Bachelor Thesis Project

Rational Synthesis in Graphical games (GG)

The aim of this project is to build a tool that a) decides if a graphical game has a NE, and b) allows the user to "play" the game of finding a NE.

Plan

1. Read paper about graphical games [5]. Pick some examples from papers on graphical games, e.g., ROAD, random games, ... 1 week
2. Decide on libraries to handle a) graphs, b) payoff functions, and code algorithm that decides if a profile is a NE 3 weeks
3. Code GUI that allow user to "play" a graphical game, i.e., the player tries to find a NE (hints can be given, e.g., which nodes have profitable deviations). 2 weeks
4. Familiarise with a SAT solver (e.g., `minisat.se`) and code algorithm that decides if a GG has a NE 3 weeks
5. Compare with other algorithms for GG [1]. 2 weeks
6. Write thesis. 3 weeks

Extensions

1. Extend to E-NASH, i.e., given a GG and an extra formula Φ, decide if there exists a NE of GG satisfying Φ.
2. Extend to Iterated Graphical Games with LDL_f objectives.
3. Extend to real-valued payoffs and aggregation payoffs (e.g., average).
4. Extend to Boolean Game.
5. Write and implement a PTIME algorithm for the case that the graphs are trees.

Additional Readings and References

- [4] helps generate GG.
- [3] shows how to code GG in SAT (read Definition 1, and Section 3 on SAT).

- [2] shows that a) deciding existence of a NE in a GG is NP-complete (Section 3), and a reduction to CSP that shows existence of a NE in a GG is in PTIME for GG of bounded treewidth (Section 4).

References

[1] Sofie De Clercq, Kim Bauters, Steven Schockaert, Mihail Mihaylov, Ann Nowé, and Martine De Cock. Exact and heuristic methods for solving boolean games. *Autonomous Agents and Multi-Agent Systems*, 31(1):66–106, 2017.

[2] Georg Gottlob, Gianluigi Greco, and Francesco Scarcello. Pure nash equilibria: Hard and easy games. *CoRR*, abs/1109.2152, 2011.

[3] Anisse Ismaili, Evripidis Bampis, Nicolas Maudet, and Patrice Perny. A study on the stability and efficiency of graphical games with unbounded treewidth. In Maria L. Gini, Onn Shehory, Takayuki Ito, and Catholijn M. Jonker, editors, *International conference on Autonomous Agents and Multi-Agent Systems, AAMAS '13, Saint Paul, MN, USA, May 6-10, 2013*, pages 263–270. IFAAMAS, 2013.

[4] Eugene Nudelman, Jennifer Wortman, Yoav Shoham, and Kevin Leyton-Brown. Run the GAMUT: A comprehensive approach to evaluating game-theoretic algorithms. In *3rd International Joint Conference on Autonomous Agents and Multiagent Systems (AAMAS 2004), 19-23 August 2004, New York, NY, USA*, pages 880–887. IEEE Computer Society, 2004.

[5] David Vickrey and Daphne Koller. Multi-agent algorithms for solving graphical games. In Rina Dechter and Richard S. Sutton, editors, *Proceedings of the Eighteenth National Conference on Artificial Intelligence and Fourteenth Conference on Innovative Applications of Artificial Intelligence, July 28 - August 1, 2002, Edmonton, Alberta, Canada.*, pages 345–351. AAAI Press / The MIT Press, 2002.