ISSN 2347 - 3983
Volume 8. No. 10, October 2020
International Journal of Emerging Trends in Engineering Research
Available Online at http://www.warse.org/IJETER/static/pdf/file/ijeter938102020.pdf
https://doi.org/10.30534/ijeter/2020/938102020

Electronic Customer Relationship Management in action: an example in business

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ABSTRACT
Nowadays, Electronic Customer Relationship Management (eCRM) constitutes a key aspect for management in the tourism and business industry. The automatic analysis of the available information is a major part of eCRM. In this paper, we address the use of eCRM in the development of tourism and business, and we consider a case of study to determine the usefulness of computational intelligence algorithms. We find that computational intelligence algorithms are very accurate for the determination of Online Shoppers Purchasing Intention, and can be easily applied for marketing purposes.

Key words : customer relationship management, internet, online retail.

1. INTRODUCTION

The modern administration considers that the paradigm of management of relations with the clients (Customer Relationship Management, CRM) is fundamental for the survival of the organizations [1-3]. CRM is defined as all marketing activities aimed at establishing, developing and maintaining satisfactory relational exchanges with customers [4].

With the emergence of new information and communication technologies, CRM has evolved in the digital age, giving way to eCRM (electronic CRM), where marketing activities have at least one virtual component. In CRM and eCRM, three phases of a customer's life cycle are considered: start, maintenance, and retention or termination [5]. For the successful achievement of this process, three types of information are considered: customer information (Of-the-customer), customer information (For-the-customer) and customer information (By-the- customer) [6]. In all cases, valuable information is required.

Computational intelligence algorithms have been widely used for data preprocessing [7-15], classification [16-28], clustering [29-31], matching [32-34] and prediction [35-37], for several disciplines such as education [38-49], medicine [30, 50-52], engineering [21, 25, 34, 53-57], finances [27, 58, 59] and others [60-65].

In this article is presented an experimental work using different computational intelligence algorithms to determine the Online Shoppers Purchasing Intention, as an example of eCRM. We use a recently created dataset with the purpose to know which of the algorithms analyzed has the best performance under the circumstances described above.

The rest of the paper is organized as follows. Section 2 details some previous works and section 3 offers a discussion about the results obtained. Finally, the paper ends with some conclusions and future research suggestions.

2. PREVIOUS WORKS

Several dimensions or attributes of eCRM have been identified [1, 66, 67], among them the quality of the information, the integrated marketing channels, the level of personalization and the use of attributes of social networks.

Due to the large amount of content that is posted daily in the form of reviews, manual analysis of reviews becomes difficult and time consuming. For this reason, various computational strategies have been used to divide the reviews into three types: positive, neutral or negative, through the analysis of feelings [68-70].

This theme is very active at present, having been applied in countries such as China [71], the Sultanate of Oman [68], Serbia [72], Spain [73, 74], among others. Text mining has also been used to establish tourist preferences in Japan [75].

In the scientific literature of the state of the art, it is possible to find research works that report using eCRM strategies. The combination of tourism and the Internet (Internet + Travel) allows people to obtain more detailed travel information. Yu and collaborators automatically extracted reviews of Chinese

tourist attractions from a Japanese travel website called 4Travel [76]. In Law and colleagues' research, user searches are used to forecast tourism demand in Macao [77]. Also, Sun and collaborators investigated the forecast of tourist demand, this time in Beijing [78]. In this case, the kernel extreme learning machine (KELM) was used. In this case, no data is available.
Zhang and collaborators have also investigated the forecast of the demand for sports tourism [79], while other researchers have done so in the classification of tourist scenarios [80, 81]. However, the above studies incorporate few datasets, and to complicate matters, many of the datasets used are not public, nor are they available for use. However, last year, an Online Shoppers Purchasing Intention dataset was made publicly available [82].

The No Free Lunch theorems [83] argue that there is no superiority of one classifier over others, over all datasets and all performance measures. However, it is possible to analyze the performance of classifiers in some particular scenarios, such as Online Shoppers Purchasing Intention.

3. RESULTS AND DISCUSSION

3.1 Datasets

In this section, we describe the dataset that will be used to evaluate performance of the computational intelligence classifiers. We selected the Online Shoppers Purchasing Intention dataset [82]. This dataset was donated to the Machine Learning Repository of the University of California at Irvine [84], in 2018.

The dataset consists of 12330 user sessions. According to the donors, the dataset "was formed so that each session would belong to a different user in a 1-year period to avoid any tendency to a specific campaign, special day, user profile, or period". The dataset has 10 numerical and 8 categorical attributes (Table 1). The "'Revenue" is the class label.

As shown, the dataset has 17 conditional features. The dataset is imbalanced, due to there are 10422 clients with no purchasing intentions, and only 1908 clients with purchasing intentions, for an imbalance ratio IR=5.46.

3.2 Algorithms to compare

In this section, the computational intelligence algorithms that will be evaluated in the present investigation are addressed. We used six simple classifiers: Nearest Neighbor [85], Naïve Bayes [86], C4.5 [87], Multilayer Perceptron [88], Support Vector Machines [89] and RIPPER [90]. In addition, we used three classifier ensembles: AdaBoost.M1 [91], Bagging [92] and Random Forest [93].

Nearest Neighbor was proposed by Cover and Hart [85], and uses distances to determine the class of the unknown pattern. To do so, it compares the patter against every training sample, and assigns the class of the closest sample. Naïve Bayes is a classifier based on the Bayes theorem of probabilities [86]. It computes the conditional probability of the unknown patter to belong to each of the training classes, and assigns it the most probable class.

Table 1: Attributes of the used dataset

Name	Description
Continuous attributes	
Administrative	Number of pages visited by the visitor about account management
Administrative duration	Total amount of time (in seconds) spent by the visitor on account management related pages
Informational	Number of pages visited by the visitor about web site, communication and address information of the shopping site
Informational duration	Total amount of time (in seconds) spent by the visitor about product related pages
Product related	Number of pages visited by the visitor about product related pages
Product related duration	Total amount of time (in seconds) spent by the visitor in product related pages
Bounce rate	Average bounce rate value of pages visited
Exit rate	Average exit rate value of the pages visited
Page Value	Average page value of the pages visited by the visitor
Special day	Closeness of the site visiting time to a special day
Nominal Attributes	
Operating system	Operating system of the visitor
Browser	Browser of the visitor
Region	Geographic region from which the session has been started by the visitor
Traffic type	Traffic source by which the visitor has arrived at the Web site (e.g., banner, SMS, direct)
Visitor Type	Visitor type as "New Visitor, Returning Visitor and Other"
Weekend	Boolean value indicating whether the date of the visit is weekend
Month	Month value of the visit date
Revenue	Class label indicating whether the visit has been finalized with a transaction
Operating system	Operating system of the visitor

C4.5 is a Decision Tree classifier, proposed by Quinlan [87]. It uses the concept of entropy and information gain to split the training set, and to form a tree structure. Then, the unknown pattern "travels" the tree according to its feature values, until it reaches a leaf. Then, the pattern is assigned to the class.

Multilayer Perceptron (MLP) is a network of simple "neurons" or "Perceptrons" [88]. It has its neurons grouped in layers of distinct levels. Each of the layers is formed by a set of neurons and three different types of layers are distinguished: the input layer, the hidden layers and the output layer. The unknown pattern is presented to the input layer of the network, and the output layer gives the corresponding class.

Support Vector Machines (SVM) are classifier based on kernels [89]. They try to find a hyperspace of characteristic with linear separability of the classes. We used the Sequential Minimal Optimization (SMO) procedure for solving the quadratic programming problem that arises during the training of SVM. SMO was implemented by John Platt [94].

RIPPER (Repeated Incremental Pruning to Produce Error Reduction) is a classifier which finds decision rules, based on the training instances values [90]. Then, after the rules are founded, the pattern is presented to the rules, and a decision according to its class is made.

AdaBoost.M1 is a classifier ensemble of decision trees [91]. It uses several C4.5 classifiers as base classifiers, each of them sequentially training to reduce the overall error of the ensemble. Once the ensemble is trained, the unknown pattern is presented, and the class with a majority of votes among the base classifiers is assigned.

Bagging is another classifier ensemble [92], which also uses C4.5 trees as base classifiers. However, it trains each of the base classifiers with a portion of the training set, named a bag. As AdaBoost.M1, the class with a majority of votes among the base classifiers is assigned to the unknown pattern.

Different from previous classifier ensembles, Random Forest [93] construct a forest of decision trees. But those trees are built by random selection of features. Class assignment is made by majority vote.

For the application of the above mentioned classifiers, we used the WEKA (Waikato Environment for Knowledge Analysis) software [95], in its version 3.8.3.

3.3 Performance measures

Due to data imbalance, we used the measures F1-score [96], Matthews Correlation Coefficient (MCC) [97] and the Area under the ROC Curve (AUC) [96]. Those measures are based on a confusion matrix (Figure 1). The equations for the computation of such measures directly from the confusion matrix are given below.

		True Condition	
		Positive	Negative
Predicted Condition	Positive	tp	fp
	Negative	fn	tn

Figure 1: Confusion matrix

$$F1 = \frac{2 * \left(\frac{tp}{tp+fp}\right) * \left(\frac{tp}{tp+fn}\right)}{\left(\frac{tp}{tp+fp}\right) + \left(\frac{tp}{tp+fn}\right)} \quad (1)$$

$$AUC = \frac{1}{2}\left(\left(\frac{tp}{tp+fp}\right) + \left(\frac{tp}{tp+fn}\right)\right) \quad (2)$$

$$MCC = \frac{tp * tn - fp * fn}{\sqrt{(tp+fp)(tp+fn)(tn+fp)(tn+fn)}} \quad (3)$$

Each algorithm was tested with a 5-fold cross validation procedure as model validation technique.

3.4 Discussion

Each algorithm was tested in the WEKA software [95] using the default parameters offered. Table 2 shows the results for the compared performance measures. Best results for each measure are highlighted in bold.

As you can see in Table 2 and Figure 2, as expected, for the F1 measure the best results correspond to Bagging and Random Forest. However, for the Mathews Correlation coefficient, the algorithms with best results was RIPPER. For the Area under the ROC curve, Bagging obtained the best results, closely followed by Random Forest.

The experiments show that classifier ensembles obtained very good results in the prediction of Online Shoppers Purchasing Intention. In particular, the Bagging classifier was the best for two of the three analyzed performance measures, having an f1 score of 0.942, and an AUC of 0.927.

Table 2: Results of the compared algorithms

Algorithms	**F1**	**MCC**	**AUC**
Naïve Bayes	0.886	0.434	0.838
MLP	0.934	0.555	0.887
SVM	0.934	0.468	0.666
NN	0.891	0.254	0.625
AdaBoost.M1	0.935	0.579	0.914
Bagging	**0.942**	0.598	**0.927**
RIPPER	0.940	**0.610**	0.807
C4.5	0.938	0.568	0.786
Random Forest	**0.942**	0.592	0.926

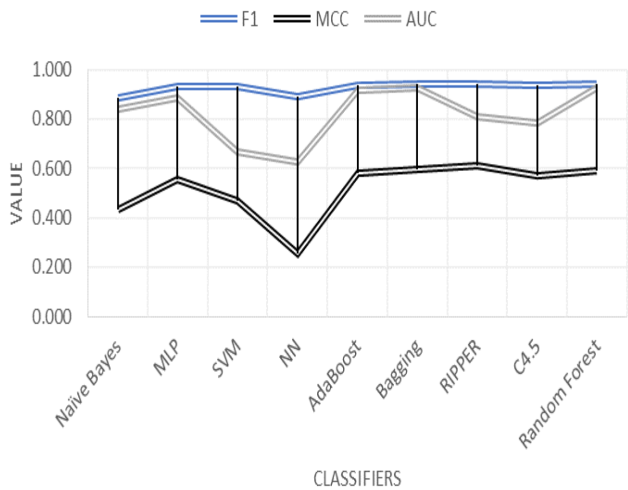

Figure 2. Results of the compared algorithms

4. CONCLUSION

In the tourism and business environment, Customer Relationship Management has an increase role. In the XXI century, with the availability of internet technologies, the Electronic Customer Relationship Management (eCRM) is a must be for almost all enterprises. Within it, the analysis of information, with computational intelligence algorithms is the key for marketing and development of user-centered strategies.

We prove in this paper the usefulness of computational intelligence algorithms in eCRM, for the automatic classification of Online Shoppers Purchasing Intention. With respect to other and diverse applications, there is an ocean of possibilities [98-117]. As future work, we want to apply computational intelligence algorithm to other tourism and business activities.

ACKNOWLEDGEMENT

The authors would like to thank the Instituto Politécnico Nacional (Secretaría Académica, Comisión de Operación y Fomento de Actividades Académicas, Secretaría de Investigación y Posgrado, Centro de Innovación y Desarrollo Tecnológico en Cómputo and Escuela Superior de Turismo), the Consejo Nacional de Ciencia y Tecnología, and Sistema Nacional de Investigadores for their economical support to develop this work.

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