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DIGITAL TRANSFORMATION OF PUBLIC AND MUNICIPAL FINANCIAL MANAGEMENT FOR THE INTEGRATION OF COMPUTER-ORIENTED REASONING MODELS

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Abstract. The ways of application of artificial intelligence elements in the activity of state and municipal finance management are investigated. The article identifies approaches to the integration of artificial intelligence elements in the fulfillment of long-term budget planning tasks. Active support from the Government of the Russian Federation of the direction of artificial intelligence affects many spheres of life of citizens of the country. At the same time, state and municipal governments have their own peculiarities in the processes of implementing innovations.

Keywords: artificial intelligence, public finances, municipal finances, budget funds, public administration bodies

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Introduction

The Government of the Russian Federation has taken unprecedented steps in the development of artificial intelligence in the country. In the last few years, the process of significant financing of the information technology industry has begun. In 2022, the Russian Government allocated 14 billion rubles to the country's 3 main funds: the Skolkovo Foundation, the Innovation Promotion Fund and RFRIT. In 2021, the SME in Science Foundation began funding projects under the new Code - AI program, where developers can receive a grant to develop open artificial intelligence libraries. At the same time, state and municipal bodies are rarely the first integrators of innovative technologies due to the complex bureaucratic procedure of implementation, as well as the scale of such implementation. Nevertheless, the development of artificial intelligence systems for state and municipal needs is an important step towards the development of speed and improving the quality of public services in all subjects of the Russian Federation. [6]

Purpose and methodology of the study

The purpose of the study was to identify possible ways of applying existing open-source artificial intelligence libraries in the sphere of state and municipal finance management.

Artificial intelligence in its classical sense is still a fantastic phenomenon of a bright future, where man was freed from the need for routine labor by his own creation. The cognitive functions of modern algorithms do not represent a single «thinking» system capable of autonomous development, perception and classification of information of external and internal environment, evaluation and decision making. Modern systems are the automation of specific tasks of information processing in large volumes. It is worth noting that over the last decade, artificial intelligence libraries in the programming language python have gained significant development largely due to the worldwide community of enthusiasts creating simulations of human cognitive functions. It is worth highlighting such areas as: computer vision, language (text) models, sound and voice recognition and generation, image generation, and others. In the field of mathematical and financial tools, the most demanded areas are analyzing financial markets and training automated robots (bots) to trade on stock exchanges, where artificial neural networks are used in addition to standard analytical tools. At the same time, neural network approaches, which today are considered as artificial intelligence, lack stability, interpretability and universality. On the other hand, computer-oriented reasoning models, which can be referred to the class of artificial intelligence programs, deserve more attention in the tasks of public administration, as they have obvious advantages, such as the construction of cause-and-effect relationships, explainability and interpretability.

Public finance is a set of economic relations arising in the real money turnover on the formation, distribution and use of centralized funds of financial resources. Public finance management includes planning, financing, spending of funds of monetary resources, as well as accounting of expenditures and revenues, reporting and control over the legal and rational use of such funds. [1]

The Ministry of Finance of the Russian Federation is an important management body in the field of state and municipal finance. In addition, this sphere is regulated by the decrees of the Government of the Russian Federation, local normative legal acts and other decisions of governing bodies, who carry out activities in the provision of public services. It is worth noting that all work on financial management begins with the creation of a regulatory framework. At each of the stages of financial management, methodological recommendations, plans of accounting accounts are developed, items (directions) of spending of budgetary funds are fixed, forms of accounting and reporting on the results of the financial period are developed. Thus, the management of state and municipal funds of monetary resources is reduced to the clear fulfillment of prescriptions, instructions and filling out certain forms of documents. [2]

The most popular means of implementing projects in the field of artificial intelligence is the python (python) programming language. The python programming language was created in 1991 by Dutchman Guido van Rossum and has since gained a large audience of fans, mainly in research and academic circles because of its clear, simple structure and syntax. Today, many people start learning python in school, and it is becoming a useful tool for study, work, and business. Large corporations have recognized the potential of automated algorithms to improve productivity as well as reduce costs. A prime example is automated document text recognition and form filling. This has made processing financial documents and keeping track of expenses and income many times faster. Security systems use face recognition "Friend-Foe", and other systems keep track of working hours by web-cameras of personal workplaces. [8]

In order to achieve the research objective, the management stage called «Planning» is selected. In the course of the study the regulatory and legal basis for planning in the Sverdlovsk Oblast is collected. Sverdlovsk region was formed on January 17, 1934, the administrative center is the city of Yekaterinburg. The territory is 194.3 thousand square kilometers. The permanent population of the Sverdlovsk region is about 4 million 311 thousand 700 people. [3]

There are 47 cities, 26 working and urban-type settlements, and 1,841 rural settlements in the Sverdlovsk Oblast. Local self-government is exercised on the territory of 94 municipalities.

The Ministry of Finance of the Sverdlovsk Region annually approves the law on the regional budget for the current year and planning periods, which reflects all financial indicators that ensure the livelihood of organizations, municipalities and citizens of the region. These are voluminous documents, for example, the Law of the Sverdlovsk Region of 10.12.2020 No. 144-OZ "On the regional budget for 2021 and the planning period of 2022 and 2023" has almost 1000 pages of text and figures. It is worth noting

that the purpose of this study is not to examine the text and meaning of the figures of the above documents, but to emphasize the amount of information that is quite difficult for a person to digest. The budget law is a coordinated work of hundreds of people and dozens of departments and divisions, which, in addition, must speak «one language».[4]

In this sense, a single digital system with a large memory capacity and the ability to process a huge amount of information at once seems more reliable. A document file containing the text of the law and all the numerical figures is 828 kb in size, which is an extremely simple task for modern processors. The machine will be able to read the file and extract all the figures into the right form in less than 1 minute, a person can not physically read and write out from 991 pages of the document information with such accuracy. The simplest usb drive can store 32 GB (32,000,000 kb) of information, which equals about 37,000 copies of the budget law. It would be impossible for a human being to store and accurately reproduce this amount of information. This colossal difference in information storage and processing capabilities rightly raises the question of the importance of applying the achieved technological progress in everyday routine operations, with which a specialist rarely copes 100%. [9]

It's worth pointing out the areas in planning that machine intelligence will help strengthen:

	Objectives	Impact on processes
Analysis	Scenario Analysis; Variance Analysis.	Predictive analytics; Prescriptive analytics; Sentiment Analysis; Value Drivers.
Forecast	Data Offloading; Prediction; Analysis of Variation.	Predictive analytics; Prescriptive analytics.
Planning	Scenarios; Simulations and analysis of variance.	Predictive analytics; Prescriptive analytics.
Reporting	Data Offloading; Data Merge; Comment.	Machine learning; Roboticization of processes; Predictive analytics.

Table 1. Problem solving by artificial intelligence methods.

Today the widespread use of accounting software allows to accumulate significant amounts of data and accounting of all financial and economic operations of even the smallest recipient of budgetary funds. The financial management body receives enough data to build an analytical system. It is worth paying attention to predictive and prescriptive analytics, as within the planning stage they are a strong tool of support and decision-making by managers.

While descriptive analytics worked with correlations, clusters and trends, predictive analytics uses regression analysis and time series models. This means that it is possible to answer, for example, the question of when a certain outcome might be achieved. The highest level of analytics, prescriptive analytics, uses optimization models. Here, decision models are used to try to explain to the financial authority what should be realized in order to achieve a certain financial outcome.[7]

The use of statistical methods is common in financial planning. The goal of both statistics and machine learning methods is to learn from data. However, machine learning is not guided by economic theory and is more concerned with algorithms than with asymptotic statistical processes. Traditional statistics emphasizes hypothesis testing and inference. Whereas machine learning methods emphasize on obtaining the best prediction. Unlike maximum likelihood estimation, the structure of artificial intelligence tends to be less unified. To date, there is relatively limited evidence of artificial intelligence applications in the finance literature. However, the increase in computing power, the advent of big data, better algorithms, and the growth of the FinTech sector of the economy since the 2008 financial crisis has led to an increase in the number of methods and applications using machine learning. Most fields (including finance) have traditionally used models such as linear regression, where the curve fit to the data is usually a straight line. However, most data tend to exhibit non-linearity. Some machine learning methods are able to infer non-linear relationships. The key difference between machine intelligence and traditional econometric analysis is that it is more focused on prediction than generalization and causal inference. Artificial intelligence emphasizes «the multivariate prediction problem» while traditional statistics emphasizes «formal statistical inference (confidence intervals, hypothesis tests, optimal estimates) in low-dimensional problems». Because of this, machine learning models are not evaluated based on statistical tests, but on their out-of-sample prediction performance. [9]

Let's consider the directions of machine learning:

Machine learning is a set of algorithms, functions and methods that allow building predictive models (predictive) algorithms capable of solving problems. Namely:

- with the teacher (data needed for learning):
- predictive analytics;
- Random Forest methods;
- artificial neural networks;
- ridge regression (Ridge).
- without a teacher (independent search for a solution, no training data required):
- clustering (classification);
- Natural Language Processing (NLP);
- computer-oriented reasoning models (DSM - method).

The python programming language has a large number of effective tools for working with financial information.

Numerical, statistical and data structures that are popular in financial activities:

Numpy is the premier package for scientific computing with python. It is a top-notch library for numerical programming, widely used in academia, finance, and industry. Numpy specializes in basic array operations.

Scipy - SciPy complements the popular numeric module Numpy. It is a python-based open-source software ecosystem for math, science and engineering. It is also heavily used for python-based scientific and financial computing.

Pandas - provides high-performance, easy-to-use data structures and data analysis tools for the python programming language. Pandas focuses on basic data types and their methods, leaving other packages to add more sophisticated statistical functionality.

Statistics is Python's built-in library for all basic statistical calculations.

Scikit-learn is a free machine learning software library for the Python programming language.

PyTorch is an open-source machine learning software library designed to solve the problems of building and training a neural network to automatically find and classify images, achieving the quality of human perception. It is used for both research and business product development.

Specific libraries for financial work:

Pyfin is a python library for calculating basic options in python.

Ffn is a library containing many useful features for those involved in quantitative finance. It stands on the shoulders of the giants (Pandas, Numpy, Scipy, etc.) and provides a wide range of utilities, from performance measurement and evaluation to charting and general data transformations.

The aforementioned Python packages for finance establish financial data sources, optimal data structures for financial data, and statistical models and estimation mechanisms. But none of them provide one of the most important Python tools for financial modeling: data visualization.

Matplotlib - Python programming language library for visualizing data with two-dimensional (2D) graphics. The resulting images can be used as illustrations in publications.

Proposed stages of implementation of artificial intelligence technology in financial planning

Collecting data according to certain rules. In order to train an artificial neural network, it is necessary to have a comprehensible data set in which the machine can find correlation dependencies and build a model.

It is then worth using such datasets in machine learning. Machine learning is not artificial intelligence, it is algorithms that take in mathematical dependencies between data and allow to reproduce new data according to a learned law. For example, expenditure classification tasks.

Use of chatbots in communication between economic entities, recipients of budget funds, and the artificial intelligence system. This approach will allow building a primary communication bridge between the intelligent expenditure planning system and the recipients of funds. Chat-bot input can receive requests for funds and aggregate information on items of expenditure, communicate information about the accounted and planned limits of budget funds.[10].

As a result, the final stage introduces an adaptive learning approach, where the system proposes certain solutions to planning problems with the participation of the final decision maker. The main task is to ensure the transparency of data and operations that served as the basis for the conclusions of machine intelligence («inference») and the development of a particular model of the budget project. Feedback from a human for machine learning is extremely important, it allows you to quickly customize the work of artificial intelligence in the desired scenario. [8]

Research results

In the course of the research the guiding documents of the Ministry of Finance of the Russian Federation are considered, the documents of the Ministry of Finance of the Sverdlovsk region in terms of approval of the budget of the subject of the Russian Federation are considered.

The tasks of budget planning in the subjects of the Russian Federation and municipalities are defined, namely:

- creation of a regulatory and legal framework for long-term budget planning;
- formation of a system of initial data for the preparation of long-term budget forecasts (forecasts of socio-economic development, including in various variants);
- development of approaches to the assessment of budget risks, their classification and accounting procedure within the framework of long-term budget planning and budget process (including state and municipal programs);
- creation of a procedure ensuring publicity and transparency of long-term budget planning;
- determination of the main trends in changes in the characteristics of consolidated budgets of constituent entities of the Russian Federation, budgets of constituent entities of the Russian Federation and local budgets (including budgets of urban districts, municipal districts and settlements);
- development of a system of measures for adjusting fiscal and debt policy, taking into account the parameters projected for the long-term period;
- creation of a system to ensure balanced budgets in the long term;
- taking into account the consequences of planned structural reforms and projects that have a significant impact on the balance of budgets;
- development of rules for adjusting (refining) long-term budget forecasts (budget strategies).

Methods and technologies of development of artificial intelligence complimentary with existing tasks of public administration are defined, and also necessary program components for realization of a task of creation of algorithms of artificial intelligence are designated.

The purpose of the study has been achieved. Methods for solving the problems of long-term planning in the budgetary system of the Russian Federation have been found. Artificial intelligence is applicable in certain areas and is able to greatly simplify and speed up the processes of information processing and construction of planned forecast values of budget expenditures, with constant risk control and optimization of strategies for distributing funds of money between the recipients of the limits of budget allocations.

Conclusion

The considered approach to the integration of artificial intelligence in the management of public and municipal finances creates a groundwork for research not only in the field of governance and management, but also in the field of information technology. Increasing the productivity of operational activities of public administration bodies significantly affects the improvement of efficiency and expediency of budget spending.

At the same time, consideration of only one stage of financial management – «planning» highlights a large layer of problems at the legislative and technological level. Significant investments are needed in the material and technical base, namely data processing centers of the state executive authorities. At the legislative level, it is necessary to work out regulations, methods, limitations and responsibilities of persons using the results of artificial intelligence for making managerial decisions.

In the Russian Federation the remoteness from the decision-making center is solved by the widespread digitalization of communication processes, exchange of documents and information. Thus, it is worth considering the use of artificial intelligence systems only in the complex of general measures for the development of information technologies in state and municipal authorities.

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