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Moon Zoo: Making the public part of a crater survey algorithm

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Abstract

The Moon Zoo citizen science website launched in May 2010 and invited the public to annotate images from the Lunar Reconnaissance Orbiter's Narrow Angle Camera (NAC). Tasks included marking the edges of craters with an ellipse tool, indicating where linear features (e.g. scarps) and special types of craters (e.g. dark haloed) are located with a box, and rating the number of boulders in an image. The goal of this project is to create crater and feature catalogues for large areas of the moon. In addition to doing science, Moon Zoo also seeks to educate its audience through educational content, to engage them through social media, and to understand them through research into their motivations and behaviors.

1. Introduction

The Lunar Reconnaissance Orbiter can acquire 300 – 350 Narrow Angle Camera stripes each day. These tens of gigabytes of images represent a wealth of information that no one scientist or even small team of scientists can analyze in real time. Computers aren't yet able to fully solve this problem of too much image data by doing basic analysis, such as crater identification, entirely on their own. Although humans are easily able to classify craters, only ~70-80% accuracy can be achieved with state-of-the-art automatic classification (Urbach & Stepinski 2009). Moon Zoo seeks to become one part of a data reduction pipeline by engaging the public in the identification and annotation of geomorphological features in LRO NAC images, both in lieu of and in concert with crater-finding algorithms. Without human intervention by citizen scientists and pros alike, crater classification is restricted to areas with large, regular craters (Martins et al. 2009).

2. Science Tasks

The initial site design (which will be updated in the second half of 2011) offered users two different science tasks the could participate in; "Crater Survey" and "Boulder Wars." [3] Boulder Wars simply asks users to compare to images and select which has more craters (or to indicate neither has craters). The Crater Survey has users do 5 different tasks: 1) mark the edges of craters; 2) indicate the level of boulderiness (none, some, many); 3) mark spacecraft; 4) mark the presence of crater features (bench / mound / flat, dark haloes, fresh white, elongate pits); and 5) mark linear features. All these tasks are performed through a Flash-based interface accessed through a web browser (moonzoo.org).

3. Data Validation

At the time of this writing, the validation of Moon Zoo volunteer data is ongoing and still being refined. The basic process includes comparing the annotations of geomorphological features, such as craters, made by individual users to those made for a subset of the data by expert users. A comparative tree algorithm is used to determine how user annotations compare to expert user annotations and to assign a confidence value to each user. The annotations of high-confidence value users are then used to weight the annotations of users in other areas. Once users have been assigned a confidence score, this is applied to all features they identified. The features are then run through a basic clustering algorithm that takes one crater and looks for all other craters within a (adjustable) distance and size buffer that is likely to be the same feature identified by another user. Once a cluster of features is generated, a weighted mean is calculated to determine a final crater center and diameter where the weights are the confidences on the different users. Features identified by only one user are rejected. We will present results for one of our first year NAC image strips illustrating how this process works and how Moon Zoo results compare with both expert crater identification and with some automated crater detection software.

3. User Behaviors

Users of the initial site design accessed the site through a sign-in page designed to funnel people quickly to the science tasks. While additional content, in the form of a tutorial, project-related content, educational materials, and data mining tools were present, the majority of the users restricted their site usage to the science tasks. Only 12% of the users who made a classification utilized the site's tutorial. Many other areas of the website were more regularly accessed, such as educational content (viewed by 37% of users), the forums (32%), and social content (18%). The data mining area of the website, however, was accessed less than others (only 5% accessing). In addition to looking at how users accessed different pages within the Moon Zoo site, we also studied how the users used the science tasks. We found less than half of the users marked additional features in the images. Until detailed comparison is made with expert annotations it is unclear if this is due to users not using these site features or these features not being prevalent in selected images. Initial comparisons will be presented.

4. User Motivations

In order to succeed, Moon Zoo requires sufficiently large numbers of people to be involved such that their combined contributions create usable feature maps faster than can be accomplished by teams of scientists either making their own expert classifications or working with feature identification software. To build and sustain a sufficiently large user base, it is necessary to understand what motivates users to become involved and to study what factors cause them to leave and to stay. To answer these questions, during the fall of 2010, interviews were conducted with 51 Moon Zoo users who possessed a mix of user histories (e.g. new and long-term users, users who only used Moon Zoo and users who used other citizen science projects, etc). The determined motivations are as follows (not ordered): 1) Apollo Mission related motivation, "I am a child of the 1960's and have a personal interest." 2) A motivation based on the beauty of the images, "The wonderful LRO images are amazing to watch." 3) A community related motivation, "It is fun to make friends." 4) Motivated by the desire to contribute to research, "I am excited to contribute to original scientific research." 5) Motivated by the possibility of making a discovery, "I might discover something scientifically interesting." 6) A motivation to help where they feel needed, "I am happy to help do what I can." 7) Motivated by the potential of learning, "I was looking for ways to learn about the moon." 8) An emotional motivation based the Moon's location, "I'm in love with the nearby moon." 9) Motivated by an interest in lunar science, "Lunar science is important for future exploration." 10) A general science-related motivation, "I find science interesting." 11) Motivations related to the nature of the project, including the Zooniverse as a whole, "I'm interested in everything the Zooniverse does", and a project-specific motivation, "I wanted to see how this project / crowd sourcing works."

We see very clear categories of motivations within our sample that represent typical work motivation factors, such as human needs and values (learning, contribute); affect and emotion (moon-emotion); social motives (community) and contextual sources such as 'project' and 'science'. This suggests that participants of citizen science projects in general make decisions to participate based, not only on their interest in the subject matter, but also on the nature of the task to be completed and other factors external to their immediate needs. Additionally, we find project specific motivations that include personal relations with the Earth's Moon as well as factors concerning the umbrella Zooniverse project and the sister project Galaxy Zoo. We also found from the interviews that lack of feedback may be users' greatest frustration. In order to determine the frequency of each of these motivations in the Moon Zoo population, and the prevalence different user needs that should be met in future redesigns, a large-scale survey is being conducted in the summer of 2011 and preliminary results will be presented.

Acknowledgements

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