MIT Introduction to Statistics 18.05 Problem Set 1

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2 Poker Hands

2.1 Two-Pair

We calculate the probability of the poker dealer dealing us a hand that is a two-pair hand. First we count the number of two-pair hands, then we divide the number of two-pair hands by the total number of hands to calculate the probability of the dealer dealing us a two pair hand.
The definition of a two-pair hand is, "Two cards have one rank, two cards have another rank, and the remaining card has a third rank. *e.g.*:$\{2\heartsuit, 2\spadesuit, 2\clubsuit, 5\clubsuit, K\diamondsuit\}$" [1]
We take a combinations approach similar to the approach Orloff and Bloom take to calculate the probability of a one-pair hand in [2].
First we choose the ranks of the pairs. There are 13 ranks, so there are $\binom{13}{2}$ ways to choose the ranks of the pairs.
Next we choose the suits for the cards in the pairs. There are $\binom{4}{2}$ ways to select the suits for the cards in the first pair, and $\binom{4}{2}$ ways to select the suits for the cards in the second pair.

To complete the hand we select one card. We have 11 ranks to choose from for the fifth card, and $\binom{4}{1}$ ways to select its suit.
We apply the rule of product to count the number of two-pair hands:

$$\binom{13}{2}\binom{4}{2}\binom{4}{2}\binom{11}{1}\binom{4}{1} = 78 \times 6 \times 6 \times 11 \times 4 = 123552 \tag{1}$$

We count the number of all poker hands as the way to select 5 items from a set of 52 items. Therefore the number of all poker hands is $\binom{52}{5} = 2598960$.
Therefore the probability of a two-pair hand is $\frac{123552}{2598960} \approx 0.048$.

References

[1] Jeremy Orloff and Jonathan Bloom. *18.05 Problem Set 1, Spring 2014*. Available at `https://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2014/assignments/MIT18_05S14_ps1.pdf` (Spring 2014).

[2] Jeremy Orloff and Jonathan Bloom. *Probability: Terminology and Examples 18.05 Spring 2014*. Available at `https://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2014/class-slides/MIT18_05S14_class2slides.pdf`(Spring 2014).