The Gin Rummy EAAI Undergraduate Research Challenge

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Objectives

• **Purpose of the contest:** to encourage faculty-mentored undergraduate researchers to experience the full life-cycle of research.
  – Gin Rummy has little AI research attention to date
    → low-hanging fruit for undergraduate research

• **Objectives of the competitors:** to develop the best AI for Gin Rummy play within software specifications (e.g. interface, time constraints)
**Gin Rummy Rules**

- **2 players, 52 cards, Aces low**
- **Object:** to be the first player to score 100 points or more.
- **Meld:** a set of 3 or more cards of the (1) same rank (e.g. 7♣, 7♦, 7♥ “set”) or (2) same suit in sequence (e.g. A♠, 2♠, 3♠, 4♠ “run”)
- **Deadwood:** cards not in melds
- **Card points:** 10 for face cards, A=1, number value for number ranks
- **Deadwood points:** sum of card points for all cards not in disjoint melds. (Melds must not share cards.)
Gin Rummy Play

- The dealer alternates. The dealer deals 10 cards to each player and turns the top card of the remaining draw pile face up to form a discard pile.
- Each turn, player may draw the top face-up card from the discard pile or the top face-down card of the draw pile.
  - First turn exception: If the dealer declines the top face-up card, the opponent may begin the deal play by drawing that card, or may also decline. If the opponent declines, the dealer begins by drawing from the draw pile.
- After drawing, the player must discard.
- A player who would have less than or equal to 10 deadwood points after discard may end the deal’s play by knocking, sometimes signaled by discarding face-down.
Gin Rummy Scoring

• After a player knocks,
  – The knocking player lays down melds face-up and reveals deadwood cards.
  – The opponent lays down any melds.
  – If the knocking player has any deadwood, the opponent may then “lay off” opponent deadwood cards to knocking player melds. Any remaining opponent deadwood is revealed.
• If the knocking player has no deadwood, they are said to have “gin”. That player scores 25 points + opponent deadwood points.
• If the knocking player has deadwood that is...
  – ... less than opponent deadwood, the knocking player scores the deadwood point difference.
  – ... greater than or equal to the opponent deadwood, the opponent “undercuts” and scores 25 points + the deadwood point difference.
A Sampling of Implementations

- Android: Gin Rummy Free by AI Factory Limited
- Web: https://www.gin-rummy-online.com/
- iOS: Gin Rummy Plus by Zynga
Gin Rummy Game Tree Nodes

• Gin Rummy, like Poker, is a game of imperfect information with choice and chance nodes.

• Types of choice nodes:
  – Take first up-card? (2 actions)
  – Draw face-up or face-down? (2)
  – Which card to discard? (11)
  – Whether or not to knock (when allowable)? (2)
  – (How to meld when knocking?) (≥1, often 1)

• Chance node:
  – Drawn face-down card (≤ 31)
DeepStack Operation for Poker

Image source: https://spencer-murray-zfht.squarespace.com/figures
Research Topics Overview

• Opponent Hand Estimation
  – Given:
    • Your knowledge of which cards are discarded and unavailable, in your hand, and in the opponents hand
    • Your observations of which face-up cards were refused by the opponent, or discarded by the opponent
  – Estimate: the probability / relative likelihood of the opponent holding a particular card

• Optimal Play
  – Given: above game state knowledge and opponent hand estimation
  – Choose: a draw/discard action that maximizes the probability of winning
Opponent Hand Estimation

• Some basic opponent hand estimation is described by Jeff Rollason (AI Factory) at [https://www.aifactory.co.uk/newsletter/2007_02_imperfect_info.htm](https://www.aifactory.co.uk/newsletter/2007_02_imperfect_info.htm)

  – An opponent *drawing* a face-up card or *discarding* a card respectively *increases* or *decreases* the probability of having same rank or adjacent suit cards.
Example Estimation

• What can we learn if we observe a player:
  – Draw a face-down card with 4H face-up?
  – Discard 6D?
  – Draw a face-down card with 6H face-up?
  – Discard 7C?
  – Draw a face-up QD?

Image source: https://www.aifactory.co.uk/newsletter/2007_02_imperfect_info.htm
Experimental Simple Gin Rummy Player

• Poor, simple strategy:
  – Ignore opponent actions and cards no longer in play.
  – Draw face up card only if it becomes part of a meld. Draw face down card otherwise.
  – Discard a highest ranking unmelded card from among the deadwood of melds that minimize deadwood points (without regard to breaking up pairs, etc.)
  – Knock as early as possible.
The Gin Rummy AI Challenge

• Email Todd Neller <tneller@gettysburg.edu> to register a team with at least one undergraduate student and at least one faculty mentor.

• One month before AAAI-21 submission deadline, submit an AI player that works with our contest code.

• Submit a paper for peer review to a special EAAI-21 track at the AAAI-21 paper deadline.

• Accepted papers will be presented and winners will be announced at EAAI-21 in Vancouver!
Questions?