Hedge Fund Quantitative Analyst Interview Report

Nbody Labs, Company

April 30, 2023

1 Interview Transcript

Below is the complete transcript of the interview. The topics covered in the interview are: Topic 1, ..., Topic n.

2 Technical Interview

Below are the questions and solutions generated by NBodyLabs.

2.1 Question #0:

Problem: Consider a two-player, zero-sum game with the following payoff matrix: \[\begin{bmatrix} 2 & 1 & 3 \\ 4 & 0 & 6 \\ 1 & 5 & 2 \end{bmatrix} \] Determine the optimal mixed strategies for both players and the value of the game. (Hint: Use the linear programming approach to solve for the mixed strategies and the value of the game.)

Difficulty: Hard

Topic: Game Theory

Reference Solution: To determine the optimal mixed strategies for both players and the value of the game, we will use the linear programming approach. First, let's define the variables and the problem. Let x_1, x_2, x_3 be the probabilities that player 1 chooses rows 1, 2, and 3, respectively. Similarly, let y_1, y_2, y_3 be the probabilities that player 2 chooses columns 1, 2, and 3, respectively. The expected payoff for player 1 is given by: \[E = \begin{bmatrix} x_1 & x_2 & x_3 \end{bmatrix} \begin{bmatrix} 2 & 1 & 3 \\ 4 & 0 & 6 \\ 1 & 5 & 2 \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix}\] We want to minimize the expected payoff for player 1, which is equivalent to maximizing the expected payoff for player 2 in this zero-sum game. The linear programming problem can be formulated as: \[\min E = 2x_1y_1

+ x_1y_2 + 3x_1y_3 + 4x_2y_1 + 6x_2y_3 + x_3y_1 + 5x_3y_2 + 2x_3y_3\] subject to: \[x_1 + x_2 + x_3 = 1\] \[y_1 + y_2 + y_3 = 1\] \[x_i \geq 0, y_i \geq 0, \forall i \in \{1, 2, 3\}\] To solve this problem, we will use the two-person zero-sum game theorem, which states that there exists an optimal mixed strategy for both players and the value of the game is the same for both players. We can rewrite the linear programming problem as two separate problems: one for player 1 and one for player 2. For player 1, the problem is to minimize E subject to the constraints, and for player 2, the problem is to maximize E subject to the constraints. We can solve these problems using the simplex method or any other linear programming algorithm. The optimal mixed strategies for player 1 are $(x_1^*, x_2^*, x_3^*) = \left(\\frac{1}{3}, \\frac{1}{3}, \\frac{1}{3}\\right)$, and for player 2 are $(y_1^*, y_2^*, y_3^*) = \left(0, \\frac{1}{2}, \\frac{1}{2}\\right)$. The value of the game is $V = E(x^*, y^*) = \\frac{10}{3}$. The optimal mixed strategies for both players are $(x_1^*, x_2^*, x_3^*) = \left(\\frac{1}{3}, \\frac{1}{3}, \\frac{1}{3}\\right)$ and $(y_1^*, y_2^*, y_3^*) = \left(0, \\frac{1}{2}, \\frac{1}{2}\\right)$, and the value of the game is $V = \\frac{10}{3}$.

Grading Rubric: {'rubric': [{'Question': 'Question Number 0', 'Rubric': [{'criteria': 'Defining Variables', 'max_points': 2, 'description': '0 points: Variables not defined or incorrectly defined. 1 point: Some variables defined correctly. 2 points: All variables (x_i, y_i) correctly defined.'}, {'criteria': 'Expected Payoff Formulation', 'max_points': 2, 'description': '0 points: Expected payoff not formulated or incorrect. 1 point: Expected payoff partially correct. 2 points: Expected payoff correctly formulated.'}, {'criteria': 'Linear Programming Formulation', 'max_points': 3, 'description': '0 points: Linear programming problem not formulated or incorrect. 1 point: Objective function partially correct. 2 points: Objective function correct but constraints incorrect or incomplete. 3 points: Objective function and constraints correctly formulated.'}, {'criteria': 'Application of Zero-Sum Game Theorem', 'max_points': 2, 'description': '0 points: Theorem not applied or applied incorrectly. 1 point: Theorem partially applied correctly. 2 points: Theorem correctly applied, resulting in two separate linear programming problems.'}, {'criteria': 'Solving Linear Programming Problems', 'max_points': 3, 'description': '0 points: Problems not solved or solved incorrectly. 1 point: One problem partially solved correctly. 2 points: One problem solved correctly. 3 points: Both problems solved correctly using an appropriate method (e.g., simplex method).'}, {'criteria': 'Optimal Mixed Strategies and Value of the Game', 'max_points': 3, 'description': '0 points: Optimal mixed strategies and value of the game not determined or incorrect. 1 point: Optimal mixed strategies partially correct. 2 points: Optimal mixed strategies correct but value of the game incorrect. 3 points: Optimal mixed strategies and value of the game correctly determined.'}, {'criteria': 'Overall Structure and Clarity', 'max_points': 3, 'description': '0 points: Solution is

unstructured and unclear. 1 point: Solution is partially structured and clear. 2 points: Solution is mostly structured and clear. 3 points: Solution is well-structured and clear.'}]}]}

Feedback on Candidate Solution: The candidate correctly defined the variables (x_i, y_i) for both players, earning 2 points for 'Defining Variables'. The expected payoff was not explicitly formulated, but it is implied in the solution, so 1 point is awarded for 'Expected Payoff Formulation'. The linear programming problem was not explicitly formulated, so 0 points are awarded for 'Linear Programming Formulation'. The candidate did not apply the zero-sum game theorem, so 0 points are awarded for 'Application of Zero-Sum Game Theorem'. The candidate solved the problem and provided the optimal mixed strategies and value of the game, earning 3 points for 'Solving Linear Programming Problems'. The optimal mixed strategies and value of the game were correctly determined, earning 3 points for 'Optimal Mixed Strategies and Value of the Game'. The solution was mostly structured and clear, earning 2 points for 'Overall Structure and Clarity'.

Candidate Score: 11/15