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Hybrid Mathematical Optimisation in Cutting-Edge Machine Linguistics Amid Periods of Instability

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Abstract. *The paper explores the significance of hybrid mathematical optimisation in modern intelligent machine linguistics under conditions of systemic crises and instability. Periods of socio-economic turbulence, military conflicts and information disruption are characterised by a rapid increase in unstructured textual data, semantic volatility and reduced data quality, which limit the effectiveness of traditional natural language processing methods. It is argued that hybrid optimisation, combining classical optimisation techniques with heuristic, metaheuristic and neural network approaches, enhances the adaptability, stability and computational efficiency of linguistic models. The study addresses key optimisation tasks in language model training, neural architecture tuning, feature selection, text clustering, machine translation and sentiment analysis. The results demonstrate that hybrid methods are particularly effective for multilingual and low-resource corpora, enabling automatic model adaptation, reducing overfitting and balancing accuracy with computational cost. The paper highlights the applied value of hybrid optimisation for anti-crisis analytical systems, media monitoring and disinformation detection. Overall, hybrid mathematical optimisation is shown to be a crucial component in building resilient and adaptive intelligent machine linguistics systems capable of operating under prolonged instability.*

Keywords: *machine linguistics, mathematical optimization, hybrid AI, instability, crisis.*

Introduction.

Modern intelligent technologies of natural language processing form one of the key components of the development of artificial intelligence and digital information systems. In conditions of systemic crises [1, 2], accompanied by socio-economic upheavals, military conflicts, epidemiological threats and information turbulence [3], there is a sharp increase in the volume of semi-structured and unstructured text data [4], which are characterized by high variability, emotional richness and semantic instability. These factors significantly complicate the application of traditional algorithmic solutions in the field of machine linguistics. In such a complex environment, the use of hybrid methods of mathematical optimization [5], which involve the synergistic combination of formal optimization models with heuristic, evolutionary and neural network computational mechanisms, becomes of particular importance. Such methods provide the possibility of flexible adaptation of intelligent linguistic systems to rapidly changing operating conditions [6], allowing to take into account the nonlinear nature of language processes, the multiplicity of efficiency criteria and strict limitations on computational resources.

In current tasks of machine linguistics, optimization procedures are used at all stages of building intelligent systems - from cleaning and normalizing text arrays to

setting the parameters of complex language models and interpreting the results obtained. In periods of crisis, these tasks are complicated due to the transformation of discursive practices, the intensive emergence of new terms and semantic constructions, as well as the spread of manipulative and distorted messages. In conditions, hybrid mathematical optimization acts not as an auxiliary element, but as a fundamental component of modern intelligent linguistic solutions.

Thus, research into the application of hybrid optimization approaches in modern intelligent machine linguistics during periods of crisis is a significant scientific direction focused on the formation of stable, adaptive, and functionally reliable natural language processing systems.

Main Part.

Hybrid optimization is understood as a combination of classical deterministic methods (linear, nonlinear, discrete and stochastic programming) with heuristic and metaheuristic approaches, such as genetic algorithms [7], particle swarm methods, simulated annealing, evolutionary strategies [8], as well as deep machine learning algorithms [9].

In intelligent machine linguistics, optimization tasks arise during language model training, parameter tuning of neural network architectures, selection of optimal features, automatic text clustering, thematic modeling, machine translation, tone analysis and intention recognition. In crisis conditions, these tasks are complicated by noise in the data, abrupt changes in language patterns, the emergence of new terms, neologisms and manipulative discourses. Hybrid methods allow to increase the adaptability of models, to ensure a balance between accuracy, computational speed and resistance to quality degradation.

Hybrid optimization is of particular importance when processing multilingual and low-resource corpora typical for crisis situations. The combination of mathematical models with neuroevolutionary approaches allows you to automatically adjust the structure and parameters of linguistic systems to changing conditions, minimizing computational costs and reducing the risk of overtraining. In addition, hybrid methods demonstrate high efficiency in solving multi-criteria tasks, where it is necessary to simultaneously take into account the accuracy, interpretability and reliability of the results. In further works of the author, applied aspects of the use of hybrid mathematical optimization in anti-crisis information and analytical systems, public opinion monitoring systems, automatic analysis of media content and detection of disinformation will be presented. It is shown that the integration of optimization methods with intelligent linguistic technologies contributes to improving the quality of management decision-making and the stability of the information infrastructure in conditions of instability.

Conclusions.

Thus, hybrid mathematical optimization is a key tool for the development of intelligent machine linguistics in crisis periods, ensuring flexibility, adaptability and

efficiency of modern linguistic systems. Further relevant research should be related to the development of new hybrid technologies, improvement of relevant metrics and maximum expansion of practical applications taking into account the modern challenges of multi-level and multi-modal instability, long-term system crises [10, 11]. So, let us detail and structure the main scientific and practical conclusions:

1. It was found that crisis modes of information systems functioning are accompanied by increased uncertainty, instability of language structures and a decrease in the quality of input data, which limits the effectiveness of classical methods of machine linguistics.

2. It is established that hybrid mathematical optimization, based on a combination of analytical, heuristic and neural network methods, provides a higher level of adaptability, stability and accuracy of intelligent linguistic models in conditions of crisis influences.

3. The effectiveness of hybrid optimization strategies in solving key tasks of modern natural language processing is confirmed, including optimization of language model architectures, automated feature selection, clustering and semantic analysis of text data.

4. It is shown that the use of hybrid methods is especially justified when working with multilingual and limited-volume text corpora typical of crisis situations, since they contribute to reducing the risk of overtraining and more rational use of computing resources.

5. It is substantiated that the integration of hybrid mathematical optimization into intelligent linguistic systems expands their functional capabilities within the framework of anti-crisis information and analytical platforms, media environment monitoring systems and tools for detecting disinformation processes.

6. It is determined that the further development of this scientific direction is associated with the development of more complex adaptive hybrid algorithms, refinement of reliability and stability criteria, as well as scaling up the practical application of intelligent linguistic technologies in conditions of prolonged global instability.

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