CS531-Final project

Teaching Machine to play Blackjack

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Agenda

- Why Blackjack?
- Rules and basic strategies
- Algorithms
  - Dataset
  - Result
- Limitations

Why Blackjack?

- Blackjack is a card game that is played in casinos and has been subject to research by mathematicians and computer scientists for 100s of years.
- Blackjack involves probabilistic card strategies like traditional card games but also has a dynamic betting aspect to it which makes this such an intriguing problem.
- It can be viewed as an optimization problem on how to play based on what cards you and the dealer(opponent or casino or the house) are dealt.
- It can also be viewed as a prediction problem on what card is likely to appear next and play according to that.

Rules

- Dealt 2 cards facing up. Dealer gets 2 cards, one facing up and the other facing down.
- Basic goal: To make sum of cards closer to 21 without exceeding 21 and have higher final sum than the dealer.
- Basic actions:-
  - Hit - Ask for card from deck.
  - Stand - Happy with the total of your hand. Don’t want anymore cards.
  - Double - Ask for card from deck, double the bet and stand.
  - Split - If pair, split the hand dealt into 2 different hands. 2 cards dealt from the deck to complete the respective hands. (Betting adjusted accordingly)
  - Surrender - Abandon the current hand, and take half the money.
- Bust: If the player bust first, the dealer won the game.
  - Dealer cannot stay under 17.
- Blackjack: earn 50% more. If both the player and dearer did it, it will tie.

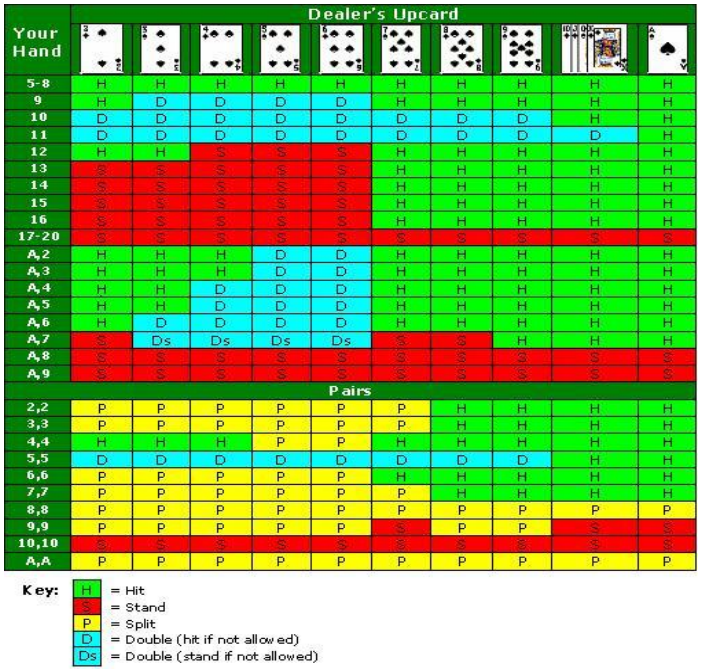
Goals

What do you think that the agent play blackjack well?

- Maximizing wins.
- Maximizing winnings.
- Get more earning.
- Play better blackjack.

In reality, there are many strategies

differentiated according to goals.



Your Hand	Dealer's Upcard									
	2	3	4	5	6	7	8	9	10	A
5-8	H	H	H	H	H	H	H	H	H	H
9	H	D	D	D	D	H	H	H	H	H
10	D	D	D	D	D	D	D	D	H	H
11	D	D	D	D	D	D	D	D	D	H
12	H	H	S	S	S	H	H	H	H	H
13	S	S	S	S	S	H	H	H	H	H
14	S	S	S	S	S	H	H	H	H	H
15	S	S	S	S	S	H	H	H	H	H
16	S	S	S	S	S	H	H	H	H	H
17-20	S	S	S	S	S	S	S	S	S	S
A,2	H	H	H	D	D	H	H	H	H	H
A,3	H	H	H	D	D	H	H	H	H	H
A,4	H	H	D	D	D	H	H	H	H	H
A,5	H	H	D	D	D	H	H	H	H	H
A,6	H	D	D	D	D	H	H	H	H	H
A,7	S	Ds	Ds	Ds	Ds	S	S	H	H	H
A,8	S	S	S	S	S	S	S	S	S	S
A,9	S	S	S	S	S	S	S	S	S	S
Pairs										
2,2	P	P	P	P	P	P	H	H	H	H
3,3	P	P	P	P	P	P	H	H	H	H
4,4	H	H	H	P	P	H	H	H	H	H
5,5	D	D	D	D	D	D	D	D	H	H
6,6	P	P	P	P	P	H	H	H	H	H
7,7	P	P	P	P	P	P	H	H	H	H
8,8	P	P	P	P	P	P	P	P	P	P
9,9	P	P	P	P	P	S	P	P	S	S
10,10	S	S	S	S	S	S	S	S	S	S
A,A	P	P	P	P	P	P	P	P	P	P

Key:
H = Hit
S = Stand
P = Split
D = Double (hit if not allowed)
Ds = Double (stand if not allowed)

Basic Strategy (chart)

Scientific approach

- Counting cards - Prediction of True Count (Monte Carlo)
  - -1 = { 10, J, Q, K, A }, If these cards depleted, it's bad for the player because these card is good for the player if the player hold it.
  - +1 = { 2, 3, 4, 5, 6}, If these cards depleted, it's good for the player because the probability of having these will be decrease.
  - 0 = {7, 8 ,9}

  Meaning: It is similar to the heuristic function in that it selects an action by calculating the remaining cards.

- Game Strategy - Optimization (Genetic Algorithm)

  Meaning: Learned from the past. Past rounds are independent of the present.

  But it is probabilistically predictable

Experimental Testing of Models

- Counting Cards
  - Profit/Loss after initial investments on varied betting.
  - Profit/Loss effect after applying strategy on gameplay actions.
  - Number of wins effect after applying strategy on gameplay actions.
- Game Play
  - Number of wins.
  - Profit/Loss after initial investments on flat betting.

Algorithm

- Fully Connected Neural Network(Completed)
  - Two Layers
  - Optimizer: adam

- Genetic Algorithm(Incomplete)

Dataset

Player Dealer Tag

	0	1
0	20	13
1	8	2
2	19	8
3	11	6
4	18	6
5	19	2
6	10	1

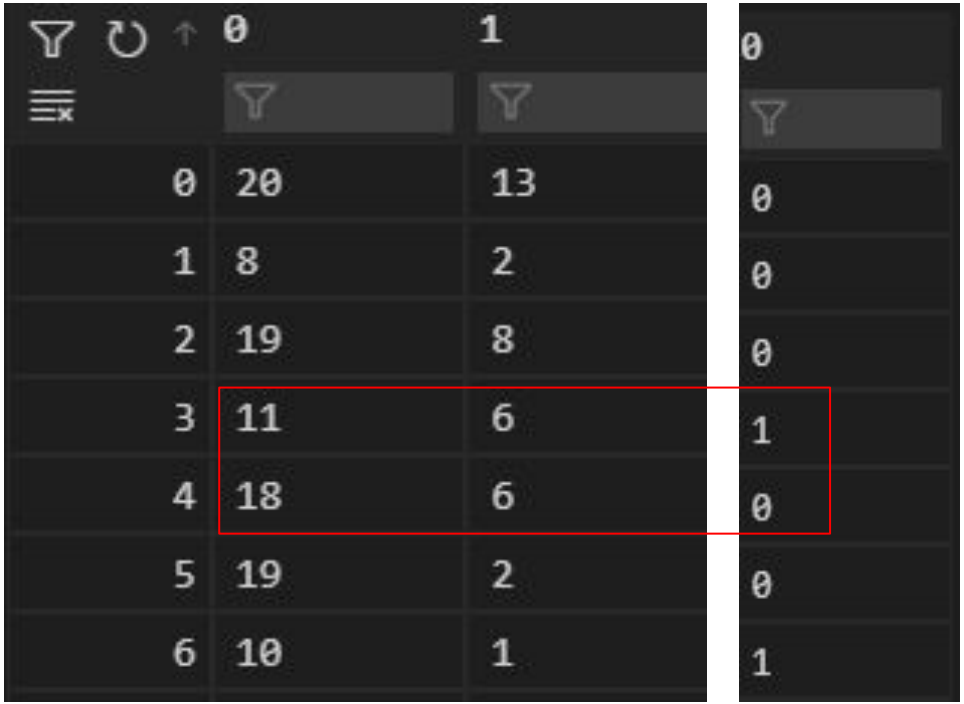
0
0
0
0
1
0
0
1

Training: (109122, 2)
Testing: (36375, 2)

Tag: 1:hit
0:stand

How to generate the dataset?

Player Dealer Tag



	0	1	0
0	20	13	0
1	8	2	0
2	19	8	0
3	11	6	1
4	18	6	0
5	19	2	0
6	10	1	1

```
if user hits and busts:
        tag = 's'
elif user hits and doesn't bust:
        tag = 'h'
elif user stays and wins hand:
        tag = 's'
elif user stays and loses hand:
        tag = 'h'
```

Result

	2	3	4	5	6	7	8	9	0	1
5	h	h	h	h	h	h	h	h	h	h
6	h	h	h	h	h	h	h	h	h	h
7	h	h	h	h	h	h	h	h	h	h
8	h	h	h	h	h	h	h	h	h	h
9	h	h	h	h	h	h	h	h	h	h
10	h	h	h	h	h	h	h	h	h	h
11	h	h	h	h	h	h	h	h	h	h
12	h	h	h	h	h	h	h	h	h	h
13	h	h	h	h	h	h	h	h	h	h
14	h	h	h	h	h	h	h	h	h	h
15	s	s	s	s	h	h	h	h	h	h
16	s	s	s	s	s	s	s	s	s	s
17	s	s	s	s	s	s	s	s	s	s
18	s	s	s	s	s	s	s	s	s	s
19	s	s	s	s	s	s	s	s	s	s
20	s	s	s	s	s	s	s	s	s	s
21	s	s	s	s	s	s	s	s	s	s

	2	3	4	5	6	7	8	9	T	A
20	S	S	S	S	S	S	S	S	S	S
19	S	S	S	S	S	S	S	S	S	S
18	S	S	S	S	S	S	S	S	S	S
17	S	S	S	S	S	S	S	S	S	S
16	S	S	S	S	S	H	H	H	H	H
15	S	S	S	S	S	H	H	H	H	H
14	S	S	S	S	S	H	H	H	H	H
13	S	S	S	S	S	H	H	H	H	H
12	H	H	S	S	S	H	H	H	H	H
11	D	D	D	D	D	D	D	D	D	H
10	D	D	D	D	D	D	D	D	H	H
9	D	D	D	D	D	H	H	H	H	H
8	H	H	H	H	H	H	H	H	H	H
7	H	H	H	H	H	H	H	H	H	H
6	H	H	H	H	H	H	H	H	H	H
5	H	H	H	H	H	H	H	H	H	H

Limitation

- 1v1
- Surrender, Insurance not considered.
- Flat Betting.
  - Limit the Budget to avoid martingale system. (Double previous bet at all the time)
- Doesn’t consider Casino specific rules
  - Some rules vary by casino.
  - Examples are Continuous shuffle, Double down, Surrender, Even money (not considered)
  - Simplify amount money when the player doing blackjack as 1.5 times.
  - Combination ‘A + 10’ is also considered as blackjack.