China Scholarships Council Project

PROJECT TITLE: Games on (in)finite boards

SUPERVISORY TEAM:

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PROJECT SUMMARY: Consider the so–called *encirclement* game. Alice and Bob play on an infinite board with the usual rectangular grid. They move in turns, each marking a node on the grid. A node can be marked at most once. Alice's goal is to produce a graph having an infinite connected component, Bob's goals is to prevent it. This is an infinite version of the game popular with schoolchildren across continents. Its name stems from the fact that Bob essentially tries to encircle each component of Alice's graph.

Who wins in the encirclement game? How to describe or compute the winning strategy? What happens if the active player is chosen randomly each period? What if the game is played on a random graph? Despite the apparent simplicity of the encirclement game, these are all non-trivial questions.

The aim of the project is to study games that have simple, intuitive rules, that resemble board games, and yet possess a non–trivial mathematical, game–theoretic and computational content. That traditional board games (such as chess, go, or sodoku) can lead to profound research questions is a commonplace. Games on infinite boards hold a similar potential to enrich analytical and computational tools of game theory. Apart from the encirclement game and variants thereof, the PhD candidate will consider coloring, covering, independence and dominating games on infinite boards.

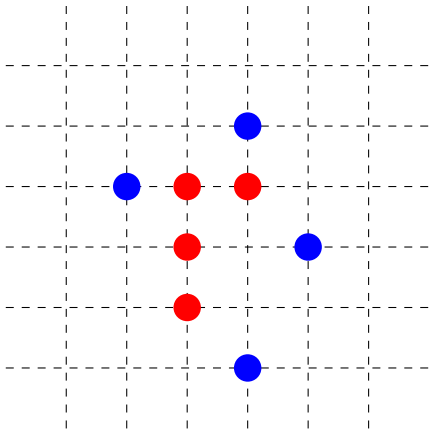

Figure 1: A play of the encirclement game.

In fact, we see a potential for the subject far beyond the scope of a single PhD thesis. The topic can eventually result in an array of scholarly publications as well as interdisciplinary workshops.

Beyond purely academic aims, this project pursues one other objective: popularizing game theory. We believe that games on (in)finite boards, thanks to their intuitive and appealing nature, could attract the attention of a broad audience. Even children can understand the rules of such games and play them. Games on (in)finite boards can help attract

Bachelor students, or even high school pupils, to mathematics in general and to game theory in particular.

To this end, a part of the project will be devoted to developing software to play and to visualize infinite board games. Such programs could be made available online. Owing to their highly visual, geometric nature, we expect these tools to captivate generation Z.

KEYWORDS: Game theory, dynamic games, winning strategies, determinacy.

REQUIREMENTS: We are looking for a student with a background in mathematics, logic, or computer science. The intrinsic motivation for deep research, and the interest and appreciation for theory are the most important qualifications.

KEY PUBLICATIONS OF THE SUPERVISORY TEAM:

Grigoriev, A., Van De Klundert, J. and Spieksma, F.C., 2006. Modeling and solving the periodic maintenance problem. *European Journal of Operational Research*, 172(3), pp.783-797.

Grigoriev, A., Sviridenko, M. and Uetz, M., 2007. Machine scheduling with resource dependent processing times. *Mathematical programming*, 110(1), pp.209-228.

Flesch, J. and Predtetchinski, A., 2016. Subgame-perfect ϵ-equilibria in perfect information games with common preferences at the limit. *Mathematics of Operations Research*, 41(4), pp.1208-1221.

Flesch, J. and Predtetchinski, A., 2017. A characterization of subgame-perfect equilibrium plays in Borel games of perfect information. *Mathematics of Operations Research*, 42(4), pp.1162-1179.

Cingiz, K., Flesch, J., Jean-Jacques, P. and Predtetchinski, A., 2020. Perfect information games where each player acts only once. *Economic Theory*, 69, pp.965-985.

Approved by the academic department (DAD): Alexandre Grigoriev