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Book 5

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BOOK 5

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TOOLS IMPLEMENTING INTEGRATED SOLUTIONS TO ANALYSIS AND TRANSFORMATIONS OF BUSINESS PROCESSES THROUGH PETRI NETS

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Abstract: *Petri net is a mathematical modeling language that can be used to describe a business process graphically. A Petri net tool can also be used to simulate the business process. The paper presents tools implementing integrated solutions to analysis and transformations of business processes through Petri nets. This survey paper aims to compare five Petri net tools.*

Keywords: *Petri nets, Simulation, Yasper, WoPeD, GreatSPN, ExSpect, ProM.*

INTRODUCTION

Business process modeling is a fast developing discipline directed to business analysis with the aim to obtain different specific concepts for a given enterprise. The concepts are mutually complementary helping the complete perception of a complex system by outlining every significant element. They are represented by models, which describe the processes and services executed within a company. All this appears to be the main reason for creating lots of languages and methods, which are used for business models description. One of the pioneering methods applied in business process modeling is Petri net technology.

PETRI NETS

Petri nets offer a graphical representation of stepwise processes including choice, iteration and concurrent execution. They are distinguished with an exact mathematical definition of processes' execution semantics, and a well-developed mathematical theory for analysis [1], [6], [7], [11]. Petri nets are one of the known techniques for describing business processes in a formal and abstract way.

There are four general approaches to Petri net analysis:

1. reachability analysis - involves the enumeration of all reachable markings, but it suffers from the state-space explosion issue;
2. the matrix equation approach - in many cases it is applicable only to special subclasses of Petri nets or special situations;
3. invariant analysis - determines sets of places or transitions with special features, as token conservation or cyclical behavior;
4. simulation - discrete-event simulation is an option to check the system properties.

Business process simulation with Petri net tools is an option to represent the properties of a system. The core idea is to use a suitable executing algorithm for revealing the presence of undesirable properties in the system, but it should be noted that the algorithm cannot show and prove the correctness of the model in the general case [4], [10]. Nevertheless, Petri net-based simulation is a convenient method for checking the desirable properties of a business process and/or system. The algorithm includes the following steps:

1. Initialization: decide the initial marking and the set of all enabled transitions in the marking;
2. If the number of preset simulation steps or certain stopping criteria is met, stop. Otherwise, if there is no transition enabled, report a deadlock marking and either stop or go to Step 1;
3. Randomly pick a transition to fire. Remove the same number of tokens from each of its input places as the number of arcs from that place to the transition and deposit the same number of tokens to each of its output places as the number of arcs from the transition to that place.
4. Remove all disabled transitions from the enabled transition set, and add all newly enabled ones to the enabled transition set. Go to Step 2.

The algorithm has been initially suggested for business process simulation based on Petri nets tools. Over the years, the algorithm underwent a number of changes in correspondence with Petri nets extensions. The algorithm was further developed and now it is most frequently used with a modification used to find out the time required for execution of the whole process and for passing the transitions.

The application of an algorithm of this kind is obviously helpful, as it allows to pre-detect a number of deadlocks, and thus, to prevent the occurrence of serious errors like an incorrectly invented technological process as part of a series production that may cause dramatic problems to the company, additional work, legal consequences, irritated clients, mismanagement and depressed employees. Therefore, the algorithm is a powerful tool for checking the correctness of a business process prior to starting it up.

TOOLS FOR BUSINESS PROCESS SIMULATION BASED ON PETRI NETS

Studies in [2] and [8] enabled to compile a list of over 200 different software tools and utilities for business processes simulation using Petri nets. Regretfully, a significant number of websites are out of operation as they have not been maintained and updated for more than 15 years, or they exist just as source-codes lacking any descriptions, which fences off the understanding of their functions.

In result of the process of preliminary filtering, the list was reduced to 47 tools and utilities appropriate for further examination and comparative analysis. Even these were too many for the purpose of detailed investigation, and speaking about an effective software product, at least it is expected that it has gained minimum popularity within society and scientific communities. As such information is not available, a number of Google Scholar results and Google search results were used to help the research work.

The above stated approach reduced the filtering criteria to the following statements:

1. The tool was created or updated over the last 16 years (after year 2000).
2. There is an operational website of the tool that can be used in real-life processes, and it is provided with relevant documentation, help menus or other scientific papers.
3. The tool has minimum 200 citations in scientific papers (ascertained with Google Scholar search).
4. The tool has minimum 5000 results ascertained with Google search.

Concluding filtering, the final list comprised 15 tools ranked by the number of Google search results:

1. Kontinuum
2. Maria
3. Wolfgang
4. Mist

5. INA
6. Yasper
7. ProM
8. LoLA
9. Tina
10. Helena
11. WoPeD
12. GreatSPN
13. ExSpect
14. Woflan
15. AIPiNA

As result of multiple filtering and exploring different tools for business processes simulation based on Petri nets, a comparative analysis was worked out (Figure 1), placing the tools in the following categories: graphical editor, tools for manual simulation, tools for automatic simulation or verification, integrated solution combining previous solutions, as well as tools for software designer assistance and tools for specific software development.

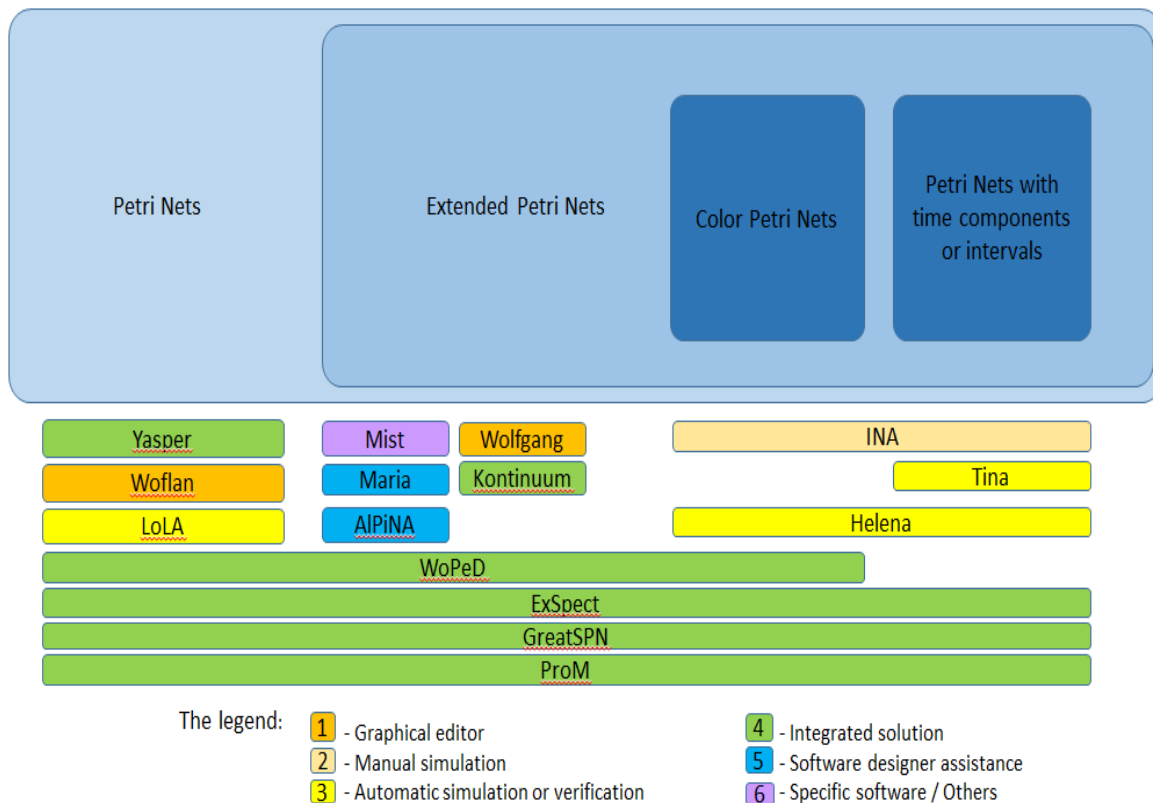


Fig. 1. Tools for business process analyses and transformations

TOOLS OVERVIEW

As seen from Figure 1 only six of the researched tools can offer all the above mentioned functionalities, i. e. Yasper, Kontinuum, WoPeD, ExSpect, GreatSPN and ProM

a. Yasper

Yasper (Yet Another Smart Process EditoR) is a tool for modeling, analyzing and simulating automated business processes. Yasper's models are based on Petri nets.

A Petri net can be further extended with the help of Yasper. Yasper provides a possibility for a more convenient editing of large business process models when a given business process has to be represented in a hierarchic structure [3].

b. Kontinuum

Kontinuum is business process management software for use by business decision makers and administrators as a tool to maximise control, save time and cut unnecessary costs. It is entirely web-based and consists of three major components – graphical editor, performance analyser and process management system.

Kontinuum gives opportunity to gain quantitative and qualitative metrics, and has direct integration with Excel and CrystalReports, as well as DB integration for SQL Server, and is offered as stand-alone installation or Software as a Service (SaaS) option.

However, the product is directed entirely towards unexperienced users and this limits the available options for serious experiments. Also, it does not have demo, trial or academic versions, so to test the product one actually needs to buy it.

c. WoPeD

WoPeD (Workflow Petri Net Designer) is an open source software product developed at the Cooperative State University Karlsruhe, Germany (distributed under GNU license). It is based on Java and runs on Windows, MacOS and Linux. WoPeD was designed mainly for academic purposes especially with its basic theoretical concepts related to Petri nets and business process modeling [12].

WoPeD runs with AProMoRe software that enables model sharing and exchange in BPMN, YAWL, EPC, XPDL and PNML languages.

WoPeD provides a graphical editor with which Petri nets and their components can be intuitively created onward the homepage. It contains a resource model editor (giving a possibility for defining roles and groups), a framework for sub-processes, token animation (with colored Petri nets framework), semantic analysis, integration with Woflan, quantitative analysis and capacity analysis.

d. GreatSPN

GreatSPN (GRaphical Editor and Analyzer for Timed and Stochastic Petri Nets) is a tool package for modeling, validation and performance evaluation of distributed systems. It has a framework for stochastic Petri Nets (PN) and their colored PN extensions and PN timed components. It can handle large data sets, which makes it suitable also for serious analyses.

GreatSPN is a commercial product developed at the University of Torino, Italy, but for universities it is available for free. Regrettably, the product is not of modular type and cannot be extended, regardless of which it has great resources.

The following features can be listed among its main advantages:

- graphical interface that, even not being updated, allows an easy measurement, rotation, cut and paste, rescaling and printing;
- interactive visualization of tokens, graphical representation of performance results and graphical simulation of timed and stochastic models;
- structural properties which allow to detect cycles and traps in models, conflicts of causal connections, mutual exclusion, etc.;

- reachability graph;
- Markov chains modeling (Markovian solvers), etc [5].

e. ExSpect

ExSpect is a software tool designed for discrete process modeling. It is also suitable for business process modeling, etc, being provided with a framework for Petri nets and their basic extensions (colored and timed). ExSpect is convenient for implementing a rapid prototyping.

ExSpect is a powerful tool for any organization as it allows tracing relevant loads and streams in different business processes without academic knowledge on PNs, yet, it is made possible by involving a mine of library components for constructing the processes.

Despite that the software was initially released 15 years ago, its interface is among the best user-friendly interfaces and it allows adding components from other libraries.

ExSpect was developed for Windows at the TU Eindhoven, The Netherlands. Regrettably, its support was ceased in 2000, which means that it can be run on Windows XP and not on later versions, and this affects our recommendation.

Yet, the ExSpect component for simulation is available as a COM component and can be used for eventual research work.

f. ProM

ProM (Process Mining) Framework is an open source framework directed to RapidMiner 5, a system supporting the design and documentation of the whole data mining process. Both systems are interconnected and allow for designers of software applications and end users to easily apply and extend their data mining algorithms.

The framework is based on Java and de facto runs on all popular platforms, being provided with official support for Windows, MacOS and Linux. ProM is an open system developed at the TU Eindhoven, The Netherlands, and it is extensible for plug-ins. The source code is also an open system and the product maintains the OpenXES standard to the utmost.

Practically, ProM is adoptable to every software product and has a set of plug-ins which help to extend the main functionality [9]:

- Mining plug-ins – algorithms that construct Petri nets based on event logs;
- Export plug-ins – objects which can be saved as Petri nets (e.g. in PNML format), spreadsheets, etc;
- Import plug-ins – loading objects in EPC, PPM format, etc;
- Analysis plug-ins – implement object property analysis, e.g. for Petri nets a number of properties can be checked such as coverability, transitions, reachability, etc. There are plug-ins to compare a log and a model, etc;
- Conversion plug-ins – for conversions between different data formats, e.g. from EPC to Petri nets, etc;
- Tshinghua- α algorithm - converting log files and their timestamps into Petri nets;
- Genetic algorithms - tackle possible noise in a log file, etc.

Being exclusively modular, ProM operation resources are practically unlimited. The product is supported, free of charge, with open source, easily adoptable, and is one of the recommended choices for simulation technique through Petri nets.

CONCLUSION

It is important that the techniques and tools, which are implemented for business processes investigation and improvement, correspond to the following requirements: to be provided with a graphical editor for visualization, to have support for different types of Petri nets, to be popular among scientific communities, and the product itself - to be frequently updated and extensible for plug-ins, import and export.

Unfortunately, ExSpec support is ceased, Kontinuum is not free of charge and is directed to inexperienced users. In result, the following tools can be listed as exclusively suitable for business process simulation:

- **GreatSPN** – it has all necessary functionalities; it is exclusively fast; it is provided with a good number of books and publications concerning its operation, but it is not an open source and it has not been updated since 5 years;

- **ProM** – exclusively modular product, free of charge, with an open source, highly extensible for plug-ins; strongly recommended;

- **WoPeD** - it is easy to use; it is provided with good options for conversions as well as with basic functionalities for simulation and analysis;

- **Yasper** – it is extremely easy for learning; the result is represented within one dialog window; the interface is nice and convenient; the program is free of charge. Unfortunately, only classic Petri nets are supported; the time components are with partial support but colored Petri nets are not supported.

It is difficult to point out which tool is the best one, having in mind that it is a matter of a concrete task, software and hardware platform, personal preferences, knowledge, etc.

Nevertheless that the recommended tools possess a great number of advantages in comparison with the rest of the tools for simulation mentioned in this analysis, they could be more or less convenient for other tasks. Besides, new tools and improvements of old versions occur every other day and for the purpose of a deeper comparative analysis it is necessary to keep informed about currently proposed tools in larger details, to follow the updates of information proposed and to continue to explore the newly offered techniques.

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ИНСТРУМЕНТИ, ПРЕДЛАГАЩИ ЦЯЛОСТНО РЕШЕНИЕ ЗА АНАЛИЗ И ТРАНСФОРМАЦИИ НА БИЗНЕС ПРОЦЕСИ ЧРЕЗ МРЕЖИ НА ПЕТРИ

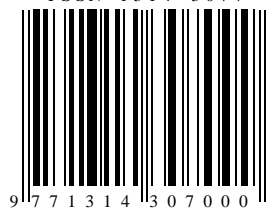
Камелия Шойлекова, Петър Събев

Русенски университет "Ангел Кънчев"

Резюме: Мрежите на Петри е математически език за моделиране, който може да се използва за графично описание на бизнес процеси. Инструментите базирани на Мрежите на Петри могат да се използват и за симулация на бизнес процеси. Публикацията представя инструментите, които предлагат цялостно решение за анализ и трансформации на бизнес процеси чрез Мрежи на Петри. Това проучване има за цел да сравни пет инструмента базирани на Мрежите на Петри.

Ключови думи: Мрежи на Петри, Симулация, Yasper, WoPeD, GreatSPN, ExSpect, ProM.

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