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Price estimation of secondhand cars sold on the internet with artificial neural network method*

Yapay sinir ağı yöntemi ile internet üzerinden satılan ikinciel araçların fiyat tahmini

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Data mining is an important field of study for e-commerce firms. With the overwhelming amount of available data, that increases exponentially it is inevitable to use data mining methods. Because cost of a good or a service, potential of selling the product, potential price of the product etc. can be estimated by these methods with enough variables. No matter which method we use it must be cost and time efficient. For this reason, we must use data mining methods to make accurate and immediate estimations without any delays. In this work we tried to estimate prices of the vehicles in the secondhand car market with artificial neural network method. For this we used six step process to solve this problem. Problem definition was made by using data mining stages, in the first stage data cleaning was done in data preparation, in second stage we arranged data for the exploration, in third stage modelling was done, in fourth stage created model was evaluated, and in the fifth step data was adapted by model deployment to the working principles of the algorithms that would be used. Then, in the final stage it was evaluated by the methods of multilayer perceptron aka artificial neural network method. Results from artificial neural networks method compared with the actual data and the results analyzed.

Keywords: *Data Mining, Multilayer Perceptron, Artificial Neural Network*

Veri madenciliği, e-ticaret firmaları için önemli bir çalışma alanıdır. Çok büyük miktardaki mevcut verinin katlanarak artmasıyla veri madenciliği yöntemlerinin kullanılması kaçınılmaz hale gelmiştir. Çünkü bir mal veya hizmetin maliyeti, ürünü satma potansiyeli, ürünün potansiyel fiyatı vb. yeterli değişkenle birlikte bu yöntemlerle tahmin edilebilir. Hangi yöntemi kullanırsak kullanalım maliyet ve zaman açısından verimli olmalıdır. Bu nedenle, herhangi bir gecikme olmaksızın doğru ve hızlı tahminler yapmak için veri madenciliği yöntemlerini kullanmalıyız. Bu çalışmada, ikinci el otomobil pazarındaki araçların fiyatlarını yapay sinir ağı yöntemi ile tahmin etmeye çalıştık. Bu sorunu çözmek için altı aşamalı bir süreç kullandık. Veri madenciliği aşamaları kullanılarak problem tanımı yapılmış, ilk aşamada veri hazırlamada veri temizliği yapılmış, ikinci aşamada keşif için veri düzenlenmiş, üçüncü aşamada modelleme yapılmış, dördüncü aşamada oluşturulan model değerlendirilmiş ve beşinci aşamada veriler, model ile kullanılacak algoritmaların çalışma prensiplerine göre uyarlanmıştır. Daha sonra son aşamada yapay sinir ağı yöntemi olan çok katmanlı algılayıcılarla değerlendirilme yapılmıştır. Yapay sinir ağları yönteminden elde edilen sonuçlar ile var olan gerçek veriler karşılaştırıldı.

Anahtar Kelimeler: *Veri Madenciliği, Çok Katmanlı Algılayıcı, Yapay Sinir Ağları*

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1. INTRODUCTION

The internet has changed the business strategies, instead of forcefully pushing the marketing messages to customers. Managers are using interactive permission-based push digital marketing strategies to send the messages to perspective consumers. Large amount of consumer data is available on internet and especially on social media. Businesses are using big data and its application for generating information for such huge sources of data and using it for business intelligence (Kiran et al., 2018: 99).

Businesses use big data analytics to make this big data meaningful. Big data analytics increasingly provides value to e-commerce firms by using the dynamics of people, processes, and technologies to transform data into insights for robust decision making and solutions to business problems. This is a holistic process which deals with data, sources, skills, and systems in order to create a competitive advantage (Akter and Wamba, 2016:190).

The main objective of big data analytics is to employ the most innovative and highly developed analytic tools and techniques in addition to gigantic, multiple forms of datasets like structured or unstructured, in the range of terabytes to zettabytes. Big data comes into play for processing of voluminous data sets that are out of range from the processing, capturing and managing the potential of conventional relational databases. However, Big Data analytics tools make use of artificial intelligence, data mining and new techniques for data analysis (Ahsaan et al. 2019:101).

Data mining is the discovery of interesting, unexpected, or valuable structures in large datasets. (Hand, 2001: 621) As pointed out data mining is always after the data anomalies. Data mining aims to see the unseen in the vast amount of data. Purpose of the data mining is to based on the past activity analysis to create decision making models for estimating future behaviors (Koyuncugil and Özgülbaş, 2009: 24).

Over the time data collected from things increased exponentially. After computer and computer storage systems become cheap and can handle more storage and more calculation capacity people started to storage and process every little bit of data for their benefit. So, as a natural outcome processing data needed to handle this vast amount of data fast and accurately. Because with the evolution of the computer systems people needed to make their decisions fast and accurate. After that many data processing algorithms became available and widely spreaded across internet. Data mining algorithms are using nearly every field that requires decision making, estimations, classification etc.

One of the most used data mining method is the artificial neural networks. It processes the data like human brain and learns from the data set and it can make calculations and estimations very fast.

We have organized this paper into four main sections. Firstly, in section 2, literature study is included. In section 3, Artificial Neural Network Approach is explained. In section 4, the application section is included. In the application section, the prices of secondhand vehicles that are being sold on the internet are tried to be estimated with Artificial Neural Network Approach. In the conclusion, the outcomes of the application and future work recommendations are discussed.

2. LITERATURE REVIEW

Many studies on the secondhand car price prediction using data mining techniques were performed since 1992. These studies used various types of data mining methods to predict accurately the secondhand car prices.

One of the earliest studies Purohit (1992) tried to explore relationship between primary markets for new cars and secondary markets for used cars with cross-sectional time series and regression. Kuiper (2008) tried to estimate car prices that belongs to General Motors with multiple regression model. Listiani (2009) in this master thesis tried to estimate rental car prices with support vector machines. Asilkan and Irmak (2009) tried to estimate secondhand car prices with artificial neural networks. Du et al. (2009) created a car auction system and in this system, they combined nearest neighbor, linear regression, and time series analysis and for the optimization they used genetic algorithm. Oprea (2011) tried to estimate with linear regression and decision trees. Ho, Romano and Wu (2012) tried to estimate car prices with decision trees and naïve bayes algorithms. Vob and Lessman (2013) tried to estimate resale prices of the cars with ensemble selection methodology. Pudaruth (2014) tried to estimate secondhand car prices with linear regression, k nearest neighbor, naïve bayes and decision trees algorithms. In this research he showed that real prices and the estimated prices are close but; decision trees and naïve bayes cannot classify numerical values. Peerun et al. (2015) tried to estimate secondhand car prices with artificial neural networks. Lin (2015) in his PhD thesis tried to estimate car prices with functional data analysis and time series. And many of the web portals are worked and currently working on this field. Sun et al. (2017) tried to make an evaluation model for secondhand car market with BP neural network algorithm. Çelik and Osmanoğlu (2019) tried to estimate prices of the secondhand cars with linear regression.

3. ARTIFICIAL NEURAL NETWORK APPROACH

Artificial neural network is inspired by studies of the brain and nervous systems in biological organisms. This powerful functionality comes from the parallel distribution of the processing nature of the biological neurons (Luk et al., 2000: 57). It mimics biological organisms brains especially human brain. Because human brain is very strong and fast at learning and analyzing the things that it processes. In most cases artificial neural network is an adaptive system that changes its structure based on external or internal information that flows through the network during learning phase (Singh and Chauhan, 2009: 37). With ability to modify itself with incoming data; artificial neural networks are like a living organism, learns from its experiences in this case provided data.

As we in the Figure 1 a simple artificial neural network consists tree main elements; input layer, hidden layer and output layer. Data that has been processes comes from the input nodes, processes in hidden layer and the results are given by the output layer. There can be more than one hidden layer. More hidden layers mean more calculations and more consumption of time and more accurate assumptions.

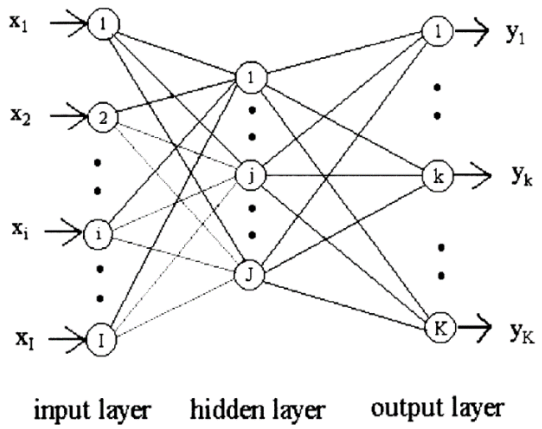

Figure 1. A Simple Tree-Layer Artificial Neural Network (Luk et al., 2000: 58)

Neural networks offer a number of advantages, including requiring less formal statistical training, ability to implicitly detect complex nonlinear relationships between dependent and independent variables, ability to detect all possible interactions between predictor variables, and the availability of multiple training algorithms. Disadvantages include its "black box" nature, greater computational burden, proneness to overfitting, and the empirical nature of model development (Tu, 1996: 1225).

4. METHOD AND FINDINGS

In this research we used one of the most used data mining technique called as artificial neural networks. İt is aimed to make price estimations of secondhand cars by making use of a website selling on the internet. For the sellers and the buyers on the secondhand car market, tried to show that artificial neural network method can be used.

In this work we used WEKA software which created by University of Waikato, New Zeland in 1993. It is named as "Waikato Environment for Knowledge Analysis" initials. First WEKA was created to analyze data from agricultural domains. Later in 1997 redeveloped by Java programming language and included implementations of modelling algorithms. With the java programming language it works most of the modern computer systems. It is an open source software that issued under General Public License and it uses its own file format.arff (attribute – relation file format), later with the extensions it gained ability to work with most of the other file formats. After that many of other analyze methods added to WEKA. It mainly contains preprocess, classify, cluster, associate, select attributes and visualize tabs. Through extensions more of algorithms can be added (WEKA, 2020).

We used WEKA's multilayer perceptron algorithm that resides under classification tab. When choosing classifier, under functions section; We can set up hidden layers node amount, training times (default number 500), learning rate, momentum and even if required it can visualize too. If these numbers increased, it can increase training times drastically but if it decreased it can downsizes training times but lowers the accuracy of results. Hidden layers are default to one hidden layer after activating gui (graphic user interface) we can add more hidden layers to create more relationships or remove relationships to get more accurate results.

In this research we use wekas multilayer perceptron algorithm aka artificial neural network algorithm to estimate secondhand car prices.

In the first stage of the application, we need to calculate the correlation, mean absolute error and mean absolute percentage error values in order to make a prediction. These values are shown in Table 1.

Table 1. Comparing Mean Absolute Error and Mean Absolute Percentage Error Values.

Brand	Sub-Model	Number of Variables	Mean Absolute Error (MAE)	Mean Absolute Percentage Error (MAPE)
Opel	Astra	1366	3729	0,100
Renault	Megane	1072	3116	0,112
Renault	Clio	962	2906	0,141
Tofaş	Şahin	939	1529	0,186
Volkswagen	Polo	846	3133	0,113
Ford	Fiesta	839	3606	0,118
Fiat	Linea	822	3377	0,140
Honda	Civic	769	3395	0,105
Volkswagen	Golf	700	4257	0,098
Volkswagen	Jetta	604	7745	0,155
BMW	3 Series	585	11037	0,260
Tofaş	Doğan	554	1328	0,149
Renault	Symbol	476	2016	0,078
Fiat	Fiorino	427	4278	0,184
BMW	5 Series	350	18820	0,364
Tofaş	Kartal	342	1334	0,153
Hyundai	Accent	337	2927	0,154
Opel	Vectra	332	2356	0,118
Ford	Tourneo	329	4352	0,155
Peugeot	206	323	2241	0,104

In this research we followed data mining process. This process contains five stages; problem statement, data preparation, exploration, modelling, evaluation and deployment.

In the problem statement stage our problem is defined as "in which price range buying a car would make sense". This problem will be our main goal to find. After the definition of the problem we move on to the data preparation stage. In this stage we have gathered data from one of the biggest secondhand car selling web site (www.hurriyetoto.com) in 14.12.2016 and it contains the active ads from 25.08.2010 to 13.12.2016 dates and 31.098 active car ads had been in the web site when we gathered the data. After the data cleaning 30.570 car ads remained.

In the third stage (data exploration) for to be able to work on data we had converted the values to numerical values. As we know artificial neural network algorithms works on the numerical values. After that we processed our data with weka after processing the data we saw that the car prices were not right. And we diagnosed that the too much brands making the prices estimations wrong. So, we divided the data set to sub models to make it homogeneous to get right estimations. We divided the data set to 70 brands and 616 sub models. After the division

we re-processed the data and for having the accurate data we cleaned the data with user inspection. After the cleaning as we can see in Table 2 some of the correlation values significantly increased.

Table 2. Correlation Values Comparison

			Original Data Set		Cleaned Data Set	
Count	**Brand**	**Sub Model**	**Sample Count**	**Correlation Value**	**Sample Count**	**Correlation Value**
1	Opel	Astra	1366	0,9372	1360	0,9401
2	Renault	Megane	1072	0,9419	1058	0,9471
3	Renault	Clio	962	0,9292	947	0,9316
4	Tofaş	Şahin	939	0,3539	891	0,6305
5	Volkswagen	Polo	846	0,9562	836	0,956
6	Ford	Fiesta	839	0,9091	835	0,9178
7	Fiat	Linea	822	0,8022	813	0,8363
8	Honda	Civic	769	0,8986	754	0,9711
9	Volkswagen	Golf	700	0,9696	689	0,9692
10	Volkswagen	Jetta	604	0,8604	595	0,8912
11	BMW	3 Serisi	585	0,9613	572	0,9508
12	Tofaş	Doğan	554	0,0955	517	0,8062
13	Renault	Symbol	476	0,9036	474	0,9111
14	Fiat	Fiorino	427	0,3218	409	0,8363
15	BMW	5 Serisi	350	0,9028	331	0,9755
16	Tofaş	Kartal	342	0,0615	302	0,8009
17	Hyundai	Accent	337	0,8268	326	0,8474
18	Opel	Vectra	332	0,9108	325	0,9351
19	Ford	Tourneo	329	0,9329	325	0,9338
20	Peugeot	206	323	0,6949	322	0,6999

Converting the values to numerical values can be count as data modelling. Because data must be converted to required type to be able to process.

After the data modelling another step came through data deployment. In this step we need to place data as to become user friendly and easy to understand by the users. After the data become ready we take the first 20 most selling secondhand car in the market under our research with multilayer perceptron algorithm (aka. artificial neural network). After processing the data and calculating mean absolute error and mean absolute percentage error values we inspect first 3 most selling secondhand cars in the market with charts and graphics.

If we inspect car with the most ads in the secondhand car market; we see that we have Opel Astra that have 1366 samples. After the data cleaning the data, we removed 6 outliers and after that we have 1360 values.

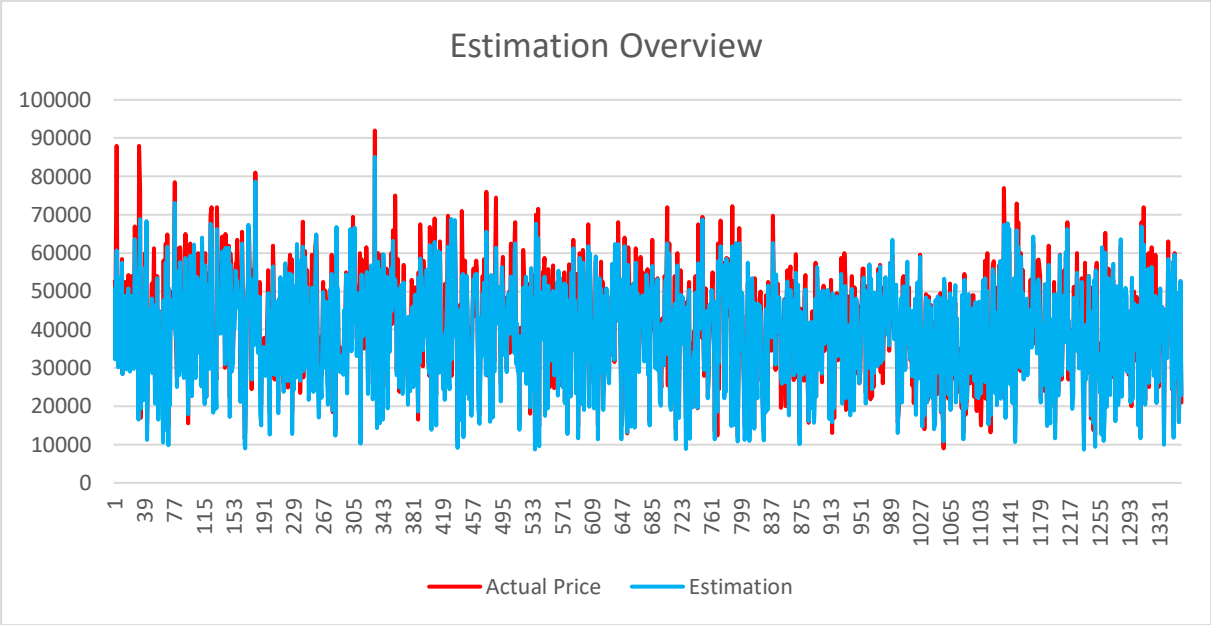

Figure 1. Opel Astra Estimation Overview

In Figure 2 we see an overview of the Opel Astra's actual prices and price estimations but as we see it is nearly impossible to inspect the values. So, we decided to inspect first 20 values of the dataset.

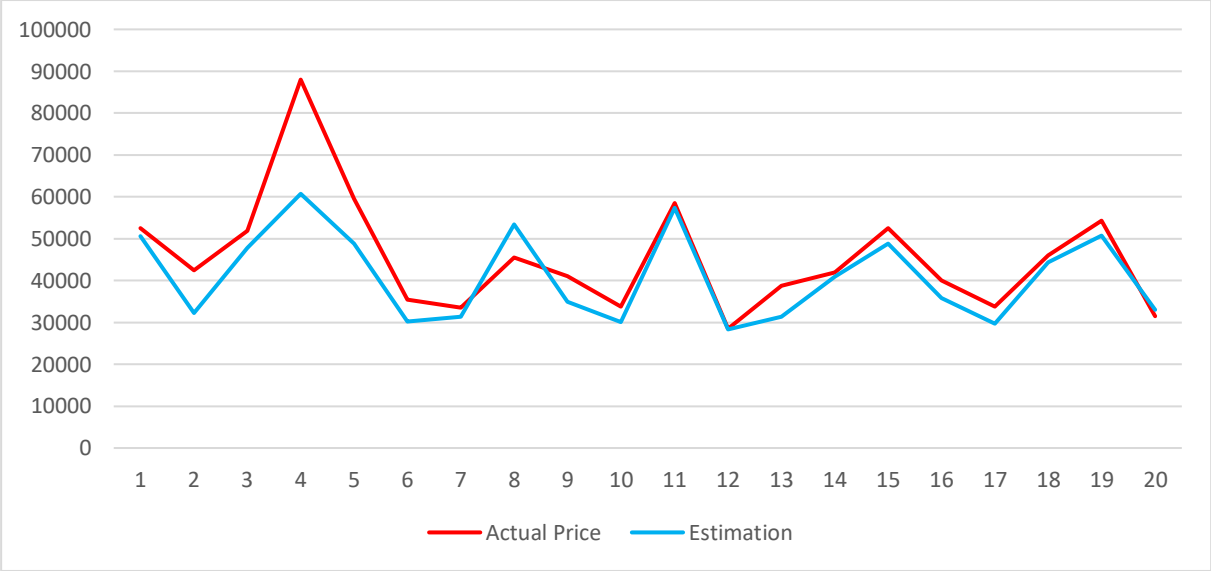

Figure 2. Opel Astra Price Estimation Overview (First 20 Instances)

In Figure 3 we see first 20 instances and price estimations. As we can see estimations are close to actual prices. In instance four we can see a big difference it can be an outlier, user error or some extras can be added into the car that makes it valuable.

Table 3. Opel Astra Price Ranges and Estimations.

Opel Astra	**Actual Price Range**		**Estimated Price Range**	
Year	**Min**	**Max**	**Min**	**Max**
1992	12700	12700	8694	8694
1993	9000	14750	8732	10817
1994	12000	18500	9029	13159
1995	13500	15750	10970	15572
1996	14000	19700	11062	17629
1997	13000	21250	8922	17132
1998	13000	25000	14941	19489
1999	12350	30000	14997	20515
2000	17750	29750	13670	24913
2001	14750	35500	18125	26209
2002	21500	33750	20375	26287
2003	16900	28500	19356	28154
2004	19500	38750	24713	31486
2005	23500	36500	26697	33195
2006	20850	39500	27929	33941
2007	24500	42500	22735	35857
2008	22500	43777	30157	37620
2009	26750	45000	32966	40804
2010	23750	52250	35851	44607
2011	32000	61250	31973	49767
2012	34500	88000	40631	57147
2013	37750	67500	39540	59915
2014	41500	88000	47838	63820
2015	40900	78500	49853	73020
2016	56500	92000	53192	85089

In Table 3 we see minimum and maximum prices and price estimations in over the time. As we can see Opel Astra is in the market since 1992 and if we want to buy a secondhand Opel Astra; for 1999 we should consider to buy 14997 to 20515 Turkish Lira for 2012 we should consider to buy 40631 to 57147 Turkish Lira price range. Lower or higher than this price range can make selling or buying this car faster or slower or can be scam or something else. If we consider to buy a secondhand car below this price range we should be extra careful.

If we inspect the second car brand Renault Megane; it had 1072 instances after the data cleaning it dropped to 1058 instances.

Figure 3. Renault Megane Price Estimation Overview (First 20 Instances)

In Figure 4 we see first 20 instances and price estimations. As we can see estimations are close to actual prices.

Table 4. Renault Megane Price Ranges and Estimations.

Renault Megane	Actual Price Range		Estimated Price Range	
Year	Min	Max	Min	Max
1998	8500	20000	13817	20260
1999	10750	24700	14713	21948
2000	14000	24750	18421	24036
2001	14000	28550	19820	26741
2002	14750	26000	22570	26074
2003	16750	29900	22570	29119
2004	19000	32750	25122	30304
2005	10000	34500	23486	30178
2006	21000	38000	27103	40736
2007	20750	41500	28096	35254
2008	22500	39000	24868	36020
2009	25100	45000	30349	41146
2010	26750	49000	34598	45910
2011	25000	79500	30132	59606
2012	31900	67500	39584	63641
2013	37900	65000	44667	59017
2014	47000	74900	45982	69370
2015	50000	82000	48700	73560
2016	75250	77500	71864	76394

In Table 4 we see minimum and maximum prices and price estimations in over the time. As we can see Renault Megane is in the market since 1998 and if we want to buy a secondhand Renault Megane; for 2003 we should consider to buy 22570 to 29119 Turkish Lira for 2015 we should consider to buy 48700 to 73560 Turkish Lira price range. Lower or higher than this price range can make selling or buying this car faster or slower or can be scam or something else. If we consider to buy a secondhand car below this price range we should be extra careful.

If we inspect the third car brand Renault Clio; it had 962 instances after the data cleaning it dropped to 947 instances.

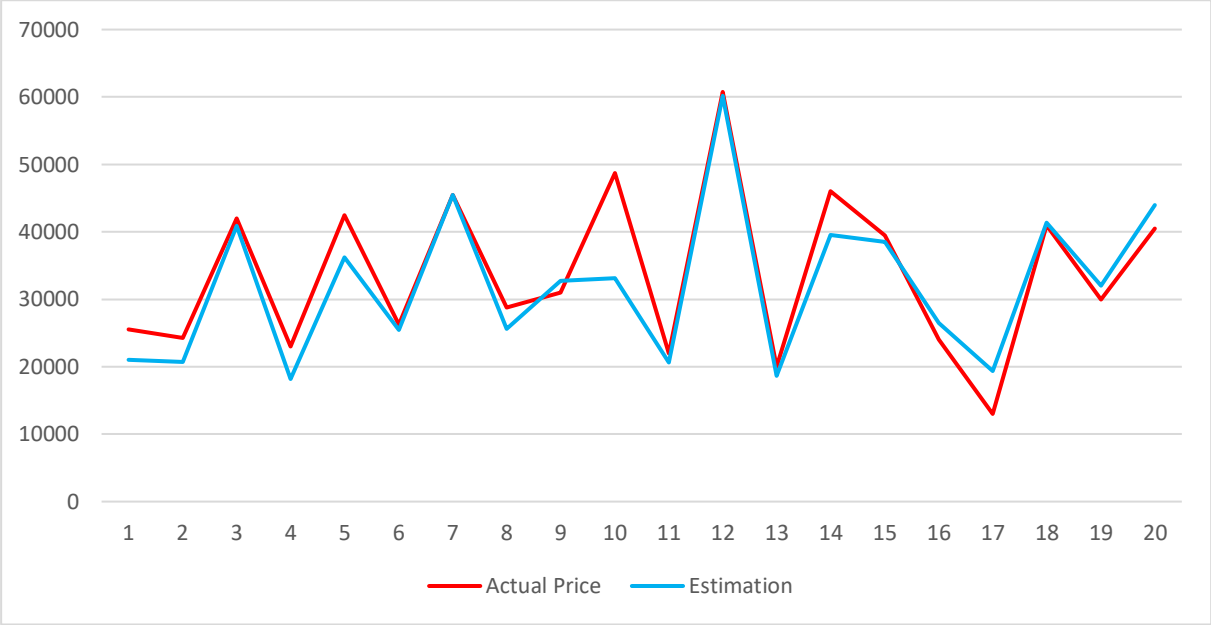

Figure 4. Renault Clio Price Estimation Overview (First 20 Instances)

In Figure 5 we see first 20 instances and price estimations. As we can see estimations are close to actual prices. In instance ten we can see a big difference it can be an outlier, user error or some extras can be added into the car that makes it valuable.

In Table 5 we see minimum and maximum prices and price estimations in over the time. As we can see Renault Clio is in the market since 1993 and if we want to buy a secondhand Renault Clio; for 2010 we should consider to buy 24057 to 35812 Turkish Lira for 2014 we should consider to buy 36515 to 53235 Turkish Lira price range. Lower or higher than this price range can make selling or buying this car faster or slower or can be scam or something else. If we consider to buy a secondhand car below this price range we should be extra careful.

Table 5. Renault Clio Price Ranges and Estimations.

Renault Clio	Actual Price Range		Estimated Price Range	
Year	**Min**	**Max**	**Min**	**Max**
1993	10000	10000	10697	10697
1996	12000	15800	10775	13396
1997	9900	16500	12548	18166
1998	10750	18750	13171	19435
1999	15000	22000	13424	21542
2000	12000	24250	15425	20954
2001	13000	24750	16147	20959
2002	15800	24500	16352	23159
2003	14000	29750	15068	22775
2004	12000	30250	18179	23653
2005	16750	26500	19649	24577
2006	1000	29500	16692	27973
2007	15500	36000	18081	27992
2008	19500	32000	21868	31626
2009	20000	36500	25508	33152
2010	16000	39150	24057	35812
2011	21250	43500	26166	38770
2012	26250	53000	28948	42124
2013	10000	53750	34171	51992
2014	33000	54500	36515	53235
2015	3000	63000	37822	59674
2016	49750	65500	52804	64111

5. CONCLUSION AND FUTURE WORK

In the developing countries like Turkey, with the inflation and tax rates become higher as a result, brand new car prices became higher. With this secondhand car market become primary market for the buyers.

In this work we tried to apply artificial neural network model to estimate secondhand car prices in Turkeys car market. With this, we tried to estimate car prices and while doing that saving time and effort for the sellers and buyers. Secondhand car market has too much variables to consider. Car mileage, engine type, engine size, body type, model year, etc. are some of them. And some of the locally important variables people consider it is important. In Turkey's case it consists painted pieces, added extras, past accidents, damage price information. But as different variables exist there are some fraud going on; people tries different techniques to elevate their post. They can past wrong prices (like either too high or

too low to when sorted price wise it shows on the top), hide some negative information, alter some information like car mileage etc. We can eliminate these posts with data cleaning techniques. In the future work we will try to build a more solid platform to eliminate or block wrong information, create a new system to combine different data mining techniques. Use advanced data cleaning techniques to make estimations more accurate and as close range as possible so it can be a reference point to sellers and buyers to make their decisions. A new star rating can be done to cars serial number to people can check this cars history on the platform and people can report the problem about the car for the fraud and misleading information and if it is a fraud to be banned from the system.

REFERENCES

Ahsaan, Ul-S., Mourya, K., A., Majid, A. (2019), Predictive Analytics And Modeling Of Big Data Through Mutual Contraction Of Map-Reduce And R-Programming Libraries, *Acta Technica Corviniensis – Bulletin Of Engineering Tome Xii [2019]* | Fascicule 4 [October – December

Akter, S., & Wamba, S. F. (2016). Big Data Analytics In E-Commerce: A Systematic Review And Agenda For Future Research. *Electronic Markets*, *26*(2), 173-194.

Asilkan, Ö. ve Irmak, S., (2009). İkinci El Otomobillerin Gelecekteki Fiyatlarının Yapay Sinir Ağları İle Tahmin Edilmesi, *Süleyman Demirel Üniversitesi İktisadi Ve İdari Bilimler Fakültesi Dergisi* Y.2009, C.14, S.2 S.375-391. Y.2009, Vol.14, No.2, .375-391.

Çelik, Ö., & Osmanoğlu, U. Ö. (2019). Prediction of The Prices of Secondhand Cars. *Avrupa Bilim ve Teknoloji Dergisi*, (16), 77-83.

Du, J., Xie, L., & Schroeder, S. (2009). Practice Prize Paper—PIN Optimal Distribution of Auction Vehicles System: Applying Price Forecasting, Elasticity Estimation, and Genetic Algorithms to Used-Vehicle Distribution, *Marketing Science*, 28(4), 637-644.

Gültekin, S. U. (2017). Veri Madenciliği: Yapay Sinir Ağı Ve Doğrusal Regresyon Yöntemleri İle Fiyat Tahmini, Yayımlanmamış Yüksek Lisans Tezi, PAU. Sos. Bil. Enstitüsü.

Hand D., (2001). *Principles of Data Mining* (Adaptive Computation and Machine Learning Series, MIT

Ho, A., Romano, R., & Wu, X. A. (2012). Don't Get Kicked-Machine Learning Predictions for Car Buying, Stanford University, CS229 *Machine Learning*.

Hürriyetoto, (2016). https://hurriyetoto.com, Download Date: 14.12.2016.

Kiran, F., Zubair, A., Shahzadi, I. and Abbas, A. (2018), Internet-Based Digital Marketing Strategies Fordata-Rich Environments: A Social Network Perspective To Study Gossips, *The Bottom Line*, Vol. 31 No. 2, Pp. 98-113. https://doi.org/10.1108/BL-03-2018-0012

Koyuncugil, A. S., & Özgülbaş, N. (2009). Veri madenciliği: Tıp ve sağlık hizmetlerinde kullanımı ve uygulamaları. *İnternational Journal Of Informatics Technologies*, *2*(2).

Kuiper, S. (2008). Introduction to Multiple Regression: How Much Is Your Car Worth?, *Journal of Statistics Education*, 16(3).

Lin, Y. (2015). Auto Car Sales Prediction: A Statistical Study Using Functional Data Analysis and Time Series, Doctoral Dissertation, University of Michigan.

Listiani M. (2009). Support Vector Regression Analysis for Price Prediction in a Car Leasing Application, Master Thesis. Hamburg University of Technology.

Luk K. C., Ball J. E., Sharma A., (2000). A Study of Optimal Model Lag and Spatial Inputs to Artificial Neural Network for Rainfall Forecasting, *Journal of Hydrology*, 227, 56 – 65.

Oprea, C. (2011). Making The Decision On Buying Secondhand Car Market Using Data Mining Techniques, *The USV Annals of Economics And Public Administration*, 10(3), 17-26.

Peerun S., Chummun N. H., Pudaruth S., (2015). Predicting the Price of Secondhand Cars using Artificial Neural Networks, *Proceedings of the Second International Conference on Data Mining*, Internet Computing, and Big Data, Reduit, Mauritius, 17-21

Pudaruth, S. (2014). Predicting The Price Of Used Cars Using Machine Learning Techniques, *Int. J. Inf. Comput. Technol*, 4(7), 753-764.

Purohit, D. (1992). Exploring The Relationship Between The Markets For New And Used Durable Goods: The Case Of Automobiles, *Marketing Science*, 11(2), 154-167.

Singh, Y., & Chauhan, A. S. (2009). Neural Networks In Data Mining, *Journal of Theoretical & Applied Information Technology*, 5(1), 37-42.

Sun, N., Bai, H., Geng, Y., & Shi, H. (2017, June). Price evaluation model in secondhand car system based on BP neural network theory. In *2017 18th IEEE/ACIS International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing (SNPD)* (pp. 431-436). IEEE.

Tu, Jack V., (1996). Advantages and Disadvantages of Using Artificial Neural Networks versus Logistic Regression for Predicting Medical Outcomes, *J Clin Epidemiol*, XLIX,11: 1225-1231. doi:10.1016/S0895-4356(96)00002-9

Voß, S., & Lessmann, S. (2013). Resale Price Prediction In The Used Car Market, *In Tristan Symposium VIII.*

WEKA, (2020). https://tr.wikipedia.org/wiki/Weka, Download Date : 20.05.2020.