**Project Proposal**

Master’s Thesis (1st year)

Software and System Engineering Programme

School of Software Engineering / FCS

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**Title: Reference and Data Semantic-Based Simulator of Petri Nets Extension with the Use of Renew Tool**

Изображение выглядит как объект

Автоматически созданное описание

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**Moscow, 2020**

# Abstract

Mention all of main points you’ll be looking at; follow recommendations that were given in ‘Research seminar’ classes (essential parts of the Abstract must be present, viz. *Background*, *Purpose* (*Aim(s)*), *Approach (Methods)*, *Conclusion (Expected Findings/Results* can be mentioned aswell)) – Times New Roman or similar font is used, 12 points, single spaced.

Abstarct is formed as a single paragraph text.

**Key Words:** Give about 5-7 keywords that allow to characterize (position) your project (research) easily – try to choose those keywords that will make others interested in the contents of the study (proposal); do not write straight away the words (phrases) that suddenly pop up in your mind! Experiment, for example, with Keyword Tool / <https://keywordtool.io/> or similar services.

Separate your keywords (phrases) with a semicolon ;

Times New Roman or similar font is used, 12 points, single spacеd.

The length of the Abstract section together with a list of keywords (one empty line separates them as shown above) is appr. 250-350 words (0.6 – 0.9 page) – please, refer to services to convert specified number of words to appr. number of pages – e.g. <https://wordcounter.net/words-per-page>.

The text is aligned at both sides of the page (the same requirement is valid for all following sections of the document).

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# Introduction

In the current days, the complexity of the software and other systems is constantly growing. One of the most important constituents of such complexity is concurrency of the processes performed by the system since it brings a lot of uncertainty and non-deterministic behaviour.

Because of such behaviour the deterministic finite state machines (FSMs) cannot support modelling and validation of these concurrent systems at all. The non-deterministic FSMs are suitable in this case, but their amount of the possible states is growing significantly, and system modelling is becoming impossible for being interpretable by human or impossible at all as well as system validation.

One of the most popular modelling formalisms which solves this problem is the Petri net which was invented by Carl Adam Petri in 1939 [1]. It allows to represent the concurrent system as the directed bipartite graph which consists of such vertices as places and transitions and such nodes as arcs. Tokens are used to represent the system’s resources and their distribution across the net’s places called marking is used to represent the current state of the system [1] [2].

Although the Petri nets are useful technique to model the concurrent software systems and the problem of the significant growth of the non-deterministic FSM graph’s nodes with the system complexity increase is solved in them, there are still problem that the Petri net may become too large for being understandable or even infinite if the data types with the very large or infinite ranges of possible values are used in the software system. The solution is the coloured Petri net which support data types called “colours”, arc expressions, guard expressions and other useful tools. They firstly were described by Jensen Kurt in his article in 1997 [3] and then in the textbook by Kurt Jensen and Lars M. Kristensen in 2009 [4].

The coloured Petri net can be used for modelling the concurrent software systems with data types which can contain any number of possible values. Also there exists yet another formalism based on the Petri net which is called reference Petri net or simply reference net. The reference nets allow to use references to objects as the tokens. One of the well-known software tools implementing reference nets is the Renew (the Reference Net Workshop) [5].

Even though the Petri nets can model the complex concurrent software systems’ behaviour, they cannot easily model working with data in the persistent database. The solution called db-nets was proposed in 2017 by Marco Montali and Andrey Rivkin [6]. A db-net is a formal model which consists of three layers: a control layer (the modified coloured Petri net), data a logic layer (queries and actions which allow the control layer to retrieve and manipulate the data in the database) and a persistence layer (the relational database). The last two layers and the modifications of the coloured Petri net used in the control layer allow to model working with the data in the persistent database while the control layer allows to model the control flow(-s) of the system as well as working with the local (non-persistent) data. Therefore, the db-net solve the problem of considering working with the persistent data in the model [6].

Moreover, the db-nets can be used with the application of the reference semantics since the reference data type can be considered as the ordinary data type (colour) in the coloured Petri net. It will allow to use complex data types with large values as tokens in the net.

Although the db-nets can improve the quality of modelling the concurrent complex software systems and their validation, especially those which use the persistent data, no their software implementations are found in the open sources. The Renew, which is mentioned above, is built as the collection of plugins written in Java and it is open-source, so extending this tool in order to support simulating the db-net’s run seems to be an appropriate solution and it will form the main part of the proposed project.

The developed software simulator is expected to provide the ability to validate possible behavior of the designed complex concurrent software system even if we need to consider the persistent data used by the system. This can be used for modelling and validating the behavior of the real safety-critical software systems as well as for the further researches. The potential users of such simulator involve the research staff of the Laboratory of Process-Aware Information Systems at the HSE Faculty of Computer Science (the PAIS Lab) [7]. This simulator is also expected to be use in research applied to the real industrial software systems which will be conducted within my master thesis which should be completed and defended next year.

This section provides the context for the proposed project (research), explains the background of the research work (from a broad sight down to more narrow one; personal motivation must be mentioned as well). The length of the Introduction section is about 1 to 2 pages – if more, do not exceed 2.5 pages under any circumstances!).

The Introduction section must provide a solid base for a reader to undestand the background of the proposed project.

The indent of the first line of each paragraph is 4 blanks (consider ‘Tab’ to be 4 blanks).

Each section in the document starts with a new page!

The titles of document’s sections as they are shown now must not be altered!

# Thesis (Research) Statement

As it was stated above, the purpose of the project is to develop the program (the software simulator), which supports the db-nets formalisms, based on the Renew open-source software tool. This simulator should meet a certain number of functional requirements at least. These functional requirements are the following.

1. The program shall allow user to model the db-net’s control layer using the Renew tool’s graphical user interface (GUI) elements for net’s interactive drawing.
2. The program shall allow user to create the database schema at the db-net’s persistence layer using the Renew tool’s GUI based dialog windows.
3. The program shall allow user to program queries and actions for the db-net’s data logic layer using the Renew tool’s GUI based dialog windows.
4. The program shall allow user to simulate the modelled db-net’s run using the Renew tool’s GUI.
5. The program shall allow user to input the external data for the db-net’s run during the db-net’s run simulation where it is necessary according to the db-net model using the Renew tool’s GUI.
6. The program shall allow user to save the modelled db-net using the Renew tool’s GUI.
7. The program shall allow user to open the previously saved modelled db-net using the Renew tool’s GUI.

The developed software product should consist of program (source code and executables) which meets the requirements listed above and developer’s and user’s documentation at least. The project should be completed by the first half of June 2020.

The material in (contents of) this section should flow naturally from what is described in the previous section. Be precise and convincing – the size of the section must be up to 0.5 page long; the statement must be absolutely coherent, all necessary details, despite the rather limited length of the section, should be presented in an unambiguous manner… Think about it carefully – now it is a right time to formulate your project’s statement.

Details were discussed during regular hours of the Research seminar.

# Methodology (Approach / Methods)

In the proposed project

The material in (contents of) this section contains the overall description of approach(-es), methods, procedures, etc. that you are planning to use in the project (research study). The size of the section is between 1 and 2 pages long. All views (statements, explanations) should be clear and convincing.

# Preliminary (Expected) Results and Discussion

Details were discussed during regular hours of the Research seminar. The presentation of ideas must be concise. Thus, try to keep this section short (appr. 200-300 words) – in any case, if a detailed explanation is required (this is not prohibited, feel free to provide all relevant details, the ones “in essense”), you can't be beyond 1 (one) page.

# Work Plan (as seen in December-January 2020)

Gantt diagram (chart) is the handiest form (<https://www.gantt.com/>) of presentation of the planned works’ stages in the project (research). In addition, it is possible to give a brief explanation (comments) of the individual aspects presented in this section.

# Implications of the Research (Project’s Work)

Say about new knowledge, what is worth knowing with regard to the work to be done... The size of the section is expected to be about 0.5 - 0.6 page long.

# Bibliography (References)

[1] Scholarpedia

[2] Reisig

[3] Jensen

[4] Jensen and Kristensen

[5] Renew

[6] DB-Nets

[7] PAIS Lab

List all sources (papers, articles, books, journals, documents, reliable Internet-sources, professional resources, training materials (of conferences, master-classes, etc.), …) in the alphabetical order. Use either APA or IEEE citation styles (depends solely on your preferences).

Make sure that all references are properly formatted, and they are all used in the text (aforesaid sections) of the proposal (no "dangling" references)…

Indents of lines are not used.

Please, don't forget that everything highlighted within the template in yellow color should disappear in the final version of the document and be replaced with the real text.

The mandatory font color (of the text) is black.