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Modeling the demand for goods using machine learning methods

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Abstract: *This article investigates the process of modeling demand for goods using machine learning methods. Each method is evaluated based on forecast accuracy, adaptability to market changes, and training time. The aim of the research is to determine the most effective method for forecasting demand for goods.*

Key words: *linear regression, demand forecasting, data analysis, electronic commerce, variable dependence, machine learning, modeling efficiency.*

INTRODUCTION

With the development of modern technologies and the evolution of consumer behavior, e-commerce has become an important element of modern business. Demand forecasting plays a key role in companies' strategic planning, helping them adapt to changes in consumer preferences, optimize inventory, and improve customer service. Given the rapid development of the e-commerce market in Uzbekistan and changing consumer preferences, effective demand management for food products has become more important than ever.

The study is based on data on consumer behavior, pricing, seasonal fluctuations, and other factors influencing product choices. The introduction of modern technologies, such as e-commerce and digital platforms, enriches data on consumer behavior, providing opportunities for the application of big data analysis and artificial intelligence methods. This requires a deep investigation into the effectiveness of these methods in the context of Uzbekistan.

Methodology

To conduct the study, a trainable system was developed, by analyzing data entered in the form of a table, can forecast the possible amount of goods that will be sold in the

next period (from 1 to 10 months) based on this data. The study of demand included three main categories: clothing size, gender, and age of buyers. Four machine learning algorithms were used for prediction: random forest, Bayesian algorithm, linear regression, and neural networks. The dependent variable was the number of units sold, while the independent variables were clothing size, gender, and age of buyers.

Customer ID	Age	Gender	Item Purchased	Category	Purchase Amount
1	55	Male	Blouse	Clothing	53
2	19	Male	Sweater	Clothing	64
3	50	Male	Jeans	Clothing	73
4	21	Male	Sandals	Footwear	90
5	45	Male	Blouse	Clothing	49
6	46	Male	Sneakers	Footwear	20
7	63	Male	Shirt	Clothing	85
8	27	Male	Shorts	Clothing	34
9	26	Male	Coat	Outerwear	97
10	57	Male	Handbag	Accessories	31
11	53	Male	Shoes	Footwear	34
12	30	Male	Shorts	Clothing	68
13	61	Male	Coat	Outerwear	72
14	65	Male	Dress	Clothing	51
15	64	Male	Coat	Outerwear	53
16	64	Male	Skirt	Clothing	81
17	25	Male	Sunglasses	Accessories	36
18	53	Male	Dress	Clothing	38
19	52	Male	Sweater	Clothing	48
20	66	Male	Pants	Clothing	90

Fragment of the original table. Figure 1

For the comparison, we used a dataset on sales, product characteristics, and demand history.

Random Forest and Linear Regression are both popular methods for forecasting demand. Random Forest combines decision trees to enhance predictions, particularly suitable for large datasets. In contrast, Linear Regression models the relationship between variables, offering simplicity and interpretability. Neural Networks, inspired by the human brain, excel in processing complex data relationships, including historical sales and product characteristics. Lastly, the Bayesian Algorithm, rooted in Bayesian statistics, estimates event probabilities, useful for handling uncertainty in demand forecasting. Each method has its strengths, with Random Forest and Neural Networks suited for complex data, while Linear Regression offers simplicity and interpretability, and the Bayesian Algorithm provides a probabilistic approach to uncertainty.

Results

In our experiments, linear regression showed the best results among all methods considered. It demonstrated high prediction accuracy and low error rates. Specifically, linear regression allows for significantly more accurate demand forecasts compared to other methods. Linear regression is often considered an effective method for forecasting demand for goods due to its simplicity and interpretability. Based on the example of the data studied above, there is data on the sales of a specific product over the last few months, as well as data on its price for the same period. In the constructed linear regression model,

where the dependent variable is the number of units of the product sold, and the independent variable is its price.Additionally, linear regression can be applied to analyze the impact of other factors on demand for goods. For example, you can add data on seasonality, marketing promotions, or product characteristics such as brand or quality to the model. If the coefficient for any of these factors significantly differs from zero, this indicates a relationship between this factor and demand for the product.

However, the model assumes a linear relationship between variables and requires certain assumptions to be met, such as a normal distribution of residuals. Thus, linear regression is a powerful tool for analyzing and forecasting demand for goods, but its use should be conscious and contextual, taking into account the limitations and specificities of the situation.

Conclusions

Our study confirms the effectiveness of using machine learning methods for modeling demand for goods. Moreover, it highlights linear regression as the most suitable method for this task. Its advantages include the simplicity of interpreting results, adaptability to various types of data, and relative ease of use. Future research could consider more complex models and improve the data processing process to further improve the accuracy of demand forecasting for goods.

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