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ADAPTIVE NEURO FUZZY ESTIMATION OF IMPORTANT FACTORS FOR E-COMMERCE PRODUCT SHIPMENT DELIVERY

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Abstract

With the rapid growth of e-commerce consumers are increasingly encouraged to co-create individualized self-collection services. This study aims to conceptualize the multiple key facets of self-collection as viewed from consumers' perspectives and identify the latent consumer segments of the service. To do so the most advanced machine learning techniques cold be used to study their customers. The main goal of the study is to establish a model for estimation of the product shipment delivered on time or not. Discount offered has the strongest influence on the e-commerce product shipment delivery. The obtained results could be of practical importance to improve e-commerce shipping delivery as a key factor for successful business.

Key words*: e-commerce; shipment delivery; feature selection; ANFIS.*

1 INTRODUCTION

E-commerce shipping delivery is key factor for successful business. Each of the e-commerce company based wants to discover key insights from their customer database. To do so the most advanced machine learning techniques cold be used to study their customers. Achieving timely last-mile order delivery is often the most challenging part of an e-commerce order fulfillment. Effective management of last-mile operations can result in significant cost savings and lead to increased customer satisfaction. Currently, due to the lack of customer availability information, the schedules followed by delivery agents are optimized for the shortest tour distance. Therefore, orders are not delivered in customer-preferred time periods resulting in missed deliveries. Missed deliveries are undesirable since they incur additional costs. However, there is no holistic approach covering the presented field of research.
In paper [1] has been proposed a decision support framework that is intended to improve delivery success rates while reducing delivery costs where results indicate the effectiveness of the decision support framework in enabling savings of up to 10.2% in delivery costs when compared to the current industry practice. During the critical literature analysis, authors in article [2] identified the relations between stakeholders, the fields of the research, and the trends for developing sustainable last mile delivery on the e-commerce market. In article [3] has been provided insight on the potential benefit of an integrated model over sequential optimization of revenue and delivery cost. Demographic characteristics (gender, age, wage, and education) influenced the motivation to give priority to last-mile deliveries linked to sustainability [4]. Despite the high urbanization in the country, the e-commerce consumption per capita is higher in rural areas while the total number of kilometres travelled remains similar to that in urban areas [5]. In paper [6] has been investigated a new variant of last-mile delivery that integrates the scheduling of static E-commerce parcels and Online-to-Offline (O2O) parcels. A distributed and transparent ledger system is considered for various e-commerce products including health medicines, electronics, security appliances, food products and many more to ensure technological and e-commerce sustainability [7]. There is high heterogeneity in consumers' participation patterns of value co-creation in e-commerce last-mile logistics [8]. E-commerce for physical goods generates a significant demand for dedicated delivery services, and results in increasingly difficult last mile logistics [9]. The emergence of e-commerce marketplace, especially the business-to-business (B2B) e-commerce sector, has created a vast market opportunity for retailers and logistics service providers (LSPs) [10]. In article [11] has been consider an e-commerce retailer who must ship orders from a warehouse to a set of customers with delivery deadlines.
The main goal of the study is to establish a model for estimation of the product shipment delivered on time or not. The main aim is to meet e-commerce customer demand. For such a purpose adaptive neuro fuzzy inference system (ANFIS) [12] is used since the methodology is suitable for the nonlinear data samples. Based on the results the ANFIS model should determine customer rating, product delivery on time, to answer customer query and if product importance is high to have highest rating or being deliver on time.

2 METHODOLOGY

2.1E-commerce product shipment delivery

The dataset used for model building contained 10999 observations of 10 variables. Table 1 shows part of the data samples used in this study. The company sells electronic products. The data contains the following information:

- **Warehouse block:** The Company have big Warehouse which is divided in to block such as A,B,C,D,E.
- **Mode of shipment:** The Company Ships the products in multiple way such as Ship, Flight and Road.

- **Customer care calls:** The number of calls made from enquiry for enquiry of the shipment.
- **Customer rating**: The company has rated from every customer. 1 is the lowest (Worst), 5 is the highest (Best).
- **Cost of the product:** Cost of the Product in US Dollars.
- **Prior purchases:** The Number of Prior Purchase.
- **Product importance:** The company has categorized the product in the various parameter such as low, medium, high.

Table 1 Input and output data samples for e-commerce product shipment delivery [12, 15]

Input1: Warehouse block	Input2: Mode of Shipment	Input3: Customer care calls	Input4: Customer rating	Input5: Cost of the Product	Input6: Prior purchases	Input7: Product importance	Input8: Gender	Input9: Discount offered	Input10: Weight [s]	output: Reached on Time Yes or No
3	0	4	2	177	3	0	0	44	1233	1
4	0	4	5	216	2	0	1	59	3088	1
0	0	2	2	183	4	0	1	48	3374	1
1	0	3	3	176	4	1	1	10	1177	1
2	0	2	2	184	3	1	0	46	2484	1
4	0	3	1	162	3	1	0	12	1417	1
3	0	3	4	250	3	0	0	3	2371	1
4	0	4	1	233	2	0	0	48	2804	1
0	0	3	4	150	3	0	0	11	1861	1
1	0	3	2	164	3	1	0	29	1187	1
2	0	3	4	189	2	1	1	12	2888	1
4	0	4	5	232	3	1	0	32	3253	1
3	0	3	5	198	3	1	0	1	3667	1
4	0	4	4	275	3	2	1	29	2602	1
0	0	4	3	152	3	0	1	43	1009	1
1	0	4	3	227	3	0	0	45	2707	1
2	0	3	4	143	2	1	0	6	1194	1
4	1	5	5	227	3	1	1	36	3952	1
3	1	5	5	239	3	2	1	18	2495	1
4	1	4	5	145	3	1	1	45	1059	1
0	1	3	3	161	2	1	0	38	1521	1
1	1	3	1	232	4	1	0	51	2899	1
2	1	2	5	156	2	0	1	2	1750	1
4	1	4	3	211	3	2	1	12	3922	1
3	1	4	5	251	2	1	0	28	3561	1
4	1	3	1	225	4	0	1	29	3496	1
0	1	4	1	172	3	2	0	24	1066	1
1	1	5	1	162	3	1	1	31	1435	1
2	1	2	3	234	4	0	1	44	3134	1
4	1	5	4	183	2	0	0	36	3819	1
3	1	3	4	266	2	1	0	38	2741	1
4	1	5	3	257	2	0	0	61	3341	1
0	1	3	1	223	3	0	0	22	3795	1
1	1	4	2	234	3	1	1	4	3261	1
2	1	4	2	227	4	1	0	22	2460	1
4	1	5	4	149	3	1	0	44	1811	1
3	1	3	5	137	4	2	0	62	1477	1
4	1	2	4	181	6	1	0	16	3605	1
0	1	5	1	215	4	0	0	56	3905	1
1	1	4	2	269	5	0	0	45	2383	1
2	1	5	1	227	2	0	1	15	3798	1
4	1	5	5	139	4	1	1	61	1265	1
3	1	3	5	137	2	1	1	38	1647	1
4	1	3	1	174	2	0	1	44	1556	1
0	1	3	1	151	2	0	1	29	1328	1
1	1	5	1	210	3	0	0	9	2944	1
2	1	3	4	169	4	1	0	32	1245	1
4	1	5	1	160	2	0	1	32	1576	1
3	1	5	4	190	2	1	1	9	3753	1
4	1	5	3	216	3	0	0	40	2146	1

- **Gender:** Male and Female.
- **Discount offered:** Discount offered on that specific product.
- **Weight in gms:** It is the weight in grams.
- **Reached on time:** It is the target variable, where 1 Indicates that the product has NOT reached on time and 0 indicates it has reached on time.

2.2 ANFIS methodology

ANFIS network has five layers as it shown in Figure 1. The main core of the ANFIS network is fuzzy inference system. Layer 1 receives the inputs and convert them in the fuzzy value by membership functions. In this study bell shaped membership function is used since the function has the highest capability for the regression of the nonlinear data.

Fig. 1: *ANFIS layers*

Bell-shaped membership functios is defined as follows:

$$\mu(x) = bell(x; a_i, b_i, c_i) = \frac{1}{1+\left[\left(\frac{x-c_i}{a_i}\right)^2\right]^{b_i}} \quad (1)$$

where $\{x; a_i, b_i, c_i\}$ is the parameters set and x is input.

Second layer multiplies the fuzzy signals from the first layer and provides the firing strength of as rule. The third layer is the rule layers where all signals from the second layer are normalized. The fourht layer provides the inference of rules and all signals are converted in crisp values. The final layers sumarized the all signals and provied the output crisp value.

3 RESULTS

Feature selection represent a task of identification of the most important factors in order to improve prediction accuracy. This is useful preprocessing task before prediction process. ANFIS methodology was used for feature selection of the e-commerce product shipment delivery. The feature selection is important as preprocessing of the input parameters in order to remove unnecessary inputs. Data samples are divided in two groups for analyzing purpose. 50% data is used for training and remaining 50% is used for testing of the ANFIS network. ANFIS network is trained based on input and output pairs in Table 1.

Figure 2 shows single factors' influence on the e-commerce product shipment delivery. The input with the smallest training error has the strongest influence on the e-commerce product shipment delivery. As can be seen in Figure 2 and in Table 2 the Discount offered (input 9) has the strongest influence on the e-commerce product shipment delivery.

Figure 3 shows combination of two factors influence on the e-commerce product shipment delivery. One can see that the combination of Discount offered and Weight is the optimal combination of two factors for the e-commerce product shipment delivery. One can note in Figure 3 overfitting occurs between training and checking errors hence there is no appropriate to increase more inputs.

Figure 4 shows comparison between one, two and three factors influence on the e-commerce product shipment delivery. One can note the small decrease in the prediction errors for three input factors hence one can conclude two parameters is optimal number of the inputs for the e-commerce product shipment delivery.

Fig. 2: *Single factor influence on the e-commerce product shipment delivery*

Table 2: Single factor influence on the e-commerce product shipment delivery

Warehouse block --> trn=0.4911, chk=0.5010
Mode of Shipment --> trn=0.4911, chk=0.4900
Customer care calls --> trn=0.4896, chk=0.4894
Customer rating --> trn=0.4910, chk=0.4902
Cost of the Product --> trn=0.4898, chk=0.4888
Prior purchases --> trn=0.4894, chk=0.4883
Product importance --> trn=0.4907, chk=0.4901
Gender --> trn=0.4909, chk=0.4908
Discount offered --> trn=0.4458, chk=0.4437
Weight [s] --> trn=0.4559, chk=0.4526

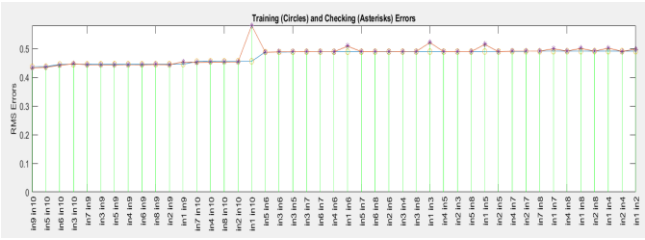

Fig. 3: *Two factors influence on the e-commerce product shipment delivery*

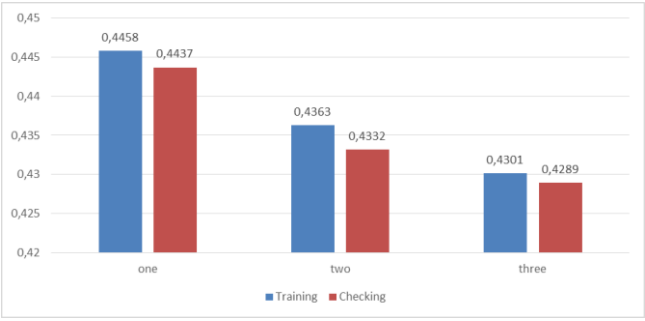

Fig. 4: *Comparison between one, two and three factors influence on the e-commerce product shipment delivery*

Two selected parameters are extracted and new ANFIS model is created and trained in 100 epochs. Figure 5 shows training and validation error curves for two selected parameters. One can note the minimal training errors occurs at 98th epoch hence there is no need for more training.
Figure 6 shows decision surface for e-commerce product shipment delivery based on two selected parameters based on the created ANFIS model. One can note the output values higher than 1 however the maximal output values should be 1. This occurs because of missing data for training. Figure 7 presents the data distribution for two selected parameters and one can note missing data in upper half.

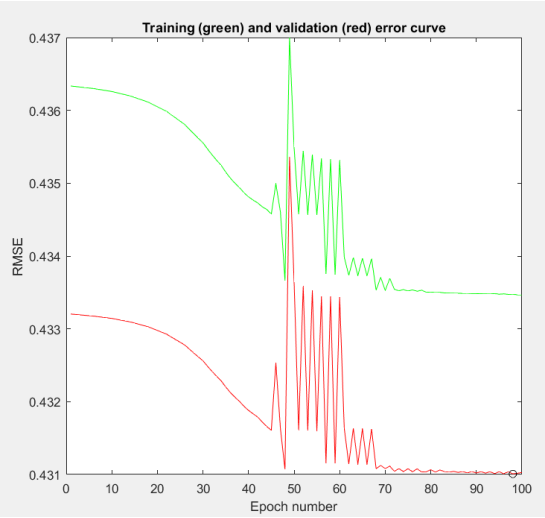

Fig. 5: *Training and validation error curves for two selected parameters*

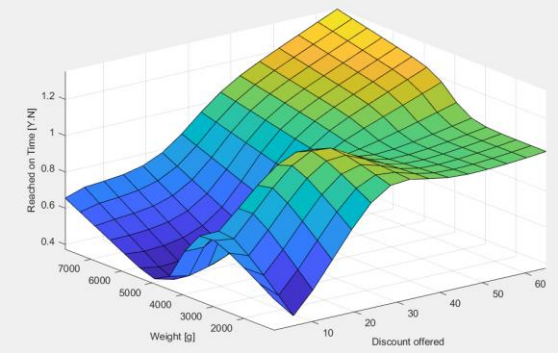

Fig. 6: *Decision surface for e-commerce product shipment delivery based on two selected parameters*

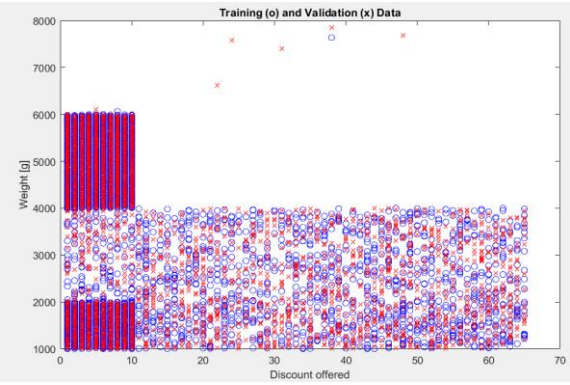

Fig. 7: *Data distribution for two selected parameters*

4 CONCLUSION

With the rapid growth of e-commerce consumers are increasingly encouraged to co-create individualized self-collection services. This study aims to conceptualize the multiple key facets of self-collection as viewed from consumers' perspectives and identify the latent consumer segments of the service. To do so the most advanced machine learning techniques cold be used to study their customers.

The main concluding remarks are:

- There is high influence of Discount offered on the e-commerce product shipment delivery.

- Combination of Discount offered and Weight is the optimal combination of two parameters for the e-commerce product shipment delivery.

Conflict of interest
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N/A

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