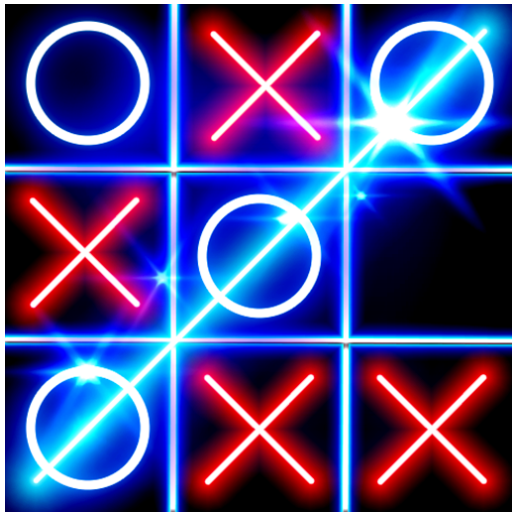
TIC-TAC-TOE GAME USING TURING MACHINE

Can Duyar - 171044075
Canberk Arıcı - 171044062
Kamil Kaya - 1801042082
Ahmet Yusuf Erdoğan - 1801042654

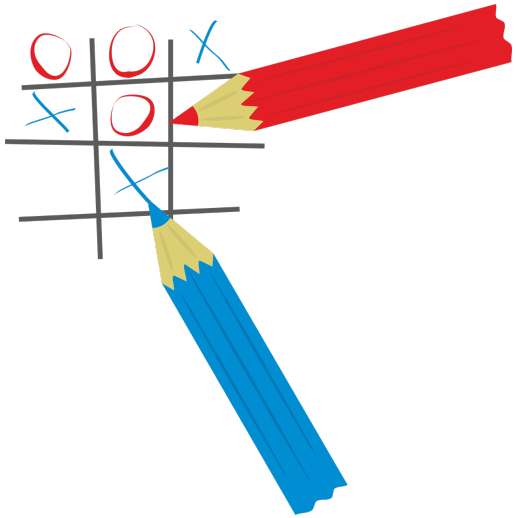
Advisor: Assist. Prof. Zafeirakis Zafeirakopoulos

TIC-TAC-TOE GAME



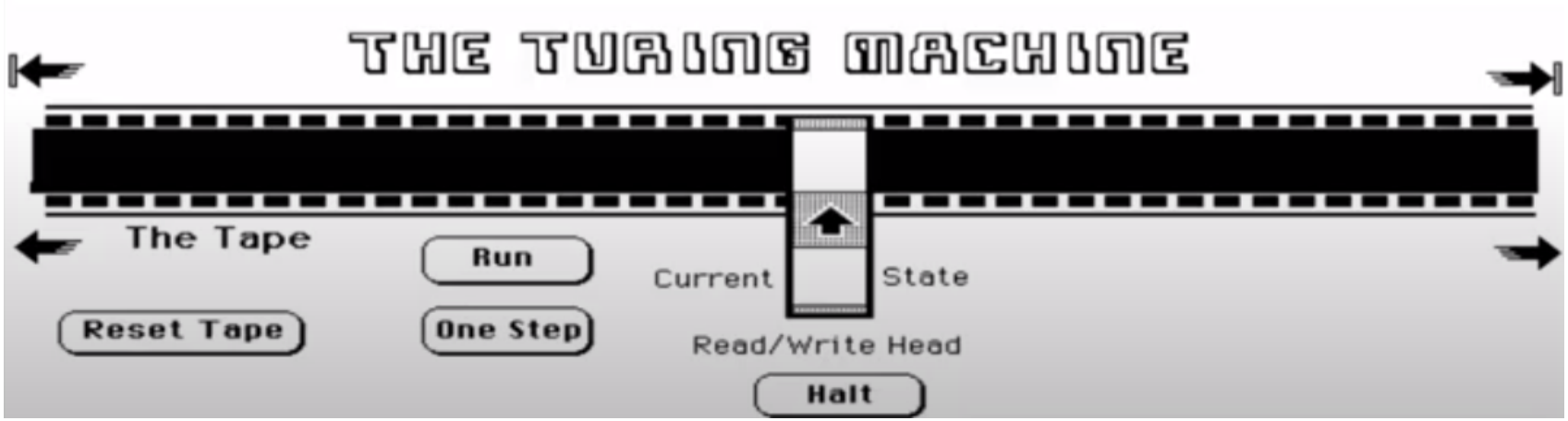
Tic-Tac-Toe (also called Noughts and Crosses) is a very simple game in which two players alternately put Xs and Os in compartments of a figure formed by two vertical lines crossing two horizontal lines. Each player tries to get a row of three Xs or three Os before the opponent does.

RULES FOR TIC-TAC-TOE



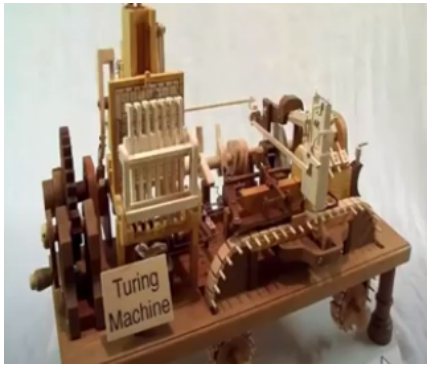
- The game is played on a grid that's 3 squares by 3 squares.
- First player is X, second player is O. Players take turns putting their marks in empty squares.
- The first player to get 3 of her marks in a row (up, down, across, or diagonally) is the winner.
- When all 9 squares are full, the game is over. If no player has 3 marks in a row, the game ends in a draw.

WHAT IS TURING MACHINE?



A Turing Machine is a mathematical model that defines an abstract machine that manipulates symbols on a strip of tape according to a set of rules. Despite the model's simplicity, a Turing machine can be built to simulate the logic of any computer method.

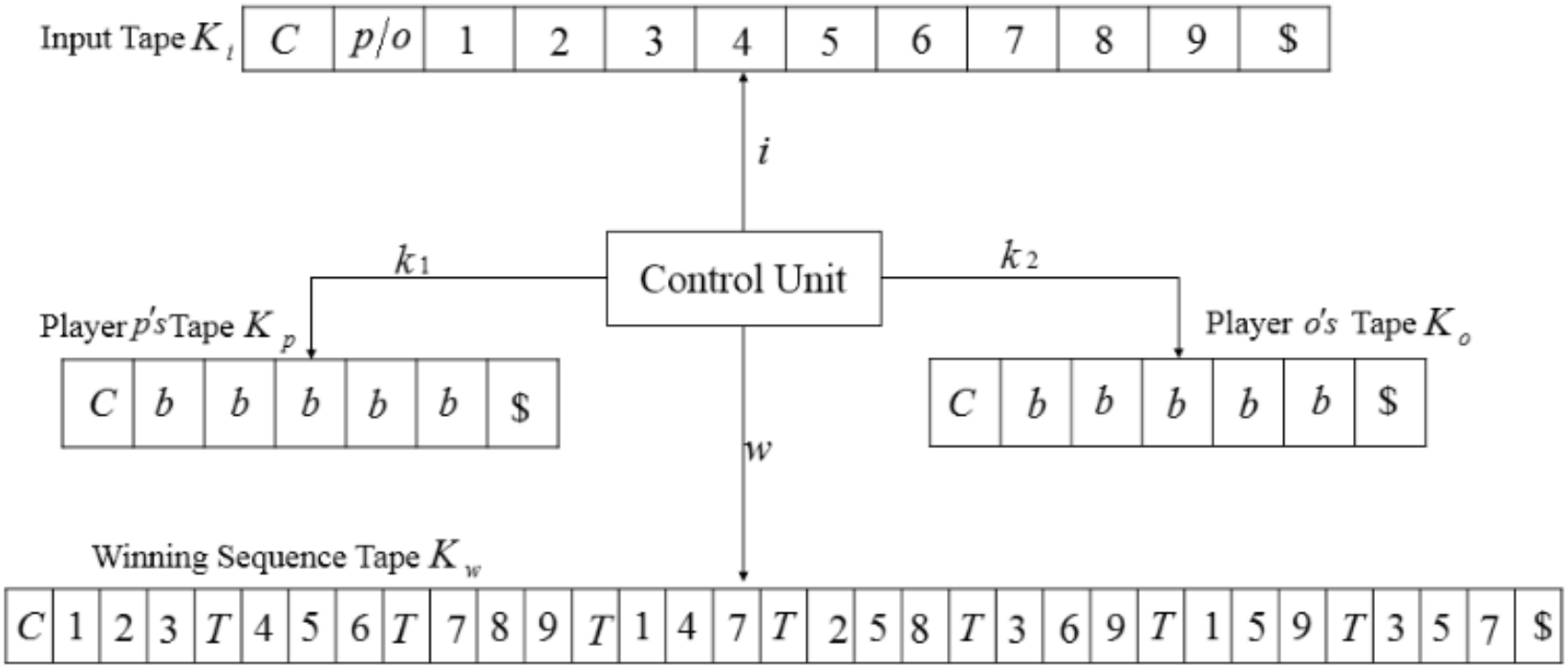
Tic-Tac-Toe Game with Turing Machine



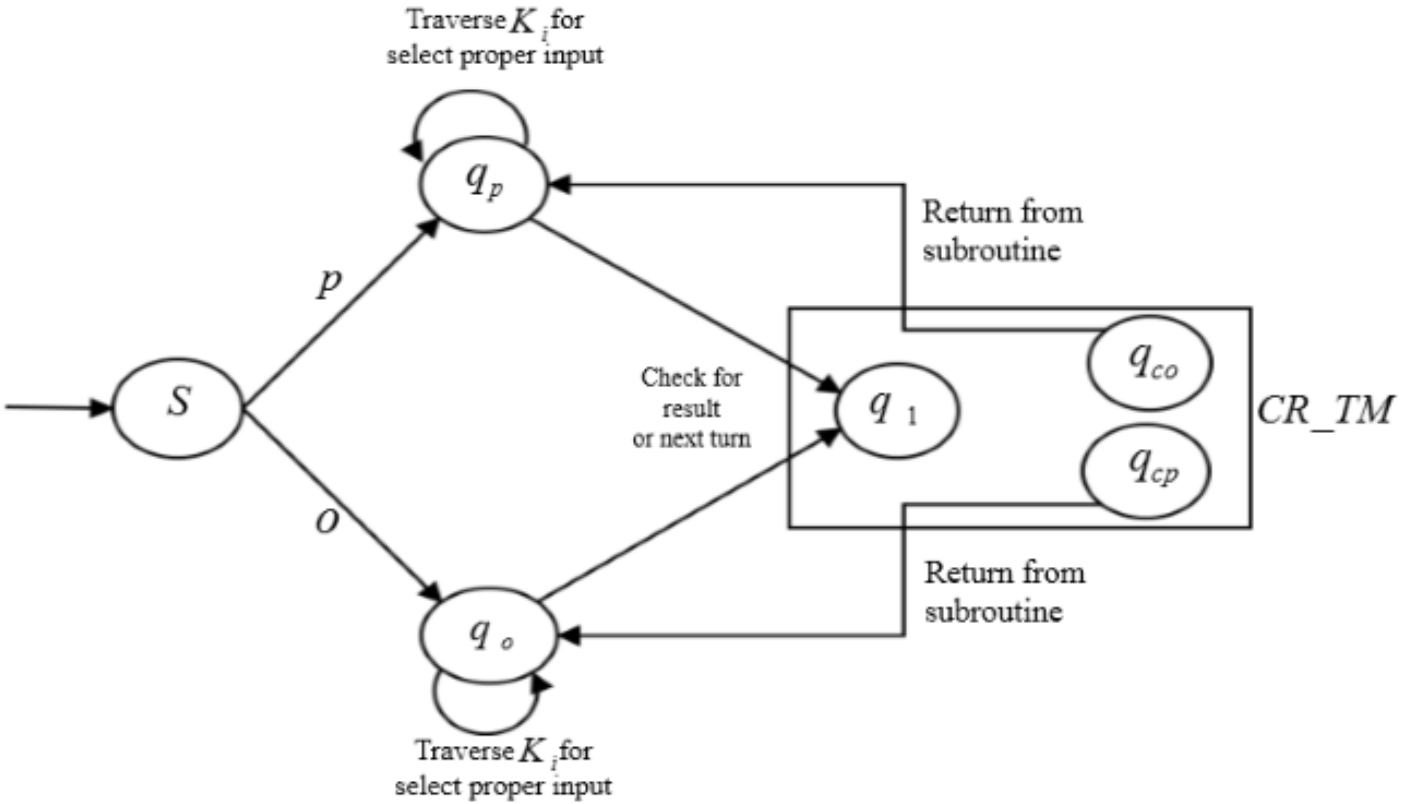
We used a 4-tape Turing Machine model for modelling the TIC-TAC-TOE game. We defined the uses of various tapes as follows:

- TAPE 1: Input tape as a board.
- TAPE 2: It is made up of player 1's input.
- TAPE 3: It is made up of player 2's input.
- TAPE 4: This is the primary working tape, and it contains the locations of both the 'X' and 'O' players.

DESIGN OF THE TURING MACHINE

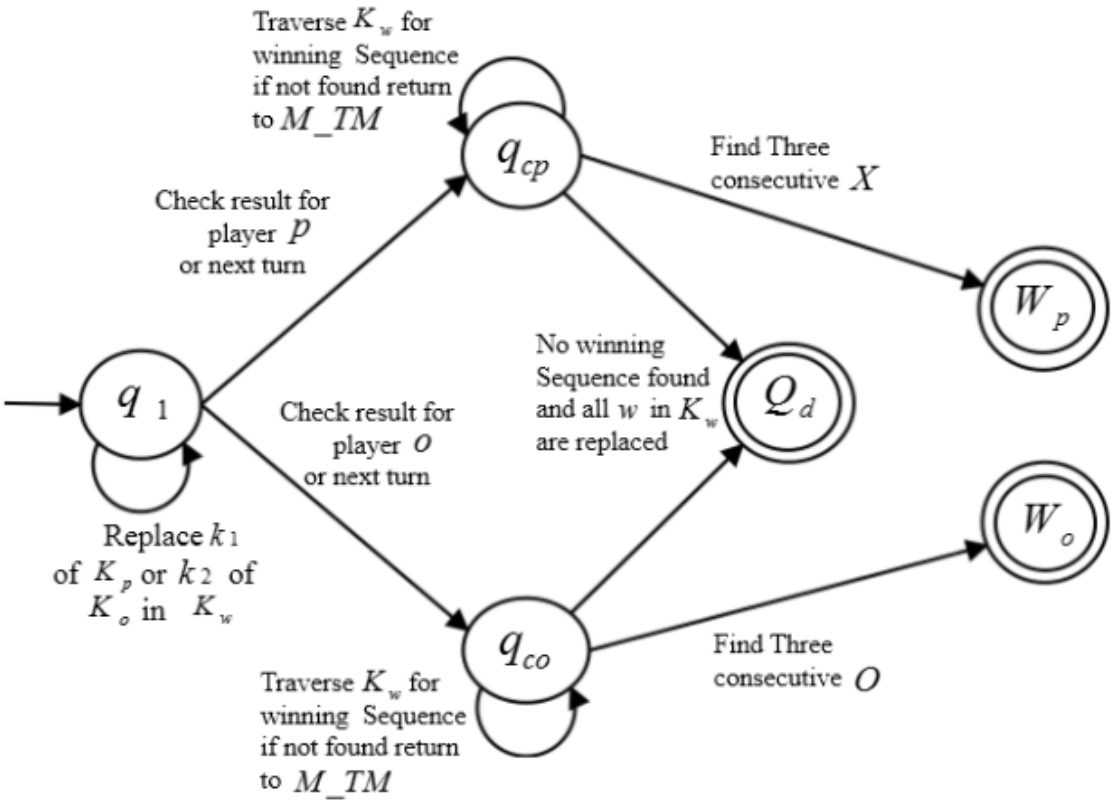


DESIGN OF THE TURING MACHINE



Transition Diagram for M _TM

DESIGN OF THE TURING MACHINE



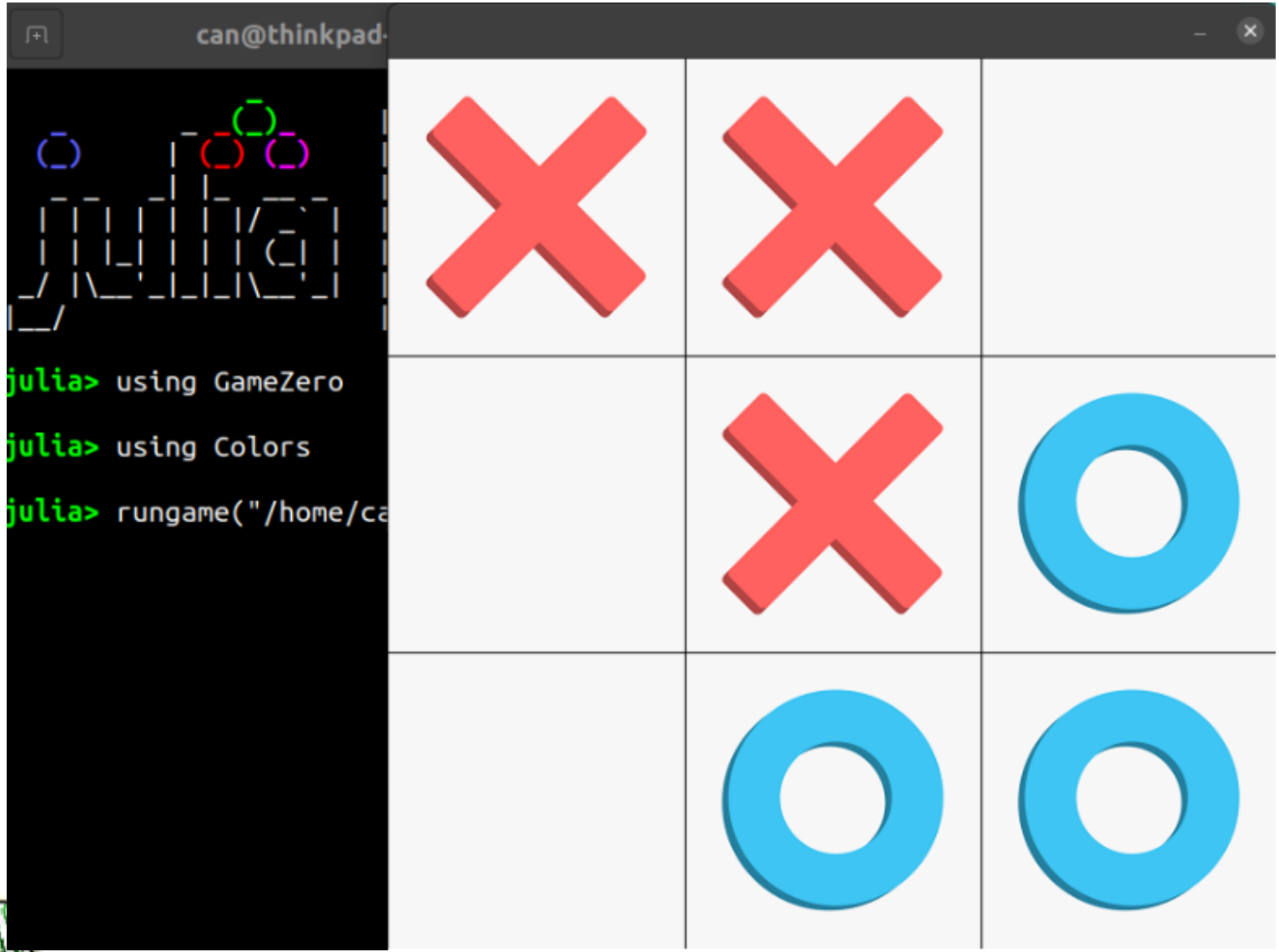
Transition Diagram for CR _TM

A player can play a perfect game of Tic-tac-toe (to win or, at least, draw) if they choose the first available move from the following list, each turn:

- **Win:** If you have two in a row, play the third to get three in a row.
- **Block:** If the opponent has two in a row, play the third to block them.
- **Fork:** Create an opportunity where you can win in two ways.

- **Block Opponent's Fork:**
  Option 1: Create two in a row to force the opponent into defending, as long as it doesn't result in them creating a fork or winning. For example, if "X" has a corner, "O" has the center, and "X" has the opposite corner as well, "O" must not play a corner in order to win. (Playing a corner in this scenario creates a fork for "X" to win.)
  Option 2: If there is a configuration where the opponent can fork, block that fork.
- **Center:** Play the center.
- **Opposite Corner:** If the opponent is in the corner, play the opposite corner.
- **Empty Corner:** Play an empty corner.
- **Empty Side:** Play an empty side.

Interface of the Tic-Tac-Toe Game



References I

- Sneha Garg and Dalpat Songara, *The winner decision model of tic tac toe game by using multi-tape turing machine*, 573–579.
- Sneh Lata Garg, Dalpat Songara, and Saurabh Maheshwari, *The winning strategy of tic tac toe game model by using theoretical computer science*, 2017 International Conference on Computer, Communications and Electronics (Comptelix) (2017), 89–95.
- Pranjal Singh and Kartik Singh, *Simulate tic-tac-toe using tm*.
- Paul Vitányi, *Turing machines*, CoRR **abs/1201.1223** (2012).