REVIEW

under the procedure for acquisition of the educational and scientific degree “Doctor”

by candidate **Ventsislav Yuriev POLIMENOV,**
of the PhD Thesis entitled: **“Adaptive Neural Network for Processing Satellite Data with Different Spatial and Spectral Characteristics ",**
in the Scientific field: **4. Natural Sciences, Mathematics and Informatics**

Professional field: **4.6. Informatics and Computer Sciences**
Doctoral **program “Informatics”**,
Department **„Software Technologies and Information Systems”**,
Institute of Mathematics and Informatics, Bulgarian Academy of Sciences (IMI-BAS).

The review has been prepared by: Assoc. Prof. Galina Dimitrova Momcheva, PhD, Institute of Mathematics and Informatics, Bulgarian Academy of Sciences (IMI-BAS), as a member and chair of the scientific jury for the defense of this doctoral thesis according to Order № 44 / 05/18/2026 г of the Director of the Institute of Mathematics and Informatics, BAS and decision of the scientific jury (Protocol № 1 / 06/05/2026).

1. General characteristics of the dissertation thesis and the presented materials

A complete list of documents for the procedure, which meet the requirements of the ADAS in the Republic of Bulgaria, the Rules for its Implementation and the corresponding Rules at the IMI-BAS for acquisition by the candidate of educational and scientific degree “Doctor” in Professional Field 4.6. is provided.

The dissertation, presented in English, contains a total of 138 pages and consists of: introduction, table of contents, three main chapters, list of abbreviations, list of figures, list of tables, conclusion and three appendices. Chapter 2. Research Background reviews satellite remote sensing for Leaf Area Index (LAI) estimation. Chapter 3. Methodology describes a workflow for multi-sensor LAI estimation, data generation, processing and analysis, evaluation metrics and validation. In Chapter 4, the conducted experiments and their results are described. The work also includes 26 figures and 25 tables.

The dissertation is based on results published in three papers by the PhD student in 2024, which are attached to the proceedings documents.

In the bibliography of the dissertation, a total of 127 titles (in English) are presented, most of which are scientific articles in the field of computer science, and satellite data sources are also indicated. All titles are relevant to the dissertation topic and cited in the text, with 40 of them published in the last five years.

The submitted abstracts (in Bulgarian and in English), as well as the publications on the topic of the dissertation, also meet the requirements of the procedure and reflect the required components of the dissertation.

The work demonstrates in-depth knowledge and skills on the subject. The dissertation is properly structured, the text is in an appropriate style, concise and informative, the scientific theses, experiments and analyzes and results are presented with the necessary depth. The whole development is of great importance for practice as well.

2. Short CV and personal impressions of the candidate

Ventsislav Polimenov, who has been a "young scientist-researcher" since 2022 in the "Software Technologies and Information Systems (SofTIS)" department of IMI-BAS, graduated from the Master's program "Advanced Computer Science" at the University of Bristol, UK in 2016, where he studied data mining, machine learning and high-performance computing and successfully defended a master's thesis on tracking 3D models using a flying robot.

Since graduation, he has also worked in the software industry, applying machine learning. Currently, his latest position as a "senior machine learning engineer" in an international company supports his research career, working on tuning pre-trained language models, building traditional ML channels and developing agent systems for scene segmentation and content moderation to predict movie ratings in different countries. In this regard, Polimenov successfully integrates digital, research and entrepreneurial competence - meeting the expectations of every modern scientist, combining leadership skills for managing teams with support from his family.

I personally know the doctoral student from 2025 as responsible, responsive and competent from his presentations at the Annual Scientific Session of the SofTIS Section of IMI-BAS, as well as from his participation in the Summer Research School for Software Developers (SofTIS Summer Camp) initiated by me.

3. Content analysis of the scientific and applied achievements of the candidate, contained in the presented PhD thesis and the publications to it, included in the procedure

The dissertation is a topical, promising and also practical topic. The results obtained with some data sets can be adapted and applied to other data. The doctoral student possesses the necessary knowledge and skills and demonstrates quality work and results of his work. Such type of research is not only interesting and necessary for the scientific community, but also necessary for innovations in agribusiness.

The main goal of the dissertation, stated in the introduction, is to develop an adaptive neural network capable of processing satellite images from various sources for the assessment of the leaf mass index - an important component of precision agriculture.

Three hypotheses are stated in the dissertation research guiding the experimental design:

1. A spectrally aware CNN can generalize between sensors at least as effectively as sensor-specific models.

2. Spatial resolution affects the accuracy of LAI prediction nonlinearly.

3. A model trained in one agricultural region can generalize to geographically and temporally different regions without retraining, provided that the predictions are expressed in absolute physical units.

The research is based on a methodology that includes the full workflow of pseudo-reference data generation and multisensor data integration, pre-processing, augmentation and normalization, model design, training and validation. Established approaches and metrics are used for model evaluations.

I accept contributions grouped into the categories scientific, applied science and applied.

The validation framework is impressive and reflects the specificity of the methodology. The neural network is trained on pseudo-labels extracted from vegetative indices, rather than from real field measurements of LAI, standard metrics on a test sample confirm above all that the model successfully reproduces its training objectives.

To provide a broader perspective, the thesis applies a five-step strategy that compares evidence from independent sources. The first level enforces geographical separation through spatial block partitioning, ensuring sufficient distance between training and testing regions to avoid spatial autocorrelation that would artificially inflate metrics. The second and third levels compare predictions with validated operational products (ESA SNAP) and radiative transfer simulations via PROSAIL, positioning the model in the broader remote sensing ecosystem without treating these products as absolute truth. The fourth level tests the transfer of knowledge to an independent target (Burgas) under simultaneous geographical change and an 8-month seasonal interval, investigating whether the model has learned general spectral-LAI relationships or has simply memorized Plovdiv-specific regularities. The fifth level compares the neural network directly to the individual vegetative indices used to generate the training labels, thus quantifying whether spatial learning brings measurable improvement over the pixel-wise indices.

The main goal is to objectively characterize what the system actually does: spatially coherent, multisensory LAI estimation through an ensemble of vegetative indices with proven generalization capacity, rather than field-validated biophysical extraction. The convergence of the results along five independent axes builds a multi-layered argument for the stability of the methodology, compensating for the cyclical nature of the training objectives through triangulation.

The author's vision for continuing the work on the dissertation research is also reflected.

4. Approbation of the results

The results have been presented at eight scientific forums (five national and three international) and have been published in three articles, which are in specialized scientific journals indexed in Scopus, one of which is with SJR.

In his Scopus profile (www.scopus.com/authid/detail.uri?authorId=59324133500) Ventsislav Polimenov (ORCID: 000-0003-3422-9703) has 3 publications (submitted under the procedure) and 2 citations. Two of the articles have been presented at international conferences related to smart agriculture. All publications are collective, no declarations of co-authorship have been attached, therefore I believe that the contribution is equal.

Based on the above, the total number of publication points is 44, which exceeds the required 30 points for acquisition by the candidate of educational and scientific degree “Doctor” (PhD) 4.6. Informatics and computer sciences, therefore the scientific works meet the minimum national

requirements ADAS in the Republic of Bulgaria, and, respectively, the additional requirements of IMI-BAS for acquiring an educational and scientific degree "doctor" (PhD) in the scientific field and professional field according to the procedure.

A declaration of authorship of the dissertation is attached.

The text of the dissertation describes the data used in Chapter 4. Experiments and results that are publicly available (satellite data are also open data), but the specific data sets and links with open codes of the implemented experiments are not indicated, but it is clear that the same are available in the author's profile, upon request https://github.com/vpolimenov, which can serve for publicity and reproducibility of research in the context of open science.

I declare that there is no proven plagiarism in the submitted dissertation and scientific works under this procedure.

5. Qualities of the abstract

The abstract is 46/45 pages long (in Bulgarian/English) and meets all the requirements for its preparation, correctly reflecting the results and content of the dissertation work and the scientific contributions of the doctoral student.

6. Critical notes and recommendations

1. The bibliography uses a citation style similar to Springer Nature, with the exception of the atypical use of “andothers” instead of “et al.”, which is not applicable to generally accepted citation styles, since it assumes the full spelling of the names of all authors, which is most likely caused in this case by the Latex settings. The use of “andothers” is typical only for the Modern Humanities Research Association (MHRA) style, used in academic essay writing at universities (literature, history, arts), which is not related to the current dissertation as a direction.

2. The authorship of Fig. 2.4. is unclear, due to the fact that no citation is indicated, I assume that it is the doctoral student's.

3. The visualizations in the dissertation (figures, tables, formulas) adequately reflect what is described and could in principle be expanded and improved (example Fig. 3.1).

In conclusion, the critical remarks described above are of a technical nature and are insignificant in relation to the contributions of the doctoral student and the quality of the dissertation work and are made with the aim of supporting the development of the doctoral student's research skills.

7. Conclusion

Having become acquainted with the PhD thesis presented in the procedure and the accompanying scientific papers and on the basis of the analysis of their importance and the scientific and applied contributions contained therein, **I confirm** that the presented PhD thesis and the scientific publications to it, as well as the quality and originality of the results and achievements presented in them, meet the requirements of the ADAS in the Republic of Bulgaria, the Rules for its Implementation and the corresponding Rules at the Institute of Mathematics and Informatics, Bulgarian Academy of Sciences (IMI-BAS) for acquisition by the candidate of educational and scientific degree "Doctor" in the Scientific field 4. Natural Sciences, Mathematics and Informatics, Professional field 4.6 Informatics and Computer Science. In particular, the candidate meets the minimal national requirements in the professional field and no plagiarism has been detected in the scientific papers submitted for the competition.

Based on the above, **I strongly recommend** the scientific jury to award **Ventsislav Yuriev POLIMENOV**, **the educational and scientific degree "Doctor"** in the Scientific field 4. Natural Sciences, Mathematics and Informatics, **Professional field 4.6 Informatics and Computer Science**.

Date: 06/29/2026

Reviewer:
Assoc. Prof. Galina Momcheva. PhD