Involving people in Citizen Science through game incentives: the case of the STARS4ALL project on Light Pollution

Irene Celino, Gloria Re Calegari and Andrea Fiano

Cefriel, Politecnico di Milano – viale Sarca 226, 20126 Milano - Italy

{irene.celino,gloria.re,andrea.fiano}@cefriel.com

Abstract

We present the serious games for awareness creation and the games with a purpose for engagement in citizen science initiatives adopted in the STARS4ALL project.

The STARS4ALL project

Light pollution is the excessive, poorly directed or unnecessary artificial light at night (Hollan, 2009); it leads to negative effects on human well-being, biodiversity, visibility of stars, safety and energy consumption. We are witnessing an increasing awareness about the light pollution issue and the strategies to fight it: overhead lamps should never emit light directly above the horizontal, blue light should be avoided in favour of a colour temperature of 3000 K or lower, light should be used only as much as needed for the specific purpose. On the other hand, the study and measurement of the light pollution phenomenon is still partially an open research question (Sánchez de Miguel, 2015).

STARS4ALL[1] is a project funded by the European Union's H2020 Program, under contract number 688135. The project started in January 2016 and will end in December 2018. STARS4ALL involves eight institutions (UPM, CEFRIEL, SOTON, ECN, ESCP Europe, IAC, IGB and UCM) from five European countries. The goal of STARS4ALL is to raise public awareness of the existence of light pollution in many of the places we live in and the importance of taking measures to reduce it, informing people about the negative effects of artificial light on human wellbeing, biodiversity, visibility of stars, safety and energy waste.

STARS4ALL involves the general public through citizen science campaigns, named "Light Pollution Initiatives". Some of those initiatives have the purpose of *involving people in the research process*, while other campaigns are aimed at *awareness creation*. We hope that the discussion at the HCOMP Networking Workshop will help exchanging experiences and best practices, as well as finding cooperation opportunities in the area of game incentives.

Games with a Purpose to involve people in the research process

One indirect method to quantify the light pollution phenomenon is by analyzing pictures of the Earth at night, and especially of cities at night. The astronauts of the International Space Station (ISS) take tens of thousands of pictures of the Earth from above during their space missions; NASA makes this wealth of images available for free on the Web. Those pictures have the right level of resolution to detect the brightness and to distinguish the light sources; moreover, they are continuously taken across different missions, therefore they can be used also to study the light pollution evolution over time.

However, those images come unlabeled and their subject can vary greatly: photos can include not only cities at night and stars, but also images of astronauts floating in space, or of the ISS itself; cities and portions of Earth during the day; astral phenomena like the Aurora Borealis; and mixed-subjects images not of interest for light pollution research. Therefore, we address the task of classifying those images in order to make them suitable for subsequent analysis of light pollution levels.

In the STARS4ALL project, we developed the *Night Knights*[2] Game with a Purpose. The human participant plays the role of an astronaut with the mission of classifying images taken from the ISS. At the beginning of the game, each player is randomly coupled with another player and a sequence of images is shown to them simultaneously. Each image must be classified into six predefined categories and players can gain points only if they agree on the same classification. Each game lasts one minute and so people have to be quick to classify as many images as possible. Night Knights takes inspiration from one of the most famous GWAP for image classification, the ESP Game by Luis von Ahn (Law and Ahn, 2011). Data collected through Night Knights is available on STARS4ALL Open Data Portal[3] with a CC-BY license.

---

[1] Cf. http://www.stars4all.eu.
[2] Cf. http://www.nightknights.eu.
[3] Cf. http://ckan.stars4all.eu.

In 9 months, the game managed to engage about 650 users that played a substantial amount of time and classified almost 28,000 photos in 9 months. In our experiments, we decided to use the images classified through Night Knights as training set to set up different supervised learning classifiers, adopting both traditional approaches like Random Forest (Kotsiantis et al., 2007) and deep learning classifiers like DCNN (Krizhevsky at al., 2012).

Once trained on the Human Computation results, the Machine Learning approaches worked well and showed a classification "behaviour" quite similar to the one of the GWAP players. On the other hand, the Human Computation system was very effective in collecting labels from human classifiers in quite a short time, even if its long-term sustainability is unknown (Re Calegari et al., 2018b).

Serious Games to create awareness

When dealing with light pollution, many measurable quantities come into play, for example, for a light source, we could have: light intensity, color temperature, energy consumption, etc. If it is quite obvious that a brighter source can, potentially, pollute more than a fainter one, an average ordinary person may be unable to say if a blue light is better than a red one, or if a LED light pollutes more or less than a halogen bulb, from an environmental point of view. A game with an educational goal could help to transfer knowledge of this kind in a funny and entertaining way. The fact that light sources can be compared with respect to measurable physical quantities that characterize them reminded to us an old card game named Top Trumps[4].

In Top Trumps, card decks belong to different themes, such as cars, dinosaurs, wonders of the world and many others. For each theme a list of characteristics is defined and each card represent an item with its values for each characteristic. Cards are dealt among the players (at least two). At each turn, a player chooses a characteristic and all players draw a card from their respective sets; the player with the card that has the best value on the chosen characteristic wins the turn, get the drawn cards and has the right to choose the characteristic at the next turn. The winner is the player who obtains all the cards.

On the Top Trumps mechanisms, we built the *Stars Beat* serious game[5]. We implemented it as a digital version of the card game where the user plays against the computer, i.e. a player that makes random choices. A first card deck of commercial/shop signs is released to make players learn about the effect of color temperature, luminosity intensity, physical dimension, energy consumption on light pollution.

While not a pure Human Computation game, Stars Beat can nonetheless be useful in understanding the learning process of players, by the analysis of the game logs. As such, it can be used to inform the citizen science campaigns to focus on some specific topics that are less known or hardly understood by game players.

Enabling technologies for the community

The games developed in the STARS4ALL project are not simply instances of a specific type of application, but were released as open source software frameworks for the community to build applications of the same kind.

Specifically, the GWAP framework behind the Night Knights game was released with an Apache 2.0 license and named "*GWAP Enabler*"[6] (Re Calegari et al., 2018a): it can be freely reused to build classification games with similar goals. We also released a full tutorial on GitHub to explain the possible reuse of the framework[7].

In the same way, Stars Beat can be seen as a platform where to add additional "card decks" to implement serious games to create awareness on specific topics, also beyond the light pollution topic.

Acknowledgments

References

Hollan, J. (2009). What is light pollution, and how do we quantify it? Technical Report. N. Copernicus Observatory and Planetarium.

Kotsiantis, S. B, Zaharakis, I, and Pintelas, P. (2007). Supervised machine learning: A review of classification techniques. (2007).

Krizhevsky, A, Sutskever, I, and Hinton, G. E. (2012). ImageNet Classification with Deep Convolutional Neural Networks. In Proceedings of the 25th International Conference on Neural Information Processing Systems. 1097–1105.

Law, E and Ahn, L. v. (2011). Human computation. Synthesis Lectures on Artificial Intelligence and Machine Learning 5, 3,1–121.

Re Calegari G., Nasi G., Celino I., (2018a) Human computation vs. machine learning: an experimental comparison for image classification. Human Computation Journal (to appear).

Re Calegari G., Fiano A., Celino I., (2018b) A Framework to build Games with a Purpose for Linked Data Refinement. ISWC 2018.

Sánchez de Miguel, A. (2015). Variación espacial, temporal y espectral de la contaminación lumínica y sus fuentes: Metodología y resultados. Ph.D. Dissertation. Universidad Complutense de Madrid.

---

[4] Cf. http://toptrumps.in/about-us.php.
[5] Cf. https://starsbeat.stars4all.eu/.

[6] Cf. https://github.com/STARS4ALL/gwap-enabler.
[7] Cf. https://github.com/STARS4ALL/gwap-enabler-tutorial.