

# Ubiquitous Framework for Creating and Evaluating Persuasive Applications and Games

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**Abstract.** Until recently human-computer interaction has focused on creating efficient tools. However with the rise of ubiquitous computing, the focus is shifting towards applications that provide better user experiences. Persuasive computing has the goal of motivating people to live better lives. In this article, persuasive computing is approached through games and game design. There is an increasing interest in games, both commercially and in research. Applying game design to applications, gamification, and serious games are two different approaches to using games to motivate. This work is particularly interested in creating ubiquitous applications and games. I propose a framework that facilitates creation and evaluation of these systems. The framework provides tools for accessing measurement data, managing avatars and enabling ubiquitous accessibility. This framework is a step towards answering the larger question about creating gamification and serious games design in ubiquitous computing contexts. The feasibility of the framework will be tested as a part of this work by creating applications and games, and also by releasing the framework for third party developers.

**Keywords:** ubiquitous computing, human-computer interaction, motivation, software framework, game design.

## 1 Introduction

According to Mark Weiser's original vision for ubiquitous computing, the future brings computing from our desktops to the world all around us [1]. This can be perceived as something life-enhancing or something disturbingly invasive, and it all depends on the implementation as noted by Greenfield in [2]. As is discussed by Bannon in [3] the first generation of HCI (human-computer interaction) treated users as factors based on statistics without putting proper effort into understanding them. The second generation brought users into the equation and was mainly concerned with understanding how people work. Differences between this and the third generation are discussed in [4] by Bødker, and the third generation is largely focused on experience and the home. The second generation created a lot of tools, but as Beaudouin-Lafon points out in

[5] the WIMP (windows, icons, menus and pointer) paradigm of desktop computers has nevertheless stayed essentially the same since its first introduction in the Xerox Star [6], and new innovations have not been adopted into these tools. When discussing the role of interaction software tools, Myers et al. also note that these past tools are no longer sufficient for certain application domains [7].

If we consider the old saying "where there's a will, there's a way", it can be argued that the focus of HCI has been on improving the way. The assumption has been that there is a will, and moreover that the will is strong enough. This holds true in the work environment where the will is typically provided by a well-known incentive: salary. However, if we want to create systems that enable users to make the world better in other aspects of their lives, we need persuasive computing. This is the domain where user experience counts as people are free to choose how to spend their free time. The perspective of this work is to look at a domain where the will is greatly enhanced by applications: games. The idea of learning from games is not a new one - it was presented as early as the 80's by Malone in [8]. Since then, the idea has been presented in HCI research every now and then including [9] and [10]. Similarly, prototypes that use game-like features have been tested with users and found to be enjoyable (for example see [11], [12], [13]). It has also been shown that game-like features can motivate people to do tasks such as physical exercise [14] or generate interest in e.g. museum exhibits [15].

There's another reason to seriously think about games. In this day and age, people are playing games. A lot. To quote some numbers, a 2011 study by the Entertainment Software Association of the US consumer market<sup>1</sup> shows that games are played in 72 % of households. In Europe Strategy Analytics' European Digital Media Survey from 2008<sup>2</sup> shows that 71 % of broadband users play games. The role of games in the twenty-first century is explored by Chatfield in [16], providing compelling reasons why attention to games should be paid. McGonigal argues that gamers are escaping to virtual realities because reality fails to meet certain human needs, and suggests that we should seriously consider what kinds of games will be played in the future to employ the skills of these gamers in a world-saving context [17]. Reeves and Read present a rather thorough analysis of massively multiplayer online games and work, paying special attention to similarities between the two environments and requirements for the participants [18]. How should we proceed with making use of games and their design?

## 2 Related Work

As discussed in the previous section, Malone presented a set of heuristics that could be used to take inspiration from computer games [8]. He presents these heuristics in three categories: 1) challenge, including goals, performance feedback and uncertainty of outcome; 2) fantasy, including emotionally appealing fantasies

<sup>1</sup> [http://www.theesa.com/facts/pdfs/ESA\\_EF\\_2011.pdf](http://www.theesa.com/facts/pdfs/ESA_EF_2011.pdf)

<sup>2</sup> <http://www.strategyanalytics.com/reports/ix7hx8in7j/single.htm>

and metaphors; and 3) curiosity, including optimal level of informational complexity and providing well-formed knowledge structures. Dyck et al. introduce four design innovations based on their research of fourteen games [9]. They note that: games support the forming of communities, people learn to play by watching others, many games feature highly customizable interfaces and games use less interruptive means of communicating information. A broad discussion of using virtual worlds, with massively multiplayer online roleplaying games as the primary example, to make work more engaging is presented by Reeves and Read in [18]. The book presents examples how mechanics and dynamics from games can be used to make working more engaging. Likewise, Lin et al. discover in [14] that by creating a scoring system and visual feedback in the form of an aquarium and a fish users can be motivated to walk more and also to become more conscious of how much they exercise.

In third wave HCI, Bell et al. explore new sources of inspiration for designing for the home by defamiliarizing themselves from the modern home [19]. They explore the cultural history of American kitchen technology and ethnographies of English and Asian homes. In the article they present twelve statements that should be taken into consideration. Two of these statements are especially relevant: focusing on efficiency unnecessarily limits the design space, and the home should not be limited to efficient tasks and passive entertainment. In their discussion of ambiguity in [20], Gaver et al. present three types of ambiguity that can be considered useful. The authors also provide tactics for making use of ambiguity with the general goal of engaging the user more effectively when interacting with the design. In other words, the goal is largely the same as that of games, only the means are different. Aesthetic interaction discussed by Petersen et al. in [21] is in some ways similar. The key idea here is that aesthetics can reach beyond what is seen to the interaction itself. The authors propose adding aesthetics as a design element.

If we shift our attention back to games, there are two common approaches: serious games and gamification. Serious games are an old idea, and have been visible e.g. as educational games. According to Koster, the true power of games is learning [22]. People are hardwired to feel good when they learn new things - and games are excellent teachers. Usually they only teach things that are relevant within the game's context but they do so in an exemplary fashion [23]. The appeal of using this power to teach useful subjects (e.g. mathematics) is easily understandable. Gamification is a more recent trend, although its ideas are not exactly new. The working definition of gamification is "use of game design elements in non-game contexts" [24]. The definition explicitly excludes serious games, as serious games are complete games whereas gamification is a way of designing applications and services. Most existing gamification attempts follow the marketing strategies described in [25]: scores, leaderboards, levels, challenges, achievements and rewards. In recent years these techniques have appeared especially on various web sites. Typical examples include user scores/levels, achievement badges and profile completion bars.

Existing gamified applications and serious games show that there is an audience. Nike+<sup>3</sup>, a motivational platform for runners, uses feedback systems familiar from games, as well as user-created challenges, and has a community of over 2 million users. FourSquare<sup>4</sup> is another simple concept: when going out, players can do a check-in in a location using a mobile application and that way inform their friends where they are. The system uses points and badges, both basic gamification techniques, and has over 1 million users. One relatively recent example of a serious game is Foldit, a multiplayer online game, where players try to predict protein structures, that has produced useful results [26]. Another example is the ESP game, for creating image metadata [27], which has been licensed by Google for use in their Google Image Labeler.

### 3 Work Proposal

This work is mostly concerned with one particular class of applications: persuasive computing. In previous sections we have looked at both HCI and game design. There is a good reason to involve both HCI and games: ubiquity of computing is so much more involved in everyday life than, say, console games, that HCI must be involved in the design process, even when making games. The most fundamental difference between applications and games is that of the goal. Games have intrinsic goals that have been put in by the designer [28]. While this is not true for all games (The Sims for example has no overarching goals) it is true enough that it has been included in some definitions of 'a game' (see e.g. [28] for an analysis of several definitions). Tool applications have extrinsic goals that exist in the user's own context. Malone differentiates between toys (games) and tools (applications) in the same way [8]. He also suggests that using toy-like features in tools can make routine and boring goals more enjoyable.

If we consider this difference of goals, we can look at it from two perspectives which correspond to the approaches of gamification and serious games. In gamification, the task of reaching the goal is enhanced by game design to introduce motivating factors such as better feedback and subgoals. This approach retains the external goal of the task while setting sidegoals that aid the user in staying more engaged with the task. This approach has varying amounts of similarity with third wave HCI propositions discussed in the previous sections. In the serious games approach, the goal of the task is reached as a side effect of playing a game. The game creates a new goal, which is intrinsic to the game, and transforms the extrinsic goal into a consequence of play. The actual task is incorporated in the game's mechanics in such a way that it gets done. The designer is tasked with creating the rest of the mechanics in a way that produces a good playing experience. This approach actually transforms the problem into a pure game design problem where one mechanic of the game is fixed.

Neither approach is effortless. In gamification the big challenge is selecting powerful incentives that work in the desired context and have a lasting appeal.

<sup>3</sup> [http://nikerunning.nike.com/nikeos/p/nikeplus/en\\_EMEA/](http://nikerunning.nike.com/nikeos/p/nikeplus/en_EMEA/)

<sup>4</sup> <https://foursquare.com/>

In serious games, the problem is the same as with game design in general: creating a truly engaging, good game is really hard. If we look at persuasive computing, there are additional problems with showing that the system has the intended effect on motivation. Furthermore, because both of these approaches are in fact quite hard, can it be shown that they are actually worth the trouble, or could similar results be gained with easier methods such as simple performance visualization? In this work I propose to create a ubiquitous framework for making these persuasive applications and games. The purpose of this framework is to facilitate creation of applications of either approach, and provide efficient evaluation opportunities for developers. This work provides tools that especially researchers with more limited resources should find useful if they want to make these applications or games and evaluate their effectiveness.

The proposed framework is specifically aimed at applications that in one way or another encourage the user or player to perform a task. In the serious game approach, the approach is less nudging and more based on framing of the task. The platform provides the basic architecture for creating applications that have ubiquitous accessibility and make use of measurement data. The accessibility plan at the moment contains the use of mobile devices, desktop computers, public displays and RFID or NFC tags. Measurement data is handled with flexible plugin-based support for retrieving data from connected sources. The framework also provides the means to manage basic virtual world assets - avatars and their possessions - in a centralized way. Another important aspect that is included in the implementation plan of the framework, is evaluation support. The centralized approach facilitates extensive logging of user or player activity. The plan also includes constructing support for different means of doing ubiquitous computing system surveys (a good summary of techniques is provided in [29]), allowing developers to do surveys and researches to perform evaluation studies.

There already exist several platforms for pervasive and ubiquitous games that have fairly recently been built. Organizations participating in the IPerG (Integrated Project on Pervasive Gaming) [30] which run from 2004 to 2008 produced a set of tools for making pervasive and ubiquitous games. The UbiComp Solution package<sup>5</sup> by the Swedish Institute of Computer Science is most closely related to the work proposed in this paper. The package is built of Java libraries and facilitates creation of games that use small networked computers, sensors and actuators. Another academic example is the UbiqGames framework from the MIT STEP (Scheller Teacher Education Program) lab with focus on educational games [31]. There is also at least one commercial system by LocoMatrix<sup>6</sup>, which uses smart phones and GPS for pervasive games. My proposed framework differs from these existing solutions by providing the important measurement data facilities as well as built-in support for data-based user avatars.

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<sup>5</sup> [http://iperg.sics.se/tech\\_space22.php](http://iperg.sics.se/tech_space22.php)

<sup>6</sup> <http://www.locomatrix.co.uk/>

## 4 Research Plan

The bigger research question related to this framework is the one from introduction: how should we proceed with making use of games and their design? What are the design considerations in ubiquitous persuasive applications and games? However, within the context of just one doctoral thesis, this question is too large. The purpose of my doctoral studies is to show that this framework is a useful step towards answering this bigger question. There are two key questions. The first one is whether the framework is found useful by other developers. One metric to evaluate this is to consider the number of games and applications made using this framework by others during the course of its development. More useful information about usefulness of this framework can be gained by using primarily qualitative research methods such as developer interviews and ethnographies. This information is not only valuable in showing the validity of the framework, but also to improve it and the development processes of ubiquitous games in general.

The second question is whether games and applications made using this framework have a notable effect on motivation. As discussed in the previous section, supporting evaluation of this topic is one of the design goals of the platform. This will be primarily tested by our own applications and games. The goal is to deploy these applications in the field and test them in real use. We are already planning first studies for an early application using this framework. In these first studies we are testing the feasibility and usability of the system in real use, and the effect of data visualization on motivation. The metrics in this study include user statistics and logs as well as qualitative surveys. In addition to providing good initial data about the framework in use, this and later studies will have a constructive impact on development of the framework. Furthermore, by analyzing the study itself, future studies can be improved based on the findings.

I have background in game design and development, and in the programming of networked applications for web, desktop and mobile platforms. During the course of this work, I intend to reinforce my knowledge in these fields, with a focus on serious games, pervasive games and ubiquitous computing systems. The work proposed in this article has already started, and a deployable test version of the core server exists and is capable of supporting data visualization applications. The next steps involve evaluating this test version for visualizing physical activity, and creating more user-friendly control interfaces for managing user profiles. After these basic visualization facilities have been completed, the support for plugging in application and game modules will be added to the core server. The exact working order will depend on what applications and games we decide to develop alongside with the framework.

## 5 Conclusions

In this article I have outlined a framework for creating ubiquitous persuasive applications and games. I have shown my motivation for building this framework: we need tools to efficiently create and evaluate these applications. Also the motivation for using games as a central theme in the framework design was

explained: on the one hand, the motivational benefit of games has been shown; on the other hand, gamers form a large part of the population. Furthermore, the rise of gamification shows an increased interest in game-based solutions to motivating people. However it is not clear if these gamification attempts are a better fit for persuasive computing than serious games. I have discussed the difference between these approaches and also their problems in the persuasive domain. The framework proposed in this article is intended for implementing ubiquitous computing applications and games that use measurement data. The contribution of this work is the framework. In the course of this work, the framework's usefulness for developers will be assessed. This work is part of a bigger context about the design of persuasive applications and games, and the intention is to continue working with this problem after showing that the framework is a suitable platform for future studies.

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