



An Efficient Product Hybrid Feature Classification on Opinion Mining using Ant Optimization Rule

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Abstract- Opinion mining refers to opinion retrieval with a set of searched results, produced for the customer's depending on the product request demand. In general, opinion refers to a person's perspective and mining is implied for identifying the result of the search query. Despite its promise, failure of clear product classification results in the ambiguity for obtaining additional product feature association. Also, several hybrid features related to the product were not classified with high efficiency rate. The list of product attributes classification (i.e., based on quality of products and specific feature selection of the products) with opinion mining algorithms was not investigated widely. To classify the product features based on the user behavior, an Ant Opinion Miner Classification Rule Learning (AOM-CRL) process is proposed in this paper. Initially, the process of Ant Opinion Miner helps to fetch the combination (i.e., hybrid) product features based on the user behavior. The Ant Opinion Miner involves the pheromone initialization, updation and fitness function for efficient classification of hybrid features. Pheromone initialization starts the process based on the user behavior with opinion patterns based classification on product features. Then the pheromone updating process is carried out with the same behavior for a set of hybrid features of the products. Both the initialization and updating uses the user behavior information to easily adopt the classification rule. The fitness function is employed in AOM-CRL process to produce quality result on classification process. In addition, different set of hybrid feature classification also produces high quality function value through ant-miner based classification rule. This ant-miner based classification rule integrates the Enhanced Rapid Repeated Attribute Reduction algorithm to improve the classification accuracy on opinion mining with minimal processing time. Experiment is conducted with classification rate on user opinions, false positive rate and precision rate on product result.

Keywords- Classification Rule, Opinion Mining, Fitness Function, Pheromone Initialization, Pheromone updation, Enhanced Rapid Repeated Attribute Reduction

I. INTRODUCTION

With the overwhelming popularity of Internet, the electronic representation of word-of-mouth emerges into a new, mostly free-of-charge opinion data wherein the users provide their opinions regarding products to millions of public. Due to this, consumers' interconnections through social media, including Face book, Twitter, Instagram reviews become the most popular form of phenomenon facilitating the dissemination of both unique and redundant features.

Feature Relation Networks (FRN) [1] presented a rule based text feature selection method to remove the redundant or less related features to improve the classification performance of opinion mining. However, hybrid feature selection method remained unsolved. Intrinsic and Extrinsic Domain Relevance (IEDR) [2] for identifying opinion features using domain-independent and domain-dependent corpora to improve the precision was presented. Though positive and negative opinions were considered, neutral opinions were not considered. Neutral opinions were introduced in [4] used semantic knowledge bases to improve the classification accuracy. Opinion mining and sentimental analysis were focused in [5] with the application of natural language processing to improve the results of opinion being mined.

Researchers have developed many lexical resources including Word Net-Affect (WNA) and SentiWord Net for several opinion-mining tasks. But several issues related to incompleteness and noisy data were not addressed. A dictionary for opinion mining and sentimental analysis was introduced in [6] to improve efficiency in terms of processing time. However, the use of elaborated classification techniques remained unsolved. An efficient method based on conditional random fields (CRF) [7] was designed to improve the prediction of aspect oriented opinions using linear chain and multi label models. SENTIWORDNET 3.0 [8] supported sentimental classification and opinion mining principles with the objective of increasing the accuracy using semi-supervised

learning model. Social opinion mining [9] using linear chain and random field designed three stage system architecture to extract different types of features and opinion polarities.

Data mining and machine learning methodologies are broadly in the field of user decision behavioral pattern with the objective of providing accurate user models help in the process of decision making. Preference based organization (Pref-ORG) introduced in [10] provided an insight into decision making process to improve accuracy in predicting the user evaluation accuracy. Sentimental analysis integrated with opinion extraction, summarization [11] aims in provided the collaborated output about the students using average opinion value. Opinion mining based on the user query, to provide the users and organizations high quality results from enormous consumers' reviews. The objectives of this paper are to (i) fetch hybrid features based on the language processing [12] classified the document as positive, negative and neutral and accordingly the review of the movie was obtained.

The applications of Opinion Mining (OM) include the identification and summarization of opinion presented in the reviews documents. Hybrid dependency pattern [13] was designed for extraction of product features to improve the average precision and recall value. However, anaphora resolution remained unsolved. Various techniques used for opinion mining and sentimental analysis were discussed in [14] with the objective of improving the precision rate. In [15], best feature set were selected where feature engineering were performed using POS tag to improve the accuracy of features being classified. Sentimental analysis using fuzzy logic was designed in [16] with the purview of increasing the decision making process by classifying the documents and gathering the data in an efficient manner. Context-aware search and analysis were made in [17] on social media to address the spatial challenges and temporal values to rank and obtain the feature for efficient information retrieval.

In several applications, the availability of labeled data may be either few or computational costly to obtain. During those cases, the available training data has to be classified in an efficient manner under the purview that the amount of human intervention to perform additional labeling is limited. Training label cleaning in [18] was introduced to improve the quality of data being obtained using nearest neighbor, committee based technique and distribution based technique. However, the time taken to obtain the quality data increased with the increase in the number of users. To reduce the time taken and to improve the precision and accuracy, in [19], fuzzy opinion classification of online product reviews were performed using opinion summarizer and classifier. However, opinion mining on increased blog datasets remained unsolved. An opinion analyzer [20] was introduced to get insight into the customers' feedback to improve the decision making process.

II. HYBRID FEATURE CLASSIFICATION ON OPINION MINING USING ANT COLONY OPTIMIZATION

This section describes the architecture of the proposed process called Ant Opinion Miner Classification Rule Learning. The main components of the Ant Opinion Miner Classification Rule Learning are shown in Figure 1. It consists of four components: (i) pheromone initialization, (ii) hybrid feature classification (iii) ant-miner fitness function and (iv) integration of ant-miner procedure with classification rule. Opinion mining is focused in our work to predict accurate result on user query request using the ant-miner classification process. Opinion mining in AOM-CRL notice and extract information about the product feature based on the user behavior patterns. Opinion mining in our research work involves the automatic discovery of patterns based on the user behavior profile. The objective of hybrid feature classification on opinion mining is to obtain the user query result based on the user behavior. The hybrid feature of the product is selected in AOM-CRL using the ant colony optimization procedure. The repeated attributes are reduced (i.e., dimensionality is reduced) using the Enhanced Rapid Repeated Attribute Reduction process.

The overall structural diagram of AOM-CRL process is depicted in Figure 1 the overall structural diagram involved in the design of Ant-Opinion Miner based Classification Rule Learning (AOM-CRL) process is explained. The user query is submitted to analyze the product opinion from various users. The opinion is analyzed based on hybrid features review of the products. For instance, the product car is reviewed with different combination of features. The result is extracted by analyzing the segmented user behavior information. The usage of this information improves the efficiency rate.

The ant-miner is used for the upcoming classification process using the pheromone liquid. The pheromone liquid performs the initialization process for efficient prediction of class products with higher precision rate. Next, the pheromone updation is carried out to improve the hybrid feature based product review of the users. Finally, fitness function is elaborated to produce the quality result with different set of attributes. Ant-miner integrates the work with the repeated attribute reduction algorithm to decrease the processing time involved in the design of AOM-CRL. An elaborate description about the four components is briefed in the forthcoming sections

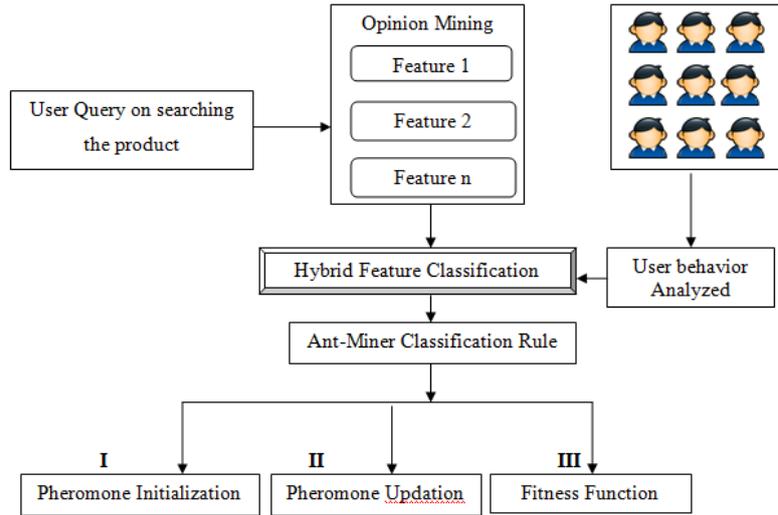


Figure 1. Overall Structural Diagram of AOM-CRL Process

A. Pheromone Initialization for Feature Classification

The feature classification on opinion mining based on Ant-Colony optimization handles all ‘ n ’ features of the products. The artificial ants with pheromone navigate through the digraph paths in AOM-CRL process with ‘ $2n$ ’ arcs to identify the product reviews. Before the initialization of the pheromone liquid (i.e., search path of the product review based on the features) it finds the source path for the query result searching process. The ‘ $2n$ ’ arcs based pheromone initialization is given below as,

$$PI(t) = \frac{[pr^j(t)^\alpha][h_i^\beta]}{[pr^1(t)^\alpha][h_i^\beta] + [pr^2(t)^\alpha][h_i^\beta]} \quad (1)$$

The AOM-CRL process includes pr^j pheromone trail on ‘ j ’ arcs in with ‘ t ’ representing the trail on placing the pheromone using the ant-miner. The heuristic feature information to be extracted is ‘ h ’ for the product reviewed by the users ‘ i ’ using an input set of product feature list ‘ α ’ to identify the product review from the different users with the user behavioral profile information ‘ β ’ that denote the user behavioral profile information

The search path is preceded with the pheromone trail in AOM-CRL process. The pheromone initialization is used to work with product features and identify the review of the product based on the segmented user behavior pattern. The heuristic information desirably extracts the information from the chosen pheromone trail arcs.

B. Hybrid Feature Classification based on User Behavior

Upon successful completion of the pheromone initialization for feature classification, hybrid features are classified in AOM-CRL process using pheromone update strategy for different combination of the product feature classification. Though, different combination of features are used, our proposed method uses the standard pheromone paths to fetch the resultant query with the shortest path (i.e., with the minimal processing time). The ants (i.e., user queries) follow the shortest paths in AOM-CRL process with large amount of the pheromone trails. The pheromone updation is the second proceeding step in the AOM-CRL process, where hybrid product features opinion is also fetched effectively. For fetching this result, the pheromone updation rule is followed.

1) Pheromone Updation

The pheromone updation on each ‘ $2n$ ’ arc updates the trails (i.e., opinions) and extracts the heuristic information. The ant chooses the arc to be updated with the higher probability rate. The pheromone updation is formularized as,

$$pr_i^j(t+1) = \rho pr_i^j(t) + f \Delta pr_i^j(t+1) + C_i^j(t) \quad (2)$$

The pheromone trail ‘ t ’ is updated for ‘ i ’ user query request on arc ‘ j ’. The probability with present features ‘ f ’ is added with the ‘ Δ ’ new combination of features where $C_i^j(t)$ is the constant trails of pheromone deposited on the path for effective product feature classification. The updated pheromone rule in opinion mining produces the best solution to the request user query related to the products. The best solution on the hybrid feature classification in opinion mining is shown as,

$$\Delta pr_i^j(t) = \frac{1}{|BS_i^j|} \sum (pf_1, pf_2, pf_3 \dots pf_n) \quad (3)$$

The pheromone updation for ‘*i*’ users with ‘*j*’ arcs identifies the best opinion from the ‘*i*’ users with different combination of the product features $pf_1, pf_2, pf_3 \dots pf_n$ whereas Δpr_i^j denote the hybrid combination of product features that are classified to improve the efficiency rate of different user ‘*i*’ opinions.

2) *Ant-Miner Fitness Function*

Once the hybrid features are classified based on the user behavior with the aid of pheromone updation, the ant-miner fitness function is applied with the objective of efficiently classifying the product features based on the user behavior. Based on the ant-miner the AOM-CRL process maintains the quality of the solution of the products being classified using the fitness function. The test accuracy measure the classification accuracy rate on product reviewing based on the features of user behavior patterns. The ant-miner fitness function is demonstrated as,

$$Fitness\ Function\ f\ (BS) = \frac{pf_{correctly}}{1+\lambda pf_{input}} \quad (4)$$

In order to produce the quality result on the product feature ‘*pf*’, the fitness function is employed in AOM-CRL process to produce quality result on the product feature ‘*pf*’ classification process. In addition, a set of hybrid feature classification is also carried out with ‘*pf*’ input with ‘ λ ’ being the constant adjusted to obtain accurate classification result. The AOM-CRL process obtains higher accuracy with greater quality function value in the AOM-CRL process.

3) *Integration of Ant-miner Procedure with Classification Rule*

Finally, the integration of the ant-miner procedure with classification rule uses the Enhanced Rapid Repeated Attribute Reduction algorithm improves the classification accuracy on hybrid features. The algorithm is to reduce the repeated attribute features and generate the classification rule. The reduction of the repeated product attribute set reduces the storage space and time complexity.

4) *Algorithmic Step of Enhanced Rapid Repeated Attribute Reduction*

Input: Training Input Set $\{S_i = S_1, S_2, \dots, S_n\}$, Product Features $\{pf_j = pf_1, pf_2, \dots, pf_m\}$, Digraphs $\{arcs_m = arcs_1, arcs_2\}$, Pheromone Trials $\{t_n = t_1, t_2, \dots, t_z\}$, BS, i, j, m, n, z

- for each S_i
- for each $arcs_m$
 - Start ant with empty rule
 - Obtain product feature classification based on user behavior pattern
 - Update pheromone by increasing pheromone trails with hybrid features
 - Trail ‘ t_n ’ is updated by ‘1’ with the present product feature set to the updated rule
 - Choose the best solution ‘*BS*’ set with hybrid product feature classification
 - If $(pf_j(arcs_1) == pf_j)$ (on $arcs_2$) then
 - Remove product feature ‘ pf_j ’
 - else
 - Perform ‘ pf_j ’ classification for product reviews
 - end if
- end for
- end for

Output: product feature classified based on the user opinions

The Enhanced Rapid Repeated Attribute Reduction algorithm as explained above remove the repeated product attributes from the set. The process is initiated with the empty set and then the artificial ant places the pheromone and identifies the path for product reviewing. The user behavioral pattern is also administered during the classification of the hybrid product features. According to this algorithm, the digraph arc is checked to identify whether the feature attribute classified are repeated or not. If the feature attribute being classified is repeated, those attributes are removed and the best solution related to the product during the design of opinion mining is obtained.

III. EXPERIMENTAL EVALUATION

This section presents the results of empirical evaluation of Ant-Opinion Miner based Classification Rule Learning (AOM-CRL) process to classify the hybrid features based on the user behavior. In order to evaluate our process, the AOM-CRL performs the experiment in the JAVA platform using the Weka Tool. The input to the system is OpinRank Review Dataset [3] from the UCI repository to conduct the experiments. The Ant-Opinion Miner based Classification Rule Learning extracts similar and dissimilar products of different features from reviews and the features are classified using (1) and (2) discussed in Section 3. Repeated attribute which are of low-quality are discarded and the remaining non-repeated attributes that possess high quality reviews are used to classify the product features based on the user behavior using opinion intensity. The output of the Ant-Opinion Miner based Classification Rule Learning is prominent feature of a given user query along with product feature classified based on the user opinions.

Review from OpinRank dataset that contains the user reviews of the car and hotels used for experiments in this work. We have conducted experiments on car that includes 140 – 25 reviews for the evaluation of efficient classification rule mining with varying features and the data extracted fields include the dates, author names, favorites and the full textual review. In addition, full reviews of hotel including 42,230 reviews are by different set of users are analyzed and expected to be 259,000.

Ant-Opinion Miner based Classification Rule Learning (AOM-CRL) process compares the result with some of the existing methods such as Rule-based multivariate text feature selection method called Feature Relation Network (FRN) [1] and Identifying Features in Opinion Mining via Intrinsic and Extrinsic Domain Relevance (IEDR) [2]. Experiment is conducted on the features such as classification rate on user opinions, false positive rate, precision rate on product result and processing time.

IV. RESULTS AND DISCUSSION

This section presents review quality classification of OpinRank dataset that include car and hotel reviews, based on the methods described in Section 3. The Ant-Opinion Miner based Classification Rule Learning is augmented with the two other methods and their classification rate on user opinions, false positive rate and processing time are compared when applied to the task of classifying the product features as well as fine-grained high quality results using hybrid feature product reviews.

TABLE I. COMPARISON OF THREE APPROACHES

Features selected	Classification rate on user opinions (%)			False positive rate (%)			Processing time (ms)		
	AOM-CRL	FRN	IEDR	AOM-CRL	FRN	IEDR	AOM-CRL	FRN	IEDR
5	53.31	42.29	35.26	0.009	0.010	0.012	11	15	21
10	58.43	47.41	42.38	0.009	0.012	0.014	18	22	28
15	61.45	50.43	45.40	0.011	0.013	0.017	24	29	35
20	65.83	54.81	49.78	0.017	0.022	0.026	23	27	33
25	62.33	51.31	46.28	0.013	0.018	0.019	19	24	30
30	67.89	56.87	51.83	0.019	0.021	0.029	22	27	31
35	71.23	60.21	55.18	0.023	0.033	0.041	30	34	40

The results of comparison of the three approaches are tabulated in Table I. It can be observed that from Table I all three methods provide acceptable classification rate on user opinions and false positive rate and processing time. However, our proposed method performs Ant-Opinion Miner based Classification with higher classification rate and lower false positive rate with minimum processing time than the other two methods.

A. Impact of Classification rate on user opinions

Figure 2 shows the review quality classification of car data set extracted from UCI repository. The dataset includes file consists of mix quality reviews of cars for model years 2007 to 2009. Short reviews with hybrid features and opinions result in great review quality. After classifying the reviews based on ant-miner based classification procedure according to the user behavior, users can drop out the low-quality reviews and redundant features. Figure 3 clearly shows that the classification rate on user opinions using car dataset is improved when compared to the two other methods.

Figure 2 compares the three methods on the basis of the features extracted based on hybrid feature classification. In Figure three methods are used, where method 1 indicates the classification rate on user opinions using the ant-miner based classification procedure used by our method as explained in detail in the Section 3, while method 2 indicates the Feature Relation Network. Method 3 indicates the Opinion Mining via Intrinsic and Extrinsic Domain Relevance. In addition, by applying ant-miner based classification on digraph arcs, with the hybrid combination of features results in accurate product reviewer improving the classification rate on user opinions by 15 – 20 % compared to FRN [1]. The AOM-CRL process based on ant-miner helps to maintain the quality of products being classified using the fitness function which increases the classification rate on user opinions by 22 – 33 % compared to IEDR [2].

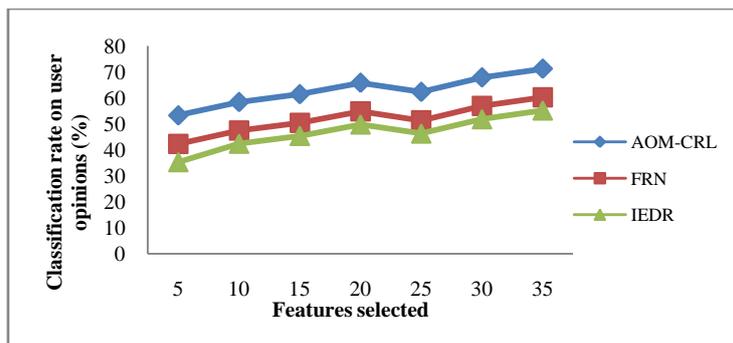


Figure 2. Classification rate on user opinions using car dataset

B. Impact of False positive rate on user opinions

Figure 3 depicts the false positive rate on user opinions using hotel dataset, based on some of the most frequently commented features considering 60 hotels in the city. In this example, feature wise comparative product summary was generated by considering 200 reviews. We evaluated the efficiency of our Ant-Opinion Miner based Classification to obtain the false positive rate when used for binary as well as fine-grained classification for product reviews. To evaluate the effectiveness of our process for incorporating features selected, we compared it with two other methods: (1) Feature Relation Network (FRN) [1] and (2) Opinion Mining via Intrinsic and Extrinsic Domain Relevance (IEDR) [2].

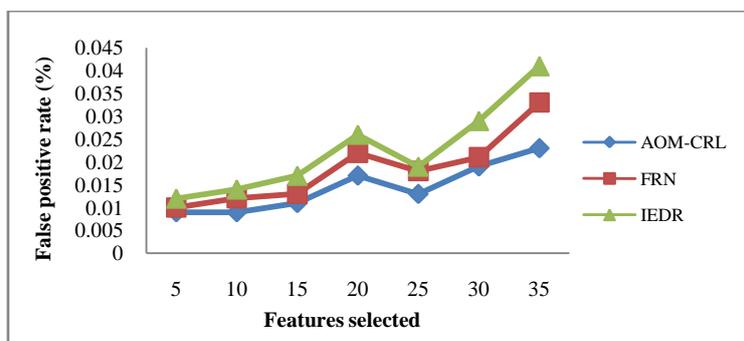


Figure 3. False positive rates on user opinions using hotel dataset

From Figure 3, we observe that the false positive rate is minimized due to ‘2n’ arcs based pheromone initialization to identify the product reviews. The ‘2n’ arcs based pheromone initialization work with product features efficiently identifies the review of the product based on the segmented user behavior pattern. Therefore, the heuristic information extracts the information from the selected pheromone trail arcs improving the false positive rate by 10 – 43 % compared to FRN and 33 – 78 % compared to IEDR respectively.

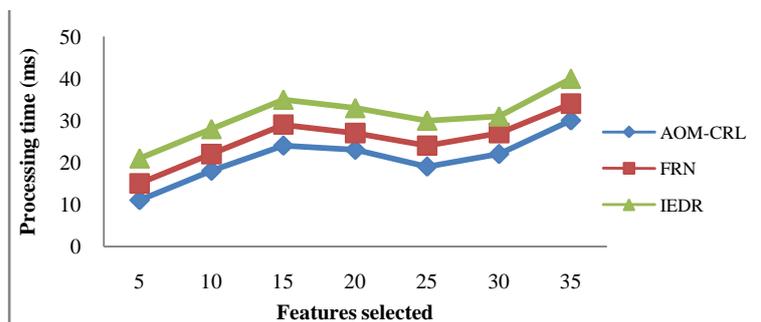


Figure 4. Processing time to classify product features using car dataset

C. Impact of processing time

The targeting results of processing time to classify product features using AOM-CRL compared with two state-of-the-art methods [1], [2] in figure 6 is presented for visual comparison based on the number of features selected. Our method differs from the FRN [1] and IEDR [2] in that we have incorporated hybrid feature classification that classifies the features based on the product review based on the user behavior pattern by applying Enhanced Rapid Repeated Attribute Reduction process. With the objective of minimizing the processing time in AOM-CRL, the hybrid features are identified based on the pheromone updation and the Enhanced Rapid

Repeated Attribute Reduction algorithm removes the repeated attribute features that are repeated by performing a checking condition using digraphs. The digraphs on arcs 1 and arcs 2 are checked with hybrid product feature being classified. As a result, the best solution related to the product is obtained and minimizes the processing time for classifying the product features by 13 – 36 % compared to FRN and 33 – 90 % compared to IEDR respectively.

V. CONCLUSION

An Ant-Opinion Miner based Classification Rule Learning (AOM-CRL) process to classify the product features based on the user behavior is introduced. We then showed how this process can be extended to incorporate Ant Opinion Miner using initialization, updation and fitness function to improve the classification rate on user opinions by determining the hybrid features being classified. Next, by applying hybrid feature classification the process AOM-CRL performs pheromone updation on each '2n' arc and updates the trails or opinions with higher probability rate resulting in the improvement of precision rate on product results. Enhanced Rapid Repeated Attribute Reduction algorithm using the '2n' arcs based pheromone initialization increases the precision rate. Finally, with the integration of ant-miner procedure with classification rule, helps in reducing the processing time drastically compared to the state-of-the-art methods. In our experimental results the ant-miner based classification with Enhanced Rapid Repeated Attribute Reduction algorithm showed better performance than the state-of-the-art-method over the parameters, classification rate on user opinions, false positive rate and processing time.

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