Stochastic Processes Analysis on Liar's Poker: State Space Abstraction and Markov Decision Process

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Introduction

Poker is a popular imperfect-information extensive-form card game. **Liar's Poker** is a variant of Texas Hold'em Poker with an exclusive card-switching effect during the street.

A **state space abstraction** is a many-to-one mapping between the game's information sets and the information sets in a smaller, artificially constructed abstract game.

A **Markov Decision Process** is a mathematical framework for modeling sequential decision-making where outcomes are partly random and partly under the control of an agent

Research Questions

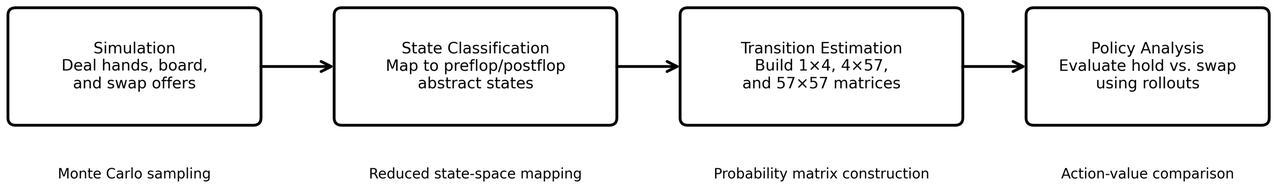
- How can we construct a compact yet explainable state-space to represent the game?
- Is switching method best understood as an immediate gain decision or an option value decision?
- Are drawing-type states more valuable than weak made-hand states under switching?

References

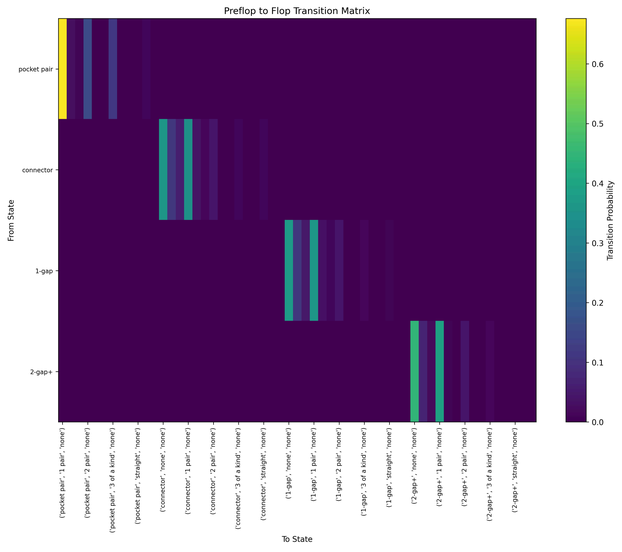
[1] M. Johanson et al., "Evaluating state-space abstractions in extensive-form games," AAMAS, 2013, p.271-278

[2] J. Yao et al., "Solving imperfect information poker games using Monte Carlo search and POMDP models," Proc. DDCLS, 2020, pp. 1060–1065.

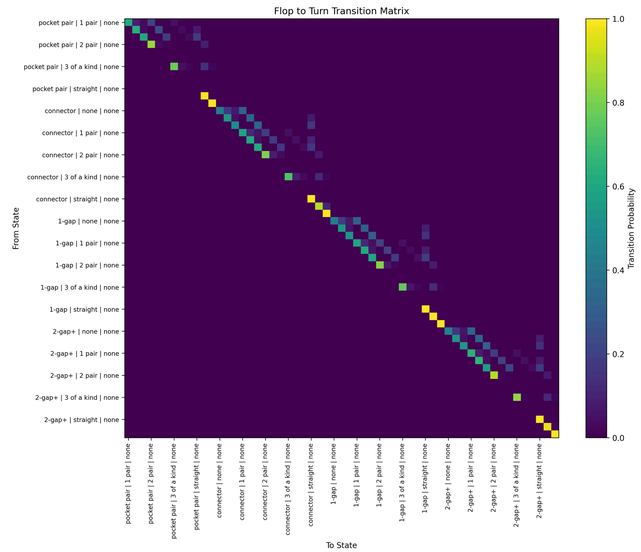
Methodologies



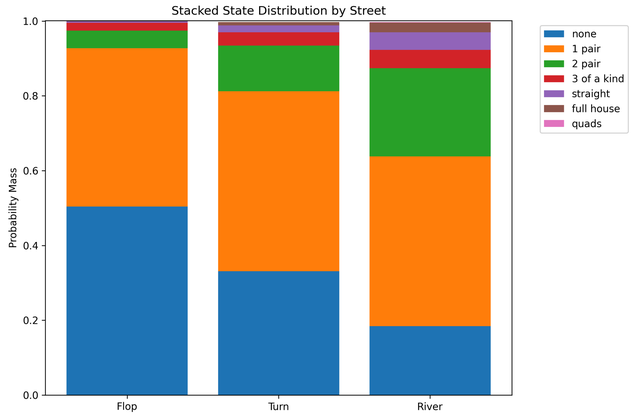
PDF: Preflop → Flop



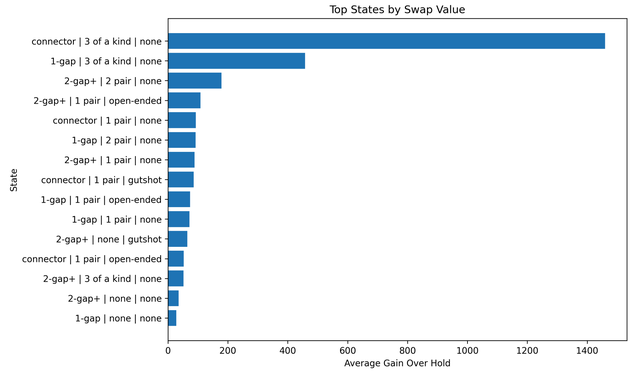
PDF: Flop → Turn



State distribution



Swap gain at Flop



State-space abstraction

S = (C, H, SD)

where:

- C = {Pocket Pair, Connector, 1-Gap, 2-Gap+}
- H = {None, 1 Pair, 2 Pairs, 3 of a Kind, Straight, Full House, Quads}
- SD = {None, Gutshot, Open-Ended}

- Preflop state-space size: |C| = 4
- Postflop state-space size: |S_postflop| = 57

Future Work

- Extend the state space to incorporate flush-related states for a more complete representation of the game
- Model hidden opponent information using a Partially Observable Markov Decision Process (POMDP) framework

Challenges

- State-space abstraction lacks a standard construction method, requiring careful iteration to ensure valid state definitions.
- Hidden information and dynamic gameplay make it challenging to build a model that is both tractable and strategically meaningful.

Acknowledgements

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