Simulation of Agents with Emotions in a Game of Poker

S.H. Battu (S4120310)
B.K. Musuadhi Rajan (S4065476)
S. K. R. Thiyyagura (S3585085)
H. Vidharth (S4031180)

Final Report, 3 November 2019

Abstract

Experiments on agents with emotions has been carried out on different scenarios and for various problems. Ana L. C. Bazzan and Rafael H. Bordini, in their paper "A framework for the simulation of Agents with Emotions", have shown that agents with emotions had better decision making due to co-operation in the Iterated Prisoner's Dilemma (IPD). In this paper, we present a framework of multiple emotional agents playing a game of poker.The purpose of this project is to evaluate the behaviour of agents with emotions in an analytical and complex task and further substantiate if emotions have a positive or negative impact in the decision making of agents.We found the agents to replicate and mirror the emotions shown in real life, we have also discussed techniques to implement the emotions in a complex environment.

1 Introduction

The effect of emotions in intelligent agents had been questionable until Rosalin W. Picard in her article "Affective Computing" [**1**] had shown substantial evidence to emphasise the need of emotions in intelligent agents. The theme of her article was to prove the effectiveness of emotions in a system to make complex decisions and assist humans. We take up a similar ideology, an inspiration from the framework [**3**] created by Ana L. C.Bazzan and Rafael H.Bordini, which made use of the OCC theory by Ortony et al. (1988) [**2**]. Their framework combined a psychological model called OCC along with decision theory to make emotions readable.

The OCC Model is a methodology that combines cognition and emotions for use in systems using formal language and rules.

1.1 Problem

Poker is a complex game involving logical thinking, analytical reasoning and a fair bit of emotions(poker faces) as well. It is a complex system in which we believe emotions may play a hand in deciding the victor. This in turn can help us see how emotions may affect general complex systems.

1.2 State of the art

The state of the art for this research is the publication from Ana L. C. Bazzan and Rafael H. Bordini - A Framework for the Simulation of Agents with Emotions [**3**]. Several publications have inspired

our project, including Affecting Computer by R. W. Picard [**1**], Using decision theory to formalize emotions by P. Gmytrasiewicz, C.L. Lisetti [**5**] and Approaches to modelling emotions in game theory by Barry O'Neill [ONe00]

1.3 New Idea

Our new idea involves rebuilding the framework built by Ana L. C. Bazzan and Rafael H. Bordini [**3**] by using a more complex problem and different emotions and having emotions effect attributes which control the decision making. This makes sure that the emotions have no direct impact on the agent, but has an impact on its personality because of which the decision may differ from one agent to another.

2 The Game

Below, we discuss the rules of the game, how each player/agent operates and how emotions are tied to each agent.

2.1 Poker Environment Rules

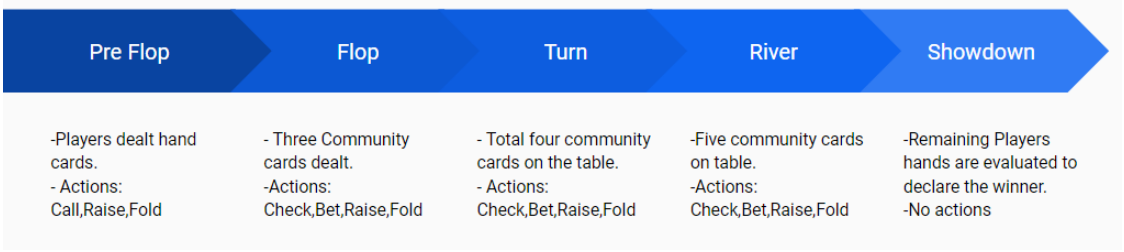

Figure 1: Rounds in Poker

The poker game we are building is a traditional Texas hold em poker with slightly modified rules. A traditional 52 card deck is used, each player gets two cards in his hand and there will be a total of five community cards by the end of the game.

Note: The terms agents and players mean the same, they will used based on the context.

Here are the sequence of events:

1. Hand cards are dealt to each player.
2. Pre-Flop round
3. Flop round
4. Turn round
5. River round
6. Showdown

The player with the best hand plus community cards(any three of five possible) is considered the winner. Each round consists of betting which is added to the 'pot'. The winner gets all the money from the pot. Here is a list of valid hands [Wik].

Rounds in Poker

The class PokerEnvironment has methods to control and simulate the rounds of poker and establish and control agents in the environment. It also has methods to render the environment.

1. Dealing

Each player gets two cards from the top of a shuffled deck of 52 cards. Each player is controlled by the 'Agent' class which has methods for making decisions and processing information available. Each agent object is separate from one another and each agent gets some coins in the beginning of the game(Default:1000).

2. Pre-Flop Round

This is the first betting round before the community cards are shown. Starting from the first player that has entered the game(first in the list), each player has three actions available to him, they are: CALL, RAISE, FOLD.

CALL: The player has to match the bet of the previous player , if it is the first player, he has to match the minimum bet(Default:10).

RAISE: The player can bet a higher amount than the previous player, it can be from double the amount to all-in. By the end of the round, if all the players don't have the same amount of bets placed, the round is re-run again to make sure they match the highest bet(tracked by minimum bet variable) or fold.

FOLD: A player quits the game, the agent is removed from the environment and any bets he placed will be removed too. The coins it has placed are not given back even if the player folds.

3. Flop Round

Three Community cards are drawn from the deck and placed in front of the agents, the agents use these community cards to make further decisions. Each player has four actions available to him: CHECK, BET, RAISE, FOLD.

CHECK: Do nothing, the player does not bet and just stays idle. But if some other player has bet, then CHECK is not possible as this player is forced to match their bet.

BET: This is similar to CALL from Pre-Flop round. The player bets the minimum bet or matches the previous player's bet.

RAISE: This is the same RAISE as the previous round, the player can bet more than the previous player up-to all-in(maximum amount it has).

FOLD: The player folds, he quits the game and is removed from the environment. No coins are given back.

The round is re-run again if the player bets are not equal until all player put in the equal amount or fold.

4. Turn Round

One more community card is drawn from the deck and placed in front of the agents, there are a total of four community cards now. Each player has 4 actions available to him: CHECK, BET, RAISE, FOLD.

The actions provided are the same as the ones in the previous round(Flop Round).

5. River Round

One more community card is drawn, making it a total of five community cards in front of the agents. Each player has four actions available: CHECK, BET, RAISE, FOLD.

The actions provided are the same as the ones in the Flop Round.

6. Showdown

Each player's hand is displayed, then they are all classified into flushes based on the legal hands [**4**]. The winning player is declared. The game is done when all rounds are done even if players have coins remaining. This is to ensure simplicity.

2.2 Model Design

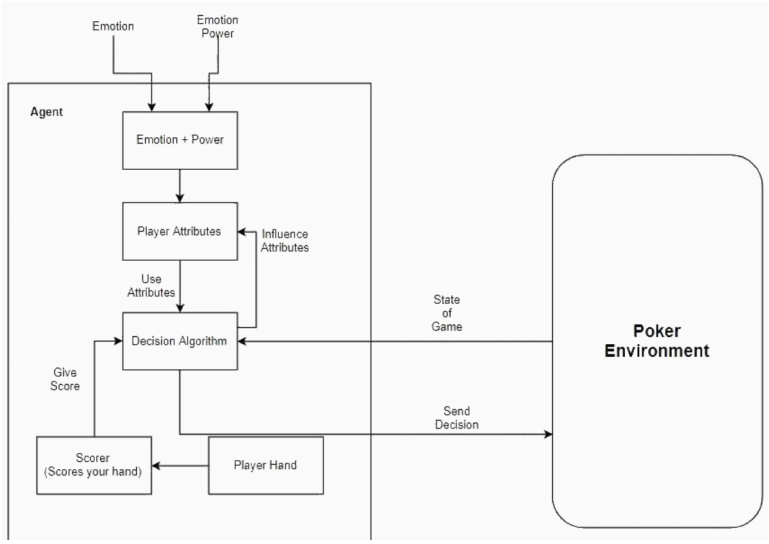

Figure 2: Model Design

The Figure 2 shows the design of the model, with the environment and its communication with the agent. It shows a flowchart of the process which will be explained in the sections below.

2.3 The Agents

An Agent is a player in the environment, each agent has a hand of two cards, each agent starts with coins to place bets and each agent is given an emotion.

2.3.1 The Emotions

We use four of the six basic emotions of humans, they are:
Fear, Happiness, Anger, Contempt
We also add two other states of emotions called: no-emotion and normal.

An agent with the state no-emotion is purely statistical and always makes the statistically optimal move.

An agent with the state normal is a random agent, this agent takes random actions.

Each emotion also has power that determines how strong the emotion is affecting the agent. Its value lies between 0-1.
Here is an example agent with emotions and its power.
$PlayerID : 0, Emotion : happy, EmotionPower : 0.4835810757205069$
In the experiments each emotion is assigned randomly to players along with a random power.

2.3.2 Player Attributes

Each agent has a set of attributes that influences the decisions they take. The attributes we have defined are as follows,

- Caution
- Greed
- Bluff

Each attributes values lie between 0-100, with 50 being normal.

Caution influences the player to make less risky moves. Even if the probability of winning is high, the agent may take a less risky move. The higher the value, the lesser the probability of taking a risky move(like raising a bet).
Greed influences the player to make risky moves despite being unsure of the probability of winning, this may actually result in a win if the agent gets lucky or it may result in severe losses.
Bluff is a special attribute, it influences the player to make riskier moves even when the winning probability is low to influence other agents to Fold.

Default attributes are Caution:50, Greed:50, Bluff:50. (Normal Emotion). Emotions affect the starting attributes of each agent. For example:
$IF\ emotion = Fear : caution = caution + Power * (50)\ AND\ greed = greed - Power * (50/2)$
Other rules are implemented in the Environment code under its appropriate section.
As the game progresses, these attributes undergo very small changes based on the status of the game. But these changes are minor compared to the initialization done by the emotions.
Emotions do not change as the game progresses, but the attributes change which may affect decision making.

2.3.3 The Decision Making

Each agent has a few details at its disposal when making a decision each round, it knows the bets placed on the table, what its hand cards are and the community cards on the table.

During the game the hand cards, the coins available in hand, the total coins in the pot, the hand score is available as information, each player then gives a score for each action.

Each action is given a score of occurring based on player attributes initially(only for emotional agents).

Then each agent adds upon on the score based on the coins in his hands, the bets placed, and the hand score.

The Decision making tends to vary based on emotions. For example the aggressive(Anger) player tends to placed increased amounts of bets even though he has weaker cards, the scared player(Fear) tends to react by folding due to the insanely high amounts of bets placed even though he has a better hand comparatively. Another example if the number of coins remaining for any player if lower than the set threshold the chances of folding increase even though the cards are good enough again this depends on the emotion and its strength. If the final score is high then the probability of greed and

bluff increases, meaning that the chances for placing higher bet amounts and also placing bets with lower value cards increases.

2.4 Experiment Design

Even though the poker game was designed based on a classical game of poker/traditional Texas Hold em Poker game, the current experiment design is 1 Game of Poker = 1 Round of Poker, the winner of the round is the winner of one game of Poker. Every agent starts with 1000 coins/points from which he can place bets. For every round in the game every agent is forced to place a bet amount of minimum 10 coins which forces the player to participate instead of quitting. Using the above criteria and rules we designed a experiment to run 10000 simulations of the poker game. For each game the emotions and the strength of the emotions are randomized. Every new game or simulation the coins/points of every player is reset to the original amount. The winner is declared after every game by criteria of maximum coins/points at the end of the game.

2.5 Results

Below are the graphs of the average of the results obtained after 10000 simulations.

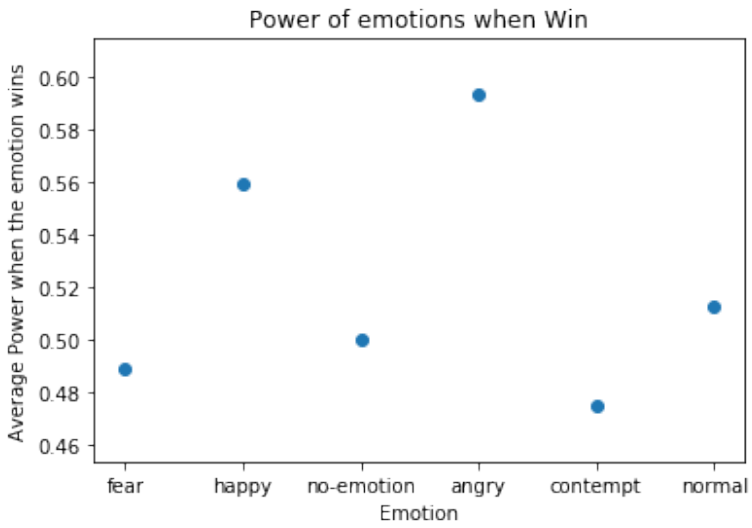

Figure 3: Strength of emotions for winning

The Figure 3 represents the Power of emotions when they win. This means that the strength of the emotions determines their performance in the player during the game. The player with anger as an emotion has the strength of aggressiveness close to 0.6 average and the player with fear as an emotion has the strength of fear close to 0.48 average when he won the game. The strength of the positive and negative emotions affect the performance of a player during the game in a directly proportional manner.

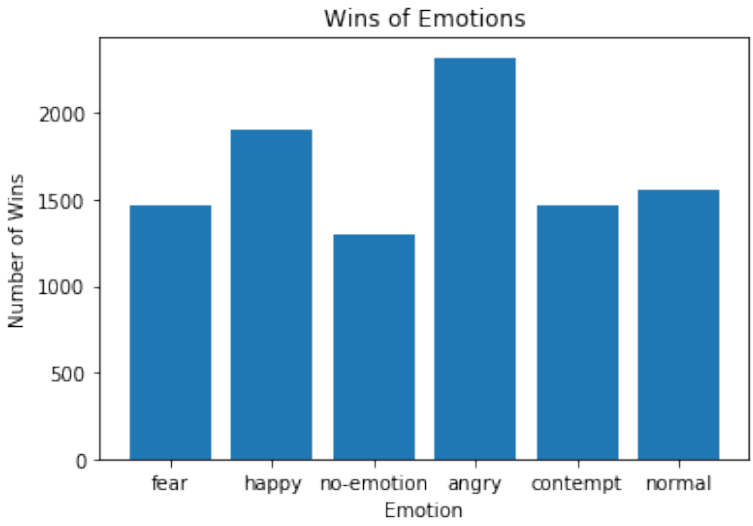

Figure 4: Emotional Agents Winnings

The Figure 4 represents the average games won by each emotion, we observe that more aggressive and more happy players have the first and second place respectively and the remaining players with the remaining emotions are behind them accordingly. The more aggressive player seems to be the clear winner but it comes with a price which will be explained in following based on below graph.

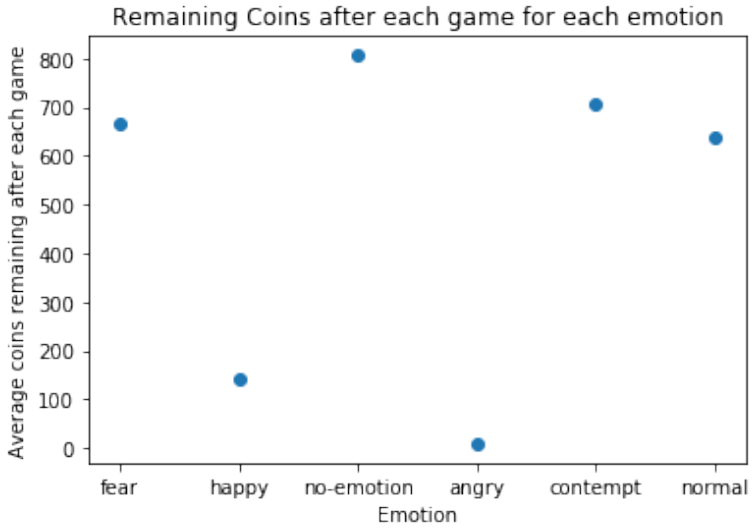

Figure 5: Amount spent after every round for each emotion

The Figure 5 represents the spending patterns of the players with different emotions that is the average amount of coins left after the games. Even though as mentioned above the more aggressive player is able to win games but at the cost of spending a lot, the player does not have any coins left after the games. The spending patterns correspond exactly to each emotional agents exact behaviour.

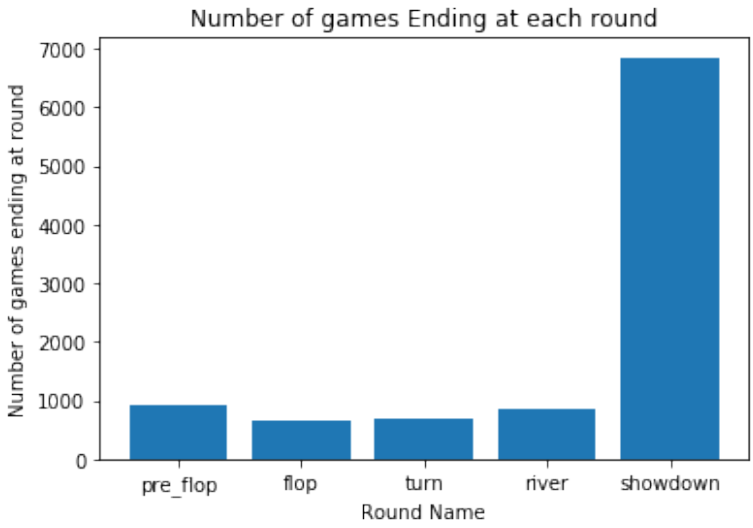

Figure 6: Games ending in which round

The figure 6 represents the number of games that ended in a showdown. This shows that the agents even though having different emotions and different attributes and different strengths of the emotions have played until the final round for most of the games. This highly depends on the forcing of bet placements during the initial rounds and the strength of the cards of each players combined with the community cards of each round respectively.

2.6 Conclusion

From the above results it can be seen clearly that the different emotions work as expected. We see how each emotion and its attributes for different players affects the decision making process. Each emotion has its own attributes which in turn affects the behavior of the agents in a particular way. The emotions and its behaviors displayed here mirror the real world emotions and its behaviours closely. Due to this close match, it gives us a system to model real world emotions in agents and study their effects, behaviours and performance on machines. Emotions highly influence the performance during decision making and even though not a direct result of our experiment, the emotions play a big role in cooperation among the agents.

2.7 Discussion

We found that the research work on implementing emotional agents has been there for the past two decades and further research work is required in order to substantiate the theory that agents with emotions will help in making intelligent systems.

2.8 Relevance

This framework can be used in designing complex systems with emotions. For example, a sports game with multiple players with emotions. We can also model environments with random occurrences and add emotions to see the outcome as shown in the poker game where hand cards maybe random. To compare this to a real life scenario, a modelling of space can be taken as space travel can be unpredictable.

It can also be used in tasks having incomplete information, like stock market, similar to how poker environment doesn't hands of players to each other. By modelling of these complex systems one can asses its perfomance and in turn model real human behaviour in those situations.

3 Role of team members

Each member of the team actively participated in the initial literature review. The implementation was split into user interface, design algorithm of intelligent agents, implementation of Poker Bot, Poker Game, Defining Rules Set for the Poker Game, Poker Hand Strength Score for Bot/Agent Decision Making and implementation of Poker Environment for the Simulation, Poker Bots/Agents with emotions, Integration of Poker Game and User Interface with Poker Environment, Experiment and testing.

Task	Bharath	Surender	Sai	Hari
Report	50%	20%	10%	20%
User Interface	10%	10%	70%	10%
Design and Algorithm	60%	10%	20%	10%
Poker Bot, Poker Game, Poker Rule Set	10%	20%	10%	60%
Poker Hand Strength Score for Bot/Agent Decision Making	10%	20%	10%	60%
Poker Environment, Poker Bots/Agents with emotions	10%	60%	10%	20%
Integration of Poker UI and Environment	10%	60%	10%	20%
Experiment and Testing	10%	60%	10%	20%
Presentation	50%	20%	10%	20%

Table 1: Role of team members: Distribution of tasks in percentage

References

[1] Rosalind W. Picard: Affective Computing. Cambridge, MA: MIT Press, 1997, xii + 292 pp.

[2] Ortony, A., Clore, G., & Collins, A. (1988). The Cognitive Structure of Emotions. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511571299

[3] Bazzan, Ana & Bordini, Rafael. (2001). A Framework for the Simulation of Agents with Emotions. 10.1145/375735.376313.

[4] Wikipedia. "List of Poker Hands". In: ().url:https://en.wikipedia.org/wiki/List_of_poker_hands.8

[5] Lisetti, Christine & Gmytrasiewicz, Piotr. (2000). Decisions, Decisions... and the Role of Emotions in the Process: Formal Theory.