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Inference of User Image-Search Goals and Personalization Using Click Through Log

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Abstract—Improving the image search engine relevance and user experience is very important to figure out user image search goals. When a user will enter a query to search an image, he should be displayed with relevant images. In proposed work, browsing history session information, bookmark data and visual information with image tags of user click through images or user feedback images are extracted. The session history is stored as click through log and the images are stored separately. This history and clicked and downloaded images by user is considered as implicit guidance, so that the personalized results can be presented to the user. From the browsing history, the URLs are visited for getting user domain keywords. By using these keywords and tags of images, user query specific topic mapping and query mapping is done. The proposed method performs Naive Bayesian classification on user clicked images to group them into relevant concepts. This classifier is tested on the images obtained as a result of user submitted, so that the user interesting images or goal images can be displayed as a result. A label wise clustering is used to display goal image results. The system is mainly for retrieving images using text-based queries. The main aim of the proposed work is an efficient image retrieval system to facilitates image search through user queries and improve user satisfaction by returning images that have a high probability to be downloaded by the user.

Index Terms—Click through log, User Profiles, Goal images, Image search goals.

I. Introduction

USERS submit queries on the World Wide Web for searching data and to satisfy their the search goals. The produced user search goals are then employed in several applications. For instance, the user image search goals as image query suggestions help users to develop their queries through image search. The interest towards searching and retrieval of images is increased due to the rapid growth of the World Wide Web. The image needs vary from user to user. Traditionally, many techniques are developed for text based search which gives rise to the image based search.

In the proposed work, the visual information of user click through images along with click session information are used for inferring and personalizing user image search goals. The clicked images are provided by users implicitly as their inter-est. And the click session information is a browsing history. The visual information or visual feature of any image is anything that is seen or felt about that image. These contents are then extracted from these images which are described by feature vectors. The feature vectors of an image constructs the feature dataset. The distance between feature vectors of two images are used to calculate the similarity between these images. The proposed work uses cosine similarity measure.

This distance measure is useful for getting the images that belong to the same class. The image classification is per-formed by using naive bayesian classification algorithm. By using the classification technique, the images belonging to the same concept can be identified. Then the image label wise hierarchical clustering technique is used to get the personalized image results.

The rest of paper is organized as follows: Section II de-scribes related work. Section III includes problem definition. Section IV includes proposed work. Section V covers math-ematical model corresponding to proposed work. Section VI shows the obtained results. Section VII concludes the paper. the paper.

II. Related Work

There has been much more search based on text search but some of the methods were proposed in image search. Some work tried to capture user goals for the visual query in image search [7] by giving visual suggestions. They had first selected some label words as literary recommendations. At that point they gathered the pictures connected with a recommended keyword and group these pictures to choose applicable pictures for the keyword. The great execution of their strategy is for the most part rely on upon the accuracy of labels. As in numerous web picture seeking approaches, manual labels are not accessible and just outside writings are achievable. Some work on differences in recovery process [10] concentrated on enhancing results recovered for uncertain query with the hope that one interpretation will satisfy the user needs. The diversity in image retrieval is focused in

[6] which stated that the diversity and novelty in image search is a low level visual content novelty. A work on giving image results under implicit guidance of users considers past users guidance [15] which exploits user click information and the multiple visual features. It cannot infer image goals for group of similar queries if exact query match not found. It analyze the click through log but it does not perform ranking and personalization of the goal images. As there can be a small number of images actually clicked by users, a click prediction for re-ranking [16] have done a click prediction by multimodal hypergraph learning. This learning method uses both image fusion and feature fusion. A voting strategy is used for click prediction as a binary event. This prediction is then applied for re-ranking web images. Another work on ranking uses query dependent on click based relevance feedback [13]. In this type of feedback the pseudo positive data are clicked images and randomly selected images for other queries as pseudo negative data.

A study on the impact of classifying a large number of object categories [8] gives the impact on false classification cost and produces more informative classification. But the performance degrades as number of categories increases. Some of the works uses query by image that is a visual query for suggesting image results. A work on predicting image relevance using bag of object retrieval model [20] maintains object vocabulary which contains query relative patches by mining frequent object patterns from resultant image collec-tion. It focuses on typical categories of queries in which the user intention is to find images containing required objects. It does image relevance prediction for re-ranking. It deals with queries from a specific domain. But it limits if the user wants a multi-concept results. In [14] a tag based social image search is done. In this work the relevance estimation is calculated by hypergraph learning approach which is used for tagging. Both the visual information and textual information of images are used. It constructs a social image hypergraph [14] in which the vertices are images and the edges are visual or textual terms.The learning process is done with pseudo positive images for which the edges changed across the training process.

III. Proposed System

The user image-search goals are important in improving image search concern and user experience.

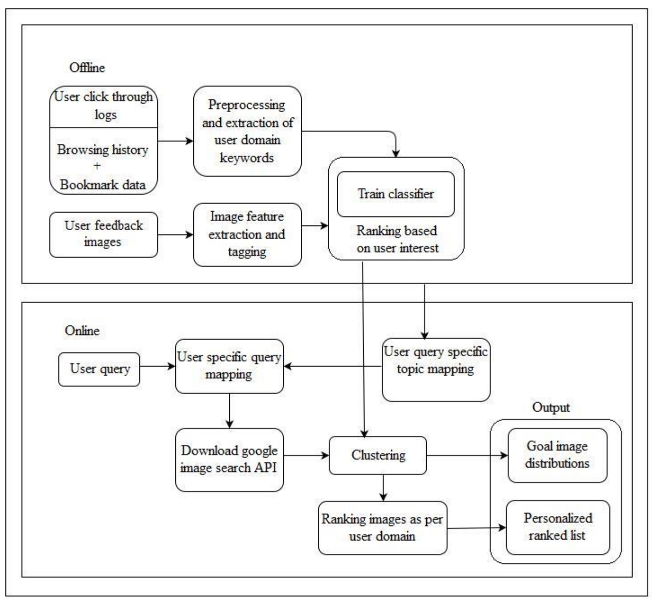

Fig. 1. Proposed System Architecture

A. User Click Through Log Creation

The user click session data is stored in click through log. This session data is the browsing history, bookmark data. It is a system wise browser history. This data is called user profile, it is a description of user interests. It is used for providing personalized search results. User profiles are created in two steps:

1) Browsing History Preprocessing: From the browsing history, the visited pages are fetched and stored in a text file and the frequent keywords from these pages are extracted which forms the user profile. These keywords are used to map user query specific topic and query.

B. Feature Extraction

The user click through images along with the browsing history serve as implicit guidance. The features of these images are extracted. These features are useful to reduce semantic gap between user entered query keyword and the generated image results. By finding the similarity values between the feature vectors of clicked images, it can be decided that in which categories these images should be divided. This can be achieved by using classification of images. It gives features vectors of user click through images. These vectors are then used for finding similarity between images for classification and clustering. Also by comparing these features with labled image features, the labels for click through images can be predicted. Below is the pseudo code for feature extraction of images:

Feature Vector Creation Algorithm

Input : Images provided by the user. Result: Feature vectors.

Step 1 Traverse through entire input image array. Step 2 Read individual pixel color value (24-bit).

Step 3 Split the pixel color value into individual R, G and B 8-bit values.

Step 4 Make the color intensity range for each R,G,B color component of pixel into 10 bins i.e. 0-25, 25-50, 50-75225-250.

Step 5 Read the color intensity value of R, G, B component of first pixel, increment the count of bin to which the intensity value belongs.

Step 6 Repeat the above step for each pixel.

C. Image Classification

The naives bayesian classifier is used which predicts labels of click through images. First the extracted features of these images from feature extraction method are used to find the similarities between these images. The nearest neighbour features of images are assigned to same group. After group image assignment, the labels prediction is done in which first the features of click through images are compared with the features of labeled image dataset(Nus Wide). After finding the nearest neighbour, the probability of image label assignment is calculated as confidence value. This trained classifier is then used to predict the lables for the images which are downloaded as a result of query so that label wise clustering for finding goal image results can be achieved.

The classification algorithm is explained as follows:

Naives Bayesian Classification Algorithm

Input : Image, Class C, Trained dataset. Result : Images which belongs to Class C.

Step 1 Extract the features of input image.

Step 2 Find out the probability P(C) of Class C that may contain the features of input image, called as prior probability.

Step 3 Find out the probability $P(X/C_i)$, probability of occurrence of input image in given Class C_i, (Likelihood).

Step 4 Find out the probability P(X) , probability of occurrence of input image among all classes. (Evidence).

Step 5 Find out the probability $P(C_i/X)$, Probability of Class C_i that contain given input image X, is the possibility of that X can be labeled C_i.

Step 6 Repeat the step 2 to 5 for all Classes.

Step 7 Assign the label of class to Input image, who has the maximum posterior probability among all classes.

D. Image Clustering

The data combining is done for finding the goal image results for the query and their distributions in terms of number of ranked labels with images clustered under those labels. By selecting the category name or label name the personalized image results are obtained. Below is the image clustering algorithm:

Image Label wise Hierarchical Clustering Algorithm

Input : Feature vectors of downloaded images. Results : Clusters of different goal images.

Step 1 Find cosine similarity and group images.

Step 2 Assign labels to images by comparing features with click through image features.

Step 3 Perform label wise grouping of images to produce goal image clusters.

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E. Image Searching

When the user gives a query keyword to get image results, the images are downloaded through google custom image search API(google REST API). Then the results retrieved are given to the classifier which is trained on the clicked images data. It will identify the labels of downloaded images. Then results are refined by ranking these labels and it will display search results with highly relevant images as the top results.

IV. Mathematical Model

S = fs; e; X; Y; DD; N DD; f; ^{H} g

Let S be the system to achieve the planned objective. s is the start state.
e is end state.
X is input of the system. Y is output of the system. DD is deterministic data.
NDD is non-deterministic data.
f is set of functions in the system.
^{H} is constraints to the system. Input : X ! Input set.
let X be the set of images. X = fL; Ig
I : User clicked images.
L : Browser history and bookmarks. L = furl; fk_1; k_2; :::; $k_n$gg
url_i : i^{th} visited url data stored in text file.
K_j : j^{th} frequent keyword extracted from visited page.
S = fs_1; s_2; :::; s_mg
S : Sessions for browser history.
S 2 L
Output : Y ! Output set Y = fIM; GIg
IM = Set of relevant images. GI= Goal image distributions. DD : I 2 D
D : Dataset of images. NDD : I 2 D
NDD : Images to be downloaded using google API.
f : ff_{FE}; f_{FVC} ; f_{IC} ; f_{CL}g
f_{FE} : Function for feature extraction.
f_{FVC} : Function for feature vector creation.
f_{IC} : Function for naive baysian image classification.

$$\text{Bayes Theorem} = P\left(\frac{C}{X}\right) = \frac{P(C)}{P\left(\frac{X}{C}\right):P(X)}$$

f_{CG} : Function for image label wise hierarchical clustering.
F_{CL}=fCL(GI_1); CL(GI_2); :::; CL(GI_m)g CL 2 fV; Eg
V=fI_1; I_2; :::; I_ng V 2 S
E(I_i; I_j) : Cosine similarity between vectors of image I_i; I_j as sim(x,y).
x = fx_1; x_2; :::; x_ng y = fy_1; y_2; :::; y_ng
x,y : Feature vectors of image I_i and I_j:

$$\text{sim(x,y)} = \frac{\sum_{i=1}^{t} x_i:y_i}{\sqrt{\sum_{i=1}^{t} x_i^2}\;\sqrt{\sum_{i=1}^{t} y_i^2}}$$

: L; I X ^{H} !

Constraints : Constraints of the system.

^{H} Success : f T^{g} I ! GI

TI : Correctly trained images.
GI : Goal image results.
Failure : fW T I; IRg
WIT : Wrongly trained images.
IR : Irrelevant images results.

V. Results

The testing has been conducted on images downloaded for query. The system is tested for image personalization for checking whether relevant images are inferred or not. The comparison is done between image search results obtained

without using click through log (normal search) and with using click through log (personalized search). Also the search time for normal and personalized search is calculated in milliseconds. Following are the performance measures:

Precision (P):

Precision is the percentage of personalized relevant image results(R_i) among all personalized image results (T_i).

$$P = \frac{R_i}{T_i}$$

Recall (R):

Recall is the percentage of personalized relevant image results(R_i) among all personalized relevant image results(T_{ri}).

R =

A. Cluster Analysis

Category Ranking	Category Name	Precision	Recall
1	Computer	0.8	0.875
2	Design	0.625	0.8
3	Icon	0.85	0.833
4	Technology	0.66	0.8

TABLE I
Image Cluster Analysis

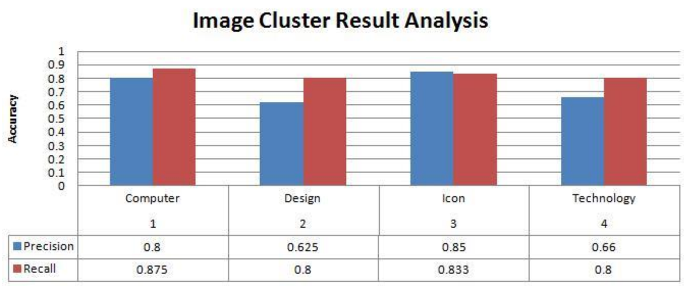

Fig. 2. Comparison of Cluster Results

B. Search Time Analysis

Query Type	Normal Search	Personalized Search
Distinct	81	84
Medium	82	82
Ambiguous	82	82

TABLE II
Search Time Analysis

VI. Conclusion

Image processing is a powerful domain in image search and retrieval as it provides a great knowledge about the images. The main aim of this contribution is to use the user clicked images provided by them as their interest and use

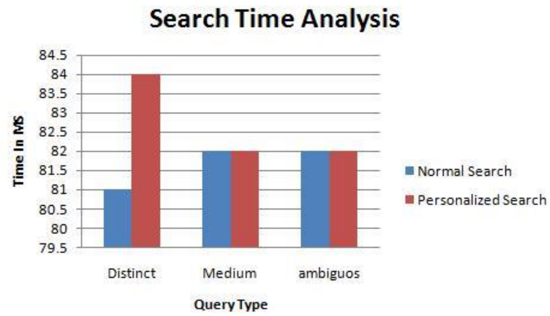

Fig. 3. Comparison of Search Time Results

the visual information of those clicked images to personalize relevant images to the users when they will enter the query for searching images. Click session data or the search history of the user for images and the clicked images provided by them will serve as the implicit information of the past queries to assist classification of those images and the obtained image classes are used for getting classes of images downloaded for user query. Image clustering is used for getting goal images and their distributions and the obtained goal images are used to personalize image results.

VII. Future Work

The current system aims to find out goal images based on naive bayesian classification of images. The proposed system can infer image results for query not presenting in click through log. For inferring goal images, the labeled image dataset is required for label prediction of user domain. The browsing history is necessary for inference. The system can not personalize images if implicit guidance is not given. The proposed system can be extended for explicit guidance from user at the time when user will enter query. This can be included as future scope of this work.

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