Machines to play the Game of Pure Strategy

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Overview

- GOPS the card game

- Reasoning and the beginnings

- Dealing a hand and game rules

- Random machines & a Heuristic Machine

- Game playing interface and Heuristic Machine

- Reflections

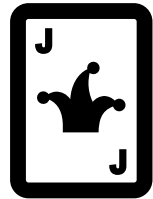# Game of Pure Strategy (GOPS)

- The game was invented by Merrill Flood while at Princeton University

- the game is called Goofspiel

- Used in game theory and artificial intelligence

Humble Beginnings

Reasoning

- Straightforward game

- Many different Heuristics

- See the results of the matches played (anything noteworthy?)

- Easy to implement so I can focus on the AI part

Creating cards

Implementation

Dealing cards

```
>>> display hand1...
--- *hand1* = NIL
>>> display hand2...
--- *hand2* = NIL
>>> display prize suite...
--- *prize-suite* = NIL
>>> display discard suite...
--- *discard-suite* = NIL
>>> dealing cards to hands...
>>> display hand1...
--- *hand1* =
((ACE . HEART) (2 . HEART) (3 . HEART) (4 . HEART) (5 . HEART) (6 . HEART) (7 . HEART)
 (8 . HEART) (9 . HEART) (10 . HEART) (JACK . HEART)
 (QUEEN . HEART) (KING . HEART))
```

Game Rules

- At Least 2 Players

- Dealt a suite of cards

- Bid from your hand for a prize card

- Highest Bid wins the round

- Higher score wins from adding the value of all prizes won

There is life

A Random Machine

```
>>>---------- Round:  13 ----------<<<
--- Prize Card = (8 . CLUB)

--- PLayer 1 plays ---

--- Card  = (KING . SPADE)

--- PLayer 2 plays ---

--- Card  = (7 . DIAMOND)
--- Player 1 won ---
```

Improvements

A Heuristic Machine

- Match the prize card with a card of the same value

- M1 in this case

- M2 is a random machine

- Sheldon Ross proved that this matching strategy is optimal on a player who plays completely random
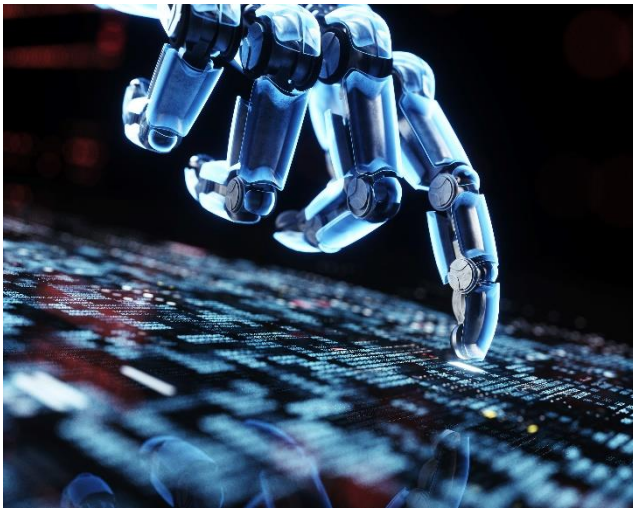
Result of 1000 games

```
M1 wins: 968
M1 losses: 27
M1 draws: 5
```

Interactivity

A game playing interface

- Switch to use CLOS

- A lot of code was rewritten

- Created players in the object system

- Created a game object

- Allows two machines to play against each other

- Allows a human to play a machine

More machines

Heuristic machine again?

```
( set-card-list '1 '( 0 20 30 40 50 60 70 75 80 85 90 95 100 ) )
( set-card-list '2 '( 5 10 15 20 25 30 35 40 50 60 70 80 100 ) )
( set-card-list '3 '( 5 10 15 20 25 30 35 40 50 60 70 80 100 ) )
( set-card-list '4 '( 5 10 15 20 25 30 35 40 50 60 70 80 100 ) )
( set-card-list '5 '( 5 10 15 20 25 30 35 40 50 60 70 80 100 ) )
( set-card-list '6 '( 5 10 15 20 25 30 35 40 50 60 70 80 100 ) )
( set-card-list '7 '( 5 10 15 20 25 30 35 40 50 60 70 80 100 ) )
( set-card-list '8 '( 5 10 15 20 25 30 35 40 50 60 70 80 100 ) )
( set-card-list '9 '( 2 4 6 8 20 45 55 65 80 85 115 120 125 ) )
( set-card-list '10 '( 2 4 6 8 10 12 20 30 50 65 95 115 125 ) )
( set-card-list '11 '( 2 4 6 8 10 12 20 30 50 65 80 100 120 ) )
( set-card-list '12 '( 2 4 6 8 10 12 20 30 50 65 80 95 120 ) )
( set-card-list '13 '( 2 4 6 8 10 12 20 30 50 65 80 95 110 ) )
```

What's the difference?

- Create a table and a use a random number to pick the columns. The row is determined by the prize card.

- M1 Random player with a slight favoring of higher valued cards for higher value prize cards.

- New heuristic loses to the old heuristic

```
M1 wins: 23
M1 losses: 973
M1 draws: 4
```

Reflections

Infrastructure

- Underestimated the amount of infrastructure

- My plan of focusing on the AI part fell through especially with the switch to CLOS

What I would've liked to have done

- More heuristics

- Use the results from playing to update the table

- Allow the machines to play a set of machines

Sources

- https://en.wikipedia.org/wiki/Goofspiel

- https://web.archive.org/web/20150310083408/http://www.princeton.edu/~mudd/finding_aids/mathoral/pmc11.htm

- https://web.archive.org/web/20170924061950/http://www.dtic.mil/get-tr-doc/pdf?AD=AD0711882