Gamification Techniques in Collaborative Interactive Evolutionary Computation

Mario García-Valdez, José-C Romero, Alejandra Mancilla
Dept. of Graduate Studies,
Instituto Tecnológico de Tijuana,
Tijuana, México
mariosky@gmail.com
josec.romero@tectijuana.edu.mx

Juan-J. Merelo
Dept. of Computer Architecture and Technology, University of Granada,
Granada, Spain
jmerelo@ugr.es

Francisco Fernández-de-Vega
Grupo de Evolución Artificial,
Universidad de Extremadura, Spain
fcofdez@unex.es

ABSTRACT

The necessary intervention of humans in interactive evolutionary computational systems has inherent drawbacks arising from the very nature of the algorithms, namely, the human fatigue caused by the interaction and the boredom arising when users evaluate a large number of artifacts. To tackle these issues, in this paper we propose a human-centered framework that can be used to increase volunteer participation in collaborative interactive evolutionary computational (C-IEC) systems by using gamification techniques. A case study is presented where the model is applied in the development of a collaborative evolutionary interactive system.

CCS CONCEPTS

•Human-centered computing → Collaborative and social computing systems and tools;

KEYWORDS

Interactive evolutionary computation, Human Centered Computing

ACM Reference format:
Mario García-Valdez, José-C Romero, Alejandra Mancilla, Juan-J. Merelo, and Francisco Fernández-de-Vega. 2017. Gamification Techniques in Collaborative Interactive Evolutionary Computation. In *Proceedings of GECCO '17 Companion, Berlin, Germany, July 15-19, 2017,* 2 pages.
DOI: http://dx.doi.org/10.1145/3067695.3076067

1 INTRODUCTION

The intervention of humans brings particular challenges to designers of Interactive evolutionary computation (IEC) systems. Namely, human evaluations are scarce, slow and expensive, there is human fatigue caused by the interaction [13], and also boredom arises when users evaluate a large number of phenotypes. The general goal of this research is to develop a human-centered [5] software framework that can be used to increase volunteer participation in C-IEC systems by using gamification techniques. Gamification is the use of game design elements in non-game contexts [2]. The gamification element employed in this work is a rewarding mechanism [3]. An example of the use of this technique is a recent work by Wagy & Bongard [14] where user interaction is needed for developing new designs of robot locomotion. Collaboration is encouraged by gamifying the system using the maximum distance indicator to inspire the user to try and "beat" previous designs. Also Seyama and Munetomo [11] propose the reduction of user fatigue by using a collaborative filtering algorithm to show only the information utilized by similar users. In Section 2 we present our proposed framework. Next the EvoDrawings application case study is presented in Section 3 and the results are discussed in Section 4. Finally, some concluding remarks are provided in Section 5.

2 HUMAN-CENTERED C-IEC FRAMEWORK

The main design considerations of the framework are explained next:

- **Users are volunteers.** Users donate their computing resources, so they are unaccountable and sometimes they try to game the system. Project owners must actively promote and design the interactive system to engage volunteers [10].
- **Users are not alone** Relationships between users in an interactive evolutionary algorithm can be modeled as a social network, with well established semantics, algorithms and metrics [1].
- **Interaction is a stream of actions.** Real time processing of users' actions could be needed for certain applications when data is captured by sensors, or directly captured as user input. For example, social networks encourage users to publish their interactions with other users, media objects and places. there are initiatives like the W3C Activity Streams 2.0 specification, used for representing common activities in social web applications [12].

A graph is proposed for modeling the social network of users and their interactions with candidate solutions, and the relationships between them in the population. The graph database system used in the implementation is Neo4J, which is a scalable solution [7, 9]. This graph is also used to increase engagement through gamification, as explained in the next section.

GECCO '17 Companion, Berlin, Germany

DOI: http://dx.doi.org/10.1145/3067695.3076067

Table 1: After a week of the announcement the total number of volunteers, nodes and edges in the graph and analytics URLs

Deployment	Users	Nodes	Edges
B	53	595	2220
G	54	648	2596
GG	68	932	3594

3 CASE STUDY: EVODRAWINGS GAMIFICATION

As a case study, a C-IEC application was developed by extending the EvoSpace-Interactive (ES-I) platform [4]. The open source code is hosted in GitHub at https://github.com/mariosky/evo-drawings. The rewarding mechanism as it is applied in EvoDrawings gives more importance to the preference of those users with higher reputation as given by their score points and experience levels. Each time a user does on of these actions their score is incremented by one: start a session, rate a phenotype, create a collection, save a phenotype of the wall to a collection, save a phenotypes from a friend's collection, and explore collections of other friends. Each of these actions are stored in the Neo4J graph. Two variables are used to determine the weight of a user's preference:

- **Experience**: This variable depends on the score and is a value between 0 and 100. A new user starts at zero, and the experience increases until it reaches 100 actions.
- **Participation**: This variable is simply the degree of the user node in the graph (number of edges).

Three versions of EvoDrawings were compared: Base (B): All users have the same weight, Non Graph Gamification (G): Only experience is considered and Graph Gamification (GG): Both experience and participation are considered.

4 RESULTS

Before release, the deployment was first tried with a few beta testers. When applying the leader board gamification technique for the first time a problem was found: some users were cheating by giving a rating to an animation even before it was returned from the server, this was done by just constantly clicking the mouse button. This is a common problem found in systems using leader boards because by making the scores visible to other players they are encouraged to compete [6]. The version used in experiments disabled the button until the drawing animation was over. The results of each of the three experiments in terms of participation are detailed next.

Table 1 shows the total number of volunteers, nodes and edges in the graph after each experiment. When comparing all the experiments the GG deployment had the higher number of participation, besides attracting also the higher number of users.

5 CONCLUSIONS

In concordance with the results obtained in other browser-based volunteer systems, after applying the gamification techniques, user participation was increased.

One of the interesting future lines of work would be to look a bit more closely at the behavior of users as they are rating artifacts in the web system. These initial experiments hint at a possible power law, which might indicate that the IEC system could be self-organizing, a process that would allow it to reach a critical state, as has been found in software repositories, for instance [8].

One of the interesting future lines of work would be to study the possible negative effects of using gamification techniques to improve engagement, like cheating or literally *gaming* the system to defeat competition. Finally, the refinement of the proposed Human-Centered framework will need more case studies and further multi-disciplinary research.

ACKNOWLEDGMENTS

This work has been supported in part by: de Ministerio español de Economía y Competitividad under project TIN2014-56494-C4-3-P (UGR-EPHEMECH) and by Consejo Nacional de Ciencia y Tecnología under project 220590.

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