# 241 Assignment Report Anthony Dickson 3348967

## **Unbroken Pair Distribution with Random Permutations**

When generating random permutations of a deck of 50 cards, with a Fisher-Yates shuffle to ensure there is no bias in the randomness, the number of unbroken pairs seems to be normally distributed around an average of about 0.5. Most (74%) of the time there will be 0 or 1 unbroken pairs, 99.7% of the time there will be up to 4 unbroken pairs, and only 0.3% of the time will we see more than 4 unbroken pairs.

## **How many random overhand shuffles seem to be necessary so that the number of unbroken pairs behaves as it would for random permutations?**

To achieve a similar distribution of unbroken pairs to that of a deck generated using random permutations, you would need to random overhand shuffle somewhere around 60 ~ 80 times. At 80 shuffles, the distribution of unbroken pairs is almost identical to that of the random permutations, as shown by the graphs and tables below.

## Unbroken Pair Distribution with Unbroken Pair Distribution After 80 Random Permutations Random Overhand Shuffles

|  |  |  |
| --- | --- | --- |
| Unbroken Pairs | Ratio | Percentage |
| 0 | 0.374966 | ~37% |
| 1 | 0.367669 | ~37% |
| 2 | 0.181000 | ~18% |
| 3 | 0.059301 | ~6% |
| 4 | 0.014224 | ~1% |
| 5 | 0.002813 | <1% |
| 6 | 0.000451 | <1% |
| 7 | 0.000066 | <1% |
| 8 | 0.000005 | <1% |
| 9 | 0.000001 | <1% |
| 10 | 0.000002 | <1% |

|  |  |  |
| --- | --- | --- |
| Unbroken Pairs | Ratio | Percentage |
| 0 | 0.37336 | ~37% |
| 1 | 0.36750 | ~37% |
| 2 | 0.18100 | ~18% |
| 3 | 0.05968 | ~6% |
| 4 | 0.01494 | ~1% |
| 5 | 0.00289 | <1% |
| 6 | 0.00055 | <1% |
| 7 | 0.00007 | <1% |
| 8 | 0.00001 | <1% |