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Web Page Recommender System for Effective Information Retrieval using hybridization of Trust, ACO and GA

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ABSTRACT: In this paper novel method is proposed for web page recommendation using hybridization of Trust, Ant Colony Optimization (ACO) and Genetic Algorithm (GA) for effective Information retrieval. The proposed approach uses the trusted colonies of web pages in a given cluster domain for rank optimization using GA in order to recommend relevant documents up in ranking for effective information retrieval. The user's clicks to the recommended web pages is captured online using pheromone update in ACO for optimizing the path of trusted clicked URLs and uses GA for their optimal ranking. The process of recommendation of optimal ranked set of clicked URLs continues till the search is personalized to the information need of the user. Experiment was conducted to confirm the improvement of precision of search results using the proposed method.

KEYWORDS: Information Retrieval, Search engines, Genetic Algorithms, Ant Colony Optimization, Trust, Personalized Web Search.

I. INTRODUCTION

Information on the Web is huge in size and identifying the information relevant to the specific information need of web users is a big challenge for search engines. The search engines retrieve large collection of ranked search results for a specific information need out of which very few are relevant. It is also found that relevant documents are found lower in ranking of search results due to imprecise search query and therefore the precision of search results decreases. [1] Research has been done to improve the ranking of search results but the comparative analysis shows that ranking algorithm needs further improvement. [2] [3] [4][5]

Optimizations techniques like ACO, GA, Trust and their hybrid have been used widely in various domains and results shows promising. [6][7][8][9][10][11][12][13][14][15][16]

It is realized in this research that no work has been done to propose a model for effective information retrieval using the hybridization of Trust, ACO and GA together. The significance of using Hybridization of Trust, ACO and Genetic Algorithm together for web page ranking is due to the reason that use of trust in pheromone initialization of web pages will filter the non relevant web pages for optimization using ACO and identify the trusted colonies of web pages browsed by the users with a similar information need in various cluster domains. The GA is applied on trusted colonies of web pages for optimal ranking in order to retrieve relevant documents up in ranking for effective information retrieval. Thus the combination of Trust and ACO provides best possible solution and GA helps in giving the globally optimal solution thus preventing the algorithm from going into the local optima and the shared optimization goal is accomplished effectively. Hence in this paper an algorithm is proposed for web page recommendation based on optimal ranked clicked URLs generated using the hybridization of Trust, ACO and GA in order to improve the precision of search results and personalize the web search effectively.

Experiment was conducted on the data set of user query sessions captured on the web in three selected domains Academics, Entertainment and Sports in order to evaluate the effectiveness of web page recommendation using the hybridization of Trust, ACO and GA. Since the proposed approach is novel hence the results were compared with closely related work PWS(with ACO and trust)[17] and classic IR(Google search results) , the improvement in the average precision of search results confirms the effectiveness of proposed approach.

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II. RELATED BACKGROUND

Information Scent

Information scent is the measure of sense of relevance of clicked web page with respect to the information need of user based on web usage data. The Inferring User Need by Information Scent (IUNIS) algorithm is used to quantify the Information Scent s_{id} of the pages P_{id} clicked by the user in ith query session. [18][19][20][21]

The page access PF. IPF weight and Time are used to quantify the information scent associated with the clicked page in a query session. The information scent s_{id} is calculated for each clicked page P_{id} in a given query session i for all m query sessions identified in query session mining as follows

$$s_{id} = PF.IPF(P_{id}) \times Time(P_{id}) \forall i \in 1..m \; \forall d \in 1..n \quad (1)$$

$$PF.IPF(P_{id}) = \frac{f_{P_{id}}}{\max_{d \in 1..n} f_{P_{id}}} \times \log\left(M/m_{P_d}\right) \quad (2)$$

$PF.IPF(P_{id})$: PF correspond to the page P_{id} normalized frequency $f_{P_{id}}$ in a given query session i where n is the number of distinct clicked page in session i and IPF correspond to the ratio of total number of query sessions M in the whole data set to the number of query sessions m_{P_d} that contain the given page P_d.

$Time(P_{id})$: It is the ratio of time spent on the page P_{id} in a given session i to the total duration of query session i.

The query session vector Q_i of the ith session is defined as linear combination of content vector of each clicked page P_{id} scaled by the weight s_{id} which is the information scent associated with the clicked page P_{id} in session i. That is

$$Q_i = \sum_{d=1}^{n} s_{id} * P_{id} \quad \forall i \in 1..m \quad (3)$$

This vector is modeling the information need associated with the i^{th} query session where n is the number of distinct clicked pages in the session i and m is the number of query sessions. [22][23][24][25][26] The k-means algorithm is used for clustering query sessions keyword vectors since its performance is good for document clustering. [27][28] .

ACO and Trust

ACO is a nature inspired metaheuristic for the solution of hard combinatorial optimisation (CO) problems. The ants communicate with each other indirectly through chemical called pheromone released by the ants on their path to food source. The initial pheromone value should be chosen carefully because small value results in slow convergence and larger value results in fast convergence yielding the suboptimal solution. The ideal value of initial pheromone value should be close to average pheromone value that is expected to be deposited by ant in a given iteration. [29]][30] [31] In [32] a method is proposed for calculating the initial pheromone value using trust value and is averaged based on number of users in web of trust in order to prevent the system fluctuation due to high pheromone value.

ACO has been used to solve many optimization problems such as assembly line balancing [33], DNA sequencing [34] , 2D-HP protein folding [35], vehicle routing problem[36], minimum spanning tree problem [37], travelling salesman[11] , Building Adaptive Domain Model [38] , Ant Recommender Systems [39] [40][41] , Use of Information Scent in ACO for Personalized Web Search [13]

It is found that recommender system can be more effective by incorporating trust than traditional collaborative filtering. [42][43][44] [45] It is found that hybrid of optimization technique Ant Colony Optimization (ACO) and trust have been applied successfully in various domains like in P2P networks [46], grid scheduling [47], recommender system [16], MANET[48], Query log mining [17] and results proved promising.

Genetic Algorithm and ACO

Genetic Algorithm is a search method based on the natural theory of evolution. The algorithm to evolve solutions to the search problem using genetic algorithm involves initialization, Evaluation, Selection, crossover, mutation and replacement. [49][50]

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The GA has been used to solve the quadratic assignment problem, vehicle routing problem with time window, traveling salesman and shop scheduling problem. [51][52][53][12].

GA and ACO have widely been used as search algorithms in various domains like in job scheduling [54] ,Travelling Salesman problem [6] [8], dynamic web service composition algorithm [9], Mobile adhoc network [10] and have also demonstrated satisfactory performances.

III. PROPOSED ALGORITHM

A. *Description of the Proposed Algorithm:*

In this paper a novel method is proposed for web page recommendations based on rank optimization of trusted colonies of web pages in clusters using hybridization of Trust, ACO and GA. The entire processing of the proposed algorithm is divided into two phase Phase I and Phase II.

In Phase I offline processing is performed and the sequence of steps are mentioned below

Step 1. The web query sessions preprocessed to keyword vectors using Information Scent and content of clicked URLs are clustered.

Step 2. The trust and pheromone of clicked URLs in clusters is initialized using Information Scent and trust value of clicked URLs in web of trust.

Step 3 Genetic Algorithm is applied on clustered clicked URLs where clicked URLs are selected using threshold value of pheromone and generates the optimal ranking of clicked URLs.

In Phase II online processing is performed

Step 1. The search query keywords are used to select the cluster for optimal ranked web page recommendation.

Step 2. The user's response to recommended search results is tracked to update the trust and pheromone value of clicked URLs along with generation of user profile .

Step3. GA is reapplied in offline to update the clusterwise optimal ranking of clicked URLs based on trust and pheromone value.

IV. PSEUDO CODE

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Phase I
Offline Preprocessing

1. Data Set Collected on the Web is preprocessed to get the Query Sessions containing input query and associated clicked URLs.
2. For each clicked URLs in the query session, the Information Scent Metric is calculated using Eq. (1)
3. Query sessions keyword vector is modeled using Eq. (3) and clustered using k-means algorithm.
4. Each cluster i is associated with the mean keyword vector clusteri_mean.
5. Clicked count and recommended count are defined for each distinct clicked URLs and are initialized to zero in the list L associated with each cluster.
6. Trust(ClickedURL$_i$)=Information Scent of clicked URLi in the List L_k associated to each cluster k.
7. Each clicked URLs i of the cluster k is associated with the initial pheromone value

$$\tau^0(clickedURL_{ik}) = \frac{Trust_{clicked\ URL_{ik}}}{count(clickedURL(cluster_k)) * \sum_{j=1}^{count(clickedURL(cluster_k))} Trust_{clickedURL\ jk}}$$

   a. For each distinct clicked URL in the given cluster identify $\tau_{avgpheremoneURLs}(0)$ which is calculated over all the query sessions present in the given cluster.

8. The list L_k of clicked URLs for each cluster k is created where $\tau_{avgpheremoneURLs}(0)$ >= ε (pheromone threshold value) .

11. For each cluster k apply the algorithm **Genetic Algorithm based ranking of clustered clicked URLs** on the List L_k associated with the cluster k to determine the top m optimal **optimal** ranking of clicked URLs represented by OR_k (Optimal Ranking k).

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SubAlgorithm:
Genetic Algorithm based optimal ranking of clustered clicked URLs
Input: List L_j, cluster mean keyword vector $clust\_mean_j$, pheromone threshold value ε, pheromone evaporation factor ρ.
Output: Ranked list of clicked URLs, OR_j
Begin

1. Select the clicked URLs in the list L_j where pheromone avgpheromone(ClickedURLi)>= ε form the M_j where $M_j \subseteq L_j$, Length(L_j)=n, Length(M_j)=m and m<n.
2. Generate the population P of m! chromosomes of length m for each of m! possible ranking of the m selected clicked URLs present in the set Mj , length(P)=m!
3. Apply the Fitness function to each chromosome in P. The fitness function is defined as follows.
   a. For each t^{th} chromosome of size m in Population P do the following
      begin
      For each clicked URL i of t^{th} chromosome starting from the left most position in the chromosome do the following
      begin
      Calculate the content similarity of the i^{th} clicked URL with the mean keyword vector $clust\_mean_j$ and store it in matrix L1[t][i].
      end
      end

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b. Select those rows in matrix L1 which are sorted according to the decreasing order of similarity measure measuring the relevance of clicked URLs to cluster mean.
c. For all selected rows in L1. Calculate harmonic means of their similarity measure of selected rows of L1 and store it in the corresponding one dimensional array entries HS[t] otherwise HS[t] is zero.

4. Select those chromosomes which have the highest value of harmonic value in HS array using Tournament selection and also followed Elitism which copies the best chromosome (or a few best chromosomes) to new population without mutation and crossover.
5. Apply the uniform order based crossover and single point mutation with mutation probability 0.25 and crossover rate of 0.8 on the selected chromosomes not included in Elitism.
6. Apply the steady-state-no-duplicates replacement policy to replace the population of parent chromosome with the reproduced offspring chromosomes obtained in step 4 and 5 in order to generate the next generation of population P.
7. Goto step 3 until the required number of n1 iterations or terminating conditions is satisfied where the difference between the optimal Fitness values of last 50 generation is less than the threshold value τ.
8. Upon termination, select the k^{th} chromosome with the highest fitness value in last generation of population P. The selected chromosome determines the optimal ranked list of docid of the m selected clicked URLs and stored in the ordered List OR_j associated with the cluster j.

endFor

Phase II

Online Processing.

1. The input query is used to find the most similar cluster.
2. For each cluster i the similarity is measured using the formulae
   $MatchScore_i$(input query , $cluster_i$_mean)={
   sim(input query , $cluster_i$_mean)

3. Identify the most matching cluster j.
4. The Ordered ranked list of clicked URLs ORj associated with the cluster j is selected and presented to the user.
5. The Recommendedcount of the recommended URLs in list L are incremented by 1.
6. The user clicks to the recommended URLs is tracked to stores it in current user profile and increment the ClickedCount of clicked URL by 1 .
7. The trust value of the recommended URLs in Lj are updated as given below.

$Trust(URL_i)$={1- $Distrust(URL_i)$| where $Recommendedcount(URL_i)$!=0}
$Distrust(HAURL_i)$ = { ($Recommendedcount(URL_i)$- $ClickedCount(URL_i)$)/ $Recommendedcount(URL_i)$ }

8. For each clicked URL of the current user session if present in the selected clusters L_j, the pheromone value is updated as follows $\tau_{avgpheremoneURLs\_ij}(t) = (1-\rho) \times \tau_{avgpheremoneURLs\_ij}(t-1) + \tau_j(t)$

   where j is the URLs clicked by the current user at time t and present in the selected cluster i. This is for all j where j is the clicked URLs of the current user and j ∈ selected cluster i and $\tau_j(t)$ is the trust of clicked URL j in the current user session. $\tau_{avgpheremoneURLs\_ij}(t)$ is the average pheromone of the j^{th} clicked URL in i^{th} cluster.

9. If the user request for the next result page
   a. Model the partial information need of the current user profile and generate keyword vector current_usersessionvector$_t$.
   b. The similarity is measured for each i^{th} cluster using the formulae
      $MatchScore_i$($cluster_i$, current_usersessionvector$_t$)= sim(current_usersessionvector$_t$,$cluster_i$_mean)

      Goto step 3.
   Else if there is new search query for web search
   Goto step 1.

10. Invoke the **Genetic Algorithm based optimal ranking of clustered clicked URLs** algorithm in offline on list L_j of cluster j to update the optimal ranking list ORj.
    Goto step 1.

End

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IV. SIMULATION RESULTS

The experiment was conducted on a data set of user query sessions captured on the web in selected domains Academics, Entertainment and Sports. In order to generate the dataset, initially the user input queries issued to GUI interface of the architecture retrieve the Google search results displayed with the check boxes on the user interface. The user' clicks to search results is captured and stored as user query sessions in database.

The experiment was performed on the i3 processor with 120 GB RAM under Windows XP using JSP, JADE , Oracle and genetic algorithm tool box of MATLAB. In the experimental set up for evaluating the performance of personalized web search using optimal ranked clicked URLs, the following parameters set as follows. The values of the threshold value of pheromone ε is set to 0.5, the pheromone evaporation factor ρ =0.5 as the experiments was conducted with different value of parameters based on the preprocessed collected data set, where the value of $\rho \in [0,1)$ [31] and Information Scent lies in [0,1]. It is further found by setting the value of ρ below 0.5, the evaporation rate of the pheromone is not effective enough to the capture the changing user's need in the clustered query sessions, therefore the pheromone evaporation factor is set at ρ =0.5. .

In genetic algorithm following parameters are used: MAXGEN(Maximum number of generations), length(P)(Number of chromosomes individuals in the population) was m! where m is the number of selected clicked URLs in set M_j associated with each j^{th} cluster, crossover rate was varied in the range of [0.6-0.8] in increment of 0.1, mutation rate was varied in the range in [0.1-0.3] in increment of .05, Tournament Size was set to 4 in the Tournament Selection method and the threshold value of Information Scent. In this study, the experiment was iterated for 100 generation for a given population P and continues till the difference in the optimum fitness value of last 50 consecutive generations is less than the threshold value τ=0 .000001. The optimal results were obtained at the crossover rate of 0.8 and mutation rate of 0.25 for the data set generated in this experimental study.

The clustering agent developed in JADE is executed to generate the clusters of query session keyword vectors using k-means algorithm. It performs the initialization of the trust of the clicked URLs of the query sessions. The pheromone value τ of each clicked URLs in the query sessions is initialized based on trust value of clicked URLs in clusters .

The performance of the Personalized Web Search using Trust, ACO and GA is evaluated from the average precision of personalized search results generated by the proposed approach and compared with Personalized Search Results with ACO and trust proposed in [17] based on GUI interface of the architecture and Classical IR(Google search results).

In order to evaluate the performance, the 25 test queries were selected randomly in each of the domains Academics, Entertainment and Sports. The purpose of selecting the queries in these three domains is to cover wide range of queries on the web. The relevancy of the documents was decided by the subject experts in the domains to which the queries belong. The average precision is computed using the fraction of retrieved documents which are relevant in the personalized search results. The experimental results showing the average precision of 25 test queries computed in the domains of academics, entertainment and sports using PWS with optimal ranking based on ACO -trust(with/ without GA) is shown in Fig. 1 below.

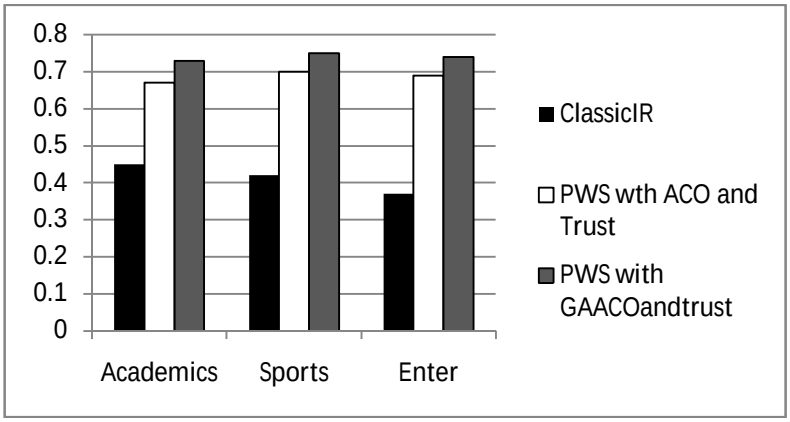

Fig.1. Shows the avgprecision of PWS with optimal ranking based on ACO and Trust(with/without GA) in Academics, Sports and Entertainment.

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The average precision is improved in each of the selected domains using personalized web search with cluster based optimal ranked clicked URLs based on –ACO-Trust(with GA). The obtained results were analyzed using the statistical paired t-test for average precision of PWS with optimal ranking based on ACO-trust GA versus both (ClassicIR/ACO-Trust) with 74 degrees of freedom (d.f.) for the combined sample as well as in all three categories (Academics, Entertainment and Sports) with 24 d.f each. The observed value of t for average precision of proposed approach(GAACOTrust) with (ClassicIR/with ACO and Trust) was (64.61/18.47) for the combined sample. Value of t for paired difference of average precision was (48.49/11.14)for academics, (106.13/12.37) for sports and (75.52/9.28) for the entertainment categories. It was observed that the computed t value for paired difference of average precision lies outside the 95% confidence interval in each case. Hence Null hypothesis was rejected and alternate hypothesis was accepted in each case and it was concluded that average precision improved significantly when personalized web search using optimal ranked clicked URLs based on ACO-trust(with GA).

The experimental results confirms the significant improvement in precision when compared to PWS based on ACO-trust(without GA) based on same clustered query sessions . Hence the optimal ranking of trusted colonies of web pages using hybrid of GA Trust-ACO brings more and more relevant documents up in ranking and personalizes the web search more effectively with respect to the information need of the user.

V. CONCLUSION AND FUTURE WORK

In this paper novel approach is proposed which uses trust and aco with genetic algorithm for generating the cluster based optimal ranked clicked URLs for effective personalized web search. Thus the optimal ranking of trustworthy colonies of web pages will bring more and more relevant documents up in ranking for improving the precision of search results. Experimental study was conducted on the clustered query sessions data set to confirm the effectiveness of proposed approach and results shows the improvement in the average precision in each of the selected domain in comparison to PWS with optimal ranking(with ACO and Trust).

REFERENCES

1. Gudivada V. N., Raghavan V. V., Grosky W. I., and Kasanagottu R. 'Information retrieval on the world wide web'. IEEE Internet Computing, 1(5), 58, 1997.
2. Kumari T., Gupta A. and Dixit A. . 'Comparative Study of PageRank and Weighted Page Rank Algorithm'. Proceedings of International Journal of Innovative Research in Computer and Communication Engineering, Vol 2, No 2, pp 2929- 2937, 2014.
3. Tyagi N. and Sharma S. 'Comparative study of various page ranking algorithms in Web Structure Mining (WSM)'. International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN, Vol 1, No 1., pp. 14-19, 2012a.
4. Sharma D.K. , and Sharma A.K . 'A comparative analysis of Web page ranking algorithms'. International Journal on Computer Science and Engineering, Vol 2 No 8, pp.2670-2676, 2010.
5. Garg Y. and Jain, M.V.. 'A Brief Survey of Various Ranking Algorithms for Web Page Retrieval in Web Structure Mining'. International Journal of Engineering Trends and Technology (IJETT),Vol 21 No 3, pp. 168-172, 2015.
6. Shang G., Xinzi J., and Kezong T. 'Hybrid algorithm combining ant colony optimization algorithm with genetic algorithm'. In Chinese Control Conference, pp. 701-704, IEEE, 2007.
7. Duan H. and Yu X. . 'Hybrid ant colony optimization using memetic algorithm for traveling salesman problem'. In IEEE International Symposium on Approximate Dynamic Programming and Reinforcement Learning, pp. 92-95, 2007.
8. Jin-Rong X., Yun L., Hai-Tao L., and Pan L..'Hybrid Genetic Ant Colony Algorithm for Traveling Salesman Problem'. Journal of Computer Applications, Vol 28 No 8, pp 2084-2112, 2008.
9. Yang Z., Shang C., Liu Q. , and Zhao C.. 'A dynamic web services composition algorithm based on the combination of ant colony algorithm and genetic algorithm.' Journal of Computational Information Systems, Vol 6 No 8, pp.2617-2622, 2010.
10. Vidhate P., and Wankhade Y.,.' Route Optimization in Manets with ACO and GA.', International Journal of Research in Engineering and Technology, Vol 2 No 11,pp. 587-590, 2013
11. Hlaing, Zar Chi, Su Su and Khine, May Aye. 'An Ant Colony Optimization Algorithm for Solving Traveling Salesman Problem'. International Conference on Information Communication and Management, Vol.16, pp.54-59, 2011.
12. Tyagi,N. and Varshney R.G.. 'A Model To Study Genetic Algorithm For The Flowshop Scheduling Problem'. Journal of Information and Operations Management, Vol 3 No 1, pp.38-42, 2012.
13. Chawla , S. 'Personalized web search using ACO with information scent'. International Journal of Knowledge and Web Intelligence, Vol 4 No 2, pp.238-259, 2013.
14. Chawla , S..' Novel Approach to Query Expansion using Genetic Algoirthm on Clustered Query Sessions for Effective Personalized Web Search' . International Journal of Advanced Research in Computer Science and Software Engineering, Vol 4 No 11, pp 73-81, 2014b.
15. Wang ,B., Chen, X. and Chang ,W., "A light-weight trust-based QoS routing algorithm for ad hoc networks". Journal Pervasive and Mobile Computing, Vol 13, pp 164-180, 2014.
16. Alathel, D. "Ant colony inspired models for trust-based recommendations "(Doctoral dissertation, The George Washington University), 2015.
17. Chawla ,S. , 'Domainwise Web Page Optimization Based On Clustered Query Sessions Using Hybrid Of Trust And ACO For Effective Information Retrieval', International Journal of Scientific and Technology Research,Vol 4 ,Issue 11, pp 196-204, 2015.

ISSN(Online): 2320-9801
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18. Chi ,E.H , Pirolli , Chen ,P., K. and Pitkow ,J. 'Using information scent to model user information needs and actions on the Web'. In Proceedings of the SIGCHI conference on Human factors in computing systems ,pp. 490-497, ACM, 2001.
19. Heer, J. and Chi ,E.H. ' Separating the swarm: categorization methods for user sessions on the web'. In Proceedings of the SIGCHI Conference on Human factors in Computing Systems ,pp. 243-250, ACM, 2002.
20. Pirolli ,P. ' Computational models of information scent-following in a very large browsable text collection.', In Proceedings of the ACM SIGCHI Conference on Human factors in computing systems ,pp. 3-10,ACM, 1997.
21. Pirolli,P. 'The use of proximal information scent to forage for distal content on the World Wide Web'. Adaptive Perspectives on Human-Technology Interaction: Methods and Models for Cognitive Engineering and Human-Computer Interaction, pp.247-266, 2006.
22. Chawla ,S. and Bedi ,P. Personalized web search using information scent. In International Joint Conferences on Computer, Information and Systems Sciences, and Engineering, Technically Co-Sponsored by: Institute of Electrical & Electronics Engineers (IEEE), University of Bridgeport, published in LNCS (Springer), pp. 483-488, 2007.
23. Chawla, S. and Bedi ,P. Improving information retrieval precision by finding related queries with similar information need using information scent. In First International Conference on Emerging Trends in Engineering and Technology, ICETET'08, pp. 486-491, IEEE, 2008.
24. Chawla,S. Trust in Personalized Web Search based on Clustered Query Sessions. International Journal of Computer Applications, Vol 59 No 7, pp.36-44, 2012a.
25. Chawla ,S. Semantic Query Expansion using Cluster Based Domain Ontologies. International Journal of Information Retrieval Research (IJIRR), Vol 2 No 2, pp 13-28, 2012b.
26. Chawla ,S. Personalised Web Search using Trust based Hubs and Authorities. International Journal of Engineering Research and Applications, Vol No7, pp.157-170, 2014a.
27. Wen ,J.R , Nie ,J.Y. and Zhang ,H.J.. 'Query clustering using user logs'. ACM Transactions on Information Systems, Vol 20 No 1, pp.59-81, 2002.
28. Zhao, Y. and Karypis, G. 'Comparison of agglomerative and partitional document clustering algorithms '(No. TR-02-014). MINNESOTA UNIV MINNEAPOLIS DEPT OF COMPUTER SCIENCE, 2002.
29. Dorigo ,M. and Di Caro ,G. "The Ant Colony Optimization meta-heuristic, in New Ideas in Optimization", D. Corne et al., Eds. (pp 11-32). London, UK: McGraw Hill, 1999.
30. Dorigo ,M., Di Caro, G. and Gambardella, L.M. "Ant algorithms for discrete optimization", Artificial Life, Vol.5 No. 2, pp. 137–172,1999.
31. Dorigo ,M., . 'Optimization, learning and natural algorithms'. Ph. D. Thesis, Politecnico di Milano, Italy., 1992.
32. Bellaachia ,A. and Alathel , D. Improving the Recommendation Accuracy for Cold Start Users in Trust-Based Recommender Systems. International Journal of Computer and Communication Engineering, 5(3), 206, 2016.
33. Blum , C. "Beam-ACO for simple assembly line balancing". INFORMS Journal on Computing, Vol. 20 No.4, 618–627, 2008. 2005.
34. Blum ,C., Yabar ,M. and Blesa ,M. J . "An ant colony optimization algorithm for DNA sequencing by hybridization". Computers and Operations Research, Vol. 35 No.11, 3620–3635, 2008.
35. Shmygelska ,A and Hoos ,H. H. "An ant colony optimisation algorithm for the 2D and 3D hydrophobic polar protein folding problem", BMC Bioinformatics, Vol. 6 No.30, 2005.
36. Bell ,J.E. and McMullen ,P.R. 'Ant colony optimization techniques for the vehicle routing problem', Advanced Engineering Informatics, Vol 18, No 1, pp.41-48, 2004.
37. Neumann ,F. and Witt , C. 'Ant colony optimization and the minimum spanning tree problem'.Journal Theoretical Computer Science,Vol 411, No 25,pp 2406-2413, 2010.
38. Kruschwitz ,U., Albakour ,M.-D., Niu J., Leveling J., Nanas , N. , Kim ,Y., Song , D., Fasli ,M. and DeRoeck , A.. "Moving towards Adaptive Search in Digital Libraries". In Advanced Language Technologies for Digital Libraries, 2011.
39. Sharma, R., Singh M., Makkar R., Kaur , H., and Bedi ,P. "Ant Re-commender: Recommender system inspired by ant colony", in Proceedings of International Conference on Advances in Computer Vision and Information Technology, 361-369, 2007.
40. Nadi ,S., Saraee ,M. H., Jazi , M. D., and Bagheri , A.. "FARS: Fuzzy Ant based Recommender System for Web Users", International Journal of Computer Science Issues, 8(1), pp 203-209,2011.
41. Sobecki , J. . Ant Colony Metaphor Applied in User Interface Recommendation. New Generation Computing. 26(3): 277-293, 2008.
42. Massa ,P., and Avesani ,P . "Trust-aware Recommender Systems." Proceedings of the ACM Conference on Recommender Systems, 17-24, 2007.
43. Lathia, N., Hailes , S ., and Capra ,L., 2008. "Trust-based collaborative filtering". Proceedings of the joint iTrust and PST Conference on Privecy, Trust Management and Security. Springer, 119-134.
44. Peng ,T., and Seng-cho ,T. "iTrustU: A blog recommender system based on trust and collaborative filtering." Proceedings of the ACM Symposium on Applied Computing. New York, NY. 1278-1285,2009.
45. Bedi ,P, and Sharma. R. "Trust based recommender system using ant colony for trust computation". Expert Systems with Applications, 39(1): 11831190, Tarrytown, NY, USA, 2012.
46. Yang L., Qin L., Z., Wang, C., and Liu, Y. "A P2P reputation model based on Ant Colony Algorithm". International Conference on Communications, Circuits and Systems, 236-240, 2010.
47. Kumar, S , and Singh ,M.. "Adaptive and dynamic load balancing in grid using ant colony optimization." International Journal of Engineering and Technology. 4(4): 167-174, 2012.
48. Sridhar S., and Baskaran R.. "ANT Based Trustworthy Routing in Mobile Ad Hoc Networks Spotlighting Quality of Service." Open Journal of Computer Science and Information Technology, 3(1), 064-073, 2015.
49. Pal S.K., Talwar V., and Mitra P. 'Web mining in soft computing framework: relevance, state of the art and future directions'. IEEE Transactions on Neural Networks, Vol 13 No 5, pp.1163-1177, 2002.
50. Goldberg D.E.. 'Genetic algorithms in search, optimization, and machine learning'. Addion Wesley Longman Publishing Co., Boston, MA, USA, 1989.
51. Ahuja R. K., Orlin , J. B. and Tiwari , A.. 'A descent genetic algorithm for the quadratic assignment problem'. Computers and Operations Research, Vol. 27, pp. 917–934, 2000.

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52. Bräysy , O.' Genetic algorithms for the vehicle routing problem with time windows'. Arpakannus,(1), pp.33-38, 2001.
53. Moon C., Kim J, Choi G., and Seo Y. 'An efficient genetic algorithm for the traveling salesman problem with precedence constraints'. European Journal of Operational Research, Vol 140 No 3, pp.606-617, 2002.
54. Surekha ,P. and Sumathi S. 'Solving fuzzy based job shop scheduling problems using Ga and ACO', Journal of Emerging Trends in Computing and Information Sciences, Vol.1 No 2, pp.95-102, 2010.

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