**CS4750-HW4 Report**

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**References:**

**Description**: Implement the minimax algorithm in Python to play a two-player, four-in-a-row game, which is a variation of tic-tac-toe: two players, X and O, take turns marking the spaces in a 6×6 grid. Player 1 The player who succeeds in placing 4 of their marks consecutively in a horizontal, vertical, or diagonal row wins the game. The heuristic function that we used for our minimax algorithm is h(n) = 5\*[# of two-side-open-3-in-a-row for me]–10\*[# of two-side-open-3-in-a-row for opponent] + 3\*[# of one-side-open-3-in-a-row for me]–6\*[# of one-side-open-3-in-a-row for opponent] + [#of open-2-in-a-row for me] - [# of open-2-in-a-row for opponent] where:

“one-side-open-3-in-a-row”: there is a blank space at one end of a 3-in-a-row.

“two-side-open-3-in-a-row”: there are blank spaces at both ends of a 3-in-a-row.

“open-2-in-a-row”: there are blank spaces at one or both ends of a 2-in-a-row.

Player 1, with symbol X, running the minimax algorithm searching in the depth of 4 moves ahead. Player 2, with symbol O, running the minimax algorithm searching in the depth of 2 moves ahead. Player 1 moves first by placing X in the middle of the board. Each player then take turn placing their symbol on the board in the location that give them the highest heuristic value after running the minimax algorithm. The result of the game is listed below

**Result:**

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AI turn [o]

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| | | x | | | |

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Total expanded nodes: 104

Execution time: 18.96 ms

AI turn [x]

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| | | x | x | | |

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Total expanded nodes: 23693

Execution time: 5219.34 ms

AI turn [o]

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| | o | x | x | | |

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Total expanded nodes: 107

Execution time: 22.29 ms

AI turn [x]

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| | o | x | x | | |

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Total expanded nodes: 21103

Execution time: 5830.1 ms

AI turn [o]

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| | o | x | x | | |

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Total expanded nodes: 210

Execution time: 48.42 ms

AI turn [x]

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| | | | x | | |

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| | o | x | x | | |

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| | | o | x | | |

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Total expanded nodes: 11102

Execution time: 3039.79 ms

AI turn [o]

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| | o | x | x | | |

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Total expanded nodes: 163

Execution time: 42.98 ms

AI turn [x]

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| | | | o | | |

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| | | x | x | | |

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| | o | x | x | | |

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| | | o | x | | |

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Total expanded nodes: 5459

Execution time: 1601.65 ms

AI turn [o]

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| | | | o | | |

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| o | | x | x | | |

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| | o | x | x | | |

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Total expanded nodes: 101

Execution time: 29.07 ms

O is the winner