Aggregating visual evidence from social media photos to monitor the natural world

ABSTRACT

Social photo-sharing websites collect a huge amount of latent visual information about the world, including information about the environment and ecology. In this work, we propose to reconstruct satellite maps of environmental status across North America through millions of publicly available geo-temporal tagged images. We apply modern deep learning-based recognition techniques to identify phenomena in images, and then aggregate evidence from multiple users to estimate whether or not the phenomena were occurring in a given time and place. We then evaluate the accuracy of these estimates by comparing to actual satellite maps as ground truth. As test cases, we consider two important ecological phenomena for which high quality ground truth is available: snowfall coverage and vegetation (greenery) coverage. We find that while the automatic recognition techniques are noisy on any single particular image, we can accurately estimate the phenomena's presence when enough users have uploaded enough photos at a particular time and place. This evidence from photo-sharing websites could create new sources of data for ecologists, perhaps helping to overcome the limitations of traditional data collection techniques like manual observation (which is labor intensive) or satellites (which are not able to observe through clouds).

Keywords

ACM proceedings; LaTeX; text tagging

1. INTRODUCTION

Monitoring the meteorology and vegetation phenomenon is the cornerstone and challenge of ecology and biology research. Expensive satellite images give large scale data but struggle with cloud cover, atmospheric conditions and fine-grained localization such as flower species distribution, human interaction with nature, while citizen science provides high quality data but is also costly and is very difficult to practice over large scale areas. The enormous popularity of photo-sharing website collects images in large spatial scale, from under clouds and in close focus (compare to aerial surveillance), moreover, they are freely accessible to the public. The more than 300 million images uploaded to social media every day [**?**] potentially contain not only human activities, but also outdoor ecology and biology information intentionally and incidentally as shown in Figure 2.

The idea of reproducing satellite maps has become more and more interesting to scientists applying textual mining on **FiXme Note: citestock, ecology, election, tourists**, and recently to computer vision researches directly deriving **FiXme Note: citetemperature, cloud, mountain peak** information from visual content. In this paper, we test the feasibility of leveraging these noisy and biased images as a new approach to observe nature. We study 2 particular phenomena, snowfall and vegetation coverage as they are fundamental topic in ecology and biology study, have relatively distinct appearance to recognize, have a good chance to appear in social media, and also have satellite maps available to serve as ground truth. Our approach is illustrated in Figure 1. First, we collect a large hand-labeled data set of the existence or absence of ecology phenomena. Then, we train a classifier for each phenomenon by combining its most discriminative visual features and by using deep learning features. Finally, we collect 12 million images from entire North America over 2 years, make prediction on geo and temporal scale by aggregating this visual evidence.

This paper is built on our earlier work **FiXme Note: citewww** analyzing ecology phenomenon from image tags only. We apply a new approach understanding visual content of images, and run experiments on the exact same data set to study how vision techniques could help in social media data mining compared to using textual data alone. Also, to our best knowledge, among all the research works performing social sensing with image data, this is the first one providing continental scale quantitative performance evaluation.

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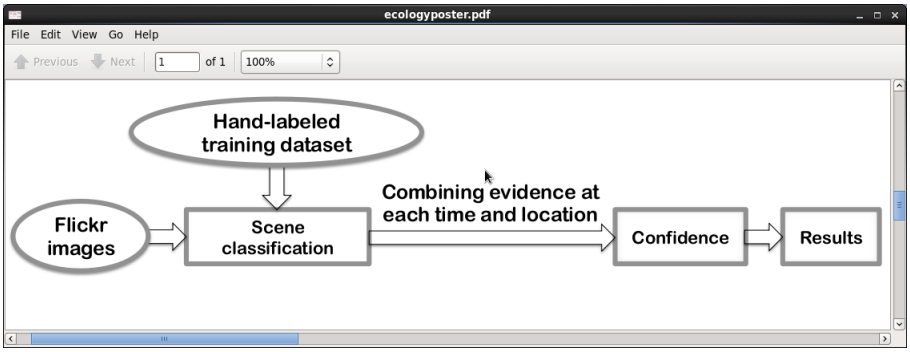

Figure 1: Overview of our approach to apply image classifiers on large scale images and make prediction by aggregating these visual evidence. FiXme Note: first classifier, then prediction

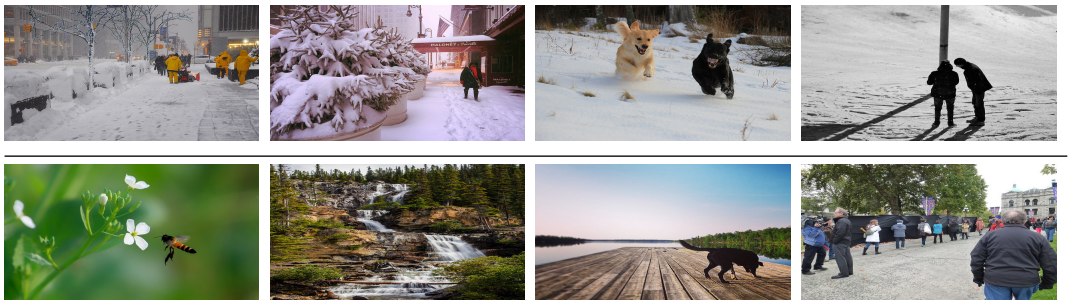

Figure 2: Flickr image examples capture snow and greenery evidence on purpose and as background.