Automated Evaluation of the Game Experience based on Game Dynamics and Motives for Play

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This paper describes an automated evaluation of the overall game experience using a synthetic agent, that we contextualize for First-Person Shooter games. This evaluation method is based on the characterization of the game experience through dynamics of major FPS games. We define dynamics as sequences of events that are meaningful for the player during the game session. As they trigger players' emotional responses, and influence their overall enjoyment and motivation, we classify them according to Motives for Play like curiosity, thrill-seeking, problem-solving, victory, and acquisition, in order to facilitate the evaluation process. Based on that, our evaluation method proposes to select synthetic agent routines that target a distinct game experience while playing a game session, using a selection of game dynamics. As the agent navigates through the level and interacts with opponents, dynamics may occur and, if so, are automatically identified, and then classified as Motives for Play. In the end, this classification can be used to evaluate the game experience and the quality of the level itself during playtesting sessions. It may also be utilized to assist the procedural generation of any level that target a specific game experience.

CCS Concepts: • **Human-centered computing** → **User models**; • **Applied computing** → **Computer games**; *Psychology*.

Additional Key Words and Phrases: user experience, game experience, video games, playtesting, synthetic player, game dynamics, motivation

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1 EVALUATING THE GAME EXPERIENCE

1.1 Automonous Agents for Game Experience Evaluation

Playtesting is a fundamental part of game production, allowing designers to check the quality of the game experience and its usability [44]. It is the only way to see how a play session unfolds the first time the game is played by its target audience. Automated agents are more and more often used to evaluate the quality of video games' design elements, allowing to test the game in a faster and cheaper way [42]. They can mimic players' performance and preferences to give designers a more diversified and realistic overview of how their game will be played, and thus, agents may help to improve the overall game experience [37]. General Video Game AI Competition (GVG-AI) was for example founded by researchers to propose open-based tools that train AI agents to play various video games [30]. Agents do not have prior knowledge of the game's rules but can retrieve information about the current game state, and use it to plan for their actions. Such research is beneficial for the growth of AI by itself, but also paves the way for ready-to-use, less biased, automated playtesters.

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A specific and interesting use of this kind of AI is to assist in the game generation, as they can evaluate the player's progression through the level regarding specific game objectives. Efforts have been made to use autonomous agents to transcribe the complexity and diversity of player experiences. Togelius et al. propose to simulate their motivational and emotional elements [38]. Guerrero-Romero et al. describe heuristics to orientate the agents' evaluation of the level: Winning Maximization, Exploration Maximization, Knowledge Discovery, and Knowledge Estimation [16]. These heuristics underline different agents' behaviors and can be used to evaluate a specific aspect of the game experience. Board games design can also benefit from agent playtesting, simulating different play styles, and analyzing the resulting game experience [35]. As for heuristics, these play styles are defined based on designers' guidelines regarding their perception of the players' behaviors. Such models rely on a detailed set of actions, that a specific type of player may execute during gameplay.

Playing a video game is by definition a subjective experience based on the interaction between the player and the system [6, 44]. For this reason, the game experience is complex to describe and to evaluate, and even more by using a synthetic player to emulate the player's behavior. These player-oriented models are indeed useful in that regard, but they remain indirect methods of defining the precise characteristics of the game experience. However, every step in this direction will be very helpful when it comes to procedurally generating game content, as it very often relies on an automated evaluation of the generated content [34, 37].

1.2 Automated Evaluation based on Game Dynamics

A game can be analyzed in many aspects, especially for a game-level generation. There exist theoretical general models such as the Mechanics, Dynamics, Aesthetics (MDA) or Design Play Experience (DPE) frameworks [20, 40]. On the other hand, Togelius et al. propose to distinguish between First/Second order generators, given that player emotions are directly taken into account or interpreted using a model of the designer; and Direct/Indirect level generators, that either measure player emotions or cognitive and/or behavioral aspects of player experience that indirectly gives information about such emotions [38]. Finding the best level of abstraction for game analysis is thus a complex matter, and for this research, we introduce a generic framework to help with the design of automated gameplay analysis systems.

This paper introduces a method to evaluate the game experience of video game levels while using an autonomous agent. This evaluation is lied to gameplay events, and in particular game dynamics that are useful to characterize the experience. As it will be discussed in the next section 2.1, dynamics can be more easily integrated into game-level generators, as they can be linked to game mechanics [20], and be evaluated as sequences of events, as we propose in section 2.2. Dynamics can also be used to highlight players' emotions, as they also are linked to specific players' behavior and motives for play [3]. This evaluation method can be integrated to playtesting and generative tools, as it will check dynamics' emergence through the level.

In this work, we focus on a specific game genre. Indeed, as we will explain, our agent relies on game dynamics analysis, and choosing a specific game genre allows use not only to describe game dynamics analysis but also to propose a specific set of dynamics. We chose to focus on First-Person Shooter games, being one of the most played game genre, heavily studied by researchers and sharing common traits with many other genres [9, 10].

This paper first introduces related works on game experience frameworks and game dynamics. We then propose a more formal definition of game dynamics, allowing us to perform quantitative analysis from gameplay event traces. Next, we present a list of dynamics for the First-Person Shooter game genre, that are classified into Motives for Play and their related players' emotions. We later discuss how this classification may be used to, first, facilitate the understanding of specific elements of the game experience and then, help designers modify their game levels according to the experience they want to target for the players. We propose an integration of our automated method of game experience evaluation during a playtesting session, for both human and synthetic playtesters.

2 GAME DYNAMICS AND PLAY MOTIVES

2.1 Game Experience Characterization through Game Dynamics

Game experience is a particular user experience in which people freely participate in a rule-based activity, defined in space and time, for which outcomes are uncertain, i.e. players acting within a game [7, 19, 22]. As Malone puts it, players can be described as motivated by the challenge provided by the game's difficulty, their curiosity about the game's progression as well as their emotional attachment to the game's fantasy [27].

Many models try to describe the game experience through the player perception and, especially, through their motivation [5, 23, 31, 36]. For example, Ermi & Mäyrä's SCI Model [14], for Sensory, Challenge and Imaginative immersion Model, states that players have a specific interpretation of the actual gameplay, that is shaped by three types of immersion: sensory immersion, based on the audiovisuals elements and the interface; challenge-based immersion, related to players' sense of achievement while facing difficult challenges; and imaginative immersion, linked to player's identification and projection processes. Any game elements, like rules, mechanics, or interface, will have an impact on these senses of immersion and may influence the meaning of the game experience, as well as players' engagement and motivation. Ermi & Mäyrä evaluate these types of immersion in various video games using gameplay experience self-evaluation questionnaires. The questionnaire's statements reflect players' sense of immersion during gameplay, while underlying game dynamics that may be at work.

Other approaches characterize game experience from a motivational and emotional perspective. Bateman explains how players behave through Motives for Play [3], described into three categories: general motives, fundamental motives of every game experience like curiosity, thrill-seeking, and social motives; functional, as they serve the goal of the play; and representational, as they emerge from the fictional elements of the game. Motives are underlined by emotions, based on Ekman's classification, and explained from a psychological point of view [3, 13]. These game experience models are also useful to link player experience to player types. Bateman's Motives for Play types highlight specific behaviors, like Bartle's taxonomy [2] or BrainHex typology [29].

Indeed, game experience, as any activity, is only performed for the experience it provides, and thus we can't rely on an extrinsic, well-defined interaction goal, as, for instance, in a user-printer interaction. However, as soon as we plan to use a design method, even more, when this method relies on automated or procedural steps, we need to try to define the game experience itself through precise and measurable metrics.

Formal conceptualizations of game experience try to link game elements to various aspects of the player's appreciation of the game, as they both describe the content of the system and players' behavior associated with their interaction. In this respect, the Mechanics, Dynamics, Aesthetics (MDA), and the Design Play Experience (DPE) frameworks were built to help designers and researchers better describe game experience [20, 40, 44]. In these frameworks, dynamics are processes that emerge from players interacting with the game. Dynamics may thereby describe behaviors, or players' preferences [39]. They can also highlight players' emotional responses through aesthetics game elements like sensation, fantasy, narrative, challenge, fellowship, discovery, expression, and submission [24]. But dynamics are rarely linked to a particular play genre, and may also be too high-level [8, 44]. For instance, dynamics of a FPS game as *Quake* are reduced to *Time pressure* and *Opponent play* [20]. Game dynamics are not listed to their full extent and, if we want to evaluate more precisely the game experience, dynamics need to be associated with objective metrics, like in-game parameters and behavior rules. Metrics will also be useful to link game dynamics to player motivations and emotions. If dynamics have emerged, we may make the hypothesis that a specific game experience is possible, and evaluate it as such. Our methodology is described and discussed in the next sections.

2.2 Defining Game Dynamics for Quantitative Analysis

Linking motivational concepts, such as challenge for instance, to actual objective measures is a complex matter [11]. In this work, we rely on the concept of game dynamics to evaluate a simulated play experience. To do so, we need a more formal definition of game dynamics, that will allow us to evaluate a game session in a more objective, quantitative way. Game dynamics are defined by Hunicke as the *run-time behavior of the mechanics acting on player inputs and each other's outputs over time*[20]. Zubek finds this definition too ambiguous and prefers referring to gameplay, defined as the *dynamic process of the player interacting with the game and each other.* In this study, neither of these definitions is formal enough for our goal. However, from these definitions and following Cassandras and Lafortune, we can argue that a game is a form of dynamic system [26]. Indeed, as a combination of mechanics that allow interesting dynamics to emerge, a game is actually a system, defined by Cassandras & Lafortune as *a combination of components that act together to perform a function not possible with any of the individual parts.* Moreover, a game can be considered a dynamic system, as *the output generally depends on past values of the input.* We can thus rely on a very helpful concept that can be used to analyze dynamic systems: the notion of event, i.e. the instantaneous transition of a state of the dynamic system to another. In a first-person shooter game, many meaningful events can be identified, e.g. every time the player is shot, an enemy spots the player, the player grabs an item, the player discovers a new place, a door opens, etc. We propose to rely on this notion of event to analyze a play session, and we thus define our dynamics as follows:

> *A game dynamics is defined as a sequence of events, happening during a play session, meaningful with regard to the game experience.*

From this definition of dynamics, we propose a game experience evaluation pipeline in the next section.

3 AUTOMATED GAME EXPERIENCE EVALUATION METHODOLOGY

3.1 Game Experience Evaluation Pipeline

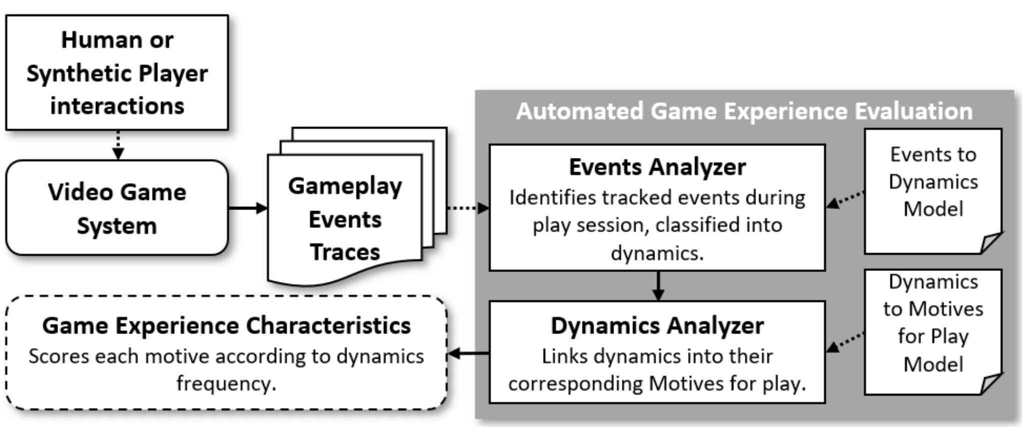

Fig. 1. Game Experience Evaluation Pipeline

Figure 1 shows how, starting from our definition of dynamics as sequences of events, we propose to evaluate a game session. To analyze a game session and identify the unfolding dynamics, we need to record the meaningful events that happen during this session, i.e. the events related to the dynamics we want to be able to detect. Then, from this trace of events, we will be able to extract sequences of events that match specific game dynamics, and analyze, for instance, the frequency of apparition of each given dynamic.

Extraction of game dynamics will be based on pattern recognition, utilizing Markov Model-like pattern matching applied to Machine Learning [15], and used for video games design [17, 43]. Thus, we will be able to spot game dynamics inside the complete database of the synthetic player's actions, classified through time.

Then, we need can make a link between the dynamics we identified and the player's motives, in order to get a more abstract point of view of the play session, linking dynamics to the overall aesthetics goal. In the next section, we propose several dynamics for First-Person Shooters, and link them with player motives, showing how to perform the last step of our framework with regard to the FPS game genre.

3.2 FPS Game Dynamics and Play Motives Classification

We have studied a dozen of FPS titles and analyze their game dynamics [1]. FPS game dynamics are described accordingly in game design methodologies [32, 33, 44], FPS games historical approaches [12, 25], game dynamics literature [20, 44], and play sessions using Game Experience Questionnaire feedback [21].

First-person shooters are, at core, action games played from a first-person perspective, while navigating through a maze and fighting opponents [1, 41]. Besides these core features, the gameplay of modern FPS tends to share mechanics usually associated with other genres, such as Adventure Games, Role Playing Games, or even Simulation Games. Even if these types of FPS present considerable interest to understand such a multi-faceted game genre, we pushed these games aside from our selection. We thus have restricted our study to classic FPS gameplay criteria as a start, considering that we have to list main game dynamics for this game genre. We will integrate diversified FPS game experiences in the future. We also focus only on solo game experience and, for the moment, do not describe social game dynamics found in multiplayer games, as the project required it.

Our list of dynamics is not exhaustive and will be compared to the evaluation of the dynamics with a target audience of FPS players. This primer inventory is a necessary first step in the elaboration of our methodology, as it offers to game designers a classification of dynamics according to Motives of Play and, by extent, players' emotions. They can choose dynamics that target specific Motives for Play for their game experience, and use the autonomous agent to verify if dynamics can emerge while navigating through the level.

As stated in section 1.1, we propose to track events and connect them to game dynamics, in order to characterize the game experience of the played session. We use Bateman's taxonomy to organize game dynamics according to Motives for Play [3]. For the moment, we focus our classification on players' motives related to *General and Functional motives*, as our AI is not currently designed to evaluate representational elements of play, like *Narrative*, *Horror* or *Agency* motives. In that way, we target goal-oriented motives and the players' types related, such as *curiosity*, *thrill-seeking*, *problem-solving*, *victory*, and *acquisition* Motives for Play. We do not take into account *luck motivations*, as Bateman's definition strictly relies on this motive to games of chance, like the lottery. FPS games, on the other hand, rely on skills and performance, and rarely put luck mechanics at the core of their experience. We also push aside *social motivations*, as

[1]The study includes *Doom* (id Software, 1993), *Quake* (id Software, 1996), *Half-Life* (Valve, 1998), *Serious Sam: The First Encounter* (Croteam 2001), *F.E.A.R.* (Monolith, 2005), *Portal* (Valve, 2007), *Mirror's Edge* (Dice, 2009), *Counter-Strike: Global Offensive* (Hidden Path, 2012), *ARMA 3* (Bohemia Interactive, 2013), *Devil Daggers* (Sorath, 2016), *Wolfenstein: Youngblood* (Arkane, 2019), *SUPERHOT: Mind Control Deleted* (SuperHot Team, 2020).

we studied solo player FPS experiences. We also note that all dynamics do not have a positive influence on the player's progression, as some are associated with failure, like *Unintentionally miss a shot* (dynamic 11). These dynamics are thus not deliberately set up by players, and in some cases are performed without players' will, but are part of the overall game experience. All these types of dynamics are presented regarding motives in follow and arranged in table 1.

Curiosity, is one of the most powerful motives and, as such, is linked with many dynamics. It is a cognitive state that will lead players to explore the level to get new information about the state of the game, as well as to experiment new strategies in order to evaluate them [4, 18, 28]. For example, *Know opponents' and items' position* (dynamic 13) may be induced by curiosity and, at the same time, motivated by the need to apply a proper tactic to solve a specific situation. To clarify the behaviors related to curiosity, we propose to follow Bartle's, Bateman's, and BrainHex taxonomies and to narrow curiosity to exploration and novelty seeking [2, 3, 29].

In the case of solo FPS titles, *thrill-seeking* is both empathized by moving in the game space and fighting situations. We make the distinction here between a *movement-based thrill-seeking* and an *opponent-based thrill-seeking*. Movement-based is mainly induced by character inertia, navigation controls, and features, such as jumping, running, and crouching. Thrill-seeking is also triggered by specific interactions with non-playable characters and, in particular, opponents during combats.

Problem-solving in FPS games may vary with the game sub-genre. For example, *Half-Life* has a strong emphasis on environmental puzzles and platforming elements, dissociated from the shooting phases. On the opposite, *Quake* reduces its puzzle aspects on shooting tactics. We choose here to focus on shooting problem-solving and planning, as it is common for all shooters.

Victory motive is closely related to *problem-solving motives*, but more focused on the desire for challenge. Based on the games we selected, we present a dynamic related to winning, one to fail, and one that consists in creating a disadvantage to make the game more difficult.

Acquisition motive in FPS games are, as in other games, related to the will to acquire as many items as possible, like weapons or power-ups, and/or to overcome any opponents on the level.

4 DISCUSSION & FUTURE WORKS

In this paper, we introduce a method for an automated evaluation of a game experience, synthesized in figure 1. Our evaluation pipeline is based on tracking game dynamics that occur during game sessions, played by an autonomous agent. To automatically identify game dynamics, we present a definition of dynamics as sequences of events that are meaningful for the players and, by extension, to their experience of the game. We propose to record these game-session events, and analyze the trace of events to identify the corresponding dynamics.

Such dynamics are often specific to a given genre or even a given game. In this paper, we thus describe a list of game dynamics related to FPS games. We link these dynamics to Motives for Play, giving a more abstract and aesthetic-related score of the overall game experience. Motives for Play can explain players' behavior, as well as their motivations to set up various strategies during a game session. These motives might thus be useful for designers, helping them to elaborate specific game experiences, and our method should help them to evaluate their levels accordingly.

As pointed out in section 3.2, our classification of FPS game dynamics according to Motives for Play will evolve. We intend to conduct a dedicated experimentation to evaluate game dynamics with both beginners and experts FPS players. As they play numerous generated FPS levels, we plan to let players describe dynamics through an adapted Game Experience Questionnaire and, at the same time, we will track their behavior through sequences of events and compare these sequences to the dynamics we described. We will extract dynamics from players' in-game temporal action

	Curiosity
1	View a large part of the level from an accessible point
2	Avoid conflict to focus only on level exploration
3	Trigger conflict in order to observe opponent and simulation behavior
	Movement based Thrill-Seeking
4	Move freely through the environment without be blocked by the geometry using player's inertia (e.g. aerowalk, slides)
5	Use the blast of an explosion to jump higher (e.g. rocket jump)
6	Equip yourself with the lightest weapon to avoid a movement penalty (e.g. knife)
	Opponent Behavior based Thrill-Seeking
7	Attack an opponent from out of their line of sight (e.g. from behind, from a height)
8	Use speed to rush an opponent and surprise them
9	Outrun an opponent, who loses sight of the player's position long enough to abandon the pursuit
10	Stay on the move to avoid being hit (e.g. side movements, bunny hop)
11	Unintentionally miss a shot
12	Survive because the opponent has missed
	Problem-Solving
13	Know opponents' and items' position
14	Follow and get close to an opponent
15	Hide and stay still (e.g. to run away from a conflict, to surprise an opponent)
16	Unintentionally lose sight of an enemy
17	Be surprised by an opponent, who comes out of the player's field of vision (e.g. while hiding, while retrieving or using an item)
18	Listen to the surroundings to predict the behavior of opponents
19	Predict the path taken by opponents and bypass them (e.g. deduce their position in relation to the direction and angle of their shots)
20	Force opponents to attack in smaller groups (e.g. move them from an open area to a tight one)
21	Encourage opponents to attack each other (e.g. place them between each other)
22	Attack while staying out of range of fire (e.g. using grenade, sniper rifle)
23	Use the environment geometry for cover
24	Take cover to use items (e.g. reload, heal)
25	Use wide range weapon, but slow or imprecise, to cover an open area (e.g. grenade, rocket launcher)
26	Maximise damage in a confined area (corridor, close-combat) with a close range weapon (knife, shotgun, etc.)
27	Use static explosive items to get rid of a group of opponents
28	Throwing a grenade at the last moment so that it explodes before hitting the ground ("cooking the grenade")
29	Temporarily incapacitate the opponent (e.g. flashbang, power-ups, precise shots) to gain an advantage
30	Injure yourself (e.g. while using rocket launcher, or grenade throw)
	Victory
31	Complete a game objective
32	Fail to achieve a goal (e.g. game objective, a fight, a personal goal)
33	Only use a specific weapon, item, and/or strategy to make the game more complex
	Acquisition
34	Collect all items (e.g. weapons, ammunition, health kit, power up)
35	Remove all opponents

Table 1. Dynamics Classification and Motives for Play

using Markov model for pattern recognition, as described in section 3.1. Results will help us improve our classification, comparing existing dynamics and using players' feedback about their play patterns and motivations.

Future works will also focus on integrating and testing our evaluation pipeline in FPS games. In the end, we want to use this game experience evaluation tool to facilitate procedural level generation according to players' Motives for Play. We will then compare the levels' game experience evaluated by the agent to the one evaluated by players, to verify the efficiency of our method. We also plan to address some limitations, as our proposition is narrowed to the evaluation of solo FPS game dynamics, meaning that we have disregarded social aspects of the player experience. Moreover, while focusing on FPS games, we did not explore dynamics associated with other camera settings, like a third-person camera or fixed angle camera, and other paces of play, like turn by turn games. Dynamics classification is intended to be expanded to other genres, as we still propose to focus on level design application.

REFERENCES

[1] Thomas H. Apperley. 2006. Genre and game studies: Toward a critical approach to video game genres. *Simulation and Gaming* 37 (3 2006), 6–23. Issue 1.

[2] Richard Bartle. 1996. Hearts, clubs, diamonds, spades: Players who suit MUDs. *Journal of MUD Research* 1 (1996). Issue 1.

[3] Chris Bateman. 2016. The Aesthetic Motives of Play. , 3-20 pages.

[4] Daniel E. Berlyne. 1954. A Theory of Human Curiosity. *British Journal of Psychology. General Section* 45 (1954), 180–191. Issue 3.

[5] Regina Bernhaupt (Ed.). 2010. *Evaluating User Experience in Games - Concepts and Methods* (1 ed.). Springer-Verlag London. Issue January 2014.

[6] Regina Bernhaupt (Ed.). 2015. *Game User Experience Evaluation* (1 ed.). Springer International Publishing. 1–9 pages.

[7] Roger Caillois. 1958. *Les jeux et les hommes : le masque et le vertige* (2 ed.). Gallimard. 374 pages.

[8] Eduardo H. Calvillo-Gámez, Paul Cairns, and Anna L. Cox. 2010. Assessing the Core Elements of the Gaming Experience. , 37-62 pages.

[9] Luigi Cardamone, Georgios N. Yannakakis, Julian Togelius, and Pier Luca Lanzi. 2011. Evolving Interesting Maps for a First Person Shooter, Georgios N. Yannakakis, Julian Togelius, C. Di Chio, and C. Cagnoni (Eds.). *Applications of Evolutionary Computation. EvoApplications 2011.* 6624, 63–72.

[10] Nicholas Cole, Sushil J. Louis, and Chris Miles. 2004. Using a Genetic Algorithm to Tune First-Person Shooter Bots. *Proceedings of the 2004 Congress on Evolutionary Computation.*

[11] Thomas Constant and Guillaume Levieux. 2019. Dynamic Difficulty Adjustment Impact on Players' Confidence. *CHI 2019: CHI Conference on Human Factors in Computing Systems Proceedings*, 12.

[12] Tristan Donovan. 2010. *Replay: The History of Video Games* (1 ed.). Yellow Ant. 501 pages.

[13] Paul Ekman. 1999. Basic Emotions. , 45-60 pages.

[14] Laura Ermi and Frans Mäyrä. 2005. Fundamental Components of the Gameplay Experience: Analysing Immersion. *Proceedings of DiGRA 2005 Conference: Changing Views - Worlds in Play.* Issue 3.

[15] Gernot A. Fink. 2014. *Markov Models for Pattern Recognition: From Theory to Applications* (2 ed.). Springer.

[16] Cristina Guerrero-Romero, Annie Louis, and Diego Perez-Liebana. 2017. Beyond playing to win: Diversifying heuristics for GVGAI. *2017 IEEE Conference on Computational Intelligence and Games, CIG 2017* (2017), 118–125.

[17] Alejandro Baldominos Gómez, Esperanza Albacete, Ignacio Merrero, and Yago Saez. 2016. Real-Time Prediction of Gamers Behavior Using Variable Order Markov and Big Data Technology: A Case of Study. *International Journal of Interactive Multimedia and Artificial Intelligence* 3 (2016), 44. Issue 6.

[18] Jonathan T. Huck, Eric Anthony Day, Li Lin, Ashley G. Jorgensen, Joseph Westlin, and Jay H. Hardy. 2020. The Role of Epistemic Curiosity in Game-Based Learning: Distinguishing Skill Acquisition From Adaptation. *Simulation and Gaming* 51 (2020), 141–166. Issue 2.

[19] Johan Huizinga. 1988. *Homo ludens, Essai sur la fonction sociale du jeu* (2 ed.). Gallimard. 350 pages.

[20] Robin Hunicke, Marc LeBlanc, and Robert Zubek. 2004. MDA: A Formal Approach to Game Design and Game Research. *Proceedings of the AAAI Workshop on Challenges in Game AI.*

[21] W. A. Ijsselsteijn, Y. A. W. de Kort, and K. Poels. 2013. The Game Experience Questionnaire.

[22] Jesper Juul. 2002. The open and the closed: Games of emergence and games of progression, Frans Mäyrä (Ed.). *Computer Games and Digital Cultures Conference Proceedings*, 323–329.

[23] Jesper Juul. 2013. *The Art of Failure* (1 ed.). The MIT Press. 176 pages.

[24] Bohyun Kim. 2015. Game Mechanics, Dynamics, and Aesthetics. , 107-114 pages.

[25] David Kushner. 2004. *Masters of Doom : how two guys created an empire and transformed pop culture* (1 ed.). Random House Trade Paperbacks. 339 pages.

[26] Stéphane Lafortune and Christos G. Cassandras (Eds.). 2008. *Introduction to Discrete Event Systems* (2 ed.).

[27] Thomas W. Malone. 1982. Heuristics for designing enjoyable user interfaces: Lessons from computer games. *Proceedings of the 1982 conference on Human factors in computing systems* (1982), 63–68.

[28] Thomas W. Malone. 1987. Making Learning Fun: A Taxonomy Of Intrinsic Motivations For Learning. , 223-253 pages.

[29] Lennart E. Nacke, Chris Bateman, and Regan L. Mandryk. 2014. BrainHex: A neurobiological gamer typology survey. *Entertainment Computing* 5 (1 2014), 55–62. Issue 1.

[30] Diego Perez-Liebana, Jialin Liu, Ahmed Khalifa, Raluca D. Gaina, Julian Togelius, and Simon M. Lucas. 2019. General video game AI: A multitrack framework for evaluating agents, games, and content generation algorithms. *IEEE Transactions on Games* 11 (2019), 195–214. Issue 3.

[31] Richard M. Ryan, C. Scott Rigby, and Andrew Przybylski. 2006. The motivational pull of video games: A self-determination theory approach. *Motivation and Emotion* 30 (2006), 347–363. Issue 4.

[32] Katie Salen and Eric Zimmerman. 2004. *Rules of play: Game design fundamentals* (1 ed.). MIT Press. 688 pages.

[33] Jesse Schell. 2008. *The Art of Game Design A Book of Lenses* (1 ed.). Morgan Kaufmann Publishers. 489 pages.

[34] Noor Shaker, Julian Togelius, and Mark J. Nelson. 2016. *Procedural Content Generation in Games* (1 ed.). Springer International Publishing. 237 pages.

[35] Fernando De Mesentier Silva, Scott Lee, Julian Togelius, and Andy Nealen. 2017. AI-based Playtesting of Contemporary Board Games. *Proceedings of FDG'17*, 10.

[36] Penelope Sweetser and Peta Wyeth. 2005. GameFlow: A Model for Evaluating Player Enjoyment in Games. *Comput. Entertain.* 3 (2005), 24. Issue 3.

[37] Julian Togelius. 2019. *Playing Smart: On Games, Intelligence, and Artificial Intelligence* (1 ed.). MIT Press. 192 pages.

[38] Julian Togelius and Georgios N. Yannakakis. 2016. Emotion-Driven Level Generation. , 155-166 pages.

[39] Jukka Vahlo, Johanna K. Kaakinen, Suvi K. Holm, and Aki Koponen. 2017. Digital Game Dynamics Preferences and Player Types. *Journal of Computer-Mediated Communication* 22 (2017), 88–103. Issue 2.

[40] Brian M. Winn. 2009. The design, play, and experience framework. , 1010-1024 pages.

[41] Mark J. P. Wolf. 2002. Genre and the video game. , 20 pages.

[42] Georgios N. Yannakakis and Julian Togelius. 2017. *Artificial Intelligence and Games* (1 ed.). Springer International Publishing. 359 pages.

[43] Marcelo Zamith, Jose Ricardo, Silva Junior, Esteban W G Clua, and Mark Joselli. 2020. Applying Hidden Markov Model for Dynamic Game Balancing. *SBC – Proceedings of SBGames* (2020).

[44] Robert Zubek. 2020. *Elements of Game Design* (1 ed.). The MIT Press. 256 pages.