EXERCISE ON SPATIAL PRISIONER'S DILLEMA

Paper references

Nowak MA & Sigmund K (2000), Games on Grids. In: The Geometry of Ecological Interactions: Simplifying Spatial Complexity, eds. Dieckmann U, Law R & Metz JAJ, pp. 135–150. Cambridge UniversityPress.

Lindgren && Nordahl (1994), Evolutionary dynamics of spatial games. Physica D 75 (1994) 292-309

We consider an infinitely repeated Prisioner's Dillema, where in every round each player has a choice between the two moves C (for cooperate), and D (for defect), and the pay-off matrix M has the following form:

	Player 2 Coop	Player 2 Defect
Player 1 Coop	(R,R)	(S,T)
Player 1 Defect	(T,S)	(P,P)

where T>R>P>S and 2R>T+S., where T ("temptation"), R ("reward"), P ("punishment), and S ("sucker's payoff) are used to denote the results. These constraints imply that in a single game it is rational for both players to defect, but also that it would be to the mutual advantage of the players to establish cooperation in the long run.

Each cell of a regular cellular space contains a single agent that plays a certain strategy in the game.

A strategy is a rule for determining the next move of a player given the history of the game. There are strategies that have no memory, such as AC (always cooperate) and AD (always defect). Some strategies have a one-time memory, such as TFT ("tit for tat") and WSLS ('win-stay, lose-shift'). Tit-for-tat does whatever the opponent has done in the previous round. It will cooperate if the opponent has cooperated, and it will defect if the opponent has defected. WSLS repeats the previous

move if the resulting payoff has met its aspiration level and changes otherwise. If the play on the current round resulted in a success (e.g., the payoff is either T or R), then the agent plays the same strategy on the next round. Alternatively, if the play resulted in a failure (e.g., the payoff is either P or S) the agent switches to another action.

Version 1: Each agent interacts with himself and his four nearest neighbors on a 2D square lattice. Each agent plays the game against all neighbors, which gives each individual a total score. For the next round, the agent chooses the strategy of neighbor who has the highest payoff.

Version 2: Each agent interacts with his 24 nearest neighbors on a 2D 5 x 5 square lattice. Each agent plays the game against all neighbors, which gives each individual a total score. For the next round, the agent keeps his strategy.

In this exercise, you should implement the AC, AD, TFT, and WSLS strategies in a cellular space in the two version and find out what are the possible outcomes, considering the following payoffs:

(a) T ("temptation"): $1 < T < 2$
(b) R ("reward"): 1
(c) P ("punishment"): $0 < P < 1$
(d) S ("sucker's payoff"): 0

Please provide at least 3 configurations for each version. Please provide a graphic with the proportion of agents in a given strategy (version 1) and the average and accumulated gain per strategy (version 2). Simulate a number of times enough to generate nice results.