

1 Normal form games

Implement a basic theory of normal form games and use it to prove the properties of the games from [4, Section 17.2]

2 Soundness and completeness of S5

Define the S5 logic and prove its soundness and completeness, as in Section 3.1 from [1]. You may find the Lean3 formalization available at <https://github.com/ljt12138/Formalization-PAL> useful.

3 Muddy children (or blue-eyed islanders) puzzle

Implement a system of epistemic logic and verify within it the general solution to the muddy children puzzle [1, Section 1.1], or for the similar blue-eyed islanders puzzle. A related formalization was done in the proof assistant Isabelle [3].

4 Decision procedure for K_n

Define the system K_n and implement a decision procedure for it, following [1, Section 3.2].

5 Byzantine Generals Problem

Formalize the proof of the general solution with oral messages for the Byzantine generals problem [2].

6 Matching logic - IMP

Following [5], define a matching logic for the system IMP and use it to verify the correctness of some simple imperative program, like in the example from the paper.

References

- [1] Ronald Fagin, Joseph Y. Halpern, Yoram Moses, and Moshe Y. Vardi. *Reasoning about Knowledge*. MIT Press, 1995.
- [2] Leslie Lamport, Robert Shostak and Marshall Pease. The Byzantine Generals Problem. *ACM Transactions on Programming Languages and Systems*, 4(3):382-401, 1982.

- [3] Jakub Kądziołka. Solution to the xkcd Blue Eyes puzzle. Archive of Formal Proofs, 2021. https://isa-afp.org/entries/Blue_Eyes.html
- [4] Gerhard Weiss, editor. *Multiagent Systems. Second edition*. MIT Press, 2013.
- [5] Grigore Roşu, Chucky Ellison and Wolfram Schutte. Matching Logic: An Alternative to Hoare/Floyd Logic. In Johnson and Pavlovici, editors, *Algebraic Methodology and Software Technology*, pages 142-162. Springer, Heidelberg, Berlin. 2011