Sandia National Laboratories

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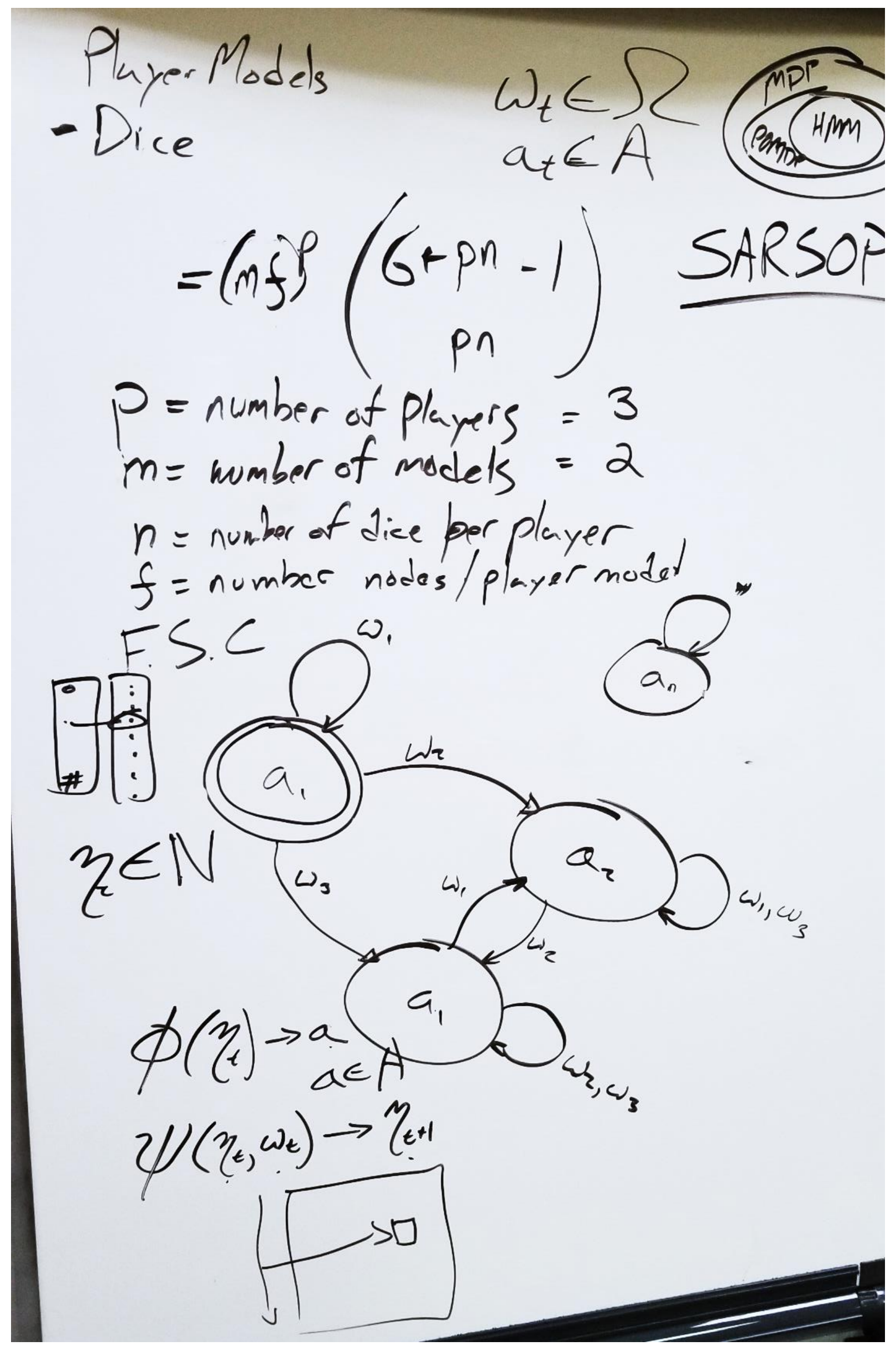
Analytically Extrapolating Strategies of Opponents from Play-data

Project Background

- Project on Nuclear Gaming (PoNG)
- PoNG's SIGNAL: Strategic Interaction Game between Nuclear Armed Lands
- Our project: Analytically Extrapolating Strategies of Opponents from Play-data (AESOP)
  1. Can having process data from conflict (or games), or conflict analogs, allow one to identify known or hypothesized strategies?
  2. Given partial process data (e.g., the play so far), can one identify likely strategies
  3. How can one identify strategic "clusters," or play approaches that are similar to one another, from a large set of play throughs?
  4. How can one identify new strategies (a priori undefined) from process data?

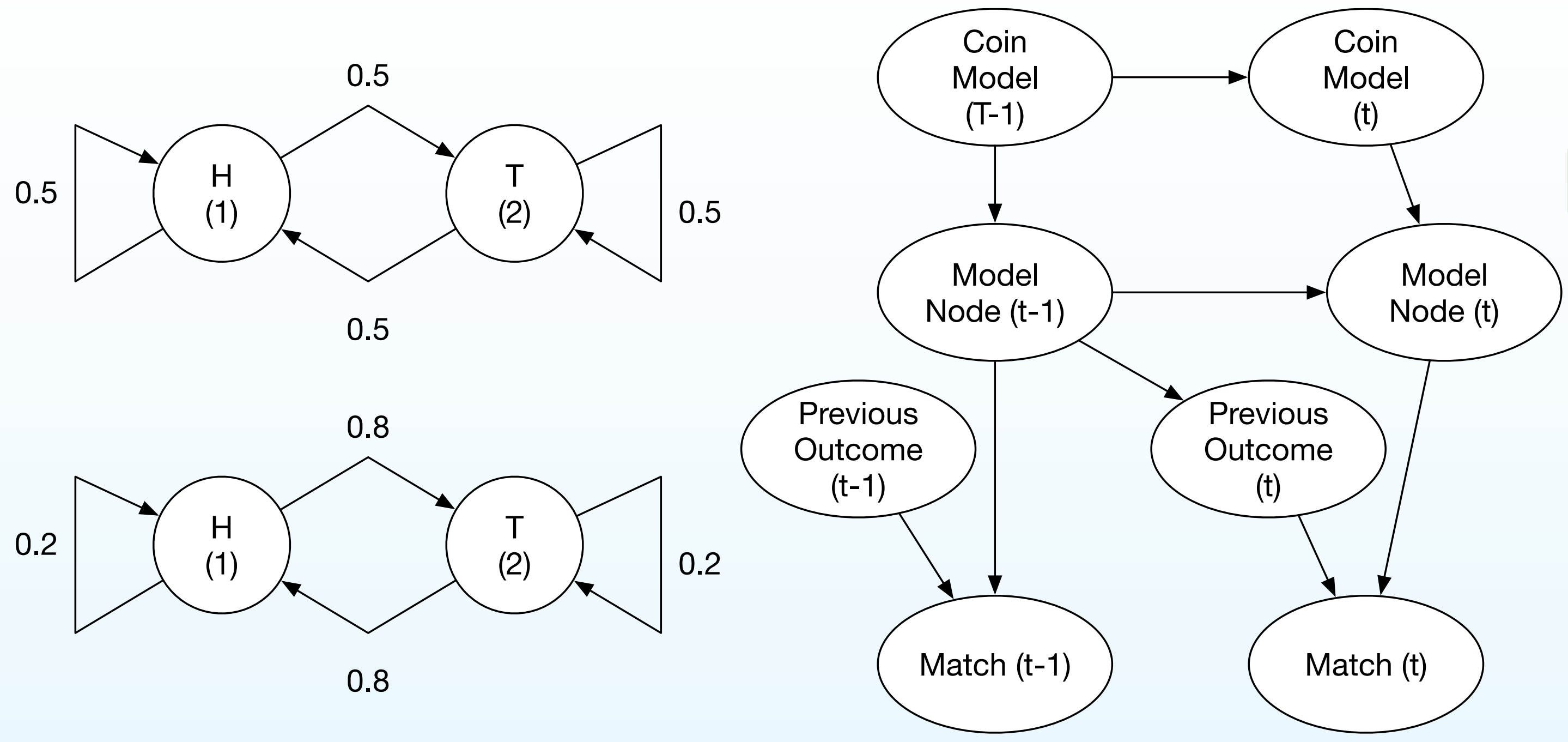


Liar's Dice Implementation

- Python simulation of a multiplayer game with strategic interaction
- Players all roll dice privately. Players take turns "bidding" a face value and how many dice they have with that value. Other players can call "liar" instead and end the round. Incorrect player loses a die. Last player with dice wins.
- Numpy and hmmlearn libraries

Stochastic Models

- Hidden Markov Model: model of stochastic process with unobservable states
- Finite State Machines: model different strategies and likelihood of transitioning to different states (actions) by making an observation
- Bayesian Networks: model relationships between uncertainties (e.g., game state)
- The outcomes and probabilities are dictated by a state transition matrix



		M	1	1	1	1	2	2	2	2
		N	1	1	2	2	1	1	2	2
M	N	PS	T	H	T	H	T	H	T	H
1	1	T	0	0.5	0	0.5	0	0	0	0
1	1	H	0	0.5	0	0.5	0	0	0	0
1	2	T	0.5	0	0.5	0	0	0	0	0
1	2	H	0.5	0	0.5	0	0	0	0	0
2	1	T	0	0	0	0	0	0.2	0	0.8
2	1	H	0	0	0	0	0	0.2	0	0.8
2	2	T	0	0	0	0	0.8	0	0.2	0
2	2	H	0	0	0	0	0.8	0	0.2	0

Figure 1: Finite state machines, Bayesian network, and state transition matrix for simple coin flip example.

PROJECT ON NUCLEAR GAMING

SIGNAL

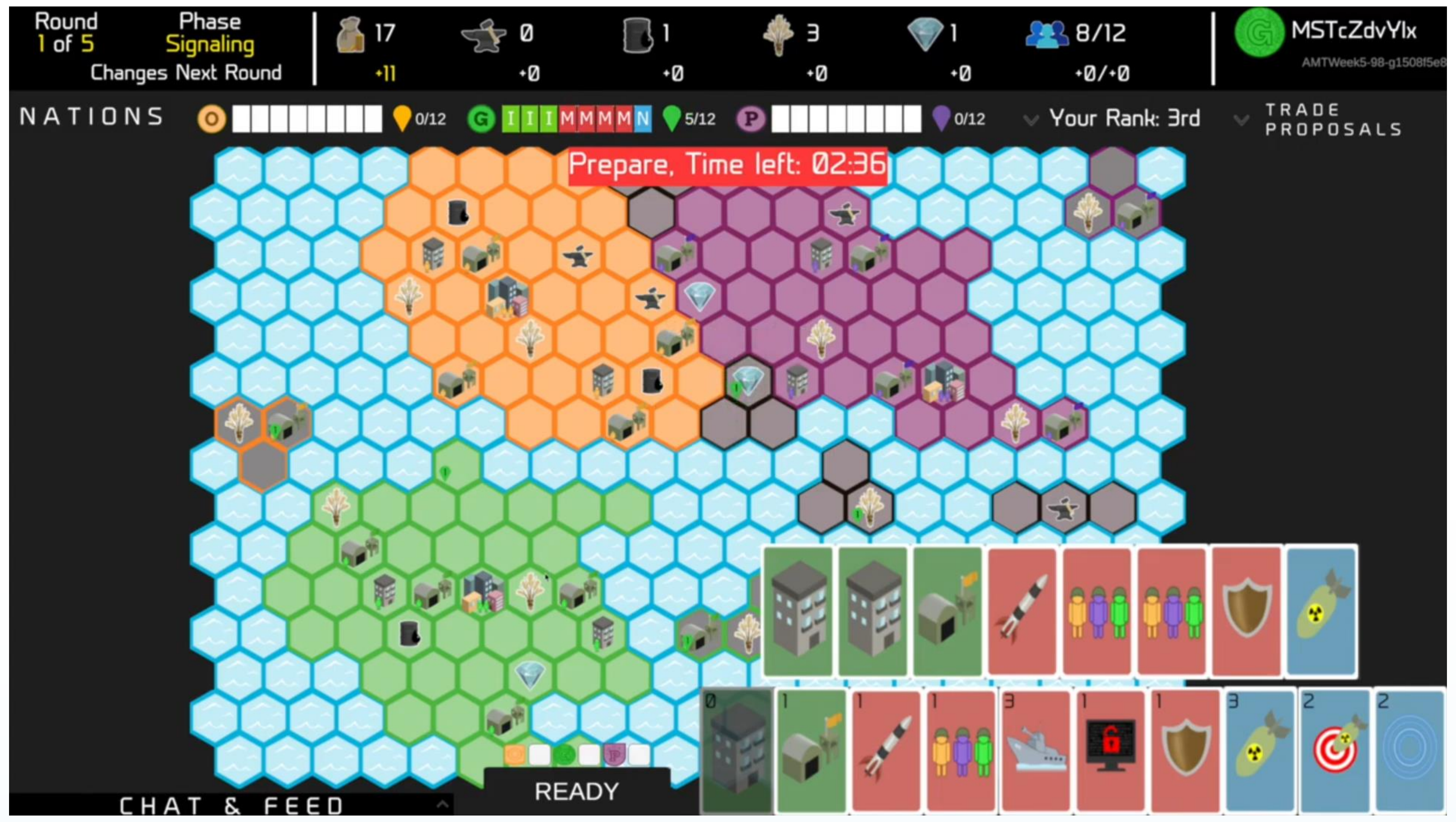


Figure 2: SIGNAL visual from PoNG – Project on Nuclear Gaming (2019)

Future

- Generate data from liar's dice simulation
- Interface simulation output with Python HMM learning toolkit
- Apply algorithmic takeaways to PoNG SIGNAL dataset

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