Personalized and Enhanced Hybridized Semantic Algorithm for web image retrieval incorporating ontology classification, strategic query expansion, and content-based analysis☆

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ABSTRACT

Most of the existing web search systems are query-centric and are not user-centric. Mining images from the Web is a challenging task as it requires choosing the right methodology. A strategy that recommends images for homonyms and contextually similar terms have been proposed. The proposed system facilitates ontology modeling for homonyms and contextually related synonymous terms using description logics semantics and semantic similarity computation. An Enhanced Hybrid Semantic Algorithm that computes the semantic similarity and establishes dynamic OntoPath for easing the web image recommendation has been proposed. The proposed system classifies the ontologies using SVM and a Homonym LookUp directory. The methodology focuses on generating unique classes of images as an initial recommendation set. Based on the user click, strategic expansion of OntoPath takes place. Personalization is achieved by content-based analysis of the user click-through data. An overall accuracy of 95.87% is achieved by the proposed system.

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1. Introduction

The World Wide Web is the ultimate source of information in the present-day world. The Web is highly dynamic and keeps changing due to numerous changes that take place on it. With the increasing number of the users on the Web, web searches are becoming quite predominant and popular. A web search is a vital strategy of retrieving useful and required contents from the World Wide Web. A web search can also be termed as a lifeline for obtaining useful information from the Web. The Web is an affluent informational repository where the information density is the highest. Web search takes place through search engines which are an implementation of several web mining techniques and algorithms that make the mining of the Web quite easy and efficient. When a web page or a web content document needs to be retrieved, a simple approach involving calculating the semantic similarity between the query and web documents; techniques such as probabilistic matching, keyword matching, etc. are traditionally applied in order to retrieve the text content whereas when an image relevant to a query has to be retrieved, a problem arises.

The World Wide Web houses billions of images in the modern Instagram era. Retrieval of relevant images from the web has become a huge challenge. It has indeed become a problem to retrieve images as per the interests of the users'.

Owing to this reason, intelligent and more efficient schemes are required for extracting images that are not only relevant to the query but also satisfies the users' needs. To retrieve relevant images from the World Wide Web based on the user's search query, one can follow either the famous Content-Based Image Retrieval (CBIR) scheme or the Annotation Based Image Retrieval (ABIR) scheme or a hybrid of both. CBIR strategy focuses on retrieving images based on the intrinsic image features namely the color, texture, contours, shapes, pixel density, etc. In CBIR strategy, traditional image processing techniques or the computer vision are primarily applied for retrieving relevant images from the World Wide Web. Although CBIR strategy was successful in the earlier attempts to retrieve images from the Web, due to the increasing number of images in the Web, it is quite difficult to analyze the actual contents of the image and then filter them based on the extracted features. This not only increases the computational complexity but also the relevance rate of the recommended images is diminished owing to the high density of image content on the Web.

The ABIR scheme uses image descriptions, image metadata, annotations or image tags, labels, etc., for recommending images from the Web. The ABIR strategy uses the knowledge associated with a specific image rather than the actual contents. This definitely reduces the computational complexity as the image features are not targeted. The ABIR scheme focuses on algorithmically formulating or generating image tags based on the contextual image descriptions. It is a strategy in which textual vocabulary is assigned to visual images. ABIR has proven to be much efficient as the computational load of ABIR algorithms is much lower than the CBIR algorithms. Semantic strategies, when incorporated in traditional ABIR mechanisms, yield results that are much appreciable. However, even ABIR has associated disadvantages specifically when homonyms are encountered in the search term. The search queries constituting homonyms require a context-based analysis as well as a strategy to predict user's exact requirement among the various meanings of the ambiguous homonym terms. There is also a need for an appropriate Semantic model for computing the relevance of results in ABIR which strategically filters out the relevant items with that of the irrelevant items.

The Web houses a large number of homonyms that are spelled the same but with entirely different meanings. There are a large number of canonically similar terms like synonyms on the Web but with a differential semantic context. Sometimes terms that mean the same would contextually differ. To analyze the contextual terms, there is always a need for reference ontologies where the various contexts for a certain term can be predicted. Most web search engines are query-driven and the results are yielded as per the relevance to the query. Personalization of web searches is a mandate when there is a need for web searches to be customized as per the needs of the user. The users' intention must also be a driving force to display the images of high correctness and must be able to satisfy the users' need for image search. The search efficiency must still be maintained, i.e., the number of relevant images for a specific query-based search must be maximized. To deal with this, an ontological approach for image recommendation is proposed for web image search. Ontologies can be visualized as the building blocks of the structure of the Web as ontological entities incorporate a semantic meaning to the web. Ontologies mainly focus on representing human conceptual understanding into machine representable and processable entities. The baseline for introducing ontologies is that ontological data can easily be obtained and ontologies have hierarchical associations between several unique and similar entities that are either visualized as classes, individuals or at least similar entities. Moreover, ontology has several associations with homogenous ontologies with in-depth hierarchical associations that may lead to several direct and indirect pathways for mining of relevant images.

Almost all the search engines that are presently existing are keyword driven that computes the relevance of the keywords, and matches it with the contents of the text which definitely makes the searches more exhausting. In the context of web image search, the relevance of the images retrieved is quite low with the resulting search images not satisfying the users' choice which in turn makes the search noisier and more cumbersome. Image search is an important application of web mining where the search engine must be able to extract the required images as per the query in a manner such that the images obtained must be highly relevant to the query that is input by the user. The user's intention, as well as the retrieved images, must have a high degree of correlation. The search engine must also be able to distinctly retrieve all the unique images for the query involving homonyms, synonyms and also several unique elements for the search query must be displayed.

More exhausting the search, noisier the search results; even the factor of green computing is lower when the search is exhaustive. The associations between the ontologies have a behavioral cognition effect that human understanding of certain ontological data is modeled as ontologies with a specific logic and human reasoning for achieving an axiomatic state between the ontologies involved. Owing to these reasons, ontologies are the most preferred entities for describing homonyms and synonyms into a machine-understandable manner for facilitating the mining algorithms to understand the terms that are highly likely. The users' intention must act as a driving force to display the images of high correctness and satisfy the users' need for image search. The search efficiency must still be maintained, i.e., the number of relevant images for a specific query-based search must be maximized.

1.1. Motivation

Most of the existing systems for web image retrieval have a query-oriented perspective and are not user oriented. The ultimate goal of any retrieval system must be based and directed as per the user's choice, thus satisfying the user's need for images. Certain existing systems which capture user's preferences still don't make a mark as they neglect the perspective of the user to give the best results. This enhances the noise of web image search and increases the irrelevance of images retrieved in the context of web image search that needs to be overcome. Apart from this, ABIR requires a context-based se-