

REVIEW

of a foreign scientific consultant on the dissertation work of **Bazarbekov Ikram Medeuuly** on the topic "Research of artificial intelligence models and methods for diagnosing diseases with impaired cognitive functions," presented for the academic degree of Doctor of Philosophy (PhD) in the educational program 8D06102 – "Computer and Software Engineering."

The doctoral dissertation of Mr. Ikram Medeuuly Bazarbekov addresses a highly relevant and interdisciplinary research problem situated at the intersection of artificial intelligence, biomedical signal processing, and computational diagnostics of neurodegenerative disorders. The growing global burden of cognitive impairment and Alzheimer's disease necessitates the development of scalable, non-invasive, and data-driven diagnostic approaches. In this context, the presented research is both timely and scientifically meaningful.

The primary objective of the dissertation is the investigation and development of artificial intelligence models for diagnosing cognitive disorders based on the analysis of kinematic time-series data derived from graphomotor activity. The work combines methodological rigor in machine learning with clinically motivated signal interpretation, demonstrating a well-balanced integration of engineering and biomedical perspectives.

A notable contribution of the dissertation is the development and evaluation of a hybrid deep learning architecture (CNN-BiLSTM) designed to process raw kinematic time-series signals without relying solely on handcrafted aggregated features. The proposed approach enables automatic extraction of local high-frequency motion patterns as well as long-term temporal dependencies, thereby preserving the intrinsic temporal structure of graphomotor dynamics. The empirical results demonstrate a high level of diagnostic performance, including strong sensitivity and robust ROC-AUC values obtained under a subject-wise validation protocol.

From a methodological standpoint, particular attention was given to the prevention of data leakage through group-based cross-validation and strict subject isolation. This significantly enhances the credibility and reproducibility of the reported results. The author's awareness of common pitfalls in biomedical machine learning research reflects a high level of methodological maturity.

The dissertation also provides a comparative analysis between classical machine learning algorithms (Logistic Regression, SVM, Random Forest, k-NN) and the proposed hybrid neural network model. The structured evaluation framework strengthens the validity of the conclusions and clearly demonstrates the advantages of deep learning approaches for modeling temporal biomedical signals.

The work is logically structured, technically sound, and supported by appropriate experimental validation. The research results have been disseminated

through peer-reviewed publications and conference presentations, indicating active academic engagement and international visibility.

Nevertheless, several aspects may be considered for further development:

1. Future studies could include multi-center external validation to further assess the generalizability of the proposed model across different populations and recording environments.
2. Longitudinal data collection would enable modeling of disease progression dynamics and enhance prognostic capabilities.
3. Additional investigation into model interpretability using explainable AI techniques may further strengthen clinical trust and adoption.

These remarks do not diminish the scientific merit of the dissertation but rather outline potential directions for future research.

In conclusion, the dissertation of Mr. Ikram Medeuuly Bazarbekov represents a substantial and original contribution to the field of AI-based medical diagnostics. The research demonstrates theoretical understanding, technical competence, and practical relevance. The work meets the international standards required for a PhD degree in Computer and Software Engineering, and the author deserves to be awarded the degree of Doctor of Philosophy (PhD).

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