

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: Nicu Sebe

I confirm the absence of any conflict of interest

Date: 20-12-2022

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

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 manuscript contains a good coverage of the subject and presents interesting contributions and results. One of the very positive aspects is the fact that the approach is very well structured and the motivations and contributions are clearly explained. The research is very much oriented towards remote sensing sector but the presented approaches have the potential to be applied in other areas. Additionally, some aspects like transfer learning are presented but are not discussed in details.

There are several contributions listed in the manuscript:

- combining target objects from georeferenced satellite images with different backgrounds in order to produce diversity in training is an interesting idea and it is shown to work well in practice. An object-based augmentation technique is presented and this is used to extend a minimum amount of labeled high-detailed data. These data are used to fine-tune the models, trained on a large forest dataset with less precise labeled masks.
- the multi-class forest classification problem is considered as a hierarchical set of binary classification tasks allowing to reach better results with both high- and medium-resolution satellite imagery. Additionally, contextual data such as tree height are used to improve the classification results of a wide variety of tree ages.
- the knowledge of dominant species is used for supporting a weakly supervised learning approach. The standard CNN sampling approach is replaced with an object oriented approach in order to reduce the effect of the spatial distribution of forest stands.
- very interesting is the proposed multimodal approach by leveraging the data from airplane-based LiDAR. This is used to predict the vegetation height by employing a deep neural network. This solution is less costly than using drone measurements and the predictions have a higher spatial resolution (less than 5m) than the vast majority of studies using satellite data (usually more than 30 m).
- another interesting contribution relates to employing GANs for creating a “fake” spectral band in the NIR domain using only RGB channels of high-resolution satellite imagery. The results show the advantages of generating this extra band for reducing the required amount of labeled data;
- as in many practical applications, one important aspect is the domain gap between the training and the training sets (e.g, because of different locations or different time). This problem is crucial when the size of the training set is small. To address this problem a novel image augmentation approach called MixChannel is proposed in the thesis. In my opinion this is the most important contribution as it opens the way toward domain adaptation and supporting the possibility to perform training of models that can generalize better in remote sensing of the environment.

Overall, the manuscript is a good example of how a thesis should be written: it presents several aspects of the problem under discussion and they are well connected together providing a comprehensive solution. I am not an expert in remote sensing but I enjoyed reading the thesis and I have learnt many things. I believe the contributions are sufficient to be defended and to be reported to the doctoral committee.

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