Proceedings of the 2025 Winter Simulation Conference
E. Azar, A. Djanatliev, A. Harper, C. Kogler, V. Ramamohan, A. Anagnostou, and S. J. E. Taylor, eds.

MAIN OBJECT-BASED SIMPLIFICATION OF OBJECT-CENTRIC PROCESS MODELS FOR SIMULATION

Seunguk Kang[1], Gyeunggeun Doh[1], and Minseok Song[1]

[1]Dept. of Industrial and Management Eng., Pohang University of Science and Technology (POSTECH), Pohang, REPUBLIC OF KOREA

ABSTRACT

Object-Centric Process Mining (OCPM) provides a more expressive representation of business processes by capturing interactions among object types. However, the resulting models often exhibit high structural complexity, which limits their applicability in simulation-based analyses. This study proposes a method for model simplification by identifying a main object within Object-Centric Event Logs (OCEL) and constructing a simplified Object-Centric Petri Net (OCPN) centered around it. Contextual information from related objects is embedded as attributes of the main object, thereby reducing structural complexity while preserving the semantic context of the original process. The proposed approach enhances model interpretability and improves the practical feasibility of simulation-driven process analysis.

1 INTRODUCTION

Traditional process mining techniques are based on a single-case notion, limiting their ability to represent the complexity of real-world processes involving multiple interacting objects. OCPM addresses this limitation by modeling diverse object types and their relationships. However, the tight coupling between objects and events often results in structurally complex models that are difficult to interpret and apply to simulation tasks. Despite its potential for realistic simulation, research on object-centric simulation remains limited. In particular, generating simulation-ready models that incorporate both object interactions and control-flow logic is still challenging. This study proposes a simplification method that reduces structural complexity while preserving the semantic richness required for object-aware simulation.

2 METHODOLOGY

This study proposes a method for simplifying object-centric process models using OCEL as the input data. The method focuses on identifying a main object from the log and generating a simplified OCPN based on it. First, the OCEL is analyzed to extract both event-to-object and object-to-object relationships. Using this information, an Entity-Relationship Diagram (ERD) is constructed to capture how objects interact within events. The ERD is constructed by analyzing which object types participate in each event type. Table 1 and Figure 1 present an example of object relationships extracted from a specific process (e.g., order management) and the corresponding ERD table.

Event Type	Object relationship
Place Order	Customer, Order, Item, Product
Confirm Order	Customer, Order, Item, Product
Pay Order	Order, Item, Product
:	:

Table 1: Event type to Object relationship.

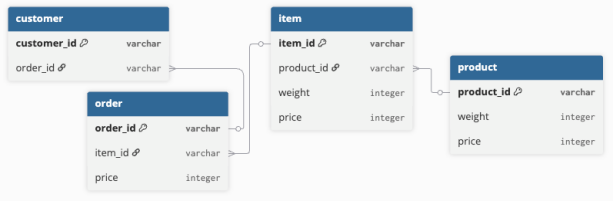

Figure 1: ERD: Place Order, Confirm Order event.

Based on the ERD, a hierarchical analysis is performed to identify the top-level object within the network of object types. This object is then designated as the main object. For instance, in the given example, the main object for both the 'Place Order' and 'Confirm Order' events is identified as the 'Customer'. The main object not only plays a key role in simplifying the process model but also serves as the central entity that drives the execution of activities. Additionally, it acts as a synchronization anchor, aligning other related objects involved in each event.

In the next step, a full OCPN is discovered using standard process mining techniques. While the full OCPN reflects all interactions across object types, it often becomes complex and difficult to interpret. To address this, we generate a Simplified OCPN by focusing solely on the main object and embedding related object information as attributes. Figures 2 and 3 below compare the original OCPN with the simplified OCPN centered around the main object.

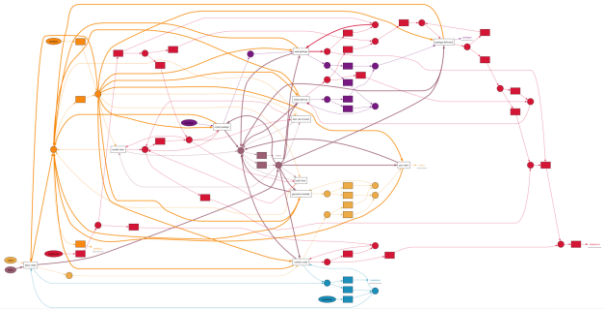

Figure 2: Object-Centric Petri-Net.

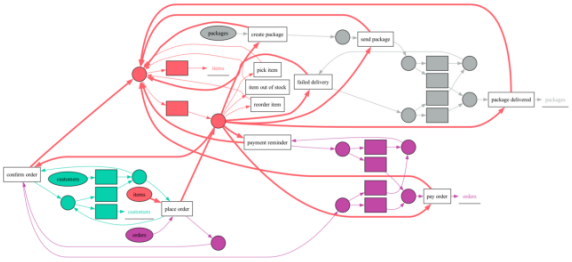

Figure 3: Simplified OCPN.

This simplified OCPN reduces complexity while preserving essential semantics, thereby enhancing the interpretability and simulation readiness of the process model. Based on the simplified model, additional analyses such as resource profiling, timestamp analysis, and decision-point evaluation can be conducted to derive simulation parameters—such as activity durations, branching probabilities, and inter-arrival times—ultimately enabling full simulation implementation.

3 VALIDATION AND CONCLUSION

To validate the proposed method, we conducted case studies using various real-world and synthetic OCEL datasets from domains such as order management and logistics. In each case, the framework successfully identified object relations, selected a main object, and generated a simplified OCPN. Agent profiles were derived from resource behaviors, and the simulation produced OCEL-formatted outputs suitable for further analysis. These results demonstrate the method's robustness and applicability to diverse object-centric business processes by supporting multi-object interactions, control-flow simplification, and integration of agent behavior.

These simplified models serve as a solid foundation for developing simulation-ready process representations. Based on the reduced model, additional analyses—such as resource behavior analysis and decision point analysis—can be conducted to construct comprehensive and scalable simulation models tailored to the business context. The results highlight the practical value of process simplification for enabling more interpretable and modular simulations in complex, object-centric environments.

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