Visual Relation Identification Using BoFT Labels in Social Media Feeds

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Abstract - *Social media is an online platform that became an inevitable part of individuals. Interest of online users can be detected from social graph. Social graph interrupts the privacy of online users so it is dubious. This paper adapt users interest from user shared images. Users share images on social media, it depicts the interest of users or criticism about a real time issue or despatch of users. These user shared images are reachable to other users in contact which provide an easier and systematic alternative for discovering connection between users. The proposed methodology investigates to discover user connection through a better alternative called bag-of-features tagging (BoFT). User shared images also helps to establish connection between users. By BoFT, the users interest are recognized and thereby estimate tag recommendation for users. This paper identifies the connection between users using the image sharing mechanism and determines the tag recommendation for friendship. These findings are useful for interest discovery which categorize users based on propensity of topic and the virality of user shared images are predicted. Predicting the virality of user shared images are computed based on the occurrence of images in social network.*

Key Words: **BoFT labels, connection discovery, user shared images, user recommendation, content virality, interest discovery.**

1. INTRODUCTION

Nowadays, owing to the behaviour of contemporary society, direct communication between individuals are decreasing day-by-day. The social network plays a vital role for communicating individuals. Smart phones, social media and internet became an indispensable part of humans. Through social media, the interaction link between the internet users are exaggerated at higher rates. Billions of users share billions of images in social network. It symbolise the social link between users. Social network enables users to chat, share images, videos, blogs etc. The proposed method relies on users shared images. User shared images on social media is a fundamental data to identify the user connection.

Most of the social media gather information of user profile using social graph. A better alternative to recognize the interconnections between users are user shared images. By taking the advantages of extreme resemblance of features in shared images for grouping users with their interest and thereby discovering user connection. For this, a computer vision technique called BoFT is adopted. Examples of user shared images are demonstrated in Fig. 1. Both user A and user B shared images of aircraft and user B and user C shared

images of bike in common. These user shared images exhibit visual interrelation in features. The visually extreme resembling images are utilized to identify interconnection between users.
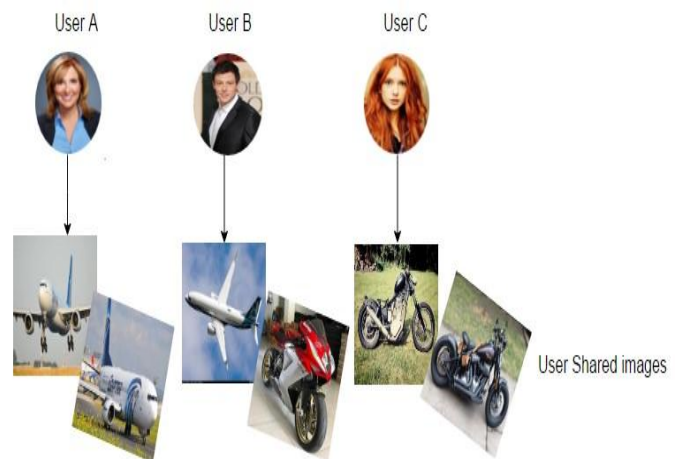

Fig -1: Example of user shared images

In the proposed framework, user shared images are the key of connection discovery. Recommendations are based on matching user shared images with other users. A better tag recommendation is possible by estimating user connection through analyzing the user profile which reflect users interest. The proposed methods are evaluated with over 200 images from Facebook and it is proven that user connections can be discovered and user/tag recommendations are made efficiently. The main contributions of this paper includes: 1) user shared images with BoFT methods helps to discover user connections 2) establish a tag recommendation approach based on user connection 3) an approach to predict the content virality based on occurrence on image 4) propose a method to recognize the interest of users. Most of the algorithm focus on predicting the content virality based on time taken for the image to become viral. But the proposed algorithm focus on occurrence of images.

This paper is organized as follows: section 2 bring out related works. Section 3 introduces proposed method for similarity calculation and connection discovery, along with user/tag recommendation and interest discovery followed by virality prediction of user shared images. Section 4 familiarize with dataset and come out with experimental results. Section 5 concludes the proposed system and future works.

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2. RELATED WORKS

A relation identification system compares the system with existing technologies. Connection between users in online social network is identified through the interest of users in sharing of images. Users interest are analyzed by accessing social graph [14]. But social graph interferes with the protection of online users thus it become improbable. Non-user generated labels with different color-based and feature-based methods are used in connection discovery [7]. But larger social network data to prove the effectiveness of the feature based method. One of the conceivable method for finding user connection is content based approach, in which the visual appearance of an image is considered, inorder to create a label for the image [23]. However, determining the relationship between the appearance and the label is not a trivial task because the same object can be visually different among images. To conquer these drawbacks, BoFT is used in [4], [27]. BoFT is a computer vision approach for image feature classification.

The virality prediction algorithm is based popularity of images. But most of the algorithm [10] is based on time constrain using basic reproduction number. But the popularity of images in social media is on the basis of number of views or sharing of images. In proposed approach the virality prediction is based on the number of occurrence of image, which precisely shows the viral images.

Recommending users from billions of user shared content is always a challenging task. The Probabilistic Prediction Framework [2] are used to improve tag recommendation. However, it is based on assumption of addictive independence which is not acceptable. So it leads a poor recommendation. One of the possible ways to make the user recommendation is by the existing connections among people [20]. User recommendation is also possible with users interests [24] or user generated content [27] and personalized information [2]. One of the possible solutions is to analyse the interests reflected in the content they have shared. Thus user interests are identified from user shared images for user recommendation.

The proposed technique is based on BoFT approach [4], [27] for connection discovery using the following ways: 1) screening user shared images and measuring BoFT similarity 2) Discovering the user connection using BoFT similarity calculation 3) recommending users with respect to the discovered connection 4) occurrences of images are obtained for measuring the virality of content 5) group of users with special area of interest are identified from user shared images. The connection discovery approach is useful for user recommendation, virality prediction and interest discovery.

3. PROPOSED METHODOLOGY

The proposed technique identifies the interrelation between users, for this, it precisely measures the similarity between user shared images in which they shared extreme comparative images. The proposed technique comprises of four phases. The first part distinguishes user connection based on similarity calculation. The second part comes out with proposal for user tag recommendation for friendship based on user interest which is figured by utilizing the similarity in user shared images. The third part presents the virality in user shared images based on popularity of images. The fourth part presents interest discovery, which demonstrates the interest of a group of users. Fig 2 shows the system flow of proposed technique.
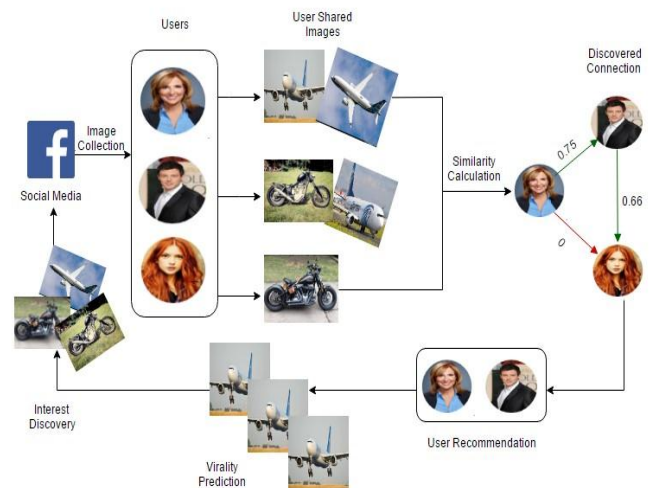

Fig -2: System flow of the proposed method.

Visual Relation identification in social media is based BoFT [4], which is a computer vision approach and is used for analyzing images. Converting local image descriptors of an image into feature vector is termed as BoF. BoF can be adapted to different methods such image classification, object detection, image retrieval. An orderless collection of visual features of an image constitute BoF, which is computationally cheaper and theoretically straightforward. The proposed technique focuses on identifying the interrelation between internet users and subsequently categorizing the users for tag recommendation. BoF is a multistep approach and each step denotes a different process. Fig 3 (a) is BoFT label annotation and Fig 3 (b) is the similarity calculation of user shared images using BoFT labels. The key steps of proposed techniques are:

- Feature Extraction
- Codebook Generation
- Coding and Pooling
- Clustering and BoFT Labeling
- Profile Learning
- BoFT Similarity Calculation

- User Tag Recommendation
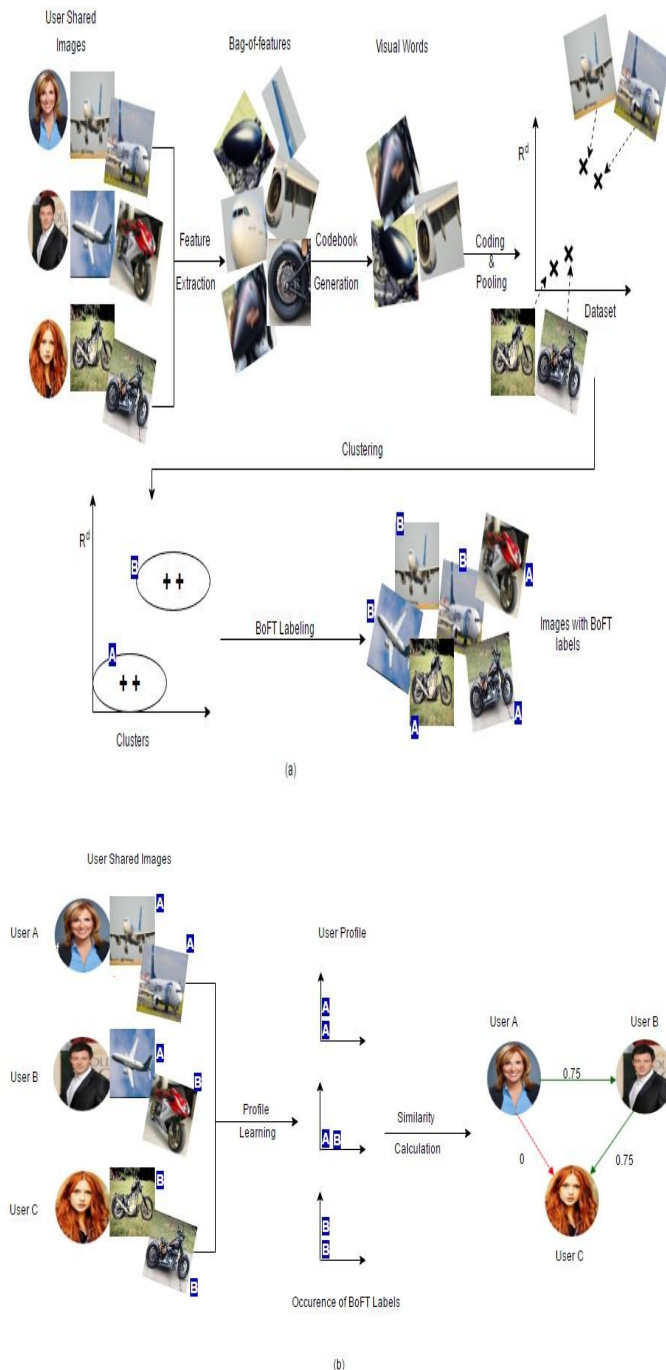- Virality Prediction
- Interest Discovery

Fig -3: BoFT approach for connection discovery

3.1. Feature Extraction

The first key step of the proposed method is feature extraction. Feature extraction is a process to obtain the unique local features. SIFT based feature extraction method [15] is used in the proposed framework. SIFT with maximum key points extraction is opted. SIFT includes a feature detector and a feature descriptor. The extracted features are compatible under different viewing angle and lightning condition and is liberated of size and orientation. SIFT includes four functions:

- Difference of Gaussian
- Keypoint localization
- Orientation
- Keypoint description

The primary phase of keypoint detection is to recognize the locations and scales. In Gaussian, finding the keypoints scale space and rotation of images. Difference of Gaussian function is for identifying images under different orientation and angles. That is, points that are invariant to scale and orientation. In keypoint localization, the selection of key points is based on the parameters such as threshold, edge threshold and remove boundary points. Keypoints are selected based on invariant points. One or more orientations are assigned to each keypoint location based on gradient information on the image and compute the best orientation for each keypoint region. The Key point descriptor is computed for the local image region about each keypoint that is highly distinctive and invariant points.

3.2. Codebook generation

Codebook generation is for acquiring the image feature categorization. It is a clustering process, so k-means clustering is adopted, which is used to obtain a set of visual words. K-means clustering is used to cluster bag-of-features of user shared images. Each cluster accommodates with different features of the images. Clustering is based on the extreme resemblance of extracted features. Afterwards, proper clustering is acquired based on the cluster parameter inorder to create Bag-of-visual word. Then visual word is obtained by taking the mean of each cluster.

3.3. Coding and Pooling

Feature coding is the pivotal component of image classification. Coding is to map local features into a compact representation. The closest visual word is obtained from codebook. Features are trained in coding. The inputs of this step are feature descriptors extracted from all training images and the outputs are codewords. The codewords are typically generated by clustering technique over feature descriptors. Feature coding is the core component, which links feature extraction and feature pooling. Each image is represented by a feature vector in the feature pooling. The output is a pooling vector for each image.

3.4. Clustering and BoFT Labeling

The feature vector obtained in pooling is used in clustering process to group images that are visually similar. K-means clustering method is adopted for grouping similar feature

vectors of image. In BoFT labeling, it assigns each cluster a BoFT label and images with the same BoFT label are visually similar. User connections can be discovered through BoFT labels. Each cluster contains a cluster id. The cluster id represents labels of each cluster and determines which cluster the images belong to. Consequently, identify the category of user shared images.

3.5. Profile Learning

The key of connection discovery is profile learning. Unique users are identified from the dataset and user category and category count are calculated from the cluster. The number of unique users who share images can be identified. The user category indicates in which cluster the user have images. Based on user category similarity between users are calculated. The category count is calculated to check whether the user have images in every cluster or not.

3.6. BoFT Similarity Calculation

The images with extreme resemblance will have high BoFT similarity. The similarity between the user shared images helps to identify the connection between users. The number of pairs and user pairs are calculated. The number of pairs are calculated using,

$$Number\ of\ Pairs = (n * (n - 1))/2; \qquad (1)$$

Owing to the homogeneous features of user shared images included in user profiles, calculate similarity of features with respect to the user category. Analyzing the user category is a better alternative for similarity calculation. Based on the number of occurrences of user category, similarity between the images are calculated.

$$S_{a,b} = sum(count)/(length(a) + length(b)); \qquad (2)$$

Here $S_{a,b}$ denotes similarity calculation, *sum(count)* represents total number of common images shared by user *a* and user *b*, *length(a)* represents images shared by user *a* and *length(b)* represents images shared by user *b*. Recommendations are made based on the similarity between two users. Inorder to recommend users to other users, the proposed technique accurately measures the similarity between users. With respect to similarity calculation, connection between the users are discovered with user pairs. User pair depicts that two users are related. The user pairs are ascertained on the basis of visual appearance of images and similarity between the users are calculated accordingly. Thus related pairs are identified and user connections are discovered.

3.7. User/Tag Recommendation

Tagging is a most important way for information propagation. Tag recommendation is used to predict the possible number of tags for a special content. Co-occurrence

of tag for user shared images are computed using similarity between images. User shared images and frequent occurrence of tags depicts personalized interest of user based on a special topic. With respect to the similarity calculation, interconnection between users are identified and user/tag recommendations [2] are made. Interest matching users are a sensible way to recommend users for friendship through tagging. Unique users are searched out and in addition, checking each user shared image against another inorder to find the matching ones. Based on that, recommendations are made.

3.8. Virality Prediction

The virality prediction is more challenging task of predicting whether an image is viral or not by looking at its content. The images in social network are augmented by virtue of the shared content. Data spread more rapidly on the extensive world system. Viral data spread through interpersonal organizations. The estimation of virality can be done by assessing the popularity. Individuals who shared, voted or saw content are characterized as infected node on the framework. Most of the algorithm concentrate on the time taken by the content to become viral. The proposed technique focus on predicting the image to end up noticeably popular in light of the number of occurrences of image. Consequently the occurrence of viral image is predicted based on a threshold value. Checking whether the images keep running ahead than threshold value, then the images are opted as viral. The basic figure in spreading of viral image is social cascade. A bigger cascade size evaluate higher virality [10] of the image.

3.9. Interest Discovery

The interest discovery [6] in online communication platform gain much importance because it helps to connect users based on their interest. Identifying the interest of user is a challenging task. Users in a group requires like-minded users and collect information about their specific area of interest. Tags on images helps to gather users with similar interest. Users in social network assign tags to the image that they are interested in. In addition to user/tag recommendation, their exhibit a list of users having common interest. Discover the interest of each communities with specific interest. On the basis of users interest, the interest discovery approach finds interest of each group of users who share similar images.

4. EXPERIMENTAL RESULTS

This chapter describes the dataset and result of the proposed technique. The results show how the experiments are conducted and connections are discovered. The proposed framework is a four phase process, where the first stage is for connection discovery of users from user shared images, second stage indicates user/tag recommendation [2] system.

The third stage is virality prediction [10] and fourth stage shows interest discovery [6].

4.1. Dataset

Facebook is a social networking site which is utilized for connection discovery. Facebook permits users to upload images and videos, recordings, exchange messages, create groups and share both internal and external information. Social networks rely vigorously on user-generated content, which spreads rapidly across social networks. Due to the privacy concerns, the vast majority of the social networking sites like Flicker, Friendster and Twitter does not provide their dataset. So images are gathered from Facebook with image id and user id. Missing information in social media is caused by numerous reasons like no access authorization on data, imperfect knowledge acquisition processes etc. The dataset is created in Microsoft Excel based on the data collected from Facebook.

The dataset comprised of nodes and image id where nodes represents users, image id represent images shared by nodes. The dataset of Facebook is resized into a standard size 250x250. 200 users shared images of different categories such as aircraft, turtle, lamp, buildings, camera, flower, mountain, ship, watches are collected for the implementation of the proposed approach. 139 users shared 200 images based on their interest. Some of the users shared more than one category of images. Through this, we can also identify the interest of users. Particular images are attracted by some of the users, so many individuals shared the same images and thus the image becomes viral. The virality of the images can be predicted from the Facebook dataset.

4.2. Connection Discovery

The first key step is feature extraction, SIFT [15] based feature extraction is used. SIFT with maximum key point extraction is opted. The extracted features are invariant to scale and orientation. Keypoint descriptor is computed for the local image region about each keypoint that is highly distinctive and invariant points. After SIFT extraction, 128 descriptors together with scales are obtained.

The images should be in proper cluster, in order to get the accurate result in the clustering process. K-means clustering is used to cluster descriptor vectors of BoF with respect to keypoints. Different values are assigned to the cluster parameter, but the proper cluster is obtained when the value of the number of clusters is assigned with 8. The Fig 4 and Fig 5 shows the precision and recall rate for k-means clustering based on the categories of image. The precision and recall rate are computed as the following,

$$Precision = T_p /(T_p + F_p) \qquad (3)$$
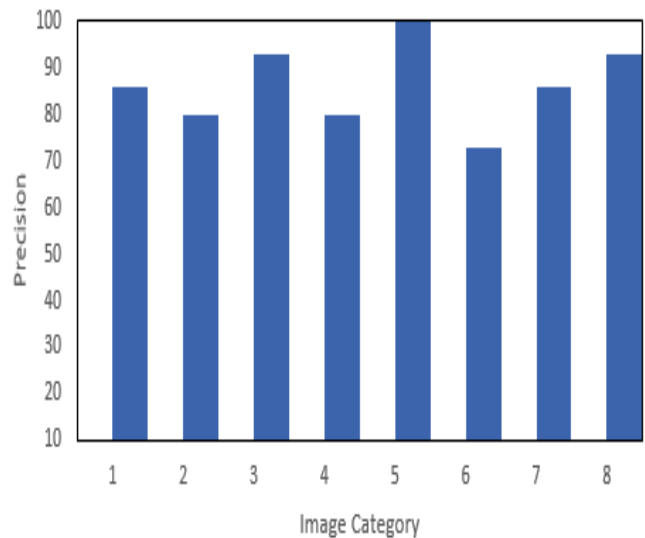
$$Recall = T_p /(T_p + F_n) \qquad (4)$$

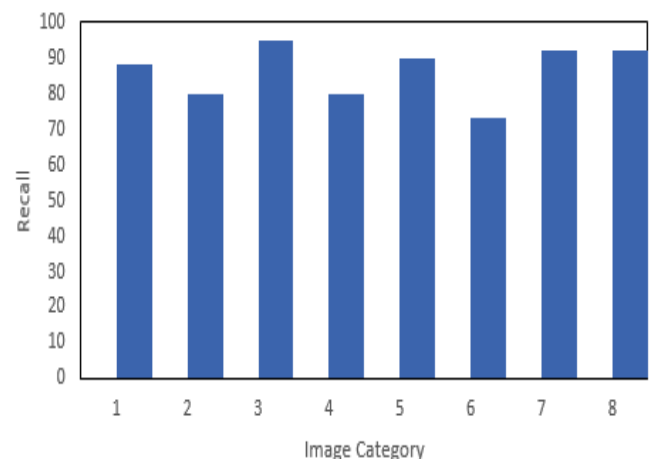**Fig -4**: Precision rate of clustering

Fig -5: Recall rate of clustering

where T_p is the true positive (correctly clustered image), while F_p and F_n are false positive and false negative respectively. F_p is the case that the clustered image that is predicted as correct. F_n is not properly clustered image. The precision rate, p, measures the percentage of properly clustered images upto a limit while recall rate, r, measures the percentage of properly clustered images from the whole dataset. Inorder to evaluate the precision rate, different dataset are used to check the accuracy of clustering. The higher value of p and r gives better result of clustering. The users and category of users in identified from users profile. Table 1 shows the category count of 12 user and Table 2 shows the user category of 12 users. The user category of user 3, user 11 and user 12 having image in only one cluster and user 5 having images in more number of cluster. The category count of user 3 have images in only one cluster and most of the users have images in more than one cluster. User

shared images appeared in different cluster indicates the interest of users in different image category.

Table -1: Category count of 12 users

Users	Category count
1	1 0 0 2
2	2 0 0 2
3	1
4	1 1
5	0 2 3 1
6	0 2 1
7	0 2 0 1
8	0 1 0 1
9	2
10	1 0 1
11	0 0 1
12	0 0 1

The number of pairs and user pairs are computed inorder to identify similarity between users. The user category is used to measure the similarity between users.

$$Number\ of\ Pairs = (n * (n-1))/2 \qquad (5)$$

$$S_{a,b} = sum(count)/(length(a) + length(b)) \qquad (6)$$

User connection is calculated on the basis of similarity calculation. Related pair exhibit user connections along with its range of similarity. Table 3 demonstrates the discovered connection between user pairs. The total number of connections obtained is 9529. Out of 9529 user connections, 10 are displayed in the table. Some of the related pairs have higher similarity in visual features and some appears with an average similarity range. The related pair with higher similarity range is occurred between 7701-7702. The user pairs with similarity range 0 is considered as non-related pairs. The non-related pairs does not have connection between users.
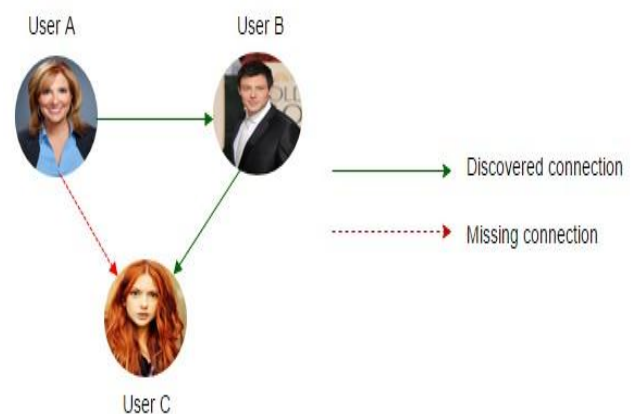
Table -2: User category of 12 users

Users	User category
1	4 4 1
2	4 1 4 1
3	1
4	1 1
5	3 3 4 3 2 2

6	3 2 3
7	2 2 4
8	4 2
9	1 1
10	1 3
11	3
12	3

Table -3: Discovered connection between user pairs

SL No.	User pairs	Discovered connection
1	7701-7702	1
2	7701-7703	0.5000
3	7701-7704	0.6000
4	7701-7705	0.3333
5	7701-7706	0
6	7701-7707	0.5000
7	7701-7708	0.6000
8	7701-7709	0.6000
9	7701-7710	0.4000
10	7701-7711	0

Fig -6: Example of connection discovery

4.3. User/Tag Recommendation

User/tag recommendation depends on connection discovery. The similarity calculation gives a precise information about interrelation between users. Comparative interest shared users having high similarity. Based on their interest, recommendations are made. Users are sorted in an order with respect to similarity calculation.

List out the users having common category of images. The unique users are then filtered out from the list and check for the matching pairs. The user id of interest matching users are stored during each iteration process. The Fig 7 and Fig 8 shows the precision and recall rate for a list of recommendation based on the categories of image. The precision and recall rate are computed using equation 3 and 4. The higher value of p and r gives better recommendation based on the image category. The Fig 9 demonstrates the recommendation of list of users based on the discovered connection between users. Most of the users are recommended to the images appeared in category 3. The category 2 is considered as least recommended category.
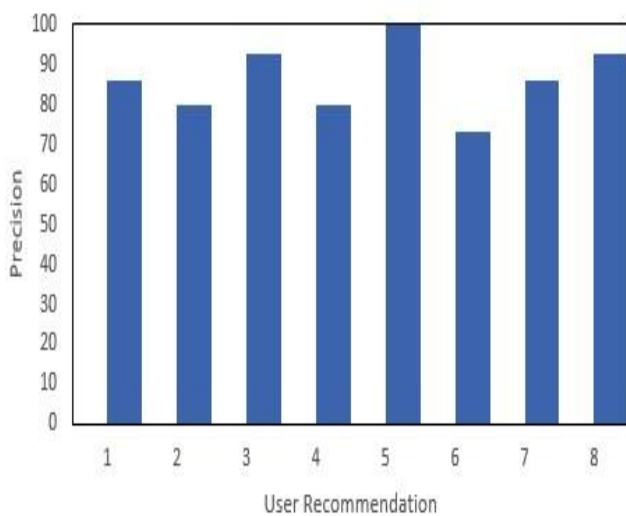

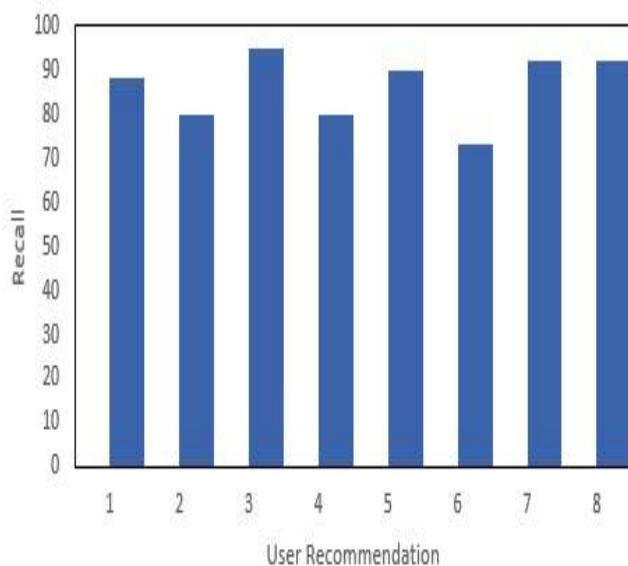**Fig -7:** Precision rate of recommendation list

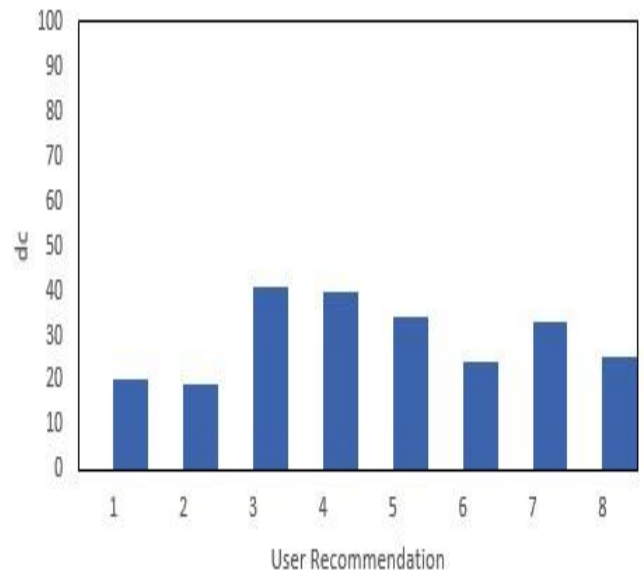**Fig -8:** Recall rate of recommendation list

Fig -9: List of recommended users based on discovered connection

4.4. Virality Prediction

Spreadability and propagativity are the two reason for content virality. Virality is a phenomenon strictly connected to the character of the content being spread, instead of users who spread it. The concept of spreadability speaks that more rapidly the content flow across the social media. Most of the algorithm in predicting the content virality focus on the time taken by the social cascade to become viral. But the proposed virality prediction method is based on counting the number of occurrences of the image to become viral. The content virality is measured based on a threshold value. For checking the virality of images, unique user shared images are taken from the database and checked the number of users who shared same image. Consequently, a threshold value is set and checking whether the occurrence of images exceeds the given threshold value. The threshold value is set as 20. If the number of occurrence of images is go beyond 20, then the image is treated as a viral. The Fig 10 shows viral images from user shared images. The result shows occurrence of images are accurately calculated without any prediction error. Large dataset from Facebook can be used to obtain a more comprehensive evaluation of the approach.
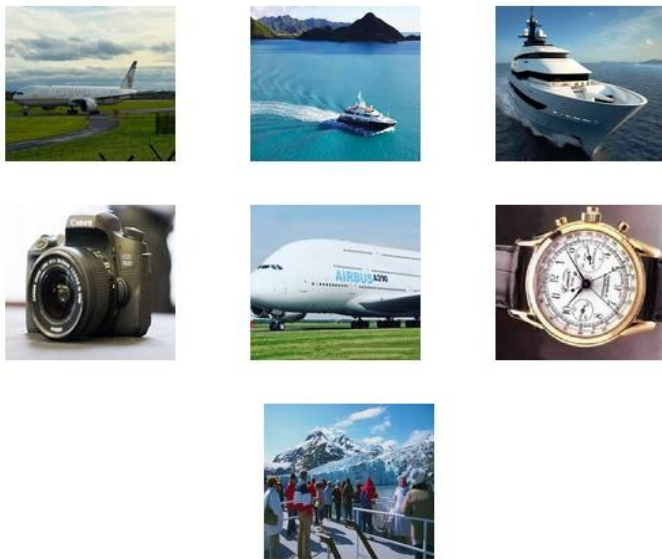
Fig -10: Viral images

SL No.	User id	User recommendation	Cluster id	User interest
3	7704	7706 7710 7712 7713 7716 7718 ...	6	Flight
4	7705	7707 7708 7709 7711 7712 7718 ...	2	Ship
5	7708	7713 7718 7720 7723 7725 7734 ...	3	Watch
6	7711	7719 7720 7722 7723 7784 7785 ...	8	Mountain
7	7714	7715 7716 7717 7718 7719 7720 ...	7	Turtle
8	7721	7722 7729 7733 7757 7761 7763 ...	4	Camera

4.5. Interest Discovery

In online social network, the recommendation list will categorize the user shared images that depicts the interest of the user. The user shared images are more concise and closely reflect the interest of user. The interest of users are identified from recommendation system. Users with similar interests are discovered through similarity calculation in connection discovery. Based on the occurrence of different category in image sharing we can identify the interest of users.

In recommendation system, users with special area of interest are identified and based on that interest of the group of users are identified. The results show that by analyzing the recommendation list, users interest is captured and is accurately measured. The interest discovery approach is highly focused on list of recommended users based on discovered connection. It is proved by experiments that the proposed approach is very effective to discover common interest of users in online social networks with the information on the online connections among users. The table 4 shows the interest of users based on 8 category. Based on user recommendation, interest of users are identified.

Table -4: Interest discovered for a group of users

SL No.	User id	User recommendation	Cluster id	User interest
1	7701	7702 7703 7704 7708 7715 7717 ...	5	Flower
2	7702	7703 7704 7708 7715 7717 7723 ...	1	Bus

5. CONCLUSION

The proposed connection discovery method and the system for user/tag recommendation, prediction of virality and interest discovery approach are based on user shared images in Facebook. The proposed method is a novel BoF based Tagging approach to make better recommendations. The matching users interests are discovered from images uploaded. BoF based approach can help discover hidden users connections from the shared images on a social network for a better recommendation. The proposed technique helps to classify image according to their visual features. Those visual features represent the user interest and hence recommendation. As a result of discovered connection, the proposed approach can recommend users based on the interest of user.

Visual similarity of users shared images helps to identify connection between users and friendship recommendations can be made based on the similarity. Also, identified the interest of users and content virality. Interest identification is a system to discover common interest topics which helps to connect more people with common interests and encourage people to contribute and share more contents and based on that friendship recommendations can be made. The virality
of the images are predicted by counting the number of occurrence of image.

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