Skoltech
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Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Aleksandra Burashnikova

Ph.D. Program: Engineering Systems

Title of Thesis: Large-scale sequential learning for recommender and engineering systems

Supervisors: Assistant Professor Yury Maximov, Skoltech

Professor Massih-Reza Amini, Grenoble Alpes University

Name of the Reviewer: Vadim Strijov

I confirm the absence of any conflict of interest (Alternatively, the Reviewer can formulate a possible conflict)	**Date: 03-06-2022**

The purpose of this report is to obtain an independent review from the members of PhD defense Jury before the thesis defense. The members of PhD defense Jury are asked to submit signed copy of the report at least 30 days prior the thesis defense. The Reviewers are asked to bring a copy of the completed report to the thesis defense and to discuss the contents of each report with each other before the thesis defense.

If the reviewers have any queries about the thesis which they wish to raise in advance, please contact the Chair of the Jury.

Reviewer's Report

Reviewers' report should contain the following items:

- A brief evaluation of the thesis quality and overall structure of the dissertation.
- The relevance of the topic of dissertation work to its actual content
- The relevance of the methods used in the dissertation
- The scientific significance of the results obtained and their compliance with the international level and current state of the art
- The relevance of the obtained results to applications (if applicable)
- The quality of publications

The summary of issues to be addressed before/during the thesis defense

The Ph.D. thesis of Ms. Aleksandra Burashnikova entitled “Large-scale sequential learning for recommender and engineering systems” is devoted to the problem of designing efficient and reliable ranking algorithms. It is applicable to multiple engineering problems, including advertisement optimization and movie recommendation, energy systems reliability, and others. The study relevance is supported by numerous publications and open-source software releases from the machine learning research community on this topic.

The candidate has made a substantial contribution to the research area by developing a ranking framework for item recommendations based on learning from sequential data blocks (user-item feedbacks). In contrast to learning over the entire dataset, the framework is more flexible and yields excellent generalization error bounds. The latter allows controlling the accuracy of an algorithm within the framework efficiently. This result is well supported by theoretical statements and empirical evaluation that show a particular advantage over the state-of-the-art methods. Furthermore, the author studies the effect of a sudden user behavior change and possible algorithm memory limitations. Both issues are typical for large-scale recommender systems.

Finally, Ms. Burashnikova showed that the proposed approach and the whole sequential recommendation approach could be applied to the post-failure analysis of power grids allowing for efficient detection of a faulted line or a set of faulted lines. The latter problem is crucial for power systems control and energy blackouts prevention.

The thesis consists of the introductory part, the contribution part, which summarizes three WoS/Scopus articles published in leading machine learning venues, and the conclusion. The introductory part consists of three chapters.

In Chapter 1, “General introduction,” the author describes problem motivation and research goals. It also contains the thesis structure and summaries of relevant publications that facilitate navigation throughout the thesis. Chapter 2 outlines two principal (statistical) supervised learning frameworks, e.g. classification and ranking. For each learning framework, Ms. Burashnikova presents the main concepts and algorithms that will be used or improved in the central part of the thesis. Finally, Chapter 3 presents the state-of-the-art methods in recommender systems and ranking along with gaps in existing research closed in the rest of the thesis.

The second part describes the contribution of Ms. Burashnikova to theoretical and applied studies in the thesis topic area. It consists of three chapters; each of them addresses a particular gap in the state-of-the-art. This part is written thoroughly, and the thesis contribution is clearly stated.

Chapter 4 presents SAROS, a sequential ranking algorithm for recommendation improving the state-of-the-art based in the classical case when each user is given a set of items in a sequential manner. The algorithm updates the scoring function weights whenever an active user interacts with the system, by clicking on a shown item. It is proven that these sequential updates of the weights converge to the global minimal of a convex surrogate ranking loss estimated over the total set of users who interacted with the system.

Chapter 5 presents a unified framework for convergence analysis of SAROS, in the general case of non-convex ranking losses. The distribution free convergence rate is established under various assumptions on the data using the state-of-the-art tools from stochastic optimization and statistical learning. Later on in this chapter, Ms. Burashnikova studies the effect of non-stationarities and memory

in the learnability of a sequential recommender system that exploits user's implicit feedback. The experimental part gives the considerable improvement against the state-of-the-art methods.

Chapter 6, the last chapter of the contribution part outlines the problem of post-failure detection of a faulted line or a set of lines in a power system. The proposed approach consists of two steps. First, the author characterizes a power grid by exploiting its topology. Second, a prediction function is learned by minimizing a loss depending on the (graph) distance from a faulted line to a predicted one. This approach has a superior performance over the classical minimization of a (graph distance independent) loss function. The latter is supported by using the Mann–Whitney U-test.

The conclusion summarizes the thesis contribution and presents open questions.

The thesis results have been published in three articles. Two articles are published in core A conferences (ECML-PKDD 2019 and ECIR 2022) and the last one is published in Q2 journal (Journal of Artificial Intelligence Research, JAIR). All papers are of high quality, went through reviewing process and satisfies the requirements of Skolkovo Institute of Physics and Technology and University Grenoble-Alpes.

The thesis needs two major improvements that need to be addressed and a few minor technical issues.

The major problems are:

(1) The author's contribution needs to be clearly stated as all papers of Ms. Burashnikova were published with a large number of co-authors.
(2) The contribution should be stated more clearly with the emphasis on the thesis results impact.

The list of minor issues I found contains following typos:

(1) Page 20 – "mathcal F" should be substituted with "\mathcal F"
(2) Page 23 – the author needs to correct Eq. 2.6 by changing "-" to "+"
(3) Page 25 – "sparser paprameters", a typo
(4) Pages 26, 31 – "hyperplan", a typo
(5) Pages 44-50 – provide the references to the sources of the Figures
(6) Page 87 – provide a reference to Table 6.2 in the text

Despite the drawbacks mentioned above, I recommend to proceed with the public defence. The contribution of Ms. Burashnikova deserves awarding the author with the Ph.D. degrees
of Skolkovo Institute of Physics and Technology and University Grenoble-Alpes.

Provisional Recommendation

☒ *I recommend that the candidate should defend the thesis by means of a formal thesis defense*

☐ *I recommend that the candidate should defend the thesis by means of a formal thesis defense only after appropriate changes would be introduced in candidate's thesis according to the recommendations of the present report*

☐ *The thesis is not acceptable and I recommend that the candidate be exempt from the formal thesis defense*