

January 25, 2018

Assignment: Investigate the “perfect shuffle” of a deck of cards and analyze patterns and repetitions.

To better organize my thinking, I will split my evaluations between “out-shuffles”, “in-shuffles”, and the number of cards used in a deck for each.

Out-Shuffles – the shuffle begins with a card that was originally in the top half of the deck.

My interpretation – when the deck is split evenly (beginning with an even number of cards), and then shuffled, the card that is on top of the newly shuffled deck will be from the top half of the original deck.

The perfect shuffle means that every newly shuffled card is in between one from the original deck

Out-Shuffle

8 Cards

1-2-3-4-5-6-7-8

would then be

1-5-2-6-3-7-4-8

12 Cards

1-2-3-4-5-6-7-8-9-10-11-12

would then be

1-7-2-8-3-9-4-10-5-11-6-12

16 Cards

1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-16

would then be

1-9-2-10-3-11-4-12-5-13-6-14-7-15-8-16

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**In-Shuffles** – the shuffle begins with a card that was originally in the top half of the deck.

My interpretation – same as with out-shuffles, but the card that is on top of the newly shuffled deck will be originally from the bottom half of the deck.

In-Shuffle

**8 Cards**

1-2-3-4-5-6-7-8

*would then be*

5-1-6-2-7-3-8-4

**12 Cards**

1-2-3-4-5-6-7-8-9-10-11-12

*would then be*

7-1-8-2-9-3-10-4-11-5-12-6

**16 Cards**

1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-16

*would then be*

9-1-10-2-11-3-12-4-13-5-14-6-15-7-16-8

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Notable patterns: out-shuffles ALWAYS begin with the card that was also on the top of the original deck. In-shuffles ALWAYS begin with the card that was exactly halfway through the deck.

Analyzing these simple outlooks has made me realize that a perfect shuffle is just a perfect insertion of half of the deck into the other half.

What happens if I again perfectly shuffle the already shuffled deck? Let's try it.

Out-Shuffle

8 Cards

1-5-2-6-3-7-4-8 *would then be* 1-3-5-7-2-4-6-8

12 Cards

1-7-2-8-3-9-4-10-5-11-6-12 *would then be* 1-4-7-10-2-5-8-11-3-6-9-12

16 Cards

1-9-2-10-3-11-4-12-5-13-6-14-7-15-8-16 *would then be* 1-5-9-13-2-6-10-14-3-7-11-15-4-8-12-16

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### In-Shuffle

#### 8 Cards

5-1-6-2-7-3-8-4      *would then be*      7-5-3-1-8-6-4-2

#### 12 Cards

7-1-8-2-9-3-10-4-11-5-12-6      *would then be*      10-7-4-1-11-8-5-2-12-9-6-3

#### 16 Cards

9-1-10-2-11-3-12-4-13-5-14-6-15-7-16-8      *would then be*      13-9-5-1-14-10-6-2-15-11-7-3-16-12-8-4

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Notable Patterns: Perfectly shuffling for the second time creates some interesting patterns. With the 8-card deck using out-shuffling, the second product is a deck split perfectly in half between the even numbers and odd numbers. The deck increases by two for each number, beginning with the odds

(1-3-5-7) and ending with the evens (2-4-6-8) directly behind it.

The 12-card deck using out-shuffling is also interesting but has a different pattern. The second product of the deck is split into 3 groups of 4 cards, with each group increasing by three every card and dropping by eight after the fourth card. The sets go (1-4-7-10) drop eight (2-5-8-11) drop eight (3-6-9-12).

Lastly, the 16-card deck using out-shuffling follows the same pattern as the previous two, splitting into groups of 4, increasing by a set scalar each card, and then decreasing by a set scalar.

The sets go (1-5-9-13) drop eleven (2-6-10-14) drop eleven (3-7-11-15) drop eleven (4-8-12-16).

ANALYSIS CONCLUSION: In my experimenting I used decks with a common dividend of 4 and increased each deck size by 4. This affected both the patterns of the shuffled decks and the size of the pattern groups that the cards were split into. Each second shuffle had a pattern group of 4. Another interesting detail was that each card increased by the multiple number determined by the deck. In the 8-card deck, 4 times 2 equals 8, therefore the cards increased by twos within their pattern groups. In the 12-card deck, 4 times 3 equals 12, therefore the cards increased by threes within their pattern groups. The size of the pattern groups and gap between each card is determined by the original number of cards and would not show such a similar pattern if the number of cards in each deck deviated from the original standard. For instance, the pattern between an 8-card deck would not be the same as the pattern between a 10-card deck, as they do not have the same common multiple. This analysis could be very useful to learn if counting cards is an interest, as a professional player could assume that professional dealers are rather skilled at shuffling cards. This would make it easier for a player to take an accurate guess as to which cards are where.