



Card Shuffling

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Introduction

Our project was to research how many times someone needs to shuffle cards before it becomes completely random. We looked at the three most common types of shuffling. Using rising sequences, we researched the idea that there is a minimum number of times that someone must shuffle cards in order to make them completely random. We will look at three different types of shuffling: riffle shuffling, overhand shuffling, and "smooshing".



Riffle Shuffling

Rising sequences occur in riffle card shuffling. The first time you shuffle, there are two rising sequences. With every shuffle after that, the number of rising sequences doubles. This means that after 6 riffle shuffles, the cards would have 64 rising sequences. This should be enough, but it is not. To add in extra security that a deck is completely random (that is, to have equally likely probability of pulling one card compared to another) 7 riffle shuffles are necessary.

Overhand Shuffling

Because overhand shuffling is just a movement of different "chunks" of cards, it is a terrible way to shuffle. Different sites consider different amounts that it takes to make these cards completely random, ranging from 2,500 to 10,000. With permutations, there are 52! ways that the cards can be organized. With overhand shuffling keeping them in groups, the cards are not being separated and rearranged as they should be.

Smooshing

This form of shuffling is when someone lays all the cards on the table, and spreads them out, mixing them up. Although this is not necessarily a very professional way to shuffle cards, it only takes about one minute of "smooshing" before cards become completely random. This is because all the cards are spread out and mixed, allowing them to separate from the other cards that they may have been grouped with before.

Conclusion: What makes something random?

A simple way to think of it is if all the cards are in order, and you only riffle shuffled once, a person should be able to guess the top card 31.17 times out of the 52 card deck. With the deck completely random, you will be adding the probability of guessing the correct card as follows:

$$1/52 + 1/51 + 1/50 + \dots + 1/1 = 4.538$$

This shows that when the deck is completely random, someone has the probability of guessing 4.538 cards correctly. This is not the case unless the cards have been riffle shuffled at least 7 times. This shows that riffle shuffling is the best way to shuffle, as it only requires 7 times to become random and is the quickest way to achieve a completely random deck.

Sources:

"Seven Shuffles." -- *Math Fun Facts*. Web. 04 Apr. 2016.

Numberphile. "The Best (and Worst) Ways to Shuffle Cards - Numberphile." *YouTube*. YouTube, 2015. Web. 04 Apr. 2016.