The classical prisoner's dilemma

The Prisoner's dilemma was originally framed by Merrill Flood and Melvin Dresher working at RAND in 1950. Albert W. Tucker formalized the game with prison sentence payoffs and gave it the "Prisoner's Dilemma" name (Poundstone, 1992).

The classical prisoner's dilemma (PD) is as follows:

Two suspects, A and B, are arrested by the police. The police have insufficient evidence for a conviction, and, having separated both prisoners, visit each of them to offer the same deal: if one testifies for the prosecution against the other and the other remains silent, the betrayer goes free and the silent accomplice receives the full 10-year sentence. If both stay silent, the police can sentence both prisoners to only six months in jail for a minor charge. If each betrays the other, each will receive a two-year sentence. Each prisoner must make the choice of whether to betray the other or to remain silent. However, neither prisoner knows for sure what choice the other prisoner will make. So the question this dilemma poses is: What will happen? How will the prisoners act?

The dilemma can be summarized thus:

	Prisoner B Stays Silent	**Prisoner B Betrays**
Prisoner A Stays Silent	Both serve six months	Prisoner A serves ten years Prisoner B goes free
Prisoner A Betrays	Prisoner A goes free Prisoner B serves ten years	Both serve two years

The dilemma arises when one assumes that both prisoners only care about minimizing their own jail terms. Each prisoner has two options: to cooperate with his accomplice and stay quiet, or to defect from their implied pact and betray his accomplice in return for a lighter sentence. The outcome of each choice depends on the choice of the accomplice, but the player must choose without knowing what their accomplice has chosen to do.

Let's assume the protagonist prisoner is working out his best move. If his partner stays quiet, his best move is to betray as he then walks free instead of receiving the minor sentence. If his partner betrays, his best move is still to betray, as by doing it he receives a relatively lesser sentence than staying silent. At the same time, the other prisoner's thinking would also have arrived at the same conclusion and would therefore also betray.

If reasoned from the perspective of the optimal outcome for the group (of two prisoners), the correct choice would be for both prisoners to cooperate with each other, as this would reduce the total jail time served by the group to one year total. Any other decision would be worse for the two prisoners considered together. When the prisoners both betray each other, each prisoner achieves a worse outcome than if they had cooperated.

Alternately, the "Stay Silent" and "Betray" strategies may be known as "don't confess" and "confess", or the more standard "cooperate" and "defect", respectively.

Generalized form

We can expose the skeleton of the game by stripping it of the Prisoners' subtext. The generalized form of the game has been used frequently in experimental economics. The following rules give a typical realization of the game.

There are two players and a banker. Each player holds a set of two cards: one printed with the word "Cooperate", the other printed with "Defect" (the standard terminology for the game). Each player puts one card face-down in front of the banker. By laying them face down, the possibility of a player knowing the other player's selection in advance is eliminated (although revealing one's move does not affect the dominance analysis). At the end of the turn, the banker turns over both cards and gives out the payments accordingly.

If player 1 (red) defects and player 2 (blue) cooperates, player 1 gets the Temptation to Defect payoff of 5 points while player 2 receives the Sucker's payoff of 0 points. If both cooperate they get the Reward for Mutual Cooperation payoff of 3 points each, while if they both defect they get the Punishment for Mutual Defection payoff of 1 point. The checker board payoff matrix showing the payoffs is given below.

Canonical PD payoff matrix		
	Cooperate	**Defect**
Cooperate	3, 3	0, 5
Defect	5, 0	1, 1

In "win-lose" terminology the table looks like this:

	Cooperate	**Defect**
Cooperate	win-win	lose much-win much
Defect	win much-lose much	lose-lose

These point assignments are given arbitrarily for illustration. It is possible to generalize them. Let T stand for Temptation to defect, R for Reward for mutual cooperation, P for Punishment for mutual defection and S for Sucker's payoff. The following inequalities must hold:
$T > R > P > S$

In addition to the above condition, Richard Dawkins suggests that, if the game is repeatedly played by two players, the following condition should be added.

$2 R > T + S$

If that condition does not hold, then full cooperation is not necessarily Pareto optimal, as the players are collectively better off by having each player alternate between cooperate and defect.

These rules were established by cognitive scientist Douglas Hofstadter and form the formal canonical description of a typical game of Prisoners Dilemma.