

Comparative Study of Feedback Session and Task Trail Approach for Recommendation and Prediction of User search Goals

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Abstract: The important aim of each information retrieval system is to make available the keywords and applies refined ranking algorithms to categories them. But unfortunately, users give short and ambiguous queries which sometimes are not sufficient to clearly identify its requirement. Due to which incorrect result is formed, sorted and offered to the user. This report tends to propose innovative approach to infer user search goals by analyzing user query logs. First method used to get completely different user search goals for a query by cluster the feedback sessions. Second, a novel approach used to get pseudo-documents to better represent the feedback sessions for clustering. In addition, the task trail clustering method is used to automatically group queries into tasks. A task is defined to be an atomic user data need, whereas a task trail represents all user activities among that specific task, like query reformulations, URL clicks. Finally, two methods are compared, shows the task trail method is better than a feedback session to find user search goals. Moreover, propose a system intend Log Likelihood Ratio method to suggest related queries to the user. The experimental results on a dataset of queries prove the excellent performance of task trail method compared with feedback session methods and confirm the importance of identification of task. The performance of the system is measured in terms of processing time, recall, accuracy and recognition rate. The recognition rate of feedback session is 74.42 % and of task trail is 89.92%.

Keywords: User search goals, Query log, Task trail, Feedback session, Query suggestion, Cosine similarity, and Clustering.

I. INTRODUCTION

Nowadays, information retrieval systems are established in all places; cookbook guides, library guides, web search engines, and so on. Information retrieval is the element of an information system. An information system must actively discover out what users want, and retrieve documents that are relevant to users need. But many users are still not capable to discover it as they are not well expert in framing their necessities. For example, when a user enters query "Java", there are two possibilities of results like "Java Sea in Indonesia", Java programming. The main aim is to resolve ambiguity of query terms. So, figuring out what information the user really needs to solve a problem is essential for successful retrieval. In recent years, some system focuses on session level analysis to give the results when user search any query. The existing system doesn't identify the task and not provide query suggestion which can be useful to user as corresponding results. Thus the query suggestion may reduce effort of users to search query which is not handled by existing system. Additionally, the existing system is difficult to find task from the search logs. The architecture proposed in this paper, carried out task-level search log analysis to find the user search goal for a query. Query clustering using the bounded spread method is introduced in proposed system which gives relevant results. A query suggestion based on task trail, i.e.; log likelihood ratio (LLR) is a best complement of query suggestion.

This paper is arranged as follows: Section 2 explains the related work used previously for finding relevant queries and suggested query and related efforts that has been made. Section 3 defines a system approach suggested for this with a complete algorithmic explanation. Section 4 includes the dataset representation, section 5 represent experiment and result analysis, section 6 includes final conclusion of this research paper with some further discussion of possible research work in this field are to be discussed.

II. RELATED WORK

The literature survey provides the background of different works carried out in different areas like information retrieval, data mining. Gives the detailed study of related topics and different techniques used to solve the previous occurred issues and methods.

In [1] used K Pathsim algorithm to give the results on user behaviour. The similarity calculation formula used to give the sorted results. Also to measure clustering accuracy NMI used. An experimental result shows that using this technique they improve the clustering accuracy. The clustering threshold and number of iterations also affect Clustering accuracy. The experiment to validate the effectiveness of the KPathsim algorithm in the digital reference and library project data set (Digital Bibliography & Library Project, DBLP). In [2] work is carried out to improve the search engine performance and to save user searching time. The Improved Page Rank algorithm used. Cheating similarity and cheating relevance are two factors added to revise the original Page Rank value. White list and blacklist are used to improve the method. Methods based on whitelist hold the idea that good sites usually link to good sites. Methods based on blacklist think spam pages usually link to spam pages. Experimental effects had verified that it was a better link-based anti-spam performance than Trust Rank algorithm and BadRank algorithm.

In [3] web pages are ranked using search engine transaction logs. After that results are sorted according to topic, relevant and the documents that are essentials are at the top of the results. Panda algorithm used, in which web pages of all URLs are clustered. To cluster the URLs query clustering tool used, before that similarity analyzer tool used to calculate similarity between URLs. Merge sort algorithm used to find the relevancy among URLs. Generalized Sequential Pattern (GSP) algorithm is applied on to the re-ranked web pages for each query in clusters to catch the repeatedly used sequential patterns. Combined use of this algorithm shows that the most relevant information on the top of the position. In [4] works on query suggestion. Proposed QuSRWTC Method uses random walk and topic concepts. Query suggestions are taken from other mature search engines, because of that suggestions are extra comprehensive. The used topic concepts are used to restructure the queries because of this query suggestion is very correct. An experimental result shows the results show the result of QuS-RWTC and QuS-RW systems. The NDCG values of QuS-RWTC is greater than the values of QuS-RW. This demonstrates that the methods of topic concept extraction and resorting are significant and beneficial to recommend exact query.

In [5-10] query suggestion technique which takes the benefits of user click history. In query processing, from user query, their information store in user log and collect the matched documents from a search engine database. After that, using interest calculation algorithm interest weight is computed. Queries are clustered by calculating the similarities between them. Finally, they compare their proposed system with the popular search engine.

In [1-25] main focus on to resolve the term mismatch problem with query expansion. Suggest QECK technique base on Rocchio's model. First pass retrieval, word selection and second pas retrieval are the three steps included in the method. Experimental results shows that the effectiveness of QECK and evaluate the effectiveness for refining the performance of code search algorithms, and explore the enactment of QECK Rocchio. Exactly, the first code search algorithm is BM25 founded information retrieval method on Lucene, which is denoted as IR in the first experiment. The second is Portfolio grounded on Vector Space Model (VSM), PageRank, and Spreading Activation Network (SAN). The next is VF based on VSM and the frequent item-set mining.

In [26-30] studied the trade off between exploration and exploitation in interactive information retrieval. Several user queries need a more various set of results for additional important relevance feedback. That is why, the authors collect traditional relevance scoring (exploitation) of a file with a novelty score (exploration), with novelty representing a document's similarity to all higher-ranking documents. So adapt this approach to get additional utility from feedback. In [31-40] user search goal is identified using feedback session. Frequent and sequential patterns are analyzed. Using semantic clustering algorithm documents is clustered. Numbers of clusters are created on demand; they are not created by the user that is why the documents made by this technique are different. And the clustering algorithm is NP-Complete.

In [41] location-aware keyword query suggestion method used in which relevant documents near the user location are retrieved. Partition-based algorithm (PA) which calculates the totals of the candidate keyword queries at the partition level and uses an ideal tool to greatly decrease the computational cost. Baseline algorithm for location aware suggestions. Weighted keyword-document graph, takes the semantic relevance between keyword queries and the spatial distance between the resulting documents and the user place. The graph formed in a random-walk-with-restart fashion, to choice the keyword queries with the maximum scores as suggestions. An overall analysis of all papers gives possible issues and difficulties in the papers and how to correct out in proposed system is elaborated in detail [42-61].

III. SYSTEM OUTLINE AND METHODOLOGY

This paper approach is to search query results by using two techniques. Given an input query, the procedure of approach is:

- 1) Using two techniques Feedback session and Task trail search the input query.

- 2) Compare the results obtained from both techniques.
- 3) Suggest related queries using Log Likelihood ratio method.

Now, a detailed presentation of each step and system architecture is shown in figure1.

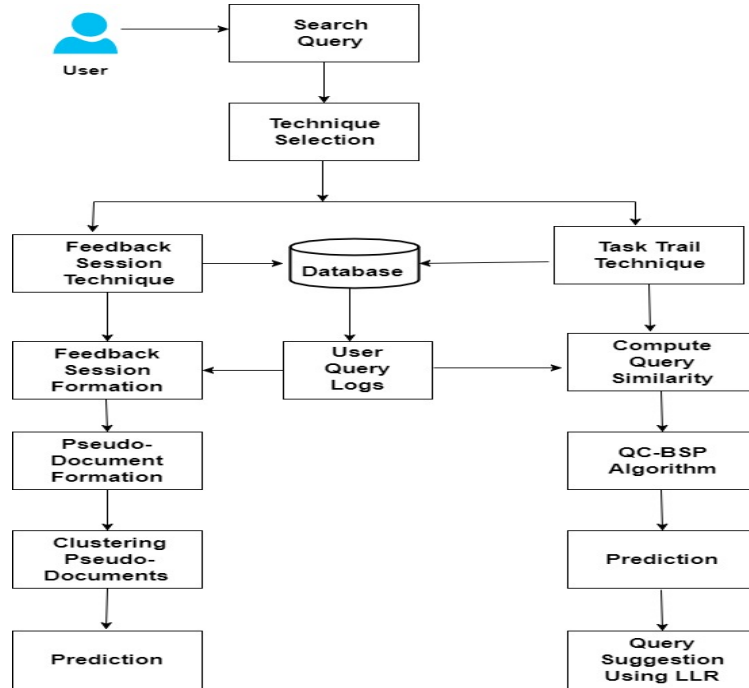


Fig. 1. System architecture.

3.1 Search Query Results using the Feedback Session

The first technique is to search the goal of users entered query using feedback session. The feedback session is formed from the user’s click-through logs; which consist of the users clicked and unclicked URLs. Feedback session starts with first search results and ends with the result that was clicked in a session. The click sequence indicates which results, click first and which is second.

3.1.1 Pseudo Documents

Pseudo-documents used to identify the user interest, means what the user wants and what he does not want. It is formed from the feedback session. So, feedback session is converted into pseudo-document. Initially URLs of the feedback session is developed by extracting the titles and snippets of URLs. Then TF-IDF vector used to represent the each URL’s title and snippet, as in

$$T_{ui} = [t_{w1}, t_{w2}, \dots, t_{wn}]^T, \tag{1}$$

$$S_{ui} = [s_{w1}, s_{w2}, \dots, s_{wn}]^T, \tag{2}$$

Where, T_{ui} -TF-IDF vectors for URL’s title,

S_{ui} -TF-IDF vectors for URL’s snippet,

u_i -ith URL present in feedback session, t_{wj} and s_{wj} - the TF-IDF value for j th term in the URLs. Sometimes low frequent term is more relevant, hence set the weight of title more as compared to snippet. Now, represent URL using weighted sum of T_{ui} and S_{ui} , as

$$F_{ui} = w_t T_{ui} + w_s S_{ui} = [f_{w1}, f_{w2}, \dots, f_{wn}]^T, \tag{3}$$

After that one method is use to pool clicked and unclicked URLs in feedback session.

$$F_{fs} = [f_{fs}(w_1), f_{fs}(w_2), \dots, f_{fs}(w_n)]^T \tag{4}$$

$$f_{fs}(w) = \arg \min_{f_{fs}(w)} \{ \sum_M [f_{fs}(w) - f_{ucm}(w)]^2 - \lambda \sum_L [f_{fs}(w) - (w)]^2 \}, f_{fs}(w) \in I_c \tag{5}$$

Where, w is a term,

$f_{fs}(w)$ Value of term w ,

F_{fs} Feature representation of feedback session,

F_{ucm} ($m=1, 2 \dots M$) - Representation of clicked URLs,

F_{uc_l} ($l=1, 2 \dots L$) - Representation of unclicked URLs,

$f_{ucm}(w)$ and $f_{uc_l}(w)$ - the values of term w in vector,

λ Balancing parameter,

I_c be the interval.

Calculating this method we get the documents which contains the term which shows what he wants and what he don't wants.

3.1.2 Clustering Pseudo Documents

Before performing clustering calculate the similarity between two documents using cosine score of two documents.

$$Sim_{i,j} = \cos (F_{fsi}, F_{fsj}) = \frac{F_{fsi} \cdot F_{fsj}}{|F_{fsi}| |F_{fsj}|} \tag{6}$$

Where, F_{fsi} and F_{fsj} are two pseudo-documents.

Finally, using k-means clustering user search goals are identified.

3.2 Search Query Results using Task Trail

Task trail is use to understand user search behaviour. Task is nothing but the log segmentation unit, which indirectly represent the user goal. When query is searched by task trail, (QC-BSP) query clustering bounded spread algorithm use. Using this algorithm, similar queries are grouped into same task and finally the results are found. Query similarity is checked by using jaro function.

The algorithmic steps are:

Input: Set of query Q , cut-off threshold b , bounded length bl ;

Output: Document related to queries;

Initialization: $\Theta = \phi$; Query to task table $L = \phi$; $M = \phi$;

Steps:

Start

Step 1: $cid = 0$; // initialize same queries to one task

Step 2: for $len = 1$ to $|Q| - 1$ do

Step 3: for $i = 1$ to $|Q| - len$ do

Step 4: if $M [Q_i]$ exists then

Step 5: add Q_i into $\Theta (M [Q_i])$; else $M [Q_i] = cid++$;

Step 6: if $|\Theta| = 1$ return Θ ;

Step 7: for $len = 1$ to bl do

Step 8: for $i = 1$ to $|Q| - len$ do

Step 9: if $L [Q_i] \neq L [Q_{i+len}]$ then

$s \leftarrow \text{sim} (L [Q_i], L [Q_{i+len}])$;

Step 10: if $s \geq b$ then

merge $T (Q_i)$ and $T (Q_{i+len})$; modify L ;

Step 11: if $|\Theta| = 1$ break;

Step 12: return Θ ;

End

The bounded length can be 3,5 or 10. Sometimes user search the same query after so many queries, in that case it is very time consuming to check that queries. Hence bounded length is very useful. Using bounded length can check the queries within bound.

3.3 Suggesting Related Queries using Log Likelihood Ratio (LLR)

The related query suggestion is very vital for search engines. Users could find essential information more rapidly and correctly with the support of query suggestions, which could significantly increase users' search experience. Thus, suggested related queries have become a research hotspot in the field of the search engine.

The LLR is calculated as: $-2 \ln \lambda$,

Where, $\lambda = \max_p L(H_1) / \max_{p_1, p_2} L(H_2)$

Suppose two queries are given q_1 and q_2 .

The null hypothesis $H_1: \Pr(q_2|q_1) = \Pr(q_2) \Pr(q_1) = p_1$

The alternative hypothesis $H_2: \Pr(q_2|q_1) \neq \Pr(q_2) \Pr(q_1) = p_2$

IV. DATASET REPRESENTATION

For the evaluation of the system, proposed system uses query information taken from Google and stored required information into our local database. The dataset contains query information like URL title, description and web site, image. When a user search any query, evaluation is performed by applying the feedback session technique. Table 1 shows the query information that is used for analysis. The title shows the title of the query, the snippet is short description of the query.

Table 1. Query information.

Sr. No.	Title	Snippet	Web URL
1	Java programming language	Java is a general-purpose computer programming lang.	https://en.wikipedia.org/wiki/Java_(programming_la...
2	Java Tutorial	Java Tutorial or Core Java Tutorial or Java Program...	https://www.javatpoint.com/java-tutorial
3	Java	Java is a general purpose high-level programming lang..	Java is a general purpose high-level programming l...
4	MATLAB	MATLAB is a multi-paradigm numerical computing envirn...	https://en.wikipedia.org/wiki/MATLAB
5	Matrix	In mathematics, a matrix plural matrices is a recta...	https://en.wikipedia.org/wiki/Matrix_(mathematics)
6	Earth	Earth is the only planet whose English name does ..	http://www.nineplanets.org/earth
7	Earth system	Earth system science (ESS) is the application of s...	https://en.wikipedia.org/wiki/Earth_system_science
8	Popular Indian Festivals	Diwali, Ganesh Chaturthi, Holi, Navaratri, Dussehra, ...	https://www.tripsavvy.com
9	Festival of Buddhism	Week. This most important Buddhist festival is kn..	https://www.bbc.co.uk/religion/religions/buddhism/...
10	Sun	Sun is the star at the center of the Solar system...	https://en.wikipedia.org/wiki/Sun

V. EXPERIMENT AND RESULT ANALYSIS

In this section, present detailed experimental clarifications and results on appraising the effectiveness of task trail. The database contains the queries of different domains. The title of each query, its description and URL are stored in the database. When user search any query, evaluation is performed by applying both techniques, feedback session and task trail. Here, only 5 queries are taken as input and the test data has ten queries such as query1 to Query10. Using two different techniques we calculate the search results for 5 queries. The test data are given below:

Test data:

- Query1: Home decor
- Query2: Earth system
- Query3: Sun news
- Query4: Songs of Mars Bruno
- Query5: Car

5.1 Time Analysis of Two Techniques

In this section, the readings of time in Milliseconds (Ms) required for all 5 queries shown in table 2. The time required to retrieve documents using feedback session is more than task trail. In table, for query “Earth system” time requires retrieving document is 578 milliseconds using task trail; and for same query 952 milliseconds. So, we say that task trail require less time as compared to feedback session. Graphical representation is shown in figure 2.

Table 2. Time to retrieve documents for two techniques.

Sr. No.	Query	Retrieval Time (Milliseconds) Task trail approach	Retrieval Time (Milliseconds) Feedback session approach
1	Home décor	560	564
2	Earth system	578	952
3	Sun news	282	532
4	Songs of Mars Bruno	345	456
5	Car	654	829

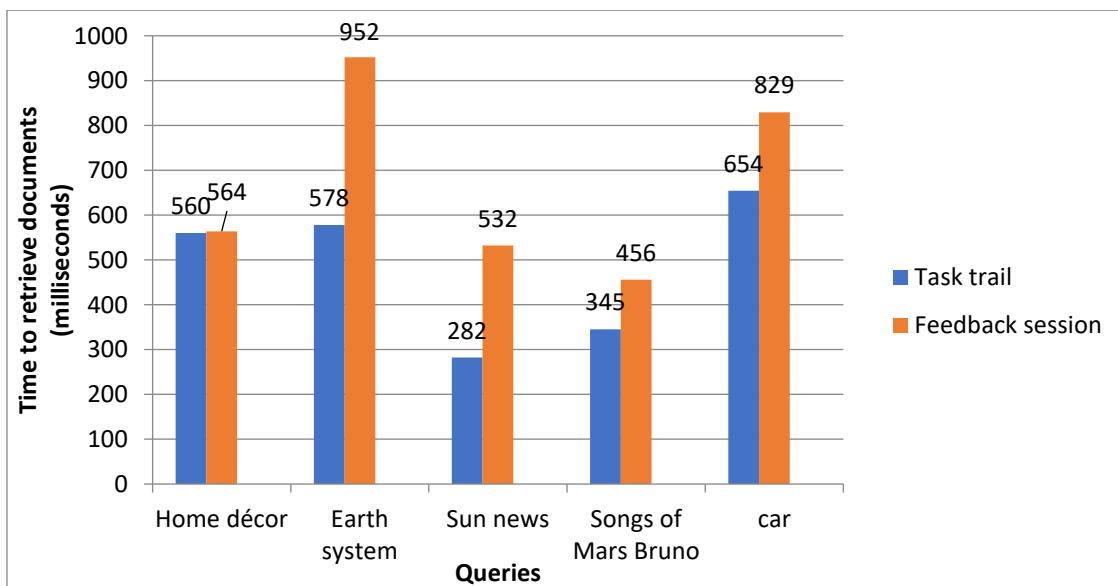


Figure2. Time comparison to retrieve documents.

On x-axis, queries are given and on y-axis time given which are required to retrieve the documents. Graph shows that, query on x-axis “Home decor” require 560 Ms using feedback session and 564 Ms using task trail. Like this all remaining four queries and their required time to retrieve documents are shown.

5.2 Recall Analysis of Two Techniques

Recall measure use to measure how relevant documents are retrieved in search. Recall can be calculated by using formula:

$$\text{Recall} = \frac{\{relevantDocuments\} \cap \{retrieveddocuments\}}{retrievedDocuments}$$

The recall values for 5 queries are given below in table 3. The readings in this table shows that proposed task trail gives better performance as compare to Feedback session. Graphical representation of readings is shown in figure 3.

Table 3: Recall analysis of two techniques.

Sr. No.	Query	Recall for Feedback Session	Recall for Task trail
1	Home décor	0.75	1
2	Earth system	0.83	0.83
3	Sun news	1	1
4	Songs of Mars Bruno	0.6	0.6
5	Car	0.6	0.5

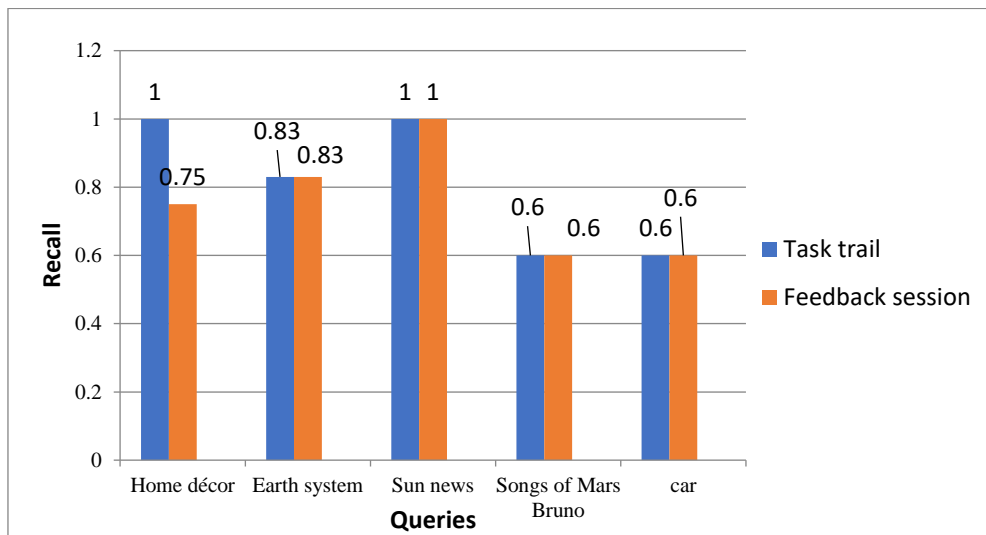


Figure 3: Recall comparison.

5.3 Precision Analysis of Two Techniques

Precision measure use to measure how retrieval documents are relevant in search. Precision can be calculated by using formula:

$$\text{Precision} = \frac{\{Relevant Documents\} \cap \{Retrieved Documents\}}{Retrieved Documents}$$

The Precision values for 5 queries are given below in table 4. The readings in this table shows that proposed Task Trail gives better performance as compare to Feedback session. Graphical representation of readings is shown in figure 4.

Table 4: Precision analysis of two techniques.

Sr. No.	Query	Precision for Feedback session	Precision for Task trail
1	Home decor	0.21	1
2	Earth system	0.28	0.83
3	Sun news	0.2	0.2
4	Songs of Mars Bruno	0.15	0.44
5	Car	0.33	0.78

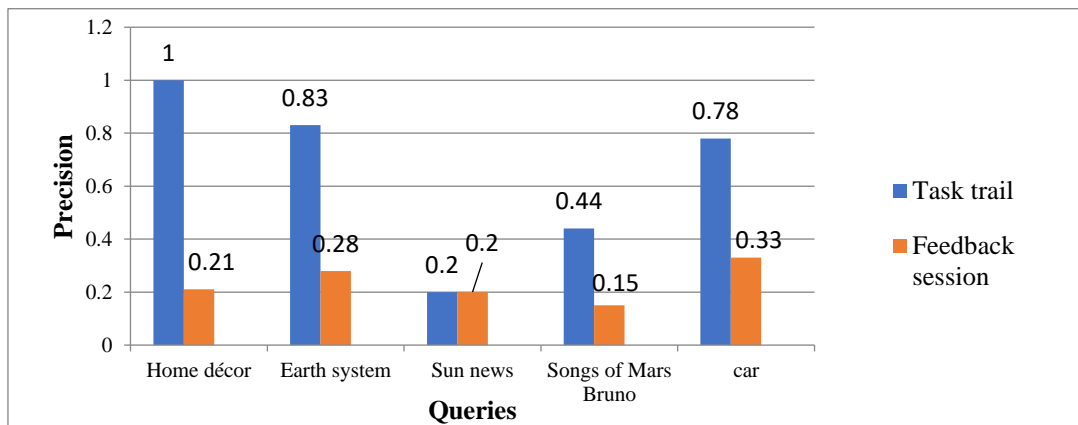


Figure 4: Precision comparison.

5.4 Accuracy Analysis of Two Techniques

Accuracy checks that how system is correct in finding the relevant results. The following table5 shows the accuracy value for each query using both techniques. On relevant document basis we can calculate the accuracy of the system. For query “Home decor”, accuracy is same using both techniques. For query “car” accuracy using feedback is 63 % and using task trail 88%. In such a way all query accuracy is given.

Table 5: Accuracy of the techniques.

Sr.No.	Query	Accuracy of Feedback session	Accuracy of Task trail
1	Home décor	75%	75 %
2	Earth system	83 %	83 %
3	Sun news	100 %	100 %
4	Songs of Mars Bruno	66 %	100 %
5	Car	63 %	88 %
Average accuracy		74.2 %	89.2%

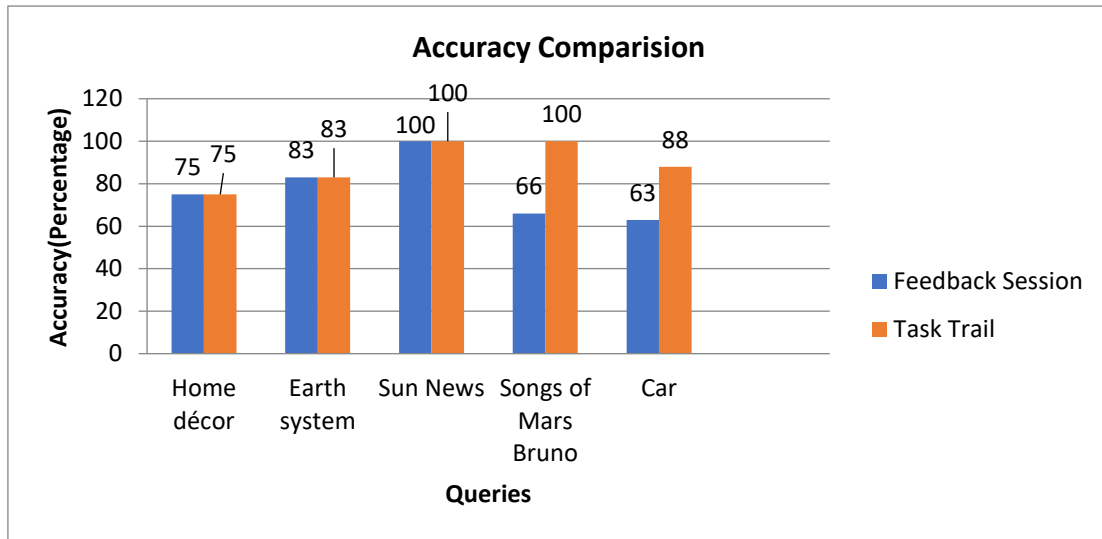


Figure 5: Accuracy comparison

The accuracy for “Home décor” is 75% using feedback session and task trail. Likewise accuracy of all the queries is given in figure 5. The recognition rate is 74.2 % for feedback session and 89.2% for task trail.

5.5 Suggested Related Queries

The log likelihood technique is used to suggest related queries. Table 6 shows the related queries to the user according to query given to search. For query “Home decor”, the related queries are “Home decorative items”, “Handmade home crafts” and “Decorative items made at home”. Similarly for other queries related queries are suggested.

Table 6. Related queries.

Sr. No.	Query	Related Queries
1	Home décor	Home decorative items, Homemade items, Decorative items made at home, Handmade home craft
2	Earth system	Earth,
3	Sun news	Sun, The sun-history, sun newspaper
4	Songs of Mars Bruno	Mars Bruno songs, Mars history
5	Car	Car basic information, Latest cars in 2017, upcoming cars in India

VI. CONCLUSION

This paper is focused on resolving the ambiguity of query terms and find accurate information immediately. Time consuming problem of Feedback session method is solved by proposing Task trail. The proposed Task trail uses bounded spread algorithm which provides the user the required results fast. Also task level analysis provides a better understanding of user’s goal. Provides query suggestion as a complementary outcome to the user. Thus in future work, a technique need to develop that gives best results on low frequent queries and considering query as a audio and video.

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