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Doctor of Technical Sciences, Professor,
Anatoliy Sachenko

REVIEW
of the opponent Igor Grebennik
Doctor of Technical Sciences, Professor, Head of the Department of Systems
Engineering
Kharkiv National University of Radio Electronics,
on the qualification thesis of Pan Tiande on the topic:
" Methods and Software Tools for Recognizing Fake or Irrelevant Information in the
Content of News-Oriented Social Networks ", submitted for the degree of Doctor of
Philosophy in
specialty 121 " Software Engineering "

1. Relevance of the Dissertation Topic.

The rapid development of social networks as one of the leading channels for news dissemination, communication, and shaping public opinion has brought significant changes to the organization of information flows in modern society. Alongside the increasing accessibility of digital communication, the problem of spreading false, manipulative, or irrelevant information has intensified, posing threats to information security, the stability of socio-political processes, and public trust in the media.

This issue becomes particularly critical in news-oriented social networks, which are characterized by high content-update rates, heterogeneous information formats, and a substantial share of user-generated posts. The absence of centralized control, the prevalence of emotionally charged publications, and the possibility of coordinated information influence create favorable conditions for the emergence and large-scale dissemination of fake news, negatively affecting public sentiment and the overall quality of the information space.

Existing tools for detecting unreliable content—such as Google Fact Check Explorer, ClaimBuster, Logically Facts, and Hoaxy—are primarily designed to address separate tasks: retrieving previously verified facts, detecting potentially suspicious statements, or analyzing diffusion structures. However, they do not

provide a comprehensive credibility assessment that accounts for user behavior, reaction dynamics, or interval uncertainty inherent in social media data.

Therefore, there is a pressing need to develop new methods and software tools capable of automatically analyzing news content streams, integrating data from multiple sources, evaluating the credibility of messages, and operating under conditions of limited or incomplete data. A promising direction is the integration of natural language processing, interval modeling, network analysis, and multi-agent systems. The use of interval mathematical models allows for a correct representation of uncertainty in user behavior and variability in the information environment, thereby improving credibility assessment accuracy even in the presence of incomplete data.

Thus, the topic of the dissertation is highly relevant due to the necessity of developing next-generation mathematical methods and software tools aimed at enhancing the effectiveness of detecting and analyzing fake content in news-oriented social networks.

2. Analysis of the Dissertation Content. Degree of Validity of the Scientific Provisions, Conclusions, and Recommendations Formulated in the Dissertation

The dissertation is a completed scientific study and consists of an introduction, four chapters, conclusions, and a list of references.

The **introduction** substantiates the relevance of the dissertation topic, formulates the purpose and objectives of the research, presents the scientific novelty and practical significance of the obtained results, and provides information on the approbation and publications based on the dissertation, including the author's personal contribution.

In **Chapter 1**, "Analysis of Methods and Software Tools for Detecting False or Irrelevant Information in the Content of News-Oriented Social Networks," the theoretical foundations of fake-information detection in news social networks are examined. The chapter discusses the characteristics of information-flow formation, the nature of fake messages, and the factors that complicate automatic recognition of unreliable content. A review of modern methods and software services for fake detection is presented, with identification of their capabilities and limitations. Based on the conducted analysis, the research problem is formulated, and the necessity of developing a hybrid credibility-assessment method based on interval models of user behavior is substantiated.

In **Chapter 2**, "Modeling User Profiles in a Social Network Based on Interval Data Analysis," a mathematical model for assessing the credibility of social media content is proposed. The model establishes a relationship between the credibility

indicator and key behavioral characteristics of the audience—dynamics of posts, shares, reactions, comments, dissemination speed, and virality coefficient. The degree of credibility is defined as an interval value in the range [0, 1], and the application of interval modeling methods for its analysis is justified. A two-stage model identification optimization problem is formulated, and a hybrid method for constructing interval models of user profiles is developed, combining a metaheuristic algorithm based on the behavioral model of an artificial bee colony with gradient-based parameter refinement methods. The final section demonstrates the practical applicability of the constructed model for credibility-based decision-making.

In **Chapter 3**, "Software Agents for Assessing Content Credibility in News Resources of Social Networks," the concept, structure, and implementation of software agents are presented, which provide the practical realization of the proposed credibility-assessment method within a multi-level system. An integral credibility index, formed based on source characteristics, content features, network dissemination patterns, and emotional tone, is used as the primary classification criterion. The choice of the threshold value for this index is justified to ensure an optimal balance between precision and recall in fake detection. The chapter describes the architecture of the software agents, principles of their interaction, mechanisms for retrieving data from social networks, and features of forming interval user profiles and storing results in MongoDB. Experimental studies confirmed improvements in the accuracy, speed, and explainability of detecting unreliable content using the developed agents.

In **Chapter 4**, "Software Environment for Detecting and Analyzing Fake Content in News-Oriented Social Networks," a complete software environment for detecting and analyzing fake content is designed and described. The modular architecture of the system is presented, including subsystems for data collection, preprocessing, credibility assessment, interval user modeling, information storage, and visual analytics. The chapter details integration with social platforms, the operation of the analytical core (CIEngine), and the structure of the MongoDB database.

A web-oriented interface in the form of an interactive dashboard is presented, providing post analysis, visualization of credibility indicators, and representation of users' behavioral characteristics. The effectiveness of the system is confirmed by an integral indicator demonstrating the advantages of the proposed solution over existing tools.

The conclusions fully reflect the obtained research results and meet the requirements for dissertation outcomes.

The structure of the dissertation fully corresponds to the logic and sequence of solving the stated research tasks.

2.2. The reliability and validity of the obtained results and the solutions, conclusions, and recommendations proposed by the author. The reliability and validity of the obtained results, as well as of the solutions, conclusions, and recommendations proposed by the author, are ensured by the correct application of analytical and numerical research tools; the consistency between theoretical calculations and verification results; the correspondence of the conclusions and obtained outcomes to the physical nature of the investigated phenomena; comparison of the proposed solutions with those reported in the literature; and correlation of the obtained results with the data of other researchers and with the objectives of the study.

The research results are illustrated with tables, graphs, and figures. The solutions adopted in the dissertation possess scientific novelty, are well substantiated, and address the research tasks, within which a software implementation of the fake-content detection system has been developed.

3.   Scientific Novelty of the Obtained Results

The main scientific provisions, results, and conclusions of the dissertation were obtained independently by the author, are original, sufficiently substantiated, and confirmed by computer-based experiments as well as by the approbation of the key findings at national and international conferences. The reliability of the scientific provisions, conclusions, and results is ensured by the correct and appropriate use of mathematical tools, the methodology of information-system design, and the successful software implementation of the proposed solutions.

The dissertation yields the following results that possess scientific novelty:

1. For the first time, an interval mathematical model has been developed that establishes a relationship between the credibility of content in news-oriented social networks and user behavioral profiles. Unlike existing models, it is based on the analysis of interval data under limited-sample conditions, which increases the efficiency of early detection of unreliable information.

2. For the first time, a hybrid method for identifying interval models of user profiles in social networks has been proposed and justified. Unlike existing approaches, it combines a metaheuristic algorithm for model-structure synthesis based on the behavioral model of an artificial bee colony with gradient-based methods for parameter identification of candidate models. This integration reduces computational complexity and enables the use of standard optimization techniques for constructing user-profile models.

3. The methods for assessing the credibility of information in news-oriented social network resources have been further developed. Unlike available approaches, they integrate classical credibility criteria (redundancy, inconsistency, timeliness, reliability, completeness) with new characteristics of digital media, such as network

confirmation and emotional tone, thereby enhancing the efficiency of fake-content detection under limited data conditions.

4. Software agents for detecting and analyzing fake content in news-oriented social networks have been further developed. Unlike existing solutions, they combine automated tools for retrieving content from social platforms with mechanisms for credibility assessment under limited-sample conditions.

4. Formatting of the Dissertation, Compliance with Academic Integrity Requirements, and Completeness of the Presentation of Scientific Results in Published Works

4.1. Formatting of the Dissertation. The dissertation comprises 156 pages of printed text, including 126 pages of the main content, which contains 38 figures and 4 tables. The list of references includes 126 sources.

The dissertation is written in English with high linguistic accuracy and stylistic quality. The scientific terminology used is generally accepted, while the style of presenting the results of theoretical and applied research, new scientific provisions, conclusions, and recommendations ensures their clarity and accessibility for perception and practical use. The content of the dissertation allows the reader to form a clear understanding of the main statements, conclusions, and recommendations proposed by the author. The style of presentation ensures proper comprehension of the research materials and scientific findings.

The formatting of the dissertation fully complies with all required attestation standards.

4.2. Compliance with Academic Integrity Requirements. The dissertation has undergone an academic plagiarism check, and the results confirm a high level of originality. The author's individual style is consistently evident throughout the text. No textual borrowings or use of other researchers' results without proper citation were detected.

4.3. Completeness of the Presentation of Scientific Results in Published Works.

The main results of the dissertation research are sufficiently presented in 8 scientific publications, among which 5 papers are indexed in the international scientometric database Scopus. In total, the author has published: 2 articles in Ukrainian peer-reviewed scientific journals, 3 articles in international scientific journals, 2 publications in the proceedings of international scientific and technical conferences.

5. Scientific and Practical Significance of the Dissertation Results.

The scientific significance of the research lies in the justification and development of new mathematical methods and software tools aimed at increasing the efficiency of detecting and analyzing fake content in news-oriented social networks.

The practical significance of the research results consists in the development of a software environment and analytical tools that can be used in fact-checking systems, information-space monitoring platforms, media-moderation services, analytical centers, and editorial offices for the prompt detection and credibility assessment of news content.

6. Comments and Discussion Points Regarding the Content of the Dissertation.

Overall, the dissertation research has been conducted at a high scientific and applied level. However, since some of its provisions are debatable due to the complexity of the subject domain, it is appropriate to highlight certain clarifications, comments, and recommendations aimed at further improving the investigated problem area.

1. The comparison with contemporary models and algorithms is performed on a thematically narrow set of methods. It would be advisable to include a broader range of modern hybrid and neural-network approaches commonly used in fake-detection tasks.

2. The dissertation presents a metaheuristic algorithm based on the behavioral model of a bee colony; however, a deeper comparison with other algorithms widely applied in model-identification tasks (genetic algorithms, PSO, DE, MBO, etc.) is lacking. Conducting experimental benchmarking against these approaches would provide a more convincing demonstration of the advantages of the proposed algorithm.

3. Although practical examples of application are provided, the dissertation lacks a clear description of potential limitations of the model: dependence on content language, platform-specific features, influence of bot activity, or coordinated manipulation networks. Indicating such limitations would significantly enhance the practical value of the results.

4. Given the rapid development of large language models (BERT, RoBERTa, DeBERTa, GPT, LLaMA, etc.), it would be reasonable to include comparisons of accuracy and robustness between the proposed approach and these models, as they currently dominate NLP and fake-detection tasks. Their absence somewhat limits the completeness of the review of state-of-the-art solutions.

5. Although the author proposes a modular architecture and containerized execution of software agents, no quantitative evaluation of system scalability is provided. In particular, the dissertation lacks data on system performance under increasing content volume, higher numbers of simultaneous requests, or integration of multiple social networks. Under present conditions of high data-flow intensity, such evaluation is an essential component of assessing the real viability of a software system.

Nevertheless, the above comments do not diminish the overall scientific and practical value of the dissertation.

7. Conclusions

7.1. The dissertation of Pan Tiande is an independent, original, and completed scientific study that presents new scientifically substantiated results. The dissertation successfully addresses the relevant scientific task of improving the effectiveness of tools for detecting fake content in social networks.

7.2. The obtained scientific and practical results represent a significant contribution to the development of the theory and practice of information credibility assessment and can be effectively used for the implementation of methods and tools for detecting unreliable content. The content of the dissertation fully corresponds to the specialty 121 – Software Engineering.

7.3. Therefore, the dissertation " Methods and Software Tools for Recognizing Fake or Irrelevant Information in the Content of News-Oriented Social Networks"— in terms of the relevance of the chosen topic, the scope and quality of the conducted research, the completeness of solving the defined scientific and practical tasks, the novelty and degree of validity of the obtained results, the practical conclusions and recommendations, the completeness of their presentation in scientific publications related to the dissertation topic, and the absence of violations of academic integrity— meets the requirements of the current legislation of Ukraine as defined in Sections 6–9 of the "Procedure for Awarding the Doctor of Philosophy Degree and Revoking the Decision of an Ad Hoc Specialized Academic Council of a Higher Education Institution or Research Institution on Awarding the Doctor of Philosophy Degree," approved by the Resolution of the Cabinet of Ministers of Ukraine No. 44 of January 12, 2022.

Thus, its author, Pan Tiande, deserves to be awarded the academic degree of Doctor of Philosophy in the field of knowledge 12 Information Technologies, specialty 121 Software Engineering.

Official Opponent:
Head of the Department of Systems Engineering,
Kharkiv National University of Radio Electronics,
Doctor of Technical Sciences, Professor   Igor Grebennik

I certify the signature of I.V. Grebennik,
Acting Academic secretary of Kharkiv
National University of Radio Electronics   Kirill Khrustalev

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