CSC340 Final Project Report

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I. PROBLEM STATEMENT

Develop an interactive and informative Blackjack application that not only allows users to play the popular casino card game with customizable deck options but also provides real-time probability assessments at crucial stages of the game. The application should give the player accurate probabilities for specific outcomes, including the likelihood of obtaining a perfect hand (21) or a favorable hand (18-21) before the initial deal. After the cards are dealt, it would also give the chances of getting 21, going over 21 or getting a favorable hand (18-21) if the user decides to hit. The goal is to create a program using topics we went over in class while also combining it with a real-world application, like a casino game. This program was designed primarily to showcase the math included and not the actual blackjack gameplay. In a regular game, the user does not have access to the cards and their counts. For example, when the cards are dealt the dealer has a "hidden" card, but when we calculate the probability, that card is taken into account.

II. MATHEMATICAL FOUNDATION

The main foundation of my math was the way I used combinations to find the probability of the initial hands. Python has a math library that allows you to use the combo() function instead of having to find each combination of cards to be drawn. I use combination here and not permutation because the order does not matter. For example, to get 21 on the first hand would mean getting a card valued at 10 (face card or 10) or an Ace. The order they are chosen in does not matter. For the other outputs, I just used regular probability math as after the first hand, only one card is dealt to the user at a time. Keeping a running count of how many of each card there was left and also the total amount of cards left was very crucial in finding all of the numbers.

III. DISCUSSION OF MATH

In order to discuss the math that I used in detail, I will have to create some fake scenarios. Most of the math I have used has come from [1],[2]. To preface, we will be using two decks and the participants are one player and the dealer.

Let's just say we finished the first hand and won. The cards we drew were a queen and eight and we decided to stand. The dealer had a three, ace, three. Now, we will go over the math on the next hand. There were a total of 5 cards drawn from the deck of 104 bringing us down to 99. In order to find out the probability of getting blackjack on the next hand we need the total number of 10 value cards and aces. Since there was an ace and queen drawn, it brings our total down to 7 aces and 10 value cards to 31. The math to find the probability is done here:

$$\frac{7*31}{C(99,2)} = \frac{217}{4851} = 0.0447 \; or \; 4.47\%$$

We use the total number of aces multiplied by the total number of 10 value cards and then divide that by the combination C(99,2) because there are 99 cards left and you pick two from that total. The math for the good initial hand (18-21) is solved the same exact way but it takes into account the different combinations. For example, a total of 18 can happen with a 10 value card and an 8 or an ace and 7. We still use the C(Cards left,2) as we can only get two cards from the deal. These are all added up together in order to find the probability of getting in the range of 18-21.

Now, if we decide to play, we get two more cards.

Let's say a ten and seven. The dealer has a queen and a face down card but we will cheat here and make the hidden card a 6. We would use the total cards left of 95 (99-4) to find the probability of getting a 4 in order to make our total 21.

$$\frac{Amount\ of\ the\ card\ \ at\ the\ start - Amount\ of\ the\ card\ dealt}{Total\ amount\ of\ cards\ at\ the\ start - Total\ amount\ of\ cards\ dealt} =$$

$$= \frac{8-0}{95} = \ 0.0840 \text{ or } 8.40\%$$

So the chances of getting a four on the next turn is 8.40%. We use this formula for the other percentages like chances of getting into the range of 18-21 and also the chances of going over 21. This is done by finding every value that will get you into that range in a list, and using that list to compute the formula for each value and adding it to a total value that is the probability of getting in the respective range. For example, if I were to find the probability of getting over 21 on the 17 I got it would be [5,6,7,8,9,10]. The ace is not included in the list because it would count as the 1 value. Then I would solve that equation on each value in that list and keep a running total.

IV. CONNECTION

This math is very similar to things we have worked on, like rolling dice and also craps. I picked this because I was able to use combination math as well as probability to show my learning on these techniques. I also enjoy the game of blackjack and have always wanted to figure out how to "count" cards and I think this is as close as I will get.

V. REFERENCES

[1]C. Barboianu, "The mathematics of blackjack: Probabilities," probability.infarom.ro. https://probability.infarom.ro/blackjack.html

[2]MATH4ALL, "The Mathematics of Blackjack," Math4all, Oct. 31, 2020. https://www.math4all.es/the-mathematics-of-blackjack/