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Artificial Intelligence a Major Asset for Serious Games

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Abstract. Serious games have been around for a very long time, and the development of information technology and the digitization of our societies have fostered the development of serious games over the past 2 decades. Robotics, virtual reality or artificial intelligence have all made it possible to provide more facilities for the learner, but also more knowledge for the teacher who can transmit the necessary knowledge at the pace of each learner. Artificial intelligence in serious games enhances their attractiveness but above all should help improve learning outcomes to be transmitted through serious games. In this study, we will present a definition of serious games while presenting the diversity of uses in various sectors and towards different targets. A definition of artificial intelligence and the possibilities it offers to improve the efficiency of serious games. A zoom will be made on the European Opensource Marketplace "gamecompenents.eu" and our project to integrate some of its A.I modules into our adaptive pedagogical hypermedia model through the development of some serious mini games.

Keywords: Serious Games, Artificial Intelligence, Machine learning, Adaptative pedagogical hypermedia

1. Introduction

Can we learn by playing? Since the 19th century, games have been introduced as a learning medium and has been used for specific learning and has given positive results. Long before that, "Ludus" in Latin already meant play and school at the same time. Plato and Aristotle emphasized the importance of play on the balanced development of children. Gamification and serious games make it possible to use the processes of games in an educational dimension while diverting the moment of play into a moment of school, educational, civic learning... taking advantage of the open-mindedness and motivation of the " player ".

The development of Information and Digital Technologies today strongly influence the learning experience of students, but also of the teacher and the education system as a whole. Role of each have evolved, which requires reinventing it by adapting the learning tools. Learning through serious games has its place in today's world and its applications touch almost every industry.
Serious games or Learning Games are games in which an educational scenario has been added as well as a mechanism for feedback and monitoring of the learner. They are also applications whose initial intention is to combine the serious aspects and the fun elements of video games. The serious aspects can be teaching, learning, communication, information, Marketing… (1).

The use of digital technologies in the development of serious games allows developers to add intelligence in the mode of transmission of the educational concepts hidden in the serious game. The use of artificial intelligence algorithms will allow real-time monitoring of the learner's actions and will allow serious game to be adapted to the learner's level (11), but also to his mood, his attendance. Serious Game can be in normal function for a good learner and in assist mode for a learner with specific problems, or with a known or detected disability. Adapting to the level of the player, his performance or underperformance, is an advantage that serious games bring to learning.

Researchers from several disciplines have been interested in serious games for more than 2 decades. From IT, to human and social science, to educational sciences and technological research, without forgetting to mention the business world. Serious games have been used in a multitude of fields ranging from health, to learning leadership, through the environment, well-being, social, commercial, industrial and also schools and universities. And the more technology evolves, the more serious game developers introduce them into the process of learning through games (Game Based Learning) for the benefit of the learner and the teacher.

And it's the case of Artificial intelligence which entered serious games through many doors, like the analysis of data collected during the game, for the benefit of the supervisor and the adaptation of the tasks of the player / learner according to his level, difficulties or handicap.

In this article, we will describe serious games and the extent of their use. We will define Artificial Intelligence and focus on AI components that can contribute to serious games as well as the future possibilities, to be included in our adaptive pedagogical hypermedia, integrating the notion of learning and adaptation. (34)(33)

2. Serious Games: Definition

Serious games are games in which an educational scenario has been added as well as a device for feedback and learner monitoring. They are also applications whose initial intention is to combine the serious aspects and the fun elements of video games. The serious aspects can be teaching, learning, communication, information, Marketing ...

Different names designate serious games:

- Computer Game
- Learning Game
- Immersive learning
- Reuse of educational games
- Adaptive Educational Game
- Digital game-based learning
- Persuasive Games…

But in the majority of these names, we find:

- A game
- One or more potential targets
- One or more potential themes
- Technology

Serious games have hit almost every potential target, and we can name a few:

- Students, children ...
- Employees
- Managers
- People with disabilities
- Sick people
- Illiterate
- Teacher
- Children ...

As for the thematic, we can cite the various and varied fields below:

- Security (22)
- Health (25) (6) (27) (35) (9)

- Languages (14) (38) (28) (21)
- Leadership (30) (29)
- Social events (violence / Addiction ...) (12) (6) (16)
- Human resources management (17) (7) (18) (3)
- Industry, Logistics… (7) (24)
- Science, Mathematics… (8)
- Psychiatry (13)
- Sustainable development (31) (2) (37)
- Culture, Museum, Literature… (19)
- Health of the elderly (20)
- …

For technologies, developers have not ceased to incorporate as far as possible any technological innovation in serious games and we can cite a few:

- Virtual Reality
- Artificial intelligence
- Robotics
- Social networks (Social Media participation)

We also noticed the interest of serious “mini games” as a quick possibility to transfer very specific knowledge trough serious game.
A Mini serious game can be developed and adapted quickly (22). It will contain a basic game with an easy mechanic, and a very small number of educational items to be included. They come with a flexibility and can be used to raise awareness on different kind of subject.

3. Artificial Intelligence: Definition

Artificial intelligence is defined in the Larousse dictionary as "A set of theories and technics implemented to produce machines capable of simulating human intelligence". With artificial intelligence, man realized one of his most ambitious dreams: to manufacture machines with a "mind" similar to human one. For John MacCarthy, one of the creators of the A.I concept in 1955, “any intellectual activity can be described with sufficient precision to be simulated by a machine”. Artificial intelligence therefore aims to reproduce as well as possible, using machines, mental activities, whether in the order of understanding, perception, or decision.

With the explosion, today, of data generated by multiple applications, programs and machines, the interest of A.I becomes essential, to help humans increase their capacities for processing and analyzing data volumes. Big Data has not made it easy and has made the use of intelligence in data processing algorithms essential to value the billions of data generated by powerful servers and connected applications that are increasingly used in all areas.

The A.I is a brick of different algorithms which, depending on the application needs, will capture, process, interpret, and exploit different types of data:

- Interpretation of information,
- Capturing the senses, especially audio and visual
- Language processing
- Use of large databases…

Artificial intelligence uses different sciences to exist (23):

- Mathematics and Statistics
- Human Sciences (cognitive, psychology, philosophy)
- Neurobiology
- New technologies used to smartly capture or facilitate data processing

A.I can be segmented into four domains (23) in a more hierarchical manner:

- Solutions, used by customers (businesses or individuals) with chatbots, autonomous vehicles, robots, recommendation systems, customer segmentation tools, predictive marketing or cybersecurity solutions.

- Tools to create those solutions, such as artificial vision, speech recognition, machine translation, expert systems, automatic forecasting or segmentation tools.

- Techniques, such as machine learning methods, neural networks, the many deep learning methods and rule engines.

- Data, multiple data sources and associated sensors or connected objects.

4. Serious Games and Artificial Intelligence

The development of technologies and the proliferation of different modes of access to information have made it possible to multiply serious games, in almost every conceivable field. The development of these serious games has also been accompanied by the generation of multiple data, captured during the period of games or learning by the "learning" player. Game developers, and for several years, have created algorithms analyzing this collected data to make use of it for the benefit of the user and / or the teacher.

Since the emergence of artificial intelligence in the 1950s, game developers have taken an interest in it and developed "smart" chess-like games to challenge human intelligence. We have seen games adapting the content to be used by the learner according to his level, according to the speed of learning, reaction or even according to the mistakes made. The possibilities are endless. The introduction of Machine Learning and artificial intelligence algorithms will bring to serious games a great wealth of uses that will improve the results of transmission of the knowledge object of the current learning. The data of the learner's interactions with the serious game will allow the teacher to make quick decisions based on the result of the analysis of the data processed by the AI algorithms hidden in the serious game. Understanding in real time, the level of the learner provides the supervisor with the opportunity to improve the learning process as it goes and in an individualized manner if necessary.

In the literature the term EDM, for Educational Data Mining, has emerged and refers to the whole concept of improving learning through the use of the analysis of data collected by the actions of the student / player, their treatment by drawing the necessary insights to increase the success rate of training by serious games. Several studies have shown the positive impact on learning of integrating A.I through Learning Analytics into serious games. (5) (10) The study (10) highlighted the different techniques used to take advantage of Machine Learning and making learning through serious games effective. Decision trees, linear prediction algorithm, neural networks, factor analysis, performance analysis and monitoring.

Making serious game data exploitable and useful for learners and educators, through the use of artificial intelligence will allow:

- The learner: to correct his errors in real time, to better interact with the game and to stay focused on the objective of learning of the serious game

- The educator: It is up to him to get to know the different learners better, and to draw the best lessons to better adapt the message according to the level of each player.

- Developers, Designers: Other learnings can also be drawn from the millions of data that will be collected and will provide insights for game developers, designers, content creators ...

5. A.I, Machine Learning, Learning Analytics in our project of development of a serious game

In our works (34) (33), we implemented an adaptive pedagogical hypermedia, integrating the notion of learning and adaptation at 3 levels:

- Modeling of the learner by structuring the main elements characterizing the learner (personal information, levels, skills, history of interactions, psychological profile, cognitive capacities, emotional statuses) (Fig1)

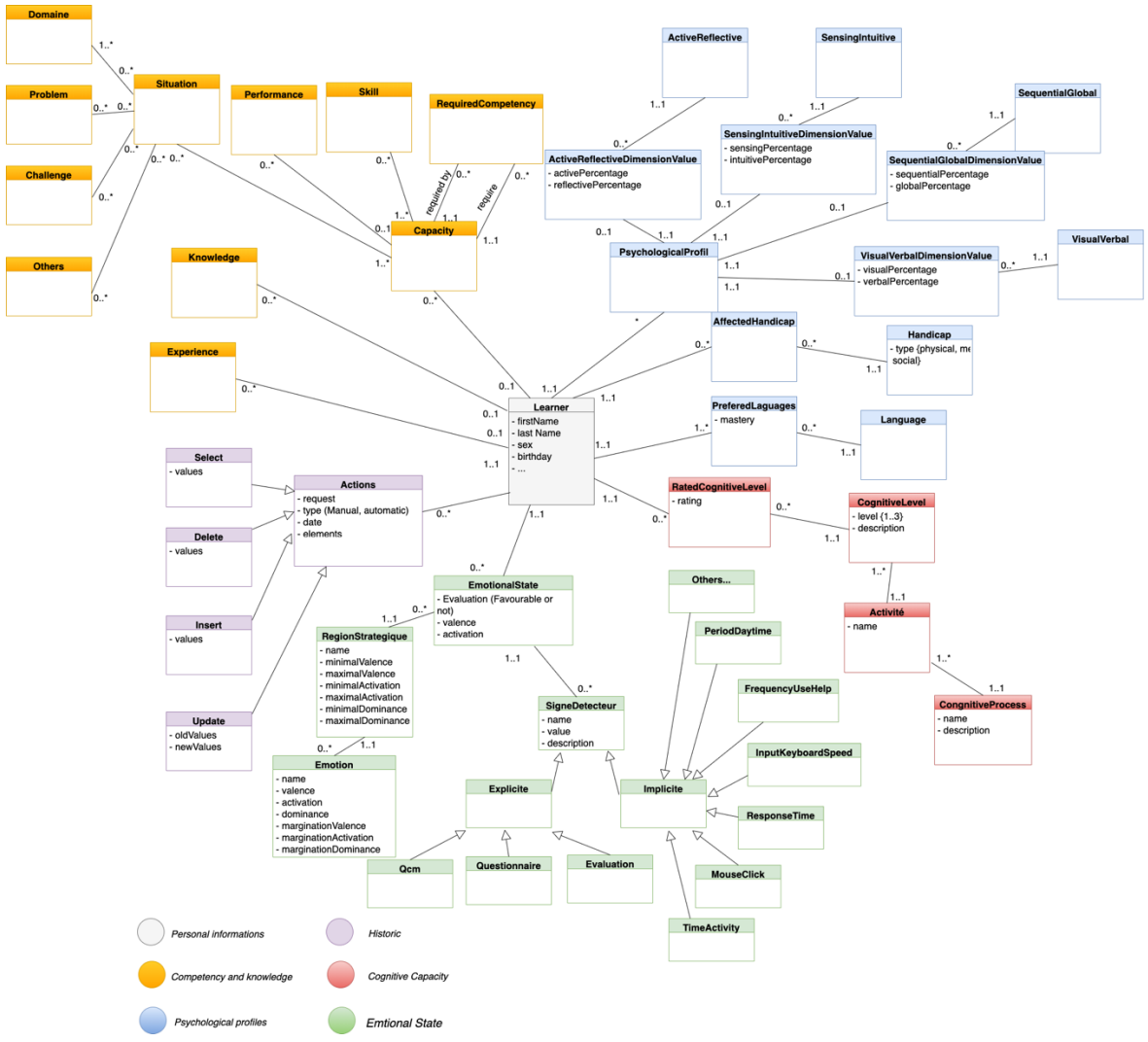


Fig 1 : Learner Model

- Domain modeling by structuring the learning elements (text, videos, questionnaires, exercises …) (Fig2)

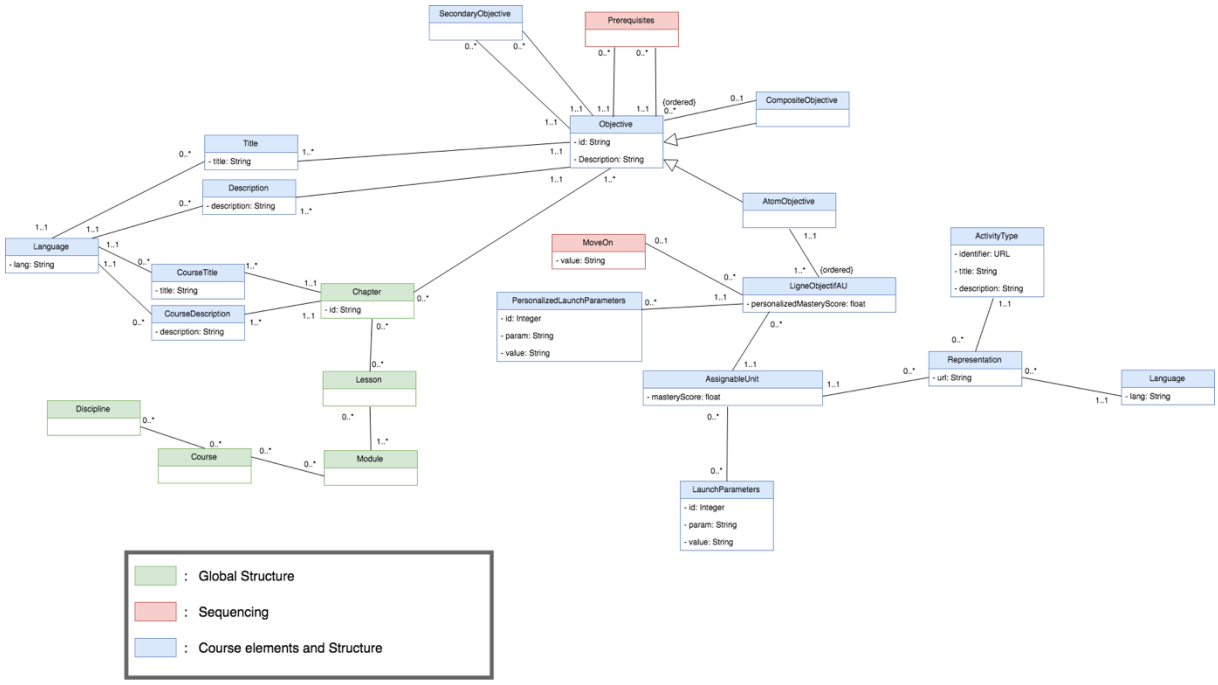


Fig 2 : Domain Model

- Adaptation modeling by representing the different mechanisms for adapting and personalizing the content and structuring of learning. (Fig3)

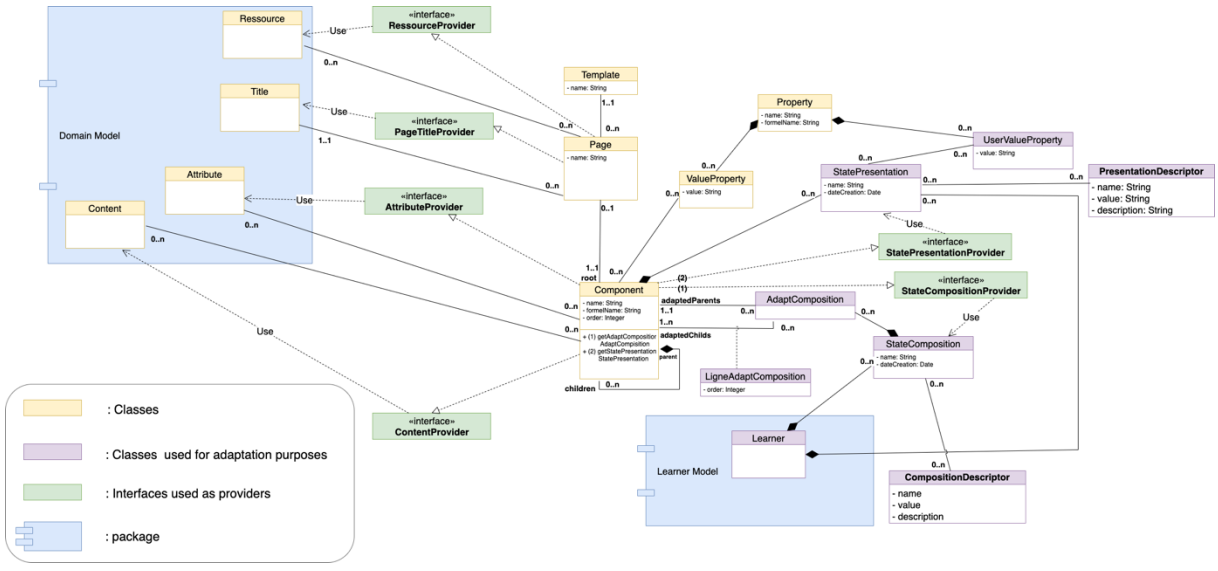


Fig 3 : Adaptation Model

Improving this modeling to strengthen its adaptive capacities using artificial intelligence should allow us to improve learning outcomes and make it easier for the educator.

We have analyzed the state of the art of available algorithms that can enhance the development of our adaptive hypermedia that can be used in the development of our serious game.

The study (36) highlighted the concept existing on the European platform "**gamecomponents.eu**" which is a kind of open source "Marketplace" of modules that can be used by serious game developers, including a variety of A.I modules.

Today, around a hundred modules are on display on this platform and we refer to modules that provide various solutions that the author of the study (36) classifies under the 3 categories below:

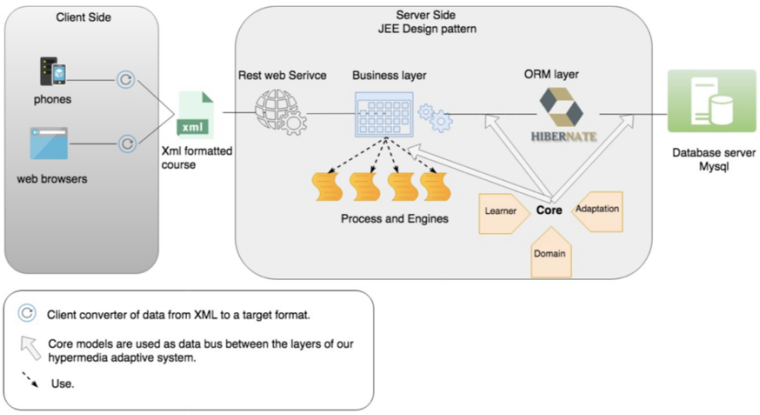
- PEM: Player Experience Modeling
- NLP: Natural Language Processing
- NPC: Advanced Non-Playing character

The interest of these items for serious games is justified by the educational framework, namely a supervisor (NPC) who monitors and notes the learner (PEM) while providing support when necessary via exchanges (NLP).

We emerge for each of these modules some of the most important artificial intelligence components that can help serious game development, namely:

- Facial recognition
- Analysis of emotions
- Analysis of behaviors and feelings
- Adaptation and evaluation
- Speech / lip synchronization (in the case of avatars)

We will use those A.I component in the global architecture of our adaptative hypermedia system (34) to help treatment of collected Data at the level of the Process/Engines to help analyzing data collected from the interaction of the user with the serious game.



6. Conclusion

The proliferation of information technologies has encouraged the proliferation of serious games in several fields of activity, and on various targets.

All of the work in reference has demonstrated the importance of serious games as an undeniable training medium. However, the majority also demonstrated the difficulty in being able to find the balance between play mode and learning mode for successful learning.

The success rates of this mode of transmitting knowledge are improving as developers and designers enrich them with the rapid technological advances that the world is experiencing today.

Artificial intelligence has taken advantage of these technological advances and will undoubtedly bring strong added value to the serious game ecosystem (Learner, Educator, developer and designer).

The Human-Machine interface, the technical design, the model of presentation of the educational content, the model of follow-up of the learner / player and the possible adaptation to his level, his style and his learning speed are all challenges still requiring research work for a guaranteed success of learning through serious games.

We will therefore, in our next work, enrich the 3-level model of adaptive pedagogical hypermedia, by connecting it to several open-source A.I modules of the European platform “gamecomponents.eu” and test the effectiveness on improving the learning through serious games, by developing serious mini games.

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