

The Parameterized Poker Squares EAAI NSG Challenge

Todd W. Neller
Gettysburg College

What is the EAAI NSG Challenge?

- Goal: a fun way to encourage good, faculty-mentored undergraduate research experiences that includes an option for peer-reviewed paper publication and presentation at a major CS conference.
- Students work independently or in teams with a faculty mentor to meet the challenge.
- Challenge submissions and associated papers would be submitted one month before and at the following EAAI paper submission deadline, respectively.
- EAAI-16's NSG Challenge: **Parameterized Poker Squares**

Poker Squares (Original)

- Materials:
 - shuffled standard (French) 52-card card deck,
 - paper with 5-by-5 grid, and
 - pencil
- Each turn, a player draws a card and writes the card rank and suit in an empty grid position.
- After 25 turns, the grid is full and the player scores each grid row and column as a 5-card poker hand according to a given point system.

American Point System

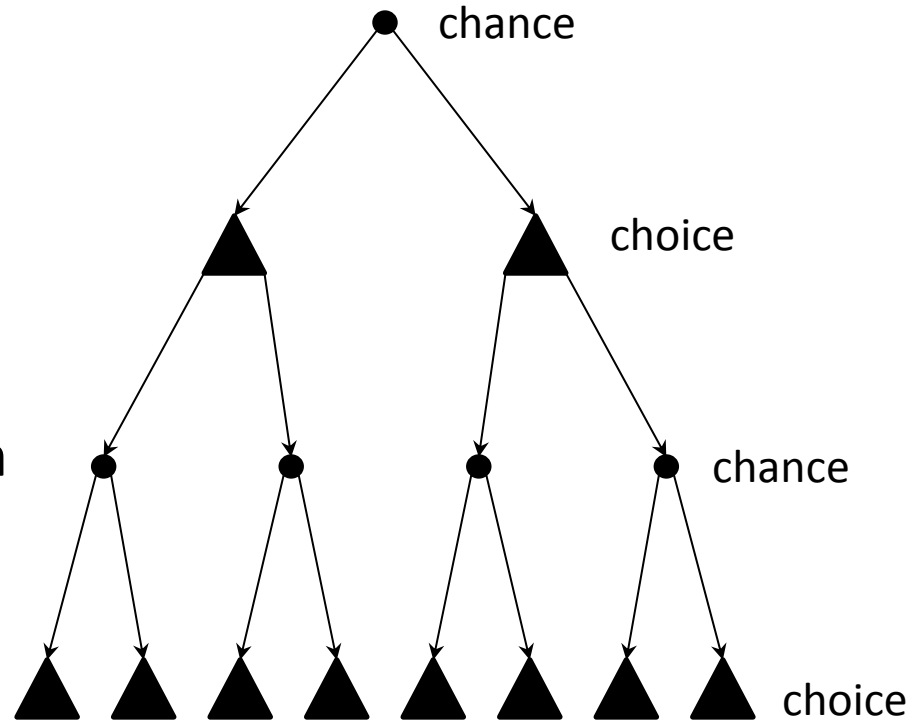
<u>Poker Hand</u>	<u>Points</u>	<u>Description</u>	<u>Example</u>
Royal Flush	100	A 10-J-Q-K-A sequence all of the same suit	10♣, J♣, Q♣, K♣, A♣
Straight Flush	75	Five cards in sequence all of the same suit	A♦, 2♦, 3♦, 4♦, 5♦
Four of a Kind	50	Four cards of the same rank	9♣, 9♦, 9♥, 9♠, 6♥
Full House	25	Three cards of one rank with two cards of another rank	7♠, 7♣, 7♦, 8♥, 8♠
Flush	20	Five cards all of the same suit	A♥, 2♥, 3♥, 5♥, 8♥
Straight	15	Five cards in sequence; Aces may be high or low but not both	8♣, 9♠, 10♥, J♦, Q♣
Three of a Kind	10	Three cards of the same rank	2♠, 2♥, 2♦, 5♣, 7♠
Two Pair	5	Two cards of one rank with two cards of another rank	3♥, 3♦, 4♣, 4♠, A♣
One Pair	2	Two cards of one rank	5♦, 5♥, 9♣, Q♠, A♥
High Card	0	None of the above	2♦, 3♣, 5♠, 8♥, Q♦

Parameterization of Poker Squares

- The American Point System (0, 2, 5, 10, 15, 20, 25, 50, 75, 100) is based on hand rank in Poker.
- The British Point System (1, 3, 6, 12, 5, 10, 16, 30, 30) is based on the difficulty of forming the hands in Poker Squares. (a.k.a. English Point System)
- For our challenge, AI players are *given the scoring system at play time* with points in the range [-128, 127]. Examples:
 - Ameritish point systems: random variations on American and British systems
 - Single Hand: 1 point for one hand type, 0 points otherwise
 - Hypercorners: all 1 or -1 score values
 - Random: random score system in range [-128, 127]

Structure of the Game

- The game is structured as an alternating sequence of *chance nodes* and player *choice nodes*.
 - Each card draw is a probabilistic event where any remaining card is drawn with equal probability.
 - Each player *action* is a commitment to a card placement.



Game Tree Size

- How big is the Poker Squares game tree?
 - Root chance node: 52 possible cards
 - 52 depth-1 choice nodes: 25 possible placements
 - 52x25 depth-2 chance nodes: 51 possible cards
 - 52x25x51 depth-3 choice nodes: 24 possible placements
 - ...
 - $52!/27! \times 25! = 52!/(27 \times 26) \cong 1.15 \times 10^{65}$ nodes
 - Although:
 - Different draw/play sequences can lead to the same state.
 - Rows/columns may be reordered without affecting score.
 - Still, we cannot evaluate entire expectimax trees except for much smaller end-game situations.

Evaluation

- Players were evaluated using 12 point systems. For each point system:
 - Players had 5 minutes to process the point system, form strategy, etc.
 - Players then played 100 games with 30 seconds of decision time per game.
 - Total scores were linearly scaled between 0 (min. total score) and 1 (max. total score).
- The player with the maximum sum of scaled total scores is the winner.

Results

1. Score: **11.821**; Player: **BMO_V2**; Students: Karo Castro-Wunsch, William Maga; Faculty mentor: Calin Anton; School: MacEwan University
2. Score: **11.763**; Player: **GettysburgPlayer**; Students: Colin Messinger, Zuozhi Yang; Faculty mentor: Todd Neller; School: Gettysburg College
3. Score: **11.334**; Player: **Tiger**; Students: Robert Arrington, Clay Langley; Faculty mentor: Steven Bogaerts; School: DePauw University
4. Score: 11.170; Player: JoTriz; Student: Kevin Trizna; Faculty mentor: David Mutchler; School: Rose-Hulman Institute of Technology
5. Score: 7.149; Player: SRulerPlayer; Student: Zachary McNulty ; Faculty mentor: Timothy Highley; School: La Salle University
6. Score: 0.192; Player: MonteCarloTreePlayer; Student: Isaac Sanders; Faculty mentor: Michael Wollowski; School: Rose-Hulman Institute of Technology
7. Score: 0.190; Player: DevneilPlayer; Student: Adam Devigili; Faculty mentor: Brian O'Neill; School: Western New England University

Players Mean Scores by Point System

	American	Ameritish	British	Hypercorner	Random	High Card	One Pair	Two Pair	3 of a Kind	Straight	Flush	Full House
BMO_V2	125.27	105.54	54.50	1.10	437.77	9.37	9.12	4.46	3.20	2.97	3.43	1.82
DevneilPlayer	14.36	15.27	7.51	-9.52	-86.92	5.22	4.10	0.45	0.21	0.04	0.05	0.03
Gettysburg	123.94	110.28	53.38	1.24	429.89	9.37	9.17	4.47	3.02	2.71	3.46	1.93
SRulerPlayer	51.83	55.39	30.29	-5.10	242.85	9.34	8.84	4.04	2.10	1.58	1.98	0.61
JoTriz	116.75	109.03	53.59	-0.78	351.07	9.31	9.15	4.59	3.03	2.59	3.36	1.67
Tiger	116.12	111.26	53.92	-2.20	411.78	9.35	9.16	4.52	2.89	2.94	3.41	1.82
MonteCarloTreePlayer	15.47	15.31	7.61	-9.30	-86.83	4.80	4.53	0.45	0.20	0.05	0.02	0.00
RandomPlayer	14.25	15.67	7.71	-9.66	-106.80	5.20	4.31	0.42	0.23	0.01	0.01	0.01
Max	125.27	111.26	54.50	1.24	437.77	9.37	9.17	4.59	3.20	2.97	3.46	1.93
Min	14.25	15.27	7.51	-9.66	-106.80	4.80	4.10	0.42	0.20	0.01	0.01	0.00

Normalized Scores

	American	Ameritish	British	Hypercorner	Random	High Card	One Pair	Two Pair	3 of a Kind	Straight	Flush	Full House	Total
BMO_V2	1.00	0.94	1.00	0.99	1.00	1.00	0.99	0.97	1.00	1.00	0.99	0.94	11.821
DevneilPlayer	0.00	0.00	0.00	0.01	0.04	0.09	0.00	0.01	0.00	0.01	0.01	0.02	0.190
Gettysburg	0.99	0.99	0.98	1.00	0.99	1.00	1.00	0.97	0.94	0.91	1.00	1.00	11.763
SRulerPlayer	0.34	0.42	0.48	0.42	0.64	0.99	0.93	0.87	0.63	0.53	0.57	0.32	7.149
JoTriz	0.92	0.98	0.98	0.81	0.84	0.99	1.00	1.00	0.94	0.87	0.97	0.87	11.170
Tiger	0.92	1.00	0.99	0.68	0.95	1.00	1.00	0.98	0.90	0.99	0.99	0.94	11.334
MonteCarloTreePlayer	0.01	0.00	0.00	0.03	0.04	0.00	0.08	0.01	0.00	0.01	0.00	0.00	0.192
RandomPlayer	0.00	0.00	0.00	0.00	0.00	0.09	0.04	0.00	0.01	0.00	0.00	0.01	0.153