Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Vladimir Fanaskov

PhD Program: Mathematics and Mechanics

Title of Thesis: Statistical inference and machine learning in numerical linear algebra

Supervisor: Associate Professor Aslan Kasimov

Name of the Reviewer:

I confirm the absence of any conflict of interest	**Lei Zhang**
(Alternatively, Reviewer can formulate a possible conflict)	**Date: 12-08-2022**

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:

- 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 candidate used Bayesian analysis and machine learning to enhance iterative methods for large sparse linear systems. The thesis is of high quality and well-structured.

- The topic of dissertation work is relevant to its actual content.

- The candidate studied belief propagation algorithms, probabilistic projection methods, probabilistic uncertainty quantification for deterministic algorithms in the Statistical Inference part, and automatic construction of solvers and preconditioners by unsupervised training, neural network architecture for multigrid methods, and online optimization of iterative methods with the help of reinforcement learning in the Machine Learning part.

- The candidate has made several contributions in his thesis, which include: generalization of Gaussian belief propagation algorithm on non-symmetric linear systems; construction of prior distribution that fixes trivial or intractable posterior distributions in contemporary Bayesian projection methods; hidden representation – an original way to construct probabilistic models for deterministic computations; generalized BPX preconditioners and algorithms that optimize them; neural architecture that is completely equivalent to the multigrid method; online optimization of linear solvers with bandits. Those results have resulted in several publications in high impact international journals such as SIAM J. Sci. Comput., Stat. & Comput. etc. It should be noted that most of the publications are single author paper, which is rarely seen at the PhD student stage, especially for applied mathematics research.

- The development of linear solvers is fundamental in the scientific computing, for example, the efficient solution of deterministic PDEs and uncertainty quantification for stochastic PDEs, the obtained research will have a lot of potential applications.

- As I already mentioned, the publications are novel and of high quality, especially when considering most publications are single-author papers.

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*