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Evolutionary and Genetic Programming for Innovative Computational Linguistics in Complex SHIVA and WARMI Environments of Modern Philology

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Abstract. The article considers the possibilities of using evolutionary and genetic programming in modern machine linguistics in the conditions of SHIVA and WARMI worlds. Their capabilities for automatic construction of language models, natural language processing, optimization of algorithms and intelligent analysis of texts are analyzed. It is shown that the use of evolutionary technologies contributes to the creation of adaptive intelligent linguistic systems of a new generation.

Keywords: modern linguistic; computational linguistics; evolutionary computing; natural language processing; evolutionary programming; genetic programming; SHIVA-world; WARMI-world.

Introduction.

Modern machine linguistics is experiencing a stage of deep intellectual transformation [1], caused by the rapid development of artificial intelligence, large language models, cognitive computing and technologies for intelligent natural language processing [2]. In the case of the transition of world development from traditional digitalization to intellectualization, the need for methods that are capable of not only analyzing language data, but also independently forming new effective algorithms for processing linguistic information [3]. This task becomes especially relevant in the modern conditions of the SHIVA and WARMI world, which are characterized by high variability, nonlinearity of processes, multidimensional uncertainty [4], information turbulence, constant adaptation and the need for quick decision-making. Classical prescriptive machine learning algorithms, as a rule,

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assume a predetermined model architecture and fixed optimization methods [5]. However, modern tasks of automatic translation, semantic analysis, text generation, speech recognition, processing of specialized corpora and intelligent search = require methods that are able to independently evolve together with the changing language environment. That is why evolutionary computing [6] is gaining increasing scientific importance, among which Evolutionary Programming [7] and Genetic Programming [8] occupy a special place.

Unlike traditional optimization algorithms [9], these approaches allow automatically synthesizing new structures of computational models, adapting information processing rules and finding effective solutions to problems of extremely high complexity [10]. For modern machine linguistics, it is evolutionary computing that increases the efficiency of automatic construction of language models, optimization of grammatical rules, formation of new semantic processing algorithms, adaptation of intelligent systems to new languages, genres and subject areas.

That is why the purpose of the article is to investigate the possibilities of using evolutionary programming and genetic programming in innovative machine linguistics, as well as to analyze their role in increasing the intelligence of language technologies in the conditions of high uncertainty of the SHIVA and WARMI environments.

Main Part.

Evolutionary computing as a new direction of machine linguistics development.

Modern machine linguistics is gradually moving from the use of pre-developed algorithms to intelligent self-learning systems capable of independently changing their own structure. Such a transformation is due to the constant complication of language data, the increase in the volume of text information and the need to process poorly structured knowledge. Evolutionary computing allows us to abandon rigidly fixed models of text processing. Instead of manually designing algorithms, the system gradually forms the most effective solutions using artificial evolution. This approach ensures high adaptability of intelligent linguistic systems and significantly increases their resistance to changes in the external information environment. Such technologies are particularly relevant in SHIVA and WARMI conditions, when language processes themselves become extremely dynamic due to the digitalization of society, the globalization of

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communications and the constant emergence of new forms of digital discourse.

Evolutionary programming in intelligent language processing.

Evolutionary programming is a direction of evolutionary computing, focused mainly on optimizing the behavior of intelligent systems without directly changing the internal structure of programs. The main feature of this approach is the sequential adaptation of algorithm parameters in the form of natural selection of the most successful solutions. For machine linguistics, this means the possibility of automatic improvement of models of morphological analysis, syntactic analysis, semantic classification and automatic knowledge acquisition. Evolutionary programming is especially effective when working with dynamic language corpora, where the parameters of the models must constantly change due to the emergence of new terminology, professional jargon, Internet communications and rapidly developing subject areas. Due to the ability to continuously adapt, intelligent language systems become much more resistant to changes in the linguistic environment, compared to traditional algorithms.

Genetic programming as an automatic synthesis of language algorithms.

Genetic programming is a higher level of development of evolutionary methods. If evolutionary programming mainly optimizes the parameters of existing models, genetic programming automatically creates new program structures. Algorithms are considered as a kind of digital organisms that are subject to inheritance, crossover and mutation operations. As a result of numerous generations of evolution, new programs are formed that demonstrate higher efficiency in solving the tasks set. In machine linguistics, genetic programming allows you to automatically create text classification algorithms, natural language processing rules, semantic analysis models, automatic translation procedures and intelligent information search. This approach is especially promising in creating specialized language systems for medicine, law, economics, engineering and digital humanities, where traditional universal models often demonstrate insufficient efficiency.

Joint use of Evolutionary Programming and Genetic Programming.

Practice shows that the greatest efficiency is demonstrated by the joint use of two technologies.

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Evolutionary programming ensures the adaptation of the behavior of an intelligent system to variable data, while genetic programming allows you to automatically change the architecture of the language processing model itself. Such a combination provides multi-level self-organization of an intelligent system. At one level, the optimization of functioning parameters occurs, but at another – the formation of new algorithms for solving language problems.

Application of evolutionary programming in modern problems of machine linguistics.

One of the most promising areas is the intelligent processing of natural language (Natural Language Processing). Evolutionary methods are used in the automatic construction of grammatical models, optimization of parameters of neural network architectures, extraction of knowledge from large text corpora, detection of hidden semantic connections and adaptation of language models to new subject areas. High efficiency of such methods is also observed in the development of intelligent systems of automatic summarization, text generation, query-response systems, new generation digital dictionaries and intelligent search platforms. An additional direction is the optimization of large language models [11] by searching for the most effective combinations of architectural solutions, training parameters and information processing strategies.

Advantages of evolutionary methods in SHIVA and WARMI environments.

The modern information environment is characterized by a high degree of uncertainty, constant variability of data and rapid updating of language structures. In such conditions, traditional static algorithms gradually lose their effectiveness, as they require manual adjustment of models and regular software updates. Evolutionary and genetic programming provide a fundamentally different approach. An intelligent system independently adapts to changes, continuously improves its own algorithms and maintains high efficiency even with a significant transformation of the subject area. Such an ability makes evolutionary technologies one of the most promising areas of development of intellectual philology of the next generation.

Limitations and directions of further research.

Despite the significant potential, the application of evolutionary and genetic programming is accompanied by a number of limitations. These include high computational

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complexity, significant requirements for computing resources, the need to form correct fitness functions and the risk of premature convergence of algorithms. In addition, automatic program construction requires the development of methods for interpreting the obtained solutions, since complex evolutionary models often become difficult to understand for the researcher. Promising areas of further research are the integration of genetic programming with deep neural networks, the use of evolutionary strategies together with transformative architectures, the development of self-adaptive multilingual natural language processing systems and the creation of hybrid intelligent platforms that combine evolutionary computing and understandable artificial intelligence. It is this multi-level adaptation that becomes especially important in the SHIVA world, where changes occur much faster than traditional software solutions can respond.

Conclusions.

The development of modern machine linguistics requires a transition from static methods of language processing to intelligent self-adapting computing systems. Evolutionary programming and genetic programming form one of the most promising directions of such transformation, providing automatic optimization of model parameters, synthesis of new algorithms and continuous adaptation of intelligent language systems to changing operating conditions.

It is shown that evolutionary programming most effectively solves the problem of dynamic tuning and adaptation of existing natural language processing models, while genetic programming allows automatically creating new algorithms for analysis, classification, interpretation and generation of language information. Their joint application provides multi-level self-organization of intelligent linguistic systems, significantly increasing their efficiency, stability and ability to self-development.

In the conditions of the SHIVA and WARMI world, characterized by high uncertainty, nonlinearity of processes, rapid updating of language data and the growing complexity of the information environment, evolutionary technologies are becoming an important tool for the innovative development of digital philology and machine linguistics. Further research should be directed towards the development of hybrid intelligent models that integrate evolutionary programming, genetic programming, deep learning, large language models and

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understandable artificial intelligence technologies to create a new generation of self-adapting linguistic systems.

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