# COSC241 Group Assignment Experiment

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**Purpose**:
To investigate whether overhand shuffles with a break probability of 0.1 performed on a deck of cards are close to a (pseudo) random shuffle, by comparing statistics of 'unbroken pairs' and looking at their distributions.

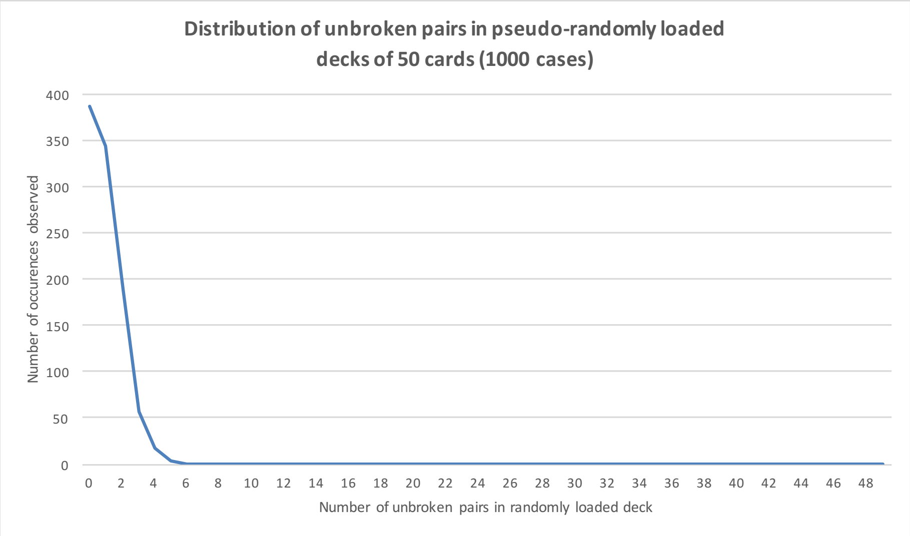
**Method**:

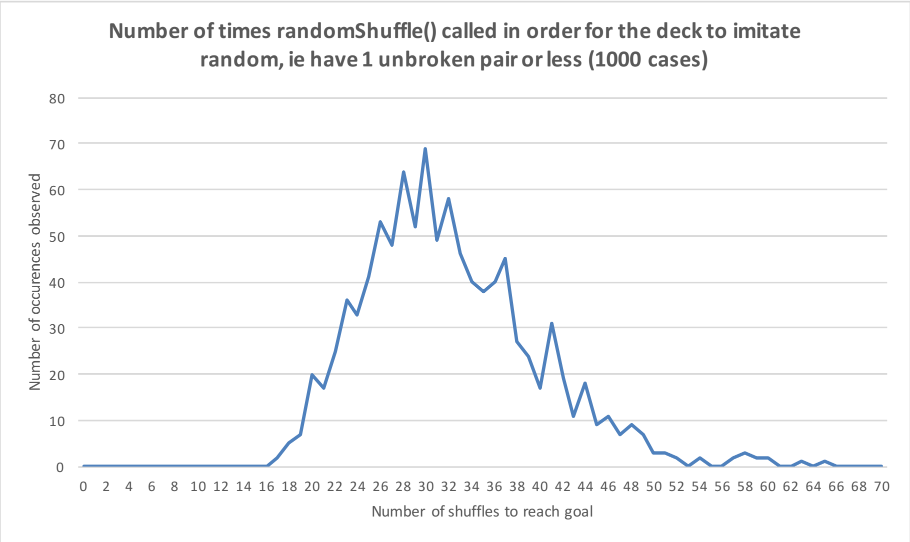
- The randomShuffle() method was set to have a break probability of 0.1.
- All the tests were run on a deck of 50 cards containing the integers 0-49.
- We coded a test application that ran each test 1000 times.
- We used our results from the first round of experiments to conduct the second.

**Results**:
We found that 92% of all randomly loaded card decks had a number of unbroken pairs of either 0 (39%), 1 (34%) or 2 (19%). We deemed then that in order for a deck to truly be considered appearing as random it must have less than 2 unbroken pairs and no more. (1 being the average from our sample). See graphs alongside.

The break probability of 0.1 was so low that on average one random overhand shuffle was returning 44 unbroken pairs (range: 36-49). This was in no way close to random. We performed this test 1000 times also, but chose to only include summary information here, as it helps to hint at just how many more shuffles were required on our next test.

Based on these results, we then used the countShuffles method to determine how many shuffles it took to produce a deck that appeared as random (i.e. with 1 unbroken pair or less). We did 1000 runs of countShuffles and found that the average number of times required to randomly overhand shuffle the deck was 32 (range: 16-65).




**Analysis**:
The number of of random overhand shuffles necessary so that the number of unbroken pairs behaves as it would for random permutations is 32, determined by our experiments. This number was calculated by taking the average of 1000 cases of calling the countShuffle method.

This result implies that upon doing 32 random overhand shuffles it is hypothetically enough for the deck to be random. However, because our range was quite large (16-65) it also implies that not every case of cards which is shuffled 32 times will fit within our confines of random. Sometimes it takes many more shuffles to produce 1 or less unbroken pairs, and sometimes it takes fewer – but on average it is 32 times. This number was calculated for both 1000 cases (our first test) and 10,000 cases (our second test).