Forecasting NOKIA Sale by Adaptive Neuro Fuzzy Inference Systems (ANFIS)

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Abstract

Sale forecasting plays a key role for each business in this competitive environment. Since the sale is dependent on many factors, the sale forecasting is not an easy job. It is difficult especially when it comes to high-tech products such as cell phone, camera and etc. For their short lifecycles, the accuracy of forecasting will decrease. However, there are some methods to increase the accuracy such as Adaptive Neuro Fuzzy Inference Systems (ANFIS) method. In this paper we forecast the sale of Nokia cell phone in Tehran based on price and camera as input variables by ANFIS method. In addition, we consider mean absolute percentage error (MAPE) as a scale to compare ANFIS with regression. By using some data from Nokia SOLICITORSHIPs in Tehran, it is seen that ANFIS method is better than regression based on the MAPE scale.

Keywords
Adaptive Neuro Fuzzy Inference systems, NOKIA sale, regression.

1. Introduction
Nokia Corporation is a Finnish multinational communications corporation. Nokia is engaged in the manufacturing of mobile devices and in converging Internet and communications industries. It has over 132,000 employees in 120 countries, sales in more than 150 countries and global annual revenue of over €42 billion and operating profit of €2 billion as of 2010. Cell Phones as one of Nokia's products are responsible for Nokia's profit because of services' range that people can access with them. By increasing 10 percent for industry volumes in 2010 and existence the intense competitor such as Android, Apple and BlackBerry, sale forecasting for Nokia has a special important today. Nokia has realized two factors are important for sales forecasting. These factors include the actual prices of Nokia competitor's devices and, the price ceiling that customers are willing to pay for mobile technology. Sales forecasting is the process of looking ahead and predicting sales results over a designated period, often weekly, monthly, quarterly and annually. Although, sales forecasting helps the company to drive sales revenue, improve efficiency, increase customer retention and reduce costs, it is the hardest part of management. Some of sales forecasting methods are Delphi, Regression analysis, Simulation, experts' opinion and etc. Shtub and Versano (1999) also present a cost estimating system for steel pipe bending which is based on a neural network. Azadeh et al. (2010) present an integrated fuzzy regression to predict seasonal electricity demand and monthly changes of consumption electricity. In addition, some researchers present a hybrid model to forecast the sales. For instance, Wong and Guo (2009), Chang et al.(2010) and Kuo et al. (2002) present a hybrid model intelligent forecaster. By using fuzzy neural network, their sale forecasting has higher accuracy in compare to the previous papers. Sun et al. (2008) also investigate the effect of significant factors on sales by using a novel neural network.

However, the forecasting's methods are not limited to the mentioned methods. For instance, ANFIS (Adaptive Neuro Fuzzy Inference System) as one of the newest methods is applied in different areas such as medical, industry, geography, econometric and etc. In these areas, variety of tasks such as analysis of decision, forecasting, pattern recognition, system control, inventory management, logistic systems and operations management are used by ANFIS. In medical field, Kenar Koohi et al.(2010) apply ANFIS in prediction of human Papilloma virus oncogenicity potency, while Devesh and Rajendra (2011) propose implementation of ANFIS for breast Cancer Detection. ANFIS method has been applied in geography field, water resources applications. For example, Talei et al. (2010) evaluate rainfall to investigate the effect of inputs used on event-based runoff forecasting. Aldrian and Djamil (2008) use multi variables ANFIS in predicting daily rainfall by using several surface weather parameters as predictors. In econometric field, Boyacioglu and Avci (2010) predict return of stock market by using ANFIS. However, Ansari et al. (2010) forecast index of stock market. Moreover, Kablan (2009) has applied ANFIS in

financial field for high frequency trading. ANFIS is extended by an expert system which is capable to use combined fuzzy reasoning with the pattern recognition capability of neural networks. In industry field, Kurian et al. (2006) propose a model for prediction of interior daylight illuminance by using ANFIS. In addition, Ekici and Aksoy (2011) present ANFIS method to forecast consumption of building energy in a cold region. Atsalakis et al. (2010) predict manufacturing index and compare accuracy of forecasting with other forecasting methods (AR and ARMA). Tamer et al. (2008) also introduce the application of ANFIS for fault classification in transmission lines.

As an intelligent system, ANFIS combine knowledge, techniques and methodologies which make a high accuracy for forecasting in ANFIS (Lin and lee1996). Therefore, in this paper we use ANFIS method for sale forecasting of Nokia's cell phone in Iran. There are various factors for a customer to buy the cell phone such as memory, price, camera type and etc. At first, we consider memory, price, camera type, weight and touch screen as the important factors influence in the sale of cell phone. By considering five mentioned factors on the forecasted sale's model and inter the sale's inputs in Matlab software, it is seen that there is a significant difference between the forecasted number of sales and the real sale. It is observed that that memory, weight and touch screen to compare the price and camera's type, have the least influence on the demand while the sale's experts have confirmed our finding. In the next step- by using data from Nokia branches in Iran- we consider price and camera's type as input variables to forecast Nokia's sale based on ANFIS method. Then, the forecasting model is compared with a linear regression method based on mean absolute percentage error (MAPE) as a comparing scale. The results show that ANFIS method is better than linear regression according to MAPE scale.

The remainder of this paper is organized as follows. In next Sections, we provide a brief overview of ANFIS and regression methods. The model with computational results is presented in Section 3. Results analysis is discussed in Sections 4. Finally, the paper concludes in Section 5 with some suggestions for future work in this area.

2. Forecasting Methods

In the literature, ANFIS and regression as the forecasting methods are used widely in practical applications. In the following, we describe these methods which will be used in the next section.

2.1 Adaptive Neuro Fuzzy Inference System (ANFIS)

Adaptive Neuro Fuzzy Inference System (ANFIS) has been suggested by (1993). ANFIS is a class of adaptive networks equivalent to fuzzy inference systems (FIS). ANFIS can serve a basis for constructing a set of fuzzy 'if-then' rules. These rules interpret the values in the input vector x, and assigns values to the output y such as:
IF x is A THEN y is B.
A and B are labels of fuzzy sets, 'low'' or ''high''. The rules have multiple parts that are linked to each other by Boolean operators such as AND, OR. The rules with appropriate membership functions generate the stipulated input-output pairs that make excellent results. We note that membership functions characterize each fuzzy set that map each element to a value between 0 and 1.

In ANFIS, an initial fuzzy inference system (FIS) is taken and then it is tuned with a back propagation algorithm based on the collection of input-output data. In fact, FIS incorporate human knowledge and perform interfacing and decision-making. The basic structure of FIS consist three conceptual components. They include a rule base, a database and a reasoning mechanism. The rule base contains a selection of fuzzy rules. In addition, the database defines the membership functions that are used in the fuzzy rules. Then, based on two previous components - the rule base and the membership functions- the reasoning mechanism performs the inference procedure to derive a reasonable output or conclusion (Line and Lee 1996). In ANFIS, neural networks recognize patterns, and help adaptation to environments. The system possesses human-like expertise which is adapting and learning itself to do better with the changes in the environment.

Many types of FIS have been proposed in literature such as Mamdani, Sugeno and etc (Sugeno 1988). However, in the implementation of an ANFIS for financial predictions and estimation the most suitable model is the Sugeno model. The Sugeno model makes use of the rules to produce an output for each rule. Rule outputs consist of the linear combination of the input variables plus a constant term; the final output is the weighted average of each rule's output.

2.2 Regression

Regression analysis is a statistical tool for the investigation of relationships among variables. Regression analysis is widely used for prediction and forecasting. It estimates the quantitative effect of the causal variables upon the variable that they influence. The focus is on the relationship between a dependent variable and one or more independent variables. More specifically, regression analysis helps one understand how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed.

Linear regression including the simple linear or polynomial regressions, consider only one predictor as a linear or nonlinear form. Linear regression has been used widely in practical applications. When two or more predictors are used multiple regression analysis is employed (David 2005).

3. The Model with Computational Results

In this section, we present forecasting sale of Nokia cell phone by ANFIS and linear regression.

3.1 Forecasting model by ANFIS

In this section, ANFIS method is applied using the MATLAB Fuzzy Logic Toolbox to predict the sale of Nokia's cell phones. At first, we consider five factors- memory, weight, touch screen, price and camera type – as inputs for the forecasting of sale. However, the obtained result of Matlab software is shown that the first three of inputs are mostly not important in the forecasting model. Therefore, price and camera's type as the most important factors are considered that have more effect on the demand. All inputs data are taken from five Nokia's branches in Iran. In Table1, 53 kinds of cell phone (different camera and price) with their sales have been shown from January till March (2011).The first 53 of the data is used as the training set to optimize the model parameters and the last 24 serves as the checking set, used to confirm the parameters defined by the training set. The used steps are as follows:

Step1: Define camera's type and price as the inputs variables and number of sales as the output variable.

Step2: Divide all data into two subsets, train data and test data. Fifty three data are for training of the neural network and ANFIS and twenty four data are for testing them.

Step3: Determine the rules and membership functions by using genfis2 function with ten times repetition.

Step4: Choose the best net based on the train data by using anfis function.

Step5: Evaluate the chosen net based on test data by using evalfis function (Table 4).

Step6: Determine MAPE of forecasted sales to evaluate ANFIS method (Table 2).

Please note that MAPE is the number of test output by the difference between net output and test output divided by test output.

3.2 Forecasting model by Linear Regression

To compare the obtained results of Nokia's sale forecasting by ANFIS, we use linear regression, in addition. Therefore we apply same data (Table 1) in ANFIS in Spss software to predict the sale of Nokia's cell phones. The steps of linear regression are as follows:

Step1: Define price and camera as two predictors and Nokia's sale as the response variable of the model.

Step2: Define inputs and the relationship between the predictors and the response variable.

Step3: Determine the coefficient of predictors by enter inputs and run Spss software (Table 3).

Step4: Obtain Nokia's sale based on the result of step3 (Table 5).

Step5: Determine the MAPE of forecasted sales to evaluate the linear regression (Table 3).

Table 1: Data for input and output variables

Number	Camera(input)	Price(input)	Sales(output)
1	0	430000	12
2	0	450000	17
3	0	420000	24
4	0	490000	20
5	0	740000	18
6	0	680000	14
7	2	1010000	9
8	2	1330000	4
9	1.3	850000	6
10	2	1050000	11
11	0	510000	9

12	2	1190000	5
13	2	1700000	18
14	2	1700000	18
15	3.2	2100000	19
16	3.2	2400000	48
17	3.2	2880000	22
18	5	2570000	39
19	2	1260000	9
20	3.2	1480000	18
21	3.2	1530000	24
22	5	4520000	5
23	5	2110000	30
24	0	430000	23
25	0	730000	13
26	2	1500000	11
27	5	2230000	61
28	3.2	1850000	40
29	5	2650000	48
30	5	3350000	72
31	8	4400000	60
32	5	2380000	24
33	3.2	2720000	47
34	3.2	2670000	22
35	8	9000000	4
36	3.2	2800000	32
37	5	3550000	45
38	5	3550000	49
39	5	3400000	25
40	5	3900000	20
41	12	6400000	65
42	12	6400000	52
43	12	6200000	18
44	12	6200000	9
45	5	4570000	5
46	5	4980000	9
47	5	4060000	29
48	5	6010000	8
49	5	1340000	23
50	3.2	1640000	16
51	5	1920000	62
52	5	3350000	11
53	5	3820000	48

Table 2: ANFIS results

Output variable	MAPE	Number fuzzy Rules	Cpu time (seconds)
Number of sales	0. 4003	4	0.803725

Table 3: Regression results

Output variable	MAPE	Coefficient's price	Coefficient's camera	constant
Number of sales	0.474964	-5.423E-6	5.199	20.074

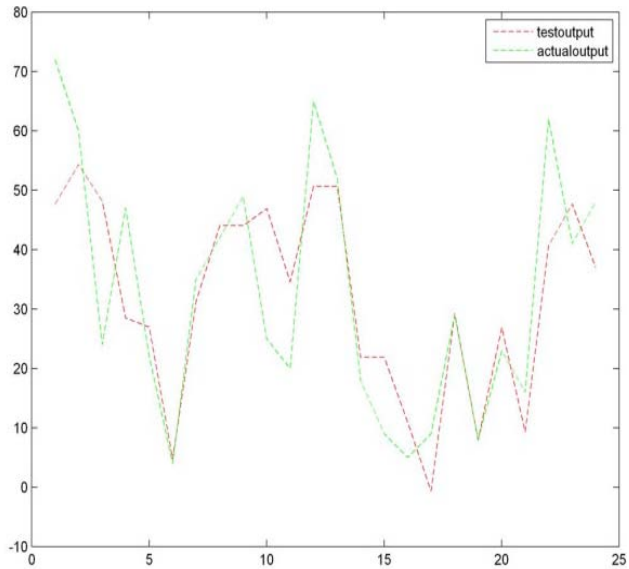

Figure 1: Actual output and ANFIS output diagrams

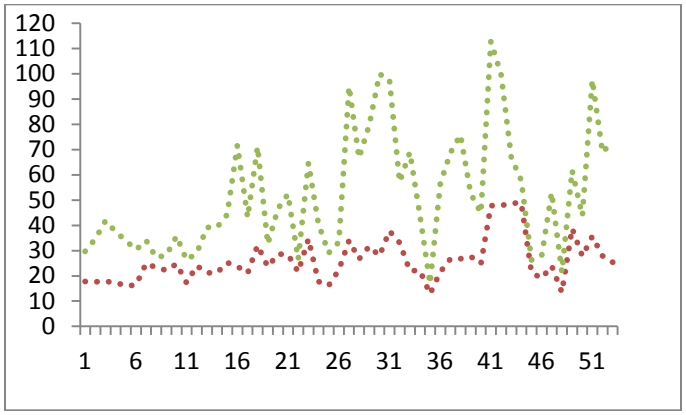

Figure 2: Actual output and Regression output diagrams

4. Results analysis

As is seen in Figure 1, there is no considerable difference between test output and actual output in ANFIS method. In other words, the test data and output data have a same trend. However, as seen in Figure 2 in linear regression, the difference between test output and actual output is very high. In addition In Table6, it is observed that MAPE for ANFIS is less than MAPE for linear regression. In other words, ANFIS error is less than linear regression.

Totally it is characterized that ANFIS method has a considerable accuracy in sale forecasting. The most important reason is ANFIS ability to predict natural system's behavior at a future time, which can be used for sales control. In addition, ANFIS is less complicate than other procedures. In other words, to compare fuzzy logic systems, ANFIS has automated identification algorithm with easier design. Moreover to compare neural networks, ANFIS has less parameters and faster adaptation**.**

Table 4: The results of ANFIS method

Actual output	Test output	Error
72	47.6916	-24.3084
60	54.2971	-5.7029
24	48.1929	24.1929
47	28.5171	-18.4829
22	26.9723	4.9723
4	4.7604	0.7604
35	31.1791	-3.8209
42	43.9905	1.9905
49	43.9905	-5.0095
25	46.8891	21.8891
20	34.5680	14.5680
65	50.6453	-14.3547
52	50.6453	-1.3547
18	21.8712	3.8712
9	21.8712	12.8712
5	10.9571	5.9571
9	-0.6383	-9.6383
29	29.2549	0.2549
8	7.9488	-0.0512
23	26.8998	3.8998
16	9.2970	-6.7030
62	40.6636	-21.3364
41	47.6916	6.6916
48	37.0177	-10.9823

Table 5: The results of linear regression method

Actual output	Test output	Error
12	17.74211	5.74211
17	17.63365	0.63365
24	17.79634	-6.20366
20	17.41673	-2.58327
18	16.06098	-1.93902
14	16.38636	2.38636
9	24.99477	15.99477
4	23.25941	19.25941
6	22.22315	16.22315
11	24.77785	13.77785
9	17.30827	8.30827
5	24.01863	19.01863
18	21.2529	3.2529
18	21.2529	3.2529
19	25.3225	6.3225
48	23.6956	-24.3044
22	21.09256	-0.90744
39	32.13189	-6.86811
9	23.63902	14.63902
18	28.68476	10.68476
24	28.41361	4.41361
5	21.55704	16.55704
30	34.62647	4.62647

23	17.74211	-5.25789
13	16.11521	3.11521
11	22.3375	11.3375
61	33.97571	-27.0243
40	26.67825	-13.3218
48	31.69805	-16.302
72	27.90195	-44.0981
60	37.8048	-22.1952
24	33.16226	9.16226
47	21.96024	-25.0398
22	22.23139	0.23139
4	12.859	8.859
35	21.5264	-13.4736
42	26.81735	-15.1827
49	26.81735	-22.1827
25	27.6308	2.6308
20	24.9193	4.9193
65	47.7548	-17.2452
52	47.7548	-4.2452
18	48.8394	30.8394
9	48.8394	39.8394
5	21.28589	16.28589
9	19.06246	10.06246
29	24.05162	-4.94838
8	13.47677	5.47677
23	38.80218	15.80218
16	27.81708	11.81708
62	35.65684	-26.3432
41	27.90195	-13.0981
48	25.35314	-22.6469

Table 6: The results of two methods

Output variable	Linear Regression MAPE (percentage)	ANFIS MAPE (percentage)
Number of sales	0.474964	0.4003

5. Conclusion

Sales forecasting plays a key role in today business. In this paper, we use ANFIS method to predict the sale of NOKIA's cell phone in Tehran. We consider price and camera type as the most important factors that influence on sale. We forecast NOKIA's sale with ANFIS and linear regression. By considering MAPE as a compared scale, it is shown that ANFIS is better than linear regression. The study shows that the performance of sales prediction can be significantly enhanced by using ANFIS. There is much scope in extending the present work. For example, considering quality factors such as appearance that a significant effect on demand in the forecasting model. Compare the proposed model with other forecasting techniques. Finally train and test the data with other functions of ANFIS or high-tech technology.

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