

OPINION

by Prof. Katia Hristova Rasheva-Yordanova, PhD, ULSIT

Subject: Dissertation thesis by Kristel Gjergi Vula entitled “Transformer-Based Detection and Epidemic-Model Analysis of Fake-News Dynamics on Social Networks”, submitted for the award of the educational and scientific degree “Doctor” in Professional Field 4.6. “Informatics and Computer Science”, Doctoral Programme “Informatics”

According to Order No. 177/29.06.2026 issued by the Director of IICT-BAS, I was appointed as a member of the scientific jury for the procedure. The first meeting of the scientific jury was held on 30.06.2026. In my capacity as a member of the jury, I hereby present this opinion.

RELEVANCE OF THE TOPIC

The dissertation thesis addresses a topical and socially significant problem: the automated detection of fake news and the modelling of its dissemination dynamics on social networks. The significance of the topic stems from the high speed and broad reach of unreliable content, as well as from the need to develop methods that analyse both the content-related and temporal-network characteristics of the process. The research combines natural language processing, Transformer models, temporal networks, the SIR and SEIZ epidemic models, and Approximate Bayesian Computation. This integration enables fake news to be examined both as a classification task and as a dynamic dissemination process under incomplete information and parameter uncertainty. The topic is therefore timely and fully aligned with Professional Field 4.6. “Informatics and Computer Science”.

KNOWLEDGE OF THE RESEARCH PROBLEM

The literature review and the 191 sources used demonstrate an in-depth knowledge of the research field. The doctoral candidate examines the definitions and characteristics of fake news, classical machine-learning methods, Transformer architectures, temporal networks, epidemic and rumour-spreading models, and Approximate Bayesian Computation. The principal research gaps are correctly identified: the customary separation of detection and diffusion; the loss of temporal ordering in static graphs; parameter uncertainty in SIR/SEIZ; the different purposes of content-oriented and diffusion-oriented datasets; and the insufficient connection between intervention modelling and posterior uncertainty. The publications related to the topic further confirm the doctoral candidate’s consistent work in the selected scientific field.

ANALYTICAL CHARACTERISTICS

The dissertation thesis has a total length of 210 pages and contains 47 figures, 111 tables, and a bibliography of 191 sources. It is structured into an introduction, three chapters, a conclusion summarising the results obtained, contributions, a list of publications related to the topic, a declaration of originality, a bibliography, and appendices. The main objective is to develop and evaluate an integrated framework connecting Transformer-based fake-news detection, temporal-network representation, SIR/SEIZ epidemic

modelling, and uncertainty assessment through ABC/ABC-SMC. Five research questions and interrelated tasks have been formulated in order to achieve this objective.

Chapter One presents the theoretical foundations and establishes the need for an integrated content-to-cascade framework. Chapter Two describes the proposed Transformer-ABC-Epidemic model. A significant methodological merit is the clear distinction between datasets for text classification and datasets for diffusion analysis. The doctoral candidate does not attribute temporal or network properties to content-based data that do not contain them, but instead uses separate temporal cascades for SIR/SEIZ modelling and ABC calibration. The proposed model comprises a data layer, a binary-detection layer, a temporal-network and epidemic-modelling layer, and a Bayesian uncertainty-assessment layer. A baseline diffusion-risk functional has also been developed.

Chapter Three presents the experimental results. BERT, RoBERTa, BigBird, mBERT, and XLM-RoBERTa are evaluated on short and long texts, health misinformation, and low-resource Albanian data. On Constraint@AAAI2021, the BERT model achieves an accuracy of 98.11%, $F1 = 98.00\%$, and $ROC-AUC = 0.9943$, while on the Albanian corpus XLM-RoBERTa achieves $F1 = 0.9285$ and $ROC-AUC = 0.9857$. The results are interpreted correctly: the probability produced by the Transformer model is used as a controlled content-risk signal rather than as an absolute factual assessment.

The comparison of two principal empirical cascades shows that SEIZ provides a better approximation than SIR, particularly for irregular and multi-wave growth. For the COVID-19 cascade, the relative L2 error decreases from 0.1626 with SIR to 0.0463 with SEIZ, while RMSE decreases from 9,958.4 to 2,838.9. ABC and ABC-SMC enable the estimation of regions of plausible parameters and posterior forecasts. ABC-SMC reduces the relative predictive error by approximately 16.2% for the COVID-19 cascade and by approximately 16.4% for the Hoaxy cascade. The counterfactual scenarios demonstrate the advantage of early combined intervention, and the author appropriately presents them as model-based scenarios rather than as proven causal effects of real platform policies.

The conclusion summarises the results, limitations, ethical aspects, and directions for future development.

OBJECT AND METHODOLOGY OF THE RESEARCH

The research examines the processes of fake-news detection and dissemination on social networks as its object, while its subject comprises the methods for their integrated content-based, temporal-network, and probabilistic assessment. The methodology employed comprises analysis and synthesis of the scientific literature, comparative analysis, data preprocessing and harmonisation, training and evaluation of machine-learning models, construction of directed temporal cascades, SIR/SEIZ simulations, ABC and ABC-SMC estimation, posterior forecasting, and analysis of counterfactual interventions. The choice of methods is well-founded and corresponds to the stated objective and research tasks.

ABSTRACT AND AUTHOR'S STATEMENT OF CONTRIBUTIONS

The submitted abstract in English is 57 pages long and accurately reflects the structure, methodology, principal results, limitations, contributions, and publications related to the dissertation thesis. The author's

statement of contributions is consistent with the content of the dissertation and the experimental results presented. The dissertation contains a declaration of originality.

ASSESSMENT OF COMPLIANCE WITH THE MINIMUM NATIONAL REQUIREMENTS AND THE REQUIREMENTS OF IICT-BAS

Pursuant to Article 3 of the Regulations on the Specific Conditions for Acquiring Academic Degrees and Holding Academic Positions at IICT-BAS, the minimum requirements for the educational and scientific degree “Doctor” in Professional Field 4.6 are 50 points under Group A and 30 points under Group G. The dissertation thesis provides 50 points under Group A. Five publications related to the topic have been submitted, which meet and even exceed the minimum threshold of 30 points. The publications are thematically related to the dissertation and reflect the principal stages of the research.

In the course of my review of the submitted materials, I did not identify any instances of plagiarism.

CONTRIBUTIONS OF THE DOCTORAL CANDIDATE

I accept the eight stated scientific and applied contributions. I consider the following to be the most significant:

1. the proposal and experimental evaluation of an integrated framework connecting Transformer-based detection, temporal cascades, SIR/SEIZ modelling, and ABC/ABC-SMC posterior assessment;
2. the methodological distinction between data for binary detection and data for diffusion modelling;
3. the comparative evaluation of Transformer architectures on different types of text, including a low-resource Albanian corpus;
4. the representation of fake news as directed temporal cascades and the extraction of measurable diffusion characteristics;
5. the application of ABC and ABC-SMC to estimate uncertain parameters from partially observed cascades and to derive posterior forecasts;
6. the development of a baseline diffusion-risk functional and the evaluation of counterfactual intervention scenarios under clearly stated assumptions.

CRITICAL REMARKS AND RECOMMENDATIONS

The dissertation thesis is well structured and balanced. As a recommendation for future development, the need for broader cross-corpus and cross-lingual validation may be noted, since some of the very high performance values, particularly on ISOT, may be influenced by dataset-specific characteristics.

I have no questions for the doctoral candidate.

FINAL COMPREHENSIVE ASSESSMENT

The results obtained convincingly demonstrate that Kristel Gjergi Vula possesses the necessary theoretical knowledge and practical skills in the field of informatics and computer science, as well as proven ability to conduct independent scientific research. The submitted dissertation thesis complies with the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria, the

Regulations for its Implementation, the Regulations on the Conditions and Procedure for Acquiring Academic Degrees and Holding Academic Positions at the Bulgarian Academy of Sciences, and the Regulations on the Specific Conditions for Acquiring Academic Degrees and Holding Academic Positions at IICT-BAS.

The results obtained on the topic of the dissertation research provide me with sufficient grounds to give an unequivocally positive assessment of the submitted dissertation thesis and to propose that the esteemed scientific jury award Kristel Gjergi Vula the educational and scientific degree “Doctor” in Doctoral Programme “Informatics”, Professional Field 4.6. “Informatics and Computer Science”.

04.09.2026

Member of the

/Prof. Katia Hristova

