Comparative Analysis of A Recommender System Based on Ant Colony Optimization and Artificial Bee Colony Optimization Algorithms

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***Abstract*—Recommender systems are the backbone of electronic commerce sites like amazon.in, netflix and flipkart.com which not only helps in achieving better customer satisfaction but also helps in bringing those products into the notice of the customer which are not easily seen by the customer but it helps in increasing the business of such e-commerce sites. This paper present a movie recommender system that uses collaborative filtering technique of recommender system and apply Ant Colony Optimization and Artificial Bee Colony Optimization and also compare the two algorithms on the basis of CPU Time and two standard functions.**

Keywords—Ant Colony Optimization; Artificial Bee Colony Optimization; Collaborative Filtering; CPU Time; Standard Functions.

I. INTRODUCTION

A recommender system is a field of artificial intelligence that filters the information and try to predict the right product for the user. The main objective of a recommender system is to guide and assist in selecting the right product, information or some sort of service. All the electronic commerce use recommender system to improve their efficiency as it helps in achieving more satisfaction for the customer and also lay down the customer to purchase some of the products that are invisible for the customer to see at the first glance. There are various techniques of recommender system that can be applied according to the requirement of the application. The collaborative filtering techniques of the recommender system uses rating or preference of the user and suggest the user a product on the basis of what other users have given a rating to it. The content based approach uses the content or semantics of the product to make recommendations [18]. Another approach called hybrid approach uses a combination of both collaborative filtering technique and content based approach.

Recommender system also uses semantic relatedness in purchased products. A good recommender system recommends the products that a customer would like to buy and also the complimentary products. For example, if a customer buys a bed sheet then the system should suggest for bed sheets of other brands and the complimentary products like pillows.

Metaheuristic techniques can be used for optimization of the dataset and then the optimized data is used to prescribe a product to the customer. The two Particle swarm Optimization techniques [11] used in building the movie recommendation system here are Ant Colony Optimization [16] and Artificial Bee Colony Optimizations [12]. Both the algorithms imitate behavior of animal societies that have no leader and they try to find food by random. One among the group reaches the food source and other follow it. There are many food sources or in other words there are many feasible solutions for the given optimization problems. Whichever animal is followed the most is declared to be the best solution for the given problem [20].

The collaborative filtering technique is used when it is very difficult to describe the items to be recommended by its prominent factors. In such conditions ratings to those items will help as one user who has already experienced the product will give a rating and a new user who has no relation with the previous wants a product with the similar interests, now, the new user can be recommended products by taking the help of the ratings.

The section 2 of the paper tells about the literature review. The section 3 discusses about the two algorithms used to design the application. The section 4 describes about the proposed approach and the section 5 discusses the results obtained after the experiment. The section 6 tells about the conclusion obtained after the experiments.

II. LITERATURE REVIEW

Baskar et al. discussed about Comprehensive Learning Particle Swarm Optimizer for Global Optimization of Multimodal Functions that tells about different unimodal and multimodal functions that can used to compare algorithms. Many Particle swarm Optimization have been discussed and they have been compared on the basis of many standard functions that give us an insight about which algorithm is better [3].

Kanika et al. discussed about Comparison of Nature-Inspired Metaheuristc Algorithms that tells about how metaheuristic techniques can be used to find the minimum or

maximum output and how metaheuristic techniques can search over a large search space and find good solutions with very less computational efforts. The paper also mentioned about many metaheuristic techniques and about which technique is suitable for which sort of application [7].

E.R. Omiecinski discussed about Alternative interest measures for mining associations in databases that tells about different data mining techniques that can be used to optimize data and it can then be used to recommend products and items to the user [13].

III. ALGORITHMS USED

A. Ant Colony Algorithm

Ant colony algorithm (ACO) is a heuristic algorithm which is based on ants efforts seeking food in nature. Artificial ants try to search for good solutions to given optimization problems and the optimization problem is transformed into a problem of finding the path in the search space and the ants gradually find solution by moving in the search space. The ACO is based on reinforcement learning and stochastic optimization which is extremely satisfying in dynamic environments. The ants deposit pheromone on the way which helps them to return back to their home. This pheromone also helps the other ants as they can sense this pheromone and by following the same path they can also reach towards the food source. The way on which the maximum pheromone is deposited is considered to be the best path, as most of the ants travel through that path and find the food. Also, pheromone evaporates with time. So, if the food source is far away from the home then there are chances that the pheromone will be evaporated and not many ants will be able to choose that path. This nature of pheromone helps in discovering new paths every time and also it makes the system evolve with the changing environment [5].

The ACO system works by iterating in a main loop where a particular number of ants let's say x build solutions simultaneously and keep on updating their trail levels. ACO working is highly dependent upon its parameters namely: alpha, beta, relative importance of trail and effectiveness, rho, trail persistence, initial trail level m, number of ants, and Q, [1] used for defining to be of high quality solutions with low cost.

Algorithm: Ant Colony Algorithm

1. Initialize the initial parameter
2. For each ant find the possible state they can move into
3. Move the selected ant to the possible state
4. Until the selected ant has completed its solution
5. For each ant, compute the trail matrix
6. End For Loop
7. If the best solution has been found
8. Provide the best solution
9. Else move to step 2
10. End

The figure 1 describes the natural behavior of ants seeking for food in the natural environment. The ants start from their home in random direction and deposit pheromone on their path so that they can follow the same path while coming back home. The other ants sense this pheromone and starts following the same path. The nature of pheromone is that it evaporates with time. So, if an ant chooses a food source that is far away from the nest then very less ants are able to follow that ant. Thus the ant which is followed the most has chosen the shortest path and that is how we obtain our optimal solution. [10]

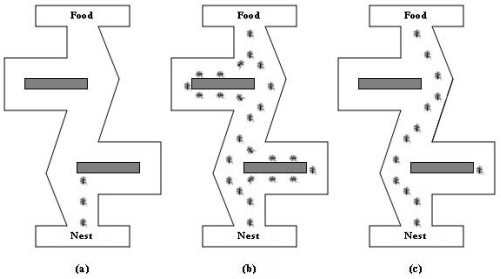

Fig. 1. Ant Colony Optimization

B. Artificial Bee Colony Algorithm

The Artificial Bee Colony (ABC) is based on the intelligent foraging behavior of honey bees. This algorithms was created by Dervis Karboga in 2005, who was motivated by the behavior of intelligent domestic bees to take process of foraging. [12]

Combinatorial Optimization in Computer Science consists of finding that one optimal point of the given data set. That optimal point either reaches to the minima or maxima or satisfies our fitness function the most. ABC is also one such combinatorial optimization based on populations, in which the solutions of the problem that is the food source in this algorithm are modified by the artificial bees who aim to find the food sources that contains the maximum nectar or in other words a solution that is the best in the search space. The bee moves in a multidimensional search space and chooses different food sources that are many times dependent on its past experiences as in where it had found food the last time. But then there are some bees also known as exploratory bees that choose random food sources irrespective of their past experiences. When these exploratory bees find a food source with huge amount of nectar, they try to memorize this position and forget the ones they had previously visited. Thus, ABC algorithm combines methods of local search, trying to balance the process of exploration and exploitation of search space [14].

Algorithm: Artificial Bee Colony Algorithm

1. Start
2. InitializePopulation()
3. While(noOfIterations)

4. Select the locations in search space for local search
5. Send the artificial bees to the selected locations and evaluate their fitness
6. Take out the bee with the best fitness
7. Send the remaining bees to search in the remaining search space
8. Evaluate the fitness of those bees
9. Update the fitness of the best bee
10. End While
11. Return the best solution
12. End

IV. PROPOSED APPROACH

The movie recommender system prescribes movies to the user that he is most likely to watch by just asking for the genres he/she is interested in. The system uses collaborative filtering technique of the recommender system and takes preferences of the genres. Whichever genre is selected by the user gets the preference value as 1 and the others get a value of 0. Now after this, the system applies the optimization technique either ACO or ABC and optimizes the database and with only those movies that will fall under the interested genres of the user. It uses the weighted graph technique and assigns weights to the entire user according to their importance and these weights are multiplied by the Euclidean distance that is calculated among the genres of two movies. As the system is trained, these weights are improved and then when the user enters the choices of the genres, it successfully recommends the three best movies and provide their ID and the Title of the movie.

The user whose data is being entered or for whom the recommendations will be made is called Active User, A. The Profile of the desired movie by the active user, A is made to make the recommendations. The profile of the movie contains many attributes, mainly the genres the user likes. The system recommends similar and complimentary movies to overcome the data sparsity and cold start problem of collaborative filtering type of recommendation system.

The database used contains 14762 movies each having the following attributes: Title of the movies, URL from where it can be watched online, Rating, Duration, Year and 29 Genres. The 29 Genres form the feature vector and that includes : "Action, Adult, Adventure, Animation, Biography, Comedy, Crime, Documentary, Drama, Family, Fantasy, Film Noir, Game Show, History, Horror, Music, Musical, Mystery, News, Reality TV, Romance, Sci Fi, Short, Sport, Talk, Show, Thriller, War, Western."

The success rate of the collaborative filtering type of recommender system is highly dependent upon how the algorithm used is able to find the appropriate neighbor of the profiles that are most similar to the active user as we assume that active user is likely to like the same thing as the best matching neighborhood profiles would like. It is also important that only the best matching profiles should be chosen and only these should be used to make recommendations for the active user because any irrelevant profile will result in bad recommendations for the active user and thus customer satisfaction will be reduced.

V. RESULTS AND DISCUSSION

The results have been obtained by comparing both Ant Colony Algorithm and Artificial Bee Colony Algorithm on CPU Time and on two standard function, one being unimodal Sphere function and the other multimodal Griewank function.

Function/Algorithm	Sphere Function	Griewank Function	CPU Time
Ant Colony Algorithm	5.493e-106	0.034421	58.9900
Artificial Bee Colony Algorithm	4.56503e-06	7.04004e-07	5.2656

[a.] Results of the comparison of algorithms

The above table shows value of the minima reached in both the algorithm ACO and ABC in both the standard functions. In both the functions ABC proves out to be better as in 2500 iterations the ABC algorithm gives better minima than ACO algorithm. Also, the CPU time taken for the complete execution of the ABC algorithm is very less as compared to that of ACO.

1	2	3	4	……. 29
Action	Adult	Adventure	Animation	Western
0	1	1	1	0

[b.] Feature Vector for the application

The table shows the feature vector selected for the application. It contains the array of the 29 genres mentioned before. The user input all the genres he/she would be interested in the form of check boxes that gives the value of either 1 (if seected) or 0(if not selected). Now this feature vector is used to compare with each of the movies in the database. The comparison is made by calculating the Euclidean distance between the feature vector provided by the user and feature vector of each movie. The movies with the least distances are taken out and top 3 movies are recommended to the user.

Similarity measure technique used in the application is Euclidean Distance. Euclidean distance is used to calculate distance between the feature vector provided by the user and the feature vector of all the movies in the database. After the distance has been computed, the movies which provide us with the minimum distance are sorted and three best movies are recommended to the user.

Euclidean Formula

$$d(p,q) = d(q,p) = \sqrt{\sum_{i=1}^{n} (q_i - p_i)^2} \qquad \text{.....(1)}$$

VI. CONCLUSION

On comparing the two algorithms, the CPU Time and their behavior on the two standard functions yield that Artificial Bee Colony Algorithm is better than Ant Colony Algorithm. The applications thus have been designed using Artificial Bee Colony Algorithm. The application uses the database of movies that have 29 genres against it. A movie falls under a particular genre when that particular genre has a value of 1 against it. The user is asked to provide the genres of the movie he/she would like to watch and then the best movies are shown him on a bar and the title and id of the 3 best movies are recommended to the user. The application successfully recommends movies for all the genres.

The limitation to the proposed techniques is that with the increasing number of simultaneous genre selection, it becomes hard for the application to take care of the very diverse genres that generally do not match altogether.

To improve the application and for more research work we can go for more data mining techniques that might yield in better results. There are different data mining techniques like clustering, classification or using Artificial Neural Network can also be used to make a recommender system. These techniques can provide better results when worked with many genres simultaneously.

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