

INTRODUCTION

Tic-tac-toe is an ancient two-player game that is essentially played on a 3x3 grid. The two players are commonly known as Cross and Noughts. According to the rules of the game, the two players take their turns alternately and mark their moves in the empty spaces of the 3x3 grid. The player who first succeeds in occupying a full row, a full column, or a full diagonal, wins the game.

The aim of this assignment is to illustrate the fact / claim that an optimal / best play by both the players, always results in a draw, by providing an exhaustive list of best strategies in the form of a program as a proof of soundness and completeness of this claim.

The fact that, given the two players play optimally, there does not exist any case of “Lose” as an outcome for any of the players, serves as a proof of Soundness, while Completeness is proved by showing that if either of the two players plays un-optimally, then there exists a possibility of win for the other player (who plays optimally). This has been discussed in detail further in the report.

Further, without loss of generality, Cross has been assumed to be the first player (i.e. every game begins with Cross’ move) and Noughts has been assumed to be the second player, and the program / strategies have been designed / discussed accordingly.

INSTRUCTIONS TO RUN A PROGRAM

- 1) Compile the program with gcc compiler.
- 2) Run the program tictactoe.c
- 3) For getting all possible board configurations starting from empty board when both the players play optimally, give the input as 0.
- 4) Now for getting all possible board configurations starting from any given board situation give the input as described below: -

1		2		3

4		5		6

7		8		9

Now suppose X plays 1 and O plays 5 then again X plays 3, then input should be given as 153.

STRATEGIES

1)**Direct Win:** - Let us suppose it is X's turn. And if X can win by marking at a particular position then it is a case of direct win.

X		X
O		
		O

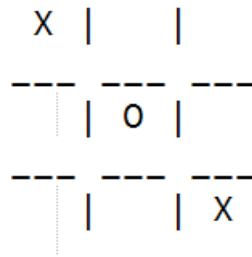
When X plays at 2 it is a case of direct win.

2)**Single Win:**-If in a given board situation there is a possibility of a direct win by placing somewhere at any empty place then it is a case of single win.

X		
	O	

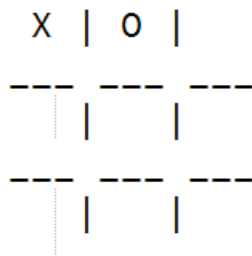
When X plays at positions 2,3,4,7 it gives a single win for X

3)**Double Win:** - If there is a possibility of a player to win in two ways in a given board situation then it is a case of double win.



If O plays at 3,7 it leads to a double win for X

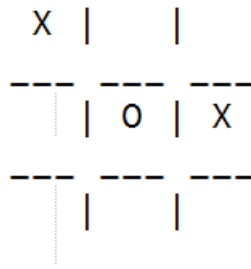
4)**Forced Win:** If in a given board situation there is a possibility of player X in which it can force a win then it is a case of forced win.



If X plays at position 7 it leads to a forced win for X

5)**Forced Loose:** -If in a given board situation if a player plays at a particular position and it results in a forced win situation of the opponent then it is the case of forced loose of the player.

6)**Block Double Win:** - If in a given board situation if a player marks in a particular position and it results in no possibility of double win of the opponent in the next turn then it is the case of block all double win.



2,3,8,9 are positions of block all double wins.

7)**Loose by Chance:** Creation of next move unstoppable double win of opponent.

Optimal Strategies

- 1) Direct win of player.
- 2) Direct win of opponent.
- 3) Double win of player.
- 4) Now if there is a double win of the opponent, then
 - a) Player places at single win which is not a loose by chance, also a Forced win to opponent and the position of newly created direct win of player is not a double win position of opponent or places at a forced win and blocking all double wins.
 - b) Places where it is able to block all double wins and is not a loose by chance or places at a single win and not a loose by chance and the position of newly created direct win of player is not a double win position of opponent or places at a forced win and blocking all double wins.
- 5) Places anywhere which does not create a forced loose of player ahead.

Results

In this section we will briefly describe two board situations of Tic Tac Toe.

1) Give the starting board: 253

Possibility 1:

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DRAW

Possibility 2:

		X	X
		O	

O		X	X
		O	

O		X	X
		O	
			X

O		X	X
		O	O
			X

O		X	X
X		O	O
			X

O		X	X
X		O	O
O			X

O		X	X
X		O	O
O		X	X

DRAW

2)Give the starting board: 384

			X
X			
		O	

Now, 'O' can avoid its lose only by playing at 5. In all other cases, 'X' can force a win. So, the next optimal move for 'O' will be 5. The game will result in a draw if after this situation both players play optimally.

3)Give the starting board: 174

Initial state was not optimal.

Possibility 1:

X	X	X
-----	-----	-----
X	X	X
-----	-----	-----
O	O O	O O X
-----	-----	-----
X	X X	X O X
-----	-----	-----
X O	X O	X O
-----	-----	-----
O O X	O O X	O O X

WIN

Possibility 2:

X	X	X
-----	-----	-----
X	X	X
-----	-----	-----
O	O O	O O X

X			

X		O	

O		O	

		X	

X		X	

X		O	

O		O	

		X	

X		X		O

X		O		

O		O		X

WIN

Possibility 3:

X			

X			

O			

X			

X			

O			

		O	

X			

X			

O		X	

		O	

X				O

X				

O		X		O

X				O

X				X

O		X		O

X				O

X		O		X

O		X		O

WIN

Possibility 4:

X			

X			

O			

X			

X			

O			

		O	

X			

X			

O		X	

		O	

X				O

X				

O		X		O

X				O

X		X		

O		X		O

X				O

X		X		O

O		X		O

WIN

Conclusion

The Program takes input in the form of a long integer of 9 digits from 1-9 where 1-9 are the cells played by the players alternatively. Given a board configuration as an input if the configuration was arrived at through an optimal sequence of moves then program displays the outputs of all possible sequence of moves that results in draw. If the given board configuration was not arrived at by playing optimally then the program outputs all possible sequences that result in either a win or loss for either of the players.