

Evolutionary Modelling in Modern Philological Education Under WARMI Conditions

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Abstract. *The article examines the features of the application of evolutionary computing and evolutionary technologies in modern philological education in the conditions of the SHIVA and WARMI worlds. Their capabilities for optimizing educational processes, personalizing learning, processing language data, and developing intelligent educational systems are revealed. The prospects for their integration with artificial intelligence technologies and the digital transformation of higher education are determined.*

Keywords: *digital education; modern pedagogy; evolutionary computation; evolutionary technologies; philological education; digital transformation; artificial intelligence; natural language processing; WARMI-world.*

INTRODUCTION. Modern humanities education is undergoing a period of profound transformation, driven by the rapid development of digital technologies, artificial intelligence, data mining methods, and new computing paradigms [1]. Traditional approaches to training philological specialists are gradually being supplemented by intelligent digital tools focused on automating natural language processing, modeling language processes, analyzing large amounts of text information, and supporting educational decision-making [2, 3]. As a result, there is a transition from a predominantly humanitarian model of training to an interdisciplinary educational ecosystem that combines the achievements of philology, computer science, mathematical modeling, artificial intelligence, and digital pedagogy [4].

This problem becomes particularly relevant in the context of the formation of a new global environment for the functioning of education, characterized by the concepts of the SHIVA-world (Split, Horrible, Inconceivable, Volatile, Arising) and the WARMI-world (Wickedness, Anxiety, Nonlinearity, Multipolarity, Incomprehensibility). These conceptual models reflect a high level of uncertainty, acceleration of technological changes, instability of the external environment, increasing complexity of socio-economic processes and the need for constant adaptation of educational systems to rapidly changing conditions [5]. In such difficult conditions, classical algorithmic methods for solving complex learning tasks become insufficiently effective, which stimulates the introduction of intelligent adaptive technologies [6]. Considering the above difficulties and complexities, one of the most

promising areas of development of modern anti-crisis management (including in the field of education) is evolutionary computing and evolutionary technologies based on them [7]. These methods belong to the class of intelligent metaheuristic algorithms that model the processes of natural evolution and allow to effectively solve complex multi-criteria optimization problems without the need for a strict mathematical description of the system under study [8]. Due to their high adaptability, ability to work with incomplete information and resistance to changes in environmental parameters, evolutionary computing is used in almost all branches of modern science, including digital philology, computational linguistics, educational analytics and intelligent learning systems.

In modern philological education, evolutionary technologies allow to optimize educational programs, personalize learning trajectories, improve knowledge assessment methods, automate the analysis of language data, support the development of intelligent educational platforms and increase the efficiency of educational process management in conditions of high dynamics of the external environment.

Thus, the main goal of this article is to study the features of the use of evolutionary computing and evolutionary technologies in modern philological education in the conditions of the SHIVA and WARMI worlds, as well as to determine the prospects for their further application in the digital transformation of higher education.

RESULTS.

Evolutionary computing as the intellectual basis of modern digital philology. Evolutionary computing is a set of artificial intelligence methods based on modeling the processes of natural evolution. They are based on the mechanisms of inheritance, selection, mutation, recombination and natural selection, thanks to which the search for optimal solutions is carried out among a large number of possible alternatives. Unlike traditional methods of mathematical optimization [9], evolutionary algorithms are able to function effectively in the absence of an analytical model of the problem under study, high dimensionality of the search space, the presence of a large number of local extrema and constantly changing external conditions. The most common areas of evolutionary computing are genetic algorithms, genetic programming, evolutionary strategies, evolutionary programming, differential evolution, memetic and hybrid evolutionary methods. Despite the differences in the mechanisms for finding optimal solutions, they are all focused on effectively solving complex multi-criteria optimization problems and can be successfully used in the development of intelligent educational systems in the field of modern philology.

Features of the digital transformation of philological education. Modern philological education is gradually becoming part of a single digital educational ecosystem, where artificial intelligence, natural language processing, educational analytics and intellectual support for learning are actively used. Digital educational

platforms, automatic text corpora analysis systems, adaptive learning environments, intelligent recommendation systems and automated education quality control tools are developing significantly. Almost all areas of digital transformation are associated with the processing of large amounts of information, the need to make decisions under many constraints and the constant adaptation of the educational process to the requirements of the external environment. That is why the use of evolutionary computing is becoming one of the most promising tools for intellectual optimization of the modern philological education system.

SHIVA and WARMI world as a new educational environment. Modern higher education is developing in a fundamentally new external environment, which is described by the concepts of SHIVA and WARMI world. SHIVA concept reflects high turbulence, accelerated obsolescence of knowledge, constant emergence of new technologies, uncertainty and destruction of traditional educational models. WARMI concept, in turn, focuses on the nonlinearity of development processes, multipolarity of educational space, growing anxiety of society, complexity of forecasting and uncertainty of adopted management decisions. In such conditions, traditional models of organization of educational process, focused on stability and long-term planning, gradually lose their effectiveness. Self-adaptive intelligent technologies, capable of continuously changing their own parameters depending on changes in the external environment, are becoming increasingly important. One of the most effective tools for such adaptation is evolutionary computing.

Application of evolutionary technologies in modern philological education. Modern philological education is a complex multi-component system that unites students, teachers, digital educational platforms, language corpora, electronic libraries, intellectual services and systems for assessing the quality of specialist training. The practical application of evolutionary technologies is possible at almost all levels of this system. The most popular direction is the optimization of educational programs and the construction of individual educational trajectories of students. Evolutionary algorithms allow you to automatically select the optimal combinations of disciplines, rationally distribute the training load and take into account the level of training, professional interests and individual characteristics of students. An equally important direction is the intelligent management of the educational process. The use of genetic algorithms allows you to optimize the schedule of classes, the distribution of teachers, the use of classrooms, digital resources and the computing infrastructure of universities. At the same time, evolutionary methods are effectively used to develop intelligent systems for automated knowledge assessment, which are able to independently improve control criteria and adapt to different types of educational tasks. These technologies are of particular importance in natural language processing. Evolutionary algorithms are successfully used in solving problems of morphological

and syntactic analysis, machine translation, automatic summarization, thematic modeling, text tone analysis, knowledge acquisition and automatic document classification. In addition, they are used to optimize the parameters of modern language models and intelligent text information processing systems.

Evolutionary computing as a tool for personalizing learning. One of the leading trends in the development of modern higher education is personalization of learning. Individual characteristics of students, different levels of training, speed of knowledge acquisition and professional interests require the construction of flexible educational trajectories. The use of evolutionary algorithms allows you to automatically adapt the sequence of studying disciplines, the level of complexity of educational materials, the volume of practical tasks, forms of knowledge control and recommendations for further mastering the educational program. Thanks to this, self-learning educational systems are formed, capable of continuously optimizing the process of training specialists in accordance with current learning outcomes.

Integration of evolutionary computing with artificial intelligence technologies. One of the most promising directions in the development of modern educational analytics is the hybrid integration of evolutionary computing with artificial intelligence technologies [10]. As a result, hybrid intelligent systems are formed that combine machine learning methods, deep neural networks, natural language processing, large language models, Big Data technologies, data mining, cloud computing and modern digital educational platforms. Such intelligent complexes are capable not only of analyzing educational processes, but also of independently improving their own models of functioning, ensuring constant adaptation of the educational environment to changing conditions and increasing the efficiency of training philological specialists.

Prospects for further development. Prospects for further development of evolutionary computing in modern philological education are directly related to the further digital transformation of higher education. In the coming years, active development of intelligent digital universities, fully adaptive educational platforms, digital educational assistants, intelligent analytics of education quality and technologies for automated design of educational programs is expected. The integration of large language models with evolutionary algorithms [11], the use of digital twins of educational processes and the development of cognitive educational ecosystems will be of particular importance. In the conditions of the SHIVA- and WARMI-world, it is precisely such intelligent technologies that are able to provide the necessary stability, flexibility and competitiveness of modern philological education, allowing universities to effectively adapt to the rapidly changing conditions of the global educational environment.

CONCLUSIONS. The analysis shows that evolutionary computing and evolutionary technologies are becoming one of the key directions of digital

transformation of modern philological education. Their application provides effective solutions to complex multi-criteria optimization problems related to the organization of the educational process, intelligent processing of language data, automated assessment of learning outcomes, personalization of educational trajectories and support for managerial decision-making.

It has been established that in the conditions of the SHIVA and WARMI worlds, traditional models of higher education organization are gradually giving way to adaptive intelligent educational ecosystems based on the use of artificial intelligence methods, natural language processing, big data and evolutionary algorithms [12]. Due to the ability to function in conditions of uncertainty, dynamic changes and high complexity, evolutionary computing provides stability, flexibility and self-adaptation of educational processes.

Prospects for further research are related to the development of hybrid intelligent systems that integrate evolutionary computing, large language models, machine learning technologies, digital educational platforms, and educational analytics methods. The implementation of these areas will contribute to the formation of a new generation of intelligent systems of philological education, capable of functioning effectively in the conditions of increasing turbulence of the global educational environment and will provide high-quality training of specialists for the digital economy of the 21st century.

References

1. I. Hrashchenko, S. Krasniuk, T. Tsalko, S. Nevmerzhytska, N. Liubymova (2024). Effective computer modeling in educational management. *ScientificWorldJournal*. – September 2024. – Issue 27, Part 3. – P. 3-17. – URL: <https://www.sworldjournal.com/index.php/swj/issue/view/swj27-03>.
2. Goncharenko S. Intelligent crisis management of sustainable education // *Innovations and New Directions in Scientific Research* : Proceedings of the 2nd International Scientific Conference (Manchester, United Kingdom, 20 September 2025). - Lulu Press, Inc., 2025. - P. 105-109. URL: <https://er.knutd.edu.ua/handle/123456789/31646>.
3. Goncharenko S. Innovative information technologies in management of educational projects in the era of turbulence // *Innovations and New Directions in Scientific Research* : Proceedings of the 2nd International Scientific Conference (Manchester, United Kingdom, 20 September 2025). - Lulu Press, Inc., 2025. - P. 159-163. URL: <https://er.knutd.edu.ua/handle/123456789/31647>.
4. Goncharenko S. Intelligent management of adaptive education in the era of turbulence // *Innovations and New Directions in Scientific Research* : Proceedings of the 2nd International Scientific Conference (Manchester, United Kingdom, 20 September 2025). - Lulu Press, Inc., 2025. - P. 40-43. URL: <https://er.knutd.edu.ua/handle/123456789/31645>.

5. Nevmerzhytska S. M. (2018). Formation of a strategy for the innovative development of enterprises in conditions of uncertainty. *Scientific Bulletin of the Kherson State University. Series: Economic Sciences*. 2018. Vol. 32. pp. 99-103. URL: <https://ej.journal.kspu.edu/index.php/ej/article/view/422/418>.
6. Naumenko M.A. (2024). Innovatsiina metodolohiia finansovoho modeliuвання yak napriamok pidvyshchennia efektyvnosti upravlinnia konkurentnym pidpriemstvom [Innovative methodology of financial modeling as a direction for increasing the efficiency of management of a competitive enterprise.]. *Naukovi perspektyvy - Scientific perspectives*, 6(48), 424–447. [https://doi.org/10.52058/2708-7530-2024-6\(48\)-424-447](https://doi.org/10.52058/2708-7530-2024-6(48)-424-447) [In Ukrainian].
7. Krasnyuk M.T., Naumenko M.A. (2024) Efektyvne zastosuvannya henetychnykh alhorytmiv u vyrishenni bahatoekstremumnykh optymizatsiinykh zadach v menedzhmenti konkurentnoho pidpriemstva [Effective application of genetic algorithms in solving multi-extremum optimization problems in the management of a competitive enterprise]. *Grail of Science*, №41, June 2024, 65-73. URL: <https://archive.journal-grail.science/index.php/2710-3056/issue/view/05.07.2024/29> [in Ukrainian].
8. Kulynych Y., Krasnyuk M., Krasniuk S. (2022). Efficiency of evolutionary algorithms in solving optimization problems on the example of the fintech industry. *Grail of Science*, №14-15, May 2022, (pp. 63-70) DOI: <https://doi.org/10.36074/grail-of-science.27.05.2022>.
9. Naumenko, M., Volkova, N., & Bakov, N. (2025, May 9). Paradigms of modelling for innovative crisis management (on the example of web design industry). *Collection of Scientific Papers "ΛΟΓΟΣ"*, 19–26. <https://doi.org/10.36074/logos-09.05.2025.001>.
10. Costa-Jussà, M. R., & Fonollosa, J. A. R. (2015). Latest trends in hybrid machine translation and its applications. *Computer Speech & Language*, 32(1), 3-10. <https://doi.org/10.1016/j.csl.2014.11.001>.
11. Wang, C., et al. (2025). When Large Language Models Meet Evolutionary Algorithms. *Research*. <https://doi.org/10.34133/research.0646>.
12. Naumenko, M., & Hrashchenko, I. (2024). Suchasnyi shtuchnyi intelekt v antykryzovomu upravlinni konkurentnymy pidpriemstvamy ta kompaniiamy [Modern artificial intelligence in anti-crisis management of competitive enterprises and companies]. *Grail of Science*, (42), 120–137. DOI: <https://doi.org/10.36074/grail-of-science.02.08.2024.015>.