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Peculiarities of Evolutionary Modeling for Modern Literature Studies AMID Dynamic Uncertainty, Turbulence and Systemic Risks: the SHIVA and WARMI Frameworks in Contemporary Philology

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Abstract. The article examines the features of the application of evolutionary modeling and evolutionary (genetic) programming in modern literary studies in the SHIVA and WARMI environments. Their capabilities for the analysis of literary texts, stylometry, modeling of literary evolution, and intellectual processing of text data are analyzed, and the prospects for their use in modern digital philology are also identified.

Keywords: *contemporary philology; machine linguistics; evolutionary modelling; literature studies; genetic algorithms; artificial intelligence; SHIVA concept; WARMI concept.*

INTRODUCTION.

Modern philology is experiencing a period of deep digital transformation, associated with the exponential growth of text data [1], the development of Digital Humanities, artificial intelligence methods [2], Text Mining, machine learning and Natural Language Processing technologies. Traditional philological methods of studying literary works are gradually supplemented by innovative intelligent computing technologies [3], which allow analyzing millions of texts, revealing hidden patterns of the literary process, investigating the dynamics of the development of language structures, artistic styles, genre systems and cultural codes.

At the same time, the modern scientific environment operates in conditions of growing uncertainty, high dynamics of change, turbulence and systemic risks [4], which in recent years have been described by the concepts of the SHIVA- and

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WARMI-world. The mentioned modern concepts of the external environment = reflect the non-linearity of the development of social, cultural and information processes, constant environmental change, accelerated digitalization, information load, instability of communication spaces and high speed of emergence of new knowledge. In such conditions, traditional algorithmic methods of analysis, analytics and optimization of literary data are NOT always able to provide the necessary adaptability and efficiency of research of complex humanitarian systems [5].

One of the most promising directions of modern computational philology is the use of technologies of evolutionary modeling, genetic algorithms and evolutionary (genetic) programming [6]. Unlike classical optimization methods, these technologies allow to automatically search for effective solutions in extremely high-dimensional spaces [7], to form new computational models, to optimize analysis procedures and to adapt to constantly changing characteristics [8].

The application of evolutionary programming is becoming particularly relevant in solving the problems of automatic detection of authorial style, stylometric analysis, classification of literary works, modeling of literary evolution, reconstruction of cultural connections, analysis of intertextuality, detection of genre transformations, optimization of architectures of intelligent text processing systems and construction of hybrid models [9], which combine machine learning, neural network technologies and evolutionary optimization methods [10].

So, for this reason, the purpose of this article is to study the features and specifics of the use of evolutionary modeling and evolutionary (genetic) programming in conducting modern research on literature in the conditions of SHIVA and WARMI environments, as well as to determine the advantages, limitations and prospects for further development of this scientific direction.

MAIN PART.

Evolutionary modeling as a new direction of modern computational philology.

Evolutionary modeling is a set of artificial intelligence methods based on the principles of natural evolution, including inheritance, variability, mutation, recombination, natural selection and adaptation. The main feature of these technologies is the ability to automatically search for

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effective solutions without the need for a complete enumeration of possible options.

For modern philology, such an approach is of particular interest [11], since literary systems are open, nonlinear, multifactorial and constantly changing. Works of art have an extremely complex internal structure, including lexical, syntactic, semantic, pragmatic, cultural and historical relationships, many of which are difficult to formalize using classical mathematical methods [12].

Evolutionary models allow us to consider the literary process as a complex, self-organizing system within which the processes of emergence of new artistic forms, transformation of genres, changes in language norms and formation of new cultural paradigms continuously occur [13]. In such a formulation, literary evolution can be studied as a process of searching for optimal solutions in the constantly changing space of cultural states.

Features of using genetic programming in the analysis of literary texts

Unlike traditional genetic algorithms that optimize the values of the parameters of a predetermined model, genetic programming directly performs the evolution of computational programs and analytical models. This significantly expands the capabilities of intelligent processing of literary data.

In modern literary practice, genetic programming can be used to automatically generate algorithms for classifying literary works, build adaptive models of stylometric analysis, form systems for automatic authorship determination, create intelligent models for thematic analysis of literary texts, and optimize procedures for identifying intertextual connections.

Of particular value is the ability of genetic programming to independently form new analytical structures that were previously foreseen by the researcher. Due to this, the influence of subjective factors during the design of computational models is significantly reduced.

In addition, genetic programming allows you to automatically select the most informative features of the text, minimize the redundancy of the feature space, and simultaneously increase the accuracy of classifying literary works.

Advantages of evolutionary methods in the conditions of SHIVA and WARMI environments

Modern literature research is carried out in conditions of constant growth of volumes of digital libraries, electronic

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archives, scientific publications and multimedia content. At the same time, the diversity of text sources, language variants, cultural traditions and literary schools is significantly increasing.

In the conditions of SHIVA-world, the researcher is faced with a high rate of change of the information environment, a large number of uncertainties, a multitude of contradictory data and the need for prompt decision-making. The WARMI concept additionally emphasizes the high dynamics of adaptation of intelligent systems to constantly changing external conditions.

Evolutionary methods have a number of advantages precisely in such conditions.

First, they are characterized by high adaptability to changes in input data.

Second, they allow to work effectively with multi-criteria optimization tasks.

Third, they are resistant to incomplete, noisy and contradictory data.

Fourth, they are capable of exploring extremely complex search spaces without going through all the options.

Fifth, they allow combining different artificial intelligence methods within the framework of hybrid computational models.

That is why evolutionary technologies are becoming one of the most promising tools of modern digital philology.

The main directions of application of evolutionary programming in literary studies.

The most active evolutionary programming can be used when solving the following research tasks.

First of all, we are talking about the automatic identification of the author of a literary work. Genetic programming allows you to form optimal combinations of stylometric features, which ensure high accuracy in determining authorship even for a limited amount of text material.

The second direction is the study of literary evolution. Evolutionary models allow you to model the processes of forming literary trends, the spread of artistic traditions, the emergence of new genres and changes in the stylistic characteristics of works over time.

The third direction is related to the intellectual analysis of large literary corpora. Here, evolutionary algorithms allow you to optimize the procedures of thematic

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modeling, automatic clustering of texts, the search for hidden patterns and the identification of new literary connections.

The fourth direction is the modeling of intertextuality. The use of evolutionary methods allows you to automatically search for the most probable connections between literary works of different eras, languages and cultures.

The fifth direction is related to the development of digital humanities research, where genetic programming is used to build intelligent systems to support research decision-making, automatic hypothesis generation, and optimization of computational procedures for text analysis.

Limitations on the use of evolutionary technologies in modern philology.

Despite the significant potential of evolutionary modeling, it is accompanied by a number of objective limitations.

One of the main problems remains the high computational complexity of finding optimal solutions when working with extremely large literary corpora.

Another important problem is the complexity of interpreting automatically generated models. The resulting solutions are far from always sufficiently clear, which is especially important for the humanities.

Additional difficulties arise when choosing a fitness function, since the quality criteria for literary analysis are most often multidimensional and have a significant share of expert assessment.

In addition, the effectiveness of genetic programming significantly depends on the quality of preliminary preparation of text data, the correctness of feature extraction and the choice of parameters of the evolutionary process.

However, the constant development of computing technologies, the emergence of new artificial intelligence architectures and the integration of evolutionary algorithms with deep learning are gradually eliminating most of the existing limitations.

Prospects for further development.

A promising direction is the creation of hybrid intelligent systems that combine the technologies of high language models, deep neural networks, genetic programming, evolutionary computing, probabilistic modeling and methods of understandable artificial intelligence.

Of particular interest is the development of self-adapting computing platforms capable of automatically

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rebuilding their own analytical models as research tasks change and new literary data appear.

In the conditions of the SHIVA and WARMI environments, such systems will be able to ensure continuous adaptation of literature analysis methods, improve the quality of scientific research and significantly expand the capabilities of modern digital philology.

CONCLUSIONS.

The conducted research shows that evolutionary modeling and evolutionary (genetic) programming are becoming one of the most promising areas of development of modern computational philology and digital literary studies. The use of the principles of natural evolution allows for the effective study of complex literary systems characterized by high dimensionality, nonlinearity, multifactoriality, and constant variability.

It has been established that in the conditions of the SHIVA and WARMI worlds, evolutionary methods have significant advantages over traditional algorithms for analyzing literary data due to their high adaptability, ability to effectively work with uncertainty, multi-criteria optimization, and large arrays of text information. Genetic programming significantly expands the possibilities of automatically building intelligent models for analyzing literary works, optimizing stylometric studies, identifying intertextual connections, and modeling literary evolution.

At the same time, the application of evolutionary technologies requires solving the problems of increasing the interpretability of computational models, improving adaptability functions, integration with modern methods of artificial intelligence and the development of specialized software platforms for digital humanities research. Prospects for further research are related to the creation of hybrid intelligent systems of a new generation that combine evolutionary computing, genetic programming, deep learning, large language models and technologies for intelligent text analysis, which will significantly increase the efficiency of modern literary research in the conditions of global digital transformation and growing uncertainty.

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