Hidden State Machine and the Game Loop of Reasoning

How Games Are Progressed?

Abstract

This paper introduces the origin, the conceptualization, and the insights of the concept of hidden state machine and the game loop of reasoning, which supplements the theory of state machine and game loop and, together, explains the entire structure of gameplay progression.

The Problem And the Origin

Let us start with a simple but not yet well-answered question: How games are progressed? A widely accepted theory is that game is progressed based on game states that are changed by one and another game loop in state machines. Here we need some clear explanations for those terminologies. For game design, game loops are functionalities that repeated during a game. Game loops affect game states, which are the values of all meaningful variables in a game at a given point, and are represented by state machines, which could be observed, stored, and modified by players (Pinckard, 2016). For example, in chess, the state machine is the chess board which displays and provides a physical mean to change the current game state –positions of different pieces at present. And the core game loop for chess is that players review the current game state and then move their pieces, in which

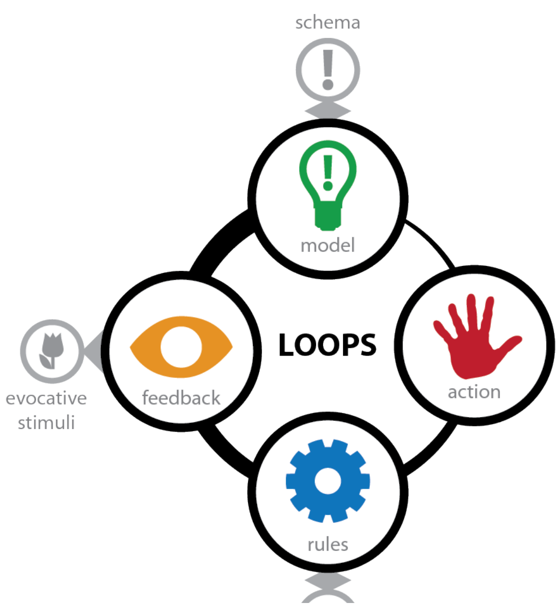

Figure 1 - Lost Garden: Loops and Arcs. 2012. Lost Garden. By Daniel Cook. Web.

way the state machine, the game board, has been modified and meanwhile the game state it represented has also been changed. The theory explains itself well, but it still has a potential problem.

Notice that those games, which focus on the interactions between players rather than the interactions between player and game, do not have an object that meets the criteria of being a state machine which can receive player inputs and display game state information. This kind of interaction focus game includes most of the sports, some party games, and some social games. For these games, you can hardly figure out what could physically represent a state machine. Is the ping-pong table a state machine? Unfortunately, the answer is no because it does not have any information other than some drops of sweat of players. Are the chairs in

Figure 2 - Review. N.d. The Games Journal | A Magazine About Boardgames. By Greg Aleknevicus. Web.

the party game of Musical Chairs a state machine? The answer is still no for the reason that players never interact with the chairs unless the music is stopped and they have to find a place to sit. Furthermore, Werewolf is an excellent example to explain specifically the absence of state machine in interaction-focus games. Werewolf is a party game in which players are secretly assigned a role by drawing a role card –werewolf, normal villager, or some other special villagers with different abilities. The game alternates between night and day phases. At night, werewolves choose a villager to kill, and special villagers use their abilities. At day, the villager who was killed is revealed, and then each player speaks his/her opinion in order. Eventually, a voting is conducted to reveal the role of a "suspicious" player who is also out of the game (Davidoff). Now answer the question that what is the state machine for Werewolf? The role cards or the security cameras installed in the room that possibly record the entire gameplay process? Obviously, none of them fulfill the proposed functions of a state machine.

The reason why there is no state machine for interaction focus game is that interactions between players could only be perceived and processed by humans, not by objects, and not by state machines. In fact, based on the theory, state machines are technically formed by rules and bounded by actual game materials, indicating that they have limitations of what and how many situations they could deal. For example, a state machine, assumed a board, could not perceive that player A is helping player B by lying to player C, even though deception could be considered as a kind of player input. However, as players, we might tell that player A and player B are either teammates or in favor of each other. In this case, the existence of state machine contradicts and ruins the core interactive gameplay because players would be distracted by the state machine and, therefore, miss a lot of valuable interaction.

This reason of the absence of state machine tells the fundamental problem of the theory of state machine and game loop that it emphasizes too much on the role of game itself to progress games, while not giving enough credit to players. Metaphorically, game is like a master in the game-player relationship. Game keeps asking players "what you want?", and waits for player inputs. It is assumed that game system can handle all kinds of player inputs and produces interesting feedbacks to players to progress the game itself. However, players are the core of any gameplay and should have a bigger role to decide how the games they played are progressed. This idea leads us to our new concept of the hidden state machine and the game loop of reasoning.

The New Concept

A hidden state machine is a state machine that maintained in player's mind and operated by player's reasoning. It is an imaginary structure inside the player's mind; hidden state machine is only modified by the game loop of reasoning, which represents a repeated mental process of valuing real world information, conducting human reasoning, and affecting hidden state machine.

Hidden state machine stores and displays player's understanding of current game state, which includes not only the uniformed game state information but also abstract perceptions. In general, what stores in hidden state machine is a personal relationship between a player and his or her ongoing gameplay. Besides, like personal financial accounts which could be trust accounts or stock accounts and have different amounts of balance, the format and the context of player's understanding of current game state varies from player to player. However, the use of player's understanding remains the same that let players take actions and progress their games, just like all personal financial accounts serving as a mean of personal financial management. Another example, we are playing soccer now. The score is 1:1, both teams have 11 players on the field, and one opponent player is dribbling the ball. Now, I am thinking that I am in defensive. However, you believe that the score is even, and we all are in offensive. Then I approach and try to steal the ball from the opponent player, and you run to space and wait for a pass. In this case, our understandings of the current game state are totally different formally and contextually, but they both drive us to make our decision for our next move.

Reasoning is the invisible fuel to keep updating hidden state machine. As discussed in *Unwritten Rules* by Stephen Sniderman, there are some "unspoken basics" that affect gameplay such as playing fair. Stephen points out that for different players, "unspoken basics or principles" have varied contextual meanings (Sniderman, 1999). For example, playing fair means no cheat for some players, but could also be showing respect for others, depending on their conventions. Reasoning is also one of those "unspoken basics" that required by the game system but not written in any rulebook. It represents different logics for different players as well. Assuming you are playing a game, and it is your turn, you look at the game board and observe all necessary information about the current game state. What and how you are going to make your move? Do the rules tell you? No, the rules only say what moves you cannot make. It is your reasoning game loop tells you the answer by valuing your hidden state machine together with all real word information, performing certain logics, and then returning some outputs that become your moves and affect your hidden state machine.

The Insights

However, only applying the concept of hidden state machine and the game loop of reasoning would not be sufficient to answer the question of how games are progressed. Instead, we need to combine both ideas to form a comprehensive theory. In general, games are progressed by players through hidden state machines through reasoning with the help of

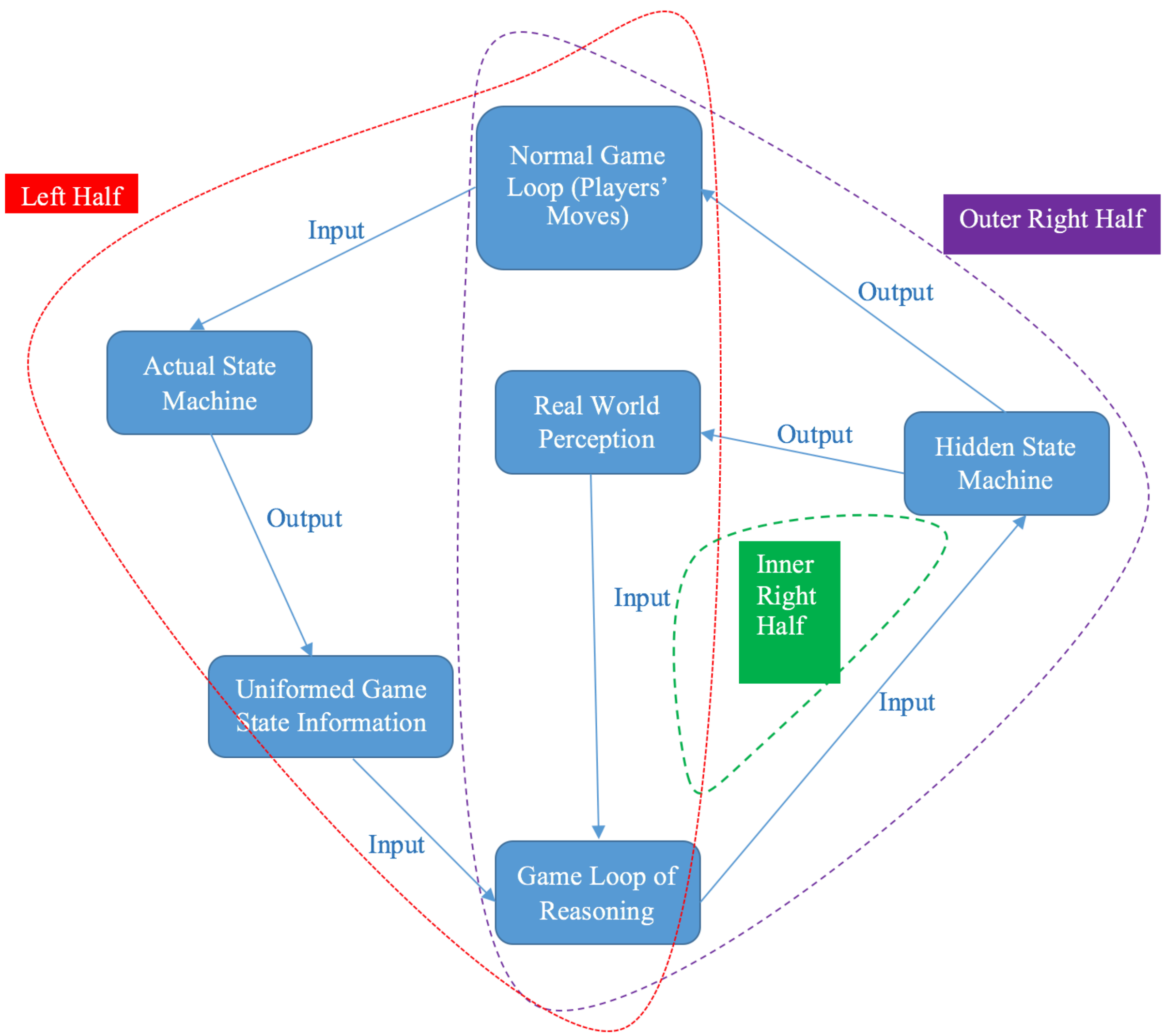

Figure 3 - The Integration. 2016. By Zijing Liu

actual state machines. Specifically, here is the integration when existing an actual state machine: On one side, the actual state machine is modified by players through normal game loops such as a move, a draw or even a skip, and displays all resulting game state information which is unambiguous and uniformed for all players. On the other side, the hidden state machine is affected by the game loop of reasoning when players perceive new information, and it drives players to take actions, usually normal game loops which create the communication between the actual state machine and itself. Let chess be our example again for this case. Assume player A is playing against player B. Player A is playing a strategy to set a trap for player B, and his hidden state machine displays a winning situation in 3 rounds (This represents the flow of the outer right half of the cycle in Figure 3). However, player B plays a nice move that turns over the entire situation (This reflects the flow of the left half of the cycle in Figure 3). Then player A receives the game state information about the new positions of pieces, performs his reasoning on the information, and changes his hidden state machine, which now displays a losing situation in 3 rounds (The flow of the outer right half again). Fortunately, player A also notices player B's worried expression when he looks at a certain location on the chess board. Meanwhile, inside player A's mind, his game loop of reasoning processes this perception and produces an output that moving his queen to that position, which affects his hidden state machine to display a drawing situation in 3 rounds (This shows the flow in the inner right half of the cycle in Figure 3). Finally, player A makes the optimal move, and then the actual state machine gets updated again (The flow of the left half again).

If a game does not have an actual state machine to store and display uniformed game state information, then the hidden state machine will take all the jobs (Only the flow of in the inner right half of the cycle exists). The only inputs that player receive are their real world perception, which could be what they see, what they hear, or what they interact. Based on these inputs, their hidden state machines get updated through the game loop of reasoning and produce players' outputs. Our old friend, Werewolf, is a great candidate to explain this situation. After several rounds, my hidden state machine shows that you are trustable. Then you give a speak, which makes me think you are suspicious based on the output of my game loop of reasoning. Obviously, this update of my hidden state machine drives me to vote against you in the future game. Notice that even though all players hear the same speak from you, it does not necessarily mean that all other players think you are suspicious because hidden state machine and the game loop of reasoning vary from player to player as discussed above.

Derived Application

Besides giving a more comprehensive answer to our original question of how games are progressed, this integrated theory also surprisingly explains the problem behind a popular phenomenon that fewer and fewer games focus on process intensity. The concept of process intensity was first introduced by game designer Chris Crawford in his article *Process Intensity* in1987. Chris defined process intensity as "the degree to which a program emphasizes processes instead of data" and explained that "Process is reflected in algorithms equations, and branches. Data is reflected in data tables, images, sounds, and text" (Crawford, 1987). However, high process intensity seems to be rare in recent games. Cited in the article *Persuasive Games: Process Intensity and Social Experimentation by* Ian Bogost, game designer Greg Costikyan's lament of "80+ percent of the man-hours (and cost) for a game is in the creation of art assets. ... In other words, we've spent the last three decades focusing on data intensity instead of process intensity" reflected a common concern of this phenomenon (Bogost, 2012). To further understand this phenomenon, we need to analyze how old games and new AAA games are progressed based on the integrated theory.

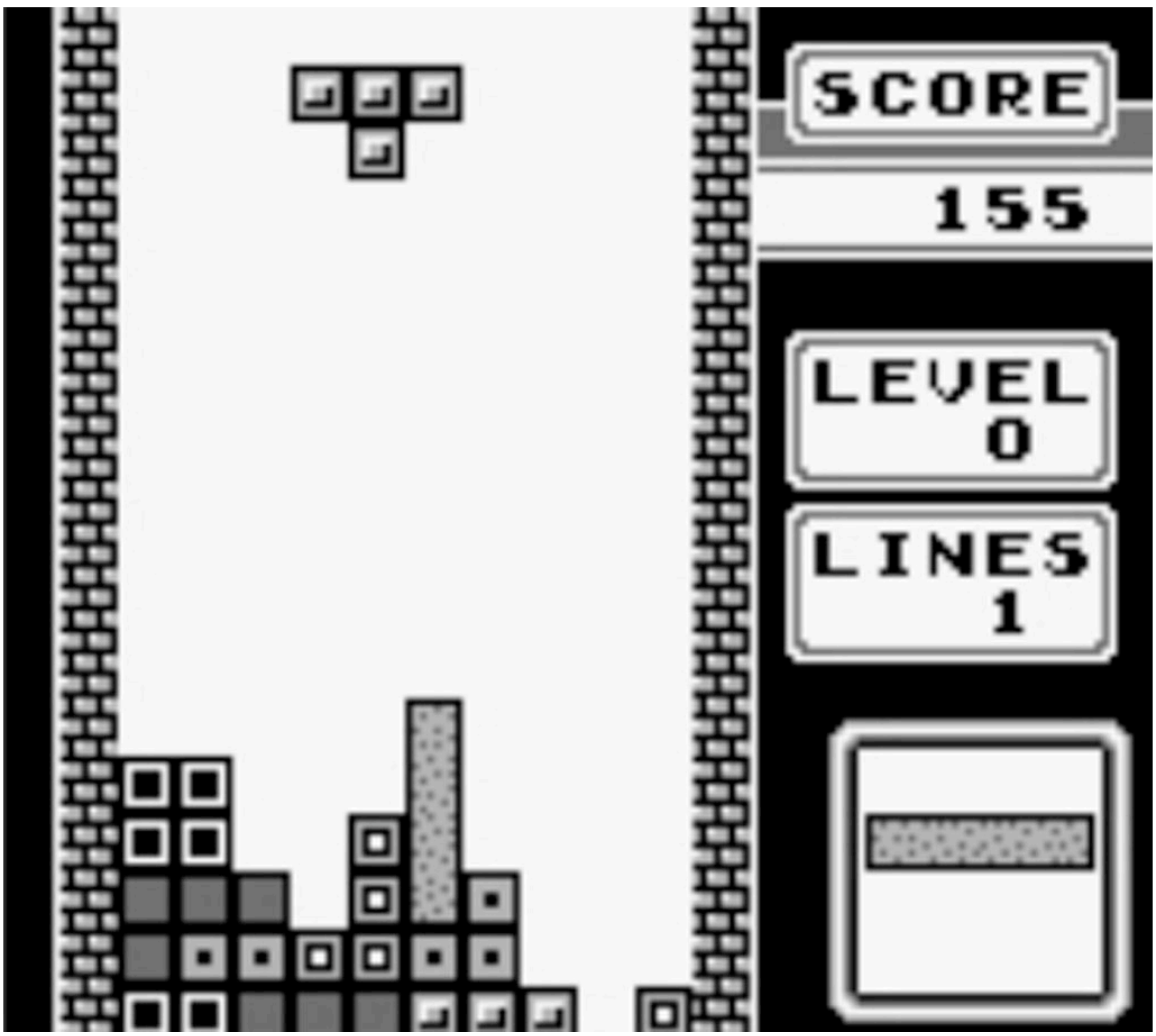

Figure 4 - A Screenshot of Tetris (Game Boy). 1989. By Nintendo

Old games usually have simple mechanics with easy simulation logics, which makes it possible to let games handle all inputs and outputs to make gameplay progression. In another word, old games are functionally simple enough to focus on process intensity. For example, in Tetris, a classic video game that has high process intensity, there is only one input, rotations of game pieces, which could be handled perfectly by the actual state machine of the game. When playing Tetris, players do not need to image what a certain game will look like after being rotated because they could just press the button and see the result, which is a kind of function overlap between actually state machine and hidden state machine.

However, recent AAA games have a complex game system embedded with tons of player interactions. Game reviewer Keith Stuart called GTA V, one of the most popular sandbox AAA game recently, is a “monstrous parody of modern life – our bubbling cesspit of celebrity fixation, political apathy and morose self-obsession” (Stuart, 2013), and another game reviewer Phill Cameron stated that Witcher 3: Wild Hunt “offers the most accomplished, convincing, and perhaps most importantly fictionally and mechanically consistent open world I’ve seen rendered in games…Witcher 3 has far more depth in terms of what you can do and how you can do it” (Cameron, 2015). With such complicity, there is no actual state machine, no matter a game database or a gaming PC, could handle all possible situations during the gameplay with pre-set equations or algorithms. Not even mention that machines could hardly perceive human interactions. This is why recent AAA games focus more on data intensity to deliver more valuable information about the current game state to help players to progress their gameplay with their hidden state machines. Better 3D graphics, more user-friendly UI design, and more realistic audios all serve as the tool not only to attract players to play AAA games but also to assist them to progress in such complex video games. It is inevitable that players will take the role of master in the game-player relationship in the future, and game is just like a toy that is passively played by players instead of actively asking for inputs and returning feedbacks.

Conclusion

After coming up the concept of hidden state machine and the game loop of reasoning, I suddenly realize that I am asking the wrong question at the very first place. Instead of how games are progressed, the real question should be how games are progressed BY PLAYERS. Although these sayings are only different by two words, the latter one represents a fundamental principle of game design that games are designed for and played by players, which is the starting point for hidden state machine and the game loop of reasoning.

Hidden state machine and the game loop of reasoning is a theoretical concept that supplements the original theory of state machine and game loop. The integrated theory of both presents a comprehensive structure of gameplay progression. I expect that more corrections are needed before this new concept is fully implemented, but it remains a useful tool in game design.

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