**The concept of Nash Equilibrium using Prisoner’s Dilemma**

**Nash equilibrium**, in [game theory](https://www.britannica.com/science/game-theory), an outcome in a noncooperative game for two or more players in which no player’s expected outcome can be improved by changing one’s own strategy. The Nash [equilibrium](https://www.merriam-webster.com/dictionary/equilibrium) is a key concept in game theory, in which it defines the solution of *N*-player noncooperative games. It is named for American mathematician [John Nash](https://www.britannica.com/biography/John-Nash), who was awarded the 1994 [Nobel Prize](https://www.britannica.com/topic/Nobel-Prize) for Economics for his contributions to game theory.

Game theory uses [mathematics](https://www.britannica.com/science/mathematics) to model and analyze situations in which decisions are interdependent. While it can be used to model recreational games such as [Monopoly](https://www.britannica.com/sports/Monopoly-board-game) or [poker](https://www.britannica.com/topic/poker-card-game), it is often used to analyze topics of real-world interest, including [economics](https://www.britannica.com/money/economics) and military strategy. In game theory, a game may be any situation in which there are interdependent decisions, and the players are all the decision-making [entities](https://www.britannica.com/dictionary/entities).

A game is noncooperative as long as no mechanism exists for the players to make binding agreements with one another. For example, in the famous [prisoner’s dilemma](https://www.britannica.com/topic/prisoners-dilemma), two prisoners have been accused of a crime and are asked to confess. If one confesses and the other does not, the one who confesses will be released, and the one who does not will receive a harsh sentence. If both confess, both will receive a serious, but not harsh, sentence. If neither confesses, both will receive a very light sentence. Because there is no outside authority enforcing any agreement between the prisoners, the game is noncooperative; neither prisoner suffers a penalty for betraying the other.

A payoff [matrix](https://www.britannica.com/dictionary/matrix) is often used to help determine the optimal strategy for the players in the game. In the payoff matrix, each row represents one possible strategy for one player, and each column represents one possible strategy for the other. In the example above, the matrix would look like the figure below.

Each player (prisoner A or prisoner B) will attempt to adopt the strategy (confess or remain silent) that results in the least amount of jail time (0, 1, 5, or 20 years). The best outcome for the prisoners is for both to remain silent, as this results in a total sentence of only 2 years (as opposed to 20, if only one chooses to remain silent, or 10, if both choose to confess). This collection of strategies results in the best payoff for the players collectively. However, it is not the Nash [equilibrium](https://www.britannica.com/dictionary/equilibrium), because either prisoner’s payoff can be improved by choosing a different strategy.

If prisoner A remains silent, then prisoner B can either remain silent and receive a 1-year sentence or confess and go free. Prisoner B’s own payoff therefore can be improved by confessing. However, one prisoner confessing and the other remaining silent is also not a Nash equilibrium, because the payoff of the prisoner who remains silent can be improved by changing strategies. If prisoner A confesses, then prisoner B can either remain silent and face a 20-year sentence or confess and face a 5-year sentence. Thus, prisoner B’s payoff can be improved by switching from remaining silent to confessing.

The only collection of strategies in which no player’s payoff can be improved by switching strategies is if both prisoners confess. In this scenario, either prisoner choosing to switch strategies will result in a lower payoff. Despite this being worse for both players (resulting in a total 10-year sentence) than if both were to remain silent, it is the Nash equilibrium.