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A COMPARISON OF PETRI NET SIMULATION TOOLS[1]
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Abstract

Nowadays it has become almost a norm for enterprises to have a well-designed software ecosystem, in order to save resources and even make some tasks automatic. It is a big risk for companies to just put a program into a software ecosystem, for it can disrupt other applications and stagnate employees, which is why computer simulation exists. Utilizing the ingenious concept of Petri nets simulation tools are extremely useful. However, there are many simulation tools out there. It is in a company's best interest to select a tool that can cater to its needs, for software ecosystems are incredibly divergent. In this article, we will look at three Petri net simulation tools, Platform Independent Petri net Editor 2 (PIPE2), CPN tools and HPsim, and compare them using a comparison framework devised by Kraisig, Welter and Frantz (2016).

1 Introduction

In today's ever more competitive and technological business world, it is important, perhaps more than ever, for companies to secure functional programs and applications in order to assist its employees, thusly saving important time and resources. Frequently new applications are introduced to a company's software ecosystem, which can be catastrophic should the aforementioned application fail, possibly disrupting the work of many employees, consequently consuming the company’s resources and even damaging other applications in the software ecosystem. Because of this computer simulation has become a common process for enterprises large and small.

Computer simulation allows for safer software integration, therefore protecting the companies resources, making for a cheaper alternative to experimenting with the real application and with no real risks but at the expense of extra time consumed. Many tools use Petri nets as a base for simulation as a result of the ease in which Petri nets can model the characteristics of a system and how well its model lends itself to discrete event simulation.

Petri nets were created in 1962 by Carl Adam Petri and were initially used as a way to describe a chemical reaction. Nowadays Petri nets are used mainly for computer simulation.

“Petri nets (Petri 1962, Peterson 1981) are a wellfounded process modeling technique that have formal semantics. They have been used to model and analyze several types of processes including protocols, manufacturing systems, and business processes (Aalst 1999). A Petri net is a directed,

connected, and bipartite graph in which each node is either a place or a transition. Tokens occupy places. When there is at least one token in every place connected to a transition, we say that the transition is enabled. Any enabled transition may fire removing one token from every input place, and depositing one token in each output place." – (Hamadi & Benatallah 2003).

In this paper, we are going to compare three Petri net simulation tools using a comparison framework created by Kraisig, Welter and Frantz (2016). We will compare the Platform Independent Petri net Editor 2 (PIPE2), CPN tools and HPsim; we will revise the elements of each comparison before presenting a table and a conclusion, where we will discuss the results of the comparison. Note that the function comparison is absent in this article.

2 Methodology

In this paper, we will compare the functionality of Petri Net simulation tools by using a comparison framework created by Kraisig, Welter and Frantz (2016). The aforementioned framework has been conceived with Enterprise Application Integration (EAI) in mind. The framework will compare: What kind of Petri nets does the tool support, what are the tools components, in which environment does the tool operate, how assessable is the tool's work interface, how simple are the simulation results, and what the tool´s editor functionalities are.

3 Results

All the three tools we are about to measure use Petri nets in order to perform simulations, so as there are several types of Petri nets it is imperative for us to contrast which tools can use what type of Petri net, we also must compare the components of each tool, the environments in which they can operate, the functionalities of the tool's graphical editor and how complex are its interface and its results. For these reasons table 1 has been constructed, making the comparison of all of the aforementioned criteria simpler to compare.

First, there is the basic Petri net in all of its simplicity, all the three tools can operate with the basic Petri net. Stochastic Petri nets are nets with random delays between transitions, these are supported by PIPE 2 and HPsim.

Colored Petri nets allow a data value to be attached to a token, CPN Tools specialize in colored nets, even been named after them(Colored Petri Net Tools), but PIPE 2 supports them as well.

"Coloured Petri nets and Predicate/transition-nets are very closely related to each other, in the sense that Coloured Petri nets have been developed as a modification of Predicate/transition-nets, in order to avoid some technical problems which arise when the method of place-invariants is generalized to apply for Predicate/transition-nets." – (Jensen 87).

Timed Petri nets are nets that incorporate the concept of time, firing transitions in accordance to a

timer, this is essential for uniform environment modeling. All three tools support timed nets.

Hierarchical Petri nets allow for the creation of large models using a small number of nets, for they allow Petri nets to be placed inside tokens, working as a net inside a net. PIPE 2 and CPN Tools support hierarchical nets.

The components are an important factor in the functionality of the tools, only CPN Tools allows user code to modify the tool´s functionality. All three tools have a graphical editor, token game animation.

Simulation results are, basically, the analysis of the performance of a simulation of which data can be extracted, such as average queue length, the place of individual tokens, the utilization of resources, among others. All three tools allow for this performance analysis, although CPN Tools boasts a series of monitoring options that allow for more complex results such as queue length, response time, throughput, among others.

PIPE 2 has a structural archive format and extensive modulus analysis. PIPE 2 permits graphical simulation and structural analysis while CPN Tools and HPsim bear fast simulation. Both PIPE 2 and CPN Tools allow for state spaces and interchange file format.

PIPE 2 operates on Java and thus can run on most machines that support java. CPN Tools and HPsim both work on the Windows operating system, while CPN Tools has a flawed and substantially inferior and Linux port but can run on a Linux or a MAC as long as Windows is emulated.

It is very important, especially for new users, that a work interface and results are simple and easy to understand. HPsim's interface is remarkably simple and one could learn how to use the tool in less than an hour. PIPE 2 is also very simple if slightly more convoluted HPsim's, it's possible to grasp the tool in very little time. CPN Tools interface is labyrinthian and overly complex, it can take an entire day to learn the bare minimum to operate said tool and much longer to master how to correctly insert user code in it. PIPE 2 and HPsim provide simple results, so does CPN Tool, should one not use the plethora of optional monitors in a simulation.

Finally, there are the editing tools of these simulators. All three provide zoom and editing. PIPE2 and CPN Tools support undo and redo functions. CPN Tools allows for the cloning of and entire net while PIPE 2 and HPsim are stuck with copy and paste. HPsim boasts text annotations and a print function. PIPE 2 has auto adhesive notes. CPN Tools allows for animations.

Table 1 – Comparison Table

	Pipe 2	CPN Tools	HP Sim
Petri Net Types	Basic, stochastic, colored, timed and hierarchical	Basic, colored, timed, hierarchical	Basic, stochastic, timed

Components	Graphical editor, token game, graphical simulation, state spaces, Invariant place, structural analysis, simple performance analysis, interchange file format, extensive modulus analyses, archive format analyses	Allows user code, graphical editor, Fast Simulation, token game animation, state spaces, simple performance analysis, interchange file format	Graphical editor, token game animation, fast simulation, simple performance analyses
Environments	Java	Linux(inferior), Windows	Windows
Work Interface	Assessable	Complex	Assessable
Simulation Results	Simple Results	Simple and Complex results	Simple results
Editor	Zoom, exportation, editing, Auto-adhesive notes, undo, redo	Zoom, editing, animation, undo, redo, cloning	Zoom, print function, text annotations, editing

4 Conclusion

Based on the date gathered and studied during this article and the table 1, it is possible to observe that PIPE 2 is the most practical of the trio due to its numerous components and the large variety of Petri net types it supports. However, HPsim is simpler and faster, making It a better option for less complex tasks and for introducing beginners to the concept of Petri nets. While nightmarish complex CPN Tools support of user code and focus on colored Petri nets guarantee that the tool has its uses, not to mention the monitors that can be employed in a simulation, making it a decent option for in-depth analysis. CPN Tools focus in colored nets works for its benefit, it makes the aforementioned tool a more specialized option that can be expanded with user code, even tough PIPE 2 is more pragmatic and interpretative. Ultimately we can see that all three Petri net simulation tools viewed in this article have their uses in a specific situation.

5 References

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