Exploding Kittens

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1. Introduction

Exploding kittens is a game designed by Elan Lee and Matthew Inman. It consists of 56 cards and is suitable for 2 to 5 players.

1.1 Objective

The objective for the project is to find a strategy to win a 3 player game.

1.2 Research questions

1. Besides logical reasoning, how can we use probability theory to enhance the strategy of winning a game of exploding kittens?
2. What is the probability of drawing an 'exploding kitten' after each turn in a 3 player game?
3. How will the elimination of one player affect the probability of drawing an 'exploding kitten' after each turn?

1.3 Rationale

"Exploding Kittens" is a game that is suitable for all ages. we decided to create a strategy for this game as it is popular. This strategy can help people understand and also play the game better. There are little resources available about the strategy of the game so we thought that creating something for this game would be newer as the game was only released in 2015.

2. Literature review

Experiments which can be repeated under same conditions are called ***trials***. For example, the experiment of rolling a die is called a trial. The outcome of rolling a die is called an ***event***. For example, an event among a die-rolling trial is when the number 3 shows. Another event would be when an even number shows. An ***elementary event*** cannot split into other events. The event the number 3 shows is an elementary event, while the event an even number shows is not, since

it can be split into 3 events 2, 4 and 6 show. The combination of all elementary events for one trial is called the ***whole event.***

$$\begin{gathered}
\text{Let } \rho(A) \text{ be the probability of event } A, \\
\eta(A) \text{ be the number of elementary events in } A \\
\text{and } \eta(E) \text{ be the number of elementary events in the whole event. Then,} \\
\rho(A) = \frac{\eta(A)}{\eta(E)} \\
\rho(A) \text{ measures the chance of event } A \text{ happening.}
\end{gathered}$$

Birthday Problem(Example)

If there are 25 people in a room, what is the probability that at least two of them share the same birthday. If your first thought is that it is 25/365 = 0.068, you will be surprised to learn it is much higher than that. This problem requires the application of the sections on P(A and B) and conditional probability.

This problem is best approached by asking what is the probability that no two people have the same birthday. Once we know this probability, we can simply subtract it from 1 to find the probability that two people share a birthday.

If we choose two people at random, what is the probability that they do not share a birthday? Of the 365 days on which the second person could have a birthday, 364 of them are different from the first person's birthday. Therefore the probability is 364/365. Let's define P2 as the probability that the second person drawn does not share a birthday with the first person. P2 is therefore 364/365. Now define P3 as the probability that the third person drawn does not share a birthday with the first nor second person. P3 is therefore a conditional probability. If there are no previous birthday matches, then two of the 365 days have been "used up," leaving 363 non-matching days. Therefore P3 = 363/365. In like manner, P4 = 362/365, P5 = 361/365, and so on up to P25 = 341/365.

In order for there to be no matches, the second person must not match any previous person and the third person must not match any previous person, and the fourth person must not match any previous person, etc. Since P(A and B) = P(A)P(B), all we have to do is multiply P2, P3, P4 ...P25 together. The result is 0.431. Therefore the probability of at least one match is 0.569.

2.1 Study and Methodology

To start off with the project, our group played 13 games of exploding kittens to get trials results. Then, we sorted out the trials results and started calculating the probability of getting an exploding kitten first before we start to answer research question 3. We also made the following simplifications to the game so that our project would not become too complicated:

- Special combinations have been omitted
- Number of players in a game is kept at 3

The following are variables that we kept the same as we conducted the trials so as to ensure that the results we had were accurate:

- Number of cards used is kept at 54. As there are only 3 players in the game, 2 exploding kittens have been removed.
- The number of cards in the draw pile will be kept at 39 after each player receives 5 cards to his hand before the start of the game.

Whilst conducting our trials, we also faced the limitation of experience. Since we had 4 members in our project group, we decided to alternate as much as possible between who plays the game so as to make our results as reliable as possible.

3. Results

We conducted 13 trials of game and recorded down every move each player made. This data would help us in discovering patterns and developing the game strategy.

3.1 Research Question 1

Based on our understanding of probability, we know that it can be used in our strategy to help us make decisions on what moves to make next. Probability can help us to make decisions on what

is likely to happen, based on a pattern of statistics collected previously. Through including probability in our strategy, it can make it a more reliable one that can help a player win more easily.

3.2 Research Question 2

Assuming that in each turn, the player draws a card, Fig. 1 shows the change in the probability of drawing an Exploding Kitten after each turn:

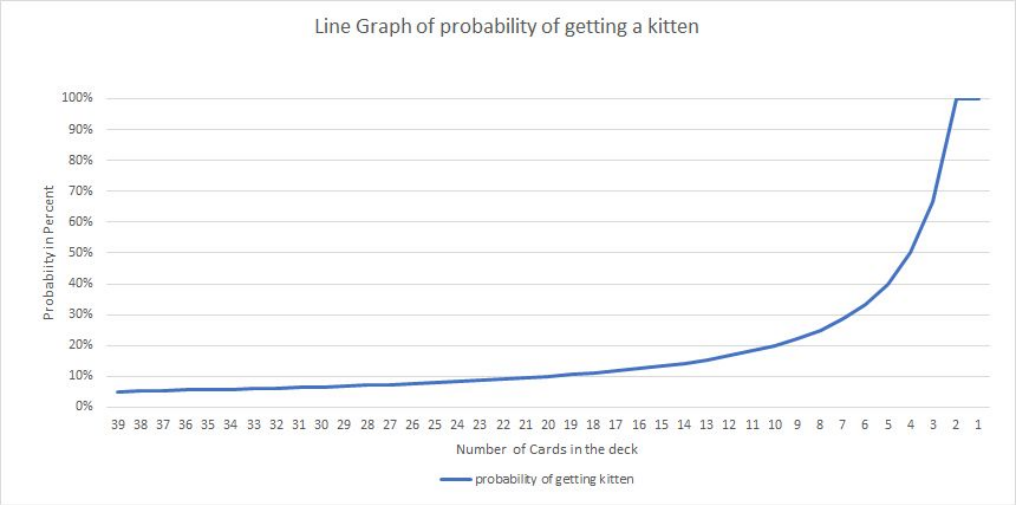

Figure 1

Conclusion

As seen in the graph above, the probability of drawing an exploding kitten increases exponentially after each player takes his turn. The average increase in the probability of drawing an exploding kitten in a 3 player game is 8.49% (2 d.p).

3.3 Research Question 3

Assuming that one player is eliminated or when there is only one exploding kitten left in the deck, the change in probability of drawing an exploding kitten will be as shown in Fig. 2 and 2.1:

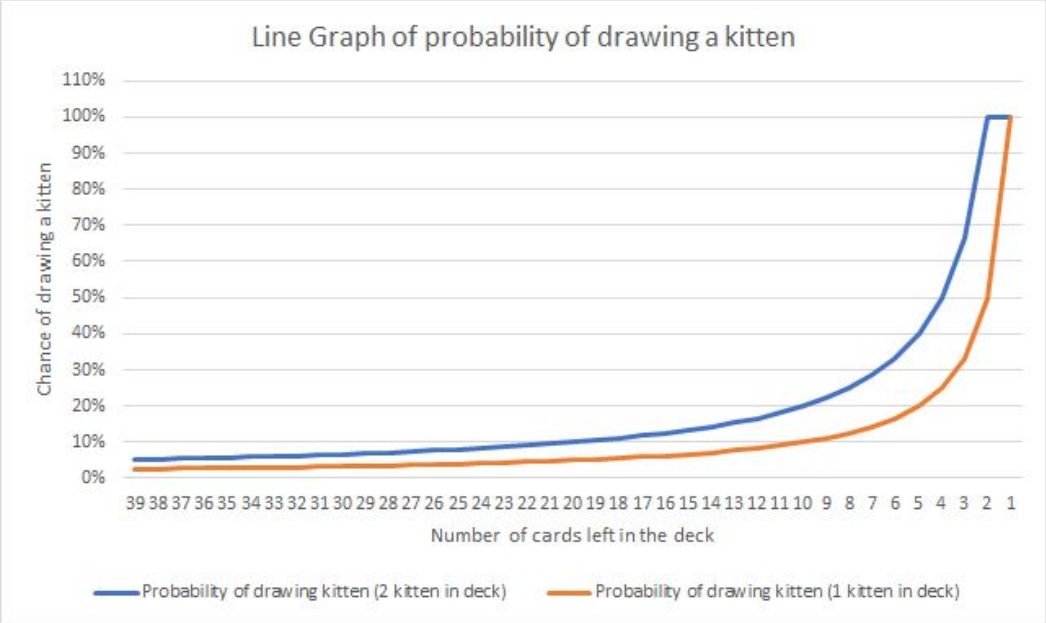

Figure 2

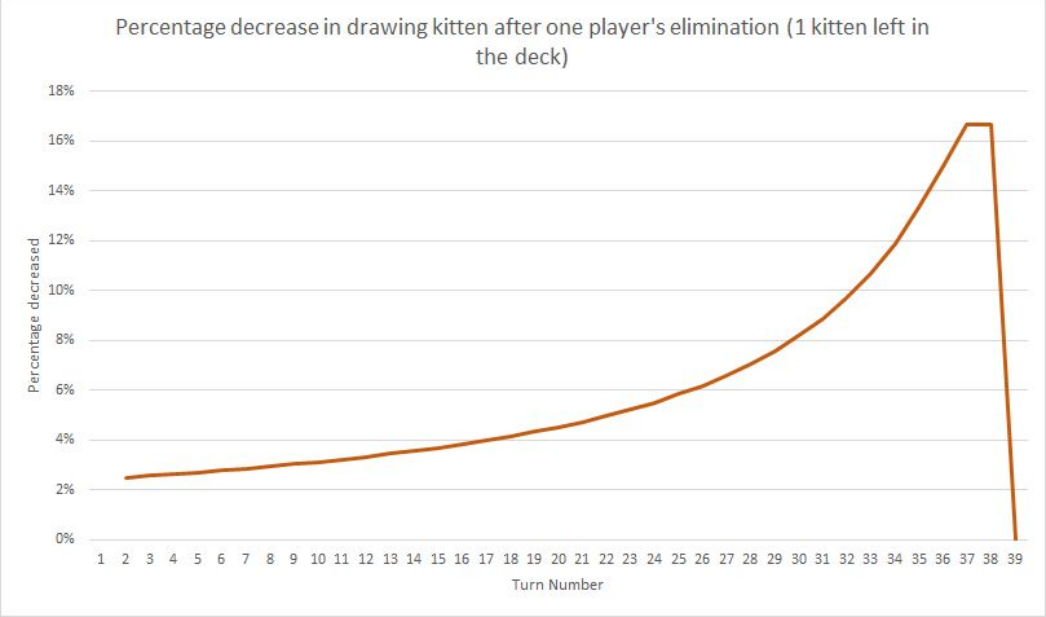

Figure 2.1

Conclusion

The probability of drawing the kitten when there is only one of it in the deck compared to when there are two of them will be halved. The elimination of one player from the game will decrease the probability of drawing the kitten by an average of 6%.

4. Overall Conclusion

From this project “Exploding Kittens”, our group has developed a few strategies as follows.

4.1 Strategy

Favour

Based on the data we had collected, we discovered a pattern when the Favour card was played. The graph below shows the events that occurred after a Favour card was played.

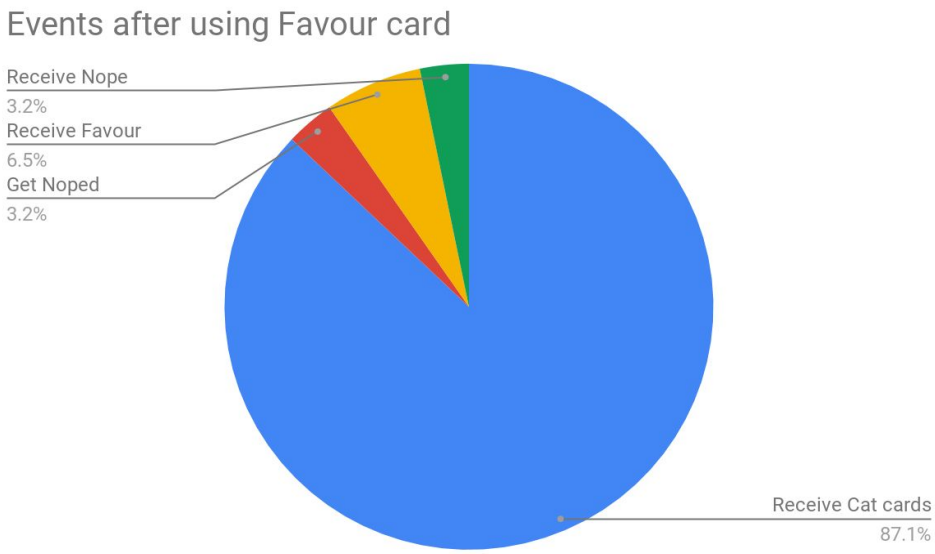

Figure 3

Out of 13 games, there were 31 instances where the Favour card had been used. Of these 31 times the Favour card had been played, 87.1% of the time the player who had used the Favour card was given a Cat card. Thus, as it is highly likely that a Cat card would be given when a Favour card is played, when a Favour is drawn from the Draw Pile, it should always be used the next turn. As the person who is targeted by the Favour is forced to give the user of the Favour a card, the number of cards he has on his hand would decrease. The person targeted is also highly likely to give out a Cat card, the chances of the user of the Favour having a matching pair of Cat cards are higher. Thus, when a matching pair is used on the target of the Favour, an action card is likely to be taken from him as the chances of taking an action card from him increases due to the decrease in the number of cards in his hand.

Saving Attack cards and See the future cards

From the 13 games that we played, we also noted the number of turns taken by each player. It is shown in the graph below.

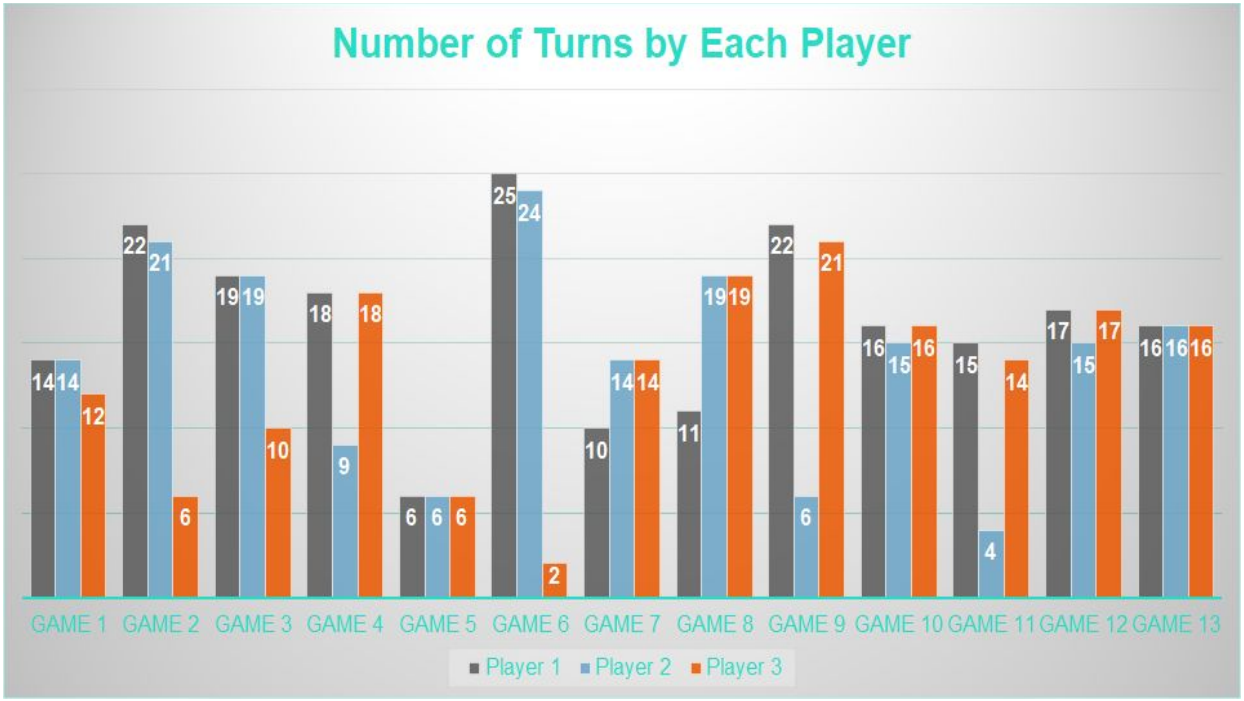

Figure 4

From the above graph, it can be seen that the average turn the first player gets eliminated is 8.

Thus, when an Attack card or See the future card has been drawn from the Draw Pile, it would be a better idea to save the cards in your hand and only use it after your 8th turn as the probability of drawing an Exploding kitten then would be higher.

4.2 Recommendations

To improve the strategy, we may be doing more trials to get more results of the project. Also, our group may also break down and zoom into the results of the trials such that we can look at what moves each player makes and how it affects the player's chances of winning. This will help as we can make more conclusions and come up with more effective strategies to win the game.

5. References

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- Basic Concepts in Probability. (n.d.). Retrieved August 16, 2018, from http://onlinestatbook.com/2/probability/basic.html