TAYLOR'S UNIVERSITY

Wisdom · Integrity · Excellence

MARCH 2022 SEMESTER

Discrete Structures

(ITS 66204)

Assignment – Group (40%)

DEADLINE: 26th June 2022 (before 00:00 am)

WEIGHTAGE: 40%

SEMESTER: March 2022

STUDENT DECLARATION

1. *I confirm that I am aware of the University's Regulation Governing Cheating in a University Test and Assignment and of the guidance issued by the School of Computing and IT concerning plagiarism and proper academic practice, and that the assessed work now submitted is in accordance with this regulation and guidance.*
2. *I understand that, unless already agreed with the School of Computing and IT, assessed work may not be submitted that has previously been submitted, either in whole or in part, at this or any other institution.*
3. *I recognise that should evidence emerge that my work fails to comply with either of the above declarations, then I may be liable to proceedings under Regulation.*

No	Student Name	Student ID	Date	Signature	Score
1	Ishihara Satoaki	0354208	27/06/2022	Ishihara Satoaki	
2	Chang Yu En	0348648	27/06/2022	Chang	
3	Wong Hong Wing	0347878	27/06/2022	tomas	
4	Cheong Mei Poh	0349211	27/06/2022	meipoh	
5	SU SUSANA	0352209	27/06/2022	Susana	
6	Saranya Kandikatti	0354361	27/06/2022		

0.0 Acknowledgement

In our assignment, we needed help and guidelines from our lecturer, Ms Samsuhada, to complete our assignment successfully. We would like to thank her for giving us a lot of advice and feedback.

We would also like to thank each group member who contributes in their own parts and also communicates well with each other . We constantly put in a lot of effort to deliver a quality assignment while taking full responsibility for it. Despite a few minor issues that came up among us while working on this assignment, the group members completed it to the best of their abilities.

Lastly, we want to express our gratitude to our parents and friends for being there for us no matter what. Without their help and cooperation,this task would not have been possible without them.The completion of the report gives us much pleasure.

Table of Contents

1.0 INTRODUCTION

1.1 Background of Study

According to Boston University, probability is the mathematical method that reflects the chance that a specific event will happen. Probabilities can be represented as proportions in a range of 0 to 1, or they can also be represented as percentages in a range from 0 to 100. A probability of 0 means that there is no chance that a particular event will happen. On the other hand, a probability of 1 means that an event definitely occurs. A probability of 0.45 (45%) indicates that there are 45 chances out of a total 100 chances of the event happening.

Although some mathematical fields taught in early educational curriculum are normally forgotten and become irrelevant topics in later life, probabilities are still used in a lot of cases in our life, and remain close throughout our lives. For example, we use random generators sometimes to create the pattern of order immediately. Or when we do rock-scissors-papers, it is also a game using probability concepts. Matching in dating applications, online battling games, etc. are also using the method of probability.

To research how useful and convenient probability can be to solve a real-life issue, we are going to design our own carnival games to investigate chance by using probability concepts that we have learned and apply them in creating our own game. For example the game should resemble types of game found easily at a casino or carnival. This proves that the game can be quickly played and multiple trials can be conducted. We have to calculate the probability of the outcomes of the game.

In this study, it is expected to be able to use probabilities to calculate the percentage of win rates to show how likely players are to win carnival games. Probabilities are expected to be used in computing each pattern of cards drawn or balls picked for games.

1.2 Problem Statement

Games that rely on chance are popular due to their unpredictable nature. Prevalent games found in casinos and carnivals are a prime example of this. However, when investigating the logic behind chance games, we uncover probability. The concept of probability is explained as the likelihood for an outcome to occur. The benefits of understanding probability are not divulged into enough. However, by researching probability concepts through a game of chance we can prove the logic behind probability. It is the algorithm which was added by the game developers by using a programming method.

In today's society, games have become an indispensable entertainment. And now during the Covid-19 pandemic, the economy is in a downturn, and for some people in quarantine, gaming will become an important part of life. People are playing games as entertainment for themselves and release their stress by playing games. In games, there are a lot of mechanisms that let the players win or lose the games. By using this method, the game's developers will gain money and earn profit from the player’s ‘support’.

Many games relying on chances and probability to win are extremely popular. Given this situation, our group tries to delve deeper into the concept of mathematical probability using mathematical concepts of probability, combined with the popular carnival game, and in the process looking at ways to increase the odds as much as possible. By doing so, we are able to learn the logic of using probability inside a game.

1.3 Objective of study

To achieve the expectations of the study, we need to:

- Demonstrate and understand the use of probability in a game to solve the real-world problems
- By using two ways to win the game and show the chances of winning in probability concept.
- Evaluate by using two balls to pair with the same card's suit in the carnival game

2.0 Methodology

The time and money spent at carnivals are enjoyable. Although some carnival games do require talent, the majority of them are games of chance. Even though the majority of carnival games appear to be simple to win, they are often not. A fair game is one in which neither the participant nor the operator stands to profit or lose. So what is it about carnival games that appeals to the people so much? The design of a carnival game, the chances of winning, the amount of money anticipated to be lost or won are all covered in this assignment.

This game costs RM1 to play. The game begins with the participant drawing a card from the prepared deck. The next step is for the participant to select two balls from a box of eight balls. There are two balls that contain each suit on them. One of the balls is red and has a black suit, while the other is black and has a red suit. The colour of the ball has no bearing on the player winning because the balls are drawn without renewal. If the card's suit corresponds to one of the balls, the player will receive a small prize. If the card that was drawn matches the same suit as both balls, the player receives a big payout. Even if the player does not match the first ball to the card suit, they still get to draw the second ball. They receive a little prize if they correctly match the second ball to the card suit.

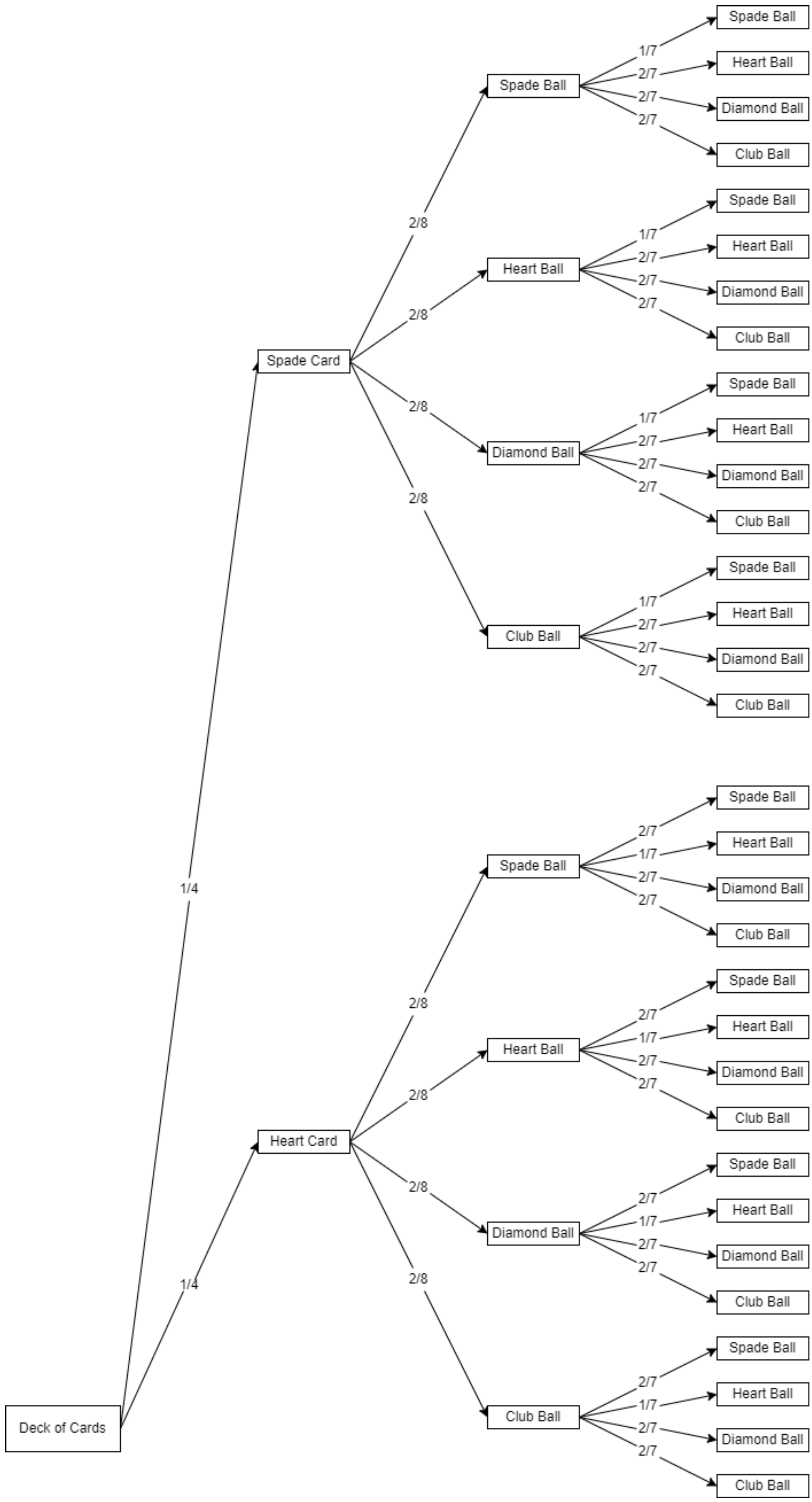
Some probability notations are used for calculations:

P( )	Power sets
∪	Set union
∩	Set intersection
$0 \le P(x) \le 1$ $\sum P(x) = 1$	Two Properties of Probability
$\mathrm{P(A)}=\frac{f}{N}$	**relative frequency probability**
$\mathrm{P(A/B)}=\frac{P(A\cap B)}{P(B)}$	**Conditional probability**
A∩B or B∩A	**Intersection of Events**
P(A∪B)=P(A)+P(B)-P(A∩B)	**Union of Events**
P(A)+P(A')=1	**Complementary Events**

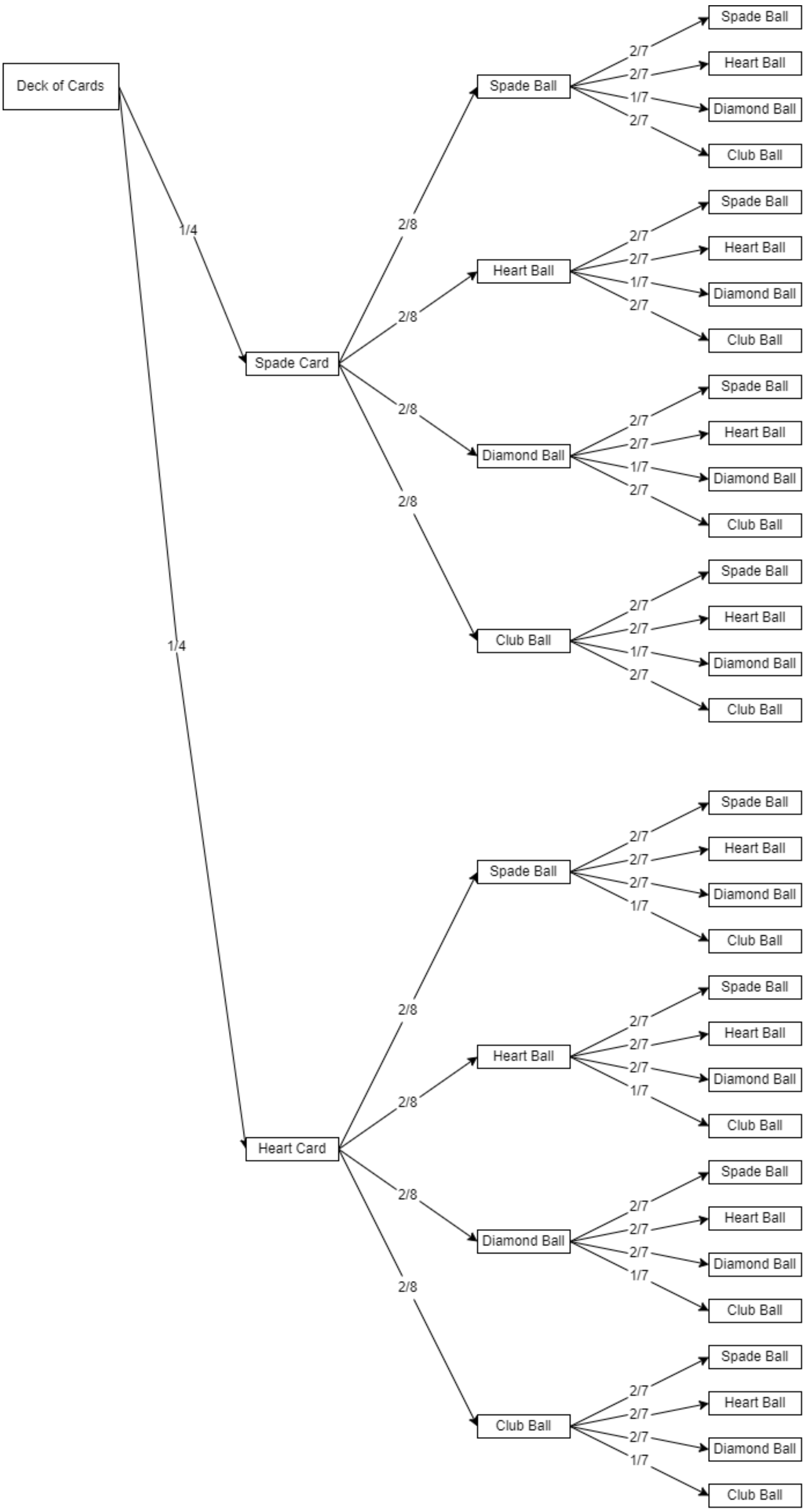
Directions:

1. The player chooses a card without glancing at it (the player can look after the card is picked)
2. From the box, the player chooses a ball at random.
3. If the ball's suit corresponds to the chosen card suit, the player is given a small bonus.
4. The player does not exchange the first ball but instead chooses a second ball from the box.
5. If the player properly matches the second ball's suit with the first card's and the first ball's suit, they are awarded a substantial prize. If the second ball's suit matches the card's suit when it is drawn, the player is awarded a small prize.

Below are the tree diagrams we are going to use in this study:



Tree Diagram 1



Tree Diagram 2

3.0 Results and conclusion

In Suit, a carnival game, players have two ways to win the game: one of the balls drawn matches the suit of the paired card or two balls drawn that match the suit of the paired card. There are 64 possibilities in this game. The following is a sample space for the game:

Sample space:（H = Heart, D = Diamond, C = Club, S = Spade）{HHH, HHD, HHC, HHS, HDH, HDD, HDC, HDS, HCH, HCD, HCC, HCS, HSH, HSD, HSC, HSS, DHH, DHD, DHC, DHS, DDH, DDD, DDC, DDS, DCS, DCD, DCC, DCS, DSH, DSD, DSC, DSS, CHH, CHD, CHC, CHS, CDH, CDD, CDC, CDS, CCH, CCD, CCC, CCS, CSH, CSD, CSC, CSS, SHH, SHD, SHC, SHS, SDH, SDD, SDC, SDS, SCH, SCD, SCC, SCS, SSH, SSD, SSC, SSS}

In order to facilitate the calculation of the player's winning rate in this carnival game, the following table is made for calculation:

	Heart(H)	Diamond(D)	Club(C)	Spade(S)
Card	1	1	1	1
Ball	2	2	2	2

3.1 Calculations

Probability of a player winning a large prize:

P(HHH) =$\frac{1}{4} \times \frac{2}{8} \times \frac{1}{7} = \frac{1}{112}$

P(DDD) =$\frac{1}{4} \times \frac{2}{8} \times \frac{1}{7} = \frac{1}{112}$

P(CCC) =$\frac{1}{4} \times \frac{2}{8} \times \frac{1}{7} = \frac{1}{112}$

P(SSS) =$\frac{1}{4} \times \frac{2}{8} \times \frac{1}{7} = \frac{1}{112}$

P(Large) = P(HHH) + P(DDD) + P(CCC) + P(SSS) =$\frac{1}{112} + \frac{1}{112} + \frac{1}{112} + \frac{1}{112} = \frac{4}{112} = \frac{1}{28}$

Probability of a player winning the small prize:

P(HHD) =$\frac{1}{4} \times \frac{2}{8} \times \frac{2}{7} = \frac{2}{112} = \frac{1}{56}$

P(HHC) =$\frac{1}{4} \times \frac{2}{8} \times \frac{2}{7} = \frac{2}{112} = \frac{1}{56}$

P(HHS) =$\frac{1}{4} \times \frac{2}{8} \times \frac{2}{7} = \frac{2}{112} = \frac{1}{56}$

P(HDH) =$\frac{1}{4} \times \frac{2}{8} \times \frac{1}{7} = \frac{1}{112}$

P(HCH) =$\frac{1}{4} \times \frac{2}{8} \times \frac{1}{7} = \frac{1}{112}$

P(HSH) =$\frac{1}{4} \times \frac{2}{8} \times \frac{1}{7} = \frac{1}{112}$

P(DDH) =$\frac{1}{4} \times \frac{2}{8} \times \frac{2}{7} = \frac{2}{112} = \frac{1}{56}$

P(DDC) =$\frac{1}{4} \times \frac{2}{8} \times \frac{2}{7} = \frac{2}{112} = \frac{1}{56}$

P(DDS) =$\frac{1}{4} \times \frac{2}{8} \times \frac{2}{7} = \frac{2}{112} = \frac{1}{56}$

P(DHD) =$\frac{1}{4} \times \frac{2}{8} \times \frac{1}{7} = \frac{1}{112}$

P(DCD) =$\frac{1}{4} \times \frac{2}{8} \times \frac{1}{7} = \frac{1}{112}$

P(DSH) =$\frac{1}{4} \times \frac{2}{8} \times \frac{1}{7} = \frac{1}{112}$

P(CCH) =$\frac{1}{4} \times \frac{2}{8} \times \frac{2}{7} = \frac{2}{112} = \frac{1}{56}$

P(CCD) =$\frac{1}{4} \times \frac{2}{8} \times \frac{2}{7} = \frac{2}{112} = \frac{1}{56}$

P(CCS) =$\frac{1}{4} \times \frac{2}{8} \times \frac{2}{7} = \frac{2}{112} = \frac{1}{56}$

P(CHC) =$\frac{1}{4} \times \frac{2}{8} \times \frac{1}{7} = \frac{1}{112}$

P(CDC) =$\frac{1}{4} \times \frac{2}{8} \times \frac{1}{7} = \frac{1}{112}$

P(CSC) =$\frac{1}{4} \times \frac{2}{8} \times \frac{1}{7} = \frac{1}{112}$

P(SSH) =$\frac{1}{4} \times \frac{2}{8} \times \frac{2}{7} = \frac{2}{112} = \frac{1}{56}$

P(SSD) =$\frac{1}{4} \times \frac{2}{8} \times \frac{2}{7} = \frac{2}{112} = \frac{1}{56}$

P(SSC) =$\frac{1}{4} \times \frac{2}{8} \times \frac{2}{7} = \frac{2}{112} = \frac{1}{56}$

P(SHS) =$\frac{1}{4} \times \frac{2}{8} \times \frac{1}{7} = \frac{1}{112}$

P(SDS) =$\frac{1}{4} \times \frac{2}{8} \times \frac{1}{7} = \frac{1}{112}$

P(SCS) =$\frac{1}{4} \times \frac{2}{8} \times \frac{1}{7} = \frac{1}{112}$

P(Small) = P(HHD) + P(HHC) + P(HHS) + P(HDH) + P(HCH) + P(HSH) + P(DDH) + P(DDC) + P(DDS) + P(DHD) + P(DCD) + P(DSH) + P(CCH) + P(CCD) + P(CCS) + P(CHC) + P(CDC) + P(CSC) + P(SSH) + P(SSD) + P(SSC) + P(SHS) + P(SDS) + P(SCS) =

$\frac{1}{56} + \frac{1}{56} + \frac{1}{56} + \frac{1}{112} + \frac{1}{112} + \frac{1}{112} + \frac{1}{56} + \frac{1}{56} + \frac{1}{56} + \frac{1}{112} + \frac{1}{112} + \frac{1}{112} +$

$\frac{1}{56} + \frac{1}{56} + \frac{1}{56} + \frac{1}{112} + \frac{1}{112} + \frac{1}{112} + \frac{1}{56} + \frac{1}{56} + \frac{1}{56} + \frac{1}{112} + \frac{1}{112} + \frac{1}{112} = \frac{9}{28}$

P(Total) =P(Large) + P(Small) = $\frac{1}{28} + \frac{9}{28} = \frac{5}{14} \simeq$ 35.71%

So in this carnival game Suit the player's win rate is about 35.71%.

4.0 Discussion

Overall, The probability of the players winning a large prize is 1/28 and a small prize is 9/28.The probability of picking the first ball having the same suit as the first card is an example of conditional probability. Conditional probability can be denoted by：

$$P(A/B) = \frac{P(A \cap B)}{P(B)}$$

This means the probability of the first ball matching the suit of the card is found given the probability of picking the suit from the deck of cards is calculated as well. When breaking that down we find that the probability of picking any card from one suit is 13/52 or ¼.This is added to the probability of getting a ball the same colour suit as the card.The reason these probabilities are conditional is because they are reliant on each other. The total probability is calculated by multiplying the probability of choosing any suit (¼) by the chance of getting the 2 balls that match (2/8 * 2/7) or don't match (2/8 * 1/7).

For the Large prize, We can deduce that it has the lowest probability as the chance of getting 2 balls that match the suit of the card is the lowest.The probability of getting a large prize regardless of the suit is 1/28 as each suit probability is 1/112. We calculate this by multiplying ¼ * 2/8 * 1/7.

For the Small Prize, it should be noted that the chances of receiving a prize from the first ball matching is higher than the probability of winning a prize from the second ball matching but not the first ball.The probability of winning with the first ball is 1/56 and the chance of winning with the seconds ball is 1/112.

The probability of not winning a prize is higher than winning a prize. The probability of losing is 9/14 or 64.2%.The application of probability in this game allows for the player to fully understand their chances of winning or losing and to get the full experience of a game of chance.

In reality, Probability has numerous applications in real-life scenarios including but not limited to games of chance. Weather forecasting, Winning the lottery and even what clothes you wear are all the subject of probability.

4.1 Limitations and Recommendations

Probability is limited when used in areas that have an infinite number possibilities. Areas that also do not have an equal or fair chance for each outcome also make probability unreliable. For example a weighted die that will always land on a certain number, or a deck of cards that has a few cards missing.All of these will affect the probability of the outcome.

It is recommended to use props that do not have any flaws in order to conserve the probability in the game.These include a full deck of cards and all the balls being the same size. This will allow all the possibilities to be equal and therefore relying on pure probability for the outcome of the game.

5.0 References

1. Basic Concepts of Probability - SPH - Boston University. Retrieved 26 June, 2022, from https://sphweb.bumc.bu.edu/otlt/mph-modules/bs/bs704_probability/BS704_Probability3.html#:~:text=A%20probability%20is%20a%20number,from%200%25%20to%20100%25.

2. What is Probability? -Towards Data Science- By Devin Soni Retrieved 26 June, 2022, from https://towardsdatascience.com/what-is-probability-175b189c0498

3. Limitations of Probability Functions -Crystal Ball User's Guide- Oracle®. Retrieved 26 June, 2022, from https://docs.oracle.com/cd/E57185_01/CYBUG/apas08s01.html