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Methods for evaluating volunteers' contributions in a deforestation detection citizen science project

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HIGHLIGHTS

- We present methods to assess the volunteers' performance in a citizen science project.
- Results from more than 500 volunteers are presented.
- We show that simple statistical increase the efficiency of the data collecting tasks.
- Procedures to identify malicious behavior and outliers are presented.

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ABSTRACT

Today, due to the availability of free remote sensing data, efficient algorithms for image classification and increased connectivity and computing power, together with international policy initiatives, such as the United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation (UN-REDD), more and more countries are investing in their own national forest monitoring schemes. However, tropical forests remain under threat worldwide. Recently, a citizen science project that enables citizens around the globe to be involved in forest monitoring tasks has been proposed, called "ForestWatchers" (www.forestwatchers.net). Its main goal is to allow volunteers (many of them with no scientific training) around the globe, with their own smartphones, tablets and notebooks, review satellite images of forested regions and confirm whether automatic assignments of forested and deforested regions are correct. Inspected images are then sent to a central database where the results are integrated to generate up-to-date deforestation maps. This approach offers a low-cost way to both strengthen the scientific infrastructure and engage members of the public in science. Here, we describe the methods developed within the scope of the ForestWatchers project to assess the volunteers' performance. These tools have been evaluated with data of two of the project's preliminary tasks. The first, called "BestTile", asks volunteers to select which of several images of the same area has the least cloud cover, while in the second, called "Deforestation", volunteers draw polygons on satellite images delimiting areas they believe have been deforested. The results from more than 500 volunteers show that using simple statistical tests, it is possible to achieve a triple goal: to increase the overall efficiency of the data collecting tasks by reducing the required number of volunteers per task, to identify malicious behavior and outliers, and to motivate volunteers to continue their contributions.

1. Introduction

Today, large volumes of data are being produced by all types of experiments, simulations, sensors and satellites. The analysis of this wealth of information is often hampered by the lack of manpower [1] or efficient computational algorithms [2].

In this context, citizen science – a term used to designate projects in which volunteers, many with no scientific training, perform and collaborate on scientific tasks [3] – has been proposed as a possible solution to these problems. A scientific task for citizen science can be defined as the primary activity performed by a volunteer within the scope of the project to achieve its objectives. The structure and complexity of the task is inherent to the project's

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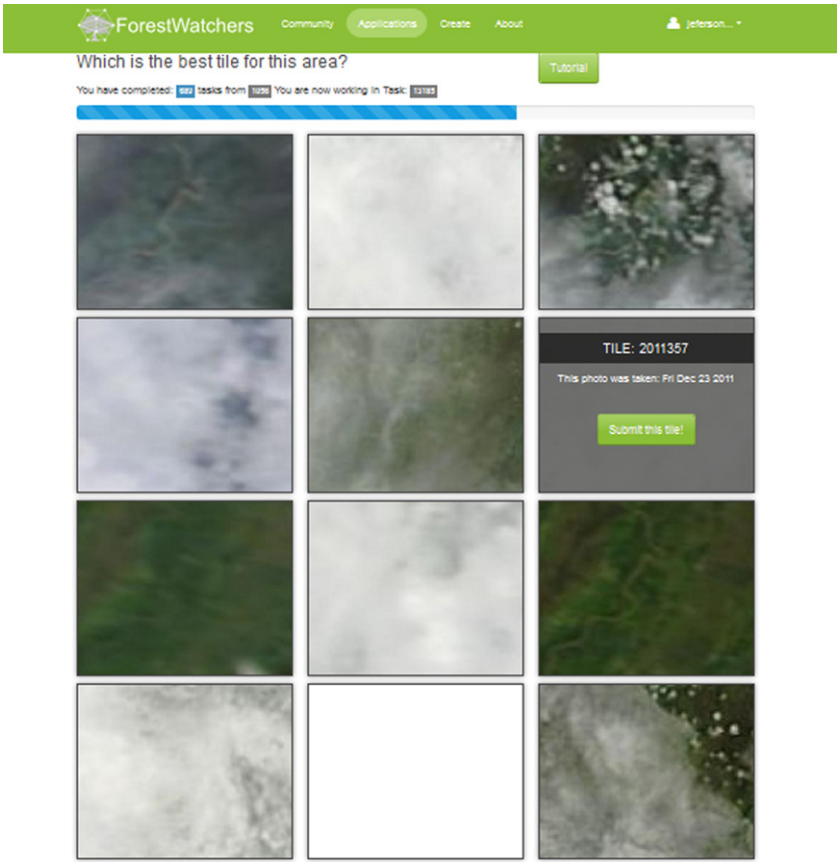

Fig. 1. BestTile task interface example.

goal [4]. For this work, the tasks considered are the following: (I) for the BestTile application (Section 3), the selection of the satellite image tile with the least cloud coverage, and (II) for the Deforestation application (Section 4), the drawing of a polygon delimiting deforested patches of forest. In the Galaxy Zoo project, volunteers are asked to visually classify galaxies according to certain pre-defined patterns. In a matter of months, more than 100 million ratings were completed by more than 200 thousand volunteers, with greater accuracy than that provided by any automated process. Moreover, the statistics showed that the ratings were as accurate as classifications carried out by professional astronomers [5,6].

Recently, based on the spirit of the 1992 Rio Declaration on Environment and Development, which states in its tenth principle that environmental issues are best handled with participation of all concerned citizens, the ForestWatchers (FW) project (www.forestwatchers.net) has been proposed. FW seeks to enable citizens around the globe to be involved in forest monitoring tasks. Its main goal is to allow volunteers around the globe, with their own smartphones, tablets and notebooks, monitor forests and search for deforested areas by inspecting satellite images. Inspected images will be then sent to a central database where results will be integrated to generate up-to-date deforestation maps.

The key to the success of Galaxy Zoo and other citizen science projects include procedures to guarantee the quality of volunteers' contributions. To assure some precision within the collected results, checks and heuristics can be applied to them [7,8]. Verification and validation techniques can also be used to improve the quality of the data [9]. As mentioned by Ipeirotis [10], errors and frauds can be detected by a redundancy system, in which volunteers' classifications are compared to expert classifications.

Here, we describe the methods developed within the scope of the ForestWatchers project to assess volunteer performance. These methods have been evaluated using data from two applications. The first, called "BestTile", asks volunteers to select among several images of the same area, acquired on different days, the one that has the least cloud cover. In the second, called "Deforestation", volunteers are invited to draw polygons on satellite images delimiting areas they believe have been deforested. Results from more than 500 volunteers show that using simple statistical tests, it is possible to achieve a triple goal: to increase the overall efficiency of the data collecting tasks, by reducing the required number of volunteers per task; to identify malicious behavior (such as sabotaging project progress or submitting misinformation [11]) and outliers; and to motivate volunteers to continue their contributions.

2. Data analysis tools

Currently, Forest Watchers has 3 applications. Correct Classification asks volunteers to assess the quality of a previous categorization executed by an automatic classification algorithm based on a neural network for two areas in Brazil: Rondônia State and the Awá-Guajá Indigenous Reserve. BestTile aims to provide an image with minimum cloud cover, which will then be used as an input to other applications. To this end, 12 image tiles from the same geographic region, acquired on distinct days, are presented to ForestWatchers' volunteers who are asked to select the least cloudy one (Fig. 1 shows an example of a task for BestTile). Deforestation asks volunteers to draw polygons on satellite images delimiting areas they believe have been deforested. These applications use NASA's TERRA-1 images, from the MODIS sensor. Images consist of True Color products with 250 m spatial resolution, delimited by FAS-Brazil7 clipping (division adopted by the Foreign Agricultural Service from the US Department of Agriculture), covering an area of approximately 2.1 million square kilometers. All images were divided into 1056 tiles or tasks and submitted to volunteers' scrutiny.