

# ARTIFICIAL INTELLIGENCE FOR FUTURE TECHNOLOGY: LUDOTRIX

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**Abstract** - In recent years, a wide variety of people are involved in playing games. Games like racing games, shooting games, board games, strategy games, etc. are most popular in all the age groups, whether being a kid or young or an old aged person. The computer gaming industry has found AI as a necessary element to make games more entertaining and challenging. As mobile phone usage is increasing day by day, we can see games are moving from boards and grounds to mobile screens. Ludo is one such example. Ludo is a ubiquitous game that is implemented using Q-learning, which is a type of reinforcement learning. It is optimally customized to reduce complexity. However, we have played the same LUDO game for at least over a decade now, be it on a board or a mobile device, and we need a change. In this paper, we propose, for the first time, a unique kind of ludo game with a mixture of artificial intelligence and concepts of two of the most popular genre that has never been implemented in the gaming industry.

**Key Words:** Artificial Intelligence, Game Theory, Reinforcement Learning, Q-Learning

## 1. INTRODUCTION

In the fast-growing field of artificial intelligence and technical developments, the sector of game development is on the burgeoning level. Gaming has conveyed media outlets by storm so that nobody might have ever envisioned it. It has been with the goal that the market for advanced games grew 8 % from 2014 to \$61 billion, as per another report from gaming insight firm SuperData Research. Right from the first game introduced in mobile phone Tetris to Pubg, the gaming industry has provided dynamic video features. Throughout the most recent fifty years, gaming has developed into a monster force to be reckoned with of diversion and self-propagating income. We have come a long way today, and the whole world has started to exist within machines that have become more powerful and efficient than ever before. In the last five to six years, Facebook games like Farmville and Candy Crush have been a rage. Games like PUBG and Clash of Clans have caught the young Indian crowd's imagination – extracting hours at length on the mobile screens. The in-app purchases in these games present the developers with excellent financial viability. Artificial intelligence defines the behavior of non-player characters(NPCs). Science

helps in developing machines, which have similar features as human beings acting as artificial intelligent agents. AI has four main areas where it has its applications. These are Data mining on user behavior, Procedural-content generation, Player experience modeling, and Non-Player Characters with alternate approaches. Ludo has its base underlying NPC's intelligence. The game we offer is a variant of LUDO; for a player to win the game, the player must kill all the other players' tokens on the board.

## 2. LITERATURE REVIEW

Generally, in human-PC games, players select a difficulty setting from a menu before starting the game. This can be as basic as choosing simple, medium, hard, or more alternatives for the player to browse. These settings have a direct and generally static impact on the expertise level of the Non-Playing Characters (NPC's). Such fixed-difficult settings can frequently be excessively expansive. For example, a setting that is expected to be simple might be excessively hard for specific players. Players may likewise improve their performance at various stages. The conventional methodology does not utilize the player's present performance measures to coordinate the interactivity. While This methodology has the advantage of effortlessness, from a game improvement perspective, it can prompt unsurprising ongoing interaction when static principle-based opponents are sent, which can adversely influence the game's amusement and entertainment esteem.

The historical backdrop of the connection of AI and PC game-playing returns to the soonest long periods of Artificial Intelligence, when Arthur Samuel[12][13] took a shot at his renowned checker-playing program, spearheading many AI and game-playing procedures (Samuel, 1959, 1967). From that point forward, the two fields have progressed extensively, and research at the convergence of the two can be found routinely in gatherings in their separate fields and all in all AI meetings. For overviews of the field, we allude to[10] Ginsberg (1998), [14]Schaeffer (2000),[8] F"urnkranz (2001); altered volumes have been accumulated by Schaeffer and van nook Herik (2002) and [9]by

Furnkranz and Kubat (2001) as games and insight have solid associations and conceptualizing. Loads of individuals have put forth great attempts to incorporate the game with frameworks. There has been a finished depiction of how to understand a game utilizing AI. The paper clarified search techniques, for example, Alpha-Beta pruning, Minimax calculation, and talked about games following tree structure as an answer methodology. [2]GeorgiesN.Yannakakis in gave an intensive depiction of Game Theory and its applications. He clarified AI and its four lead preparation about the term reach. Riedmiller proposed the main system thought that consolidates profound learning and fortification learning in a visual learning technology utilized presently in games. [3]Carla P.Gomesin gave an association between search calculations with hard combinational issues. He assembled this association under three things arranging, duality, and randomization. Execution of a Q-learning based Ludo player utilizing fortification learning. Likewise, as of late, prosper consideration in Deep learning, particularly a spatial-based profound neural organization called Convolutional Neural Network (CNN), energized more variations of CNN utilizations in the auto pictures include extraction. After the highlights are separated from the offbeat arrangement of screens caught during ongoing interaction, Reinforcement learning is typically applied as the learning calculation. The main system thought that joins profound learning and support learning in a visual learning task was proposed by Lange and Riedmiller. Afterward, Mnih et. al. proposed an advancement learning general operator for ALE. The calculation they proposed is called Deep Q-Network, which is a mix of a Deep convolutional neural organization and Q-learning in support learning. Computer-based intelligence research on PC games started to follow improvements in the games business right off the bat, however, since John Laird's feature address at the AAAI 2000 gathering, in which he supported Interactive Computer Games as a remunerating and challenging application zone for AI (Laird and van Lent, 2001), various workshops (Fu and Orkin, 2004; Aha et al., 2005), meetings, and uncommon issues of diaries (Forbus and Laird, 2002) exhibit the developing significance of game-playing applications for Artificial Intelligence.

### 3. GAME THEORY

Game is characterized as a movement between at least two people, including exercises by every individual as per many rules, toward the finish of which every individual gets some advantage or fulfillment or endures a

misfortune (pessimistic advantage). Game theory is modeling strategic interaction between two more than two players in a situation that contains rules set and their outcomes.

**Number of Players:** If a game involves only two players(competitors), it is called a two-person game. However, if the number of players is more, the game is referred to as an n-person game.

**Sum of gains and losses:** If in a game, the sum of the gains to one player is precisely equal to the sum of losses to another player, so that the whole of the additions and misfortunes approaches zero, at that point, the game is supposed to be a lose-lose situation, or else it is said to be a non-zero-sum game.

**Strategy:** The strategy for a player is the list of all possible actions (moves, decision alternatives, or courses of action) that are likely to be adopted by him for every payoff (outcome). It is assumed that the players are aware of the game's rules governing their decision alternatives (or strategies). The outcome resulting from a particular strategy is also known to the players in advance. It is expressed in terms of numerical values (e.g., money, percent of market share, or utility).

The peculiar strategy that optimizes a player's gains or losses without knowing the competitor's strategies is called an optimal strategy. The expected outcome, when players use their optimal strategy, is called the value of the game.

Generally, the following types of strategies are followed by a player in a game:

**Pure Strategy:** A particular strategy that a player chooses to play repeatedly, regardless of other player's strategy, is a pure strategy. The goal of the player is to amplify their wins or limit their losses.

**Mixed Strategy:** A set of strategies that a player chooses on a particular game's particular move with some fixed probability is called mixed strategies. Thus, there is a probabilistic situation. Each player's objective is to maximize expected gains or minimize expected loss by choosing pure strategies with fixed probabilities.

**Optimal Strategy:** The strategy that puts the player within the most preferred position regardless of his opponents' strategy is perfect. Any deviation from this strategy would scale back his payoff.

**Zero-sum game:** It is a game during which the sum of payments to all or any the players, after the play of the game, is zero. In such a game, the gain of players that win is precisely adequate to the loss of the players that lose, e.g., two candidates fighting elections, wherein the gain of votes by one is that the loss of votes to the opposite.

#### 4. GAME FEATURES

**Game:** Any circumstance set creates a result, which relies upon the moves/activities of two or more than two chiefs ("players").

**Players:** These are the leaders who settle on a critical choice in the setting of the game.

**Strategy:** It is a finished strategy that a player takes under the situation that may come up in the game.

**Payoff:** The outcome a player gets after showing up at a specific arrangement. The payout could be in quantifiable structure or utility.

**Information Set:** The arrangement of data that is accessible at a given point in the game. The data set is generally utilized when the game has a consecutive segment.

**Equilibrium:** Dynamic point from where the two players can arrive at a result.

#### 5. METHODOLOGY

In a game, the fun factor must be maintained in the first place. Therefore, to provide a rich and engaging environment that presents educational goals, educational psychology practices are needed. However, the best educational practices are those that are interpreted as fun. Real learning does happen in games, and this learning process shares many characteristics with the knowledge of problem-based learning. Players must think strategically to progress through the game, and they can only solve a given problem by using the necessary experience and tools in the game. In short, our methodology proposes two main components for the design and development of a game, a primary game with enemies and a set of learning mechanisms. These learning mechanisms are related to the main game, but they are independent and played in parallel with the main game. Thus, it is easier to include learning content in the game by defining independent learning mechanisms.

This type of learning mechanism can be distinct, for example, mini-games, puzzles, or quizzes. However, the knowledge is embodied mainly in those mechanisms that appear during the game, which means that the main game

can be more oriented for fun factor engaging the player more.

#### 6. ARTIFICIAL INTELLIGENCE

Game playing was a zone of exploration in AI from its foundation. The absolute first case of AI is the Nim, an automated game made in 1951 and published in 1952. A checkers program with the utilization of the Ferranti Mark 1 machine of the University of Manchester was composed in 1951 by Christopher Strachey, and Dietrich Prinz composed chess, the first computer programs are ever written. The previously evolved computer games resembled Spacewar!, Gotcha, Pong (1973), which depended on the discrete logic and on the clash of two players, without AI. These days, the games have remained in a static environment as well as they have been formed into intelligent dynamic environments where the framework goes about as the second player. A great many people appreciate these sorts of games just where there is a conceptualizing part spoken to. This part is AI (Artificial Intelligence), where the writing computer programs are done so that framework additionally goes about as an intelligent creature, making clients' enthusiasm in games. In Games, AI can be established using different types of searches. These may be:

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

There is a great deal of unpredictability in these algorithms, and large trees are made utilizing a top-down or bottom-up approach. Presently, if looking through profound into the game tree is so difficult, how are people ready to play games like Chess, Ludo, and go so well? Are we playing drawing a game-board in our minds and performing minimax? No, it appears that rather people utilize some significant level heuristic investigation and ground their proceeds onward insight from past, ongoing interaction or a few.

The main objective of utilizing AI in gaming is to convey a practical gaming experience for players to fight against one another on a virtual stage. Likewise, AI in gaming additionally helps increment the player's advantage and fulfillment over quite a while. Artificial intelligence and gaming are getting entangled in a typical relationship. Most of the technology giants are using Artificial Intelligence to offer the next level of gaming experience. No doubt, AI has ended up being a game-changer in

blending the game with real-world experiences. This is the explanation the gaming business is perceiving the adaptation openings. AI is helping the game advancement organizations change the possibility of games. It is assessed that portable gaming keeps on developing and will reach \$91.2 billion by 2021. With the execution of this trend-setting innovation, computer games are coming into life. Repetitive games are currently being prepared with the assistance of AI to test and improve their algorithms. Nowadays, the vast majority of the games are stimulated with real-life experiences, for example, entertainment parks, combat zones, films, bike rides, and numerous other mainstream games. For video game development, practical AI involves applying algorithms, such as the Minimax algorithm, into machine learning to give the innovation all of the data it requires to outmaneuver a human. After applying game theories and formula information into AI technology, researchers found that they could program a computer with enough data to beat experts at no-restriction Texas hold'em. Human-made intelligence can do this because the data it holds brings every choice down to a science. The entirety of the data utilized by AI originated from people, yet with enough data from enough assets, the machine has more vital information than is workable for a human being to have at the culmination of the priority list consistently.

There are various manners by which AI and game improvement are becoming through one another. Regardless of how AI continues being acquainted with bringing life into computer games, PC games are presently being planned with the reason to contemplate their own examples to improve their algorithms, which is one of the few different ways that AI is getting additionally created. Subsequently, artificial intelligence is generally significant for making the game more intelligent and engaging for the client. This paper proposes a Ludo game-based strategy to enhance its ability. The proposed procedure recreates the standards of playing the game Ludo utilizing two or four players to play.

## 7. ARTIFICIAL INTELLIGENCE APPROACH

Q-learning is an off-policy transient distinction learning algorithm in Reinforcement Learning, which is a Machine Learning paradigm that expects to locate the best approach to respond in the difficult it is comprehending. This is done by maximizing reward signals given from the environment for each accessible activity in a given circumstance. Q-learning is a model-free RL technique that permits web-based learning, and it refreshes the present

status values according to maximum return values of all states after subsequent giving free activities. A primary challenge in Reinforcement Learning is to balance, exploitation, and exploration. Exploitation chooses the best activity found up until now, while the investigation chooses another alternative option to improve the current policy. A simple solution for this is to apply a greedy policy, which selects an action at random with probability. Our implementation was initialized at 1 and decreased by 0.1 in every time step until it stabilizes at 0.1.

Q-Learning is an AI algorithm figuring out how to carry on in an unknown environment. Q-Learning regularly prompts a solution and ideal behavior. It is an algorithmic methodology from artificial intelligence literature that has a place with reinforcement learning algorithms. In the artificial intelligence field, reinforcement learning is chiefly worried about how an agent can learn to behave optimally from interactions with its current circumstance. A general idea in reinforcement learning can be portrayed as an agent that cooperates consistently with its area. Firstly the state of environment  $s \in S$  is seen during each stage. The Agent at that point chooses to execute an action  $A$ . This results in a payoff  $r$  and its payoff in future the periods according to the choice of action. This environment is usually assumed to be a Markov Decision Process.

Randomization strategies in local search techniques have been very exceptionally fruitful. The local search methods or meta-heuristic methods are typically utilized for following the difficult Complex and Combinational issues. These techniques start with an initial outcome/solution, which probably will not be fundamentally achievable, and so improvisation upon it is being done by performing a little local change. An example of this would include the solutions for the traveling salesman problem (TSP).

## 8. USES OF AI IN GAMES

There are essential modeling Areas where AI is valuable in the gaming field. They are:

**Player experience modeling:** Understanding the capacity and enthusiastic condition of the player to find the game suitably. This can incorporate unique game trouble adjusting. Game AI may likewise assist with knowing the significant parts in intent (like gesture recognition)

**Procedural content generation:** Creating components in a gaming environment, for example, environmental conditions, levels, and music, sequential and automated

way. Artificial intelligence strategies could create more up to date contents or engaging and interactive user stories.

**Data mining on the utilization of conduct:** This part permits the game designers to distinguish how individuals utilize the game, what is the pass they are playing the most and what causes them to stop playing along these lines. It permits the engineer to polish the ongoing interaction and improve adaptation.

**NPCs additionally have substitute methodologies:** These might incorporate changing the game arrangement to improve NPC's believability, investigating social instead of individual NPC conduct.

AI is exploring new open doors in the gaming industry, apart from offering a captivating gaming experience. Consequently, AI-enhanced the fascination of the game players with time. There are numerous ways Artificial Intelligence is being utilized to present the best in-game industry.

#### **AI in Pathfinding:**

Nowadays, game designers offer the most developed games that are a lot quicker than any time in recent memory. Pathfinding is utilized in many of the most recent games where AI is utilized to plot the shortest route between two points. It is viewed as a central part of most games today. Characters of various sizes and shapes can be moved in an objective, coordinated way. Hence, an AI-empowered program is created to recognize a good path from a starting point to a goal of dodging hindrances.

#### **AI in Characters designing:**

Making a human-like character in a 3D pretending computer game is not simple. Today, the vast majority of the games are brimming with animated characters with facial appearances, expressions, voices, and movements. The game developer is utilizing an automated real-time deep learning strategy to make 3D facial animations. Together AI with deep learning is offering extreme games with player characters that are controllable by a player.

#### **AI in Object detection:**

AI is utilized for object detection, to find objects in a picture/scene and recognize each item. High-end quality games with the ability of PC and programming frameworks are accompanying object detection. Game developers are using TensorFlow for stunning uses of object detection in games. This trendsetting innovation is accustomed to comprehension and utilizing genuine experience. Games with object detection are generally

utilizing in face recognition, vehicle location, pedestrian counting, pictures, driverless vehicles, and some more.

#### **AI in Finite state machines:**

Artificial Intelligence is used in a finite-state machine game model to represent and control execution flow. In many development games, finite-state machines are valuable to implement AI logic. This permits the game designer to see the higher perspective, tweaking, and upgrading the eventual outcome. It is ideal for utilizing AI in games, bringing about incredible results without complex code. The AI usage in FSM (finite state machines) utilizes functions or methods to represent states is straightforward, however prevailing.

#### **AI in Game Analytics:**

Artificial Intelligence-powered gaming analytics provide unique insights, allowing developers to quickly. Artificial intelligence fueled gaming analytics which gives unique experiences, permitting developers to survey genuine flaws rapidly. Artificial intelligence is useful in sending the proper fix before any effect on the game. Mobile gaming organizations are supporting AI for an effective experience. Also, gaming analytics can quickly discover issues that can lead to costly business incidents in real-time. Along these lines, with AI-controlled gaming analytics, the game designers can coordinate with caution and eliminate them with the information.

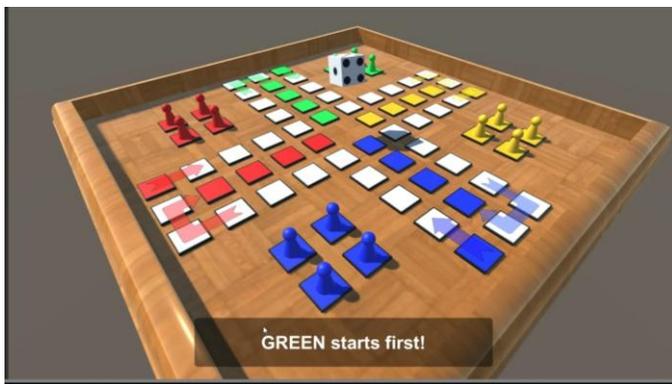
## **9. RULES**

1. 2 to 4 players begin by placing their respective tokens on their bases. Each player then takes turns throwing the die. On each player's turn, the player rolls the dice to choose a move.
2. Just a single token is permitted to go into an individual beginning square and move likewise according to the move of a dice a clockwise way following the total load up until each other player's tokens are dead.
3. If a six is rolled, the player can decide to either move a piece out of his base onto the beginning position or move a piece in play.
4. Whenever a six is rolled, the player gets an additional move after his turn.
5. If a player's token lands on an opponent's token, the opponent's token is killed, and the opponent is left with one less token.
6. The only player remaining with a token on the board, in the end, wins the game.

## 10. GAMEPLAY

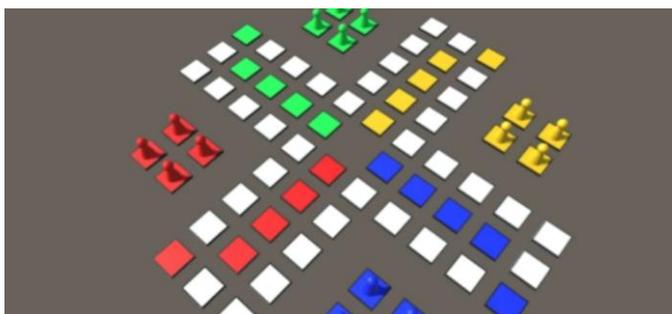
The game starts when the first player rolls the dice; the first player can be anyone the game decides it. With a “6” on the dice, the player can come to the board’s play area, or else the turn is transferred to the next player.

If the player has more than one token in the game to race around, at that point, by the strategy for Q-learning, he can pick which one player to allow to race around the track. Here we have AI that we look forward to if there is any rival's token at that point; we attempt to pursue that symbolic keeping oneself at a more secure side because of a possibility of other token being given a transition to race.



Also, if a player gets a “6” on the dice, then the player has a bonus chance to roll the dice again, and if the player gets a “6” the second time, then one more roll can be done, but if “6” appears the third time then players chance is discarded, and the turn is transferred without any movement of the token.

Here we allocate an index to each square block. Presently we start from one block (say, red block) yard. The red yard's absolute first square in the track zone is given file "1", and persistent ordering is followed to neighboring cells. In this manner, we have 12 cells focusing on each yard. Presently, there is one cell over each home segment.



The winning condition depends on values that are decided by using the terms:

1. **No of tokens.**
2. **No of tokensRemaining.**
3. **No of tokensOut.**

**No of tokens:** It is the total number of tokens currently on the board.

**No of tokensRemaining:** It is the total number of tokens remaining for each player. For every player, this value would be different.

**No of tokensOut:** It is the number of tokens that are killed and currently not on the board.

The winner of the game will be decided by the **No of tokensRemaining** for a particular player. The only player whose value of **No of tokensRemaining**, in the end, is greater than one will win the game.

## 11. CONCLUSION AND FUTURE SCOPE

Here we attempted to show a short portrayal of Game theory. Along with this, we gave a few highlights of the game. At that point, we gave a brief of Artificial Intelligence alongside games and the use of AI in games. After this, we clarified the game in calculations utilized predominantly for the Ludo. Furthermore, after this, Ludo’s portrayal as the contextual analysis is clarified where the calculation is enhanced for utilizing lesser files. There is a less multifaceted nature for speculating the tacking number and afterward computation as we follow shading ordering alongside the number and a point. In the end, a LUDO game would be made and ready to upload on Google Play Store for users, The current Ludo game that is made is very streamlined, yet at the same time, there are possibilities of upgrades by finding stunningly better algorithm that will prompt more advancement. Using the user feedback, there will be a lot of future updates and new features added to the game.

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