A Business Process Simulation Tool Bridging Control-Flow and Resource-Centric Paradigms

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Abstract

Business process simulation (BPS) supports data-driven decision-making by enabling organizations to evaluate the impact of process changes through digital process twins. However, existing BPS tools often either require manual model construction, neglect realistic resource behavior, or lack graphical user interfaces. To address this gap, we present a web-based BPS tool that overcomes these limitations by offering automated model discovery from event logs, flexible simulation paradigms—both control-flow- and resource-centric—and an intuitive graphical user interface. The tool supports both as-is and what-if analyses, making it accessible to a broad range of users and applicable to diverse types of processes.

Keywords

Process mining, Business process simulation, Data-driven simulation

1. Introduction

Business process simulation (BPS) plays a vital role in analyzing and redesigning organizational processes. By creating a digital process twin [1], simulation facilitates the estimation of how changes to a process may affect key performance indicators such as cycle time, resource utilization, and activity waiting times. This enables counterfactual reasoning or "what-if" analysis [2], helping organizations make informed decisions, enhance operational efficiency, and mitigate risks associated with process redesign [2]. In response to this potential, both academia and industry have developed a variety of simulation approaches and tools to support data-driven process analysis and decision-making. Academic contributions include BIMP[1], $\text{RIMS}_{\text{Tool}}$[3], SimuBridge[4], and Prosimos [5], while commercial solutions are offered by vendors such as Apromore, SAP Signavio, and Celonis.

Despite their utility, existing BPS tools face notable limitations. First, many tools require users to manually construct simulation models—a process that is both time-consuming and prone to errors [6]. Second, most tools overemphasize the control-flow perspective and fail to adequately capture resource behavior and characteristics, which are critical for realistic simulations [7]. Third, several tools lack an intuitive graphical user interface, limiting accessibility for non-technical stakeholders and thereby hindering broader adoption.

To address these limitations, this demo paper presents a web-based BPS tool that enables users to automatically discover simulation models from historical process execution data and perform both as-is and what-if simulations of the underlying process. Acknowledging the varying degrees of human decision power across process types—ranging from knowledge-intensive processes to highly structured workflows—our tool is the first to support both a resource-centric mode by leveraging AgentSimulator [7] for discovery and simulation, and a control-flow-centric mode by leveraging Simod [8] for the discovery

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[1] https://bimp.cs.ut.ee/simulator/

and Prosimos for the simulation. In doing so, our tool addresses all three of the aforementioned limitations: it provides (1) automated model discovery from event logs, (2) flexible simulation capabilities that go beyond control-flow by incorporating realistic resource behavior, and (3) a user-friendly graphical interface.

The remainder of this demo is structured as follows. We first describe the workflow of the tool, its technical architecture, and the enhanced resource-centric visualization in Section 2. We describe the maturity of the tool via a concrete application scenario in Section 3 and conclude the paper in Section 4.

2. Tool Description

This Section introduces the tool's workflow, architecture, and distinguishing features. We first describe how the tool constructs simulation models from event logs and executes process simulations. Then, we outline the underlying system architecture. Finally, we highlight how the tool differs from existing solutions by supporting resource-centric simulation and enabling comparisons with control-flow-centric approaches.

The source code as well as detailed documentation can be found at https://github.com/5dv214vt25/Data-driven-BPS. A short video is provided to explain the tool's main functionality[2].

2.1. Workflow of the tool

Our tool is designed to offer an end-to-end implementation from an event log to simulation insights. As depicted in Figure 1, this workflow consists of the following five steps:

1. **Upload process data.** Users begin by uploading an event log in either XES or CSV format. This event log requires resource-related information as well as start and end timestamps for each event. The tool assists in mapping required columns—such as case identifier, activity, and resource—also offering automated suggestions.
2. **Discover BPS model.** The tool leverages one of two established approaches—AgentSimulator [7] or Simod [8]—to automatically discover a BPS model from data. This BPS model consists of control-flow logic as well as several common parameters, such as distributions of activity durations and resource calendars. Users can select their preferred approach and optionally configure its corresponding hyperparameters before starting the automatic discovery of a simulation model.
3. **Define simulation scenario.** Once a model is discovered, users can define and store different simulation scenarios based on the model. The tool provides a visual interface to explore the process flow and manipulate simulation parameters.
4. **Simulate process.** Using the selected simulation engine—AgentSimulator or Prosimos (based on Simod's discovery)—the tool executes simulations based on the chosen scenario, thereby generating a new event log.
5. **Investigate process performance.** Post-simulation, users can download the simulated event log. The tool presents a performance analysis highlighting key process indicators, such as cycle times, waiting times, and resource utilization. Additionally, it enables comparisons across multiple scenarios to facilitate decision-making and process optimization.

2.2. Tool Architecture

The tool is composed of five distinct components that follow the Model-View-Controller (MVC) pattern, as shown in Figure 2. The first major component is the *Controller*, which exposes a RESTful API implemented in Python using the Flask[3] framework. The API serves as a central interface, orchestrating the overall functionality and communication between components. Next, the *View* implements the frontend using React and Typescript. It is responsible for presenting data and handling user interactions. Finally, the *Model* consists of three parts, two of which are the simulators, and one being a PostgreSQL

[2] https://www.youtube.com/watch?v=RF_lYoKAo8E
[3] https://flask.palletsprojects.com/en/stable/

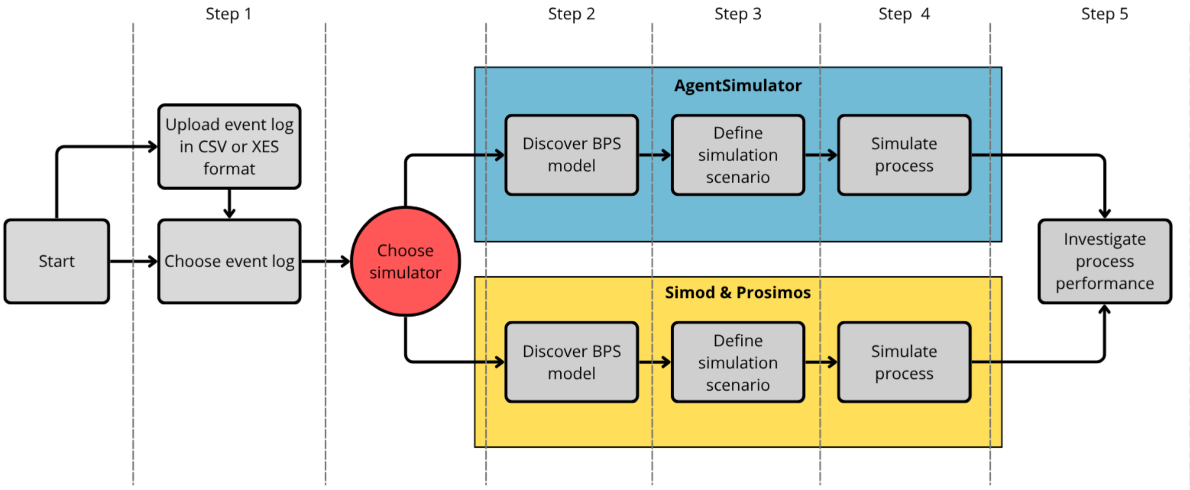

Figure 1: The workflow of the tool.

database. Two APIs were developed, one for each simulator, which are used to start the discovery or the simulation phase. The database is accessed through the controller's database manager implemented using the psycopg[4] library, which stores the users' event logs along with the simulation results.

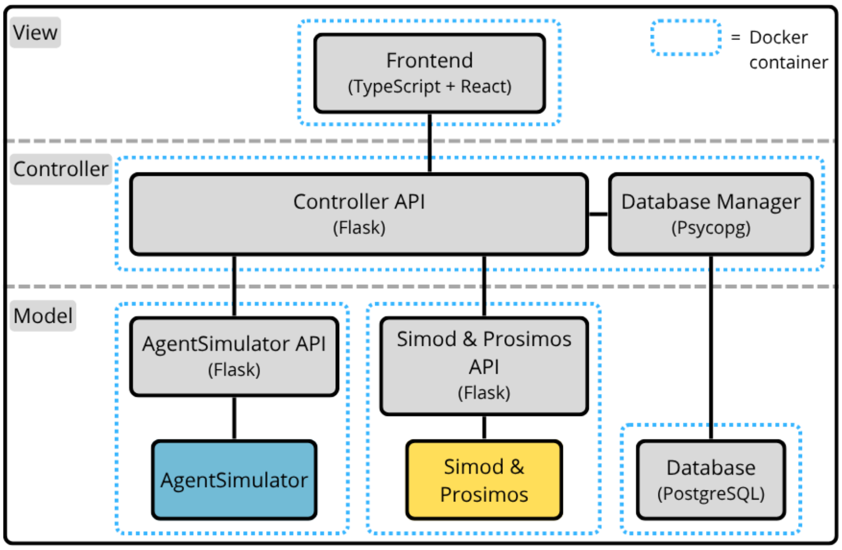

Figure 2: The technical architecture of the tool.

2.3. Enhanced Resource-Centric Simulation Interface and Comparative Analysis

Enabled by the previously described workflow and its underlying architecture, our tool distinguishes itself from existing tools in two key ways: (1) it is the first to provide a user interface for a resource-centric data-driven BPS approach, and (2) it enables direct comparison of simulation results with a control-flow-centric approach.

Resource-Centric User Interface. Our tool implements AgentSimulator [7] to focus on resource-centric simulation and enables users to investigate agent-based simulation models and create scenarios from them. Unlike other tools that implement control-flow-centric simulation approaches [8, 3], our tool captures resource interactions and individual behaviors to more realistically reflect real-world dynamics.

[4]https://www.psycopg.org/

To effectively convey these interactions, the interface employs Directly Follows Graphs (DFG) across three interconnected visualization views:

1. The **activity view** presents the sequence of activities via a DFG, familiar to process mining users.
2. The **role view** shows interactions among organizational roles, exposing collaboration patterns and handoffs, with probabilities indicating the likelihood of transitions between those roles.
3. The **resource view** focuses on individual agents, revealing specific interaction patterns and workload flows between individual resources.

Through these resource-centric views on the BPS model, users gain a deeper understanding of the dynamics between the resources prevalent in the event data, allowing for enhanced insights in and interpretation of the simulation.

Comparison of Simulation Results Across Approaches. In addition to offering an interface for investigating the BPS model and creating scenarios, our tool enables the comparison of simulation outcomes not only within a single approach but also across different ones. While this is also part of a prior tool's vision [4], it has not been implemented yet. Our tool bridges this gap by leveraging both AgentSimulator and Simod to offer accessible comparisons of these two process simulation approaches.

3. Maturity and Application Scenario

To demonstrate the maturity and practical relevance of our tool, we present a representative application scenario. Specifically, we consider a synthetic loan application process (cf. [7]), which is publicly available via our GitHub repository. The process involves six resources, five of whom are human employees of a bank. Now consider the following scenario. One of these employees, Oliver, currently works full-time as a senior clerk. He expresses the desire to switch to a part-time schedule, prompting his department manager to evaluate the potential impact of this change on process performance. Concerned that reduced availability might lead to increased customer waiting times, the manager turns to the simulation tool for support. After uploading the event log and discovering the corresponding BPS model, the manager configures alternative scheduling scenarios for Oliver and runs simulations to compare their effects. Figure 3 illustrates three such simulations: Scenario 1 represents the current (as-is) situation, Scenario 2 explores a part-time schedule with reduced daily hours from Monday to Friday, and Scenario 3 assumes Oliver is only available in the second half of the week. The results clearly indicate that a reduction in Oliver's working hours leads to an increase in average cycle time, primarily due to longer waiting periods. Nonetheless, Scenario 2 proves to be significantly more favorable than Scenario 3.

Figure 3: A comparison of three different simulated scenarios as they are shown on the analysis page of the tool.

4. Conclusion

This paper presented a web-based tool for conducting data-driven business process simulations. The tool automatically derives a simulation model from event logs and supports two distinct simulation paradigms, thereby enhancing its versatility across a range of process types—from knowledge-intensive to centrally orchestrated workflows. It further provides users with an intuitive interface and integrated analysis features to facilitate scenario exploration and decision support. While the current version allows for the adjustment of several key simulation parameters, future work will focus on enabling more fine-grained and flexible configuration options to further extend the tool's applicability. Furthermore, future work should focus on improving the UX via user feedback as well as enhancing the maturity of the tool by executing additional tests.

Declaration of generative AI

During the preparation of this work, the authors used ChatGPT in order to improve the readability and language of the manuscript. After using this service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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References

[1] M. Dumas, Constructing digital twins for accurate and reliable what-if business process analysis, in: BPM Workshops, volume 2938, 2021, pp. 23–27.

[2] M. Dumas, M. L. Rosa, J. Mendling, H. A. Reijers, Fundamentals of Business Process Management, Springer, 2013.

[3] F. Meneghello, C. Di Francescomarino, C. Ghidini, et al., Rims_tool: a hybrid simulator for business processes., in: ICPM Demo, 2023.

[4] B. Leon, F. Klessascheck, S. Nepeina, C. Warmuth, T. Kampik, L. Pufahl, Simubridge: Discovery and management of process simulation scenarios., in: BPM Demo, 2023, pp. 77–81.

[5] O. López-Pintado, I. Halenok, M. Dumas, Prosimos: Discovering and simulating business processes with differentiated resources, in: EDOC Demo, volume 466, Springer, 2022, pp. 346–352.

[6] W. M. P. van der Aalst, Business process simulation survival guide, in: J. vom Brocke, M. Rosemann (Eds.), Handbook on Business Process Management 1, Introduction, Methods, and Information Systems, 2nd Ed, International Handbooks on Information Systems, Springer, 2015, pp. 337–370.

[7] L. Kirchdorfer, R. Blümel, T. Kampik, H. van der Aa, H. Stuckenschmidt, Discovering multi-agent systems for resource-centric business process simulation, Process Science 2 (2025) 4.

[8] D. Chapela-Campa, O. López-Pintado, I. Suvorau, M. Dumas, SIMOD: automated discovery of business process simulation models, SoftwareX 30 (2025) 102157.