Physica A 507 (2018) 123–132

Contents lists available at ScienceDirect

Physica A

journal homepage: www.elsevier.com/locate/physa

Automatic image annotation using community detection in neighbor images

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HIGHLIGHTS

- We proposed a method for automatic image annotation using community detection.
- A network among neighbor images tags for each query image is created.
- The densest community in the network is recognized and use its tags to the final tags.

ARTICLE INFO

Article history:
Received 4 October 2017
Received in revised form 17 March 2018

Keywords:
Automatic image annotation
Community detection
Densest community
Relevance tags
Image retrieval

ABSTRACT

Automatic image annotation is useful in automatic image management and, understanding their contents. Automatic image annotation refers to the process of assigning tags/labels to images so that they clearly indicate the content which is meant to be conveyed. In this paper, a new method of automatic image annotation is presented. In the first phase of the proposed method, neighbor images which are similar to the query image, are retrieved using low-level features. In the second phase, a network (a relative graph) of the tags neighbor images is created and, finally, the tags of the densest community among all communities is selected for the query image as final tags. In order to show the efficiency of the proposed method some metrics such as precision, recall, and f-score are used in three standard datasets namely Corel5k, IAPR TC12 and Mir Flickr. The results show that the proposed method is more efficient than some state-of-the-art approaches.

1. Introduction

Growing interactive tools in different networks such as the internet has made the users not only to be data consumers, but also data producers. They share posts, images, and videos and sell their belongings on retail sites as well. Accordingly, the need for understanding and automatic management of multimedia contents has increased [1–4]. Analyzing multimedia data has been the center of attention for researchers in recent years and it is useful in marketing, recommendation, advertisement, etc [5–11]. In this regard different automatic image annotation methods have been developed in recent years. Automatic image annotation aims at analyzing and tagging the images content so that the tags can describe the contents suitably [2–4].

According to the fact that the same tags are usually used for similar images, automatic image annotation based on the nearest-neighbor images has attracted the researches' attention in recent years. The nearest-neighbor-based automatic image annotation obtains neighbor images through comparing low-level features between query image and training set, and next, extracts the tags to query image based on neighbor images [3].

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https://doi.org/10.1016/j.physa.2018.05.028
0378-4371/

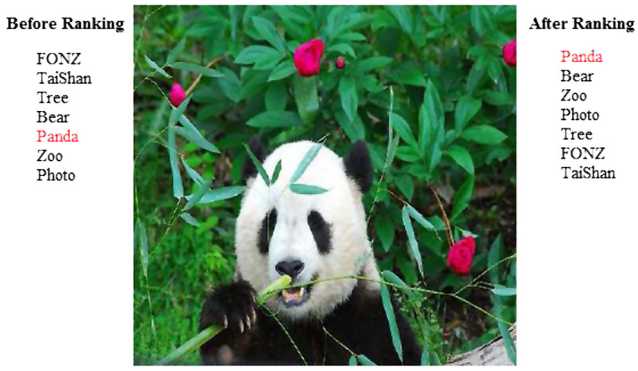

Fig. 1. An example of tags ranking.

In spite of vast studies and valuable ideas carried out in the field of automatic image annotation based on the nearest-neighbor images, considering the relationships of tags of similar images in a collection in a network and obtaining final tags for inputting an image using community detection in the network is an idea which has not been taken into account in previous works. Some studies have been done in the field of using community detection based on automatic image annotation [12–14]. In paper [13] community detection is used for clustering the tags. Each community is represented as a collection of interrelated concepts. In [12] a graph of the image's tags is created, afterwards the communities among them are recognized by the help of common methods. In the online phase, hidden communities for the input image are recognized using support vector machine. The communities are then used for ranking final tags. These approaches are limited because constructing tag graphs and partitioning them (detection of the communities) is done statically and the same process is carried out for all query images.

The proposed method in this paper uses community detection in the nearest neighbor images tags. First, the proposed method extracts the features from images and neighbor images. Afterwards, the most similar images to the query image are identified. Next, using similar images, a graph of associated tags is created and a community detection method is used to find its communities. Finally, the best (densest) community for the final tags of the query image is chosen from the network.

The contributions of this paper are as follows:

1. A tag network (i.e. a graph) is created from tags of neighbor images of a query image.
2. The tags are clustered together based on the graph connectivity (communities) and the most important community is selected and corresponding tags are assigned to the query image.

The outline of the paper is as follows: related works are reviewed in the second section. The proposed method is described and explained in details in the third section. The experimental results and simulations carried out based on the proposed method are explained in the fourth section. The conclusion is presented in the last section of the paper.

2. Related works

Various methods and studies have been tested and done by different people on automatic image annotation whose aims and applications are different [1–4]. Survey paper [2] analyzes different methods of automatic image annotation and also their classifications with putting emphasis on its two main parts including feature extraction and semantic learning/annotation. A recent survey [3] is another one which aims at filling the semantic gap existing among the tags of the images on social networks. In this paper grouping the methods of automatic image annotation based on the method used for similar image retrieval and neighbor images by the use of query image is presented. Considering the above-mentioned papers and also according to the fact that the images in different fields, especially the web and social networking websites, have incomplete and unreliable primary tags, tags refinement and ranking methods in image annotation have been considered in different works [15–24]. The previous studies are classified in two groups including tags ranking and tags refinement.

2.1. Tags ranking

The main idea of these methods is to add a new part to ranking, prioritizing and showing obtained primary tags considered as a post-processing section or the use of other tools/methods such as matrix factorization. Fig. 1 indicates the efficiency of the tags before and after ranking. As it can be seen clearly, primary tags are presented without considering the importance of different parts of the image content and the word Panda which is the clearest concept and considered as the fifth tag, while after ranking it is considered as the first tag.