The Prisoner's Dilemma

Key Learning Content

This film introduces Game Theory, which explores how one person will behave when their actions depend in part on someone else's action. The classic example of Game Theory – The Prisoner's Dilemma – is described in detail.

The Nash Equilibrium is also featured and is described by its creator, John Nash. It suggests that in a given situation, neither party will gain by changing their decision once they know what the other person has done. The film shows that in this way the Nash Equilibrium is stable, although it is not the optimum outcome if cooperation is allowed. This logic is then applied to explain the Arms Race between the US and USSR in the 20th century, where stability was achieved but at great cost to both sides.

The film requires no specific prior mathematical knowledge, but the ideas it addresses could be challenging for younger students.

Core Outcomes

Learning Points

- Be able to understand the language of probability in terms such as 'outcomes', 'dependency' and 'equilibrium'.
- Be able to list systematically all the outcomes for single events and for two successive events.
- Be able to draw and use tree diagrams.

Suggested Activities

- Analyse the Prisoner's Dilemma game use tree diagrams.
- Find other examples of the Prisoner's Dilemma in everyday life.

Extension Outcomes

Learning Points

- Be able to understand what is meant by a pay-off matrix and use it to determine player strategies.
- Be able to understand what is meant by a zero-sum game.

Suggested Activities

- Analyse the Prisoner's Dilemma game using a pay-off matrix.
- Work out what would happen if the Prisoner's Dilemma was a zero-sum game.

Game Theory uses maths to identify winning strategies in games.

Related Films

To use before the lesson plan:

Beating the Stock Market

This film describes the lengths to which people go to try to predict and overcome the uncertainties of the stock market.

To use after the lesson plan:

The Monty Hall Problem

This film explores a counter-intuitive yet simple use of conditional probability in a game show.

Probability: Irrational Fears

This film looks at why rationality has its limits when used to explain human behaviour.

Primed for Survival

This film looks at the question of whether insects use Game Theory to regulate their breeding cycles.

Guide Lesson Plan

Introduction

Tell students that you have been watching them in the lunch queue: you have noticed that if they jostle and push to get first place then the queue moves slowly; but if they wait quietly then the queue moves quickly. Ask them to explain why, given this information, everyone jostles and pushes in the lunch queue.

Show Film

The Prisoner's Dilemma

Main Activity

Foundation
Go over the terms of the offer made to the two prisoners and get students to analyse it using a tree diagram. Let the first branch of the tree be the other prisoner's decision, and the second branch their own decision. Explain that a Nash Equilibrium is a strategy followed or a decision made that will always gives the better outcome, whatever the other prisoner decides. Derive the equilibrium strategy for the Prisoner's Dilemma.

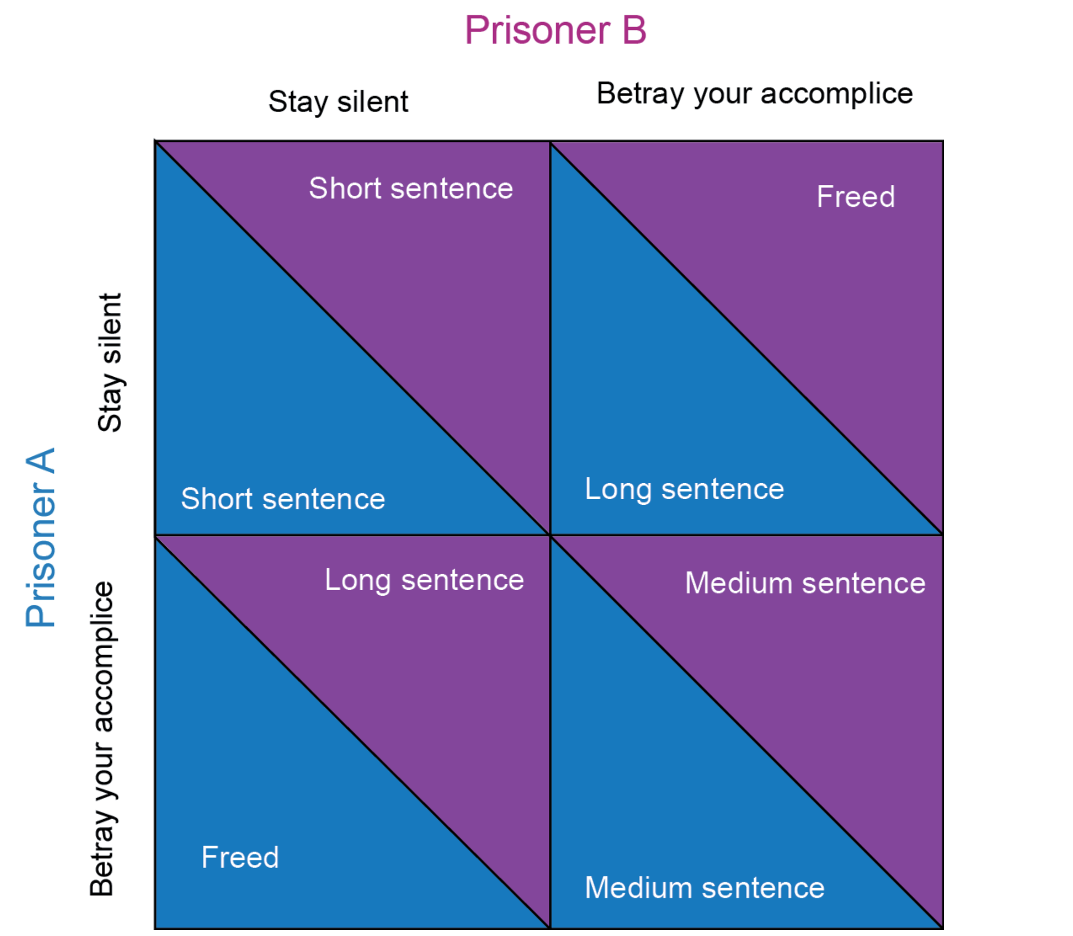
Advanced
Explain the concept of a pay-off matrix for a two-player game. Get students to draw the pay-off matrix for the Prisoner's Dilemma and hence derive the equilibrium condition. Explain what is meant by a zero-sum two-player game (where the gain to one player is exactly equal and opposite to the loss of the other). Establish that the Prisoner's Dilemma is not a zero-sum game. Redraw the pay-off matrix so that the game is zero-sum and comment on how this changes the interpretation of the game.

Extension Activity

Explain that much economic theory is based on people optimising their circumstances, i.e. doing the best they can for themselves without necessarily considering the benefits of cooperation, hence the relevance of Nash's ideas. Find examples of the Prisoner's Dilemma in everyday life. Emphasise that students are looking for examples of a competitive equilibrium which could possibly be bettered if cooperation is allowed. Ask students what could be done by governments or lawmakers to achieve a superior cooperative equilibrium, where one exists.

Optional Extra

A classic problem in Game Theory is the position of two competing ice-cream sellers on a beach evenly covered by holidaymakers. Each wants to position their stall so as to minimise the walking distance of their customers and hence get more trade. Show that the Nash Equilibrium is for the two sellers to set up back-to-back in the middle of the beach. Is this the optimum outcome from the buyers' perspective?



Mathematician John Nash argued that the only rational decision for the individual is to betray their accomplice.