Towards Applying a Model Driven Approach to Generate Gamified Graphical User Interfaces

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Abstract: Context: Model Driven approaches were introduced to help provide models, transformations between different levels, and code generators to deal with several issues in software development. These approaches help reduce time in the coding phase along with targeting higher level of abstractions to deal with all the cases. Along with developement in software areas, gamified graphical user interfaces are used in several domain, including business. Indeed, it helped reaching new goals such as descovering new talents or even motivating employees. Objective : In this paper, we present a new model driven approach, starting from a high abstraction level which is platform independent models to reach code genenrating of gamified graphical user interface. Starting from a high level, such as Platform Independent Model (PIM), helps software developers to focus mostly on business knowledge and less about technical details of the targeted platform. Results: The paper presents an end-to-end approach including proposed metamodel and mappings between their elements developed using Eclipse Modeling Framework (EMF) tools and Acceleo for code generation.

1 INTRODUCTION

Gamification were introduced as a new e-business strategy for employee engagement journey. In addition to that, it is used recently in healthcare, Ecommerce, banking, education ... because of its remarquable benefits. It helps including better analytics, predictions and management reporting. Besides, as explained by (Wang, 2011), gamified applications in e-business/ecommerce promise new additions even when studies are so diverse, by promoting the discovery, design patterns, dynamics of games, and several other elements and characteristics that provide a more positive user experience.

Online games have become a significant part of our ever-daily life (Mochocki, 2011) gamification is a trending phenomenon that aims to influence people, by developing a game design in different business contexts (Deterding et al., 2011). Thus, the development of enhancing business applications with game design has been entitled as “gamification” (Dicheva et al., 2015).

When software is designed correctly, gamification has a substantial business impact, and become an important means for organizations, to engage, and motivate them to modify behaviors, develop skills, or solve problems (Burke, 2013). This goes along with the fact that behavioural scientists have a specific goal in helping people attain better outcomes. Indeed, all new design interventions including gamification elements tends to get people engaged in activities such that their probability of completion is increased.

We can say that gamification consists on applying game design principles and mechanics into ”non-game-oriented” environments. It encourage users to engage in desire behaviors and taking advantage of innate reflexe of play. For the specific case of business, they are turning to gamification for both engaging their customers and motivating their emloyees. That is why we concluded that gamified user interfaces are mostly used and are integrated in all areas. That is why in this paper we present a new metamodel for graphical user interface that gathered some of the most common gamification elements. This approach will help reaching the goal of gamified applications using less effort on technical side and be more focused on the gamification part.

In the last decades, applications and software developpement have known an exponential growth and became very challenging to keep up with that evolution. Many approaches were introduced to help software developper and Model Driven Engineering was a revolutionaly one. indeed, Model Driven Development has shown its contributions and efficiency to the

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field of engineering and helps improving the quality of applications as well as time saving and increasing the productivity. It focuses on modeling the system in different levels of abstraction and relate elements through mappings and transformation.

In this paper we present a new model driven approach for modeling and generating graphical interfaces for applications taking into consideration gamification elements. The input model contains meta classes with their attributes and parametrs and are related to gamification concepts. These elements are related to mechanics in gamification and will be generated automatically. The whole process would help generating corresponding graphic elements regarding the user wishes.

2 RELATED WORK

Several works were introduced dealing with modeling and generating graphical interfaces. An approach for RIA was proposed to generate the application focusing on graphical part and respecting the MVC pattern. Also, a new modeling language for graphical interfaces was normalized by the Object Management Group (Brambilla et al., 2014a). It is true that this language covers the graphical and interaction part, but still does not cover all the aspects of applications. That is why this language was extended for mobile applications (Brambilla et al., 2014b) and for RIA also to improve its coverage (Roubi et al., 2016).

In addition, some works argue for the use of gamedesign patterns and mechanics, such as rewards, points, badges, leaderboards or storytelling, as building blocks (Kumar, 2013), and assume that the combination of these elements can invoke engaging challenges and motivate goal-directed behavior.

For gamification area, we can say that it is still rising in popularity and several researches and studies have been interested on gamification and introducing game elements in several areas. First, in business, in (Kumar, 2013) authors explain how designing engaging business software could help impoving employees rendering .

This position, however, reflects mainly its use in business contexts. The penetration of the gamification trend in educational settings seems to be still climbing up to the top as indicated by the amount and annual distribution of the reviewed works.

In educational context, the term “serious games” was first established for learning software with multimedia elements and small educational games. A meta-analysis of serious games (Wouters et al., 2013) provides a good overview and summarize the research on the effects of serious games on learning and motivation.

Furthermore, in (Muntean, 2011) authors expose how gamification can be applied in the context of an e-learning course and defined some metrics fo that purpose.

In our study, being aware of gamification benefits and improvement to software, we used model driven prinicples along with including gamification concepts and elements into user interfaces independently from a specific platform. This approach can be applied to any of the areas presented above.

3 GAMIFICATION CONCEPTS

Gamification is particularly related to web and mobile software, in order to encourage people to adopt the applications and enhance their use. Gamification aims at combining intrinsic motivation and extrinsic one, in order to raise engagement. Intrinsic motivation come from within, the user/actor decides whether to make an action or not, some examples are: altruism, competition, cooperation, sense of belonging, love or aggression. Extrinsic motivation, on the other hand, occur when something or someone pushes the user to make an action for example: classifications, levels, points, badges, awards, missions (Viola, 2011).

Those concepts were gathered in the gamification framework MDA for Mechanics, Dynamics and Aesthetics (or Emotions in some works). Indeed, not all elements are used for all purposes, but rather we choose the adequate elements for each case. In other words, some mechanics can be used for education and not for business, or the dynamics of the user in business context is not similar in a banking one. The MDA framework helps the designers to analyse the gamified experiences in more detailed way (Hunicke et al., 2004).

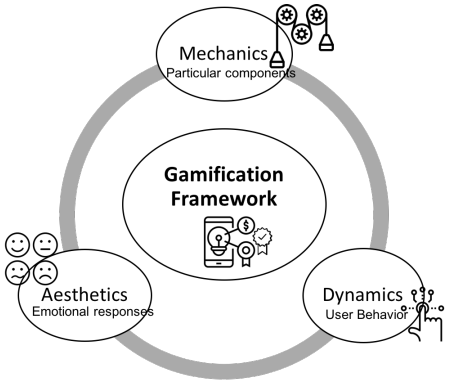

Figure 1: Gamification Framework: Mechanics, Dynamics and Aesthetics.

We can say that game mechanics are certainly the most related part in gamification concepts to user interfaces. Indeed, the user interacts with such elements give control over the application and guide user actions. That is why we focused on this part in this paper.

3.1 Game Dynamics and Aesthetics

Dynamics shape the behavior of users and players towards mechanics acting on inputs outputs over time. Since it is related to a person behavior and actions it is hard to predict; designers do not know exactly what will happen (Hunicke et al., 2004). That is why the challenge for designers remains in anticipating diffrent types of dynamics that can emerge and to develop approriate mechanics.

Related to dynamics, we find aesthetics or emotions that are a product of how players interact with the mechanics and then generate dynamics. This part is also a very crucial since the players will not continue to play if they do not enjoy themselves. So, creating player enjoyment represents one of most important player engagement goal for gamification.

3.2 Game Mechanics

Game mechanics have therefore managed to change the way graphical interfaces for applications are designed, for the better and ensure how to specify the goals, the rules, the settings, the context, the types of interactions. The basic mechanics of gamification are closely related to the mechanics of game design: addressing the human desire for socializing, learning, mastery, competition, achievement, status, self-expression, altruism, or closure (Schell, 2014).

We can devide mechanics into three different types : setup mechanics, rule mechanics, and progression mechanics and all of them are remarkably important not only for games, but also for gamified experiences as defined and explained in (Robson et al., 2015) throught (Elverdam and Aarseth, 2007).

In our work, we focused on setup and progression mechanics since they are closely related to graphical interfaces we want to elaborate. We defind the following elements :

- **Points:** are a tool for measurment in gamification and the way the system keeps count of the player's actions because they provide instant feedback to the player.
- **Badges:** as a result of accumulating a certain number of points, players may be awarded badges. Badges are a form of virtual achievement by the player. They address positive reinforcement and drive collection and achievement.
- **Leaderboards:** bring in the social aspect of points and badges and display the players on a list and are ranked regarding their number of points collected in descending order.
- **Constraints:** used basically to encourage and motivate the player such as deadlines.
- **Progress:** refers to providing feedback to the user on where she is in the journey, and encouraging her to take the next step.

4 ALIGNING MODEL DRIVEN APPROACH WITH GAMIFICATION CONCEPTS AND MECANICS

As presented, we can say that including game elements remains a good tool to reduce perception barriers for user's interaction with software. That is why gamification has been coupled with several areas and have shown its efficiency. However, the developement of such application, especially the graphical part, can be very tedious and time consuming.

Since Model Driven approaches have been introduced in several areas dealing with diffrent problems espacially, for software applications and generate the whole application from models, we align the model driven principles by presenting new metamodel and transformation engine to generate easily a first part of gamified graphical user interface.

In addition, icons and images related to the game are important to design gamified graphical interfaces. For our work, we opted for the use of the google material icons library (Google, 2014). Indeed, Material design system icons are very simple yet modern and join perfectly gamification aspects and are used commonly throughout a user interface. The use of these library makes the task easier for designing an ergonomic interface with all elements included.

4.1 Proposed Metamodel and Its Instances

When we adopt a model driven approach, the first step is to define metamodels for the concepts we will work with and choose the appropriate level to work with. In our case, we began with platform independent model to represent gamification elements that will be gathered with previous metamodels for user interfaces as presented in our previous works.

We present a new simplified metamodel that model and describe mechanics to be introduced in the intefrace with several information. We integrated mechanics in the metamodel to cover the components of the game at the level of representation, along with basic component and activities that constitute the graphical part of the application.

The major element is Mecanics meta class that gathers several children as diffrent types. Every one of these elements has its own properties that define how it will be included in the interface along with common properties.

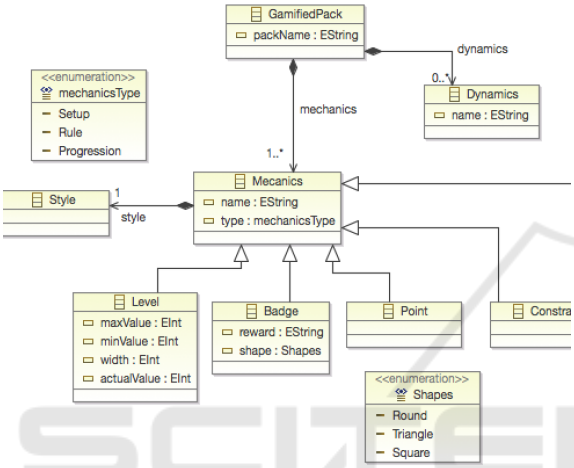

Figure 2: Exerpt of proposed metamodel.

Once we developped our entry metamodel, we generated the modeling artefacts using Eclipse modeling framework. This permits to define input models respecting the metamodel in an abstract level, without needing to know how code source should be written. We present in figure 3 the model part for progression bar and badges for rewarding user and how it will be generated automatically.

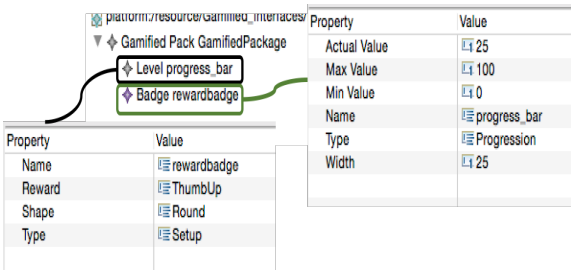

Figure 3: Input model instance: Progression bar.

As mentionned, the input model gathers a number of necessary elements for transformation engine to generate the code for gamified graphics and the whole interface also in the desired language. These abstract elements that we propose describe efficiently mecanics to be integrated in the interface and can be used for several platforms, the transformation should be re writen only.

4.2 Transformation Engine

Once we defined metamodel that describes the gamification elements to be included into the user interfaces, we coupled it with our metamodel already presented in previous works . Aftrwards, the transformation phase remains crucial in any model driven approach. Indeed, we defined transformation rules and transformation engines that allow to generate code of the application.

We present an exerpt of Acceleo templates to generate graphics for gamified elements such as progression bar and its parameters:

```
...
[file ('index'+'.html', false, 'UTF-8')]
[for(theMecanic:Mecanics |
    aGamifiedPack.mechanics)]
[generateMecanics(theMecanic)/]
[/for]
[/file]
[/template]

[template public generateMecanics(
aMecanic : Mecanics)]
<div class = "[aMecanic.type/] style = "" >
  <div class = "[aMecanic.type/]-bar
    role ="[aMecanic.type/]"
     aria-valuenow = "[aMecanic.
      oclIsTypeOf(Level).actualValue]"
     area-valuemin = "[aMecanic.
      oclIsTypeOf(Level).minValue/]"
   </div>
[/template]
...
```

All mecanics we defined in the metamodel are coupled with the metamodel of graphical interface that we presented in our previous works for MVC application (Roubi et al., 2015) and also its extension for Interaction Flow Modeling Language as defined. The proposed model driven approach is an entry to to cover the generation of end-to-end gamified interfaces that will be the subject of our futur work.

Figure 4: Generated User Interface with gamified element from input models.

For our input model, we get the generated source code for gamified elements that we integrated into the HTML page. These elements were associated with an

adequate CSS to place them and add style. In figure 4 we find elements that were generated using our input models.

5 CONCLUSION

Gamification is introduced in several areas and domains, health, education, banking ... and have shown its efficiency. Gamification framework gathers three major principles that are mechanics, dynamics and emotions. Since Mechanics are the most visible part of it and tend to be the primary focus, we presented a new model driven approach to model and generate gamified applications, focusing on the graphical part. We presented the motivations behind our work and presented metamodel along with their input models and transformationss using Acceleo. This proposed model driven approach helps designers to integrate gamified elements into the software interfaces. The case we applied on our proposed approach gives the possibility to generate a first gamified web application and is oriented to student for motivation in taking courses and quizes.

We are fully aware that our proposed approach still needs to cover other aspects of gamification to cover the whole framework. In future works, we will complete metamodels proposed and their transformation to cover more gamification elements and raise the abstraction level. This would help choosing the ideal elements for generating the more adequat graphical elements to add.

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