Prelab 6 Prisoner's Dilemma

This is a preview of the published version of the quiz

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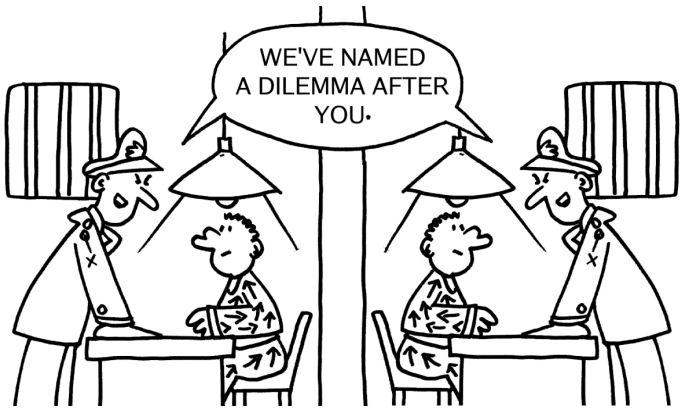
Quiz Instructions



Consider the following scenario: you and your partner just robbed a bank and eventually got picked up by the police. During interrogation, they split you and your partner up into separate rooms. Not knowing what your partner is telling them, you have to decide between: (1) confess and try to leverage a shorter sentence, even if the information you volunteer might increase your partner's sentence, and (2) stay quiet and hope your partner doesn't say anything either, banking on the fact that without your confessions, the police won't be able to prosecute. What do you do? How do you decide?

Prisoner's Dilemma

This scenario is known as the "prisoner's dilemma," which highlights a classic example in game theory. Game theory takes a set of rules, and players, and allocates consequences for these players based on their actions. A strategy is the set of actions that a player makes during the course of a game. Players may receive "payoffs" based on their performance, which tracks how well they are doing in the game. The "best" strategy at any given time depends on what everyone else is doing.

Table 1	PARTNER		
		Cooperate	**Defect**
ME	**Cooperate**	2 years	5 years
	Defect	0 years	4 years

The prisoner's dilemma has the payoff structure given above (Table 1), which shows what you ("ME") gets as payoff for a particular scenario. Likewise, you can determine what payoff your partner will receive by swapping "ME" and "PARTNER" in the table above. Here, your payoff is defined as the years of your sentence that you must serve, which depends on what you and your partner did. The "best" score a player could receive would be zero. According to this table, there are four options:

- **Cooperate/Cooperate:** If you decide to cooperate, and keep your mouth shut, and your partner does the same, then you both end up getting a 2 years sentence.
- **Cooperate/Defect:** If you decide to cooperate, but your partner decides to defect, then you end up getting a harder sentence of 5 years because the police have a better case against you. Conversely, your partner gets no sentence (0 years) because of their confession.
- **Defect/Cooperate:** If you decide to defect, and your partner decides to cooperate, then you get off without a sentence while your partner gets 5 years.
- **Defect/Defect:** If you decide to defect, and your partner also decides to defect, then you both confess information about the other and so both of you get a 4 years sentence.

Question 1 1 pts

Consider yourself in a prisoner's dilemma scenario. You decide to cooperate and your partner decides to defect. Using the payoff structure from Table 1:

What is your sentence? _____ years

What is your partner's sentence? _____ years

Iterative Prisoner's Dilemma

Things become even more interesting when we consider this scenario more generally. What happens if two players play multiple games against each other? How will that affect things? Let's consider a the strategy TIT-FOR-TAT, in which the player does the action that their opponent did in the last round. For example, if their opponent chose DEFECT in the previous round, then a TIT-FOR-TAT player will DEFECT this round. We also have the RANDOM strategy, which does something randomly (Cooperate or Defect) at each round:

Table 2	Player 1	Player 2
	RANDOM	**TIT-FOR-TAT**
Round 1	DEFECT	COOPERATE
Round 2	DEFECT	DEFECT
Round 3	COOPERATE	DEFECT
Round 4	DEFECT	COOPERATE
Round 5	COOPERATE	DEFECT
Round 6	DEFECT	COOPERATE

Round 7	DEFECT	DEFECT
Round 8	COOPERATE	DEFECT
Round 9	DEFECT	COOPERATE
Round 10	DEFECT	DEFECT

As before, we can calculate payoffs for both players but now we have to add up the payoffs from each round.

Question 2 1 pts

Using the payoff structure from Table 1, what is the payoff score for the TIT-FOR-TAT player (Player 2) after round 10?

- 0 years
- 5 years
- 13 years
- 27 years
- 34 years

Question 3 1 pts

Calculate the payoff score for Player 1, the RANDOM player. At the end of the 10th round, which player "wins" by having the lowest prison sentence?

- Player 1: RANDOM
- Player 2: TIT-FOR-TAT

Question 4 1 pts

What will the RANDOM player do in round 11? [Select]

What will the TIT-FOR-TAT player do in round 11? [Select]

Prisoner's Dilemma Strategies

Let's write the previous scenario in a different way, where each strategy is given as a list of characters, and each character represents what to do for each round of the game. For example, we could write 10 Cs (CCCCCCCCCC), which would represent a player who cooperates for all 10 rounds of the game.

So far we have learned four strategies:

Strategy	Character	How the strategy is enacted
RANDOM	R	Randomly choose between DEFECT and COOPERATE
DEFECT	D	No matter what, choose to DEFECT
COOPERATE	C	No matter what, choose to COOPERATE
TIT-FOR-TAT	T	Match what your partner did in the previous round; If my opponent from the previous round cooperated with me, COOPERATE this round. If my opponent from the previous round defected against me, DEFECT this round. If this is the first round, COOPERATE.

We can write the scenario in Table 2 like this:

Player 1: DDCDCDDCDD

Player 2: CDDCDCDDCD

However, this is deterministic, and therefore doesn't capture the fact that both players were enacting a particular strategy that just happened to lead to the outcome above. For example, it is not possible in advance to determine what the RANDOM player will do in any round. Additionally, when there are multiple players, it is not possible to know in advance who will be paired with who.

In the previous questions, while both players chose either COOPERATE or DEFECT in each round, both players performed the same strategy each time: the TIT-FOR-TAT player always performed what their opponent did in the previous round, and the RANDOM player always randomly choses between DEFECT and COOPERATE. Therefore, if we were to write out their strategies for each round, it would simply look like:

Player 1: RRRRRRRRRR

Player 2: TTTTTTTTTT

This format of writing strategies is stochastic, or randomly determined, because we do not know in advance what Player 1 (the RANDOM player) will do, and thus we do not know in advance how Player 2 (the TIT-FOR-TAT player) will react. The only way to figure this out is to run the game forward and iteratively determine what happens in each round.

Question 5 1 pts

Let's consider a new scenario with two players using multiple strategies:

Player 1: RCCCTDTCTC

Player 2: CTDCDTTCTC

Assuming that Player 1 randomly chooses to DEFECT in the first round. Using Table 1, what payoffs score does Player 1 have after all ten rounds?

Question 6 1 pts

What payoffs score does Player 2 have after all ten rounds?

In 1980, Robert Axelrod set up a tournament and asked people from around the world to contribute their strategies to the prisoner's dilemma tournament. Let's learn some more advanced strategies that were submitted for that tournament:

Table 3

Strategy	Character	How the strategy is enacted
RANDOM	R	Randomly choose between DEFECT and COOPERATE
DEFECT	D	No matter what, choose to DEFECT
COOPERATE	C	No matter what, choose to COOPERATE
TIT-FOR-TAT	T	Match what your partner did in the previous round; If my opponent from the previous round cooperated with me, COOPERATE this round. If my opponent from the previous round defected against me, DEFECT this round. If this is the first round, COOPERATE.
TIT-FOR-TWO-TATS	W	This is a forgiving strategy that defects only when the opponent has defected twice in a row. If my opponent from both of the two previous rounds defected against me, DEFECT this round. Otherwise, COOPERATE. If this is the first round, COOPERATE.
TWO-TITS-FOR-TAT	A	This strategy, on the other hand, is a strategy that punishes every defection with two of its own. If my opponent from either of the previous two rounds defected against me, DEFECT this round. If this is the first round, COOPERATE.
REVERSE TIT-FOR-TAT	V	Do the opposite of whatever your opponent did in the previous round. If my opponent from the previous round cooperated with me, DEFECT this round. If my opponent from the previous round defected against me, COOPERATE this round. If this is the first round, DEFECT.
GRIM	G	If my opponent defected at any point during our interaction, DEFECT this round.
SOFT-MAJORITY	S	If the total number of times that my opponent has cooperated with me exceeds the number of times that they defected, COOPERATE this round.
HARD-MAJORITY	K	SOFT-MAJORITY S If the total number of times that my opponent has defected with me exceeds the number of times that they cooperated, DEFECT this round.
HANDSHAKE	H	If my opponent opens the first round with DEFECT, the second with COOPERATE, and the third with DEFECT (DCD is the handshake, or signal of friendliness to other players), they are considered a friend and COOPERATE from this round on.

So, what strategy would you implement if you were playing in a tournament?

Question 7 1 pts

First things first, come up with a name for your strategy! What is the (unique) name of your strategy?

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Question 8 3 pts

Finally, what is your strategy? Try to pick a good strategy because we are going to put them all to the test in a class-wide tournament! In this tournament, every player will play a 10-round prisoner's dilemma game against every other player. The "winning" player is the one with the **lowest** payoff score at the end, which represents the shortest prison sentence.

Your strategy should have 10 characters and look something like this: XXXXXXXXXX. However, instead of Xs, fill in each character with one taken from Table 3. Whatever character you place in the first slot will represent the strategy you implement in the first round of the game. For example, if you put D in the first slot (DXXXXXXXXX) and everyone else puts C in the first slot (CXXXXXXXXX) then during the first round of the tournament, you are guaranteed to win by earning a payoff of zero while everyone else gets 5 years. However, things are more complicated than this because you don't know what everyone else will be doing!

Please enter your strategy here:

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