually. Additionally, these experts gave us recommendations on how to further improve the tool, including to support different currencies within a single simulation scenario and to make the simulator output directly presentable to the company's decision-makers.

In the future, SimuBridge can be extended in several directions. First, we want to provide the business experts with more guidance in reviewing their discovered simulation model and improving it where necessary. Furthermore, we want to allow the flexible integration of different discovery techniques and process simulators. For this, we must allow the visual specification of which discovery outputs are used for which internal simulation parameters, a form of visual data mapping. With regard to the process simulators, it must be possible to define how the internal data representation is transformed into the input format of the simulator. Specific simulator information might be missing, so the user should be able to add them manually.

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²<https://fluxicon.com/book/read/tutorial/>

³https://promtools.org/prom-6-tutorial/introduction/#running_example