INTELLIGENT VIRTUAL ASSISTANT FOR GAMIFIED ENVIRONMENTS

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Abstract

Gamification aims at improving people's motivation and performance in certain tasks by introducing different mechanics taken from traditional games. Gamification has been successfully applied in different domains, such as education, marketing, and the workplace. In this paper we present an intelligent virtual assistant for gamified environments. This assistant will provide the players with help on the tasks they have to complete using natural language dialogues. The intelligent virtual assistant includes other advances technologies, such as sentiment analysis, and player's profile and interaction network analysis. This allows the assistant to analyze the sentiment polarity of each message submitted by the user, and to adapt its dialogues accordingly. It also allows the assistant to have knowledge about each player, including basic personal data and their social network. This allows the assistant to use those data in the dialogues to, for example, suggest players to ask for help to their friends, or even to suggest new friends to a player. We also present a case study in which the intelligent virtual assistant has been introduced in the gamified environment of a real company.

Keywords: Gamification, Virtual Assistant, Sentiment Analysis.

1 INTRODUCTION

Gamification aims at improving people's motivation, engagement, and performance in a given task (or set of tasks) by incorporating mechanics taken from traditional games to make those tasks more fun and attractive (Zicherman & Cunningham, 2011). Typical game mechanics include point-based rewards (that is, accumulating points on successful task completion), badges, levels based on the number of points players have accumulated, rankings comparing the performance of players compared with those of their mates, etc. (Hugos, 2012; Zicherman & Cunningham, 2011; Deterding 2011; Werbach, 2012).

Existing research on gamification focuses mainly on the analysis of gamification in real scenarios in order to measure its effectiveness (Hamari et al., 2014), and in the design and introduction of new game mechanics that can complement the basic ones.

In this paper we present a intelligent virtual assistant for gamification environments. This virtual assistant can be viewed as a conversational agent introduced in the gamified environment to interact directly with the players using natural language. The main goal of the virtual assistant is to assist the participants of the gamified environment providing help on the tasks they have to complete (for example, giving them instructions on how to complete a task, or providing them with help about the tools they have to use). The idea for this virtual assistant also comes, as it happens with most gamification mechanics, from traditional videogames, in which the different characters of the game interact with the players using natural language.

The assistant is able to understand and respond to the user in natural language. In addition, our intelligent virtual assistant goes beyond the natural dialogue generation and includes other advanced technologies. Its main components are dialogue generation, sentiment analysis, and player profile analysis. The dialogue generation component allows us to define different dialogues we want to keep with the players, and to change live from one to the other on a give criteria. However, the first step when the virtual assistant receives an input message from the user is to analyze its sentiment polarity (which can be positive, negative, or neutral). In addition, the output of the sentiment analysis component allows us to change the dialogue the virtual assistant keeps with the player. In our current implementation, when the assistant detects a sequence of consecutive messages of the user with a negative polarity (which can indicate low player motivation or state of mind), it changes the main dialogue (which provides help about tasks and tools), and tries to motivate the player. Finally, the player profile analysis gathers data about the user that can also be used in the generation of the dialogues.

In the paper we also present a case study on the application of our intelligent virtual assistant in a real scenario, namely a software development company. The application of gamification in software engineering has gained attention in the last years, both at research and industrial levels (Pedreira et al., 2015). In the case study we present in this paper we describe the company and how it has developed an integrated gamified workplace (that is, including all the tools used in their software development projects), and how our virtual assistant was introduced in this environment.

The rest of the paper is structured as follows: the next section presents the background knowledge. In section 3, the architecture of our intelligent virtual assistant is explained. Section 4 presents a case study on the application of the virtual assistant. And finally, Section 5 presents the conclusions and future work.

2 BACKGROUND

Virtual assistants are a particular case of conversational agents that has become very popular in the last years. A virtual assistant is a software system capable of recognizing, in a basic way, natural language

and to respond in natural language too, thus have a conversation with the person. Its goal is to provide rapid assistance to the most common problems within a domain.

In recent years, the integration of conversational agents has been increasing, especially by new approaches that have appeared (Gorin, Riccardi, and Wright 1997). The current trend is to achieve natural and intuitive human-machine interaction, avoiding making the system simply static and impersonal. A task that has gained attention is to provide emotions, personality or ability to detect the emotional state of the user to the dialogues generator; these systems are called "affective". Many studies approve their benefit and conclude that the people use the tool for longer and more often, also getting enhance their satisfaction at the end of the conversation (Gebhard 2005; Skowron et al. 2013).

The goal of sentiment analysis is to analyze the sentiment polarity of a text introduced by a person, which can be positive, negative, or neutral (Pang et al., 2002). The main use of sentiment analysis technology is to analyze opinions and critics on products from the customers, to obtain more information about the general opinion about the product.

There are two main approaches for sentiment analysis: natural language processing, and machine learning (Pang et al., 2002), although the best solutions proposed to the date usually combine the two approaches. In the machine learning approach, support vector machines (SVM) (Cortes and Vapnik 1995) and naive Bayes (NB) (McCallum and Nigam 1998) are the two methods giving better results (Joachims 1998; Pang, Lee, and Vaithyanathan 2002).

3 INTELLIGENT VIRTUAL ASSISTANT

In this section we present an intelligent virtual assistant for gamified environments. The virtual assistant we propose includes advanced functionalities that allow it to adapt the dialogue to each player, and to gather relevant information for the gamified environment. First, it includes a sentiment analysis component that evaluates the polarity (positive, negative or neutral) of each message submitted by the player. This allows the virtual assistant to adapt the dialogue to the situation, for example, by offering the player help and recommendations when his/her messages show a negative polarity. Second, it contains rich information about the players including not only their personal data, but also their interaction network, that is, a graph which tells which users interacted with them in some way. This virtual assistant allows the players of a gamified environment (employees, or students, for example) to interact with the system in a more natural way.

3.1 Architecture

The architecture of our virtual assistant is shown in Figure 2. As we can see in this diagram, the main components of the virtual assistant are:

- *Natural language dialog generation*: it generates the responses to each player message. It supports the use of many different, but complementary, dialogues.
- *Sentiment analysis of the player's messages*: it allows analyzing the sentiment polarity of each text introduced by the user. This allows the system to adapt the dialogue if we detect a negative/positive/neutral polarity.
- *Player profile and network*: it allows to obtain information about the player (name, birth date, location, and other basic data) and also its collaboration network, that is, his/her relationships with other players. This allows the virtual assistant to generate responses including data about the player, and about other players he/she interacts with.
- *Session management*: a session comprises the dialogue with a player from the player's first message until the chat finishes.

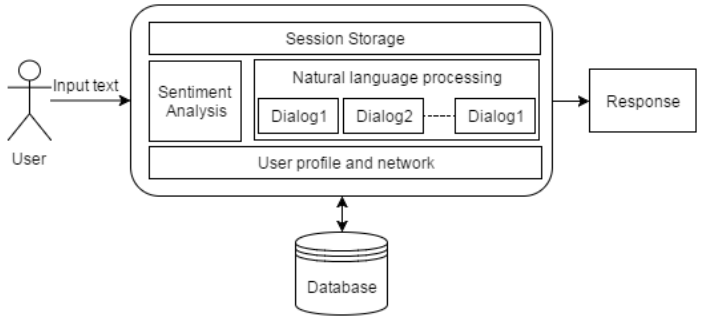

Figure 1. General architecture of intelligent virtual assistant

The activity diagram in Figure 3 shows the processing flow of the virtual assistant. When a player starts a conversation, a new dialogue session is created, and the player's data are loaded. Then, each text introduced by the player is first analyzed by the sentiment analysis module. Depending on its result, the dialogue generation module will choose among its dialogues to generate a response. As we have already mentioned, in our current implementation we have introduced two dialogues. The first one is a general dialogue providing assistance about the gamified environment and the tasks to be completed, and the second dialogue tries to increase the player's motivation when we have detected a sequence of inputs with a negative polarity.

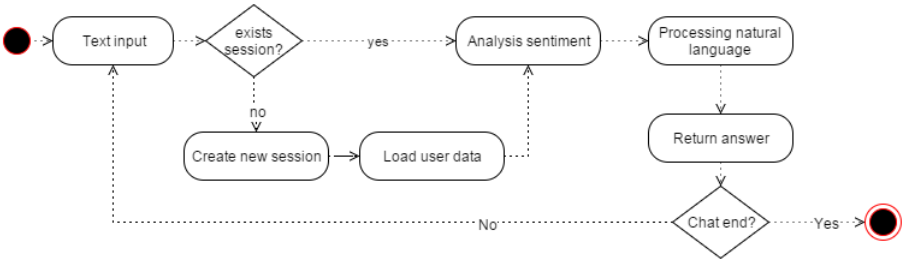

Figure 2. Input text processing flow in the virtual assistant

3.2 Natural language dialogue generation

The dialogue generation is implemented with chatbot software making use of the AIML[1] language (Artificial Intelligence Markup Language), more specifically, its version 2.0[2]. Our virtual assistant was initially thought to be used in gamified environments, although it could be used in other scenarios. In any case, the specific dialogues we pretend to generate (that is, the categories, the patterns, and the response templates) depend on each particular scenario. For example, the dialogues for an education environment are not the same dialogues we would use in a workplace. However, the virtual assistant allows us to just replace the AIML files so the dialogue generation can change without modifying the software. The virtual assistant also includes a set of general context independent dialogue patterns common to general conversations. For example, the assistant can answer certain question about date, such as the current date. It is also able to solve basic math operations and reacts (friendly) when insulted.

[1] http://www.alicebot.org/TR/2011/
[2] https://docs.google.com/document/d/1wNT25hJRyupcG51aO89UcQEiG-HkXRXusukADpFnDs4/pub

The virtual assistant also contains what we could call a "motivational dialogue" that tries to motivate the users when their texts show a sequence of negative polarities. This dialogue contains questions and messages like "Each new day is another chance to change your life." or "I've learned that mistakes can be as good teachers as success. Why do not you go talk to your friend?". Of course, this dialogue should also be adapted to the gamified environment the virtual assistant would be introduced in. We use the AIML interpreter Program AB[3] that supports AIML 2.0.

3.3 Sentiment analysis

Sentiment analysis is a useful tool for gamified environments, since this technology allows us to automatically detect information about how the sentiment of the participants towards the tasks they have to complete, or to the gamified environment itself, and to act accordingly on the presence of negative sentiments.

The result of the analysis of each message allows us to modify the dialogue generated by the virtual assistant. Our current criteria is that, upon three consecutive messages with a negative polarity, the dialogue is changed for a number of messages by another dialogue with the purpose of asking the user how he/she feels about the tasks and the environment, to try to motivate the player, and even to suggest the player to ask for help to some of his/her friends (this information is taken from the network analysis module).

During the development of the virtual assistant we used SVMs and NB classifiers for sentiment analysis, and compared the results we obtained. The training phase takes a training set composed of texts manually classified, and uses them to create a classifier. These texts are first preprocessed so we remove meaningless words (such as stopwords, numbers, special symbols, etc.), we tag each word with its type (noun, verb, etc.), and we add an additional tag that indicates if there is a negation close to this word. We created a training set for the classifier with texts extracted from the tools of a real company, and classified them manually into the categories of positive, negative, or neutral. To add more variety and improve the results, we has been decided also include a set of user reviews about products commonly used in sentiment analysis applications. Finally, we have added a set with basic phrases.

3.4 Player's profile and interaction network

The goal of user profiling is to obtain data describing the user and its environment. The basic data we can usually have about a player in a gamified environment includes personal data such as the name, birth date, location, position, interests, etc. Gamification is usually applied in domains such as education or the workplace. In this cases, an important aspect of how the players work and behave is the collaboration between them. We model the interaction network of a gamified environment as a graph with a node corresponding to each user, and labeled weighted edges connecting users that have interacted in some way. Two given users could connected by more than one edge if they have interacted in different ways. The weight of each edge reflects, for example, the number of interactions of a certain type between two users.

We consider that this information is also relevant for the virtual assistant. For example, if the virtual assistant knows who are the people a player usually interacts with, it can suggest the player to ask them for help, or to talk to them to keep in touch. If the virtual assistant has knowledge about that interaction network, it can also use that information to suggest new contacts to each player.

Of course, for this module to provide information to the virtual assistant, it must be fed with data about how the users interact, which may not be possible in all cases.

[3] https://code.google.com/archive/p/program-ab/

4 APPLICATION CASE

In this section we present a case study on the application of the intelligent virtual assistant in the real gamified environment of a software development company.

SWComp is a small software development company with around twenty employees. The working environment of the company is composed of many software tools that help in the development and management of the projects. SWComp embraced the gamification of its workplace as a whole. The purpose of this gamification project was to improve the motivation and engagement of the people in all the tasks of the software project lifecycle (project management, requirements, configuration management, development, testing, etc.) Having different tools for different tasks, gamifying each of these tools separately was not feasible, since all achievements of a player should be part of his/her profile, no matter in which tool the achievement was obtained. In order to obtain such an integrated gamification environment, they used a gamification engine that centralizes the evaluation of the player's actions and assigns the corresponding achievements. The evaluation of the actions in the gamification environment is implemented through a flexible rule system that allows to define each rule as a set of conditions on the attributes that describe each action. All the tools of the company communicate the player's actions to the gamification engine through a REST API. The gamification engine centralizes the evaluation of these actions, and the assignment of achievements to the players if that evaluation is successful.

In addition, SWComp has developed a player's portal in which the players can see all the information about their profiles: achievements obtained (such as points, badges, and so on), their level (computed in terms of their points), and rankings comparing their results with the results of their workmates. In addition, the player's portal provides other functionalities, such a company social network, and chat rooms for the players.

The intelligent virtual assistant was integrated into the gamification engine and the players can access it through the player´s portal. Two of the components of the virtual assistant have been adapted to this particular scenario, namely the AIML dialogue files (so the dialogues considered by the virtual assistant are tailored to this gamified environment), and the player's profile and network data.

The first step in creating the AIML files has been to identify the different areas or topics, that a user can ask for assistance. For each topic, we have created a diagram that groups each of its sub-topics and different formulations that makes a user can ask about. Then, the corresponding AIML files are created to cover all topics and sub-topics. Figure 10 shows an example of topic diagram for user management in SWComp environment. Similar diagrams have been created for requirements, project management, and so on.

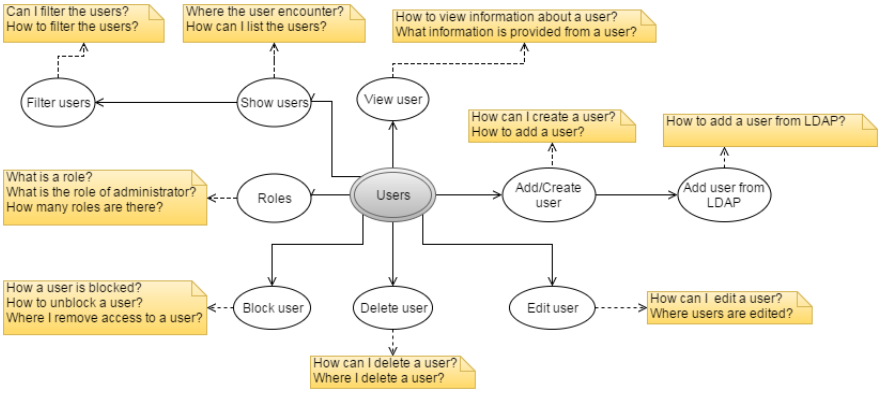

Figure 3. Diagram for the "Users" topic, and examples of questions to be answered.

Figure 11 shows an example of conversation with the virtual assistant. First, the assistant greets the user by his/her name (in this case the user name is "Player"). By analyzing past conversations, the assistant has detected that the user's messages have a positive polarity and, therefore, adds to the greeting phrase "How well I see you today!". Player asks for help, in this case, on how to add a new user. Then, the assistant searches in the AIML files the category with the pattern that matches the question and uses it to generate the response. The dialogue for this question has each of the steps to complete the task. Furthermore, the assistant has detected that Player is talking about the topic "Users" and assumes that the next questions will be related to them. So when Player asks "How remove it", without specifying what to remove, the assistant knows that Player refers to a user and then responds with the appropriate steps.

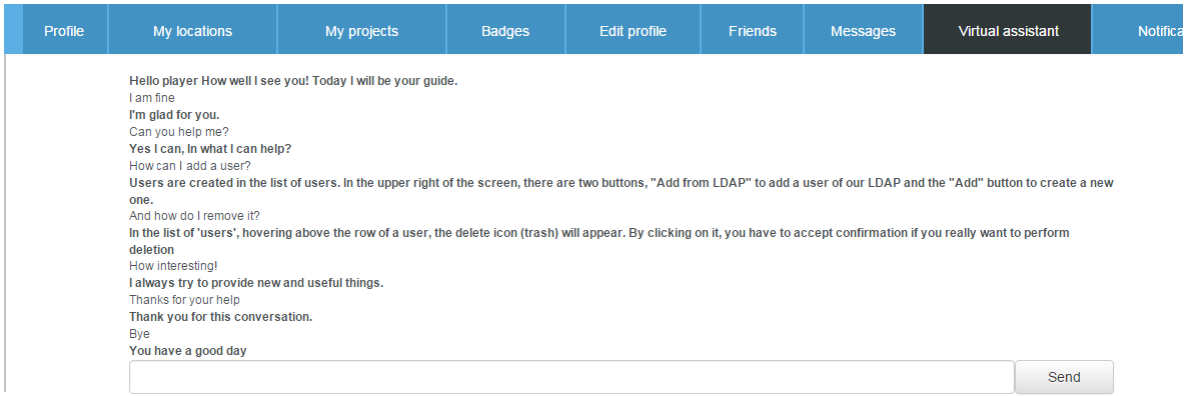

Figure 4. Conversation between user and the intelligent virtual assistant. In bold, responses from assistant to the user.

5 CONCLUSIONS

In this paper we have presented a intelligent virtual assistant for gamified environments. The main purpose of the assistant is to provide the players with help on the tasks they have to complete and the tools they have to use, in natural language. But in addition, the virtual assistant includes other components that allow it to have knowledge about each player profile and social network, and to analyze the sentiment polarity of each message of the players. This virtual assistant allows us to introduce a new game mechanic in gamified environments that is very typical in traditional games.

We have also presented a case study in which the virtual assistant was introduced in the gamified environment of a real company. In this case, the virtual assistant provides the developers of the company with help on how to carry out different tasks, and in which tools they have to do them (e.g., issue management, requirements, project management, etc.). The difference with existing virtual assistants would be that our proposal is able to add more intelligence by analyzing the sentiment of each player's message and adapting accordingly.

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