INFO 6205 Spring 2022 Project

Menace

GitHub Link: https://github.com/revanth606/INFO6205_Final_Project_Tic_Tac_Toe

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Introduction:

- **Aim**:
    - Implement the MENACE by replacing the matchboxes with the values in a hashtable with a key as the state of the game.
    - Train the menace by choosing values for:
        - alpha: at the start of the game for first, second, or different moves
        - beta: in the event of a win
        - gamma: in the event of a loss
        - delta: in the event of a draw
        - Probability with which human implements human strategy
    - Implement the human strategy to play with Menace:
        - Win
        - Block
        - Fork
        - Block Fork
        - Center
        - Opposite corner
        - Empty Corner
        - Empty side
    - Play trained menace against human strategy with different probability and log the results.
    - Implement Logging
    - Unit tests

INFO 6205 Spring 2022 Project

Menace

- **Approach**:
    - After finalizing the values, Menace is trained against human strategy for 10000 matches.
    - Everytime menace faces a new state, a key is created with a list of all possible moves by menace as the value.
    - For every match all the states and moves by menace are tracked.
    - After each match the map for menace is updated by taking beta, gamma, delta values and the list containing match moves is reset.
    - The trained menace is played against human strategy with 0.9 probability for a total of 100 matches and results are logged.
    - Observations are made on different parameters for different runs.

INFO 6205 Spring 2022 Project

Menace

Program:

- Data Structures and Classes:
    - Session (Class):
        - Train (Method) - Trains menace by taking all the inputs
        - Play (Method) - Uses the trained menace with all the inputs
        - Menace (Object)
        - Human(Object)
    - Round (Class):
        - Start (Method) - Starts a new game till it ends and returns a value based on the winning party or draw
        - Checkwin (Method) - checks the win conditions
        - Chooserandom (Method) - chooses a random position in all possible positions for human
        - convertBoardtoString (Method) - converts the 2D array format of current state of game to string to make it easier to store it as key in the map
        - curBoard (Method) - logs current state of the game.
        - Board (Object) - 2D array by using which the game runs
        - Menace (Object) - Gets the menace from session class
        - Human (Object) - Gets the human object from session class.
    - Menace (Class):
        - CreateKey (Method) - creates key with a list of all possible values when the map encounters a new state.
        - Turn (Method) - Takes in current state of the game as string and returns a int which represents where the next move is to placed.
        - UpdateMap - updates map after the match is completed depending on the result of the map
        - botBoards (Map) - contains states in string format as keys and list of next possible moves as value for that state
        - curString (List) - stores all the current states the menace encounters during a match and which is reseted at the end of the match
        - curPlaces (List) - stores all the current moves the menace encounters during a match and which is reseted at the end of the match
    - Human (Class):
        - Turn (Method) - takes in current state of the game as string and return a integer based on the optimal human strategy

INFO 6205 Spring 2022 Project

Menace

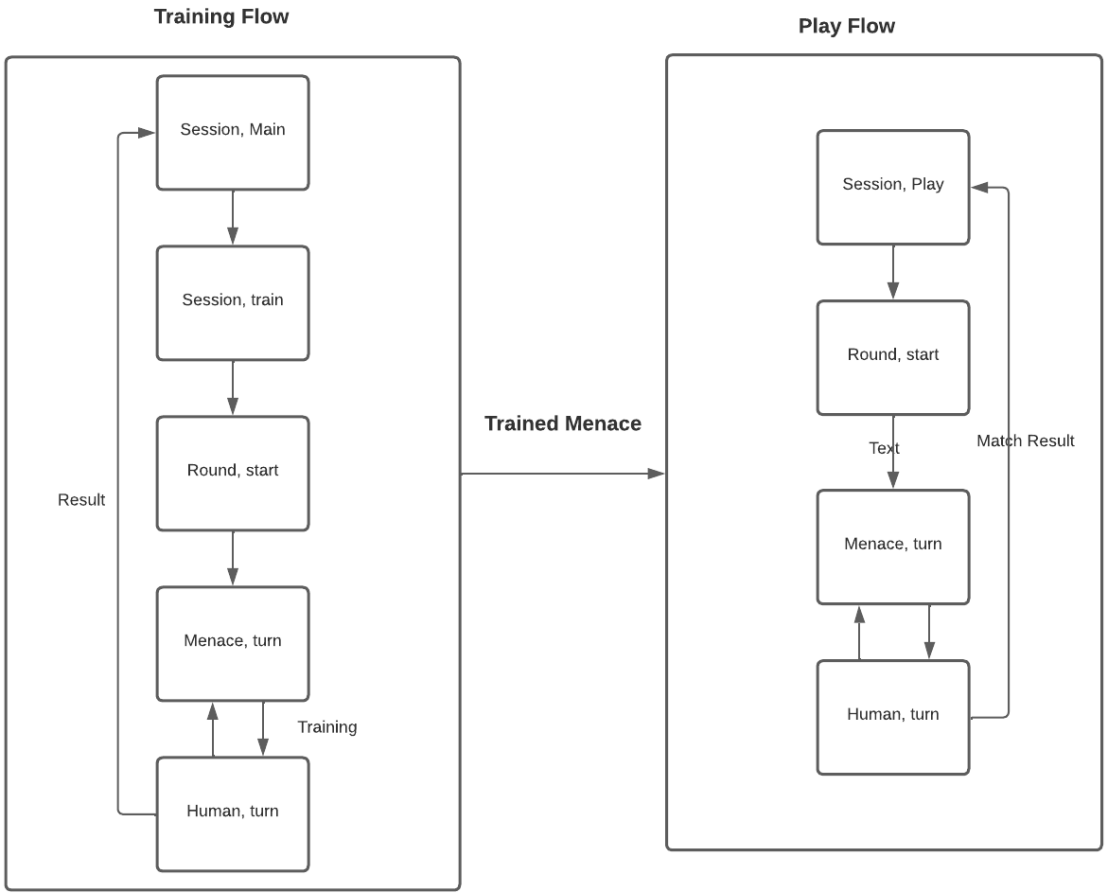
- Checkwin (Method) - takes the current game and return a integer value after checking the match win condition
- convertStringtoBoard (Method) - takes in current state of the game as string and converts it to 2D array
- Board (2D array) - stores the current state of the game

- **Algorithm:**
  - Initiates a menace with alpha value.
  - Start a game by initiating an empty board with zero as an empty cell. Menace places 1 and human places 2 based on their turn logic.
  - Menace plays 10000 matches and updates its map automatically at the end of each match depending on the match outcome.
  - Menace plays 100 matches with human using this updated map.
  - Results are logged along each move made by the menace and human.
- **Invariants:**
  - Starting state of the game
  - Size of the board (3*3)
  - Number of players - 2
  - Three integers forming a line horizontally, vertically or diagonally accounts for a win.
  - None of the player winning and no place to mark results in draw.
  - The probability of the human strategy in final games is 0.9.

INFO 6205 Spring 2022 Project

Menace

Flow Charts:



INFO 6205 Spring 2022 Project

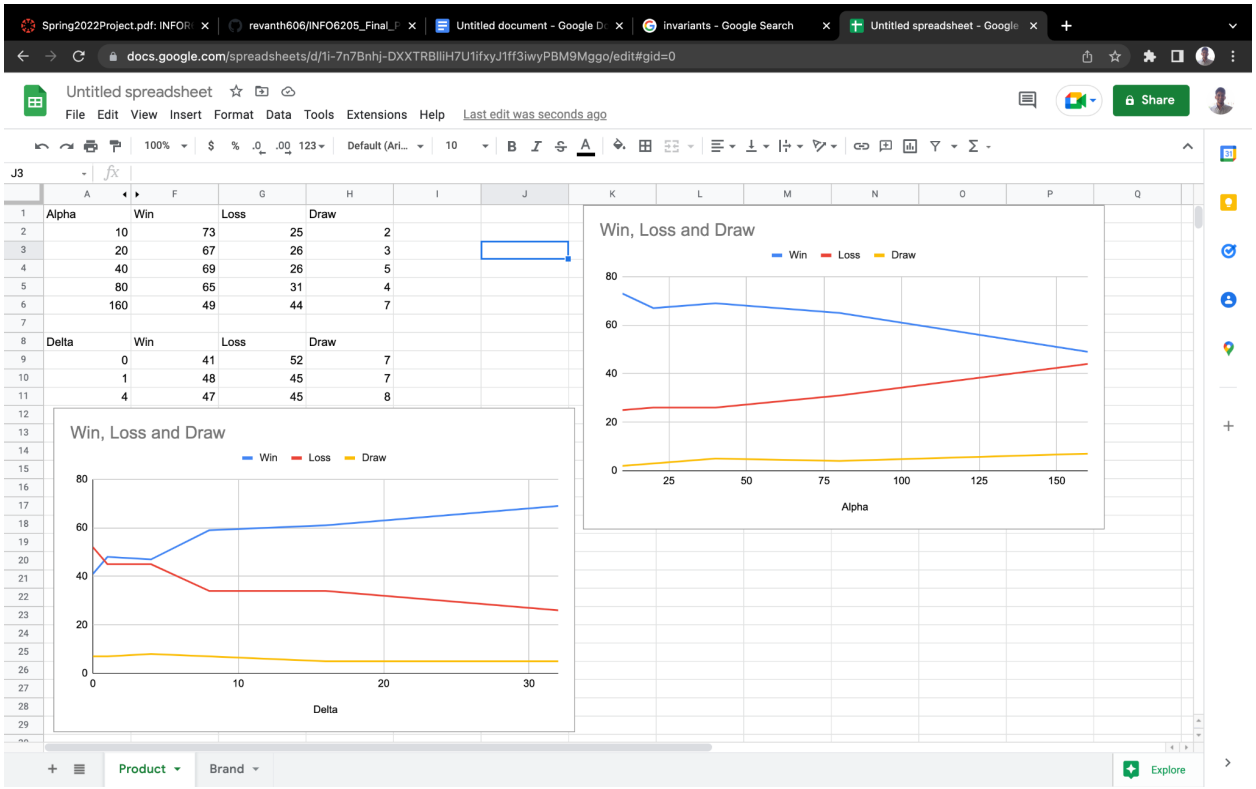
Menace

Observations & Graphical Analysis:

Alpha	Beta	Gamma	Delta	Probablity	Win	Loss	Draw
40	8	1	2	0.5	44	42	14
40	8	1	2	0.2	50	41	9
40	8	1	2	0.1	53	38	9
40	8	1	2	0.05	41	44	15
40	4	1	2	0.1	49	40	11
40	2	1	2	0.1	38	49	13
40	16	1	2	0.1	43	48	9
40	12	1	2	0.1	48	44	8
40	8	1	1	0.1	48	45	7
40	8	1	0	0.1	41	52	7
40	8	1	4	0.1	47	45	8
40	8	1	8	0.1	59	34	7
40	8	1	16	0.1	61	34	5
40	8	1	32	0.1	69	26	5
20	8	1	32	0.1	67	26	3
10	8	1	32	0.1	73	25	2
80	8	1	32	0.1	65	31	4
160	8	1	32	0.1	49	44	7
5	8	1	32	0.2	70	28	2
5	8	1	32	0.4	67	32	1
5	8	1	32	0.6	78	21	1
5	8	1	32	0.8	79	20	1
5	8	1	32	0.9	74	25	1
5	8	1	32	0.95	70	26	4
5	8	1	32	0.99	73	26	1

INFO 6205 Spring 2022 Project

Menace



Results & Mathematical Analysis:

As we can see from the graphs, the two main factors affecting the win probability of menace is the alpha and delta. The rest are affecting but not significant to the amount these two variables are affecting.

Win probability $\propto$ Delta

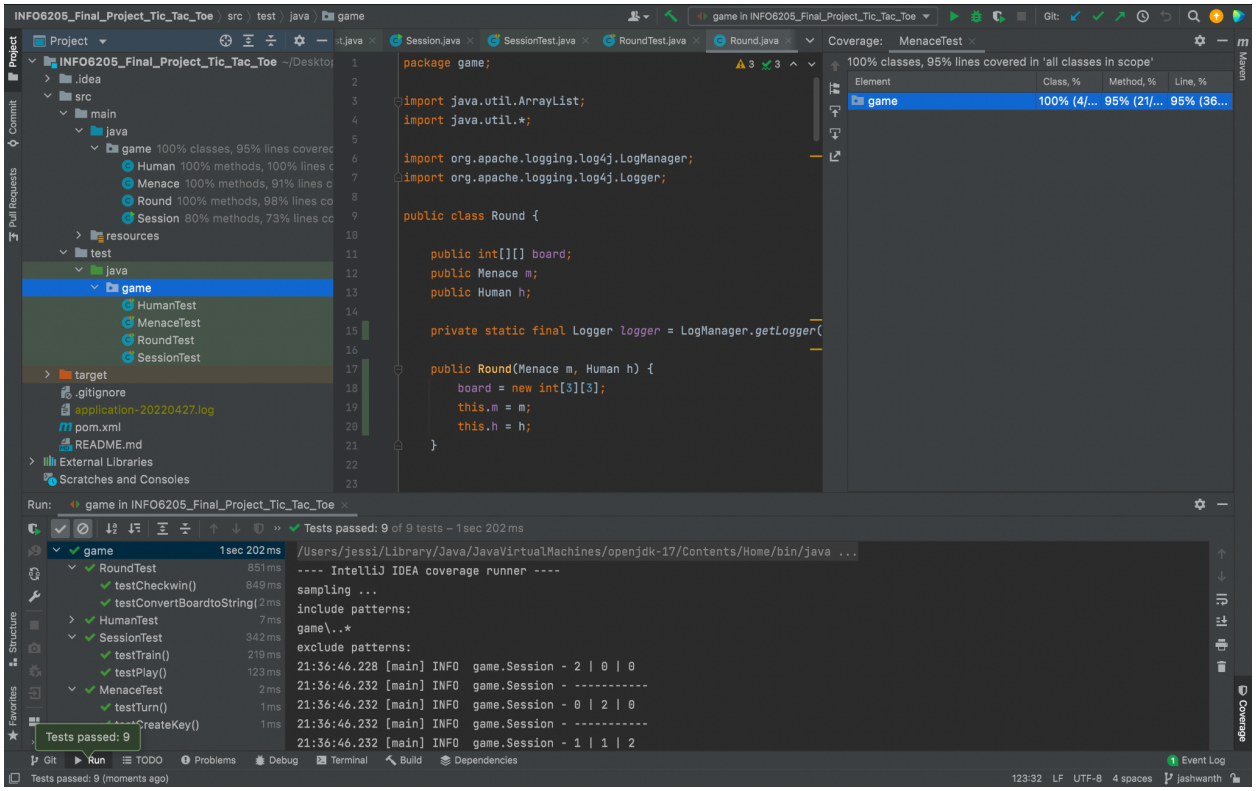
Win probability $\propto$ 1/Alpha

The win probability is capping at ~80% with delta as 32.

INFO 6205 Spring 2022 Project

Menace

Testcases: Please find below the test cases run and test case coverage report.



Conclusion:

As delta is increasing and alpha is decreasing performance of menace is improving. By punishing the menace harshly with a delta value of 32 we are getting the best results.