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**ARTIFICIAL INTELLIGENCE AND MODERN INFORMATION TECHNOLOGIES IN SOLVING ROUTING PROBLEMS**

The modern economy is characterized by a growing need for effective solutions to routing problems, which is critically important for optimizing logistics processes and reducing time intervals between supply and delivery. The aim of this research is to develop new models and methods for routing management that can function effectively under conditions of input data uncertainty.

The dissertation study examines approaches to solving routing problems using modern information technologies, in particular the machine learning framework TensorFlow [1] and the optimization solver OptaPlanner [2]. TensorFlow is planned to be used to build predictive models that take into account uncertainty factors, such as traffic jams, demand changes, or unforeseen circumstances, allowing to predict future needs and optimize routes proactively. OptaPlanner will be used to develop and implement effective routing algorithms that are able to find optimal solutions in complex conditions with a large number of constraints and criteria. The main challenge when working with TensorFlow was the high computational complexity of training neural networks on small data sets. This problem was solved by using data dimensionality reduction methods and applying pre-trained models. The proposed hybrid approach allowed to avoid the main shortcomings of individual tools and ensure stable operation of the system under uncertainty. Effective application of OptaPlanner often faces difficulties in modeling complex real-world constraints and multi-criteria routing problems, which can lead to long computation times. This study proposes an improved approach to formalizing constraints and developing specialized heuristics, which allows to significantly increase the efficiency of finding optimal routes. When using TensorFlow to train routing models, there is a problem with processing incomplete or fuzzy data, which makes it difficult to create accurate forecasts. However, by using advanced data preprocessing methods and advanced neural networks, the accuracy of forecasts has been significantly improved. Integrating OptaPlanner for route optimization with TensorFlow's predictive capabilities requires overcoming the difficulties associated with the coordination of different modeling paradigms and data formats. In the presented study, a unified architecture is developed that provides seamless information exchange between the predictive and optimization subsystems, which increases the overall efficiency of routing management.

To achieve the goal, the following goals were defined: developing a method for element-by-element route formation using OptaPlanner capabilities for flexibly determining the sequence of point visits; solving multi-criteria route optimization problems by integrating TensorFlow forecasting models with OptaPlanner decision-making mechanisms; conducting simulation modeling for step-by-step optimization of two- and three-step routes in order to assess the effectiveness of the proposed methods and compare them with existing approaches.

The research is based on the scientific achievements of the department in the field of optimization and management, reflected in monographs and dissertations. Expected results include the development of hybrid models and routing management methods that combine the predictive capabilities of TensorFlow and the optimization algorithms of OptaPlanner, which will allow to increase the efficiency of logistics processes under conditions of uncertainty and to offer practical recommendations for their implementation.

The main results of the study are aimed at creating a methodology that allows you to effectively form routes under conditions of uncertainty and optimize processes at different stages of product supply. The use of information technologies significantly improves the efficiency of decision-making and contributes to increasing the productivity of enterprises engaged in logistics and delivery.

References

1. TensorFlow API // <https://www.tensorflow.org/api_docs/python/tf>
2. OptaPlanner Documentation // <https://docs.optaplanner.org/9.44.0.Final/optaplanner-docs/html_single/index.html>