



**NANYANG  
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**SINGAPORE**

INTELLIGENT AGENTS ASSIGNMENT 2  
THREE PRISONERS DILEMMA

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## AGENT DESIGN

The agent used for this assignment uses a combination of two strategies, namely, Simple Majority and Expected Utility strategy, which we can call the “Hybrid” strategy. All these three strategies are explained below followed by how our agent uses these strategies.

### SIMPLE MAJORITY

In this strategy, the actions of the agent are decided based on the actions that the agent predicts its opponents will perform in the next round. If an opponent has performed both actions equally in all the previous rounds, the agent predicts that the opponent will defect in the next round. For all other cases, the agent predicts that the opponent will perform the action that it has performed for majority of the previous rounds. The agent then selects the action that will maximize its payoff if its opponents perform the actions predicted by the agent.

### EXPECTED UTILITY

In this strategy, the agent calculates the expected utility for both of the possible actions it can perform and then performs the action that maximizes its expected utility. In order to find the expected utility of its actions, the agent first finds the probability of each of its opponents for performing each of their actions based on how often that action was performed by the opponent in the previous rounds. After finding these probabilities, the expected utility gained by the agent for an action  $i$  is calculated as follows:

$$EU(i) = \sum_{j=0}^1 \sum_{k=0}^1 P_1(j)P_2(k)payoff[i][j][k]$$

$EU(i)$ : Expected Utility of performing action  $i$

$P_1(j)$ : Probability that opponent 1 performs action  $j$

$P_2(k)$ : Probability that opponent 2 performs action  $k$

$payoff[i][j][k]$ : Payoff gained by the agent if agent performs action  $i$ , opponent 1 performs action  $j$  and opponent 2 performs action  $k$

### HYBRID STRATEGY

The agent uses either Simple Majority or Expected Utility strategy based on how well it is currently performing in the match. In order to evaluate how well its performing so far, it calculates its score and its opponents' scores using the knowledge of the actions taken by them during the previous rounds. The agent then decides the strategy to follow based on its current standing in the match. If the agent has the least score, it decides its next action using the Expected Utility strategy. In other cases, it uses Simple Majority strategy to decide its next action. This was generally found to work better than the other case, wherein the Simple Majority strategy is used if the agent has the least score and the Expected Utility strategy otherwise. This might be due to the fact that Simple Majority strategy tends to be a safer strategy since it predicts the actions that the opponents have performed for the majority of their previous rounds and selects the agent's action accordingly. On the other hand, Expected Utility strategy tends to be a bit more risky since it might not always select the action that maximizes the payoff if the opponents perform the actions that they have performed for the majority of their previous rounds.

However, if and when it works, the payoff can be quite high as the expected utility is high. As a result, this strategy ensures that if the agent has the least score, it is willing to take a few risks in order to bridge the gap between itself and its opponents and plays relatively safe in all the other cases in order to avoid going down in the standings, which seems like a reasonable approach.

### AGENT'S STRATEGY

The agent first finds the majority of the actions performed by its opponents in the previous rounds. We have 3 possibilities:

1. Both opponents have mostly co-operated: The agent chooses to co-operate.
2. Both opponents have mostly defected: The agent chooses to defect.
3. One opponent has mostly co-operated and another opponent has mostly defected: The agent uses the Hybrid Strategy.

## AGENT EVALUATION

The Simple Majority strategy, Expected Utility strategy, Hybrid strategy and our agent's strategy were evaluated by competing those strategies with each other and with other example strategies provided. Multiple sets of 5 tournaments were conducted with each set having different participants and the average scores of each participant in a set of tournaments were calculated.

### SET 1

PARTICIPANT	AVERAGE SET SCORE
Mundhra_Shreyas_Sudhir_Player	41.939377
ExpectedUtilityPlayer	30.183035
SimpleMajorityPlayer	30.181858
HybridPlayer	30.180386

### SET 2

PARTICIPANT	AVERAGE SET SCORE
Mundhra_Shreyas_Sudhir_Player	244.47713
TolerantPlayer	239.44914
T4TPlayer	233.73862
ExpectedUtilityPlayer	221.06783
NastyPlayer	217.27888
SimpleMajorityPlayer	217.17569
HybridPlayer	216.65164
FreakyPlayer	210.52547
RandomPlayer	198.71378
NicePlayer	193.49496

**SET 3**

PARTICIPANT	AVERAGE SET SCORE
Mundhra_Shreyas_Sudhir_Player	170.77707
TolerantPlayer	165.14651
T4TPlayer	159.58153
NicePlayer	156.46846
FreakyPlayer	146.67953
RandomPlayer	144.96281
NastyPlayer	140.96577

As we can see, our agent has the highest average score for all the three sets of tournaments that were conducted.