Adaptive gamification of citizen science projects

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Abstract. Mass collaboration mediated by technology is now commonplace (Wikipedia, Quora, TripAdvisor). Online mass collaboration is also present in science in the form of Citizen Science. These collaboration models, which have a large community of contributors coordinated to pursue a common goal, are known as Collaborative systems. Gamification is a strategy to convene participants to CS projects. However, it cannot be generalized because of the different users' profiles, and so it must be tailored to the users and playing contexts. This Ph.D. project approaches the problem of adapting gamification to the user's profile, project objectives, and global status.

Keywords. Citizen Science, Gamification, Adaptive Gamification, Collaborative Project.

1 Introduction

Citizen science encompasses a range of methodologies that encourage and support the contributions of the public to the advancement of scientific and engineering research and monitoring. The public contributes co-identifying research questions; co-designing/conducting investigations; co-designing/building/testing low-cost sensors; co-collecting and analysing data; co-developing data applications; and collaboratively solving complex problems [13].

Citizen science has become widely known in recent years thanks to the ubiquity of technology through communication technologies and the mass use of smartphones. In addition, there is a growing number of scientific projects and volunteers that collect data through their daily used resources. Consequently, research interest is awakened for the design, development, and implementation of the technologies that are needed for the exercise of citizen science [12].

As a strategy to reach the most significant number of people, considering the multiple cultural characteristics (origin, language, gender, age, among others) can be approached by scientific developments in the area of HCI (human computer interaction), and particularly gamification [12]. Gamification is the application of game strategies in spaces or areas whose nature is not playful [6].

The natural use of gamification is in citizen science projects [8], and there are already examples of gamified experiences. Although in some of these approaches, the exact related game mechanisms have different impacts on different people, the use of gamification elements may be more valued by some volunteers than by others. Some found it motivating and rewarding, while others ignored it or made them stop participating in the project. For some time, the HCI has been working on the formalization of playability heuristics and models of the components of games and game experiences [6].

Despite the rapid growth of the gameful design research area, and the current level of success in the user engagement that it reveals, these findings are not general in terms of the domain. Neither can be generalized to all users. The one-size-fits-all approach presents several limitations because of the different motivations, personalities, needs, or values of the users [1]. The design of game environments that are appropriate for everyone must consider a personalization or adaptation of the game elements and mechanics offered for each volunteer in each case. This adaptation should recognize the cultural aspects of the people and the interaction between them. Currently, the research stream on adaptive gamification is taking care of the gamification that each particular user needs in a particular moment, tailoring the gamification to the users and contexts[9].

For example, adaptation can be made on many aspects: the game storytelling, the game difficulty, the content generation, the guidance or hinting on the goals, the presentation, the curriculum sequencing, among others [7]. Nevertheless, the existing adaptive gamification approaches are not directly applicable to citizen science, given that they do not necessarily focus on the community aspect or project's objectives.

2 State of the art

A systematic mapping was carried out [11]To identify representative studies related to adaptive gamification and CLCS. The review allowed identifying different proposals for the scope (standard, ad-hoc or flexible) and the user model's versatility (dynamic vs. static). However, it was found that in most of the cases, the model is neither defined nor explicitly specified.

As a result of the evaluation, there were found different adaptation points of view, such as difficulty adaptation, storytelling adaptation, community-based adaptation, or gamification elements adaptation, where the goals/challenges and points are the most used. The user modeling is also important for an adaptation strategy and must be considered the scope of the model (standard, ad-hoc or flexible) and the versatility

(dynamic vs. static). The aspect that deserves further research is the adaptability considering the community, focusing on features that have not yet been worked on, such as cultural diversity, gender, and multiplicity of knowledge. Also, it is interesting to develop an approach of community modeling in community-aware adaptive gamification. These findings are compiled in [5].

3 Problem Statement and Contributions

The contributions of this Ph. D. project should include: a) a state of the art research, b) a conceptual framework modeling user behavior profile as well as the citizen science ecosystem and the game elements and mechanics applicable to these projects, c) an adaptation device based on machine learning techniques, to tailor the gamification to the users and community.

4 Methodology and Evaluation Plan

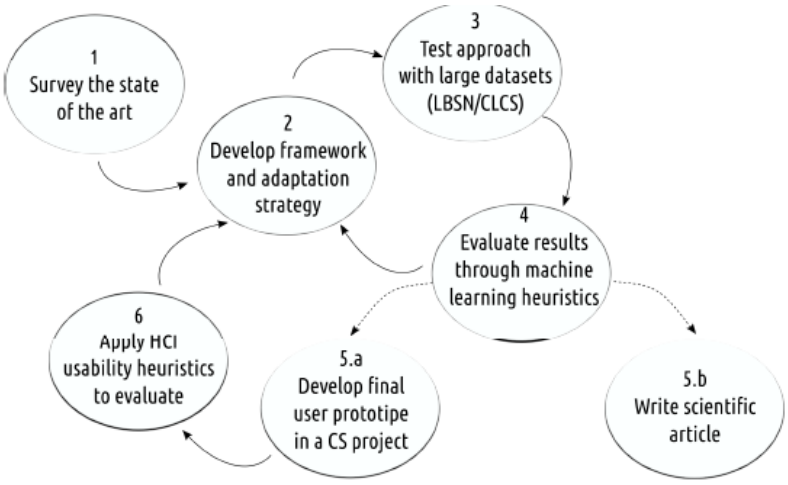

Fig. 1. Methodology

The main objective of this Ph.D. project is to develop and design an adaptive gamification approach in the context of citizen science projects. This objective can be decomposed into other finer-grained objectives. Firstly, to build a conceptual

framework as a set of modeling elements and relationships that can describe the users' behavior through their interaction activity (among them and with the system); the citizen science community ecosystem; and the applicable game elements and mechanics to these collaborative projects. Lastly, to design an adaptation strategy based on machine learning techniques to tailor the game experience using the user behavior, community, and game elements models. The research methodology is a process with the following steps: 1) to survey state of the art in the game elements adaptability research area, related to collaborative collecting projects and citizen science, in particular, 2) Development of an approach over the conceptual framework and the adaptation strategy, 3) testing the approach on historical data of large scale datasets from Location-Based Social Networks (LBSN) or Collaborative Location Collecting Systems projects (CLCS), 4) to evaluate results by applying machine learning quality heuristics, 5) to consider these partial results to give place to new concerns and the potential writing of a scientific article, 6) to develop a prototype for end-users where this adaptation strategy is incorporated to a citizen science application, 7) to conduct heuristic evaluations for usability in HCI [10]. Steps 2 to 7 are part of an iterative process (see Figure 1).

5 Preliminary or Intermediate Results

The project has reached the following milestones:

- Adaptive Gamification in Collaborative systems, a Systematic Mapping Study: a study of the published research on the application of adaptive gamification to collaborative systems

The study focuses on works that explicitly discuss an approach to personalization or adaptation of the gamification elements in this system. It employs a systematic mapping design in which a categorical structure for classifying the research results is proposed based on the topics that emerged from the papers' review. Published in Computer Science Review journal [5]

- Adaptive gamification in collaborative location collecting systems: a case of traveling behavior detection

This work is focused on the first steps to detect users' behavioral profiles related to spatial-temporal activities in the context of collaborative location collecting systems. This article was accepted in IX Conference on Cloud computing, Big Data, and Emerging Topics.

- Adaptive gamification in collaborative location collecting systems: a case of traveling behavior detection

This work is focused on the first steps to detecting users' behavioral profiles related to spatial-temporal activities in the context of CLCS. Specifically, this article introduces: (1) a strategy to detect patterns of spatial-temporal activities, (2) a model to describe the spatial-temporal behavior of users based on (1), and a strategy to

detect users' behavioral patterns based on unsupervised clustering. The approach is evaluated over a Foursquare dataset. The results showed two types of behavioral atoms and two types of users' behavioral patterns. [4]

- Relevance of non-activity representation in traveling user behavior profiling for adaptive gamification

This work presents two approaches of traveling user behavior profiling: a raw series built up with categorical data that describes the activity of the user in a period, and a timed series that is an enhanced version of the first that includes a representation of the non-activity time frames. This article seeks to analyze what aspects the different representations can contribute to describing user behavior categories to offer a tailored gamification strategy. Conference paper published in the XXI international conference in HCI [2].

- A model of adaptive gamification in collaborative location-based collecting systems

This article presented an automatic game challenge generation approach for CLCS. The needs and characteristics of the CLCS are presented, such as the space-time objectives and the space-time user behavior, to later be valued during the automatic generation of game challenges. The contributions are a user profile model considering the space-time behavior and challenge completion, a model for the different types of challenges applicable in CLCS, a model for the CLCS objectives and coverage, and a strategy for the application of Machine Learning techniques for adaptation. Conference paper published in the 3rd International Conference on Artificial Intelligence in HCI [3].

6 Conclusions and Learned Lessons

The project's next step is to develop the game challenge recommendation system on synthetic data or from an existing CLCS. The recommendation must then be incorporated as a gamification strategy into an end-user prototype.

7 Ph.D. Stage

This PhD project can be considered in a middle stage.

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