Gamification in Information Retrieval: State of the art, Challenges and Opportunities

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Abstract. Gamification aims at applying game design principles and elements, such as points, badges, feedbacks or leader boards in non-gaming environments. An interesting goal of gamification is to combine and exploit the fun factor for targeting other aspects like, for example, to achieve more accurate work, more cost effective solutions and better retention rates. In the context of Information Retrieval (IR), many tasks can benefit from gamification techniques. Think, for example, the manual annotation of documents or the important role of user studies to tackle interactive IR challenges. The application of gamification techniques in IR tasks poses interesting research challenges. In this paper, we propose an overview of the state of the art in this field and we summarize interesting challenges and opportunities for the near future.

1 Introduction

Gamification relate with the use of game thinking and techniques in non-game contexts to enable the engagement of users in solving problems and to increase users' self contributions [19]. It is defined in [5] as *the use of game-play mechanics for non-game applications*. For this reason, any application, task, process or context can theoretically be gamified [15].

The main goal of gamification is to rise the engagement of users by using game-like techniques such as scoreboards and personalized fast feedback [9] making people feel more ownership and purpose when engaging with tasks [16]. Gamification also implies a social game and interaction with other participants. It employs game mechanics, i.e., points, levels, challenges, virtual goods, leaderboards, gifting and charity, and aesthetics (motivations), i.e., reward, status, achievement, self expression, competition, altruism to enact such interactions [18]. There are precise gamification effects that one may wish to stimulate and clear game mechanics that adress these changes. For example in order to stimulate the sense of achievement challenges can be proposed to the user. Similarly status can be stimulated through levels, competition through leaderboards and rewards through virtual goods and points.

In this rule-bounded, goal-oriented play, valuable content is also an important incentive. According to Groh [11] it is important for a product to offer real benefits and real value rather and just rewards which in the long run will seem less appealing to users. Thus by stripping a site down of its point and badges there is still meaningfull content in it. Accordingly, it is important to catch the users personal goals, or more general, customizable goals, which are connected

to any interest or passion of the user that he already has in his everyday life. Gamification is more making an application or a task more fun rather than actually stimulating playfulness.

Gamification has been applied in several domains, typically for increasing the engagement of a user, for teaching, entertaining, measuring, and to improve the perceived ease of use of information systems. Successful examples are Foursquare, Twitter, Stack Overflow, Hacker News. While both Foursquare and Twitter employ gamification for increasing their user engagement, Stack Overflow[1] and Hacker News[2] are powerful platforms for question answering that promotes also authoritativeness of trustworthy users with both reward and punishment mechanisms. Gamification here is thus used for stimulating and propoting users to be authoritative and active.

Another important aspect to have in mind is the fact that all users are not the same. In gamification it is important to understand users and create scenarios that appeal to their personality types: explorers, achievers, socializers and/or killers.

Gamification can bring various benefits like increased engagement, loyalty, time spent, influence, fun or productivity. A possible benefit for IR is the understanding that the contribution of user will help raise the quality of the service and content, thus indirectly the satisfaction of users.

2 Gamification in IR

Bartle argues that although game design is an art form, gamification is an application of psychology, thus one of the most important aspect of gamifying information retrieval tasks relies on understanding of the human motivation [2].

Pothineni *et al.* argue the importance of designing incentives for reaching various system goals like user retention or content generation [17]. They consider there is not a universal recipe for all problems also because the target personality types are different. They base their model on "Incentive Economy" while also providing some measures that can be adopted by website owners. They apply their model to a company's social collaboration platform. The benefits of gamification result in an increased user retention and crossed-network engagement and collaboration.

Maltzahn *et al.* authors propose a game that stimulates players to organize their private archives [14]. InfoGarden is a game that turns document tagging into an individual activity of weeding a garden and protecting plants from gophers. It also includes a reward system that encourages orthogonal tag usage and creating consistent taxonomies.

Relevance Assessment and Feedback and Ranking

An interesting application in Information Retrieval is relevance assessment. Chamberlain introduces a model for rewarding and evaluating users using retrospective validation, with only a small gold standard required to initiate the

[1] `http://stackoverflow.com/`

[2] `https://news.ycombinator.com/`

system [4]. The model is not based on the quantity of tasks performed but rather is focused on an agreement-based reward which prizes the quality of the solutions. The evaluation of the theoretical model indicated that the reward mechanism success in awarding the high quality answers, but in practice it is not such a strong signal for predicting the user performance.

Harris exploits groups' ability to assess relevance of documents and images and also rank their choices [12]. During their experiment participant are divided in two groups, one making judgements based on their own assessments while the other make judgements based on their estimate of consensus decision. The primary focus of the paper is not the design of the game and how gamification is done. Instead, authors are more focused in the relevance assessment task. In order to motivate participant, financial rewards are offered. The results obtained differ for the two groups. When participants use consensus opinion as a guide, relevance assessment are homogenous probably due to the fact that they are more conservative.

Another paper that uses player feedback is [3]. Here, authors' objective is improving image recognition accuracy. The process is divided in three steps: first the systems performs recognition, then the information on which they wish to retrieve feedback is compiled and lastly they retrieve the feedback form the players through the crowd-sourced gamified approach. They also propose a method for leveraging ambigous feedback by introducing a measure of certainty. They conclude that due to the feedback received from the players the accuracy of the recognition systems improves.

Web Search

Azzopardi *et al.* proposed a gamification enhances sequel of Page-Fetch, a game where participants, given a web page, must enter the query that they consider most suitable for that page [1]. The shorter the query the higher the score they receive for the task. Users are also time constrained, they gain points, are ranked in leaderboards and receive badges. As motivational factors the main triggers are avatars and badges. The overall utility lies in the fact that it allows the evaluation of the quality of competing search engines or evaluating the capacity of players for performing a task. Fernandez-Luna *et al.* focus on gamifing a collaborative information seeking system (CIS), defined as a process of information seeking "that is defined explicitly among the participants, interactive, and mutually beneficial"[8]. They proposed several ways to gamify a CIS system that could end up in intensifying a seeker's engagement.

He *et al.* apply gamification to crowsourcing tasks to make them more appealing and so users play, rather than work, but nevertheless differences in task design and incentives elicits different player behavior [13]. The proposed solution simulates user behavior when performing a search task. Moreover a faceted interface is proposed, which turns out that is preferred to the basic one and with this interface the rank bias present in a typical SERP is not as prevalent.

Crowdsourcing

Eickhoff proposes a solution for crowdsourcing through the use of a game in order to attract and retain a larger share of reliable workers to frequently

requested crowdsourcing tasks such as relevance assessments and clustering [7]. The task involves cognitive and social aspect, users are motivated through points, leaderboards and challenges with results in the quality and speed of the completed task. The game based alternative is able to achieve high quality at significantly lower rates while also facing fewer malicious submissions.

Eickhoff *et al.* claim that although crowdsourcing tasks are preferable to the expensive labour of experts from a financial point of view, such objective is not always desirable due to required quality standars [6]. They initilly compare the effectiveness and efficiency of medical imaging experts to that of crowd workers, finding significantly better performance at greater cost. In a second series of experiments, they show how the comparably cheap results produced by crowdsourcing workers can serve to make experts more efficient and more effective at the same time.

Fort *et al.* propose a Game With a Purpose that allows annotation of corpora with dependency syntax [10]. Students in linguistics are trained to annotate certain phenomenons whereas a previous pre-annotation step gives an idea of whether there are significant inconsistencies between the two. These can be however easily discovered and corrected. In order to motivate players the MICE method is used. MICE stands for: Money (reward), Ideology (interest), Constraint and Ego. In this case the reward is the acknowledgement of a task completed thus stimulating the player's ego, without actually offering a physical or visual reward. They do not motivate users by claiming it is useful for research instead they focus on the playful aspect of the game and at the same time allow the users select corpora according to their personal interests. Two points regarding the quality of the data were considered: the trustworthiness of players and the assessment of the correctness of analyses.

3 Challenges and Opportunities

In this paper we discussed the latest research results employing gamification approaches within IR tasks. However, we believe that the application of gamification to Information Retrieval tasks is still in a preliminary stage. It opens the way to many research challenges, in particular for tasks that are difficult to quantify or qualify, based on crowdsensing, or requiring user evaluation. Here we highlight some promising directions that we believe could be natural scenarios where gamification can be successfully exploited.

User profiling: modern Web search engines track the activities of the users in order to derive their *profile* to be used and then exploited again during search, for personalizing the search experience. This activity is done by distilling implicit feedbacks from clicked results, query logs, etc. Gamification approaches that enable users to select preferences on specific domains, i.e., documents, images, videos, etc. contribute to building the user profile explicitly, that in turn allows deriving more precise and detailed information that can be later exploited.

Document annotation: modern Web search engines deeply rely on machine learning to perform several important tasks ranging from document and query

classification to document ranking and spam detection. Machine learning needs labeled data during the training phase. Labeled data is produced by employing hundreds of human assessors judging documents returned by a query to assign a relevance label. Human labeling is a complex, hard and time-consuming task. For this reason, we believe that by exploiting gamification, and thus by adding fun and competitiveness to an annotation platform, will lead more motivated annotators producing more higher quality results. The annotation task can be referred to indicating a certain class of a document (domain, part-of-speech etc.), to offering a relevance judgement (true or false) or to ranking objects according to preference, correctness etc.

Diversification and Query Intent Discovery: diversification of Web search results is an important research field studying the best way to answer ambiguous or "multi-faceted" search queries. Roughly, diversification aims at covering all (the majority of) the possible meanings behind a search query in a single results page. We believe gamification approaches could help in discovering the most popular interpretations behind a given query. The same approach could help in determining the quality of a diversified results page.

Gamification opens the way to many research challenges that has been only partially addressed so far, especially in the Information Retrieval field. The proposed literature review also revealed that more rigorous methodologies ought to be used in further research on gamification.

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