Is Love All Around?
Visualization of Sentiments via Tagged Photo Analysis

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ABSTRACT
With the ever increasing user-generated content on the World Wide Web, many research works focus on the study of tag words associated with blog posts, news articles and photos. We propose a new idea to discover and visualize the emotion / mood / sentiment of our world based on geo-tagged photos on Flickr.

Categories and Subject Descriptors
H.3.1 [**Information Storage and Retrieval**]: Content Analysis and Indexing
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Algorithms, Measurement, Experimentation, Human Factors

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1. INTRODUCTION
The ever increasing computing power and the growing speed of data transmission capabilities encourage the growth of linked and semantically enriched data to be present on the Web. The Web is now growing with user-annotated / tagged information. Web information resources such as blog posts, documents, photos, etc. are often tagged to facilitate search and subsequent retrieval. For textual information, tags can be generated by classic keyword extraction algorithms such as tf-idf and LDA. With expanded bandwidth and faster computing power, rather than plain text, the Web has been transformed to a world full of visual or multimedia objects. Visual resources are largely dependent on user-tagging. According to findings by Lee et al. [7], much user-generated content on the Web are geo-tagged, tagged with geographical data such as place name, and country. Mobile phones and cameras with built-in GPS functionality becoming common and popular that photo-sharing websites are loaded with photos with associated geographical metadata generated by GPS.

With the increasing popularity of photo-sharing sites and user-generated visual content, tags play more important role in search & retrieval. Recent research related to tagging mainly concentrated on indexing & retrieval such as the facilitation of the selection of tag words [4], [5], [6]. Some researchers [8], [12] begin to correlate the concept of a photo to the meanings of their tags. On the retrieval side, popular image search engines, such as Google image search, base their search on keywords generated from text content associated with images. For example, Yahoo! has provided keyword search integrated with Flickr images based on tags.

Section 2 describes our method to determine the emotion / mood / sentiment of photos on Flickr using SentiWordNet lexicon [1] as a knowledge-base. We discuss our approach to the visualization of the sentiments generated from geo-tagged photos on Google Maps [3]. To the best of our knowledge, EmoCloud is the first attempt to visualize the world's mood over Google Maps by emotional context generated from geo-tagged photos in the public domain.

2. SENTIMENT OF PHOTOS
Our research project focuses on the discovery and visualization of the sentiment / emotion / mood of the world by analyzing the tag words associated with Flickr Photos. We analyze positive & negative polarity sentiments of geo-tagged photos on Flickr, using SentiWordNet, a lexical resource [1] for opinion mining as a knowledge-base. This lexicon assigns to each set of cognitive synonym (synset) of WordNet three sentiment scores: positivity, negativity, objectivity. In our study, we translate positivity and negativity scores from SentiWordNet to a single sentiment value which ranges from +1 (positive) to -1 (negative) with zero to indicate neutrality. To determine the sentiment of a photo, we calculate the sentiment value for each of the tag words associated with the photo. The averaged score of all the tag words is then assigned as the overall SentiScore to the photo as illustrated in Table 1.

Table 1. Calculation of Sentiment Scores

Photo	Tags / sentiment values	SentiScore
	ready / 0.0613 slow / -0.043 fun / 0.375 fast / 0.009 go / 0.2500	0.1304

3. VISUALIZATION OF SENTIMENTS

We adopted the beauty of pie charts and designed a glyph in form of a pie chart, namely EmoCloud, to represent the overall sentiments of a geographical location. As shown in Figure 1, EmoCloud has a color transition from blue to red with a flow of purple gradients/slices in between. In this encoding scheme, red and blue represent the extreme positive and negative sentiments and the overall size of the pie illustrates the total number of photos. We formulated a scale from 1 (being most negative) to 9 (being most positive) with a color transitioning from blue to red. The width of slices encodes a sentiment level's frequency of occurrence. If an EmoCloud is dominated by either blue or red color, one can interpret the overall sentiment as either very negative or very positive in that geographical location.

Figure 1. Polarized Pie Charts provide Sentiment Overview

Flickr allows users to upload Geo-encoded photos in Exchangeable image file format (Exif) or to annotate the Geo-location after a photo is uploaded. The availability of this geo-information results in accurate positioning of the EmoClouds. Figure 2 shows a snapshot of sentiments interpreted from the Sentiment scores generated from a collection of Flickr photos taken in the first week of 2011. As a snapshot of sentiments on a specific day does not cater for events or any natural phenomenons happening over a period of time, we implemented time windows of week and month to capture related photos created in adjacent timeframe. A static EmoCloud only reveals the mood of the world in a certain window of time, we have extended our visualization to support multiple zoom levels and temporal setting, making possible a detailed examination of changes in sentiments over time; with EmoCloud floating on a world map (Google Maps) like weather maps.

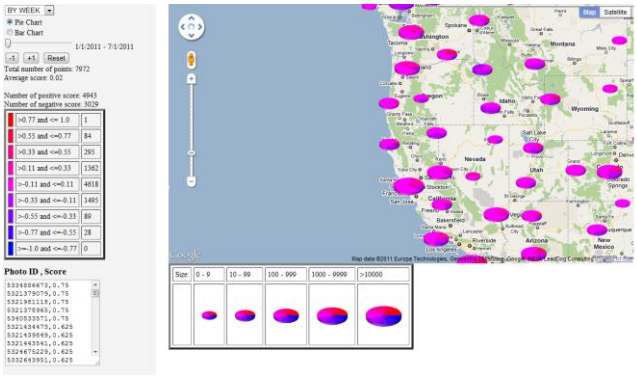

Figure 2. The EmoCloud System

4. FLICKR DATASET

We obtained the photo ID's and their tag words via Flickr API service [2] to create our dataset. The dataset contains a total of 480,218 geo-tagged photos in the public domain taken in USA between January 1, 2011 and March 31, 2011.

5. PRELIMINARY RESULTS

We implemented EmoCloud based on the sentiment analysis and visualization approach described in previous sections. The Flickr dataset we use in our study consists of 480,218 geo-tagged photos with a total of 5,925,938 tag words. 198,633 photos without sentiment score are excluded. Figure 3 shows an overview of the sentiments of USA on the New Year day. For instance, the EmoCloud at location Y indicates distinctive sentiments. We drilled down to a few individual photos as shown in Figure 4 contributed to the EmoCloud.

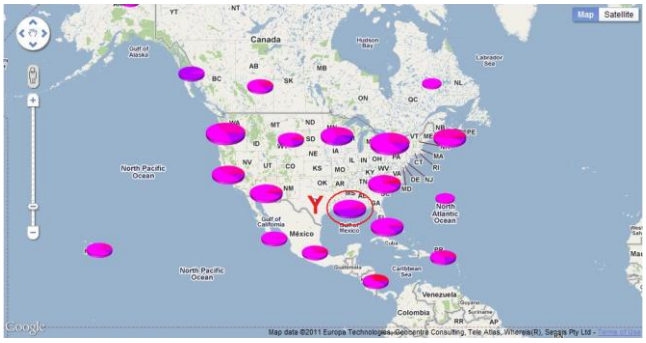

Figure 3. Sentiments of USA on Jan 1, 2011

(a)  (b) 

Figure 4. Photos in location Y contributed to strong sentiments: (a) Positive, (b) Negative

Photo (a) with positive sentiment reflects the true seasonal atmosphere of New Year. In our wondering on what gives a negative sentiment on New Year day, we sampled photo (b) which shows a happy face of a homeless old man due to the tag word "homeless". It is arguable this photo should be considered as positive with a happy face.

From our preliminary results, we have observed the following issues we have to address in future studies:

- Tag words provide far less information than the photo description written by the user. One shall consider mining the opinion of the photo description in addition to the tags.
- Many vocabularies and important entities not covered by SentiWordNet. One can expand the vocabularies coverage with additional knowledge-base such as Wikipedia proposed by Overell et al. [10].
- Inadvertent interpretation of named entities in tag words into either negative (e.g. Salt Lake City = -0.75) or positive sentiments. One approach to avoid this issue is to classify tag words into semantic categories with WordNet [9] and to include emotion related words only in the calculation of sentiment score.
- Overall sentiments of a geo-location can be skewed by large number of photos from single occasion (e.g. studio shooting for commercials) uploaded by one user.

- The challenge of languages and regional differences. WordNet's for Chinese, Korean and Japanese are available. However, we need corresponding SentiWordNet's in order to analyze photos tagged in languages other than English.

With the understanding of the above limitations in the current version of EmoCloud, the system provides some insights on our world's sentiments and a useful visual analytical tool to researchers in this area and users from social studies, humanities, new agencies, etc.

6. CONCLUSIONS

In this paper, we presented an approach to translate photo tag words into sentiment scores and to visualize sentiments over a world map. Future applications of EmoCloud will be on analysis of geo-tagged photos with domain-specific knowledge. New knowledge or insights can be obtained by overlaying interpreted information associated with photos on a map. Instead of displaying the photos, genres or themes derived from the tags associated with photos can be overlaid on the map. Our preliminary results show an interesting satellite's view of USA in a whole new spectrum other than the usual visible light, infrared or Gamma-ray. EmoCloud, an attempt to answer the question "Is Love All Around?", allows us to see the mood of our world for the first time. Our future research works will be on the issues outlined in section 5 with major focus on improvement of tag word interpretation and to classify the sentiments with emotion models such as the circumplex [11].

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