Game Theory Simulation Projects

Simulate Spatial Pattern Formations in eg "The Prisoners' Dilemma"

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The so-called "Prisonners' Dilemma" game involves two prisoners held in separate police cells and both accused of joint involvement in some crime. There is not enough evidence to convict either prisoner if they both stay silent. The prisoners face the dilemma of helping the police to inform upon their co-prisoner and hence receiving a reduced sentence, or of cooperating with their co-prisoner and staying silent. The best outcome (for them) is if both go free, the worst if both are convicted. What should they do given they do not know what the other will do?

We can describe such a scenario by a "payoff matrix of outcomes" and we can **program a simulation** to investigate what happens with different numerical payoffs for the prisoners under changing payoff circumstances. We can also simulate the so-call spatial prisoner dilemma where we imagine a spatial layout of such "prisoner agents" who play this game against their neighbouring agents. We can examine the spatial patterns that occur for different mixtures of co-operators and traitors. This sort of model is the **basis for game theory**, which is used in economics predictions and in other planning scenarios. Many of the ideas originally invented to manipulate such game arose from trying to predict possible outcome s during the cold war. Modern applications are usually more peaceful and are connected with marketing and financial predictions.

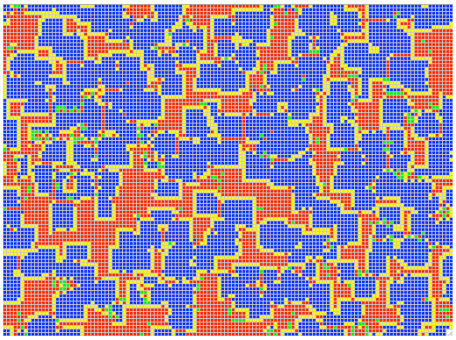
This project involves **adapting some existing Java simulation codes or developing new simulation programs** in C/C++ or Java to study the spatial prisoner dilemma and other games and carrying out a systematic study of the pattern growth. We can ask questions about the parameter phase space – under what circumstances will co-operators have an overall advantage and under what situations will it be better to be a traitor? Are there circumstances when it pays to play a mixed strategy? Development of a flexible and interactive visual simulation will allow exploration of these ideas.

This project will also involve learning how to manage the data output from simulations, and how to apply some simple statistical analyses to it. In particular looking at metrics to describe the spatial clusters.

A **possible extension will be to consider more advanced and sophisticated games** and to develop a modelling framework to express different playing strategies and even to evolve strategies using evolutionary/genetic algorithmic approaches. One well known winning strategy is to play a "tit for tat" strategy – cooperating until your opponent betrays you then retaliating before once again trying to cooperate.

Parts of this project could be carried out at **undergraduate, honours or masters level** with obviously more work required to implement more of the aspects of the system at higher levels of study. These projects would suit a programmer with interests in simulation and modelling economics.

Software development work for this project could be carried out using C/C++ or Java. It would be best if you have taken and passed papers 159.234 (and its pre-requisite papers) to have any reasonable chance of carrying out enough work on this project at undergraduate or honours level.



Red=traitor, Blue=Co-operator