

Recommendation System with Sentiment Analysis as Feedback Component

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Abstract. In today's world Artificial intelligence (AI) is known for deploying human like intelligence in to computers, so that they behave like humans. One of specialization areas of AI is expert systems. This area focuses on programming machines to take real life decisions. System with its intelligence helps users by suggesting them with variety of choices and making it easier for people to take best decisions while purchasing items. This work is intended to develop and deploy a Hotel Recommendation System. The work makes use of Collaborative user and item filtering techniques in combination with sentiment classification for generating recommendations. To improve the recommendations results, sentiment classification results are used as the feedback. There is also performance comparison between two different classifiers "Naïve Bayesian" (NB) and "K-Nearest Neighbor" (K-NN) with respect to their ability to recommend. This hybrid technique helps us in the case where an item has no ratings but has only textual reviews. Since this technique draws conclusion based on reviews along with the ratings, recommendation results are more accurate compared to recommendation systems based solely on filtering techniques.

Keywords: User and item based collaborative filtering · Sentiment analysis · Naïve Bayesian · K Nearest Neighbor classifier

1 Introduction

With introduction of World Wide Web lots of information is being contributed and shared through the internet. As the growth of information is exponentially increasing machines are used to handle this information. Right from the time when the computers or machines were invented, their ability to do the different types tasks has been growing at an exponential rate. It has been noticed that there is a growing trend of people purchasing products on the internet via e-commerce websites. This kind of trend has created the pre requisite for developing the systems that can help people by assisting them while they are purchasing goods online. This has led to the need for Intelligent Recommendation Systems. Artificial intelligence is responsible for creating the computers or machines as intelligent as human beings. Natural Language Processing is a methodology provided by Artificial intelligence using which we can communicate or interact with intelligent systems in the any of the

languages spoken by the humans like English. In this work we are using a hybrid approach for developing a recommendation system.

2 Background and Related Work

This section gives a thorough understanding about the variety of techniques involved in designing and deploying the recommendation frameworks as well as techniques involved in sentiment analysis.

Bucurab [1] has performed extensive work regarding sentiment analysis. The work intends to recognize and study the sentiments contained in the surveys which are put forth by the tourists on the websites. This work discusses performance of unsupervised sentiment analysis on hotel reviews. Accuracy of the technique shows to be around 74% which is good for unsupervised method.

Ghorpade, et al. [2] research focuses “Natural Language Processing” (NLP) and Bayesian classification, the study is on improving the extraction of sentiments from reviews or opinions that is, to minimise loss of information while extracting sentiments. The study here has developed some ontology modules to easily refine the attributes depending on the user requirements using “Jolly and Pleasant Exercise” (JAPE) mathematical techniques. Study reveals that improved word dictionary for a certain domain ontology produces well trained training sets which in turn helps in easy classification of reviews into positive and negative that is done using machine algorithm.

Suresh et al. [3] from their research work has stated that many text mining techniques like sentiment analysis and question answering system, the query matching score is affected by the presence of noise. To overcome this problem study in this area generates the bag of words using “context”, this may result in generating less in number but the highly probable members which helps in easy look up and process of spelling correction of query and is made efficient.

Kumar et al. [4] proposed a system which is improved version of movie recommendation by combining collaborative filtering and sentiment analysis. The study explains in detail about the types of recommendations, how to train the classifier and how the sentiment analysis can be done using Naïve Bayesian algorithm in movie review context. The results of the study say that using combined filtering and sentiment analysis leads to better accuracy.

As per the study by Cane Wing-ki Leung et al. [5], an attempt is made transform user’s opinions which are expressed in natural language in textual form in to ratings that is understood by collaborative filtering. Here all the reviews are first pre processed. Then reviews are classified as positive and negative. Next the polarity or orientation of reviews are transformed in to ratings scale. Thus experiment provides a new approach for mapping sentiment results to filtering results.

As per study of Bagchi [6] performance and quality aspects of recommendation using different types of similarity measures are analyzed using Apache Mahout. The work is based on recommendations collaborative filtering. And to calculate similarity different techniques like Euclidean distance, cosine similarity, Pearson correlation, Tanimoto and Log Likelihood similarity measures are used and the performance of recommendation

system with each of these is measured. The work confirms that performance of system is best with use of Euclidean distance similarity measure.

As per work done by Subramaniaswamy V et al. [7] purposes a system that assists user to look out for tourist locations that they might likes to visit a place from available user contributed photos of that place available on photo sharing websites. This work suggests an algorithm ADA-Boost to classify data and Bayesian Learning model for predicting desired location to a user based on his/her preferences. The Work includes collecting geo tagged photos from social media and identify destinations. Next group tourists based on age, gender and travel season. Trips generation or route planning is done using attributes of people and by building recommendation model is built

3 Recommendation System – An Overview

Basically, a recommendation system does the analysis of the set of items, towards which users may be attracted and finally suggest the most suitable items to users. Hence recommendation systems help users to take better decisions in situations where they are supposed to choose from huge variety of options.

Recommending hotels to a tourist given a particular tourist location is the one of best applications of the recommendation systems. Recommendation systems can be used in different domains apart from tourism like recommending video clips for a particular user in You-tube based on user's past video preferences. This type of recommendation is done by collaborative filtering approaches. To do the recommendation we need to identify user's attributes or features as well as item's attributes or features of. Using these attributes, recommendation systems will analyze which set of users are attracted to which set of items. This type of analysis is done by content based filtering systems and these systems do not rely on users past preferences. In this paper we make use of collaborative filtering techniques.

This includes

- User Based Collaborative Filtering
- Item Based Collaborative Filtering.

Hybrid Recommendation System

We can create a hybrid recommendation system by integrating collaborative filtering systems with Sentiment Analysis. Training and testing these hybrid systems using the concepts of machine learning. Sentiment analysis is process of identifying and analysing opinions expressed by the people in a certain piece of text. Here we use sentiments expressed by tourists in their reviews about a particular hotel in order to recommend that hotel. We then combine these results with collaborative results to refine list of final recommended items.

4 Proposed Work

This work focuses on enhancing the already existing recommendation systems. The goal is to perform sentiment analysis on the hotel reviews using Naive Bayesian and K Nearest Neighbour classification algorithms. The results of classification are used as feedback for recommending the hotels using collaborative filtering technique.

The proposed approach is divided in to three modules. The Fig. 1 below gives understating of System Architecture and Fig. 2 below provides clear knowledge of all steps performed

1. Parser Module

This module does the primary task of reading the reviews file that has been loaded. After parsing the file it does the tokenization of review text which is followed by POS tagging. Purpose of tagging the review text is to choose the opinion word and form a “bag of words” model.

2. Classification Module

This module consists of creating training dataset. Next step here is to build the classifier. Once classifier is built next step is to train classifier. Then finally test the classifier and determine the accuracy of the classifier. This helps us to know how well classifier can assign label of “positive” or “negative” to the review.

3. Recommendation Module

This module computes the user based similarity and item based similarity using the rating provided. Hence finds the similar users and items. And finally predicts or recommendations the items for new users based on computations.

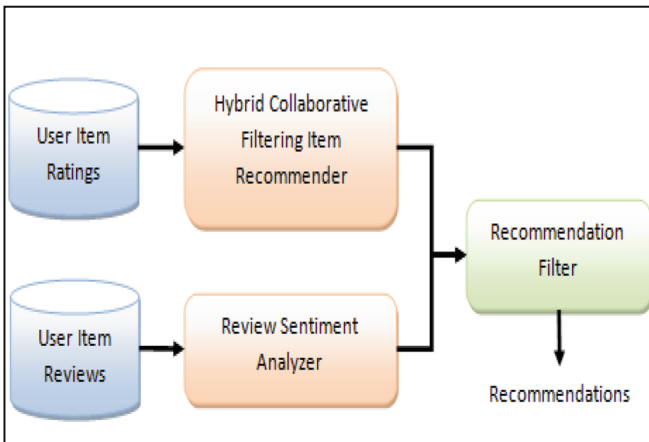


Fig. 1. System Architecture

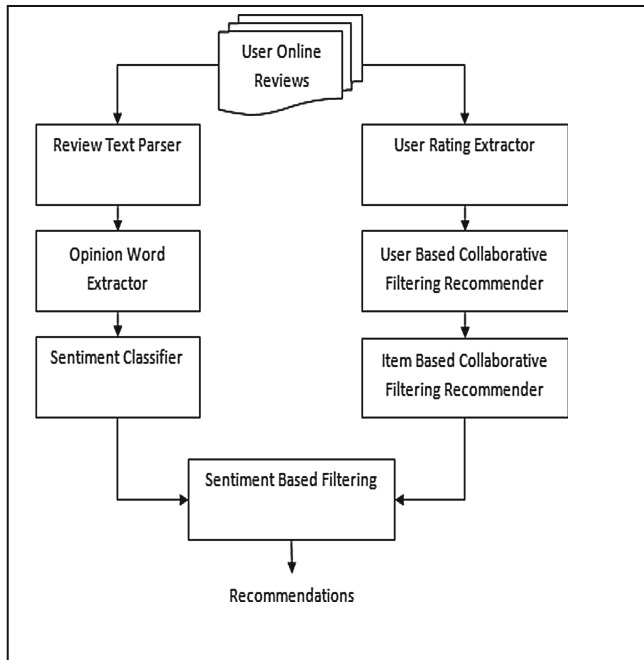


Fig. 2. Detailed Design

Steps Involved

1. Parsing the review dataset file
2. Creating bag of words or opinion word extraction
3. Creating training dataset
4. Build Classifier
5. Train and Test Classifier using textual reviews
6. Generating user based recommendations using ratings
7. Generating item based recommendations using ratings
8. Integrating classification and filtering results for recommendation

5 Results

For analyzing the performance of the hybrid recommender we consider the TripAdvisor dataset. Here first we use the ratings of hotels as input to traditional recommendation system. By performing user and item based filtering we get list of hotels that are recommended. Results are as in the figure below

```
Recommendations for User ID 2

RecommendedItem[item:80879, value:5.0]
RecommendedItem[item:80925, value:5.0]
RecommendedItem[item:81170, value:4.0308137]
RecommendedItem[item:73787, value:4.005326]
RecommendedItem[item:80836, value:4.0]
RecommendedItem[item:73757, value:3.9973497]
RecommendedItem[item:81466, value:3.9959776]
RecommendedItem[item:81251, value:3.7673535]
RecommendedItem[item:81165, value:3.6471615]
RecommendedItem[item:80930, value:3.6271572]
BUILD SUCCESSFUL (total time: 5 minutes 7 seconds)
```

Fig. 3. Traditional Filtering Results

In the above Fig. 3, numbers displayed after “item” are list of hotels recommended for USER 2. The review files of list of these hotels is given as input the Naïve Bayesian classifier and K-NN classifier. Sentiment analysis is performed on textual reviews for each hotel in the list to determine which hotel is recommended and which is not.

Table 1 shown below shows the performance of Naïve Bayesian Classifier.

Table 1. Performance of Naïve Bayesian Classifier

	TP rate	FP rate	Precision	Recall	F-measure	Class
	0.788	0.219	0.814	0.788	0.801	Positive
	0.781	0.212	0.751	0.781	0.766	Negative
Weighted average	0.785	0.216	0.786	0.785	0.785	

Table 2 shown below shows the performance of K-Nearest Neighbor Classifier.

Table 2. Performance of K-Nearest Neighbor Classifier

	TP rate	FP rate	Precision	Recall	F-measure	Class
	0.977	0.483	0.711	0.977	0.823	Positive
	0.517	0.023	0.948	0.517	0.669	Negative
Weighted average	0.77	0.276	0.818	0.770	0.754	

Comparative Study of Classifiers

Looking at the numbers in the table above we can see that the K-NN classifier has good precision value as compared with Naive Bayesian (NB). But when we take look at time taken by both classifiers NB Classifier performs very well compared to K-NN.

Table 3 shown below shows the performance comparison of K-NN and Naïve Bayesian classifier.

Table 3. Performance comparison of K-NN and Naïve Bayesian classifier

Parameters	Naive Bayesian	K-Nearest Neighbor
TP rate	0.723	0.842
FP rate	0.327	0.460
Precision	0.769	0.846
Recall	0.723	0.842
F-measure	0.738	0.819
Time taken	12.84 s	184.072 s

Considering the fact that we have taken dataset having 15 hotels where each hotel file has around 100–150 reviews which turns out to be data of 1500 to 2000 reviews where in a single review may be of sentence or paragraph. Thus if we want better accuracy it is advisable to use K-NN classifier by compromising time taken.

If the concern is related processing speed, then NB classifier is recommended, also NB gives better tradeoffs between time taken and accuracy since its precision is not totally unacceptable when compared to K-NN classifier.

Table 4. Results of sample dataset

Hotel name	Overall rating	No. of positive reviews	No. of negative reviews	Ratio N/P	Recommended
Barcelona Catalonia	4	95	23	0.242	Yes
Affinia50 New York City	3.5	471	157	0.333	Yes
San Juan Hotel	3	27	14	0.51	No
Casa Fuster Hotel	3.5	62	11	0.177	No
Country Inn Suites New Orleans	3.5	129	51	0.39	Yes
Cremorne Point Manor	3.5	28	12	0.42	No
Rydges World Square	3.5	41	33	0.80	No
Simpsons of Potts Point Hotel	5	89	37	0.41	No
Suite Hotel Berlin	4	86	16	0.18	Yes
The Soho Hotel London	5	116	26	0.22	Yes

Accuracy of Recommendation

The details recorded in the above Table 4, and values are obtained by keeping the user specified Negative to Positive (NP) ratio to 30%. This NP ratio is threshold value for determining whether or not to recommend the hotel. In the above data the recommender has recommended the hotels with quite good accuracy. System has incorrectly recommended the hotel highlighted with boldface. This recommendation is obtained by using filtering with trained Naïve Bayesian classifier, and with rating threshold value set to 3.

6 Conclusion

Recommender Frameworks seems to have taken an extremely predominant place in the web world of the people. We have considered a hotel review dataset which contains reviews and different ratings for different aspects of hotel although we take only overall rating. The major objective of the paper is deploying a “Hybrid Recommender Framework” that performs thorough refining of products to be recommended for clients. This proposed model works in combination with “sentiment classification” or “opinion mining” and “collaborative filtering”. The recommendation of products that have not been rated earlier is main issue that is resolved. Sentiment classification results are used as feedback to improvise the results of “user-item” filtering. Ultimately top best ‘n’ results are recommended.

Major difficulty is to find overall sentiments that lie within reviews, that are written in more general form like reviews whose first few lines show positive side and last few lines depict negative side of the product. This kind of reviews make it hard classify them. Also we cannot put them under “neutral” class as they do express sentiments. Be that as it may, this strategy without a doubt exhibits better proposals than utilizing synergistic separating alone and consequently is a superior recommender framework outline. Any recommendation framework that gathers user’s reviews can be adjusted to utilize hybrid proposal approach.

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