Exploring Billiards Games

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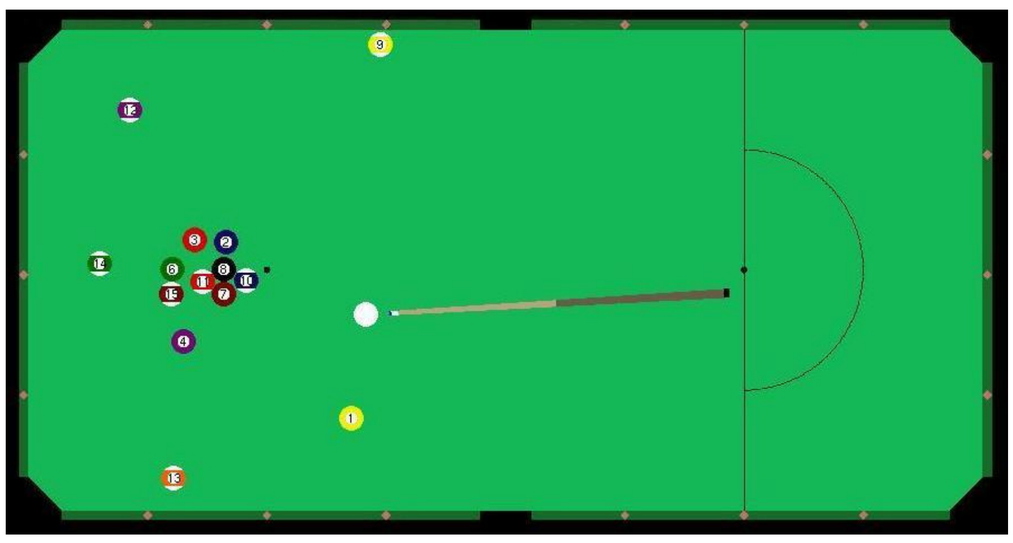
Stanford Computational Billiards



Billiards Games

Billiards games characteristics

Continuous state and action spaces, actions are taken at discrete-time intervals, there is a distinct turn-taking structure, and the results of actions are stochastic.

Computational Pool Tournament

8-ball is played on a deterministic simulator. 10 minutes is allotted per agent per game. An agent must specify 5 real numbers which specify the orientation of the cue stick, location of impact on cue ball, and velocity of cue stick. Gaussian noise added to each of these parameters.

Our agent: CueCard

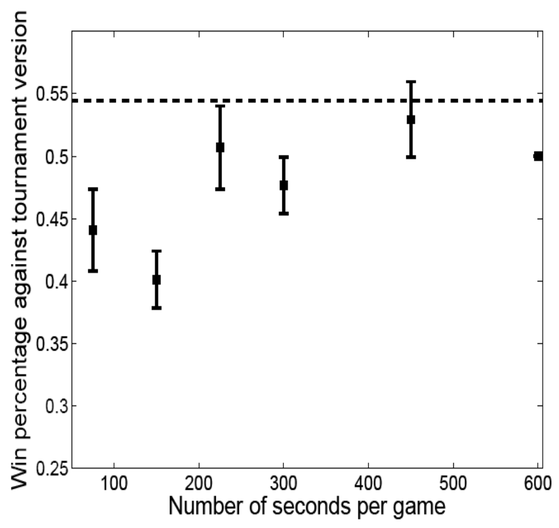
- Random shot exploration to avoid limitations of discretization.
- State clustering to allow more shot samples at first level.
- Variable num. of samples (25-100)
- End-game noiseless look-ahead
- Re-implemented physics engine
- Distributed architecture – ran on 20 EC^2 CPUs to increase effective time
- Optimized break shot

Result = Gold Medal

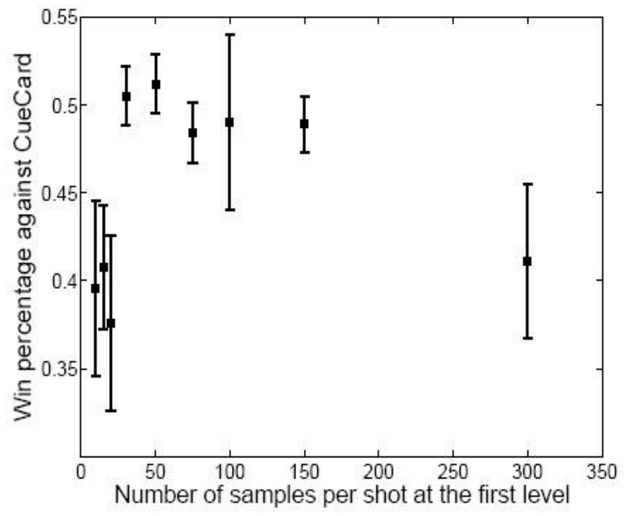
CueCard won the gold medal in the 2008 ICGA Computer Olympiad computational pool tournament.

Experimentation

Ran experiments to determine and analyze main contributors to victory.
Effective : break shot, clustering/number of samples, more time
Not effective: level 2 search, variable shot sampling



Amount of time



Number of samples

Agent	Win % vs. CUECARD-TV	SD
L2 = PickPocket	49.88%	1.4%
Ignore level 2	45.23%	2.0 %
More level 1	51.60%	1.4%

Level 2 of search

Agent | break vs. agent | break	Win %	SD
CC | CC vs. PP | PP	77.4%	2.0%
CC | PP vs. PP | PP	65.4%	2.4%
CC | CC vs. PP | CC	69.3%	1.6%
CC | CC vs. CC | PP	70.1%	5.1%

Break shot

Other / Future Work

Modeling Billiards Games

Previous game-theoretic models are not appropriate for modeling billiards games. We propose a model and state the conditions under which Nash equilibria exist in this game.

Skill and Strategy

Billiards provides an interesting distinction between skill and strategy, as well as an ideal test-bed for exploring their interaction and questions such as: how does the ideal strategy change as the skill changes? What happens if strategic planning uses false assumptions about the skill? How should an agent play if it doesn't know its own skill?

References

Analysis of a Winning Computational Billiards Player. C. Archibald, A. Altman and Y. Shoham. Proceedings of IJCAI-09, to appear.

Modeling Billiards Games. C. Archibald and Y. Shoham. Proceedings of AAMAS-09, to appear.