A Report on

Black Jack

"Bringing Down the House"

CSCI 264

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Abstract :

My Goal was to explore Probabilistic reasoning involve in Black Jack game play. Primary objective was to develop Black Jack game with C++ and simulate AI player using a variation of already established Card counting techniques to create illusions of smart decisions.

Introduction :

What I have created is a command based Blackjack game where player can choose to play or can observe as Program itself can play as a Dummy player and make decisions according to the basic strategy of Black Jack. Initially I was planning to implement AI using Card Counting technique with Kelly criterion but as it turn out Kelly Criterion in term of black jack is quite Complicated as variables keep on changing with each extra card we draw. So finally current version is using just card counting HI-Low method.

Functions :

randomizer : Randomizer is used to simulate Card shuffling where numbers form 0-51 are randomized number are allowed to repeat depending on number of decks used.

shuffle : These numbers are passed to shuffle function to assign a Playing card value to them including Suit and stored in a string array.

face : This function checks the value of randomize number and assign them a Face Value Like K for 'King Q for 'Queen' and J for 'Jack'.

next : this function collets cards which are drawn in game and puts then in back of the deck.

hitOrstay : This function is invoked each time a card is drawn; it determined next move of player while auto play sequence and next move of dealer.

count : count is used to calculate the Table count for particular game as we reached to the end of the current card stack Count is reset to 0.

Body :

Standards Black jack rules are applied. Game is implemented with 3 deck shoe although this number can be easily altered. Face cards are worth 10 and aces are either 1 or 11. Other cards are worth face value. The player must try to get the sum of their as close to 21 as possible, without going over. The player must place a bet before the cards are dealt. Both player and dealer are dealt 2 cards initially. Player cards are open and deal has just one open card. Player now choose to either STAY or HIT. once player decided to STAY dealer hits until it is at 17 or more. If Dealer manages to beat Player in sum of dealers cards without going over 21 dealer win otherwise player win. If dealer and player sun is equal then game is PUSH or DRAW.

Card Counting :

The card counting algorithm that i have used is called Hi-Low counting, which comes from the MIT card counting team as documented in the book ”Bringing Down the House”. It is based on the fact that high cards favors the player and low card favors the house/ casino. Give that if more high value cards are present in the deck probability of player winning current game increases and with more lower valued cards present in the deck probability of House winning current game increases.

cards 2 to 6 are assigned a value of +1.
Cards 7 to 9 are neutral or value of 0.
cards 10 to 11 (10s, face cards and aces) are -1.

The "table count" and recommended bet is calculated by the following equations:
Table Count = continues sum of values of cards.
recommended bet depends on Table Count.
as table count increases it is advised to increase bet and as in decreases less bet should be placed if Table count goes to negative it is advisable to place minimum bet possible.

This puts the player at about a 2 percent advantage over the house. By playing multiple tables at a time and only signaling people in when the deck’s true count was high, the MIT blackjack team was able to give themselves a 12 percent edge over the casinos.

Working :

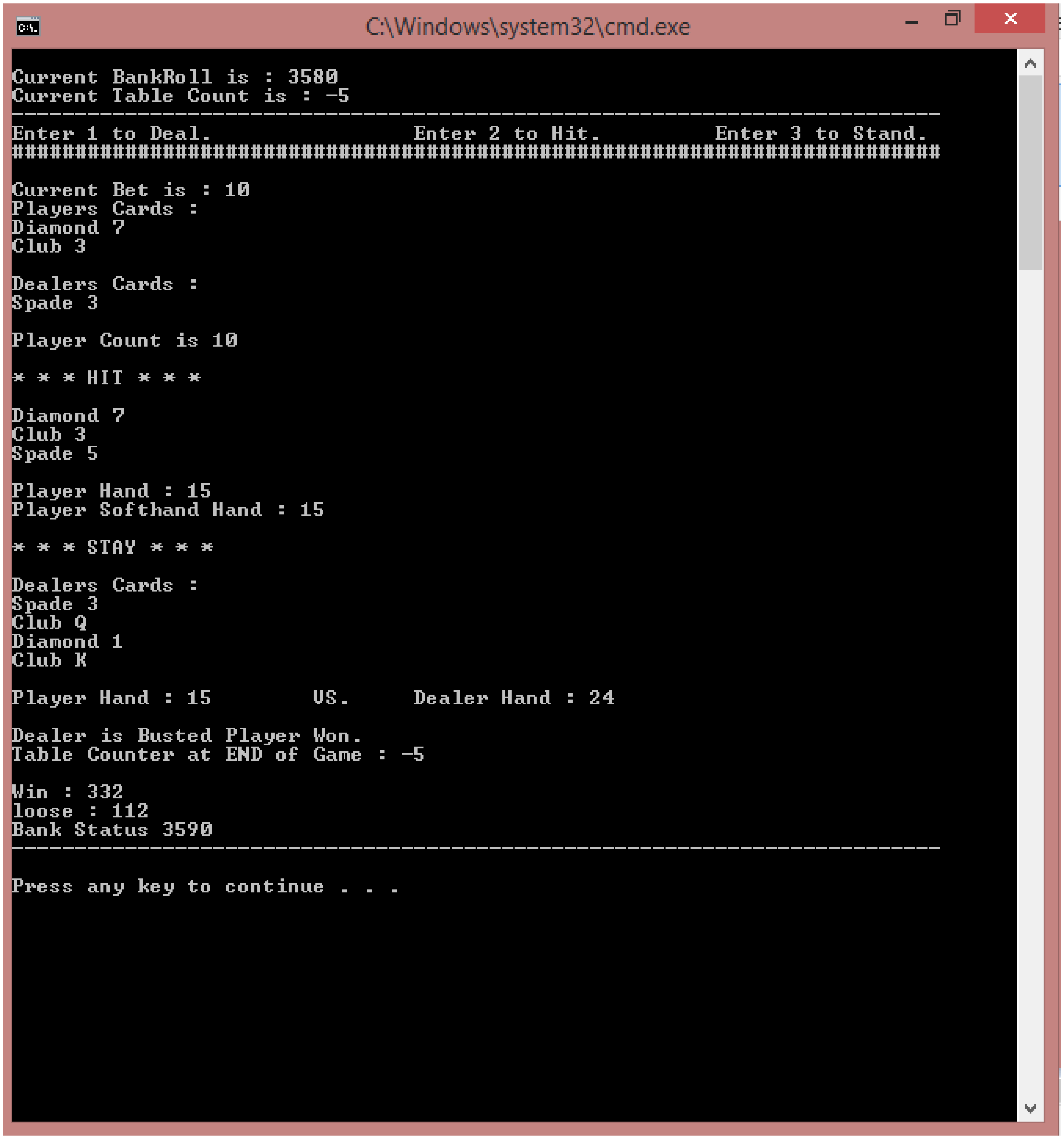
at beginning program prompts user to choose if they want to play the game or just be an observant where program automates game and pose as a virtual player. If playing option is selected Program will continue asking user each move and follow the instructions about Hitting or Staying. after user choose to Stay House will start drawing cards and according to black rules winner will be decides. If user choose to be an observant program will continues to run the code for 500 hands (a number which can be easily change by just changing 'hand' variable values) and play according to basic BlackJack strategy.
After end of each hand Our Current bank roll and number of wins and losses can be seen.

Human Factor :

While playing a major component is persona who is playing and instincts of a player to take risks or quit a game according to intuitions which is hard to simulate in code. and most important fixable problem which is in a sort of gray area is a good player always try to remember number of cards which are drawn in the game and try to calculate a separate probability of accruing same cards again (eg. if in a 3 deck shoe 7 can be drawn 12 times not more than that unless we shuffle) so ability to memories all drawn cards is a very important but even though a computer can memories all the cards drawn easily doing something like that won't be fare if you are simulating a real life player.

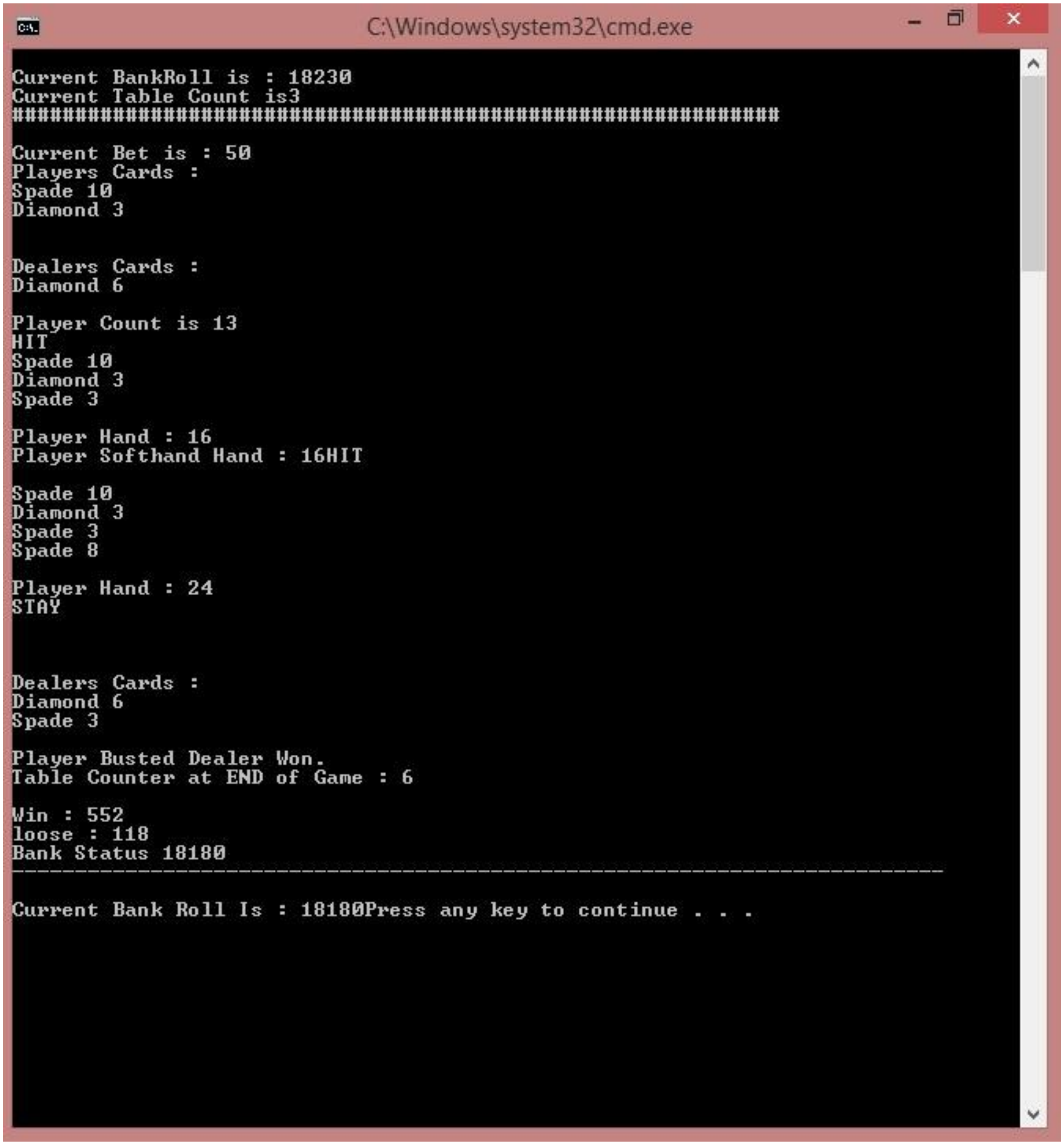
Some Examples Of final state after running program multiple times.

Moderate Win :



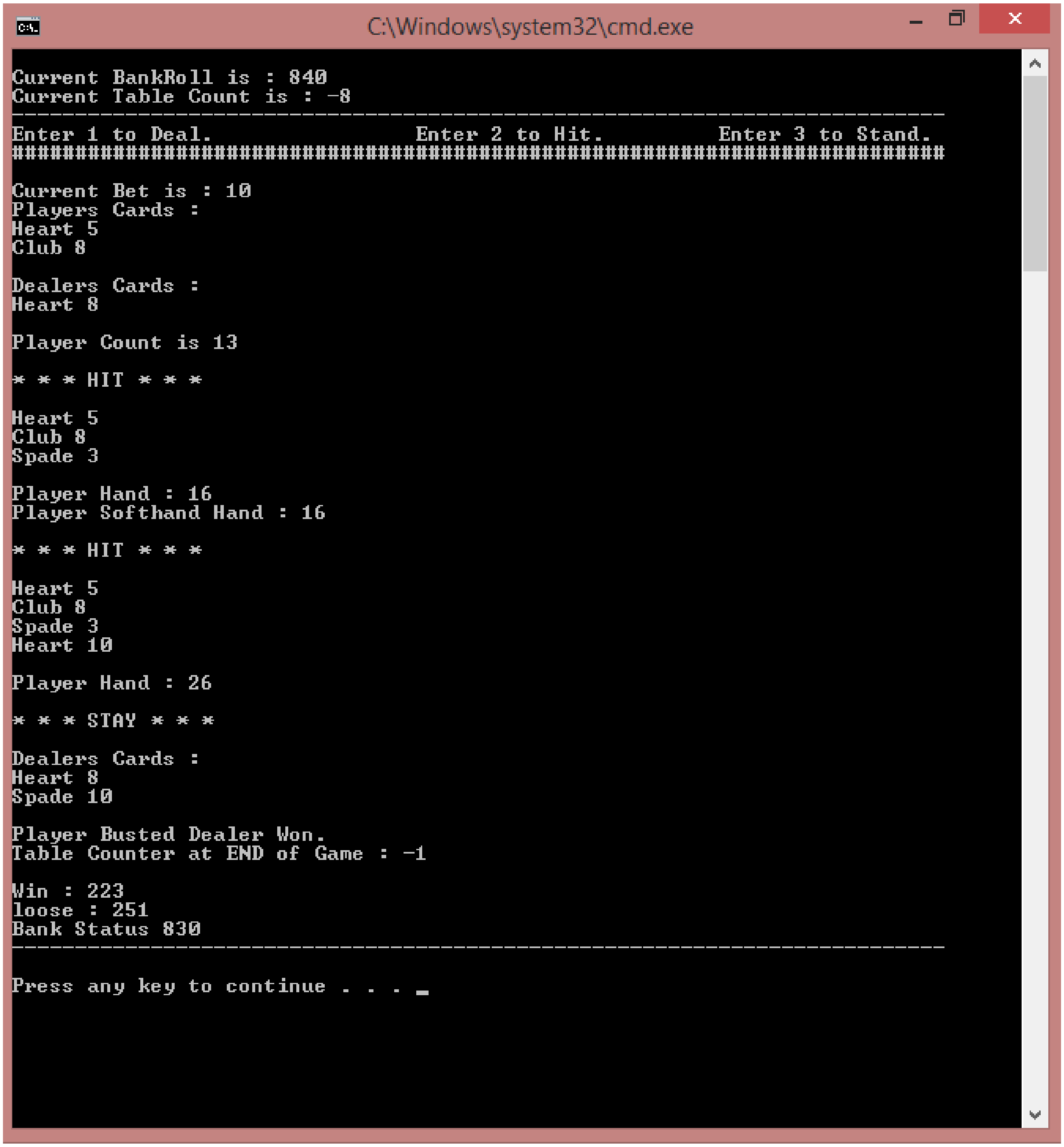
```
Current BankRoll is : 3580
Current Table Count is : -5
--------------------------------------------------------------------------
Enter 1 to Deal.                Enter 2 to Hit.         Enter 3 to Stand.
##########################################################################

Current Bet is : 10
Players Cards :
Diamond 7
Club 3

Dealers Cards :
Spade 3

Player Count is 10

* * * HIT * * *

Diamond 7
Club 3
Spade 5

Player Hand : 15
Player Softhand Hand : 15

* * * STAY * * *

Dealers Cards :
Spade 3
Club Q
Diamond 1
Club K

Player Hand : 15        VS.     Dealer Hand : 24

Dealer is Busted Player Won.
Table Counter at END of Game : -5

Win : 332
loose : 112
Bank Status 3590
--------------------------------------------------------------------------

Press any key to continue . . .
```

JACKPOT :



```
Current BankRoll is : 18230
Current Table Count is3
#############################################################

Current Bet is : 50
Players Cards :
Spade 10
Diamond 3


Dealers Cards :
Diamond 6

Player Count is 13
HIT
Spade 10
Diamond 3
Spade 3

Player Hand : 16
Player Softhand Hand : 16HIT

Spade 10
Diamond 3
Spade 3
Spade 8

Player Hand : 24
STAY



Dealers Cards :
Diamond 6
Spade 3

Player Busted Dealer Won.
Table Counter at END of Game : 6

Win : 552
loose : 118
Bank Status 18180
--------------------------------------------------------------------------

Current Bank Roll Is : 18180Press any key to continue . . .
```

Losing Money :



```
Current BankRoll is : 840
Current Table Count is : -8
--------------------------------------------------------------------------
Enter 1 to Deal.                Enter 2 to Hit.         Enter 3 to Stand.
##########################################################################

Current Bet is : 10
Players Cards :
Heart 5
Club 8

Dealers Cards :
Heart 8

Player Count is 13

* * * HIT * * *

Heart 5
Club 8
Spade 3

Player Hand : 16
Player Softhand Hand : 16

* * * HIT * * *

Heart 5
Club 8
Spade 3
Heart 10

Player Hand : 26

* * * STAY * * *

Dealers Cards :
Heart 8
Spade 10

Player Busted Dealer Won.
Table Counter at END of Game : -1

Win : 223
loose : 251
Bank Status 830
--------------------------------------------------------------------------

Press any key to continue . . .
```

Future :

Current system is using just card counting technique but if we could use **Kelly criterion** along side this then player could have better edge against the dealer.

The **Kelly Criterion** is a way to decide how much to bet when the odds are in your favor. Formula to determine bet is

$$\frac{p(b+1)-1}{b}$$

where p is Probability of winning and b is payload if win. According to which an Ideal Bet size where

- probability of winning is 50%
- and payback is 2 to 1

should be **25 %** of the total Bank Roll. If we bet more than that then in long run Player will lose rather than winning. Following table show the change in bankroll with different betting percentages.

	50%	25 %	75%
Win	2	1.5	2.5
Loose	1	1.125	0.625
Win	2	1.406	1.093
Loose	1	1.0545	0.273

Conclusion :

Even after following Basic Strategy and card counting techniques it is seen that player won't win big all the time or sometime looses everything he got and more. So it's safe to assume that Card Counting just Indicates Probability of wins or loses not the Future.