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Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Svetlana Illarionova

PhD Program: Computational and Data Science and Engineering

Title of Thesis: Deep learning for remote sensing of environment and land cover analysis

Supervisor: Professor Ivan Oseledets

Name of the Reviewer: Victor Lempitsky

I confirm the absence of any conflict of interest	**Date: 26-12-2022**

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

Brief evaluation of the thesis quality and overall structure of the dissertation.

The thesis is based on the collection of seven publications augmented with a short introduction and a short conclusion. The first publication (Chapter 2) provides an in-depth and detailed review of the subject of the thesis. The other six publications are more specific and describe contributions to the field. Each of the chapters 3-8 consider an important problem in Remote Sensing, shows how this problem can be attacked with a modern deep learning toolkit, and then provides a new way to improve the performance of a generic deep learning approach using the specifics of the considered problem. In each case, the proposed improvement has novelty, and is carefully evaluated against baselines/ablations, so that the improvement is validated empirically. Specifically:

- Chapter 3 investigates how object-based augmentation (which was previously not used in remote sensing) can boost the performance of land cover segmentation.
- Chapter 4 shows that hierarchically-structured classification can perform better that flat one-vs-all classification in a certain important image classification task.
- Chapter 5 suggests and investigates another non-standard formulation of land cover analysis task that takes into account the mixed class nature of the problem.

- Chapter 6 addresses the “long-debated” issue of whether regression tasks are better handled by their reduction to classification and shows that at least for a particular problem at hand the answer is negative and pure regression formulation leads to better performance
- Chapter 7 considers synthetic data generation using image-to-image translation and, after applying a fairly standard technique, shows that the resulting synthetic data can considerably improve the performance of a network trained for semantic segmentation.
- Chapter 8 provides a new augmentation type (*MixChannel*) that recombines images of the same locality taken at different time moments and considerably improves the performance of a deep network trained for land cover analysis.

The thesis is very well written.

The relevance of the topic of dissertation work to its actual content

All thesis material is highly consistent and is relevant to the topic of the dissertation work.

The relevance of the methods used in the dissertation

As far as I can judge, from the standpoint of deep learning the thesis are using state-of-the-art methods and network architectures (or those that were state-of-the-art at the time of the submission of the original publications), and are relevant to the tasks being considered.

The scientific significance of the results obtained and their compliance with the international level and current state of the art

The scientific significance of the results are supported by the acceptance of the papers to top-level journals on remote sensing. Eventhough in each case the proposed improvements use some specifics of a particular remote sensing set up, these improvements can often be generalized and improved to other tasks. For example, the channel mixup suggested in Chapter 8, can be reused to the computer vision tasks associated with ground-level surveillance cameras in a similar way.

The relevance of the obtained results to applications (if applicable)

The contributions of the thesis are all motivated by specific applications of remote sensing, namely land cover analysis, including the subtasks such as dominant forest species classification/mapping, canopy height estimation. The obtained results are thus highly relevant to applications.

The quality of publications

The results are published in leading remote sensing journals (Remote Sensing x 3, Forests, Sensors, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing), a strong wide-scope journal (IEEE access), and a workshop proceedings of a strong computer vision conference. The publication list is thus strong both in terms of quality and in terms of quantity.

Based on the considerations outlined above, I recommend that the candidate should proceed with thesis defence.

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*