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CREATION OF INTELLIGENT MAPS USING ARTIFICIAL INTELLIGENCE AND THEIR CARTOGRAPHIC ANALYSIS

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Abstract

This article analyzes the issues of creating intelligent maps using artificial intelligence technologies and their cartographic analysis based on scientific literature. In modern cartography, challenges related to processing large volumes of spatial data, their automatic classification, and visualization are effectively addressed through artificial intelligence methods. The study highlights the role of approaches based on machine learning, neural networks, and geospatial data analysis in the development of intelligent maps. In addition, the cartographic accuracy, analytical capabilities, and practical application areas of AI-generated maps are evaluated on the basis of scientific sources.

Keywords

Artificial intelligence, intelligent maps, cartographic analysis, GIS, machine learning, spatial data, automatic classification.

Introduction

In the twenty-first century, the rapid development of digital technologies has led to fundamental changes in the field of cartography and geographic information systems (GIS). In traditional cartographic approaches, maps were mainly analyzed and created manually by specialists using visual interpretation methods. However, the sharp increase in the volume of spatial data has significantly reduced the effectiveness of such approaches [1]. Therefore, modern cartography increasingly requires automated analytical methods based on artificial intelligence.

In scientific literature, the concept of “intelligent maps” is interpreted as maps created through the analysis and visualization of spatial objects and processes using artificial intelligence algorithms [2]. Such maps make it possible to identify hidden relationships within data, perform forecasting, and support decision-making processes.

Methodology

The research methodology is based on the analysis and synthesis of scientific sources. Studies conducted at the intersection of artificial intelligence and cartography, articles published in international scientific journals, and monographs related to GIS technologies were examined [3]. Methodologically, machine learning, deep learning, and spatial data analysis methods were selected as the main research directions.

According to scientific literature, artificial intelligence algorithms are widely used for the automatic processing of raster and vector data, object recognition, and classification [4]. These methods contribute to reducing cartographic errors and increasing accuracy in the process of creating intelligent maps.

Results

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According to the analyzed scientific sources, intelligent maps created using artificial intelligence have higher analytical capabilities compared to traditional maps. For example, it has been reported that algorithms based on neural networks achieve an accuracy of 85–95% in the automatic identification of land cover from satellite imagery [5].

In addition, scientific experiments have demonstrated that maps related to climate, urbanization, and environmental monitoring can be updated in real time using machine learning models [6]. This enables cartographic analysis to become more rapid and adaptive.

Analysis and Discussion

An analysis of the scientific literature indicates that intellectual maps created using artificial intelligence are forming a qualitatively new stage in cartographic analysis. In traditional cartographic approaches, spatial data were often analyzed through visual observation and statistical generalization, whereas modern artificial intelligence methods enable the automatic identification of complex spatial relationships [7]. This is particularly significant when working with large volumes of geospatial data.

The application of machine learning algorithms in cartography makes it possible to identify hidden patterns between spatial objects and phenomena. Scientific sources note that while classical statistical methods are limited in analyzing multidimensional spatial data, the increase in the number of dimensions in artificial intelligence models does not reduce analytical efficiency [8]. This substantially enhances the analytical value of intellectual maps.

The role of clustering algorithms in cartographic analysis deserves special attention. K-means, DBSCAN, and hierarchical clustering methods allow territories to be grouped based on socio-economic, environmental, or demographic indicators [8]. Studies using these algorithms have identified relationships between the level of urbanization, infrastructure development, and population density. As a result, intellectual maps are increasingly evaluated as important analytical tools in decision-making processes.

Artificial intelligence–based classification algorithms represent another important direction in cartographic analysis. Scientific research demonstrates the high efficiency of classification models in identifying land cover based on satellite imagery [5]. These models enable the automatic detection of forests, water bodies, and agricultural lands. Such an approach increases both the accuracy and the operational speed of cartographic analysis.

The development of deep learning algorithms has further expanded the capabilities of intellectual maps. Convolutional neural networks (CNNs) are used to identify complex structures in spatial imagery [6]. According to scientific sources, CNN-based models demonstrate higher accuracy than traditional methods and significantly reduce the proportion of errors in cartographic analysis. This is particularly important in environmental monitoring and natural resource assessment.

One of the key advantages of intellectual maps is their dynamic nature. With the help of artificial intelligence algorithms, maps can be updated in real time [6]. For example, data on climate change, water resource conditions, or traffic flows can be continuously processed and reflected on maps. This transforms cartographic analysis from a static process into a dynamic system.

At the same time, scientific literature highlights several limitations of artificial intelligence–based maps. One of the main issues is data quality. Researchers emphasize that incomplete, outdated, or inaccurate geospatial data negatively affect the results of artificial intelligence algorithms [9]. Therefore, data preprocessing, normalization, and verification are essential stages in cartographic analysis.

Another widely discussed issue is the “black box” nature of algorithms. Although deep learning models ensure high accuracy, their decision-making mechanisms are difficult to interpret [3]. In cartographic analysis, this may complicate the explanation of the causes behind certain results. Consequently, the literature emphasizes the necessity of applying explainable artificial intelligence (Explainable AI) approaches in cartography [11].

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The significance of intellectual maps in cartographic analysis is particularly evident in territorial planning processes. Studies show that artificial intelligence–based maps are effectively used in evaluating infrastructure projects, identifying risk zones, and optimizing resource allocation [10]. This increases the practical value of cartographic analysis.

In the field of environmental cartography, intellectual maps also play an important role. Scientific sources report the use of artificial intelligence algorithms in assessing air pollution, soil degradation, and water resource conditions [5]. Such maps serve as an important scientific basis for identifying environmental problems and developing strategies to prevent them.

Overall, the analysis of scientific literature demonstrates that intellectual maps created using artificial intelligence enable the automation of cartographic analysis, increase accuracy, and support decision-making processes. At the same time, issues such as data quality, algorithm interpretability, and computational resource requirements remain relevant. These aspects are considered important directions for future research.

Conclusion

The conducted scientific analysis shows that the creation of intellectual maps using artificial intelligence plays a significant role in the development of cartography as a discipline. Methods based on machine learning and neural networks allow for in-depth analysis of spatial data, increased accuracy, and the automation of cartographic processes. Intellectual maps can be effectively applied in scientific research, territorial planning, and monitoring systems.

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