Analysis of Serious Games based Learning Requirements using Feedback and Traces of Users

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Abstract: Identify the games that best meet the needs and expectations of teachers and objectives of their courses remains a necessity about the integration of serious games among active teaching methods. Indeed, several serious games have developed in recent years, and it is often difficult for a teacher, not a computer scientist in particular, to find a game that meets these specific needs. Our aim is to develop models and tools enabling the teacher to find serious games adapted to his needs, considering user feedback and their traces of interaction with the game. To this end, we have explored the evaluation methods of serious games as well as methods of extracting knowledge from traces and texts. In this paper, we present our method of knowledge extraction of educational objectives. Thus, our proposal is assisting and supporting teachers/trainers to choose serious games and easily integrate them into their learning processes and devices.

1 INTRODUCTION

According to the definition of (Alvarez, 2007), a Serious Game (SG) is "a software that combines a serious intention, educational kind, informative, communicative, marketing, and ideological or work-out with fun spring". This fun part of the game allows motivating and maintaining the player in a dynamic learning. Currently, thousands of students invest a tremendous amount of time in playing computer and the Internet. This generation of the game, strong in technology, has difficulty in cognitive learning, methodological and social. The serious game can therefore make an important place and establish itself as a complement to traditional training methods.

Moreover, its usability in most activity sectors gives him a definite advantage for its future. Besides, the use of serious game is growing exponentially and dramatically to reach several fields such as education, learning, continuing training, health care, military, etc. The serious game has been the objective of various research studies (Zyda, 2005). Indeed, there has been increasing interest of using SG for promote learning in carries serious objectives and learning outcomes. In this respect, several research works have been developed to highlight the specific place and the original role of play in the learning process. This research specifically aimed at enhancing the effectiveness of the use of games in learning. The teachers have been attracted by these games because they facilitate the manner of receiving the information by the learners. Therefore, the evaluation of their efficiency and effectiveness according to the course objectives becomes necessary. In fact, the increasing use of SGs in teaching laying the problem of their use by the objectives and content (Paraskeva et al, 2010).

The lack of reliable methods of evaluation and characterization of SGs constitutes a research gap linked to a real need for teachers. Indeed, selecting the most appropriate game at a given learning objective appears to be insufficiently treated in literature and the teachers/trainers whose specialties and knowledge are far from serious games and computer science in general have difficulty locating themselves. In a context of strong growth in the use of SGs, it becomes necessary to help teachers to identify the most suitable SG according to the defined educational objective and their own pedagogical needs. Through an evaluation and characterization approach of SGs and based on the extraction and analysis of the objectives treated by the game, we are trying to solve the research question addressed by this paper. Indeed, the extraction of information is a new discipline of analyzing an automatic manner to extract text a set of information considered relevant (Poibeau, 2003).

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Our proposal is to collect all the descriptions, the feedbacks, the possible traces of the players of a given game in a bank of games. Then, analyze each one according to the predefined ontology to extract the criteria and the key concepts of the game from the texts already stored in the corpus. After having had the criteria in result of the extraction, we will have ontologies relative to the games in quest of analysis and characterization. We then align these ontologies with the ontology of the needs of the teacher/ trainer in order to obtain, through automatic calculations, the precision rates of the information contained in the first ontologies in relation to the last ontology (ontology of the needs of the teachers).

Finally, and through the values of adequacy obtained during the previous stage, it is automatically recommended to the teacher/trainer the game best suited to his pedagogical needs. In order to meet our objective, we first carried out a state of the art on the methods of evaluation and analysis existing in the literature to identify the common characteristics cited and to consider and judge their usefulness according to our approach analysis of SGs. We also explore the techniques and tools used in related work to decide which analytical techniques to adopt.

In this paper, we proceed as follows: Firstly, we will present in section 2 the back-ground of our research work. In section 3, we will present our method of research. Section 4, describes in detail our methodology and used techniques. In section 5, we present the field application of our research. In section 6, we expose a part of preliminary results. Finally, we conclude by summarizing our work and the proposed perspectives.

2 BACKGROUND

Serious games' users still have difficulty with the choice of the most appropriate game for their needs. In this section, we present attempts to establish evaluation systems existing in the literature as well as the terminology associated with the characterization and modelling of Sgs.

2.1 Serious Games Evaluation: Methods and Used Tools

Several studies are currently devoted to evaluating the contribution of games in learning. The evaluation and analysis of serious games has affected several aspects. Some of these works evaluated the design component of the games such as the evaluation of the playability of the gameplay experience (Nacke et al, 2010), the user-friendliness of the interface of the game which tends to keep the attention of the player (Pinelle et al, 2008), the verification of the compatibility of the objective of the game with the content. For example, (Mitgutsch and Alvarado, 2012) proposed an evaluation of the content of the game through a questionnaire which offers a potential for a critical discourse on the strengths and weaknesses of a serious game and Emphasize cohesion between the essential elements of design and consistency in relation to the objective of the games (Calderón and Ruiz, 2015) (Lameras et al, 2016). Others have evaluated the amount of information acquired by the learner/player (Oulhaci et al, 2013), and follow his actions during playing the game and therefore assess the assimilation's degree of the knowledge provided by the game.

On his part, (Molnar and Kostkova, 2013) suggests an evaluation of the gain offered by a serious game. Nevertheless, these works are most dedicated to game designers and applies during the creating and developing games process. Numerous research advocates the use of methodologies and theoretical approaches such as grids, questionnaires, logs, interviews, monitoring, etc. to help teachers/trainers to analyze an educational game and evaluate its pedagogical profitability (Boughzala, 2014).

In relation to our research question, few studies have tried to associate Natural Language Processing techniques (NLP) with serious games (Picca et al, 2015) and has talked about the importance of such association. They admit that with the use of NLP, they can collect information without destroying the game and more accurately interpret the users' behaviour.

2.2 Serious Game Criteria

Works related to ours, tried to evaluate various aspects of the game. The frequently evaluated criteria are the usefulness of the game, the domain, the understandability, the motivation, the kind of the game, the feedback and the objective of the game (Bellotti et al, 2013). The learning outcomes in turn are a very selective criterion of SG (Mayer, 2012) (Ra et al, 2016) (Arnab et al, 2015). Other studies have proposed tools and databases of games where we find an educational games collected and analyzed by certain number of criteria.

In fact, our approach differs from above works and our objective is to extract the content of the SG, especially the educational goals through the descriptions accompanying SGs, feedbacks, to beable to compare and evaluate the course objectives, in order to make the right choice of the game to

Table 1: Serious Game Criteria.

Category	Criteria	Definition
Game	Gameplay/Playability	Evaluate the gameplay and the pleasure it offers to the player.
	Usability/interface	Evaluate the user-friendlness of the interface and the learning of the game by the players.
	Usefulness	Measure the interest of the serious game in relation to the field.
	Domain	Thefield and discipline of the game.
	Understandability/ Degree of difficulty	The ability of serious game to be understood.
	Game type	Competitive or cooperative
	Game genre	Role game, strategy, action, reflection, simulation, etc.
	Timing	The duration oft he game.
	Feedback	Clear information on how the partici-pants are doing.
Pedagogy	Objective	Define and describe the skill to be acquired via the game.
	Learning outcomes	Describe the desired learning that students should have acquired at the end of a game: skills and attitudes.
	Learning style	Informations and indicators that how students learn and interact with the game.
Target Audience	Age	The age range of learners whose game is dedicated.
	Prerequisites	Determine basic knowledge levels.
	Engagement	A generic indicator of involvement in the game.

incorporate it into the learning process by any instructional designer, we propose our terminology associated to characterizing and modelling SGs. Table 1 define and describe these criteria.

2.3 Serious Game Knowledge Modeling

In spite of the hopeful results of the use of SGs in teaching and learning presented in the literature, their analysis and evaluation still require metrics to characterize games in an educational context. In our context, ontologies allows to model a knowledge formally. Thus, they make it possible to represent the learner/player profile, the context of the game and the learning offered and integrated into the SG.

This section identify ontologies and meta-models of SG available in the literature. We proceeded as follows :

- Search for available ontologies of serious games.
- Analyze and compare the concepts used in each of them in relation to our needs.

In (Tang and Hanneghan, 2011), authors introduce a SG ontology that aims to develop a high-level creation environment to facilitate the development of SGs for teachers. We see that this ontology defines technical concepts and aspects of the game more than the pedagogical concepts. It is an ontology dedicated to the development of SGs. Other searchers define ontology of SG (Prayaga and Rasmussen, 2008), it is an ontology that describe and define the essential elements of games, the essential elements of the learning environment and the essential elements of SGs.

Moreover, a meta-model for SGss in higher education (Longstreet and Cooper, 2012), consists of three basic parts namely external entities, educational game elements and traditional game components. This model focuses mainly on the educational elements of the game. The knowledge of the domain is defined in an ambiguous way which requires an imprecise communication of the domain knowledge. A new ontology has appeared in the work of (Rocha and Faron-Zucker, 2015). It aims to enable the modelling and creation of SGs that use Linked Data datasets as a knowledge base to represent resources in the game and considering the profile and context of the player.

3 RESEARCH METHOD

To help and support teachers in choosing the right SG, we are trying to invent and create an evaluation model of SG content. Design methods, development of SGs and how they integrate pedagogy unwittingly are diverse. These differences should be taken into consideration when designing our automatic evaluation model (see Figure 1).

The goal is to extract the objectives and the description content that accompanies SGs, feedbacks and interaction of users of such SG. This research implements the technologies of semantic web and information retrieval. It fits in the field of Natural Language Processing (NLP) and specifically in that of the information extraction. It accepts input in plain text with domain ontology. The extraction process used to identify entities and aims to extract and generate annotations for each text feature.

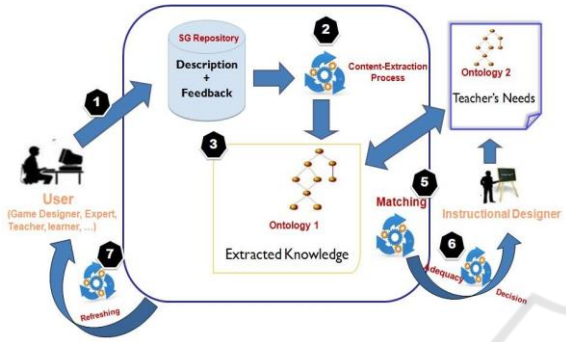

Figure 1: Architecture of our proposed.

To this end, we are trying to implement a systematic approach for teachers and trainers. The information extraction is a technology that aims to meet a user needs, it seeks to gain knowledge from text. Discover information of interest that we help us to take decision to adopt or not such SG in such learning process, is often our approach in this work. We use ontologies for the description and formalization of game knowledge and the needs of the teachers/trainers. After extracting the SG content and save it, we obtain in result ontologies of characterization of the SGs. These latter's instantiate the categories of the criteria of a given game already mentioned above in the previous section. On the other hand, we have a teacher/ trainer who is looking for a game that matches his or her educational needs. After having formulated the needs of the teachers/trainers in an ontology, we make the matching between the two (or more) ontologies corresponding to obtain a list of the most suitable games in percentage in relation to the needs of the end user.

4 METHODOLOGY

4.1 Serious Game Ontology

As we stated above, ontologies represent and deal with information at the semantic level effectively. Their use continues to cover various areas such as technical knowledge, research and indexing of information. They promote sharing, knowledge organization, interoperability between systems and facilitate communication between experts in software development as they establish a common vocabulary and semantic interpretation of terms.

The SGs evaluation process for teaching is very important for their adoption in the learning process. It is directly related to the pedagogical needs of teachers/trainers. Each serious game is specific in terms of design, modelling, how pedagogy has been integrated, and so on. It is for this reason that we propose an ontology to model the knowledge offered by such game. It is generic and has a reasonable size. We have developed our top-down ontology starting from the most general to the most specific concepts. In order to model all the information of interest to extract from the SG, we will update and exploit a domain SG ontology already proposed in (Ghannem and Khemaja, 2011). The main purposes of our SG ontology are: (i) a formal modelling to provide an automatic interpretation of the SG to solve problems related to standardization and interoperability. (ii) Promote the sharing of knowledge associated with SG in the educational field. (iii) Favour reuse of knowledge related to SG analysis and characterization.

The purpose of our SG ontology is to facilitate characterizing and the extraction of the contents of such game through the criteria mentioned in the previous sections. Indeed, a SG is characterized by one or more objectives, actions that compose it, the skills to develop among players, etc. A pedagogical objective can be affective, cognitive or psychomotor type. Pedagogical Objective accomplishes many skills such as knowledge, know-how and know-be. Actions that can accomplish the objectives, also used to describe and develop the skills covered by the game. The ontology will guide us to our knowledge extraction approach and to our evaluation system. Effectively, our ontology should answer the following questions:

- What are the different criteria of the serious game?
- How can they be characterized?

In order to answer to these two competency questions, we referred to the related works which tried to characterize the SGs and we then classify them by category (previously mentioned in section 2). The Figure 2, presents the SG ontology formalized under the Protégé ontology editor.

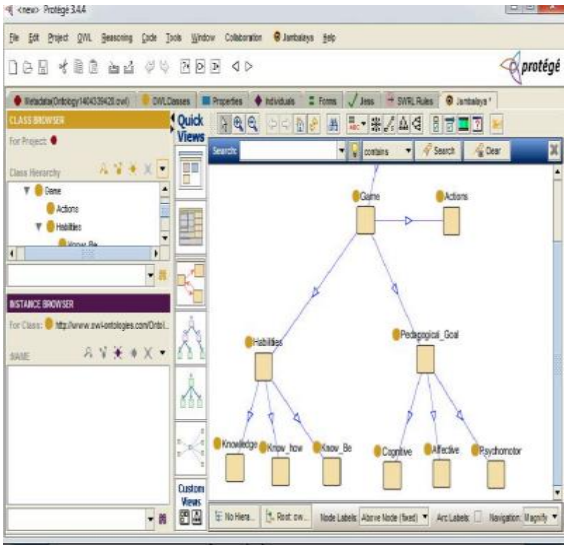

Figure 2: Partial view of our serious game ontology.

To validate our ontology, we create several instances of serious games belonging to different fields of education. The instantiated concepts are used for characterization and extracting the main knowledge of SGs.

4.2 Definition and Modeling of Teacher's Needs

We booked more time for modelling the needs of teachers/trainers in terms of the criteria and functionality offered by such a game and more particularly the objective class given the importance of these entities for the adoption of such game in learning. Considered as essential element in the context of teaching and learning, the Oxford Advanced Learner's Dictionary defines an objective as an act of kicking or hitting. Moreover, (Guilbert, 1984) defines an objective as the result sought by the learner at the end of the educational program, i.e what the students should be able to do at the end of a learning period that they could not to do beforehand. These are the statements which express specifically and in measurable terms, an attitude that will be developed cognitive or psychomotor skills that the students would be able to do because of prescribed treatment method or mode of instruction.

From these two definitions, we can shoot a statement of a learning objective contains a verb (an action) and an object (usually a noun). The verb generally refers to the intended cognitive process. The object generally describes the knowledge students are expected to acquire or construct (Anderson and Krathwohl, 2001). Thus, to represent an objective formally, we rely on the definition and Bloom's taxonomy. Bloom's taxonomy is a research tool in education and evaluation. It represents an objective classification system of the educational process. It is used to categorize the level of abstraction skills to be acquired during the learning process. The taxonomy consists of three domains cognitive (about knowing), affective (about attitudes, feelings) and psychomotor (about doing).

Defining the way whose users will express their pedagogical needs regarding the SG will allow us to exploit the information collected from teachers/trainers. Then, we align them with the knowledge extracted during the previous section to decide one or more adequacy between users' needs and our annotated games corpus.

5 APPLICATION FIELD

It is essential when we want to practice active learning to set goals to determine what the participant will get of training. But, the most common tasks in information extraction are the extraction of named entities (Nadeau and Sekine, 2007), and relationships. Therefore, extraction of objectives can be conceived as a form of relationship extraction where an action (verb) is related to other entities such that a player can perform in game. The development of such system first requires defining the nature of that in-formation to share with other information processing services. Ontology is the mode of representation most used for this purpose. Comes then the central phase of textual analysis to extract these types of information.

Our method of automatic identification of objectives and criteria is based on the description accompanying each game, the user's feedback and the user's interactions with the game such as logs, player's traces, etc. These descriptions can then be exploited to extract the concepts, relations and rules of the game ontology. Through the semantic annotation, we provide To users the useful knowledges to characterize the serious game. This extraction process follows the following steps: (1) The first concerns the definition and construction of the two ontologies. (2) The second is related to the identification of concepts/relationships in ontology, locating the corresponding terms and synonyms in the corpus. (3) The third concerns the export of the obtained result in RDF format, (4) in the fourth step, we align the obtained ontologies through the exploration of the corpus previously stored in our serious gaming bank with that of the users' needs and calculate the performance evaluation. To begin with, we define a

set of criteria considered as advertiser's criteria and objectives likely to realize it in the text. These advertisers are divided into different lists that each of which is associated with a specific class. For example, a type of objective can be cognitive, affective, or psychomotor. In other words, identify the different types of objectives defined in our domain ontology. Thereafter, it is specified the class of the ontology associated to advertiser's verbs present in the text to be analyzed.

Then, we need to associate their circumnutates involved to achieve the objective. For that, we must identify the relationship between the advertiser and other entities of the sentence. It is useful to use a parser defining dependencies between the different elements of the sentence. For each game analyzed, we could extract if they are present, the different types of objectives of the game, the type of the game, its domain, the level of difficulty, etc.

The tool presented here, uses semantic extractors suitable for text engineering platform named General Architecture of Text Engineering (GATE) (Cunningham et al, 2003) and aims to extract the goals, relationships, etc. The recognition component is based on the Gate Transducer component that uses JAPE to manually define the models. JAPE provides a layer between the user and regular expressions that are used internally. A JAPE rule consists of a pattern that must be identified LHS (regular expression for annotation pattern), followed by the code to be executed RHS (manipulation of the annotation patter from LHS) when this model is compared. The result of JAPE rule is stored in an annotation property. In GATE, each goal (verb) to be with his entry in the ontology. We opted for an automatic extraction of criteria from the descriptive text accompanying the SGs as a first filter in our overall evaluation approach. To get there, we developed a new resource type JAPE Transducer which adds to the Gate processing resources. We defined a JAPE rule to identify objectives. To avoid having false results and for the extraction engine does not consider any verb as an educational objective, we developed heuristics that eliminate noise that can be generated.

- The verb should be an infinitive.
- The verb must be followed by an object.
- The verb must belong to a predefined area.

These three heuristics are translated into rules to filter the results.

To conclude, we did not find any research work to automatically extract knowledge from serious games, and to characterize this knowledge through a concrete and semantic model. Moreover, to our knowledge there are no works based on semantic web technologies, specifically NLPs to automatically extract the content of serious games from texts and therefore give a formal and structured characterization to this knowledge and understandable by machine.

6 EXPERIMENT AND VALIDATION

With the aim of helping and supporting future SGs users for learning, and more specifically teachers / trainers, to adopt new teaching methods, ie teaching and training through games, We try to propose a generic and formal referential. Integrating SGs in a meaningful way into learning processes requires a well defined and precise protocol.

We adopted an approach based on the collection of data through the descriptions contained on the net, user feedback from the forums, collection of formalized and non-formalized traces of users and exploit them as input of our system of extraction and characterization of SGs. The output and the result of our system will be an ontology of criteria followed by statistics of the correspondence rates of one or several games with the criteria sought by the teacher / trainer. Next, our SGs evaluation protocol provides useful recommendations for the game user to adopt and favour one game over another based on the suitability values derived from the previous step.

The implementation of our content extraction method and the objectives of serious games are currently underway. But, we can expose some preliminary results. To test the effectiveness of our system and to validate our proposal, we have built our own repository through a range of serious games collected from the web, based on that they are open source and having educational objectives. The advantage of using NLPs to solve the problem of finding and characterizing SGs in favour of learning lies in its potential to develop a semantic network of knowledge related to the description of the game. Be exploited to find the adequacy between the learning objectives of a learning process and the learning outcomes that such a game can offer. Unlike existing work, we try to provide a complete solution while defining a generic tool for evaluating and analyzing SGs. We provide teachers/trainers especially non-computer scientists and non-connoisseurs of advanced technologies help and support to find the most appropriate game in relation to their pedagogical needs and therefore adopt it in their learning processes.

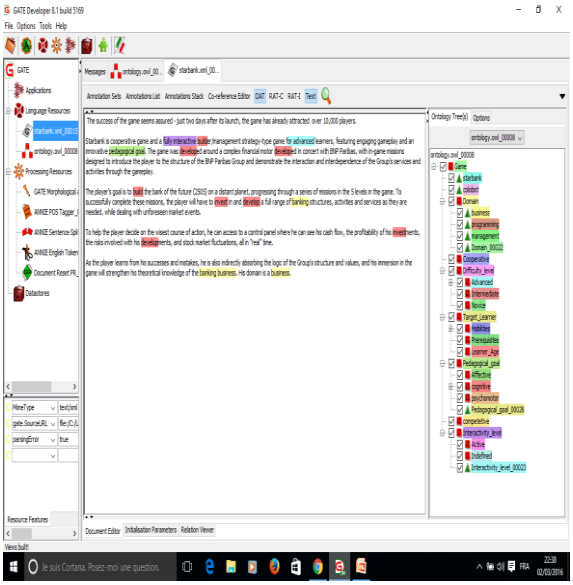

Figure 3: Annotation of ontology concepts.

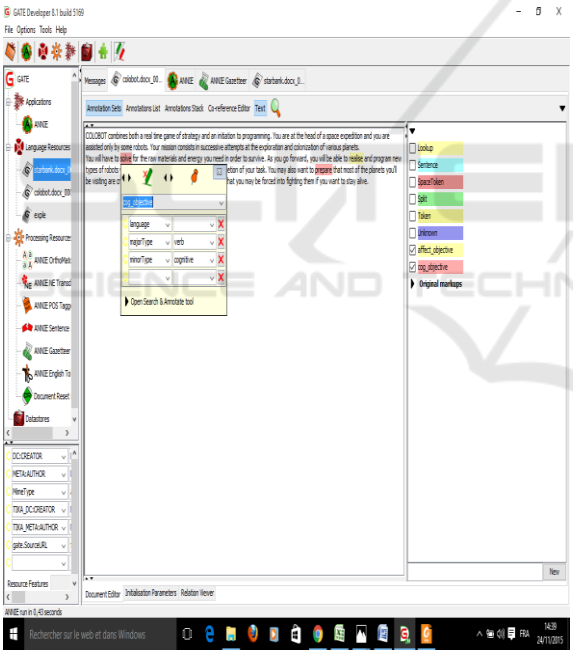

Figure 4: Objectives extraction.

Figure 3 and Figure 4, show the output from the extraction of some objectives present in the description of the Colobot and the stanrbank game. Through this extraction, w can get information on:

- What do we teach to the learner/player?
- What type of knowledge to be acquired?
  - The abstraction level of educational objectives?

In fact, this is the first filter of the first lines of extraction results in our approach adopted for evaluation of serious games through their educational objectives.

7 CONCLUSION AND FUTURE WORK

The principal aim of the work presented in this paper is to provide a method and model for extracting (semi-) automatically the serious game content. This model extracts automatically the objectives and content of the game through the description that accompanies it as first filter. This responds to the serious game users' needs to help and support teachers in their choice of the SG and to facilitate its evaluation.

Our future research consists of fully automating the content-extraction and evaluation process of serious games.

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