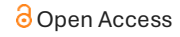**Research Article**

Machine Learning-Powered Forecasting for Social Media Campaign Optimization in E-Commerce

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Abstract

In today's conditions, competition is increasing day by day, companies that want to survive in these difficult market conditions are looking for new solutions. This is where e-commerce and social media sales come into play. In this paper, artificial intelligence applications have been used to increase the efficiency of the social media campaigns of an e-commerce company, which sells through retail and e-commerce. In this way, it will be predicted whether the campaigns will be popular or not before campaign advertisements are published on social media accounts and all waste will be prevented. Stocking of raw materials, unnecessary advertising shooting costs, and costs spent to highlight videos will be exactly eliminated. This prediction is provided through the artificial intelligence application Orange Software. The necessary data for the study was obtained via the internet from companies operating in this sector. These data have been tested in artificial intelligence applications and increase of the efficiency has been analyzed.

Keywords E-commerce, artificial intelligence, forecast, machine learning

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1. Introduction

In today's trade, competition pushes companies more and more every day. The competitive rate is much higher in e-commerce and social media sales than in normal commerce, because customers can reach the price of the product with just a click. While the conditions are like this, customers who shop on the Internet search for various features in the company where they make purchases and compare the features found with other companies. For example, a customer who wants to make a purchase examines all the parameters such as paying at the door, delivery time of the offered product, return conditions, free shipping option and makes his purchase from the most advantageous place. During the day, sales, especially on Instagram, are organized by offering a discounted price under the title of a campaign and attracting the attention of customers. Instagram has risen to an important position among all social networks, and in terms of businesses, marketing has become a social media platform that must be included in terms of marketing, promotion activities, increasing sales and market share and thus strengthening competitive advantages (Deniz, 2020). In this paper, it is aimed to increase the success of a company that sells via Instagram and to reduce the difficulty it faces to a minimum.

Bringing together the company, which wants to get a share in online sales and prevent waste, with artificial intelligence applications is the most important pillar of targeted success. Nowadays, many discount offers and opportunities are offered on social media to increase sales, acquire customers, and increase market share. Some special time periods make campaigns more effective. These special times are periods when consumers' purchasing tendencies are high. Brands that want to turn these special days into opportunities organize various campaigns and discounts both in stores and on e-commerce websites (Akçadağ and Keklik, 2021). This trend also applies to the nuts industry. Currently, mixed discount packages are popular in online sales of nuts. For example, preparing half a kilo of pistachios, cashews, almonds, hazelnuts and peanuts in packages and offering them to customers with shipping included will increase sales significantly with the right price and a solid infrastructure, but this process is not as easy as it seems from the outside. Distance to raw materials, labor costs, fixed costs, time and cost spent on advertising shooting cause companies to suffer great losses.

In this paper, companies that sell through social media in the nuts sector have been contacted and it has been decided which parameters are needed to measure the consistency of a campaign video to be published on the journey to success. In addition to experienced companies in the sector, the papers in the literature were examined and additions were made to the missing parameters. The main purpose of the paper is to predict whether a promotional campaign on social media will be successful or not, in order to reach this consistency, social media campaign videos have been examined accompanied by various parameters and the number of likes, comments that came to the videos beforehand , the data of the number of shares and the number of orders, which are the objective function of the article, were obtained.

All the parameters were got from papers, companies and videos have been transferred to digital with the help of Orange Software and different results have been achieved here with the help of various algorithms. Data mining tools such as Orange Software also offer powerful features in terms of visualizing and analysing data (Aksu and Güzeller, 2024). An absolute solution has been reached with an artificial neural network algorithm that gives the optimal result in them, and campaign forecasting has

been successfully performed. Among the artificial intelligence algorithms that we have scanned the literature and tried; the best results are obtained with artificial neural networks (Eroğlu, 2020).

2. Literature Review

Data mining has attracted a lot of attention in the community in recent years, being able to convert large amounts and large amounts of data into useful information and knowledge. The information and knowledge obtained can be used to apply such as market analysis, fraud detection, and customer retention, for production control and exploration science. Data mining is a process that uses statistical, mathematical, artificial intelligence, and machine learning techniques to extract and identify useful information and related knowledge from various large databases (Ishak et al., 2020). Orange Software is an open-source data mining software that provides users with capabilities such as data preparation, exploratory data analysis, and modelling (Tekerek, 2011). Today, to define a relationship between a parameter and its dependent parameters and to build a model to estimate or predict the chosen parameter, a variety of computational intelligence methods are used, and of course, they also provide favourable results. The purpose of this research is to use these types of algorithms in order to create an efficient model for predicting the deformation modulus on a database. In this regard, the performance of three models created by artificial neural network, K-nearest neighbor and random forest methods have been evaluated with the Orange Software (Fattahi and Jiryaee, 2023). K-Nearest Neighbor classification method has been studied for economic forecasting. Due to the effects of companies' financial distress on stakeholders, financial distress prediction models have been one of the most attractive areas in financial research (Imandoust and Bolandraftar, 2013). The machine learning algorithm, K-Nearest Neighbor (KNN) is introduced for human action recognition. A classifier is trained using KNN and the training set. It is aimed to recognize human actions when given acceleration signals (Wang et al., 2021). Predictive models for prognosis of small sample advanced schistosomiasis patients have not been well studied. We aimed to construct prognostic predictive models of small sample advanced schistosomiasis patients using two machine learning algorithms, k nearest neighbour (kNN) and support vector machine (SVM) utilizing routinely available data under the government medical assistance programme (Zhou et al., 2022). Given that the population is increasing and energy resources are decreasing, in this study we examine the amount of domestic energy consumption. The purpose of this study is to predict the factors affecting energy consumption in buildings. For this prediction, algorithms of decision tree, random forests and K-nearest neighbors have been used. These algorithms are available in Orange Software (Hosseini and Fard, 2021).

3. Methodology

In this paper, we used a software called Orange3, which is one of the machine learning applications of artificial intelligence. Orange3 is an open-source data visualization and machine learning software package used for data mining and data analysis. The data in this article were obtained from companies that trade nuts on social media. When deciding which data should be collected, first of all, articles and studies in the field of e-commerce were examined after that one-on-one interviews were conducted with companies that have been engaged in e-commerce for many years in the light of these sources. After reviewing the source and conducting interviews, it has been decided which data should be used in this article. As a common opinion of most businesses, it was determined that campaigns, especially for new

companies, should offer payment at the door service for reliability. In addition, it was decided that the payment at the door service should be added to the campaign amount and that it should not be reflected as an extra fee. Our other determining parameters include how many kilograms the products can be sold more effectively, the positive effects of product diversity, price policies, effective use of the Instagram profile, credit card payment and having a sales store to overcome the trust problem. All data can be clearly observed in Table 1.

Direct transfer of data into a table when entering data into this application makes the work easier. It is possible to easily import an Excel table from the file section. In the Orange application, it is determined which features will be processed from the select columns section, where the data that should be ignored and used is distinguished, and the target value is also determined here. There are various algorithms for statistics and prediction in practice, and it is possible to choose the most appropriate one by connecting data to these algorithms. After testing and training in the algorithms are completed, the scores are transferred to another table. Orange 3 application, the working logic of which is explained above, plays an important role in preventing waste and high costs.

Table 1. Data of the company selling nuts online

| Campaigns	Price	How many types	Weight /Kg	Background of Video	Accept Credit Card	Cash on Delivery	Extra Payment at door	Having Sales Outlet	Efficent Profile Managment	Tendency to Trend	Number of Likes	Number of Comment	Number of Share	Number of Order
1	985	6	3	NORMAL	YES	YES	YES	YES	NO	YES	3500	405	556	15
2	700	4	2	NORMAL	NO	YES	YES	NO	NO	NO	55	1	3	0
3	1900	5	4	NORMAL	YES	YES	YES	NO	NO	YES	1435	228	300	7
4	2072	5	4	NORMAL	YES	YES	NO	NO	NO	NO	350	68	50	2
5	1640	9	5	NORMAL	NO	YES	NO	NO	NO	NO	300	47	53	2
6	985	6	3	NORMAL	NO	YES	NO	YES	NO	YES	2610	241	320	8
7	1550	8	4	STRONG	NO	YES	NO	YES	YES	YES	2383	267	205	4
8	1500	8	4	STRONG	YES	NO	NO	YES	YES	YES	95.000	7500	108.000	200
9	1500	8	4	STRONG	YES	NO	NO	YES	YES	YES	3000	434	2700	15
10	1500	8	4	STRONG	YES	NO	NO	YES	YES	YES	9761	515	5225	30
11	1400	4	5	STRONG	YES	NO	NO	YES	YES	YES	17.700	730	12.300	50
12	2500	8	8	STRONG	YES	NO	NO	YES	YES	YES	4950	237	1700	40
13	1500	10	5	NORMAL	YES	YES	YES	YES	YES	NO	271	242	70	5
14	2000	14	7	NORMAL	YES	YES	YES	YES	YES	NO	386	28	89	1
15	1000	5	3	NORMAL	YES	YES	NO	YES	YES	NO	302	24	39	1
16	2000	10	5	STRONG	YES	NO	NO	YES	YES	YES	1500	55	806	6
17	1450	10	5	NORMAL	YES	NO	NO	YES	YES	YES	308	41	227	2
18	1400	10	5	NORMAL	YES	NO	NO	YES	YES	YES	3780	267	1904	25
19	1300	8	4	STRONG	NO	NO	NO	YES	NO	NO	82	18	18	1
20	1500	15	7	STRONG	NO	NO	NO	YES	NO	YES	695	182	194	10

3.1 Neural Network

Artificial Neural Networks are very powerful brain-inspired computational models, which have been employed in various areas such as computing, medicine, engineering, economics, and many others. An artificial neural network is based on the optimization theory. An Artificial Neural Network is a computational model inspired by the functioning of the human brain. It is composed of a set of artificial neurons (known as processing units) that are interconnected with other neurons, and these neurons depend on the weights of the neural network. As the word "network" in Neural Network refers to the interconnection between neurons present in various layers of a system, these weights represent the connections between the neurons, which determine the impact of one neuron on another (Zakaria et al., 2014). The structure of neural network example is given Figure 1.
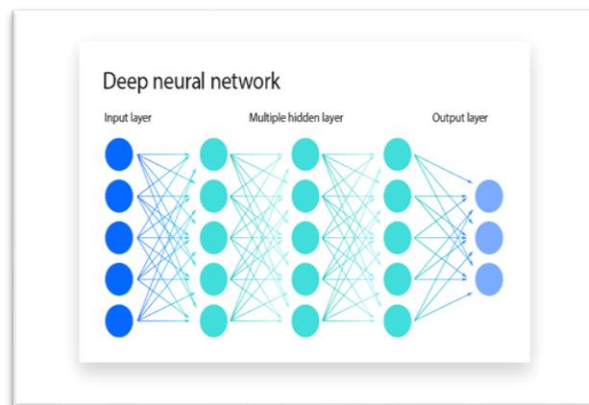
**Figure 1.** Representative view of deep neural network algorithm

3.1.2 AdaBoost

The AdaBoost algorithm, introduced by Freund and Schapire (1997), is a key method in the boosting approach to machine learning, which combines multiple weak learners to create a highly accurate prediction model. AdaBoost iteratively adjusts the weights of incorrectly classified data points, allowing the algorithm to focus more on difficult cases in subsequent iterations (Schapire, 2013). The representation of the Adaboost algorithm is shown in Figure 2.
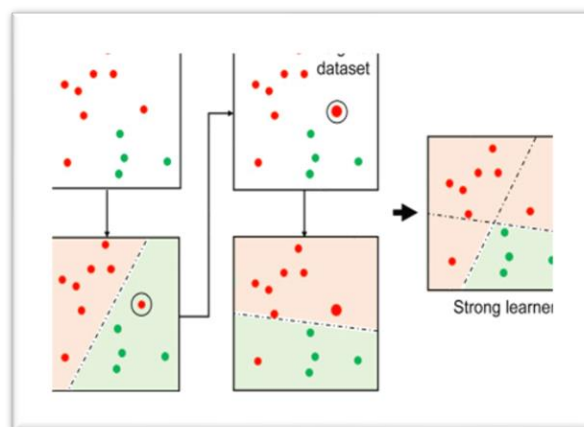
**Figure 2.** Representative view of adaboost structure

3.1.3 Random Forest

The random forest algorithm, proposed by Breiman (2001), has been highly successful as a general-purpose classification and regression method. This approach combines several randomized decision trees and aggregates their predictions by averaging. It has demonstrated excellent performance in situations where the number of variables is significantly larger than the number of observations. Furthermore, it is versatile enough to be applied to large-scale problems, easily adaptable to various ad hoc learning tasks, and provides measures of variable importance (Biau and Scornet, 2016). The representation of this method can be seen in Figure 3.
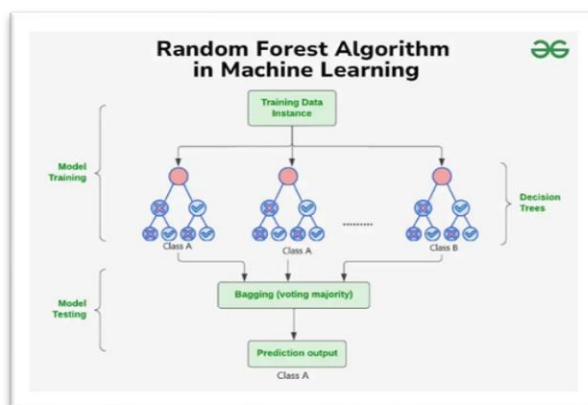
Figure 3. Representative view of random forest method

3.1.4 Tree Algorithms

Decision-tree learning is one of the most successful learning algorithms, due to its various attractive features: simplicity, comprehensibility, no parameters, and being able to handle mixed-type data. In decision-tree learning, a decision tree is induced from a set of labelled training instances represented by a tuple of attribute values and a class label. Because of the vast search space, decision-tree learning is typically a greedy, top-down and recursive process starting with the entire training data and an empty tree (Su and Zhang, 2006). Tree Algorithms showed by Figure 4.
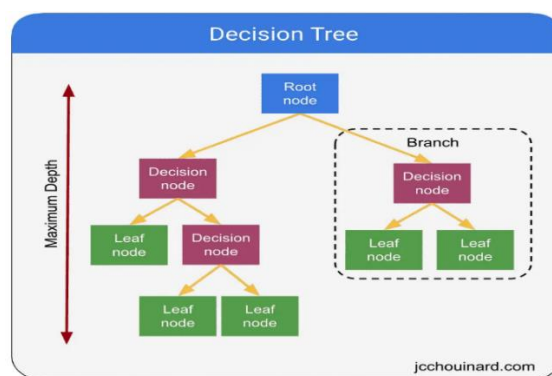
Figure 4. Representative view of decision tree method

3.1.5 KNN (Kernel – Nearest Neighbors)

The K-Nearest Neighbors (KNN) algorithm is a supervised learning method widely used for classification and regression problems, known for its simplicity. In this algorithm, the class of a given data point is determined by examining the "K" nearest neighbours in the training dataset. KNN typically uses distance metrics, such as Euclidean distance, to identify the nearest neighbours and then performs classification by majority voting. One of the main advantages of KNN is that it does not require learning any model parameters during training; in other words, it does not make any assumptions about the data. However, KNN can be computationally expensive for large datasets, as it must check the entire training set for each new instance. Additionally, the scaling of features plays a crucial role in the algorithm's accuracy because unequal feature scales can lead to misleading distance calculations (Altman, 1992). The schematic representation of KNN method shown in Figure 5.
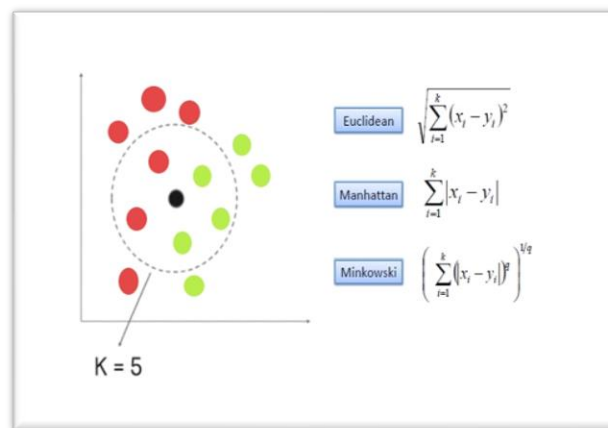
Figure 5. Representative view of KNN method

4. Result And Discussion

During this paper, real-world data was collected from companies active in this sector when gathering datasets. For forecasting, criteria were first determined with experts in the field. These criteria are essential for measuring the consistency of the campaign. In e-commerce, the most important factor is undoubtedly trust, and there are several possible solutions to establish this trust. In this article, Cash on Delivery, the most preferred solution, has been included in the criteria.

Afterward, the importance of several key criteria was identified: the campaign amount, the number of different products included in the campaign, the weight of the package, the efficient management of the advertising platform, and, finally, the absence of any additional fees for cash on delivery.

To observe the consistency of these features, previously published campaign videos on social media platforms was analysed. To measure the effectiveness of the campaigns, outputs based on likes, comments, shares, and the number of orders made in relation to these metrics was collected. We found that the features we defined were consistent at an optimal level. Therefore, this data was entered into the Orange 3 application and performed training sessions using machine learning statistical and forecasting algorithms such as Adaboost, Neural Network, and KNN. In our experiments, generally correct results in the test phase were obtained. However, in the actual application, the Neural Network model yielded almost flawless results with an R2 value of 0.99. Thus, significant progress in achieving

optimal results and measuring the consistency of the campaigns were made. The Figure 6 below gives an overview of the Orange model.
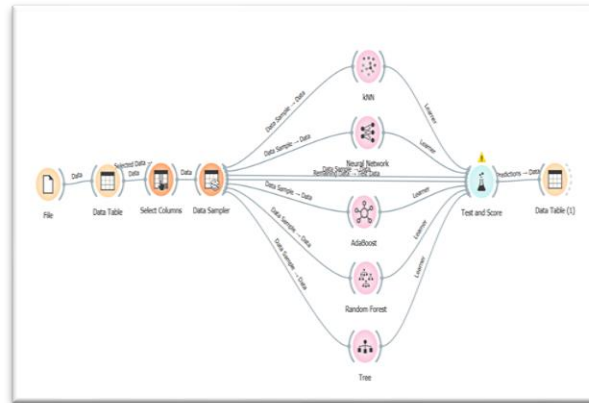
Figure 6. Overview of Orange software

After the data is collected and solved in various algorithms, each algorithm produces its own results. In such cases, the training data is not important because training data usually gives optimistic results. Below, the test on final solution phase of the paper is given in a Table 2.

Mean Squared Error (MSE) is an accepted measure of quality and control in various fields, particularly in statistical process control (Köksoy, 2006). MSE (Mean Squared Error) is also a metric used to evaluate the accuracy of a regression model. It calculates the average of the squared differences between the predicted values and the actual values. A low MSE value indicates that the model is making accurate predictions, while a high MSE value indicates poor performance.

Root Mean Squared Error (RMSE), as the name suggests, is the square root of MSE. Similar to MSE, it measures the average magnitude of the differences between the actual values and the predicted values. However, instead of using the mean squared differences, RMSE takes the square root of the average squared differences. The main difference between RMSE and MSE is that due to this mathematical operation, RMSE gives more weight to large errors, acting almost like a penalty for them. On the other hand, very small errors are, in a way, "rewarded" since their impact is lessened.

Mean Absolute Error (MAE) is an error metric that measures the average of the absolute differences between the predicted values and the actual values. This metric calculates the prediction errors directly based on absolute values and treats both large and small errors equally. In other words, the absolute difference is calculated for each error, and then the average of these differences is taken. The advantage of MAE is that it presents the magnitude of errors in a more understandable way, as it directly reflects the units of measurement.

The Mean Absolute Percentage Error (MAPE) is calculated using absolute errors in each period divided by the actual observation values for that period. Then, the average absolute percentage error. This approach is useful when the size or size of predictive variables is important in evaluating the accuracy of predictions. MAPE indicates how much error in forecasting is compared to the real value in the series (Prayudani et al., 2019).

R²: The R^2 (R-squared) metric is used to evaluate the effectiveness of a regression model. It indicates the proportion of variance in the target variable explained by the model and essentially reflects how accurate the predicted values are compared to the actual values. A negative R^2 does not indicate that the solution is wrong, it indicates that the model performs poorly relative to the real data; This may be due to over-tuning of training data or poor performance on testing data.

Table 2. Performance Results of the Models

MODEL	MSE	RMSE	MAE	MAPE	R^2
Neural Network	11.044	3.323	2.183	0.123	0.998
KNN	7804.644	88.344	51.236	0.852	-0.189
Random Forest	7495.025	86.574	50.120	0.815	-0.142
Adaboost	7334.250	85.640	49.250	0.938	-0.117
Tree	7171.599	84.685	47.688	0.620	-0.092

5. Conclusion

Social media has now become a platform that people constantly prefer for shopping. Companies that can observe these purchasing behaviours in the best way certainly achieve success. Companies that can find out what their customers want to get the best results in this context. In this study, the preliminary estimation for sales to be realized within social media and websites was successfully realized. Before the social media discount campaign was launched in the nuts sector, how successful the campaign would be was estimated based on various parameters and previously available data, and 98% success was achieved in test results. As a result of the paper, artificial neural networks provide the best results among algorithms. With the results was obtained, the company using our application will be able to activate the transactions that other companies plan to do very quickly. Companies pay a lot of money to agencies for advertising shoots, it becomes a big waste to shoot these videos and not get trending and interaction, the studies using artificial neural networks prevented this.

For this reason, it becomes clear how important the determining parameters, which are written in an ordered manner, are. Before the campaign starts, it has been determined which route should be followed and which way this tracking should be done. In addition, the entry of sponsored ads into a campaign video is a widely used method on Instagram, and if the desired interaction is not received, the investments made in this video again lead to waste. The preparation of raw materials and packaging materials for the campaign, which is one of the most important costs, also entails inventory costs, and if this is not prepared well, customer evasion costs arise in campaigns, all these costs disappear after the consistency of the campaign is predicted in advance and provide a great profit to the company.

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