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Reinforcement learning in Connect 4 Game

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ABSTRACT

Reinforcement learning allows a machine or software agent to learn its behaviour based on the response of the environment. It permits machine and software package agents to mechanically confirm the perfect behaviour in a very explicit context to maximise its performance. The distinction in reinforcement learning for supervised learning is that only partial feedback is given regarding the learner's predictions. Beside, predictions can have long-term effects by affecting the future state of the controlled system. Thus, time plays a special role. The goal of reinforcement learning is to develop efficient learning algorithms, as well as to understand the algorithm's qualifications and limitations. It is very interesting to learn reinforcement learning from a large number of useful practical applications from artificial intelligence problems to control engineering. In this project, we focus on those algorithms of reinforcement learning. Scaling the project looks at challenges for reinforcement learning in Connect4 game, together with a review of proposed solution methods. While this list has a game-centric approach and some items are specific to the game, a large part of this overview may also provide an understanding of other types of applications.

Key words: Reinforcement learning, Computer games, Artificial intelligence, Connect4 game

1. INTRODUCTION

Reinforcement learning is a part of machine learning. There are three parts of machine learning first is supervised learning. Supervised learning means to supervise some data. Data is called training data and in training data, there are input and output that is already decided. And use training data to create some models. Supervised learning is a learning in which we teach machine how to use the data and that is also well managed, After, the machine generates a new set or collection of data. An example of supervised learning is an election and object reorganization. Second is unsupervised learning. In unsupervised learning, we have only input even we don't have expected output. Clustering, k-mean, sensor - these are examples of unsupervised learning. The last part is reinforcement learning. There are two parts: positive and negative. Positive is called reward and negative is called policy. In reinforcement learning, we can already know input and output. Reinforcement learning is taking particular reward to increases policies in the particular situation. Reinforcement learning is used by various software or machines to find the best possible reward that should be taken in a particular situation. The best example of reinforcement learning is computer games. In this project, we present how reinforcement learning is used in games. Without reinforcement learning and artificial intelligence, we can get output but it is not a proper manner but if we would use some kind of algorithm so we will get proper output.

2. RELATED WORK

[1] This paper covers an artificial intelligence, behavioral and game-making decision-making processes, opponents, and generations current computer games. A surprisingly interest test for AI research. Most of games combine's rich and complex environments and high level development, but with the static physical simulation. According to learning that is basically from mistake and successes, it adapts to the strengths and weaknesses learn from the player and it's tricks. [2] In this paper, They present a pre-learning model which is successfully learning control policies and directly comes from high-dimensional input with the use of reinforcement learning. In paper the model is decorated with neural network and it trained with a variety of cue-learning. Here input is in raw pixel, and output is in function. They think it outlines all previous approach in seven games and supersedes the human expert on four of them. [3] In this paper, they increases the graphic sophistication and it was begun to result in declining returns, the technological focus in game design has shifted to AI. This paper is based on art and entertainment. how create an interdisciplinary agenda, combining sports teaching, design, practice, and technological innovation. [4] The game has been a famous field of artificial intelligence and it has the growing software industry since 1990s. Video game and other games have become an aspect of daily resource and a easy way to entertainment. In the dimensional and numerical characteristics of the action space, and the complexity of the game is one of the major obstacles to applying game learning when simulating with the virtual world. This paper shows

that how computational intelligence techniques, characterized by statistical education and self organization, it can provide toolset to overcome learning difficulties in the games. [5] Reinforcement learning (RL) is also called approximately dynamic programming (ADP). In this area though performed in Artistic Intelligence (AI) community and recently it has attracted the attention of optimization. Some of operation Management's most significant success stories. It has a important tool for solving sequential decision and complex problems in controlled theory. A pointer to numerous examples of applications has been provided. [6] In this paper we tend to survey the recent add AI on multi-agent reinforcement learning (that is, learning in random games). We tend to then argue that, whereas exciting, this work is blemished. The basic flaw is un clarity concerning the matter or issues being addressed. When tracing a sample of the recent literature, we tend to establish four well-defined issues in multi-agent reinforcement learning, single out the matter that in our read is best suited for AI, and build some remarks concerning however we tend to believe progress is to be created on this downside. [7] This paper provides a survey of antecedently revealed work on machine learning in game taking part in. The concept is organized around a range of issues that generally arise in game-playing which are often solved with machine learning ways. This approach, we believe, permits each, re-searchers in game taking part into search out acceptable learning techniques for serving to resolve their issues likewise as machine learning analysisers to identify appreciated topics for any research in game-playing domains. The paper covers learning techniques that vary from neural networks to call tree learning in games that vary from poker to chess. However, area constraints forestall the U.S. from giving elaborated introductions to the used learning techniques or games. Overall, we tend to geared toward putting a good balance between being thorough and being exhausting. [8] In this paper, they increase the graphic sophistication and it was begun to result in declining returns, the technological focus in game design has shifted to AI. This paper is based on art and entertainment. how to create an interdisciplinary agenda, combining sports teaching, design, practice, and technological innovation. [9] In this paper, They present a pre-learning model which is successfully learning control policies and directly comes from high-dimensional input with the use of reinforcement learning. In paper the model is a decorated with neural network and it trained with a variety of cue-learning, and input is in raw pixel, and output is in function. They think it outlines all previous approach in seven games and supersedes the human expert on four of them. [10] This paper shows how computational intelligence techniques, characterized by statistical education and self-organization, can provide a toolset to overcome learning difficulties in the games. The game has been a famous field of artificial intelligence and it has a growing software industry since the 1990s. Video games and other games have become an aspect of daily resources and an easy way to entertain. [11] The dimensional and numerical characteristics of the action space, and the complexity of the game is one of the major obstacles to applying game learning when simulating with the virtual world.

3. ARCHITECTURE OF REINFORCEMENT LEARNING

Reinforcement learning depends on how humans and robots predict the output. The given diagram Fig1 consists of three major components. A robot, Human and Artificial intelligence. Humans and robots give the value to artificial intelligence that is called "action" and AI returns are called "perception".

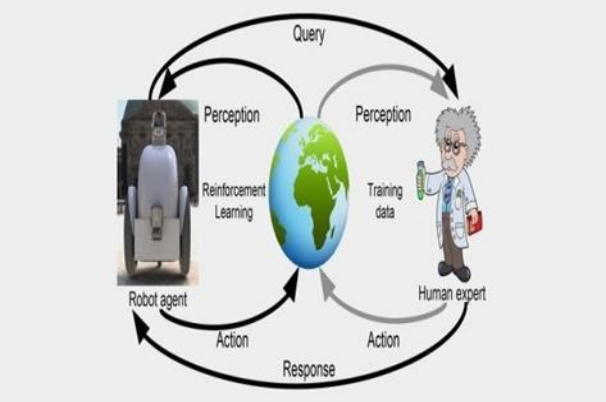

Fig.1: Architecture of Reinforcement learning

According to the diagram, the Robot agent gives query to Human-agent and the human agents solve that query and give a response to the robot agent. If we see in the robot agent side, reinforcement learning is used but in human agent side training data is used. In last, Reinforcement learning is only for robots not for humans.

4. RECENT TRENDS IN GAME METHODOLOGY

The gameplay is an important part of artificial intelligence. In games they do not need a lot of information, we'd like to supply information is thatthe legal moves, rules, and conditions of winning or losing game. Computer to humans and humans tohumans both try to win the game and for winning the game they try to move the best possible move at each turn. The major reason to play a game is the computer can not cheat on humans. If we want to use an algorithm in a normal or low-frequency game so we will use the BFS algorithm but if it will a very high branching factor then we can not use the BFS(Breadth-first search) algorithm. Games are not only for entertainment but also to how we will train our an agent to best perform with humans and it is also

necessary to how our agent increase the score with humans. And it is dependent upon artificial intelligence algorithms. Using searching and sorting algorithms we can develop the game.

In this project we will search how reinforcement learning use in games. Also we will try to search how artificial intelligence and reinforcement learning use in CONNECT 4 game. There are two terminologies for reinforcement learning in games. First is possible move generator and another is static evaluation function. possible move generator is also called a legal move generator. In CONNECT 4 game, there are 50 moves. now we cannot write code for all of 50 moves. but we can select random code for 20 possible moves is called possible move generator terminology. but if we have more than 100 moves then we can use another terminology called static evaluation function. in this terminology, we cannot select dynamic moves but we can select static moves.

5. PROPOSED SYSTEM – CONNECT4 GAME

Reinforcement learning is the process to make decisions. In reinforcement learning we pass rewards or policy it is depending on the system and algorithms, and that algorithms need to learn which steps can take maximum rewards. In connect 4 games, computers and humans both need to understand how it takes a decision and it is also important to know what is the T table is. Table 1 T table is a matrix, In which the state column represents the possible actions that the system will adapt. Here, the value depends on the moves which are negative or positive.

Table 1. T Table

State	Left	Right	Down
1	0	0.37	0.98
2	0.99	0.87	0.20
3	0.18	1	0.30
4	0.19	0.01	0.10
5	-0.12	0.98	0.76
6	1	-0.09	0.99

In the table yellow color is to show the probability of success and it is based on the rewards. The T values are updated according to the Bellman equation.

$$NewQ(s,a) = Q(s,a) + \alpha[R(s,a) + \gamma maxQ'(s',a') - Q(s,a)$$

New Q-Value; Current Q-Value; Learning rate; Reward; Discount rate; Maximum predicted reward, given new state and all possible actions

Fig.2 : Bellman equation

5.1 ALGORITHM FOR CONNECT4 GAME

1. When the game starts, very first the T-value is bydefault initialized.
2. S defines the current state of the system.
3. According to current state, reward will executeand it will be based on a neural network.
4. Artificial intelligence chooses the reward whenthe system collects the networks.
5. The last two operations are repeated until whenthe correct condition finishes.

The state is the representation of the situation which is found by the system. In our project, the S is a matrix or array format. There are some criteria for the game:

- Red and Blue balls possibilities
- Balls move down, right, left.
-Any four-color balls connect then win the game.in

$$loss = \left(r + \gamma \max_{a`} \hat{Q}(s,a`) - Q(s,a) \right)^2$$

loss algorithm,

Fig 3: Loss Equation

Suppose we predict that red color will win or lose. Sothis type of prediction called Loss. The main job of the neural network is to minimize the loss and in reward, if any player win its point +10 other player point will be reduced automatic -10.

6. EXPERIMENTAL RESULTS

Player to Player:

Here, Red color ball is Player 1 and Yellow colorball is Player 2.

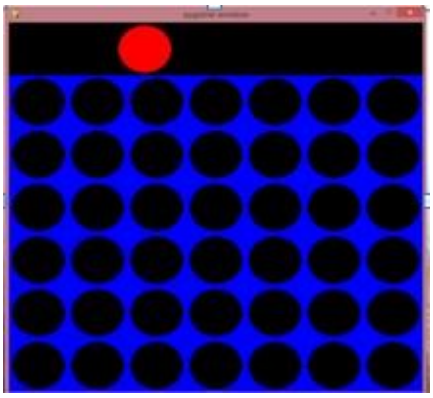

Fig. 4 : Player 1's Move

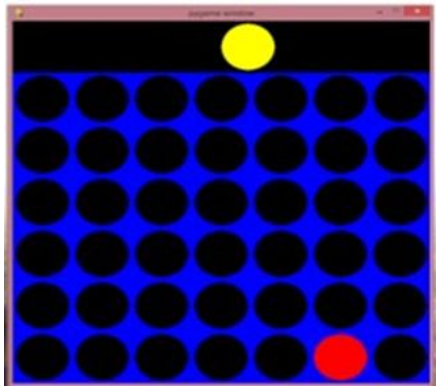

Fig.5 : Player 2's Move

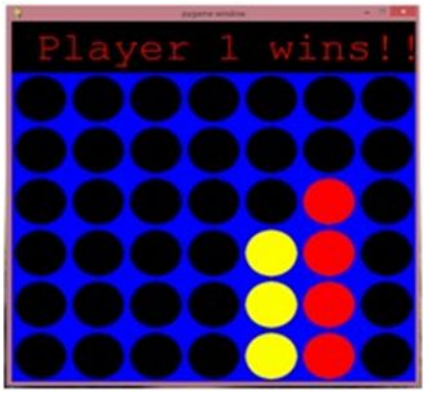

Fig.6 : Winning Player

Player to Computer:

Here, Red color ball is player and Yellow color ball is Computer.

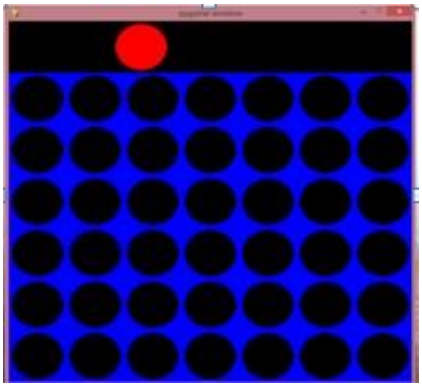

Fig.7 : Player's Move

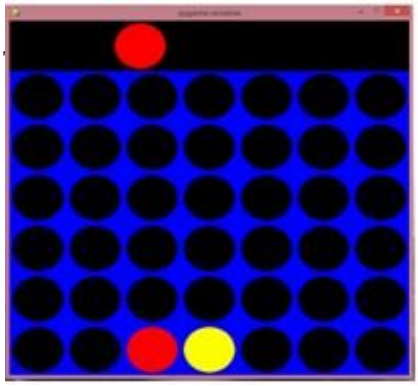

Fig.8 : Computer's Move

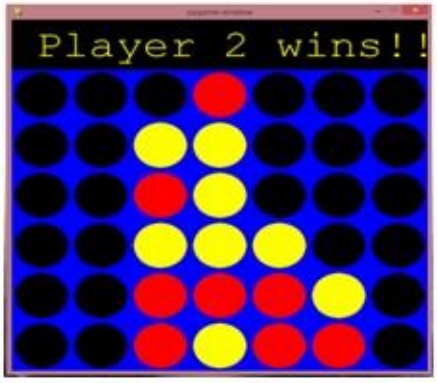

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Fig 9: Winning Player

In this two-player game, players alternately place discs on a vertical board seven columns across andsix rows high. Fig 4 to Fig 6 represents the player to player game.

Fig 7 to Fig 9 represents the player to computer game. Every player uses disc of a selected color (here it's yellow and red), and also the object is to be the primary to get four items in a very horizontal, vertical, or diagonal line. As a result of the board is vertical, items inserted in a very given column perpetually drop to all-time lower unoccupied row of that column. As presently as a column contains six items, it's full and no alternative piece are often placed within the column. Both players begin with their choosen color identical discs,and also the 1st player to attain a line of 4 connected items of same color wins the game. As shown in the above pictures in player to player part player1 winthe game and in player to computer part computer win the game.

7. CONCLUSION

The final analysis is that we collected the details for the algorithms and search how reinforcement learning is used in games and how artificial intelligence also used in games. In this project, we focus on algorithms of reinforcement learning. The project starts with choosing a game and use of reinforcement learning in implementation, The basic reinforcement learning algorithms are sufficient for high-level playing game.

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