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**MONOPOLY WITH ARTIFICIAL INTELLIGENCE**

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**Chapter-1: INTRODUCTION**

Artificial Intelligence is now used in many computer games to introduce robot players that can play with human players. Based on the level of artificial intelligence used in the robot players, they can play on easy to expert level with humans and can outperform the level of human players if made on a good level.

We are trying to add artificial intelligence to a trading board game called **Monopoly** which is basically a property trading game which also needs mind to play. After playing so many games of this game, we realised that intelligence plays an important role in this game. If played with intelligence a player with bad luck can also win the game.

Now some basic concepts of this game are:

* 2-8 players can play this game but for computer version, we are fixing that to 4 players so that it becomes easy to add AI to it.
* The basic aim of a player in this game is to bankrupt all the remaining players in order to win the game.
* Each player starts with fixed amount of money 1500 with no property owned on the board.
* Now a pair of dice is used to move the token of the player on the board.
* Now there are some types of board positions such as colour properties, utilities, stations, community chests, chances, jail etc.
* Now if player lands on a property then he can buy it by giving money to the bank if it is unsold or if its is sold to a player then he has to pay a certain amount of rent to that player, it will be auctioned off to the highest bidder if the player denies to purchase the property.
* Now if player lands on community chests, chances he has to pick that card from the deck and perform the given task.
* Now if player lands on go to jail then he has to go to jail for three chances at most and there are other rules also regarding this case.
* When a player crosses GO he gets 200 cash from the bank.
* Now a player can trade properties with other players upon mutual agreement by giving/receiving some money and giving/receiving some properties.
* A player can also build houses by giving some money to the bank if he has all properties of that colour on which he wants to build houses.
* A player can also sell houses to bank by getting half the money of the house price from the bank.
* A player can also mortgage his properties and receive half the money from the bank and unmortgage by paying extra 10% of the money to the bank.
* Basic strategy to win the game is to maximize the combination of good properties and money first then by trading making sets and then houses on that to bankrupt all the players and prevent other players to do the same.

AI can be used in robot players to make decisions such as buy, trade, build, sell, mortgage, unmortgage and some other decisions too.

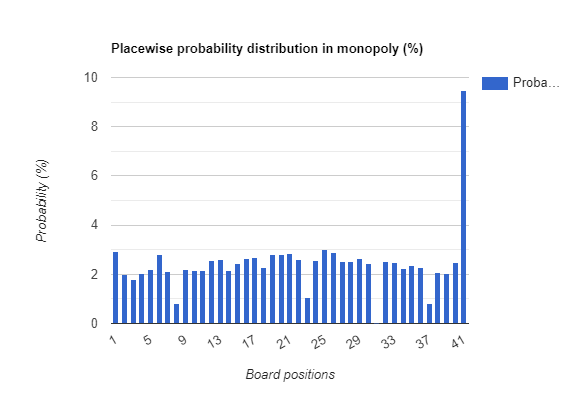
If the robotic is player is trained good based on human experience then it can outperform the human players by taking good decisions at every point of time in the game.

**CHAPTER 2: PROBABILITY ANALYSIS**

Probability plays an important role in every field associated with random events or luck-based games. Now probability analysis results can be used in artificial intelligence games to perform better and is a good way to add intelligence to games.

The main event of luck in monopoly is with the pair of dices. Anything can come on the pair of dices, so there are 41 positions on the board and each position has a certain probability.

Now we calculated probability of each position on the board by simulating the game and then we draw a bar graph where on x axis there are board positions and on y axis there are probability percent out of 100%, where 41th position is inside jail.



Now this graph can be used to deduce many conclusions that can be used further to make an intelligent robot player that uses results of this probability analysis to improve his decisions and these results will be used in any of the AI algorithms we are going to develop.

Now based on above analysis and some other factors we made a table giving priority value of properties.

|  |  |
| --- | --- |
| Priority | Properties |
| Very high | Orange, Red |
| High | Yellow, Pink |
| Medium | Green, Blue, Purple |
| Low | Brown, Station, Utilties |

**CHAPTER 3: AI ALGORITHMS AND CODING**

At the elementary level, there are certain decisions to be made by the robot. These are to buy a property, trade properties, building houses, mortgaging/unmortgaging properties and sell houses.

At any instant, the game can broadly fall under one of the following stages:

1. Beginning stage –

Criteria: There are not even a single colour set whose all properties from the bank are sold out.

1. Intermediate stage-

Criteria: All properties of at least one colour set are completely sold from the game and not available on a single player.

1. Prominent stage-

Criteria: At least one player has at least one colour set.

Now these all decisions will depend on the current stage of the game.

**Algorithm for Buying an unsold property:**

For colour properties:

* Low priority:

if cash>cost then Buy

if cash<cost it completes the set then Buy by mortgaging non set properties.

else Not Buy it.

* Medium priority:

if cash>cost then Buy

if cash<cost it completes the set then Buy by mortgaging no set properties then try with trading on good price.

Else Not Buy it.

* High priority:

if cash>cost then Buy

if cash<cost it completes the set then Buy by mortgaging no set properties then try with trading at low price also

* Very High priority:

if cash>cost then Buy

if cash <cost then arrange money to Buy it. First by mortgaging, then by selling other properties minimum at original price, then by selling houses.

For stations:

If no station then Buy if cash>cost

If one station then Buy by mortgaging only

If two stations then Buy by mortgaging then by trading at a high price.

If three stations then Buy by mortgaging then by trading at a low price.

For utilities:

If cash >cost then Buy

Else Don’t buy

**Algorithm for Selling a property:**

Select a property to sell

Low priority:

-Sell it at not less than original price

Medium priority:

-Sell it at not less than 1.25 times the original price.

High priority:

-Sell it at not less than 1.5 times the original price.

Very high priority:

-Sell it not less than 2 times the original price.

**Algorithm for buying a property from player:**

If only one property to complete the set then try by mortgaging, trading and selling houses of sets worse than this set.

If all properties are there in the game of that set then try mortgaging then by trading at a low price.

If no properties are there in the game then don’t buy it.

**Algorithm for auction:**

If cash in hand of players less than the property value than buy the property by sending it in auction.

Else if any other player does an auction for a property then:

If it is very high priority property bid upto 2 times the original price.

If it is high priority property bid upto 1.5 times the original price.

If it is medium priority property bid upto 1.25 times the original price.

If it is low priority property bid upto the original price.

There are many small algorithms which we have not included here but will be useful while playing the game from robotic point of view.

**Coding:**

We have developed a base back end code for AI in JAVA language that can be used for developing the AI. Because it is very big game to be developed in computers, its base code consists of more than 4000 lines of self-written code and consists of more than 50 functions that supports every aspect of the game.

**CHAPTER 4: CONCLUSION AND FUTURE SCOPE**

Now this is a very big project if developed on a professional level and it will take at least 1 year to complete. We have only done some percent of work till now. We will definitely continue doing research and development of this project in future.

Conclusion of work till now is that we have developed back end code for the game in java and developed AI algorithms on an abstract level and some good theories.

Now our future work will consist of mathematical formulating the AI algorithms and then integrating it the base back end code to completely see it as a console-based monopoly with AI.

We also want to include front end code in this game, so we will try to add graphical user interface to this AI game and then integrate the backend code with this using some gaming engine such as Unity.

Then we will deploy this game on the internet to be available to all the users.

Our basic aim to improve the quality of the AI of monopoly now available in the market, that we can done in some extra time.