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The computer program to verify the hypothesizes and to predict the parameters for operational process

Keywords

Poland – Singapore Joint Research Project, computer program, verifying hypothesizes, operational process

Abstract

The theoretical background and technical information for the program are presented. Further, the components of the program are described and user manual is given.

1. Introduction

The computers programs are the tool to make life easier. Especially it is important if we have to perform a lot of complex and laborious calculations.
It is usually when we are a contactors in research projects. Since 2007 team of Department of Mathematics in Gdynia Maritime University has been working on Poland – Singapore Joint Research Project entitled "Safety and Reliability of Complex Industrial Systems and Processes". The described computer program is one of the tools coming from this Project.

2. Theoretical background and technical information

The computer program is written in Java with using SSJ V2.1.3. The SSJ is a Java library for stochastic simulation, developed in the Département d'Informatique et de Recherche Opérationnelle (DIRO), at the Université de Montréal.
The computer program implements the results from Poland – Singapore Joint Research Project [3], [4].
Its first part is verifying the hypothesizes about the conditional distribution functions $H_{bl}(t)$ of the system operation process $Z(t)$ sojourn times θ_{bl}, $b,l = 1,2,...,v,\ b \neq l$, in the state z_b while the next transition is the state z_l on the base of their realizations θ_{bl}^k, $k = 1,2,...,n_{bl}$ during the experiment time Θ. We assume that the typical distributions to describe these sojourn times are:
- the uniform distribution;
- the triangle distribution;
- the double trapezium distribution;
- the quasi-trapezium distribution;
- the exponential distribution;
- the Weibull distribution;
- the normal distribution;
- the chimney distribution.

The non-parametric chi-square goodness-of-fit test has been used to verify the hypothesizes in the computer program.
Second aim of the program is to estimate the unknown parameters of the system operation process. It estimates the following parameters:
- the matrix of probabilities of the system operation process $Z(t)$ transitions between the operation states $[p_{bl}]$
- the mean values $M_b = E[\theta_b]$ of the unconditional sojourn times θ_b, $b = 1,2,...,v$,
- the steady probabilities π_b, $b = 1,2,...,v$,
- the limit values of the transient probabilities at the particular operation states p_b.

3. Components of the computer program

There are two main tabs in computer application. One of them gives possibility to verifying hypotheses

about distribution function of sojourn times in particular operational states. Second one gives the predicts of parameters of operational process. (see *Figure 1 and Figure 2*).

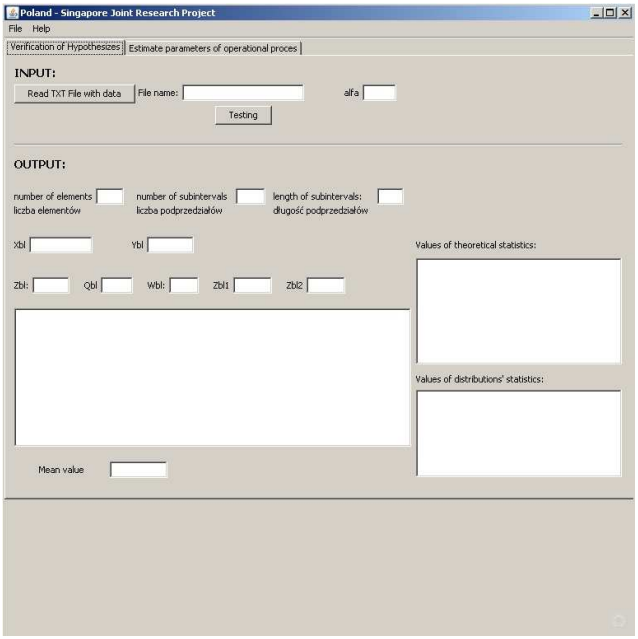


Figure 1. Main window for verifying the hypothesizes

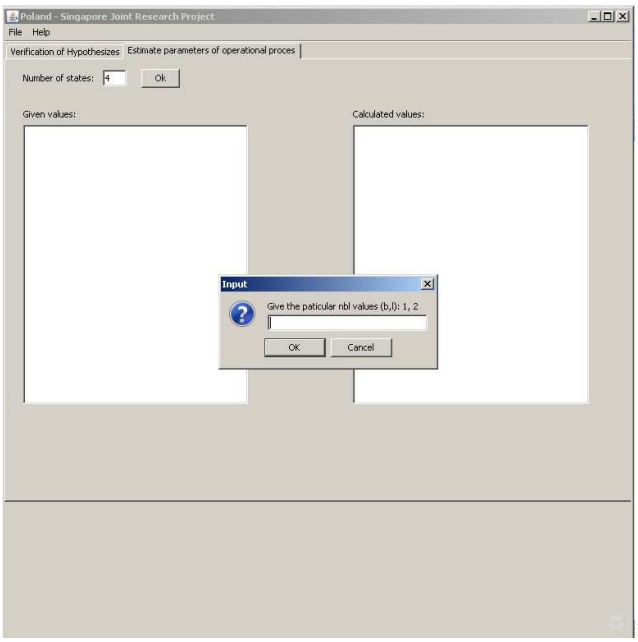


Figure 2. Main window for estimation the parameters of the operational process

As it is shown in *Figure 1* the window of the section for verifying hypothesizes has the two parts: INPUT and OUTPUT.
The INPUT is composed by the following components:

- button to choose the file with probe;
- text field with the path to chosen file;
- text field to set a factor α - the level of significance for investigated hypothesizes,
- button to start of the verification of the hypothesizes.

In OUTPUT it is shown the following results in particular text fields:

- size of probe – n_{bl}
- number of subintervals – r;
- length of subintervals – d;
- the begin of the interval and the end of the one (x_{bl}, y_{bl}),
- mean value from probe,
- values qbl, wbl and in case of quasi-trapezium distribution: zbl1, zbl2,
- values of theoretical statistics,
- values of statistics u_n,
- mean value of the conditional sojourn times θ_{bl} of the system operations process at the operations state z_b when the next transition is to the operation state z_l – Mbl.

In the text area it is shown:

- name of the validate distribution
- density function for this distribution.

In the case of using the computer program to estimate the unknown parameters of operational process, the main window has following components:

a) text field to set a number of operational states,
b) button to accept setting parameter,
c) text area to present the given data
d) text area to present the determined values.

After pressing the button “OK”:

a) the program allows to set the following values:
   - the matrix of the realizations of the numbers of the transients of the system operation process between the operation states,
   - the matrix of the realizations of the mean values M_{bl} of the conditional sojourn times θ_{bl} of the system operations process at the operations state $H_{bl}(t)$ when the next transition is to the operation state z_l ;
b) the program determines:
   - the matrix of the realizations of the probabilities p_{bl}, $b,l = 1,2,...,\nu$, of the system operations process transitions from the

operations state z_b to the operations state z_l during the experiment time Θ,

- the vector of the mean values $M_b = E[\theta_b]$ of the unconditional sojourn times θ_b, $b = 1,2,...,v$,
- the vector of the probabilities π_b of the vector $[\pi_b]_{1xv}$, $b = 1,2,...,v$,
- the vector of the limit values of the transient probabilities at the particular operation states.

4. Instructions for users

Now, we present the steps how fluently using the particular sections of the computer program.

4.1 Verifying the hypothesizes

Our work with program we start from preparing the data file. This text file should include a data set in one column as below example shows. (see *Example 1*)

Example 1. Correct form of the text file with data.

...
34.6
31.0
56.9
60.4
...

When we have the text file in correct form we can use the program with the following instruction of use:

In the section "INPUT":
Step 1. Press the button "Read TXT file with data" to choose the file with the data set,

Step 2. Set the level of significant alfa;

Step 3. Press the button "TESTING".

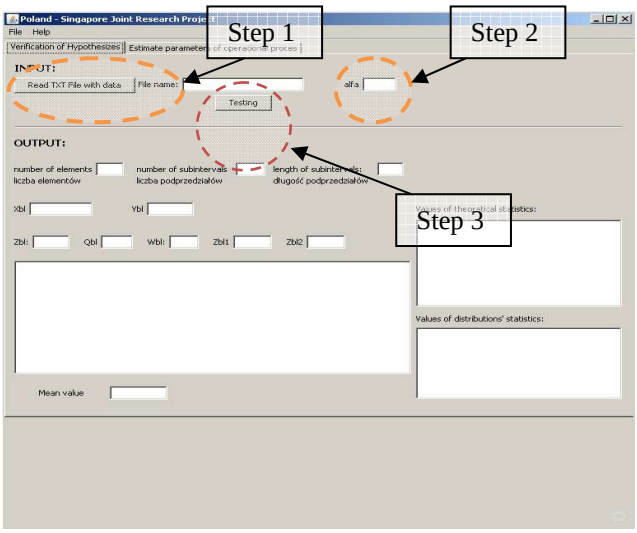


Figure 3. Instructions for users

The computer program fits the correct distribution function for the included file and shows results in section "OUTPUT" as it has been described before.

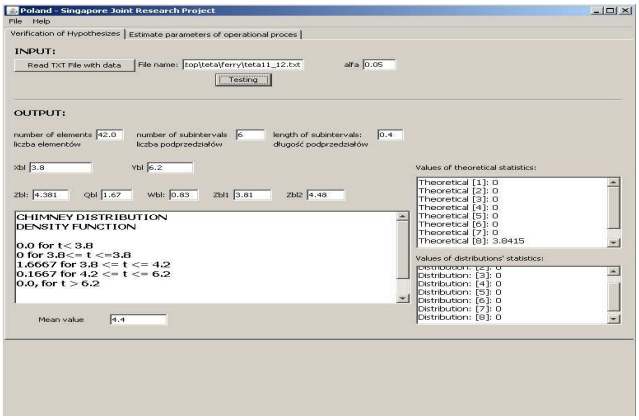


Figure 4. Exemplary results of the computer program

4.2 Predicts of operational process parameters

The instruction of use is as follows:

Step 1. Set the number of states.

Step 2. Press the "OK" button.

Step 3. Set the realizations of the numbers of the transients of the system operation process between the operation states,

Step 4. Set the matrix of the realizations of the mean values M_{bl} of the conditional sojourn times θ_{bl} of the system operations process at the operations state z_b when the next transition is to the operation state z_l ;

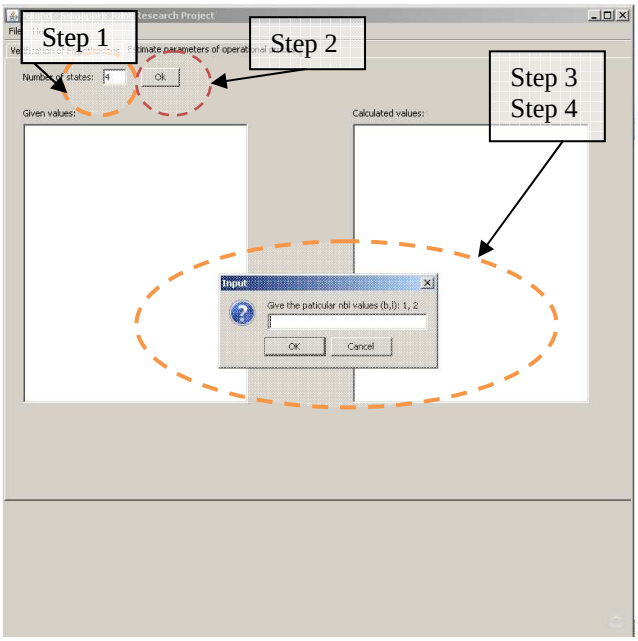


Figure 5. Instruction of use for prediction parameters

The computer program based on these values calculates:

a) the matrix of the realizations of the probabilities p_{bl}, $b,l = 1,2,...,v$, of the system operations process transitions from the operations state z_b to the operations state z_l during the experiment time Θ,
b) the vector of the mean values $M_b = E[\theta_b]$ of the unconditional sojourn times θ_b, $b = 1,2,...,v$,
c) the vector of the probabilities π_b of the vector $[\pi_b]_{1xv}$, $b = 1,2,...,v$,
d) the vector of the limit values of the transient probabilities at the particular operation states.

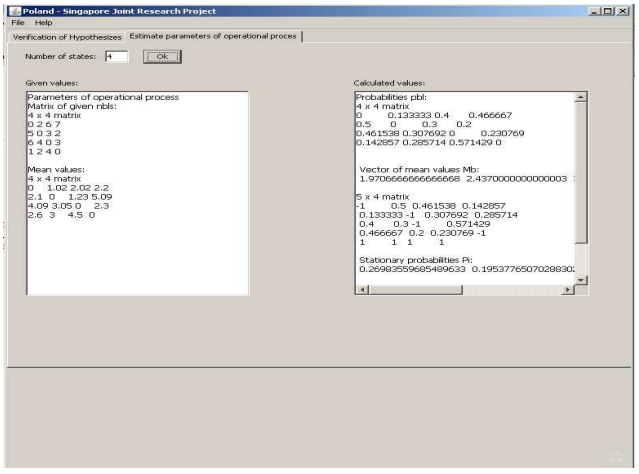
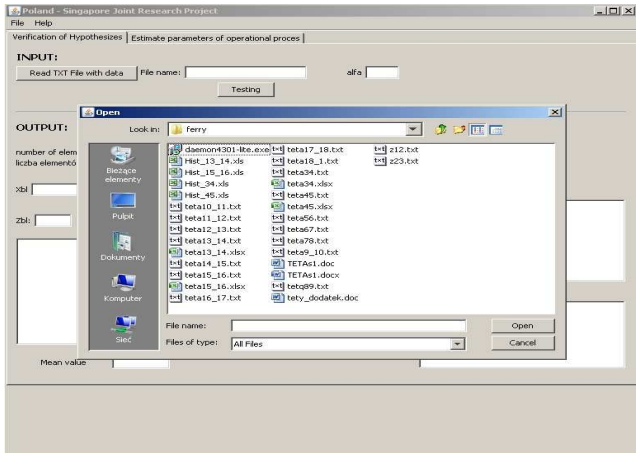
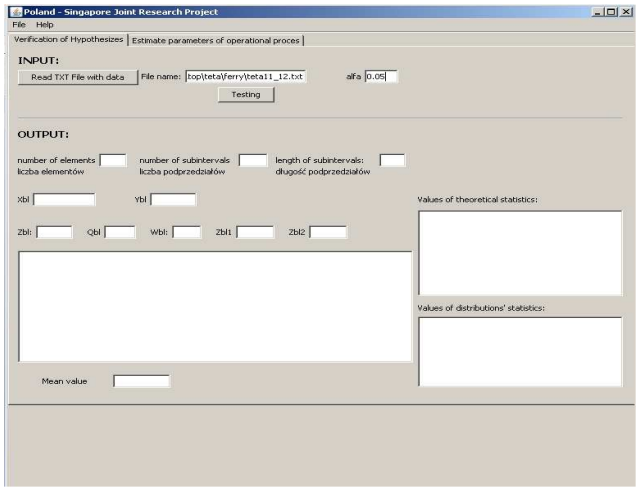


Figure 4. Exemplary results for estimating parameters

5. Applications

Example 2. There are shown the consecutive steps of using the computer programme for hypothesizes verification.





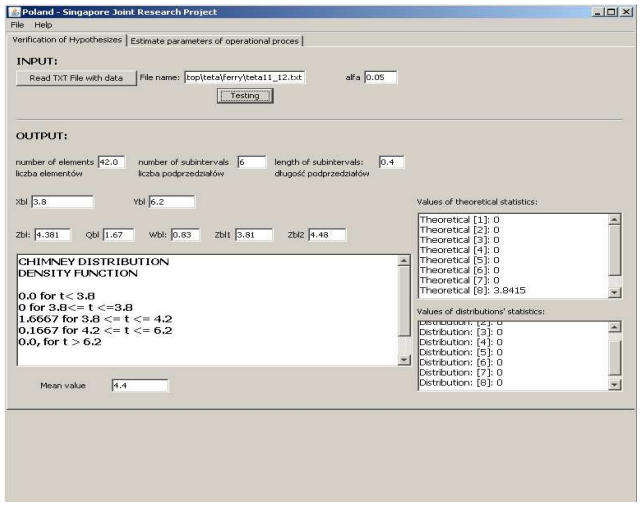
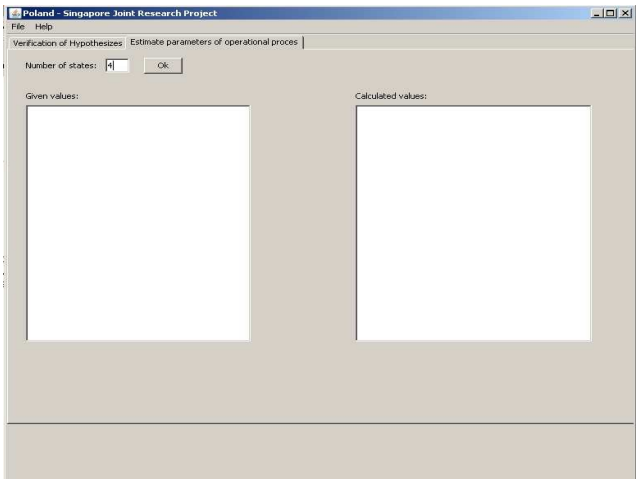
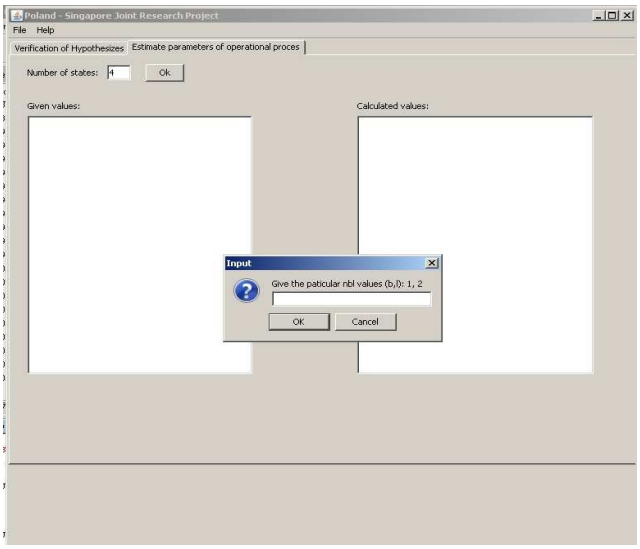
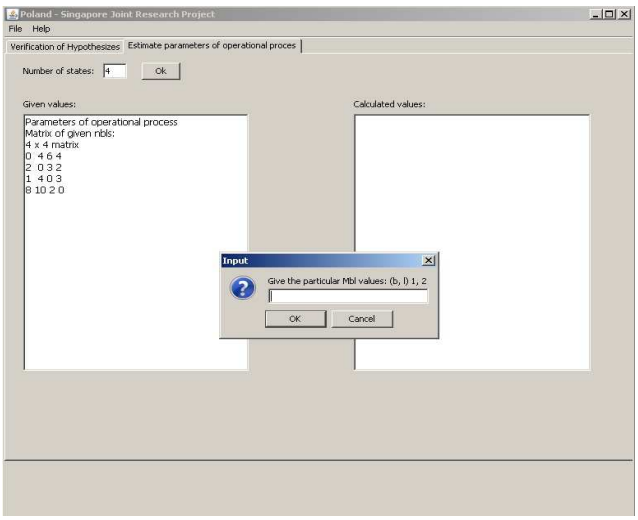


Figure 5. The steps of using computer programme for the verify the hypothesizes

Example 3. It is shown how to use the computer programme for validation of parameters of operational processes.







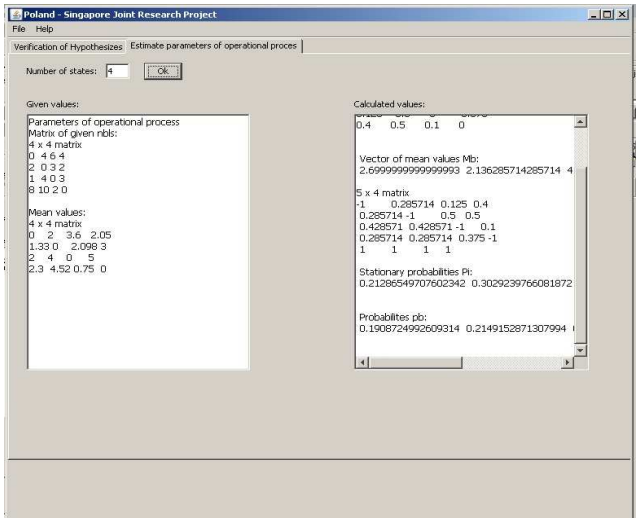


Figure 6. The steps of using the computer programme for prediction of parameters of operational process

6. Conclusions

The paper has described the computer program for Poland - Singapore Joint Research Project. The theoretical backgrounds and the technical information have been presented. Further, the short introduction about components of the program have been discussed and the manual for users has been given. The computer program can be used to verification and prediction for every operational process.

Acknowledgements

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References

[1] Barlow, R. E. & Proschan, F. (1975). *Statistical Theory of Reliability and Life Testing. Probability Models.* Holt Rinehart and Winston, Inc., New York.

[2] Eckel, B. (2005). Thinking in Java, 4th Edition. *Prentice Hall.*

[3] Kołowrocki, K. & Soszyńska, J. (2008). *A general model of technical systems operation processes related to their environment and infrastructure.* Task 2.1, Poland - Singapore Joint Research Project, internal papers.

[4] Kołowrocki, K. & Kwiatuszewska–Sarnecka, B. (2008). *Methods – Algorithms for evaluating unknown parameters of operation processes.* Task

6.1, Poland – Singapore Joint research Project, Internal papers.
[5] On-line documentation of SSJ. http://www.iro.umontreal.ca/~simardr/ssj/indexe.html