An Introduction to the Current Approaches in

Computer Poker

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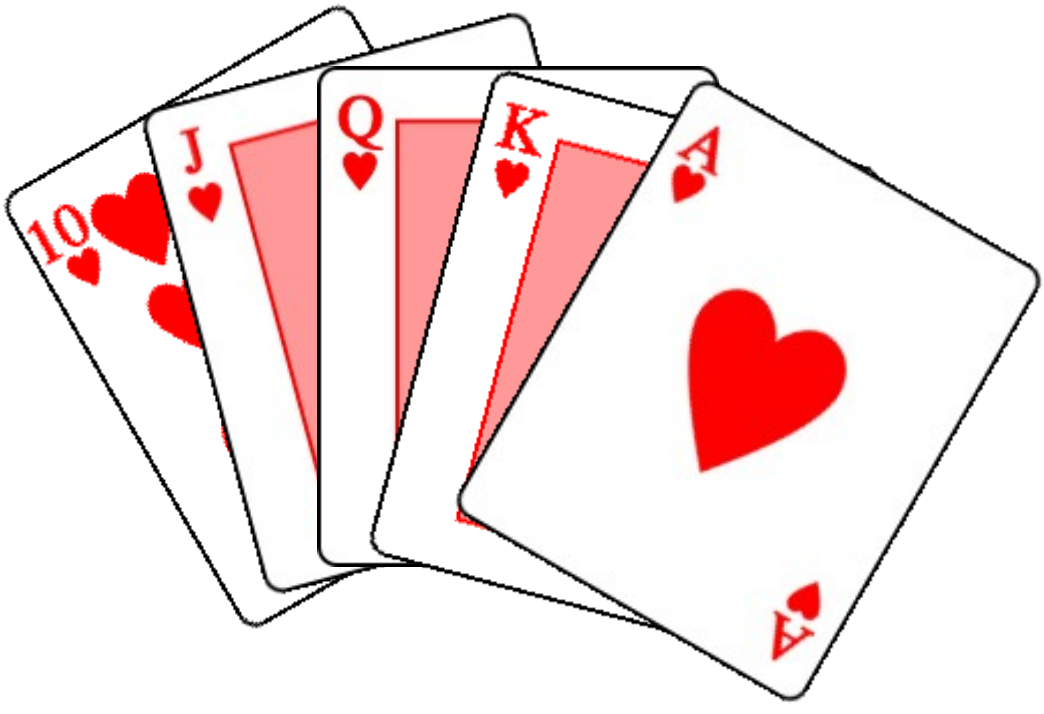
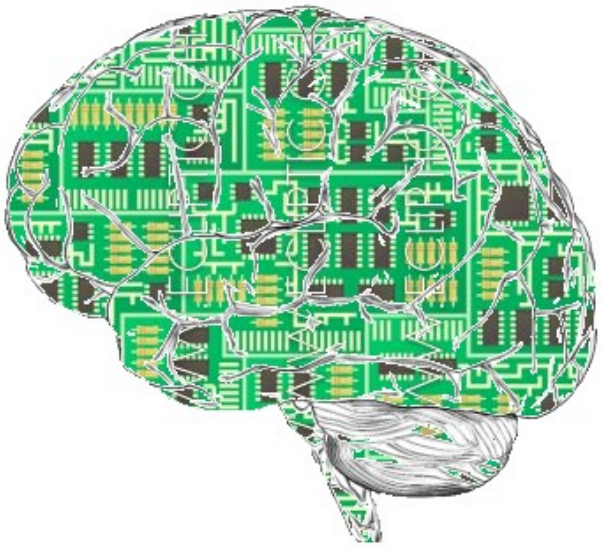
December 4, 2009



Source (all card images)http://en.wikipedia.org/wiki/Playing_card

Motivation

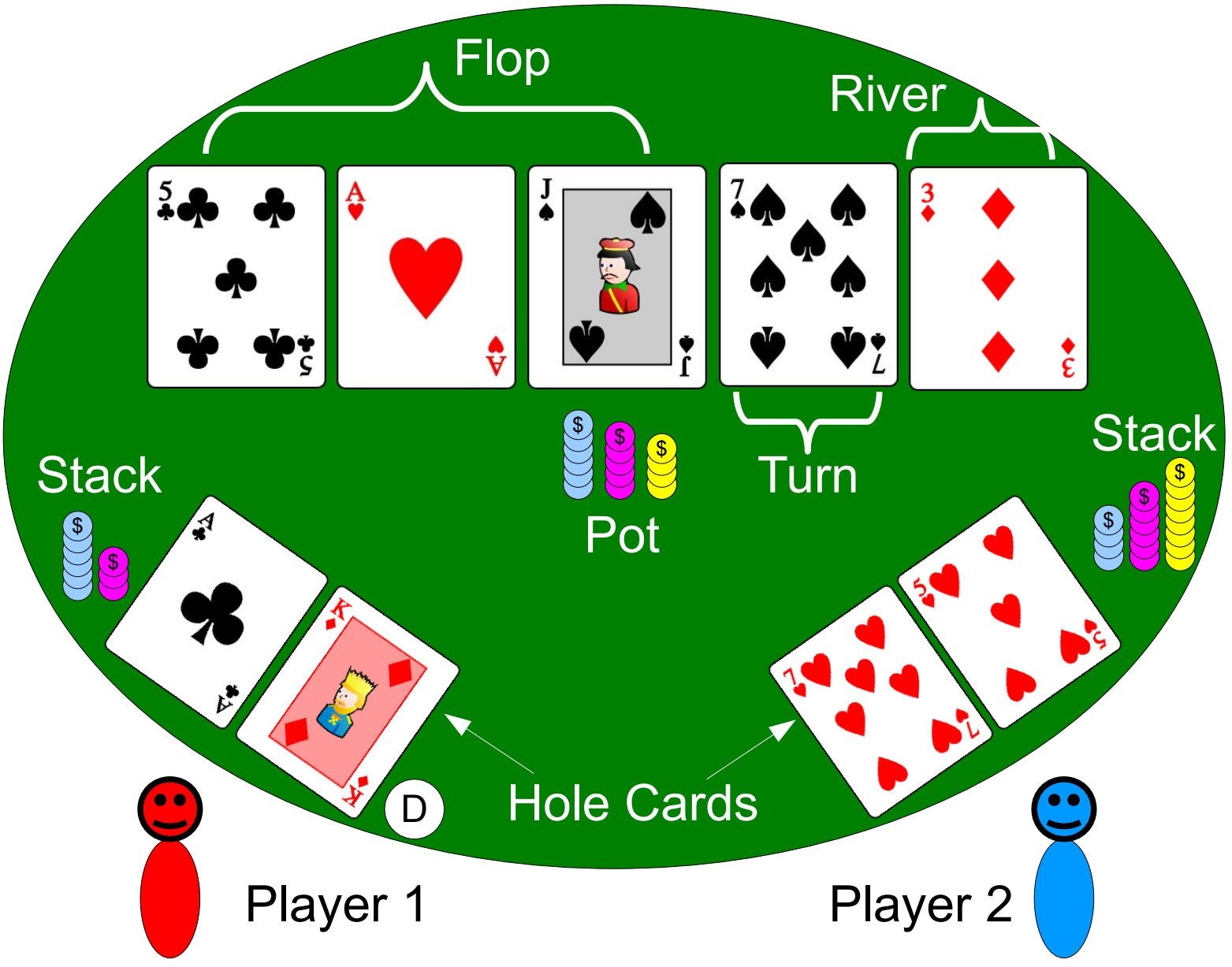
Source:http://www.flickr.com/photos/andresrueda/3453821052/



Source:http://en.wikipedia.org/wiki/File:ArtificialFictionBrain.png

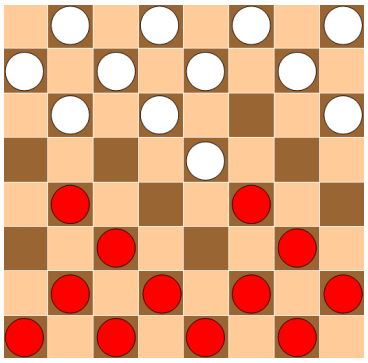
- Fully autonomous intelligent computers
- We are far from completely autonomous behaviour
- Use games as a stepping stone for artificial intelligence research

Texas Hold'em

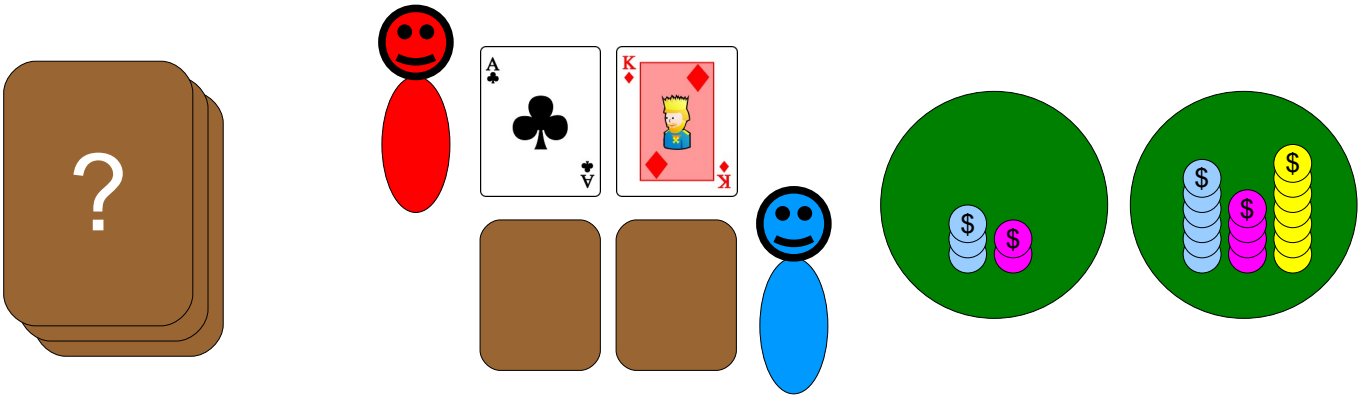


- Example: Player 2 wins the pot in a showdown

Challenges

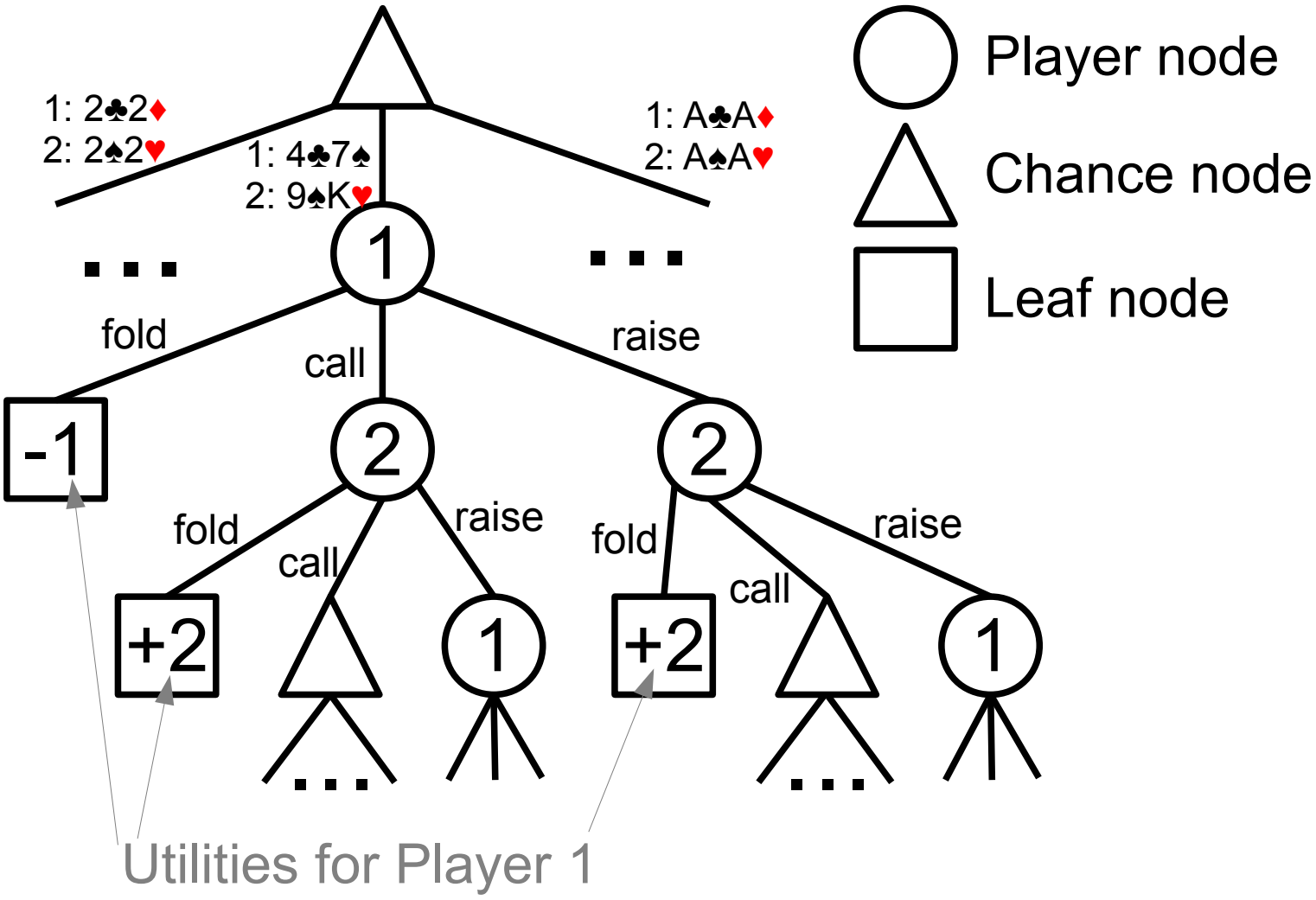


- Other studied games, like Checkers, are:
  - Deterministic
  - Full information
  - Win, lose, or draw



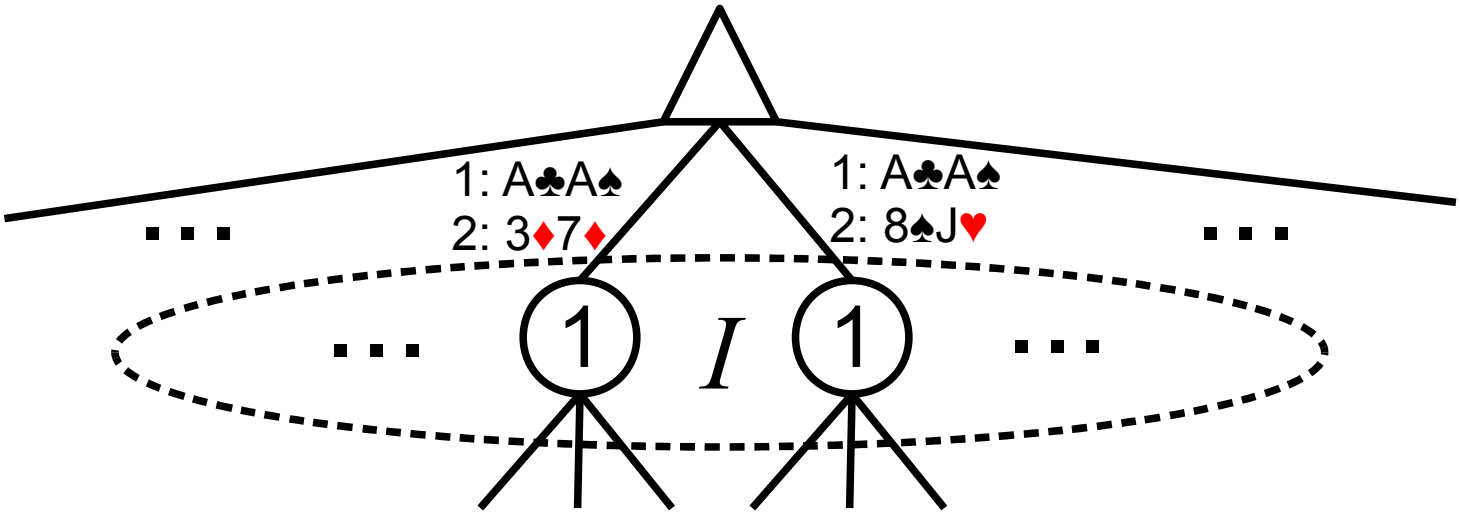
- In Texas Hold'em:
  - Card deals are random
  - Hole cards are private
  - Variable degrees of winning and losing

Extensive Form Games



- Upper part of the extensive form game tree [Osborne & Rubenstein 1994] for Heads-Up Limit Texas Hold'em

Extensive Form Games



- Two states in the same information set for Player 1

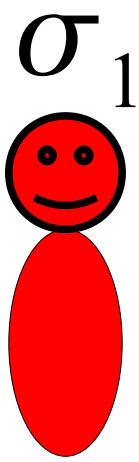
$$\sigma_1(I) = \{p_{fold}, p_{call}, p_{raise}\}$$

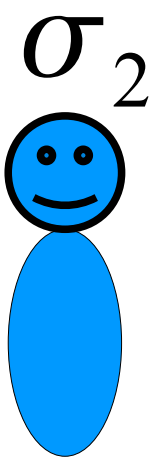
Strategy

Information Set

Action Probabilities

Nash Equilibrium

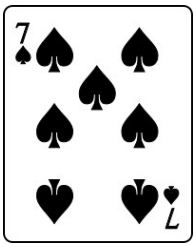




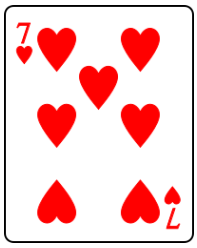
For all σ_1', $\mathbf{u_1}(\sigma_1, \sigma_2) \geq \mathbf{u_1}(\sigma_1', \sigma_2)$

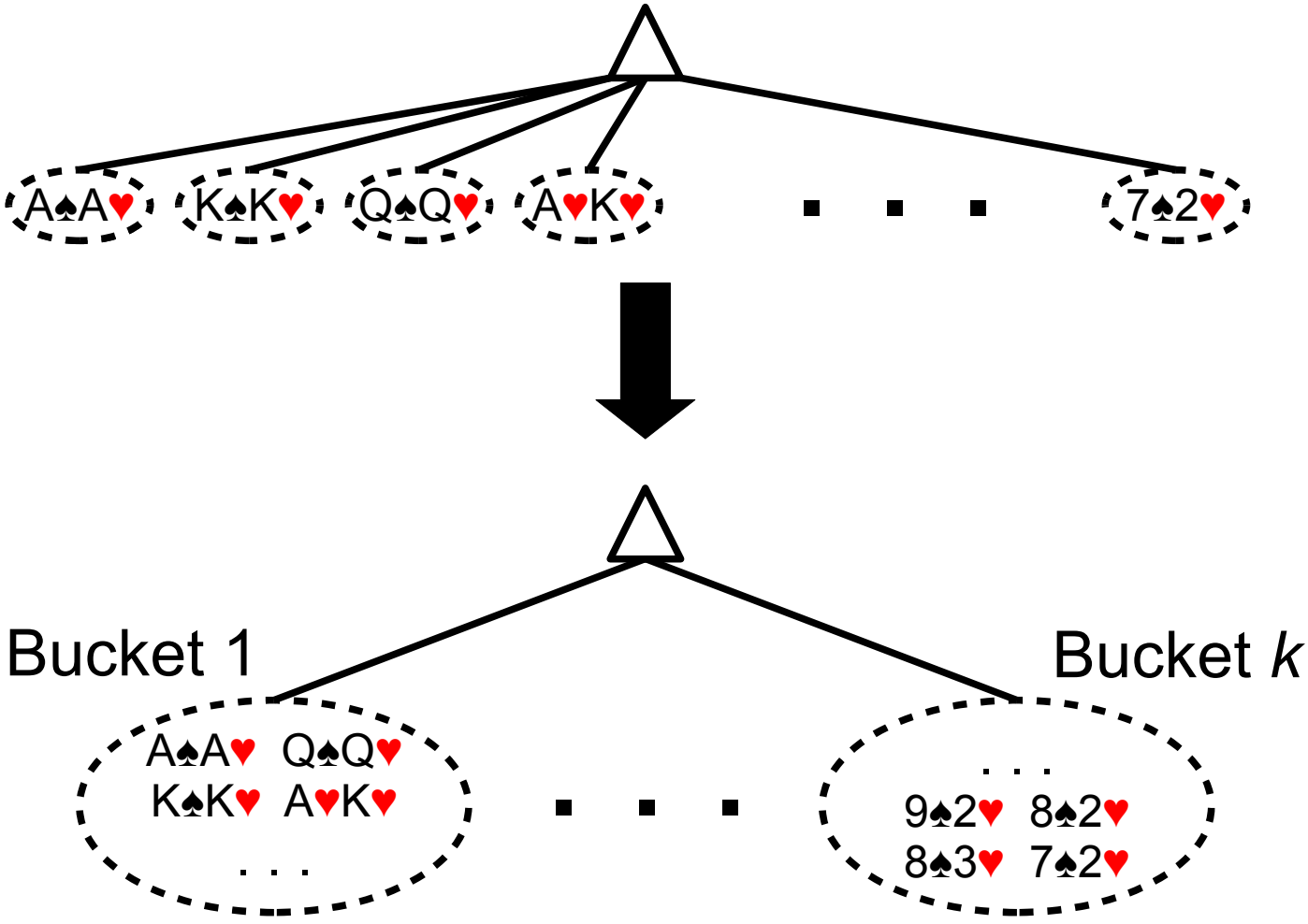
For all σ_2', $\mathbf{u_2}(\sigma_1, \sigma_2) \geq \mathbf{u_2}(\sigma_1, \sigma_2')$

- (σ_1, σ_2) is a Nash equilibrium [Nash 1951]
- Provides a guarantee on expected winnings in Heads-Up games ($\mathbf{u_2} = -\mathbf{u_1}$)
- Can theoretically approximate via linear programming [Koller et al. 1994]



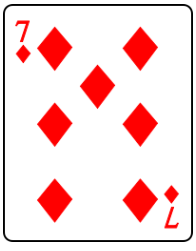
Abstraction

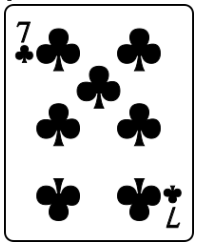


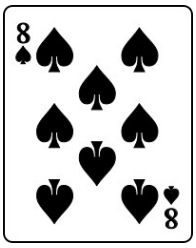


- Heads-Up Limit Texas Hold'em too large; instead, analyze an abstract game

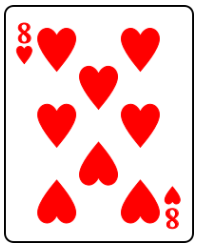
- Group hands according to *expected hand strength* = probability of winning against a uniformly random hand (as found in [Johanson 2007]).







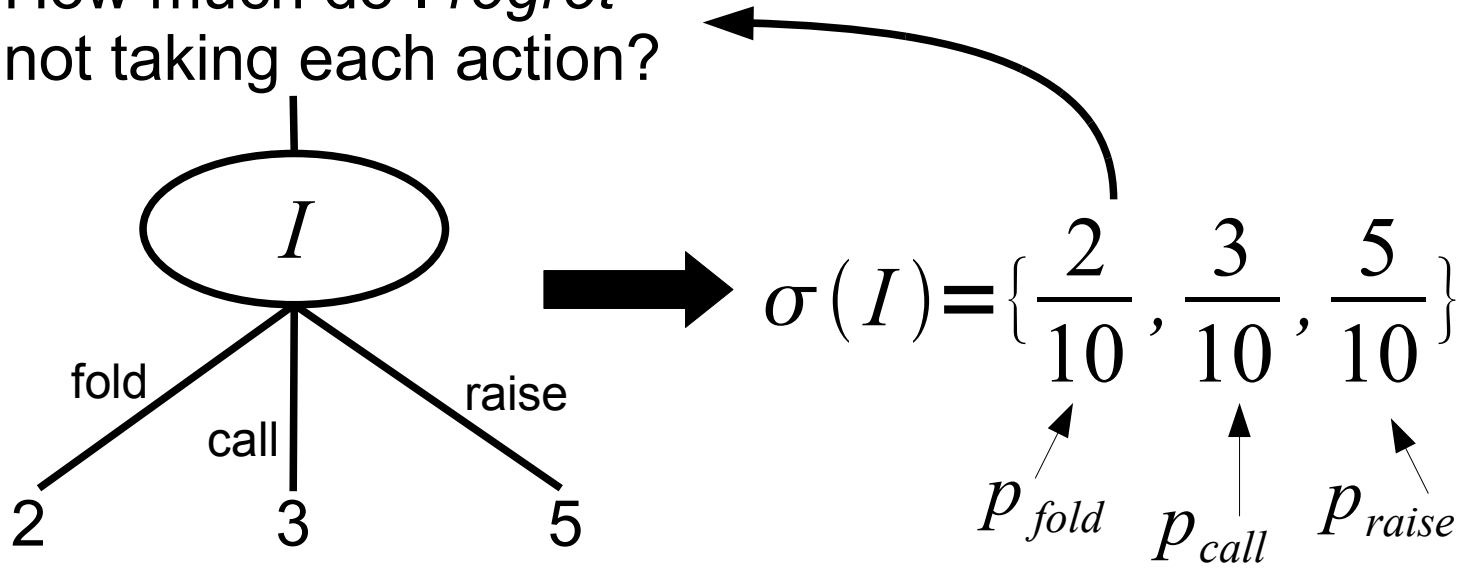
CFR



Counter-factual Regret Minimization algorithm [Zinkevich et al. 2008]:

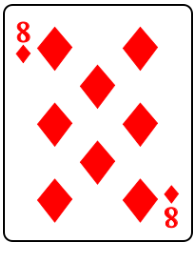
Input: Extensive form game tree, number of iterations *T*

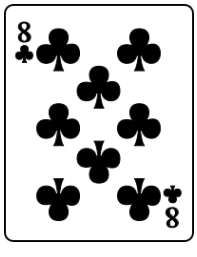
How much do I *regret* not taking each action?



Output: $(\bar{\sigma}_1, \bar{\sigma}_2)$

- Finds an approximate Nash equilibrium
- Can analyze larger abstractions than linear programming





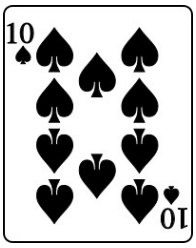
Polaris

Man-Machine Poker Championships
2007 and 2008 [man-machine]

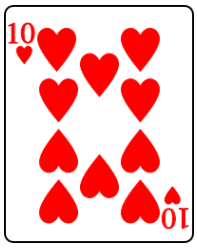
Source:http://www.lasvegasvegas.com/viewer/v/WSOP2004-2006/WSOP2006+2006+World+Series+of+Poker+-+Rio+Las+Vegas/3619-lg.jpg.html

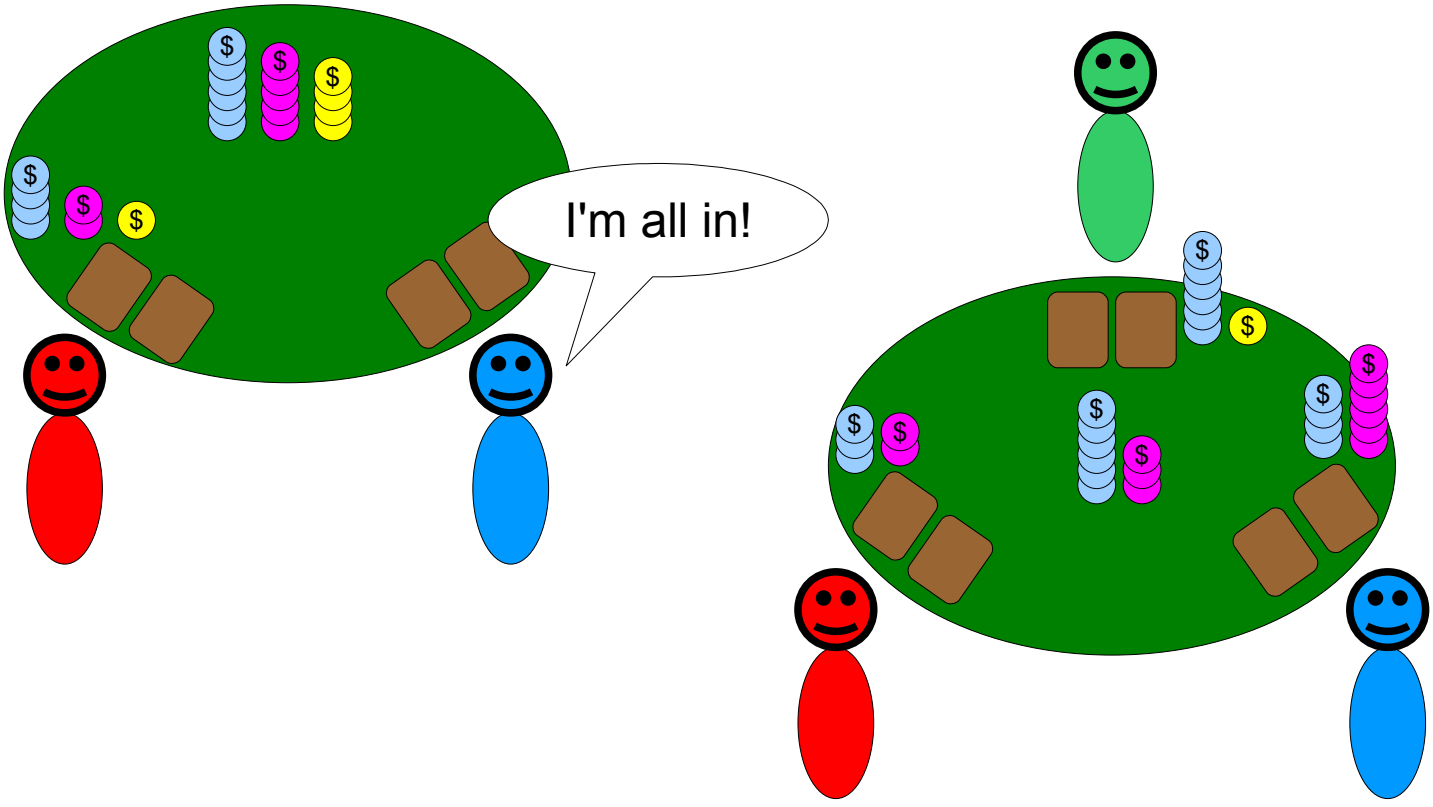
vs Polaris

- Heads-Up Limit Texas Hold'em only
- Polaris used strategy based on CFR
- 2007: Polaris loses to Phil Laak and Ali Eslami
- 2008: Polaris defeats a team of professionals including Matt Hawrilenko and IJay Palansky



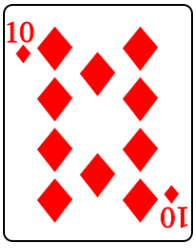
Future Work

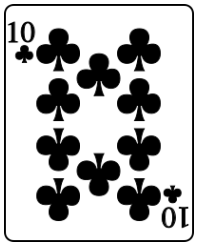


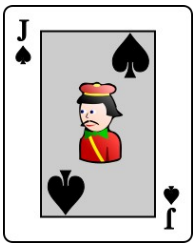


- No Limit Hold'em
  - Must also abstract actions. But how?

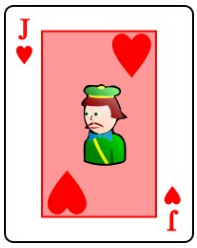
- Ring (Multi-Player) Limit Hold'em
  - Will CFR find a “useful” strategy?
  - Do we even want to play in equilibrium?







References



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