Model Factors Influencing Petri Net Understandability: A Case Study on Simplicity

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Abstract. A user's ability to understand a Petri net is influenced not only by personal factors, such as their familiarity with the semantics and confidence with specific structures, but also by structural factors like the size of the net or the number of arcs. Identifying the most important factors impacting understandability requires empirical studies rather than mathematical analysis. In this work, we outline our plans to conduct a survey to evaluate how different model factors impact the understandability of Petri net models. We expect this survey to yield insights into the factors that influence Petri net understandability and provide a foundation for future research.

Keywords: Process Mining · Case Study · Simplicity

Process mining allows its users to automatically discover process models from event logs. Due to the autonomy of process discovery algorithms, it is important to check the quality of the generated models. Four quality criteria are used to do this: Fitness, precision, generalization, and simplicity. While fitness and precision are well-understood, simplicity is often overlooked or handled only implicitly. For our purposes, we consider simplicity to be how easily the model can be understood, reflecting its level of understandability. Unlike other measures, understandability depends on the specific use case and the preferences of the users working with the model. As a result, it cannot be universally defined; instead, it must be tailored to the use case and user base before the evaluation. In this work, we focus on the *understandability* of Petri nets as an indicator for its simplicity.

Existing empirical studies explored process model understandability, focussing on various modeling languages and aspects [1]. Recker et al. examined the differences between languages like BPMN and EPC, analyzing which is easier for beginners to learn [3]. Other studies focus on single modeling languages, investigating whether specific structures improve understandability. For example, Figl et al. analyzed how the design of routing symbols affects the understandability of BPMN models [2]. Reijers et al. introduced a valuable methodology while examining multiple model factors and their correlation with understandability [4]. In their study, participants evaluated eight EPC models with distinct characteristics, answering six Yes/No questions and one open-ended question regarding

model understandability. The authors assigned a score to each model based on the number of correct answers to these questions, which served as the dependent variable in a regression analysis. This analysis revealed significant effects of model factors such as density, average connector degree, and cross-connectivity on the understandability of the models.

Our goal is to adapt the methodology of Reijers et al. to Petri nets and conduct a case study to identify the factors influencing their understandability. Similar to this work, we differentiate between personal factors, such as participants' experience and knowledge, and model-related factors, which can significantly affect Petri net understandability: Experts potentially understand Petri net models better than beginners, which could obscure the relationship between model factors and understandability. To minimize the impact of personal factors, we will invite only students from the University of Augsburg who passed the Process Mining course, ensuring participants have similar knowledge of Petri nets. While additional surveys with other groups are planned, their differing knowledge levels will require separate analysis. We want to analyze 20 model factors, which we will use as independent variables in our correlation analysis. These factors include density, average connector degree, and cross-connectivity, which showed significant effects on the understandability in the study by Reijers et al. and will be validated for Petri nets. Additionally, we selected factors specific to Petri nets, focusing on the reachability graph. These factors are listed in Table 1, where we differentiate between the amount of model elements, quantitative, and qualitative factors.

Table 1. Structural model factors that might influence understandability.

Elements	Amount of nodes, edges, tau/duplicate transitions, connectors
Quantitative	Avg./Max. node/connector degree, Ratio of parallel transitions, Connectivity, Density, Separability, Sequentiality, Max tokens
Qualitative	Safe?, End places, deadlock markings, Parallel transitions, Traces

We designed eight models with significant variation in their factors, and created two slightly different variants for each model. In the case study, we will show one of the variants of each model to the participants. They will then be asked 13 single choice questions on the models' properties, like execution order, exclusivity, repeatability, and concurrency. Afterward, participants will compare all pairs of the eight models and choose the one they find more understandable in each comparison. These pairwise comparisons will generate a ranking of the models based on subjective understandability, allowing for correlation analysis between the correctness of responses and the ranking.

To conduct the case study, we developed a tool called *Petri-Dish* that automates the creation, execution, and evaluation of surveys for Petri nets. The tool automatically imports Petri net models in PNML format and calculates all 20 model factors from Table 1 for each model, simplifying model creation and question formulation. During the survey, participants can adjust the model

layout via an interactive interface, minimizing the layout's effect on understandability. *Petri-Dish* also includes a feature for pairwise model comparisons. For evaluation, the tool consolidates the participants' responses and comparisons and calculates a score based on the correct answers, reducing the overall effort to evaluate the results.

Our case study aims to validate the findings of Reijers et al. for Petri nets and uncover additional factors influencing Petri net understandability. The rankings from pairwise comparisons will serve as an extra indicator of understandability, complementing the survey scores in our correlation analysis. It will be interesting to see whether a significant difference exists between the correlation of model factors and the subjective perception from pairwise comparisons. The *Petri-Dish* tool will streamline the survey process, enabling efficient and accurate evaluations. We expect this approach to produce significant results and establish a foundation for future research on the simplicity dimension.

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