Evolutionary Game Theory

Elena Rosskopf and Ellen Halaburt, *Module Evolutionary Game Theory WS 2014/15*

December 17, 2014

Here is our super nice abstract with the solution which will bring peace to the world

Explanation of problem

why is it important to such things modelling of nature for forecasting, understanding, estimating get old paradigm of the behaviour in HD right - paradigm shift to the new paradigm that HD players could act in a way not known until now

super important for theoretical ecology both games 2 person-player games with two strategies both social dilemmas coop are exploited by defectors coop normally not persisting in PD, but in SD at moderate frequency

what is cooperation, defection in nature/ecology?

$$A = \begin{bmatrix} A_{11} & A_{21} \\ A_{21} & A_{22} \end{bmatrix} \tag{1}$$

Looking at evolutionary game structures, the payoff is crucial to determine each players fitness and the fitness of a whole group.

Spatial structure added to the game results in a population, where its individuals occupy patches on a spatial lattice (here two dimensional). Each tick (update) will be done by letting individuals play against their nearest neighbours. The resulting payoffs will be used to decide upon the focal patch's future occupant. It could be an offspring of the last occupant resisting the invasion or from a neighbour spreading its strategy. The lattice is updated and the evolutionary process takes place with every update.

Prisoners Dilemma

Explanation of PD in general: The cooperators get exploited by defectors, subsequently defectors are naturally selected. The cost to the donor of fitness(payoff?) is always higher than zero, but generally lower the benefit to the receiver of the pay-off (b ¿ c ¿ 0). The defectors pay-off is the highest pay-off b if the other player is cooperating. The lowest pay-off, namely only the cost, has then (-c) the cooperator which is defected in the unilateral cooperation. Finally it is best to defect regardless of other players decision. Mutual defections result then in pay-off zero for both players, not reducing the fitness but also not increasing it (see 1). Here, the defector strategy is the ESS.

Table 1: *Prisoner's Dilemma*

	C	D
Payoff to C	$b-c$	$-c$
Payoff to D	b	0

Spatial PD: Spatial structure in Prisoners Dilemma is a potent promoter of cooperation. Cooperators stay on forming large compact clusters thus reducing the exploitation by defectors as one can see in figure 3. In this case the cooperators are not close to the threshold of extinction and survive in big clusters.

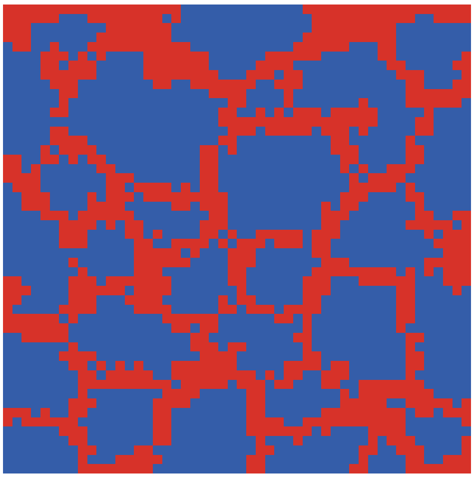

Figure 1: *Clustering*

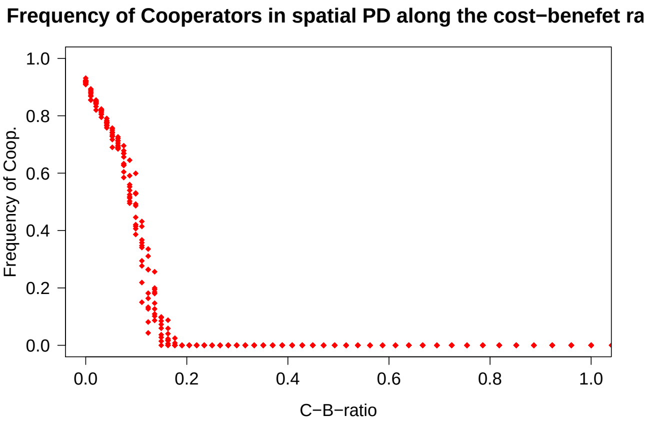

Figure 2: *Frequency of cooperators against c-b-ratio*

Snowdrift game

In general:
At the snowdrift game we have the difference to Prisoners Dilemma. The players can share the benefit and the cost, depending on their strategies. Another feature in this game is, that if one defects, the pay-off could be less than the sucker's pay-off of the unilateral cooperator. Still defecting if the other player cooperates is, according to the matrix, the best response choice. As one can see in table 2, the pay-off matrix is slightly different than the one of Prisoners Dilemma in table 1. If $2b > c > b > 0$, meaning that if costs are high, these pay-off structures change the game to a PD and affect the reverse pay-off structure. If $b > c > 0$, the best action depends on co-players action resulting in a mixed strategy population, where rare strategies can invade, either defector or cooperator with an ESS at cooperator proportion is $1 - c/(2b - c)$.

Spatial structure in snowdrift: In comparison to the spatial structure of the Prisoner's Dilemma's resulting cooperation lattice, the cooperators form only small filament-like clusters in the snowdrift game. The defectors have via the isolated cooperators structure the advantage to exploit fitness and break in those fragile clusters.

Table 2: *Snowdrift game*

	C	D
Payoff to C	$b - c/2$	$b - c$
Payoff to D	b	0

Spatial HD ideas: Individuals occupy sites on a regular lattice Next tick: present occupant + nearest neighbours compete to populate this site with their offspring Competitive success: depends on differences between payoffs that each pot. Parent obtains from game interactions with nearest neighbors Next tick/update done synchronously, pop. With descrete, non-overlapping generation Or asynchron with overlapping generations Spatial structure fails to enhance coop And reduces proportion of coop in spatial pop. Small ratio: high benefits, low cost: proportion of coop higher than $1 - r$ expected in well-mixed pop. Large ratio: defectors, depend on lattice geometry: the higher the neighbors the heigher the D Sufficiently high r: coop is lost Coop vanish near r where $1/N > 1 - r$

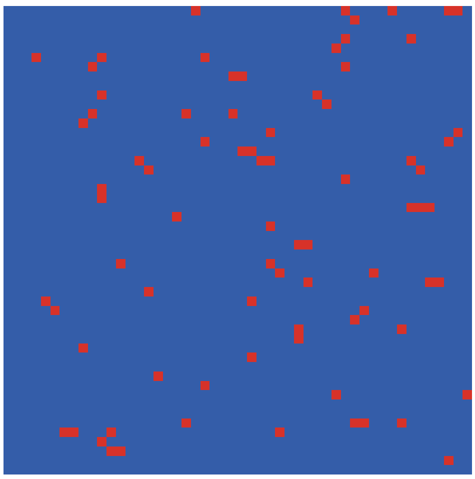

Figure 3: *Clustering*

task 1 the experiments

First explanation of spatial modelling structure

Last explanation of experiments

task 2 the neighbourhood problem

We choose 3 different types of neighbourhoods to be experimented on. The first one is the Moore neighbourhood with the default value of N=8 neighbours. The neighbours surround the focal patch in 8 directions. The second neighbourhood is the Von Neumann neighbourhood with the default value of N=4 neighbours which are orthogonally surrounding the focal patch on a two dimensional square lattice. The last type of neighbourhood introduces a parameter instead of a defined neighbourhood, having the attribute of a radius equal or less than 3 patches.
To increase the certainty of our results, the behaviour space model is used to compare different cooperation frequencies against the ratio of cost and benefit within different neighbourhood features and between the snowdrift game and the prisoners dilemma game. The mutual cooperation ratio in the snowdrift game is calculated as $r = c/(2b - c)$, cost to benefit ratio. The mutual cooperation ratio in the Prisoner's Dilemma is calculated as $r = c/(b - c)$.

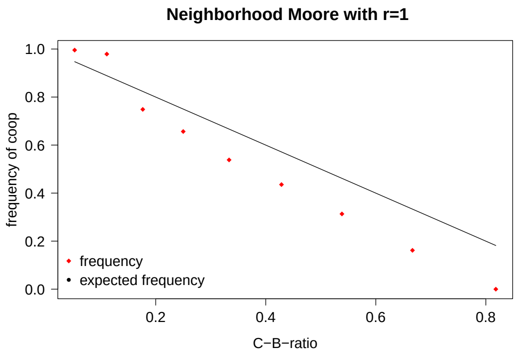

Figure 4: *N=8*

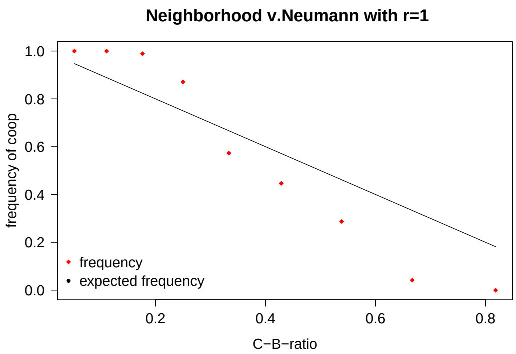

Figure 5: *N=4*

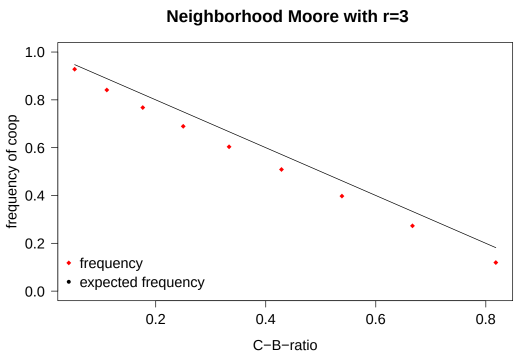

Figure 6: *N=3*

task 3

discussion

maybe discuss difference to the hauert paper? differ our results with their results?

where can we give in more time, where are options to prolong this topic? relation to nature, where is the importance here ?

Discussion: Paper: http://iopscience.iop.org/0253-6102/57/4/04 Not included the noise, like in this paper - could it make even more realistic but heavier to implement Our study more straighforward to understand the snowdrift game and the players evolution better Afterwards you could add those noise to our model to make it more exact

"Some analytical results have been obtained using geometrical arguments about cluster formation (Nowak May 1992; Killingback et al. 1999; Hauert 2001), and Schweitzer et al. (2002) recently gave a classification of the dynamic regimes in the spatial PD."

http://www.math.pitt.edu/ bard/classes/mth3380/spatialgame.pdf

bibiography:

References