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INTELLIGENT SYSTEMS OF DECISION-MAKING AND PROBLEMS OF COMPUTATIONAL INTELLIGENCE



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ORDER FORECASTING SYSTEM FOR VEHICLES

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The modern development of transport services requires new approaches to management, optimization and marketing. Over the last ten years, taxi services have undergone significant changes, especially due to the influence of digital technologies. Traditional methods of ordering a taxi, which involved calling or waiting on the street, have been almost completely replaced by mobile apps that allow users to order a ride with just a few taps on the screen. These apps also offer additional features such as real-time vehicle location tracking, pre-trip cost estimates, and the ability to choose between different car classes. Also, digital payment systems have made the payment process more convenient and secure, minimizing the need for cash. All these innovations have changed taxi services, making them more accessible, efficient and user-oriented. The use of software based on the processing of statistical data can significantly facilitate the process of forecasting demand in the work of taxi services and ensure optimal use of resources.

The purpose of the research is to create a forecasting system using artificial neural networks that can be used for ordering transport services. The main idea of the development is to create an integrated solution that takes into account a wide range of factors that affect the demand for transport services and can significantly influence the decisions of consumers regarding the choice of transport.

To achieve the goal of the research, the following steps must be taken:

- Comparative analysis and justification of the choice of a machine learning demand forecasting model for Vehicles.
- Selection of a neural network and a model learning algorithm for creating a demand forecast for transport services.
- Analysis of initial input dataset used to demand forecast for transport services and identification of key factors affecting demand dynamics, including time of day, day of week, weather conditions, public events, etc.
- Assessment of the forecasting quality by determining the determination coefficient
- Designing the demand forecasting system architecture, which will allow collecting and storing all the data necessary for forecasting, as well as generating forecasts on a powerful server instead of a client terminal.
- Development of an approach to the system server part deployment, which will allow to perform the requirements for system security and reliability, as well as to foresee the of system scaling possibility, which will be needed in the future during commercial operation.
- Test the software tool, evaluate its effectiveness and compliance with the formulated requirements.

The review of modern technological solutions showed that the use of machine learning algorithms, especially artificial neural networks, is a promising direction for increasing efficiency and optimizing costs [1-4], and also allows not only to increase customer satisfaction, but also significantly improves workflow and management of company resources. This includes the application of predictive models for demand analysis, pricing and determining optimal routes.

The neural network at the heart of the system is designed to handle large amounts of information coming from both the internal data storage cluster and external sources via APIs. This provides an in-depth and comprehensive analysis of the conditions affecting transport needs and allows accurate forecasts to be made.

A model for forecasting the demand for vehicle orders has been developed. The forecasted indicator is the number of orders at the relevant hour. By comparing this indicator with the basic average value, the transportation tariff is calculated, which will be indicated in the user application.

In the work, data exploration was carried out, during which the influence of various factors was analyzed - environmental temperature, precipitation, mass events, etc. During the preliminary study, new ones were also constructed on the basis of existing signs - day of the week, month, etc. and their influence was studied. The regression model created on the input data takes into account the following factors: time of day, day of the week, geography: downtown / remote areas, precipitation, public events, extreme temperatures, high (tourist) season, holidays.

The accuracy of the XGBRegressor and multilayer perceptron models, which are artificial neural network models, has been evaluated, and preference has been given to using the multilayer perceptron for demand forecasting in the system due to its flexibility, automatic feature learning ability, and efficient training. Additionally, the model is relatively simple to implement and operate, reducing development time and resources required for model utilization. The results of multilayer perceptron training are shown in Fig. 2. On the test sample, the coefficient of determination was 0.92.

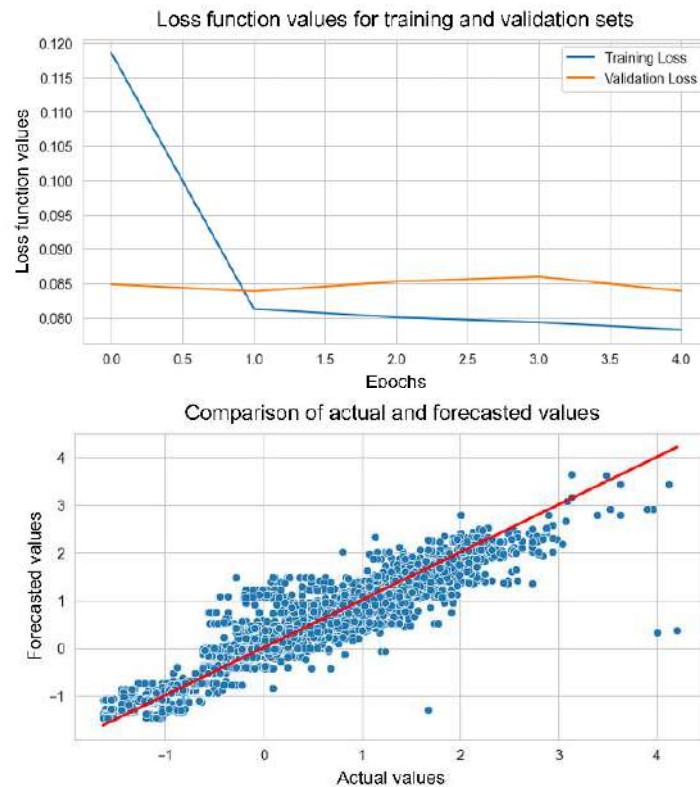


Figure 1. Training results of the artificial neural network

The system architecture is designed, which consists of a client application installed on an Android smartphone, and a server part represented by a REST API and a database management system. Such an architecture allows collecting and storing all the data necessary for forecasting, as well as generating forecasts on a powerful server instead of client terminals, many of which have limited capacity. The server can handle complex computations, store, and analyze large volumes of data without impacting the performance of the mobile device. In this case, the mobile application acts as a client, sending requests to the server through the API, receiving the necessary forecasts, or sending data for analysis and storage in the database. This approach not only reduces the load on the mobile device but also simplifies the process of updating and improving the model since all changes can be implemented on the server without the need to update the mobile application itself, meaning that only one instance of the server application needs to be maintained instead of a large number of client instances. Interaction of client application and REST API occurs via the HTTP protocol, the format of the POST request payload is JSON.

A significant emphasis in the work is made on the development of a REST API, which is a key element to ensure the availability of forecasts. This interface allows you to integrate forecasts into various software platforms and applications, which makes the system universal and flexible. Transportation service managers can use this information to optimize vehicle allocation, route planning, and reduce customer wait times. This, in turn, can lead to an increase in the efficiency of transport services and a decrease in the overall cost of transportation.

A stack of modern technologies was used to implement and deploy the system. The client application is developed in Java. When working with the database, the object approach implemented on the basis of SQL Alchemy is applied. The database management system chosen is Postgre SQL, which is a modern, well-supported and regularly updated system. Deployment of the server part of the system is performed in Docker containers under Linux management, and Docker is also used for container orchestration. This approach to deployment allows you to meet the security and reliability requirements of the system, as well as lay the foundation for scaling the system, which may be needed in the future during commercial operation. It can be argued that it uses a modern stack of tools that are also used in many large-scale commercial projects. Such tools are a guarantee of long-term support and trouble-free support of the software.

A components diagram of the software tool presents on Fig. 2 [5]. The composition of components embodies the encapsulation principle of object-oriented approach to software implementation, where each of the components is responsible for a certain functionality, which is to some extent isolated from other blocks. In the client application, the components process the behavior on the corresponding application screens, in the server application, the distribution is done by direction: main is responsible for the basic functionality of the API - receiving request, forming and sending responses, db - processes interaction with the database, responsible for encrypting and comparing user passwords, and ml - implements the use of the created machine learning model.

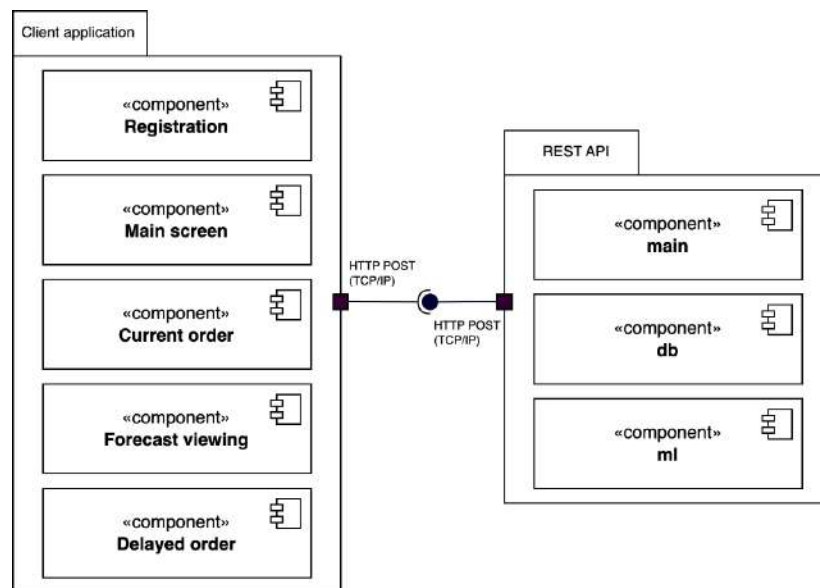


Figure 2. Diagram of components

The test deployment of the server part of the system was performed using Docker containerization. The REST API and statistics database used in forecasting are launched in separate containers. The application receives weather forecast data for the next 48 hours from the OpenWeatherMap API. The free version of the API is used for testing purposes, but a subscription is required for commercial use.

Therefore, for end users, the integration of forecasts into mobile applications opens up new opportunities for convenient selection and ordering of transport services. Users will be able to receive recommendations on the best time to order a taxi, taking into account current and forecasted demand, as well as alternative routes that can reduce the cost of the trip and travel time. The developed software will help improve the quality and availability of transport services for users, increase the level of service and user satisfaction with the service, and ensure more effective management of carriers' resources.

Among the prospects for the further development of the forecasting system, such areas as integration with Internet of Things technologies to collect additional data on the state of roads and traffic, expanding the functionality of the neural network for more accurate forecasting in changing environments, as well as the development of the user interface to ensure greater convenience can be highlighted and availability of information for end users. The proposed system will contribute not only to the improvement of the work of transport companies, but also make a significant contribution to the development of "smart cities" and the automation of urban transport.

REFERENCES

1. Géron A. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow. O'Reilly Media, 2019. - 856 pages. ISBN 978-1492032649.
2. Shishvan M. S. and Benndorf J. Operational Decision Support for Material Management in Continuous Mining Systems: From Simulation Concept to Practical Full-Scale Implementations // Journal: Minerals. - 2017. - Vol. 7. Num. 116. URL: <https://doi.org/10.3390/min7070116>.
3. Jones H. Neural Networks: An Essential Beginners Guide to Artificial Neural Networks and Their Role in Machine Learning and Artificial Intelligence. CreateSpace Independent Publishing Platform, 2018 - 76 pages. ISBN: 978-1725058514.
4. Ciampiconi L., Elwood A., Leonardi M., Mohamed A. and Rozza A. A survey and taxonomy of loss functions in machine learning. 2023. URL: <https://arxiv.org/abs/2301.05579>.
5. Miles R. and Hamilton K. "Learning UML 2.0: A Pragmatic Introduction to UML". 1st edition. O'Reilly media. – 2006. - 290 pages. ISBN: 0596009828.