Dynamics of learning and iterated games 2021-2022
Project 2: Reciprocity and the success of TFT strategies

In this project you are allowed to use books and the hand-outs, but it is important that you write up your project by yourself and that you can explain what you have written in detail during a short oral.

Attached to this project description are

- a section from the book of Sigmund (The calculus of selfishness),
- a paper by W.H. Press and F.J. Dyson `http://www.pnas.org/cgi/doi/10.1073/pnas.1206569109`.
- You are also asked to look at various discussion of the paper of Press and Dyson on the internet, e.g.

  `https://golem.ph.utexas.edu/category/2012/07/zerodeterminant_strategies_in.html`,

  `https://www.technologyreview.com/2012/08/16/85388/the-emerging-revolution-in-game-theory/`

  `https://plato.stanford.edu/entries/prisoner-dilemma/`
- A good paper discussing Press and Dyson's paper is A. Stewart and J.B. Plotkin, "Extortion and Cooperation in the Prisoner's Dilemma," Proceedings of the National Academy of Sciences, 109: 10134–10135: `http://www.pnas.org/cgi/doi/10.1073/pnas.1208087109`.

---

1. Submit your solutions of the exercises which will be distributed separately. The deadline for submitting these solutions is the last Friday of term 1 at noon.
2. As discussed in the lectures, over the last 40 years every year tournaments were held, in which an interative version of the prisoner dilemma (or donation game) (IPR) was played. These tournaments are often called after its founder, Axelrod. In this project you are asked to explore the success of the TFT strategies in these tournaments. In a few paragraphs, explain the rules of the Axelrod tournaments, the various strategies that were used, and the outcomes in the tournament.
3. Discuss in a few pages what arguments are given in Sigmund's book, based on evolutionary game theory (and replicator dynamics), of the success of TFT games and explain why in these arguments the success of TFT depends on the environment in which it is used (i.e. on which other strategies are used).
4. Describe the results and proofs from the paper by Press and Dyson in detail (and fill in 'gaps' in the arguments).
5. Explain why the paper of Press and Dyson has created so much excitement, and discuss to what extend this excitement was warranted.

6. Discuss why the notion of Nash equilibrium hardly appears in Press and Dyson's paper, nor in most other discussions on the iterated prisoner dilemma.

7. Run the Axelrod tournaments through one of the following

   - https://github.com/Axelrod-Python/Axelrod, see also https://vknight.org/unpeudemath/code/2015/02/20/an-iterated-prisoners-dilemma-on-github.html.

   - https://github.com/cristal-smac/ipd.

   Carefully append your code, documenting how you ran this code, and draw conclusions from these tournaments. Formulate your own strategy (for example some variant of TFT) and run this strategy in these tournaments. How does your strategy do?

8. [**Mastery question for 4th year and MSc students**] Discuss the following two papers

   [-] C. Hilbe, M.A. Nowak, and K. Sigmund, 2013, "Evolution of extortion in Iterated Prisoner's Dilemma games," Proceedings of the National Academy of Sciences, 110 (17): 6913–6918. https://doi.org/10.1073/pnas.1214834110.

   [-] S. Wang and F. Lin, 2020, "Nice Invincible Strategy for the Average-Payoff IPD", https://aaai.org/ojs/index.php/AAAI/article/view/5604

   There are quite a few other recent papers on this topic, and you are also allowed to discuss any of those (instead), provided your discussion goes into sufficient depth:

   [-] E. Akin, 2013, "The Iterated Prisoner's Dilemma: Good Strategies and Their Dynamics," https://arxiv.org/abs/1211.0969.

   [-] P. Mathieu and J.P. Delahaye, 2017, "New Winning Strategies for the Iterated Prisoner's Dilemma", Journal of Artificial Societies and Social Simulation 20 (4) 12, http://jasss.soc.surrey.ac.uk/20/4/12.html.

   [-] Y. Murase, S.K. Baek, 2020: "Five rules for friendly rivalry in direct reciprocity", https://arxiv.org/abs/2004.00261

   [-] M. Harper, V. Knight et al., 2017: "Reinforcement learning produces dominant strategies for the Iterated Prisoner's Dilemma" Plos One 12 (12) , e0188046. https://doi.org/10.1371/journal.pone.0188046