Snake Eyes:

A Study of Dice Averages

Fig 1: The pair of dice used for the experiment [Backdrop from Swimomish Casino]

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Abstract:

This experiment was done using two color coded dice, as seen in Fig 1. The experiment was conducted with the hypothesis of 7 being the most rolled summation. The pair were rolled 100 times, with the sum and each individual roll being measured down for later calculations. From the rolls, 7 matched the hypothesis and mathematical expectation, emerging as the most frequently rolled sum, appearing 20% of the time. Notable edge cases were 2 being seen 5% of the time and 12 not appearing once, along with 5 being seen 15% of the time.

Introduction:

Snake eyes: An infamous term associated with rolling two 1s, with one of the lowest chances to be rolled with a pair of dice. While matched with rolling two 6s, or ‘boxcars’, snake eyes is a significantly more known term, known for its bad luck. However, how likely is it to actually roll snake eyes? Is it something to reasonably anticipate in a game of luck? What should and should not be expected from rolling your average pair of dice? In this experiment, we will observe the results from rolling a pair of dice 100 times to see the frequencies of each sum. We expect the sums to appear as a bell curve, hitting a maxima at 7, and gradually equally decreasing towards the edges, with 2 and 12 being the least likely. This is due to the average of a die being 3.5, and though this 3.5 cannot be rolled, two dice combined should in theory yield 7. With that logic, each sum going further away from 7 is less and less likely, expecting a bell curve as each further sum is increasingly less likely than the previous one.

Materials:

Two same sized, differently colored, six-sided die

Methods:

1. Gather the two dice in your palms.
2. Clasp your palms together, leaving empty space inside.
3. Shake your hands.
4. Release your hands, ideally expelling the dice with light downward force.
5. Note down the sum of the die pair, alongside the individual rolls of each die.
6. Repeat steps 1-5 as many times as desired.

Results:

Presented below are the total number of times each sum was rolled, along with the frequency of individual rolls for each dice.

Sum	2	3	4	5	6	7	8	9	10	11	12
Frequency	5	6	7	15	10	20	13	11	7	6	0

Fig 2: The frequencies of each rolled dice sum

Roll	1	2	3	4	5	6
Frequency	22	13	12	20	16	17

Fig 3: The frequency of each roll for the blue die

Roll	1	2	3	4	5	6
Frequency	16	19	19	14	14	18

Fig 4: The frequency of each roll for the yellow die

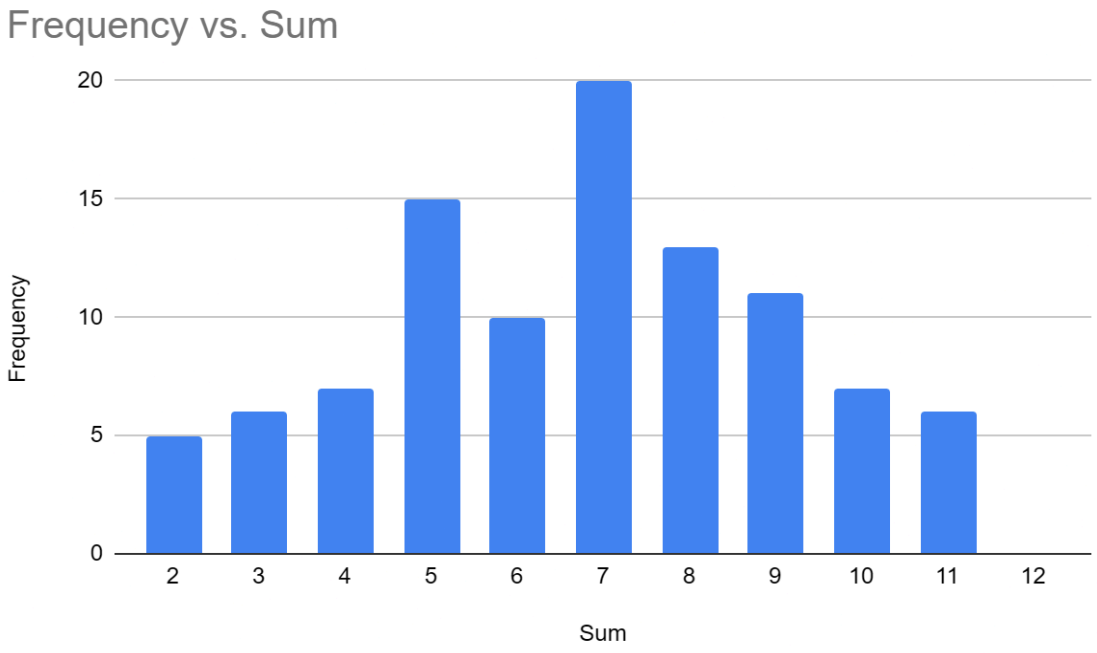

Fig 5: The bar graph for the sums and frequencies

Analysis:

The results did not entirely match the expected hypothesis. While 7 is seen to be the most frequent sum, the expected bell curve did not emerge, with Fig 7 instead showing the resulting line graph. The general trend of sums being less likely as they diverge from 7 is seen, however 5 is a clear outlier, being the second most likely summation. This however is to be expected, as only rolling the dice pair 100 isn't a large enough sample to reliably average out outliers. While each individual die didn't deviate from the expected 16.67% chance for each number rolled, with the largest deviation being 1 on the blue dice appearing 22% of the time as seen in Fig 3, the combination of rolls in Fig 4, even with 1 emerging only 16% of the time, simply resulted in snake eyes and 5s being more prevalent due to raw luck.

The theoretical behavior of dice sums is well established in probability research. Ashok K Singh, Rohan J. Dalpatadu, and Anthony F. Lucas, researchers at the University of Nevada, New Vegas explain in "The Probability Distribution of the Sum of Several Dice: Slot Applications" (2011) that the "probability distribution of the sum of two faces of the dice, needed to compute the house advantages of various bets, is easy to calculate"(2011), following this claim up with mathematical formulas that can be easily applied to find the frequency for a sum of any amount of dice. For two six-sided dice, their results found a symmetric distribution centered at 7, which has the greatest number of possible combinations and therefore the highest probability. As sums move further away from 7, the number of possible combinations decreases, reducing their likelihood. Their mathematical framework provides a clear benchmark for evaluating experimental results, as it defines the expected distribution that should appear over a sufficiently large enough number of trials. It additionally aligns with my hypothesis, as well as generally my

expected summation frequencies. As seen in Fig 6, their calculations did generally align with the tested frequencies in Fig 2, except for the major outlier that is 5.

Conclusion:

Snake eyes, as unfortunate as they are, are not as unlikely as one would believe them to be considering their association with bad luck. While they are tied for the lowest appearance frequency, 1/36, or 2.78%, isn't so rare that it isn't to be expected. At the same time, while 7 is the most likely sum to appear, it only having on average a 16.67% rate of appearing isn't so high that it is nonoptimal to not bet on its appearances. While edge cases did appear in the form of 2 being more common than it should have been, and 5 being more common and disrupting the bell curve, a larger sample size would have in theory yielded frequencies that would match the calculated odds found in Fig 2.

Works Cited

Singh, A. K., Dalpatadu, R. J., & Lucas, A. F. (2011). The Probability Distribution of the Sum of Several Dice: Slot Applications. *UNLV Gaming Research & Review Journal*, *15*(2), 109–118.

Appendix:

Table 1: Probability distribution of the sum of 2 fair dice

x	2	3	4	5	6	7	8	9	10	11	12
$f(x)$	$\frac{1}{36}$	$\frac{2}{36}$	$\frac{3}{36}$	$\frac{4}{36}$	$\frac{5}{36}$	$\frac{6}{36}$	$\frac{5}{36}$	$\frac{4}{36}$	$\frac{3}{36}$	$\frac{2}{36}$	$\frac{1}{36}$

Fig 6: Probability Distribution (2011)'s calculated expected sum frequencies

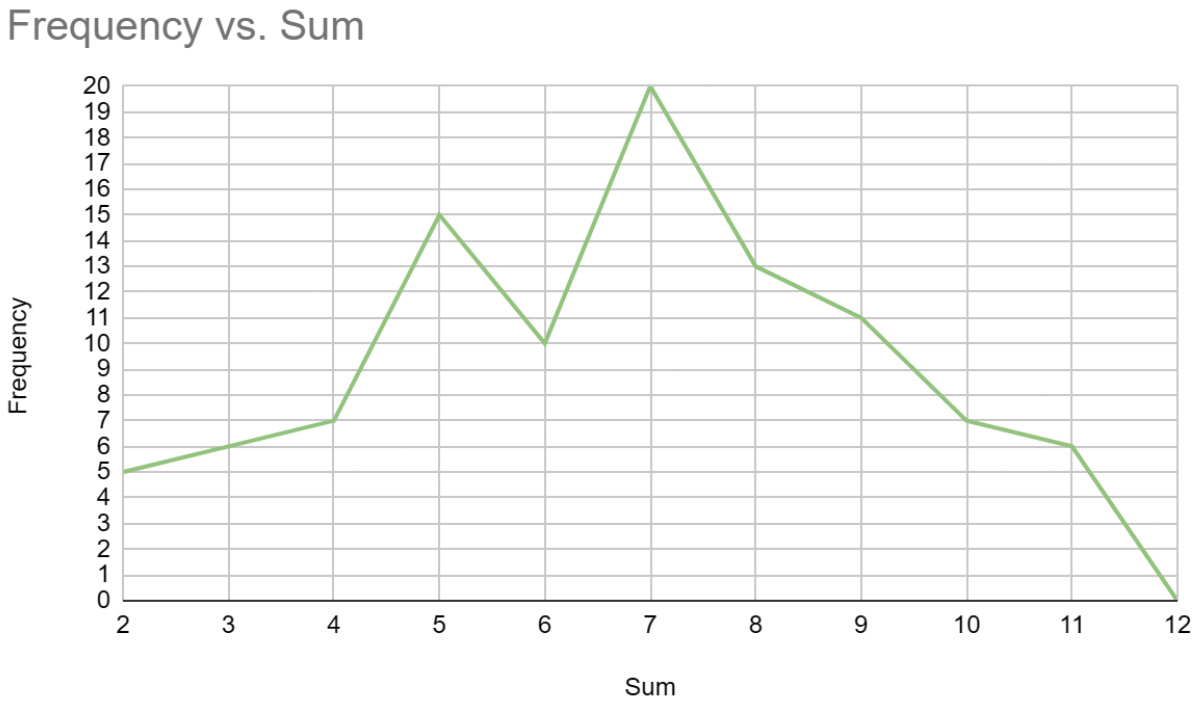

Fig 7: Line graph of tested sums