The model description follows the ODD (Overview, Design concepts, Details) protocol for describing individual- and agent-based models (Grimm et al. 2006, 2010).

Purpose

The purpose of this model is to demonstrate how different payoff structures, strategies, and players can affect the outcomes of prisoner's dilemma games.

Entities, state variables, and scales

Each entity possesses a strategy for the Prisoner's Tournament simulation. Each strategy should consist of a series of ten characters that include the following letters of the alphabet: R, C, D, T, W, A, V, G, S, K, H.

Process overview and scheduling

When the simulation runs, entities are repeatedly pitted against each other in a series of prisoner's dilemma games that determine the relative payoffs of both players. Each player plays every other player twice per tournament. When a diad plays each other, they play ten games and choose the decision (cooperate or defect) as determined by one of the ten letters of their strategy. If both players cooperate, they both receive the "*reward"* payoff amount. If one player cooperates and the other defects, the cooperating player receives the "*sucker*" payoff amount, and the defector receives the "*temptation*" payoff amount. If both players defect, then both receive the "*punishment*" payoff amount. The simulation ends once every player has played each other twice and all payoffs have been allocated. The "winning" strategy is that which received the highest total payoff in the tournament.

Basic principles

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? 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.

The prisoner's dilemma has the payoff structure given below (Table 1), which shows what you ("Player receiving the sentence") gets as payoff for a particular scenario. Likewise, you can determine what payoff your partner will receive by swapping "Player receiving the sentence" and "Other player" in the table below. Here, your payoff is defined as the years of your sentence that you must serve, which depends on what you and your partner did.

Table 1	Other player		
Player receiving the sentence		Cooperate	Defect
	Cooperate	2 years	5 years
	Defect	0 years	4 years

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.

Emergence

What emerges from the simulation are the entities who participated in the tournament ranked by their total payoff from all games played. The entity with the highest payoff "wins" the tournament.

Interaction

Entities interact with each other by playing a series of ten prisoner's dilemma games with each other, twice per tournament. During each game, both players choose their decision (cooperate or defect) before knowing what the other player will do. Each strategy for determining a decision is represented by a letter of the alphabet. The following contains a list of possible codes and their corresponding names and a description of the strategy.

RANDOM [R] Randomly choose between DEFECT and COOPERATE.

COOPERATE [C] No matter what, choose to COOPERATE.

DEFECT [D] No matter what, choose to DEFECT.

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] 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.

Stochasticity

Entities are chosen to play games against each other in a random order. The order in which they choose either to cooperate or defect is not random but instead determined by the order of the letters in their strategy.

Observation

During the simulation, the Output window periodically prints out the current standings of the top competing entities in the tournament, ranked by highest to lowest payoff.

Initialization

Upon initialization, a population of entities are created and given strategies based on the chosen input data.

Input data

A user may select any csv file that fulfills the following criteria: (1) there are two columns with the headers "name" and "strategy"; (2) any number of cells in the "name" column contain text to represent strategy names; (3) the same number of cells as in the "name" column are in the "strategy" column; and (4) the "strategy" column contains cells with the structure

XXXXXXXXXXX, each X representing any letter (R, C, D, T, W, A, V, G, S, K, H) and each letter representing a different strategy for choosing a decision (either cooperate or defect).

References

Grimm V, Berger U, Bastiansen F, Eliassen S, Ginot V, Giske J, Goss-Custard J, Grand T, Heinz SK, Huse G, Huth A, Jepsen JU, Jørgensen C, Mooij WM, Müller B, Pe'er G, Piou C, Railsback SF, Robbins AM, Robbins MM, Rossmanith E, Rüger N, Strand E, Souissi S, Stillman RA, Vabø R, Visser U, DeAngelis DL (2006) A standard protocol for describing individual-based and agent-based models. *Ecological Modelling* 198:115-126.

Grimm V, Berger U, DeAngelis DL, Polhill G, Giske J, Railsback SF. 2010. The ODD protocol: a review and first update. *Ecological Modelling* 221: 2760-2768.