Game AI

Project 1: simple strategies for turn-based games

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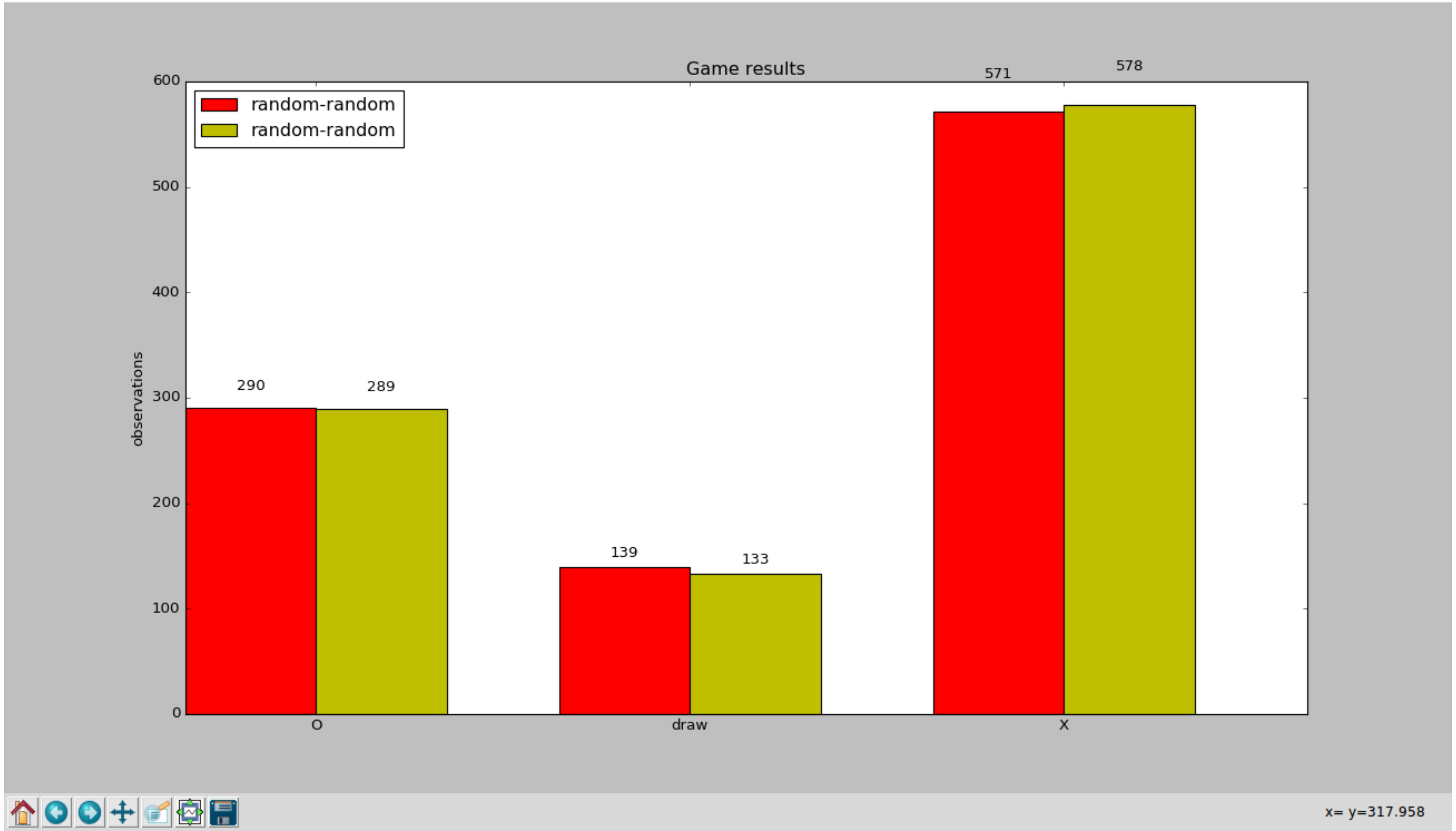
Task 1.2 Simple Strategies for Tic Tac Toe

Getting started

- Random moves are random
- Random moves != random chances
- Random vs Random will result almost the same way

Task 1.2 Simple Strategies for Tic Tac Toe

Getting started



Task 1.2 Simple Strategies for Tic Tac Toe

Probabilistic strategy

The idea:

- play a statistically sufficient number of games
- rank points on a *tic-tac-toe 3x3* board according to their win participation
- use ranks in decision-making going from top ranked down

The approach:

```
weights = {}
for point in points:
    weights[point] = sum([1/len(winStates) for winState in winStates if point in winState])
```

Task 1.2 Simple Strategies for Tic Tac Toe

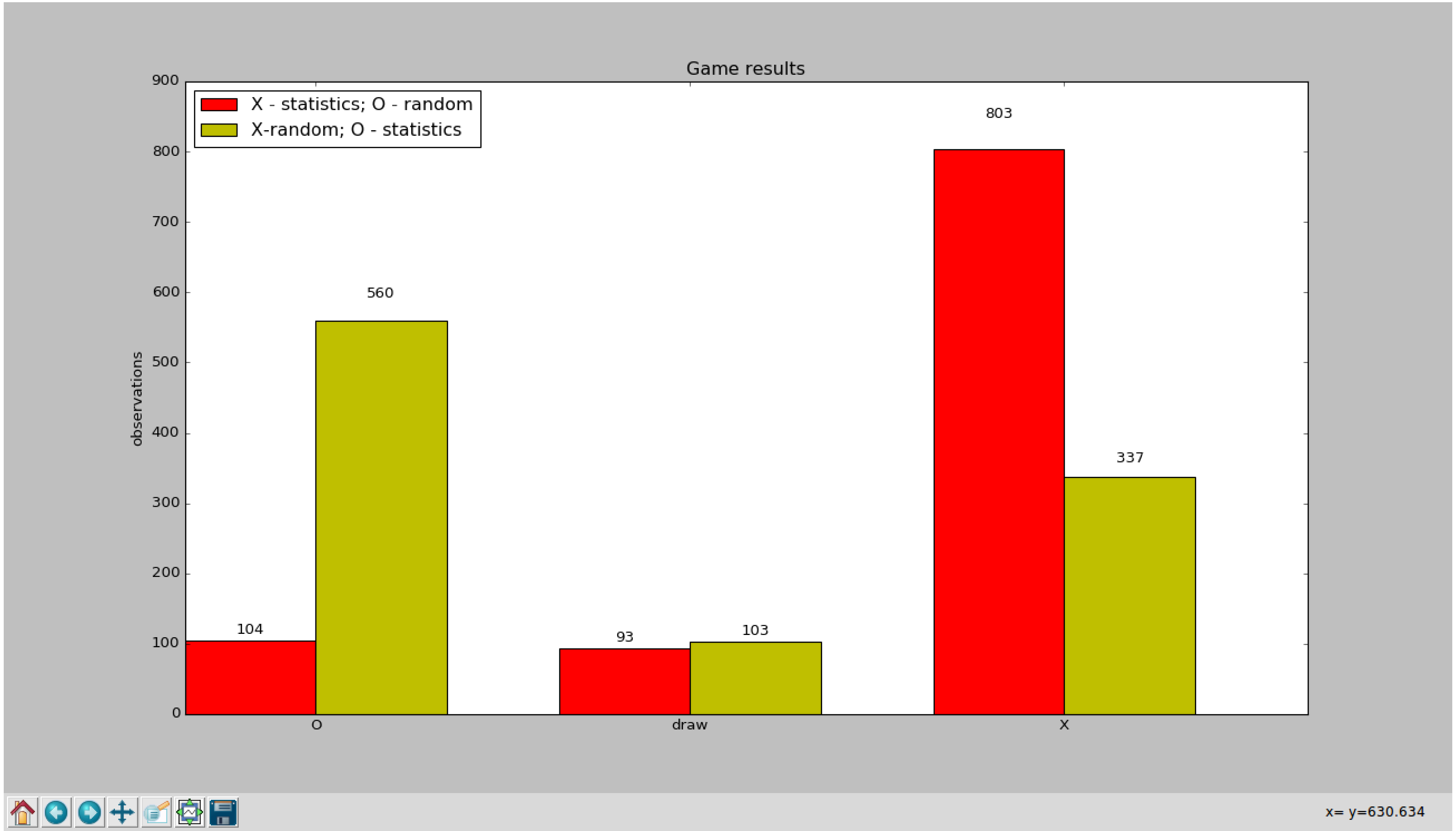
Probabilistic strategy

The results (odds):

47%	39%	45%
37%	61%	38%
48%	37%	50.5%

Task 1.2 Simple Strategies for Tic Tac Toe

Probabilistic strategy



Task 1.2 Simple Strategies for Tic Tac Toe

Heuristic strategy

The idea:

- evaluation (utility) function + depth-one-search combo-wombo
- benefits:
  - low complexity and therefore fast calculations
- drawbacks:
  - lower chances to win comparing to full-tree-search

Approach:

- function eval(S,p):

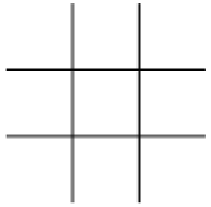
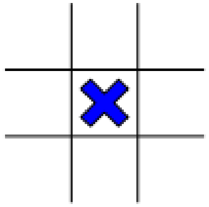
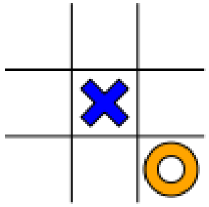
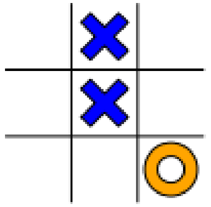
```
        return n_winning_states(S, p) -  n_winning_states(S, -1*p)
```

- depth-one-search algorithm is here to make sure a player *p* will not lose in the next step. (e.g. to move accordingly if there is a threat of loosing)

Task 1.2 Simple Strategies for Tic Tac Toe

Lecture recap

$$
\begin{aligned}
Eval(n,p) = {} & (\text{number of lines where } p \text{ can win}) \\
& - (\text{number of lines where } -p \text{ can win})
\end{aligned}
$$

n				
$Eval(n,\mathbf{X})$	$8-8=0$	$8-4=\ 4$	$5-4=\ 1$	$5-3=\ 2$
$Eval(n,\mathbf{O})$	$8-8=0$	$4-8=-4$	$4-5=-1$	$3-5=-2$

The key point– is to move in a way to have more potential winning states than the opponent

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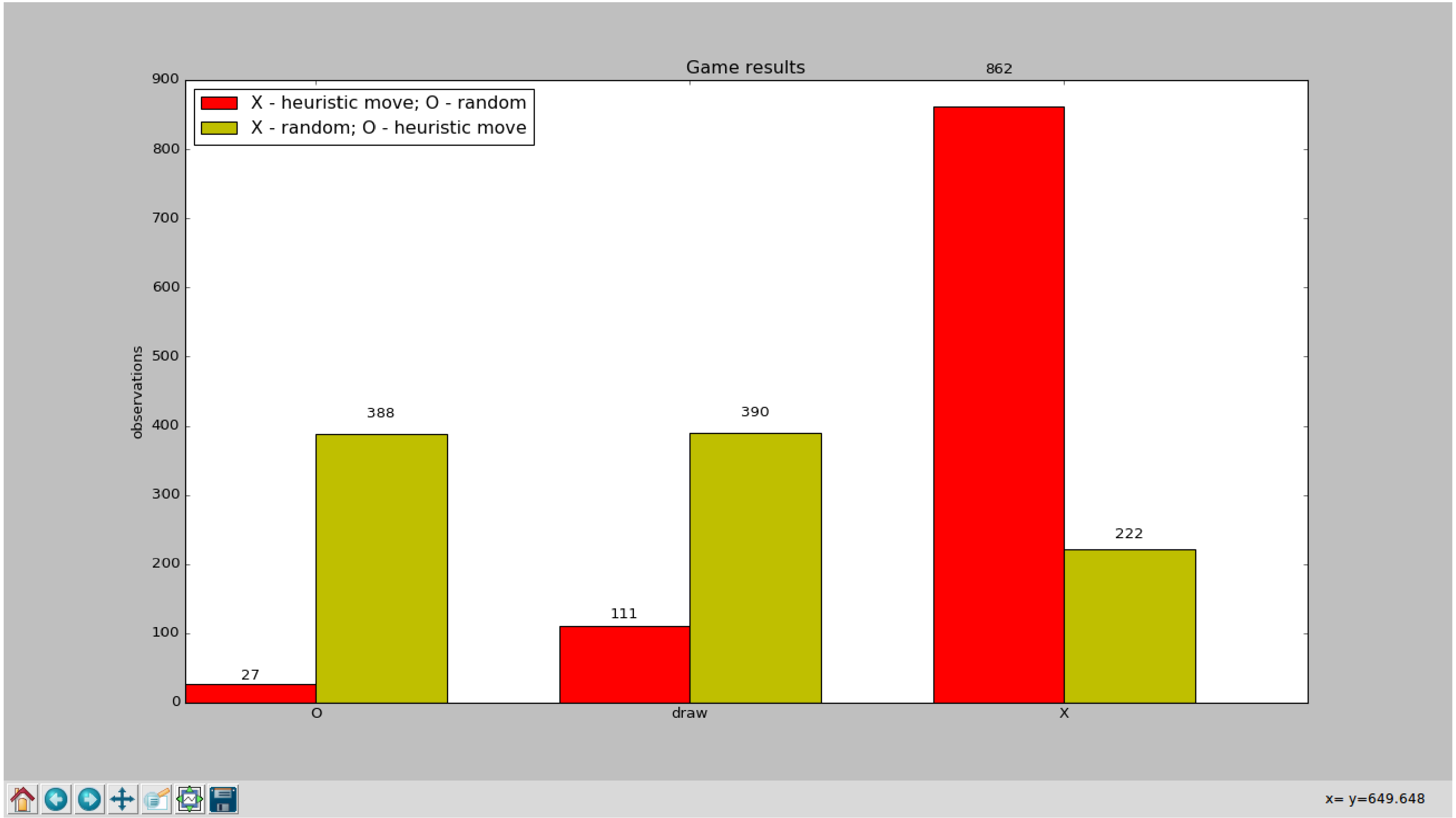
Heuristic strategy



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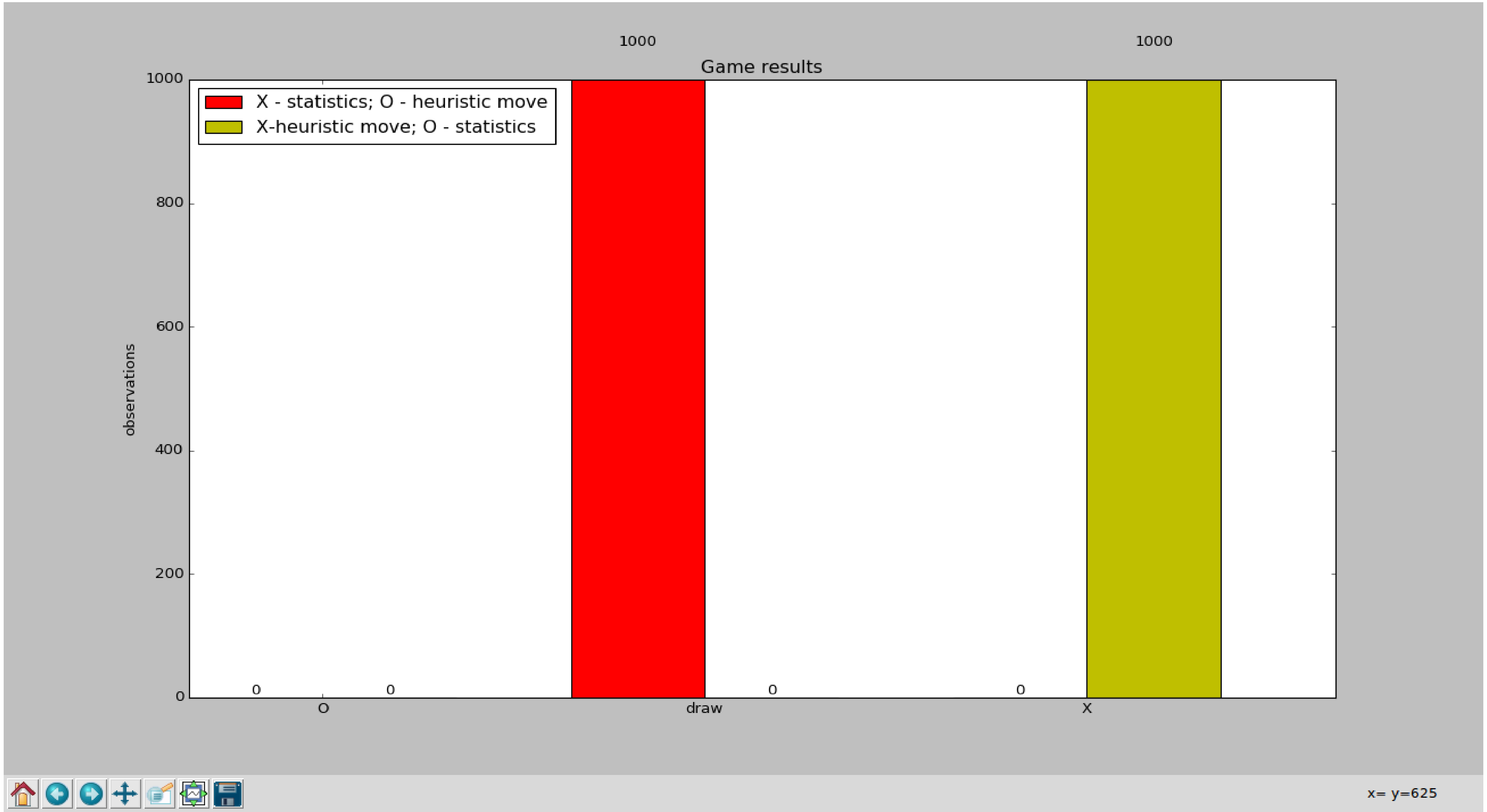
Heuristic vs Statistic


Game results
observations
1000
800
600
400
200
0
O
draw
X
1000
1000
0
0
0
0
🟥 X - statistics; O - heuristic move
🟨 X-heuristic move; O - statistics
x= y=625

Task 1.3 Connect Four

Game implementation description

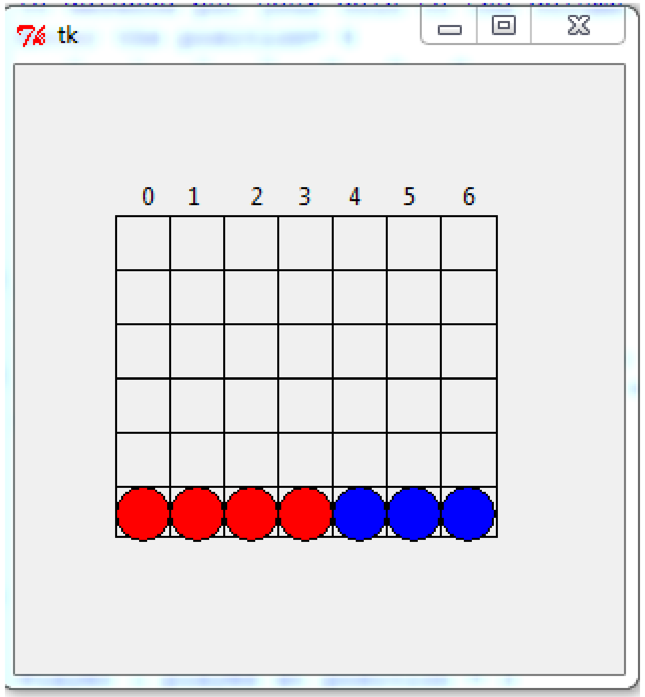
Structure:

- neighbor-checking functions
  - def checkUpandDown(grid,line,column,player)
  - def checkRightandLeft(grid,lin,column,player)
  - def checkDiagonalLeftUpRightDown(grid,line,column,player)
  - def checkDiagonalRightUpLeftDown(grid,line,column,player)

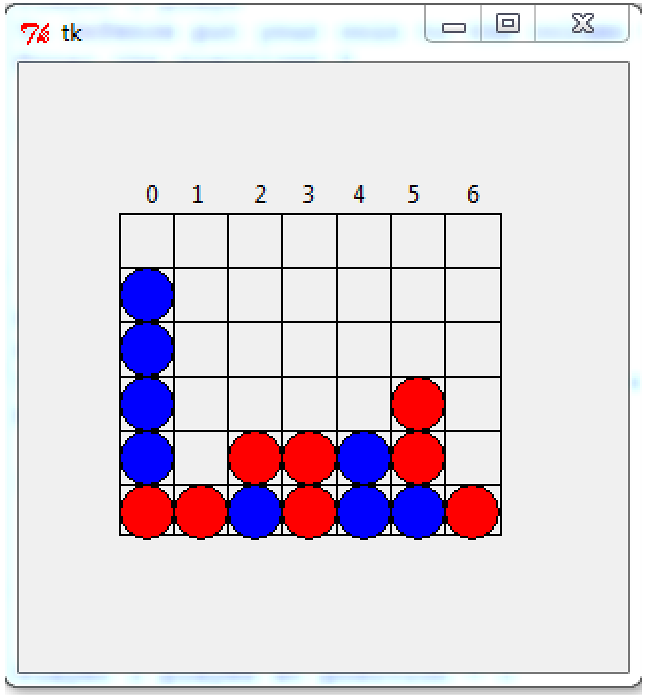
- “smart-advice” function def nextMove(a,player)
  - hints the user of a potential danger or victory

Task 1.3 Connect Four

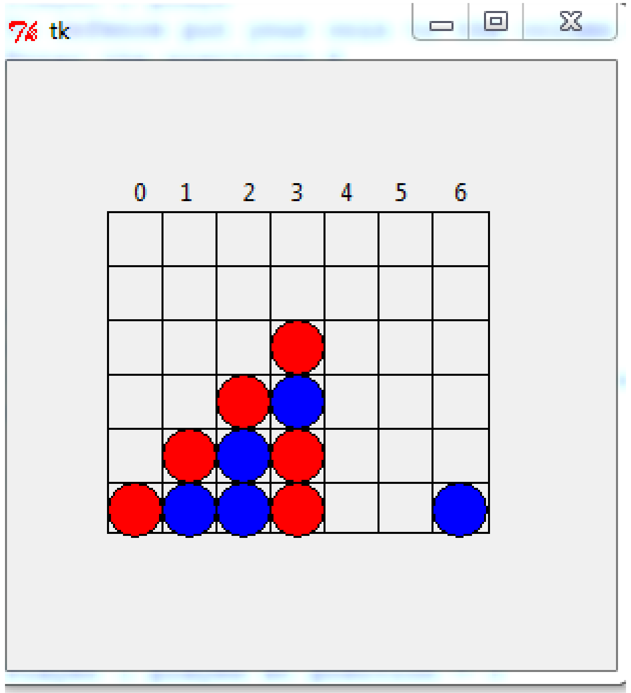
Game demonstration



```
Player 1 wins
```



```
Player 2 wins
```



```
Player 1 wins
```

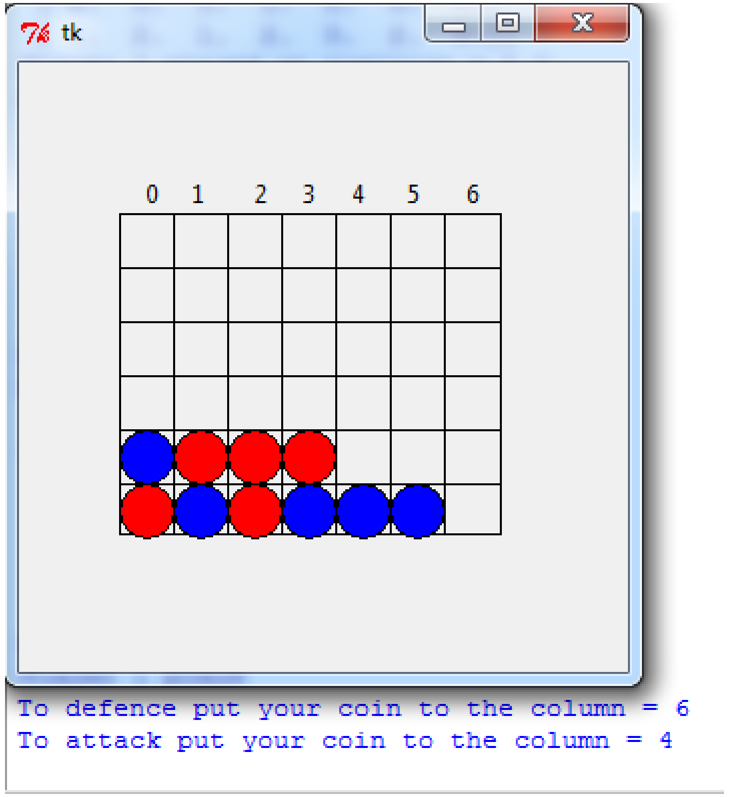
Task 1.3 Connect Four

Game demonstration – “smart-advice” strategy

Warn when three connected checkers of same color detected

Ideally:

- warn when two or three connected checkers of same color detected
- problem:
  - brute force too expensive
- “smarter” would be to eliminate two or three connected checkers that can’t turn into longer chain
- left for further work…



```
To defence put your coin to the column = 6
To attack put your coin to the column = 4
```

Task 1.3 Connect Four

Statistics of winning fields – random strategy

Runs: 100
Wins of player 1: 51
Loses of player 2: 49
Draws: 0

18	33	24	35	28	26	21
22	20	28	27	19	20	19
10	16	21	15	10	11	16
11	14	15	10	8	10	9
4	7	5	6	2	4	6
2	3	5	6	1	3	3

Runs: 1000
Wins of player 1: 537
Loses of player 2: 460
Draws: 3

265	292	289	338	274	253	258
172	221	210	240	219	193	190
145	161	170	164	143	144	137
116	121	105	16	119	98	119
49	57	40	61	55	43	40
29	22	17	28	27	23	25

Task 1.3 Connect Four

Statistics of winning fields – “smart-advice" strategy

Runs: 100
Wins of player 1: 53
Loses of player 2: 46
Draws: 1

23	26	30	30	27	31	30
15	26	19	29	24	23	21
15	22	27	26	22	27	11
13	8	16	19	13	15	21
8	11	10	11	7	10	6
4	5	6	6	6	10	6

Runs: 1000
Wins of player 1: 494
Loses of player 2: 478
Draws: 28

239	230	255	254	270	247	238
186	207	251	277	222	216	168
122	189	219	246	225	169	136
138	126	137	167	161	135	110
63	71	72	86	76	86	54
37	44	34	37	43	36	55

Thank you for your attention!