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Short Research Article

An Opinion Predictor for Products using recurrent Neural Networks

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ABSTRACT

Aims: With the rapid growth of Internet, web public sentiment can reflect the majority's attitude to some opinions, which pertain to a specific topic(dimension) of the subject domain. Netizens can express personal experiences and opinions on almost anything, at review sites, discussion groups, blogs, forums and etc. Opinions are important because whenever a person needs to take a decision, he likes to hear others' opinions. Quotes of the attitude may be generally positive or negative. We propose a system for classifying text sentiment based on Neural Networks classifier. In this paper, we focus on classifying product reviews according to opinion and value judgment they contain, into two polarities, positive and negative using the multilayer neural network.

We also address opinion prediction application for future products being launched. The product features given as input to recursive neural network are used to predict the opinions that are going to come from customers. The prediction is done using back propagation with time(BPTT) algorithm implemented on recurrent neural network**Study design:** Mention the design of the study here.

Place and Duration of Study: Department of Computer Science and Engineering,Shirdi Sai Engineering College,Anekal, Bangalore between July 2014 and December 2014.

Methodology: We experimented on 500 opinions, among them 400 were used as training set, and 100 were taken to be testing set , for each type of mobile(Nokia Lumia 720, LG G3)

Results: For each mobile type we achieved upto 85% of correct classification of opinion reviews

Conclusion: We presented a system for determining text sentiment of product reviews by classifying them using Neural Network. The method uses feed-forward Neural Network with ten hidden layers. From the presented results, it can be seen that, a new approach is developed categorizing product reviews in 2 classes in the context of opinion mining. Experiments conducted on training sets show that with our approach we are able to extract relevant feedback from a specific domain of products. We compared our proposed opinion classification algorithm to standard algorithm BPNSO which showed the results are good between 60% to 80%..

Keywords: Opinion mining , Neural networks, Generalized Delta Rule, Opinion prediction,Recursive neural network, Back propagation with time

1. INTRODUCTION

Before the internet was commercialized and popularized, the medium relied upon word of mouth of individuals, with respect to suggestions about movies, electronics, books, products, etc. But, now-a-days it is simple to access reviews and opinions of a large number of people online, who express their opinions from every corner of the world. These opinions

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can be considered as fresh and recent, because these people have first-hand knowledge or experience regarding the particular product and they wish to share their reviews with others. Today, more and more strangers are posting their opinions by sharing their reviews available to strangers via the Internet through forums like twitter, Facebook, Wordpress.com, Blogspot.com, etc.

Data warehouses are used to store the textual data and data-mining techniques can be used to analyze them. Classification of documents according to the opinion expressed by the reviewer in a blog such as, positive or negative mood of a review, the favourable or unfavourable aspect by an expert, results into polarity of a document (positive, neutral, negative) and/or the intensity of each opinion (low, neutral, high), etc. Mining of unstructured data such as feedback surveys, e-mail complaints, bulletin boards, opinions, and product reviews that are available at websites is a challenging issue. In particular, online product reviews are often unstructured, subjective, and hard to digest within short timeframe. Product reviews exist in various forms across different websites [1]. This work concentrates on two tasks, one is opinion mining and second is opinion prediction.

Classification of a large number of user product reviews using neural network techniques into bipolar orientation (i.e. either positive or negative opinion) could help consumers in making their purchasing decisions. Research results along this classification can lead to users' reducing the time on reading threads of text and focusing more on analyzing summarized information. Review mining can be potentially applied in constructing information presentation. For example, review classification could be integrated with search engines to provide statistics such as "350 hits found on Nokia Lumia 720 model review, 80% of which are positive and 20% are negative" . Such kind of summarization of product reviews would be even more valuable to customers if the summaries were available in various forms on the web, such as review bulletin boards. Mobile reviews are available in many websites. We gathered our reviews on 2 models Nokia Lumia 720 and LG G3 from the 10 most popular review sites like gsmarena.com.

Opinion Prediction helps the product manufacturers to manufacture the perfect products which may not give any negative feedback in future. If the product is expected to receive negative feedback or reviews the manufacturer need not go for such type of product development. We have used recurrent neural networks to predict future reviews because it stores relavant data about past sales and generalize trends. The results of the experiment have shown that recurrent NNs are good in predicting the opinions.

The main contributions of the paper are

1. Opinion classification by multilayer perceptron NN using generalized delta rule algorithm.
2. Opinion prediction by recurrent NN using back propagation with time algorithm.

The rest of paper is organised as follows. Section 2 details all the related work. Section 3 details the opinion classification. Section 4 shows all the screen shots. Section 5 details opinion prediction domain and algorithm. Section 6 discusses the results.

2. RELATED WORK

Jebaseeli at [illegible]], built an opinion mining system for M-Learning reviews, to extract ,determine whether the opinions and reviews, are positive or negative. Classification of opinion documents as blogs or news is addressed by the text mining community very well [21, 23, 6, 2]. Several methods exist for determining the polarity of a document. Actually, the opinion polarities are often given stated by adjectives [23, 6]. The use of adverbs attached to adjectives (for instance, the adverb "very" attached to the adjective "promising") allows to

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determine the intensity of phrases (a group of words) [2]. For example, P. Turney, et al,[21] proposes an approach based on the polarity of words in the document. The main idea is to compute correlations between both adjectives in the documents and adjectives coming from a seed set. Two seed sets are considered: positive (e.g. good, fortunate, nice, ..) and negative (e.g. bad, inferior, poor, ..).

The computed output [4] is compared to the known output. If the computed output is correct, then nothing more is necessary. If the computed output is incorrect, then the weights are adjusted so as to make the computed output closer to the known output. This process is continued for a large number of cases, or time-series, until the net gives the correct output for a given input. The entire collection of cases learned is called a "training sample" (Connor, Martin, and Atlas, 1994). In most real world problems, the neural network is never 100% correct. Neural networks are programmed to learn up to a given threshold of error. After the neural network learns up to the error threshold, the weight adaptation mechanism is turned off and the net is tested on known cases it has not seen before. The application of the neural network to unseen cases gives the true error rate (Baets, 1994). Hui Gao et al,used clustering analysis for opinions extraction using the multilayer neural network.

Long-Sheng Chen, at el, proposed a Neural Network (NN) based index to detect negative blogger comments through machine learning techniques and information retrieval [24]. They had proposed a NN based approach for blogosphere classification by the combination of 2 customary techniques BPN(back propagation) and several SO(semantic orientation) indexes which was very effective in terms of classification accuracy and training time. We suppose to call this technique as BPNSO. Our research contribution, Opinion classification by multilayer perceptron NN using generalized delta rule algorithm, outperformed the same BPNSO in terms of accuracy and error rate for significant amount of training sets.

3. OPINION CLASSIFICATION

3.A. PREPROCESSING

Preprocessing is done same as stated in our previous paper[3].Data preprocessing is done to eliminate the incomplete, noisy and inconsistent data.

1. Filteration:- Data is filtered by removing the urls, usernames, redundant characters in a particular word, questions, special characters.

2. Tokenization:- we segmented text by splitting it by spaces and punctuation marks ,and form a bag of words.

3. Stopword Removal:- Stopset words were removed from the data.

4. Stemming:- We used Porter stemming to stem the terms.

5. Part-Of-Speech Tagging:- POS tag for each word in the blog post. The online Part-Of-Speech tagger was used for POS tagging through http://nlpdotnet.com/Services/Tagger.aspx. Generally, adjectives in the text represent emotions such as good, superior etc for positive nature and poor, unfortunate for negative nature.

6. Detecting False Positives and False Negative Adjectives:- The comment is passed through the negation detection stage.

7. Discard rare words by giving a lower limit to the frequency of accepted words equal 3.

8. Group all product reviews into D batches, where each batch size is m.(m is a constant)

3.B. PREPARING INPUT TO THE NEURAL NETWORK

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To prepare the input to the neural network , the process uses the following steps.

1.Generally, adjectives in the text represent the opinion of the reviewer. So, in this paper we treat only the adjectives of the review post to determine the reviewer's opinion. As stated in [7],we used TF*PDF algorithm for counting the significance or weights of the terms in the reviews. This helps us now to recognize the most significant adjectives, which explain the nature of review in blog posts. For each batch of reviews calculate the weight of the terms separately using the formula, where the total weight of a term (Wj) is equal to the summation of the weight of the term in each batch of product reviews respectively using the Eq.1. and and where |Fjb| is calculated using the Eq.2.

$$W_j = \sum_{b=1}^{b=D} |F_{jb}| exp\left(\frac{n_{jb}}{N_b}\right) \qquad \ldots\ldots(1)$$

$$|F_{jb}| = \frac{F_{jb}}{\sqrt{\sum_{k=1}^{k=K} F_{kb}^2}} \qquad \ldots\ldots(2)$$

where, Wj=Weight of term j; Fjb=Frequency of term j in batch b; njb=Number of reviews in batch b where term j occurs; Nb=Total number of reviews in batch b; k=Total number of terms in a batch; D=number of batches.

2. Consider the batch of reviews ,one by one. Each batch is a set of reviews, where each word in the review is tagged by a part of speech. Omit all other parts of speech words, except the ones with adjectives. List all adjectives in the particular batch of review with their corresponding weights calculated in step 1. Sort the table descending according to their weights. We expected the topmost weighted adjectives in the list may better represent the opinion of all the reviews in the particular batch. Now consider the 25 adjectives in the topmost order with the topmost weight. If it is a negative adjective make its weight negative.

3. In the pre-processing step, we mentioned that the number of batches are D. Represent each batch of review as a vector of 25 dimensions, where the values of all the dimensions are the weights of the top weighted 25 adjective terms calculated in the step 2(in case of the negative adjective terms, dimension value is also negated). So, this process gives us D number of vectors each of 25 dimensions, where the value of each dimension is an integer.

4. This D vectors are given as an input to the neural network finally as the training data. Each input vector pattern is of form (i_1,i_2,i_3,..i_{25}).

3.C. DESIGNING A NETWORK FOR AN OPINION CLASSIFICATION SYSTEM

In the *Opinion Mining* system we are going to use *Generalized Delta Rule* (GDR) algorithm for training a multilayer perceptron neural network with feedforward interlayer connections. The Weight vectors v and w are randomly assigned. The threshold for i/p layer is 0 and for hidden and output layers it is taken as 1. We used sigmoid activation function. Learning rate (η) and Momentum Coefficient are taken as 0.9 and 0.7 respectively. NN design is shown in Fig. 1

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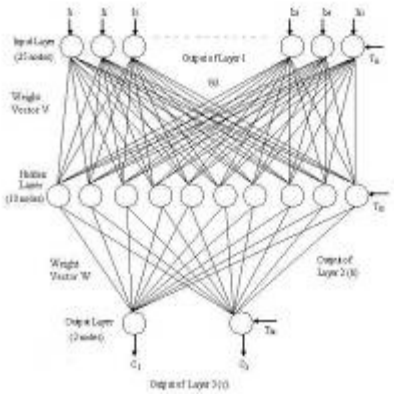

Figure 1: Design of the Neural Network

4. SCREEN SHOTS

A. Training Weights are shown in Fig.2.

Figure 2: Trained Weights.

. B.Weight Vector V is shown in Fig.3.

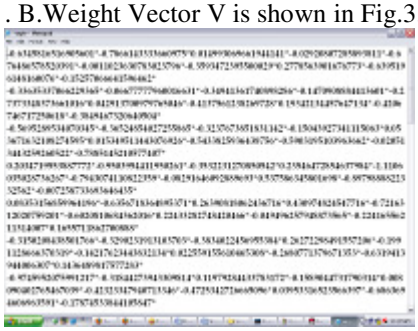

Figure 3: Weight Vector V.

C. Weight Vector W is shown in Fig.4.

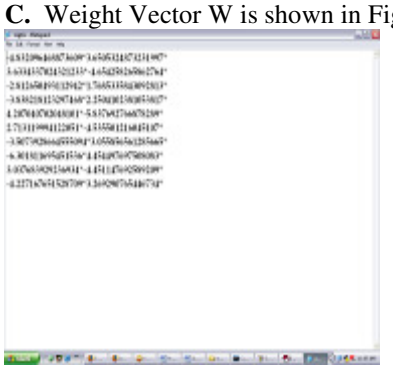

Figure 4: Weight Vector W.

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D. Testing for a negative result of a new batch of reviews is shown in Fig.5.

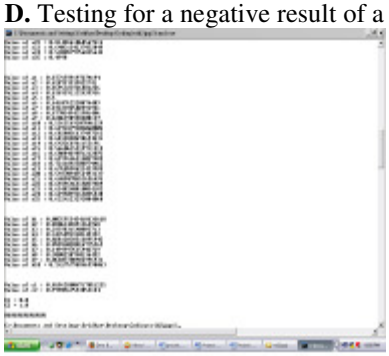

Figure 5: Testing for a negative result of a new batch of reviews.

E. Testing for a positive result of a new pattern is shown in Fig.6.

Figure 6: Testing for positive result of a new batch of reviews.

5. OPINION PREDICTION PROBLEM DOMAIN

Generally the new products are launched basing on the feedback of old products. If one of the feature of product is absolutely bad , then it is obvious it gets bad opinions/reviews from customers. Before manufacturing any product, depending on the current trend, the customers feelings are assumed by the company men. But, this may not be successful always. There may be certain deviations of the manufactured product from the current trend. So, it is very useful to the manufacturer if a opinion predictor is built.
Let us suppose it takes 1 year to manufacture a product which includes design, development, test, release etc. So, the requirement is to predict the opinion one year in advance. So, the network considers one year as one time unit. At each time instance t, the features for the product t were given to the network and the opinion for day t + 1 were obtained as the output of the network.

5.A. PREPROCESSING

1.List out all product features.
2.Pre-processing and Preparing input to Recurrent Neural Network
Do same as described in section 3.A and section 3.B.

5.B. DESIGNING A NETWORK FOR AN OPINION PREDICTION SYSTEM

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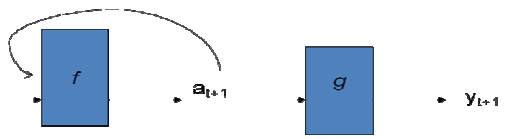
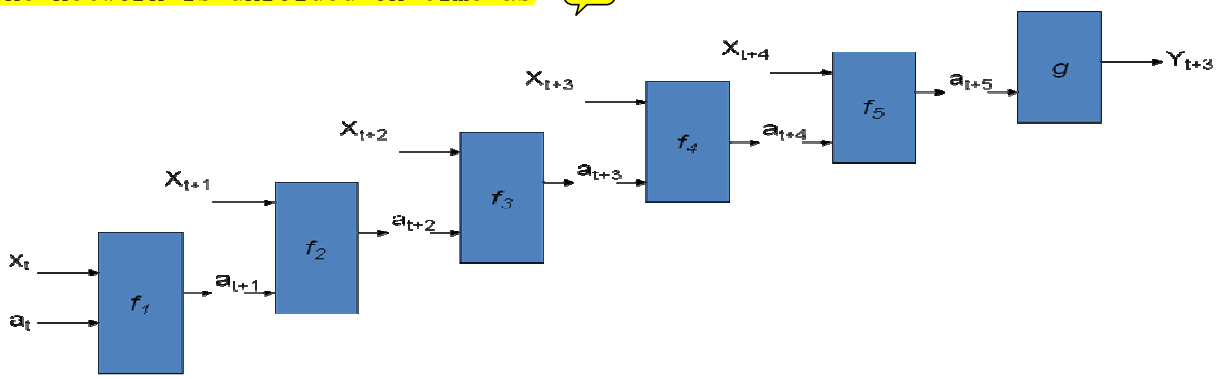


The network is unfolded on time as



One initial vector is required called a[illegible]e vector values are randomly assigned.

The training data for Back-propagation through time algorithm should be always in pairs, (x0,y0), (x1,y1), (x2,y2), .. (xn-1,yn-1). Where xi, yi are inputs and outputs respectively. The figure shows the unfolded RNN.

Each training pattern consists of 7-tuple (at, xt, xt+1, xt+2, xt+3, xt+4 , yt+4,) . Then training is similar to training done with back-propagation algoritm, but only difference is each epoch runs for yt times.

From section.5 in the preprocessing step we obtained each input vector pattern of the form (i1,i2,i3,..i25). Now at xt consider i1 to i5 , at xt+1 consider i6 to i10, at xt+2 consider i11 to i15, at xt+3 consider i16 to i20, at xt+4 consider i21 to i25.

The output is whether the feedback is positive or negative.

The network parameters are

a) the number of nodes in the recurrent neural network If the number is very less, it could not properly generalize the problem, if the number is more than enough,it could overfit the problem.

(b) The learning rate of the neural network – Initially ,we couldn't determine the learning rate, we tried with various learning rates and finally decided at the learning rate of 0.001 for positive opinions and 0.01 for negative opinions.

(c) The momentum rate 0.7 is used to remove high frequency variations in the error surface.

6. RESULTS

Accuracy = no:of opinions correctly classified / no:of input opinions

	Training		Testing	
	Positive opinions	Negative opinions	Positive opinions	Negative opinions

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LG G3	250	150	50	50
Nokia Lumia 720	200	200	50	50

$$Accuracy = \frac{No.\ of\ Opinions\ currently\ classified}{No.\ of\ input\ opinions}$$

	BPNSO's NN		Proposed NN	
Performance / Training Set	Accuracy (Y)	Error rate (Y)	Accuracy (Y)	Error rate (Y)
50%	69	31	65	35
60%	70	30	74.4	25.6
70%	71	29	72.5	27.5
80%	70	30	63	27
90%	71	29	58	42

Table 1 Performance Table

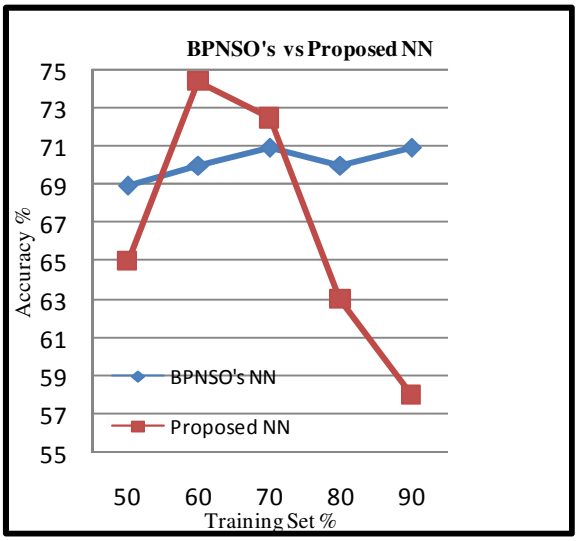

Fig. 9 Accuracy

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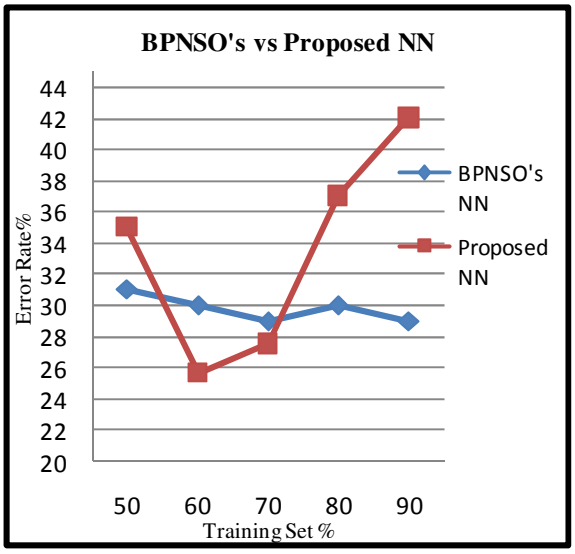

Fig. 10 Error Rate

CONCLUSION

We proposed an algorithm for opinion prediction to predict if the product is going to give positive feedback or negative. This is helpful for the product designer/manufacturers such that they will develop only products of good feedback. Results showed there was 65% accuracy in prediction.

Future works may be manifold. First, our method depends on good quality of reviews extracted from blogs. We want to extend our training corpora method by applying text mining approaches on collected reviews in order to minimize lower noisy texts. Second, in this work we focused on adjectives, we plan to extend the extraction task to other categories. Third would be extending these results by using Deep Multilayer Neural Networks with more than two hidden layers for determining text sentiment.sent during submission, we may request to see a copy at any stages of pre and post publication.

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