The Parameterized Poker Squares
EAAI NSG Challenge

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What is the EAAI NSG Challenge?

• DARPA has energized research with its Grand Challenges.
• We would like to similarly energize student research.
• However, the goals would need to be Not So Grand.
• Core idea:
  – Students may work independently or in teams with a faculty mentor to meet the challenge.
  – Challenge submissions and associated papers would be submitted at the following EAAI paper submission deadline.
  – At the next EAAI: challenge results, accepted paper presentations, next NSG Challenge
  – Over time, we would ideally cover diverse, deep, and simply-specified challenges to invite students into the craft of research.
Poker Squares

• 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

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

• For our challenge, AI players will be given the scoring system at play time with points in the range [-128, 127]. Possible examples:
  – Ameritish point systems: random variations on American and British systems
  – Specialty: All points for one or two hand types, 0 otherwise
  – Hypercorners: all max or min score values
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
  – ...
  – \( \frac{52!}{27!} \times 25! = \frac{52!}{(27 \times 26)} \approx 1.15 \times 10^{65} \) nodes
  – Although:
    • Different draw/play sequences can lead to the same state.
    • Rows/columns may be reordered without affecting score.
  – Still, we will not be able to evaluate entire expectimax trees except for much smaller end-game situations.
To Be Determined

• Client-server or real-time on single machine
  – Client-server – pros: simplicity of interface, distribution of testing and evaluation computation; con: uneven playing field with team computational resources

• How many scoring systems for evaluation and how many games played per scoring system

• Distribution of scoring systems

• Input to these decisions is invited now.

• Sign up here to indicate possible interest and be in the loop for determination of such details.
Resources and References

- My email: Todd Neller <tneller@gettysburg.edu>
- Poker Squares Page: http://tinyurl.com/pokersqrs
  - References
  - Rules and play grids
- Monte Carlo Tree Search (MCTS):
  - C. Browne et al. A Survey of Monte Carlo Tree Search Methods
  - http://www.mcts.ai/?q=mcts
- MCTS application to similar problem: R. Lorentz. An MCTS Program to Play EinStein Würfelt Nicht!