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Artificial Intelligence: Game Techniques Ludo - A Case Study

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Abstract—*Today wide range of people are engaged in playing games. Games are most common in all the age groups, whether being a kid or a young or it's an old aged person. Gaming is growing at a faster rate day by day in the field of entertainment. Specially, where artificial intelligence is there that means the end user along with live user is also playing. Therefore, artificial intelligence is most important for making the game more interactive and entertaining for the user. As mobile phones are in boom, we can see games are moving from boards and grounds to hand held screens. Ludo is one such example. Ludo is very common game, that is implemented using Q-learning, which is a type of re-inforcement learning. It is optimally customized to reduce the complexity.*

Keywords: *Games, Game Theory, Features, Artificial intelligence, Ludo, players.*

1. INTRODUCTION

Today Games and intelligence go side by side.Ludo is an intelligently played mind game. It requires some basic knowledge for different moves that need to be taken on ones move.

Game theory is the theory that bridges the gap between the complexity and simplicity of the game. It is a modeling tool that has certain set of rules to go ahead with the implementation of game. There are different typesof game theories that have been implemented to bring out a solution that is possibly a game from live users to firm users. We have introduced in the paper, the basic concept of game theory and related games. It's connection with artificial intelligence.

Artificial intelligence defines the behavior of non-player characters. Itis the sciencethat helps in developing the machines, which have similar features as human being acting artificial intelligent agents.

AI has four main areas where it has it applications. These arePlayer-experience modeling, Procedural-content generation, Data mining on user behavior, NPCs having Alternate approaches.Ludo has its base underlying the intelligence of NPC in which the player uses basic Ludo rules to bring that game from human to non living but machine/programmed players and as intelligently as humans.

2. LITERATURE REVIEW

As game and intelligence have strong connection and brainstorming. Lots of people have made great effort to build the game into systems. In[1] there has been a complete description about how to solve a game using AI. The paper explained search methods such as Alpha-Beta pruning, Minimax algorithm and discussed on games following tree structure as solution strategy.

GeorgiesN.Yannakakisin[2] gave a thorough description of Game Theory and its applications. He explained about AI and its four flagships, briefing about the terminology used currently in games.

Carla P.Gomesin[3] gave connection between search algorihms with hard combinatorial problems. He grouped this connectionunder three things planning, duality and randomization.

In[4], Ludo is implemented a TD(λ)based Ludo player and also implemented a Q-learning based Ludo player using re-inforcement learning.

2.1 Comparative Analysis

MajedAlhajry, Faisal Alvi, Member, IEEE and Moataz Ahmed used 240 representations of blocks to solve theLudo algorithm implementing the AI. To this we have tried to optimizethe research work by using the Q learning in more optimal way and using the index of only "72" blocks and probability based on token color. Here we instead of giving a more that one index to a block we tried to execute Ludo by giving single index to single block.

3. GAME THEORY

Game theory is the modeling of strategic interaction between two more than two players in a situation that contains rules set and their outcomes. In other words, it is a strategic decision making.

Particularly,we can say that, it is "the study, of mathematical models of conflict and cooperation between the decision makers those are intelligent and also rational"[5]. There can be interactive decision theory which can be thought of as an alternative in terms of more explanatory attribute in different fields/areas. This theory will take into consideration the areas of sciences such as computers, political, economics and psychology mainly.

Decision theory: It could be seen as theory of with one player or the player playing against nature. The formation of preferences and beliefs are under main focus. In this theory, we can represent the uncertainty of outcomes and is represented by Probability theory, and to model the new information to revise belief Bayes Law is used frequently

As it is logical in computer science, it has increasingly important role in logical theories that have game semantics as their base. Also interactive computations have also been modeled to this field, that serve the basis for multi-agent systems.There may be two main theory types:

1. **Co-operative** and
2. **Non co-operative** game theory.

Non co-operativetheory: deals with effective interaction of users to achieve goals in an intelligent manner.

Addition to game theory, there are three more theories that are related in a number of ways to game theory. These may be:

1. Decision theory,
2. General equilibrium theory and
3. Mechanism design theory

Decision theory: It could be seen as theory of with one player or the player playing against nature. The formation of preferences and beliefs are under main focus. In this theory, we can represent the uncertainty of outcomes and is represented by Probability theory, and to model the new information to revise belief Bayes Law is used frequently.Decision theory is the decision analysis in order to get most of the information before any decision is being stated.

General equilibrium theory: It could be seen as the specialized game theory type that deals with the producing and trading the products that connects with large number of producers and consumers.

Mechanism design theory: It is different from game theory in such a way that game theory is based on the rules of the game as they are given, while this mechanism design theory calls for the consequences of different types of rules. In a way, this theory heavily relies on game theory.

4. GAME FEATURES

Following are some common terms for game theory:

Game: It is any situation set that produces an outcome, which depends on the moves/actions of two of more than two decision makers ("players").

Players: These are the decision makers, who make a strategic decision in context of game.

Strategy: It is a complete plan of action that a player takes under the set of circumstances that may come up in the game.

Payoff: It is the result that a player receives after arriving at a particular solution. The payout could be in quantifiable form or utility.

Information Set: The set of information that is available at a given point in the game. The information set is used mostly when the game has a sequential component.

Equilibrium: Decision making point from where both players can reach to an outcome.

5. ARTIFICIAL INTELLIGENCE

Game playing was an area of research in AI from its establishment. The very first example of AI is the Nim, a computerized game made in the year 1951 and published in the year 1952.

In 1951, Christopher Strachey had written a checkers program with the use of the Ferranti Mark 1 machine of the University of Manchester and chess was written by Dietrich Prinz, alais the first computer programs ever written.

The first developed video games were like Spacewar!, Pong, and Gotcha (1973), were based on discrete logic and on the competition of two players, without AI.

Nowadays, the games are not just stayed to static environment but also they have been developed to intelligent dynamic environment where system acts as second player. Most people enjoy these types of games only where there is a brainstorming part represented. This part is AI (Artificial Intelligence), where the programming is done in such a way that system also act as an intelligent creature, creating interest of users in games.

In Games, AI can be implemented using different types of searches. These may be:

1. Heuristic Search
2. State Space Search
3. Minimax algorithms
4. Trees, etc.

In these algorithms, there is a lot of complexity involved and large trees are made using top down or bottom up approach. Now, if searching deep into the game tree is so hard, how are humans able to play games like Chess,Ludoand go so well? Are we playing by drawing a game board in our minds and performing minimax? No actually, it seems that instead humans use some high level heuristic analysis, and ground their moves on experience from previous game play or some

sort of intuition. This method only is sometimes defined as Artificial intelligent system

6. AI APPROACH

Q-learning is an AI algorithm of learning how to behave in an unknown environment. Q-learning often leads to a solution under optimal behavior. It is algorithmic approach from artificial intelligence literature, which belongs tothe class of reinforcement learning algorithms.

In the artificial intelligence field, re-inforcement learning is mainly concerned for the problem of how an agent can learn to behave optimally from interactions with its environment. A general idea in reinforcement learning can be described as:An agent interacts repeatedly with its Domain. Firstly, the state of environment s $\in$S is seen during each interaction.The agent then decides to execute an action a $\in$ A. This results in a payoff r that is received by the agent and in a transition of the old state S to the new state s′ in the environment. As the environment state changes, the executed result affects agent's immediate payoff r and also its payoffs in future the periods in accordance to choice of action. The environment is usually assumed to be a Markov decision process.

Randomization strategies in local search techniques have been very successful. The local search methods or meta-heuristics methods are usually used for solving the challenging complex and combinational problems. These methods begin with an initial outcome/solution, which might not be necessarily feasible, and so, improvisation upon it is being done by performing a little "local" change. Example of this would include the solutions for the Traveling Salesman Problem (TSP).

7. USES OF AI IN GAMES

There are four potential modeling areas where AI is useful in gaming field. These are:

Player-experience modeling: understanding the ability and emotional state of the player, so as to locate the game appropriately. This can include dynamic game difficulty balancing. Game AI might also help to know the player's intent (like gesture recognition).

Procedural-content generation: Creating elements in the gaming environment such as environmental conditions, levels, and also music in a sequential and automated way. AI methods could produce newer contents or attractive and user interactive stories.

Data mining on user behavior: This part allows the game designers to identify how people use the game, what are the parts they are playing the most, and what makes them quit playing. This way it allows the developers to polish the gameplay and improve monetization.

NPCs also have Alternate approaches: These might include changing the game set-up to enhance NPC believability and exploring social rather than individual NPC behavior.

8. LUDO: A CASE STUDY

Artificial Intelligence Ludo (ai-ludo) provides environment for playing to the artificial agents.

Its main purpose lies in the comparison of several approaches in the area of artificial intelligence. At one side, Ludo is instead a very simple game and is fully observable but on the other side it contains a few challenges due to the stochastic and multi agent environment.

Therefore it offers a good balance between simplicity and complexity and is able to attract a wide audience and not only professionals. In addition, it is very common and well- known around the world. Our goal was to provide a simple platform on which everybody could add an own player and check its strength compared to several other ones.

8.1 LUDO

Ludo means, "I play". It is being derived from an ancient game of India, that, is known by the name "Pachisi". It is a board game for two, three, or four players. In this game the players race against their four tokens from initial to end state according to roll of a dice

Played by four players, Ludo is a board divided into four main areas:

- Red
- Blue
- Green
- Yellow

Each player occupies one area of a color. In this he is given four tokens of his chosen color that he race around the board to win.

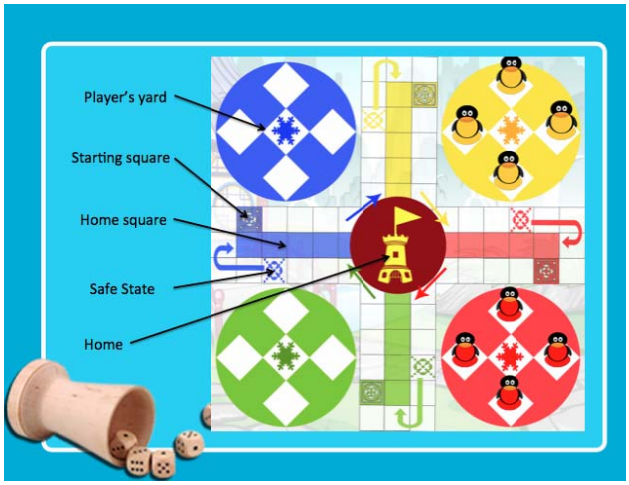

Fig. 1: Ludo board with play directions

The Ludo board is generally a square with the game track, that is cross-shaped. Here each arm in the cross consists of three columns that are subdivided into again squares—generally six squares within a single column. Representing the home column of player,there are five colored squares in the middle column of every cross part,. There is a sixth colored square that is not a home column square but the initial point of every player to start the race.

At the board center there is a large square that is home for every player. If a player reaches in this area with all four tokens, he wins.

9. RULES

This game can be played by two, three or four players. The tokens under each player are out of play at the start of and stay in one of the large corner portion of the board in the color chosen by player usually termed as player's yard.

At a time only one token is allowed to enter into a respective starting square and move accordingly as per the roll of a dice in a clockwise direction tracing the complete board until he reaches the home squares.

10. STRATEGY INVOLVED

1. Continue to race to reach the home square in middle to win.
2. Trace and continuously have a keen look over the opponent's move so as to decide your own move.

11. GAME PLAY (PROPOSED WORK)

The roll of dice starts the game. One by one each player gets a chance to move. A "6" on dice allows a player to come into the play area of the board else the turn is transferred without any move of the token.

If the player has more than one token in the game to race around, then, by the method of Q-learning, he can chose which one player to give a chance to race around the track. Here we have AI that we look forward if there is any opponent's token then we try to chase that token keeping oneself at safer side due to a chance of other token being given a move to race.

Here, also, if a player gets a "6" on the dice roll then he is given a bonus chance to roll the dice again and after this if any other number comes then normal glow of game continues.

Also, if any player occupies the square that has already been taken by opponent's token, then, the opponent token is out of game and it has to again start the game from very initial point.

Here we assign an index to each square block, some of them represent the safe states. Now we start from one color (say, yellow color) yard. The very first block of yellow yard in track area is given index "1", and continuous indexing is followed to adjacent cells. In this way we have 12 cells centering each yard. Now, there is one cell above every home column. So, there is "1" more box for indexing. Also, there are "5" home column cells so, in total there are 18 cells (12+1+5=18) per yard. Hence, a total of "72" cells (18*4=72) are there and so "72" indices for all four yards and complete track area. There is no duplication of single cell for index. Then, we define a start index for every color token and calculation is preceededaccordingly in clockwise direction. The entering of token into home column is done using combination of color and index and finally then into home.

Now, the winning conditions is based on values that is calculated using the terms:

1. No of gots
2. No of gotsWin
3. No of gotsout.

No of gots: it defines total number of token in game.

No of gotsout: it defines the token that are in their yards and have not yet been into play track.

No of gotsWin: it defines the number of tokens of a particular player that have crossed the play track and has entered the middle home area of Ludo board.

As soon as the **NoOfGots** for a particular player is equal to 4(that is all the 4 tokens have been raced and moved to their houses in the middle area), then that player wins the game.

12. CONCLUSION

Here we tried to show the brief description of Game theory. Along with this we showed some features of game. Then we gave a brief of Artificial Intelligence along with games and usage of AI in games. After this we explained about the gaming searches in algorithms used mainly for the Ludo. And after all this, description of Ludo in the form of case study is explained where the algorithm is optimized for using lesser indices so that there is less complexity for guessing the tack number and then calculation as we follow color indexing along with number and assign.

13. FUTURE SCOPE

The current Ludo game that is made is very optimized but still there are chance of improvements by finding even better algorithm that will lead to more optimization.

Four more safe states can be added as there is in general board Ludo.

Also, we can also implement the game to start from initial by not only getting "6" at dice but also with "1".

Currently, here I have only used continuous rolling of dice after getting "6" as a bonus move. We can also restrict that to "two" only. As we get continuous "three" "6", the turn is altered without any move of token.

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