

Cooperative Agents in Euchre

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April 16th, 2015

Abstract

Typically, agents use a set of rules or follow a specific strategy when given options in order to maximize their expected utility. This project explores such a setting in the card game euchre. Euchre gives an interesting setting where two teams of two agents compete in an incomplete information game. A suite of euchre playing agents are given which each follow a specific and quick strategy in order to maximize not only their personal utility, but their team utility.

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1 Introduction

A good heuristic or static evaluation function in games helps an agent make decisions which maximize their utility. This idea works well, however in team settings, maximizing a personal score may not be a good team strategy. In this project, we investigate this setting in the card game euchre, where two teams of two compete to maximize their team score. Some agents show, among those studied, that cooperation is a much more powerful strategy. This idea was defined in the prisoner’s dilemma, where two rational agents that maximize their personal score end up both losing. If these agents cooperated instead, their personal scores and “team” scores would be optimal.

Card games remain popular to study, as they offer interesting settings which lead to good understandings and findings. For example, a common thread in many card games is that they are incomplete information games – other players’ hands or the deck is not known to the agent. Perhaps the most interesting about card games is that humans are (generally) much better than the best known artificial agent. Famously, poker was solved in [1], however they study a very small version of poker compared to what is normal in tournament play. Not to discredit their results, but just to say that much work needs still be done in order for artificial agents to consistently beat the best human players in many card game settings. Euchre, compared to other card games, is less conventional in that it is also a cooperative game. This project details various artificial agents for euchre in order to discover a strategy that is superior.

1.1 Euchre

Simply put, euchre is a trick taking card game. It plays very similarly to other trick taking games, such as hearts or bridge. The euchre deck only consists of 24 cards, 9 through ace of each suit. Each of the four players is dealt five cards which makes up their hand. Each player’s hand is only known to them. The 21st card of the deck is turned face up to be offered as trump. The remaining three cards remain hidden and are not used in the hand (known as the “kitty”).

Players then take turns deciding on if they wish to “order up” the offered trump card. If so, the dealer must pick up the offered card, place it in his hand and secretly discard a card. If the card is not ordered up, players take turns having the option to call a trump suit or pass – but players cannot call the same trump suit as what was offered prior. Players can also choose to “go alone” when they call a trump suit, which forbids their partner from playing the hand in the hopes of scoring more points.

Once trump is called, the main portion of the game takes place. The player left of the dealer leads the first trick. Each player adds a card to the trick in turn. The winner of the trick leads the next trick. This play continues for five rounds, until all players are out of cards. Afterwards, teams count how many tricks they won, and the team that took at least 3 of the tricks scores points as:

1 point : if called trump and took 3-4 tricks

2 points: if called trump and took all 5 tricks
2 points: if didn't call trump and took 3-5 tricks
4 points: if went alone and took all 5 tricks

This play continues, shifting who deals every hand, until a team scores 10 points. That is euchre in a nutshell – though trump hasn't been explained. The general play follows the above guidelines. There are additional rules with trump and which cards you can play into a trick, which are explained below.

When a player leads a trick, the card they play determines the lead suit of the trick. Other players must play a card of the same suit if possible, otherwise they can play any card from their hand. The player with the highest ranked card in the trick wins it, however those cards which are not the lead suit or trump cannot ever win the trick. For example, if I lead the 9♥ and you followed with A♦, my lowly 9 is still winning the trick because you did not follow suit (assuming ♦ is not trump).

Trump in euchre is peculiar, and leads to much confusion for beginners. For non-trump suits, the rankings of cards is as you would expect, ace > king > queen The lowest trump cards beat the highest non-trump cards (easy enough), however the rankings in among trump is not the same as non-trump. Let ♠ be trump for a concrete example. The ordering of trump then goes J♠ > J♣ > A♠ > K♠ > Q♠ > 10♠ > 9♠. The jack is the highest card in the game, followed by the other jack of the same colour – in our example J♠ is the best and J♣ is the second best (called the “right” and “left” bowers respectfully). The left bower is the confusing part. Though it is printed J♣, it becomes a ♠ as long as ♠ is trump. So when ♣ is led and your only ♣ is J♣, you are not forced to play it as it is not a ♣, but a ♠. Likewise, when ♠ is led, you must play J♣ since it is a ♠. This means there are 7 ♠ in the game, 6 of each red suit and only 5 ♣. Similarly when a red suit is called trump, the other red jack becomes the left bower and it becomes on the trump suit rather than it's printed suit.

1.2 Agent Considerations

With the rules of euchre in mind, we can consider what information is known and important to an artificial agent. When it comes times to play a card into a trick, the following information is known:

the rules of euchre
their own hand
the card offered as trump
all of the cards played so far, and by whom
the trump suit
the lead suit of the trick, is any
the overall rankings of each card

This is all the information an agent has access to. Additional information can be inferred, such as when a player doesn't follow the lead suit, it is known that the player

cannot possibly have any cards of that suit in their hand. Making the best use of all the information available will lead to a powerful euchre agent. In the next section, we introduce several euchre agents which make different uses of all this available information. Afterwards, we compare these strategies to each other to determine which is best among them. Lastly, we will discuss the strengths and weaknesses of particular strategies and conclude with ideas for future work.

2 Euchre Agents

The overall objective in euchre is to take as many tricks as possible. This ensures the other team does not benefit from them. Generally, this strategy works well, but it ignores the team aspect of the game. In this section, we give several euchre strategies making various use of the information available in the game. All agents know the basic rules of the game, as a useful agent could not be constructed without this knowledge. Additionally, no agent can cheat. When we say an agent chooses to play a card with some property, it is assumed that the card is chosen from the set of legally playable cards. These strategies range from simple to selfish to complex. These strategies aimed to produce a very quick but good decision when playing a card from their hand into a trick.

2.1 Simple Strategies

The first strategies discussed will be very simple, but serve as a very good base for more complex strategies. These agents only make use of the information given directly to them, their hand. The first agent plays a random card from their hand. This agent exists to serve as a basis for comparison. The next two agents are opposites of each other, one always plays the lowest card in their hand while the other always plays the highest card. Since these agents do not use any additional information, they all play selfishly.

The agents High and Low serve as an excellent foundation for more complex agents. In euchre, the overall goal is to maximize the number of tricks your team earns. Playing High will give you the best possible chance of winning a trick, while Low allows you to throw away your worst card if you resign a trick. Playing a “Middle” strategy would not help compared to High and Low as it seems to give you the worst traits of both the other strategies. With Middle, you could have an increased chance of taking a trick, but if you lost the trick, you’ve lost a decent card which could have been used later to win a different trick. Do to this, no Middle agent was explored.

2.2 More Complex Strategies

The next agents become slightly more complex. These agents make use of the information given to them in the trick. The first one, called HighLow, behaves as follows:

if I have a card that can win the trick, play High
otherwise, there’s no hope, play Low

This HighLow strategy proves to perform quite well, and makes a lot of sense. If it is possible to take a trick, playing the best card gives the highest chance of actually winning the trick. If there's no hope of winning a trick, playing your worst card saves your better cards in the hopes that they can win later tricks.

A cooperative version of HighLow was created as well, called CoopHighLow. The logic of this agent is as follows:

if partner has played in the trick and is winning, play Low
otherwise, play HighLow

This strategy aims to not take tricks from your partner if it can be avoided. If your partner is winning the trick, saving your good cards for later and allowing them to win will generally be a very powerful strategy. However, if your partner is losing the trick, or hasn't played, the semi-aggressive HighLow strategy makes sense to play to try to win tricks or avoid losing better cards.

2.3 Markov Decision Strategy

2.4 Card Counting Strategy

2.5 Hybrid Strategy

2.6 Monte Carlo Agent

3 Agent Comparisons

3.1 Simple Strategies

3.2 More Complex Strategies

3.3 Markov Decision Strategy

3.4 Card Counting Strategy

3.5 Hybrid Strategy

3.6 Monte Carlo Agent

4 Discussion

4.1 Strengths of Particular Agents

4.2 Weaknesses of Particular Agents

5 Conclusions and Future Work

References

- [1] Michael Bowling, Neil Burch, Michael Johanson, and Oskari Tammelin. Heads-up limit holdem poker is solved. *Science*, 347(6218):145–149, 2015.