Game AI: Project 1

Simple-strategies for turn-based games

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Outline

1. Simple strategies for tic tac toe
   - Probabilistic strategy
   - Heuristic strategy
2. Connect 4
   - Random Play
   - Statistical Approach

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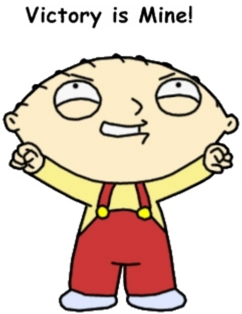
Probabilistic strategy

Main idea

Approach: Find out, which positions *usually* (over the huge number of games) contribute to the victory the most and choose one of them as the next move in the game.



Probabilistic strategy

Pseudo code

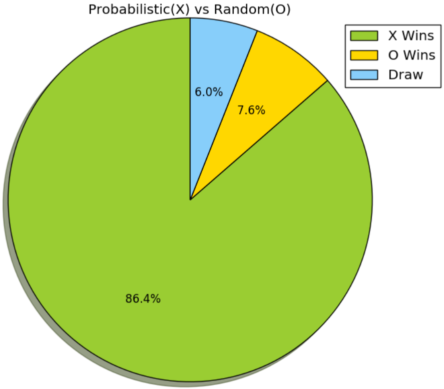
Learn probabilities

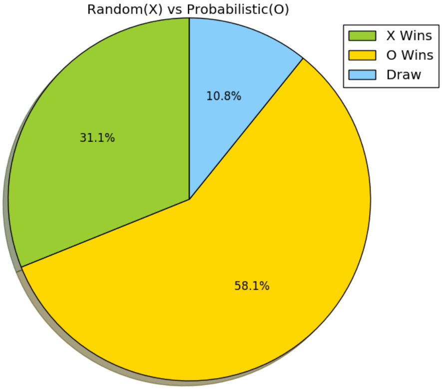
```
1.      for 10000(or any large number)times:
                play_game
                store moves of both player
                update the counter of winner moves
        store the winner moves in a file
```

Play using probabilistic approach

```
1. read probabilities from file;
2. while move is still possible:
         ...
3.       next move = possible move which has maximal probability;
         ...
```

Performance





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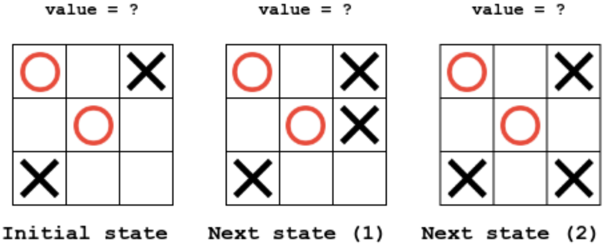
Evaluating the quality of a potential move

How to pick next move from possible ones?
We need to see difference!

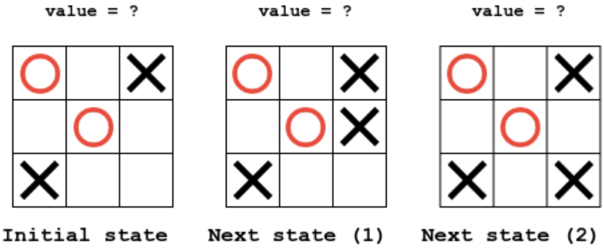


Heuristic / Evaluation function

Provides an estimate of the utility of a game state that is not a terminal state

Simple evaluation function for Tic-Tac-Toe (from slides)

Eval(n, p) = (number of lines where **p** can win) − (number of lines where **-p** can win)



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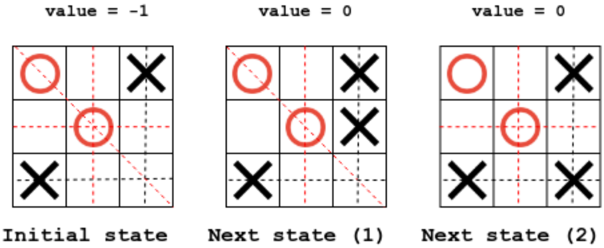
Simple evaluation function for Tic-Tac-Toe (from slides)

Eval(n, p) = (number of lines where **p** can win) − (number of lines where **-p** can win)

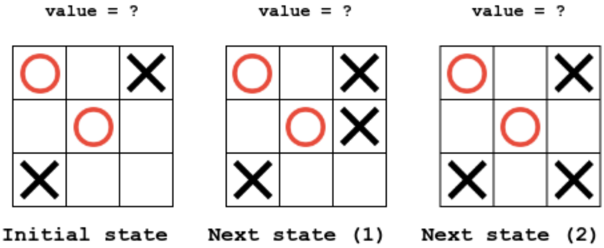


Obviously, current function is not a good one! We can do better!

A Better Evaluation Function (Russell & Norvig, Artificial Intelligence)

Eval(n) = 3 * X2 + X1 (3 * O2 + O1)

- X2 is the number of lines with 2 Xs and a blank
- X1 is the number of lines with 1 X and 2 blanks
- O2 is the number of lines with 2 Os and a blank
- O1 is the number of lines with 1 O and 2 blanks



Heuristic / Evaluation function (cont.)

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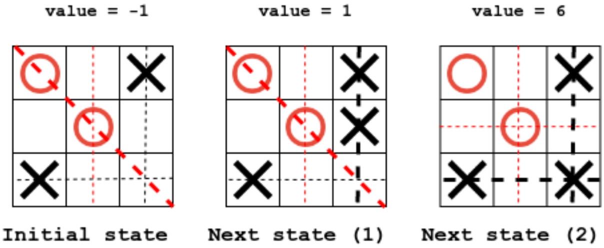
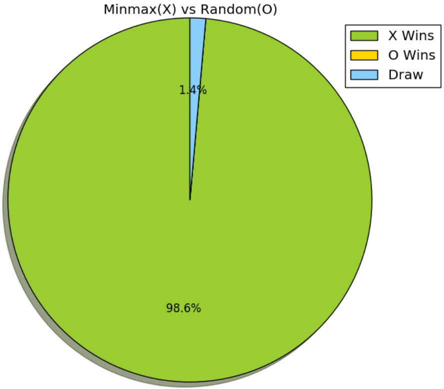
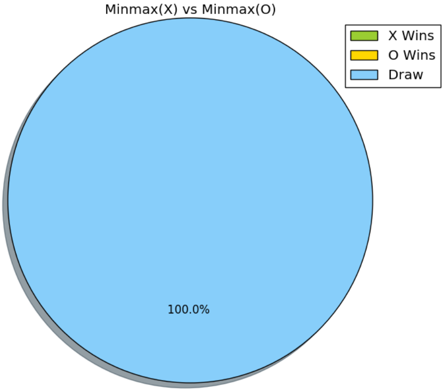


Minmax algorithm

```python
def minmax(board, player, max_depth, current_depth):
    # Check if we're done recursing
    if board.game_is_over() or current_depth == max_depth:
        return board.evaluate(player), None

    best_move = None
    if board.current_player() == player:
        best_score = -INFINITY
    else:
        best_score = INFINITY

    # Go through each move
    for move in board.get_moves():
        new_board = board.makeove(move)

        # Recurse
        current_score, current_move = minmax(new_board, player, max_depth, current_depth + 1)

        # Update the best score
        if board.current_player() == player:
            if current_score > best_score:
                best_score = current_score
                best_move = move
            else:
                if current_score < best_score:
                    best_score = current_score
                    best_move = move

    # Return the score and the best move
    return best_score, best_move
```

Performance



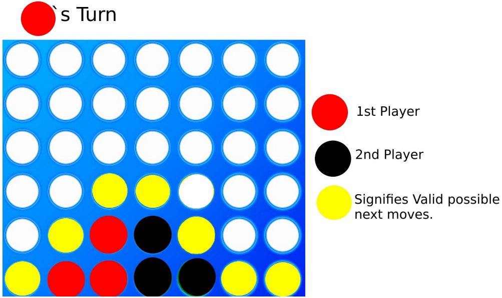


Outline:

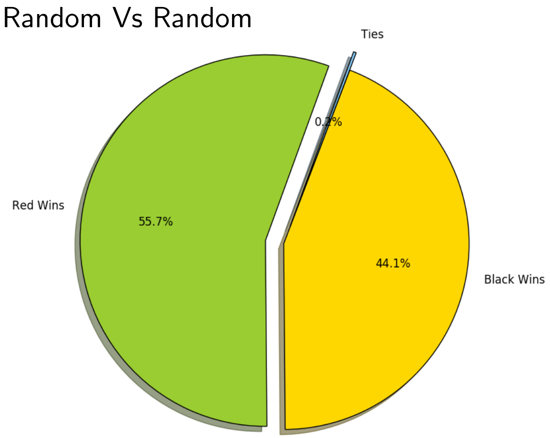
How to pick next move from possible/valid ones?

We choose randomly!

```
while NotFound:
    move=Generate a random move
    if move isValid
        return move
```



Performance and Issues



- No strategy is followed,moves are picked completely radomly

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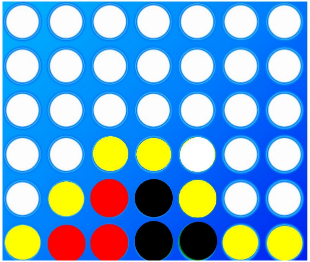
Learning from random play

Using a lookup table

- We store all the bins used by a winner over a million games in a lookup matrix
- From all the valid moves in a given state we pick the one which was used the most in lookup matrix

`s Turn



1st Player

2nd Player

Signifies Valid possible next moves.

601	577	570	533	523	558	579
1155	1076	1081	1066	1054	1075	1110
2138	2118	2225	2372	2148	2201	2250
2753	2987	3175	3235	3209	3044	2758
3500	3784	4167	4417	4144	3880	3582
4303	4493	4971	5789	5075	4582	4320

Pseudo code

Play using Statistical approach

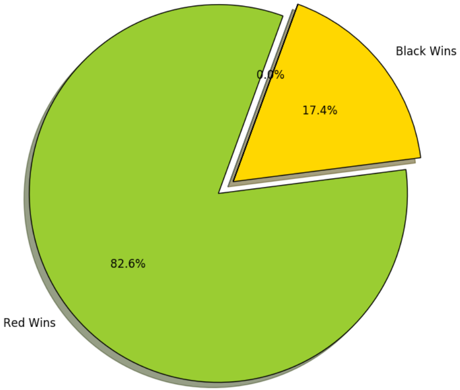
```
1. for 10000 (or any large number) times:
2.       play_game;
3.       update counters of winner's moves;
5. write winner's counter to a file.
```

Play using Statistical approach

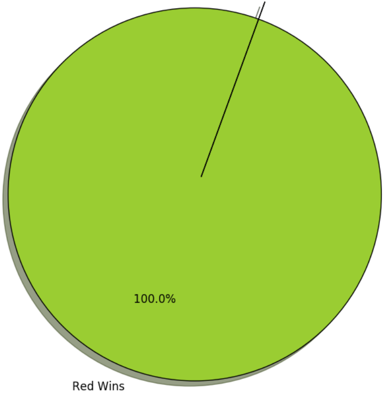
```
1. read the lookup from file;
2. Find all valid moves:
3. Pick the highest value
```

Performance

Statistics Approach VS Random



Statistical Approach VS Statistical Approach



Do we need Summary ?

That's All Folks!

Thank you for attention!