1. Definition of the Law of Averages

Consider a random process in which the probability of success in a single trial is a fraction, p. A trial might be a single roll of a die, a single flip of a coin, a single spin of a wheel, a single person selected out of many. Suppose that the single trial of this random process is repeated many times, and that the outcome of each trial is independent of the others. The larger the number of trials, the more likely it is that the overall fraction of successes will be close to the probability, p, of success in a single trial. Also with more trials: You are likely to miss the expected number of outcomes by a larger amount as measured by raw numbers, but you are likely to miss by a smaller amount in terms of percentages.

2. Examples: 10,000 tosses of a coin (handout), pair of die, roulette wheel

A roulette wheel has 18 black numbers, 18 red numbers and 2 green numbers.

Find the probability of a red on a given spin.

18/38 = 9/19 or about 0.47

If you spin the wheel 3 times, how many times will it come up red?

No clue, it's a random process but you can calculate the chance that it could be 0, 1, 2 or 3 times. HOW?As yourself, how many spins and what are the possible outcomes.

3. Box Models (16.4) a tool to help you calculate sums from a random process

5 Questions you should ask yourself about box models:

1) What numbers (tickets) go into the box?

2) How many of each kind of ticket? You might be thinking in terms of percentages or actually counts or proportions. Example: roulette is a like a box with 3 tickets that are colored red, green, and black and there are 18 red, 2 green, 18 black or about 47.5% red, 5% green, 47.5% black.

3) Should I replace tickets after each draw? In the case of roulette, yes, the spins are independent if you didn't replace the tickets, the odds would change.

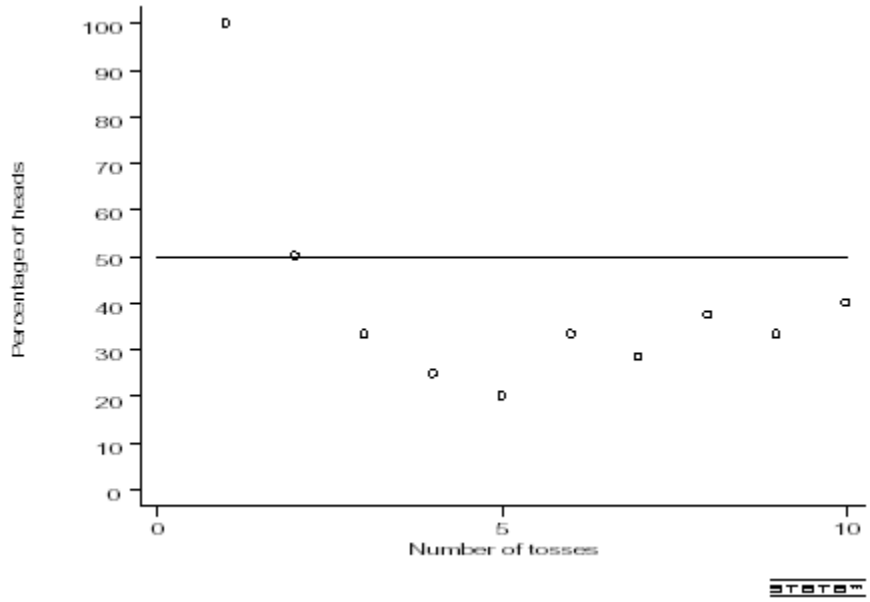
4) How many draws? How many times are you going to allow this random process to proceed?

5) What do I do with the numbers I draw? Do I sum them up or calculate an average or calculate a percentage (or proportion)?

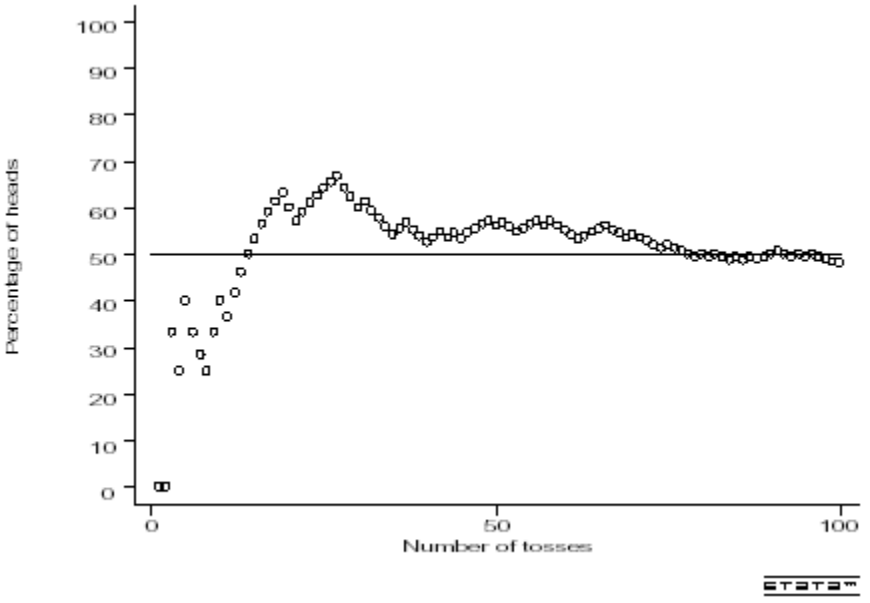
4. PRACTICE, PRACTICE, PRACTICE

I can't stress this enough. Review pages 285-286.

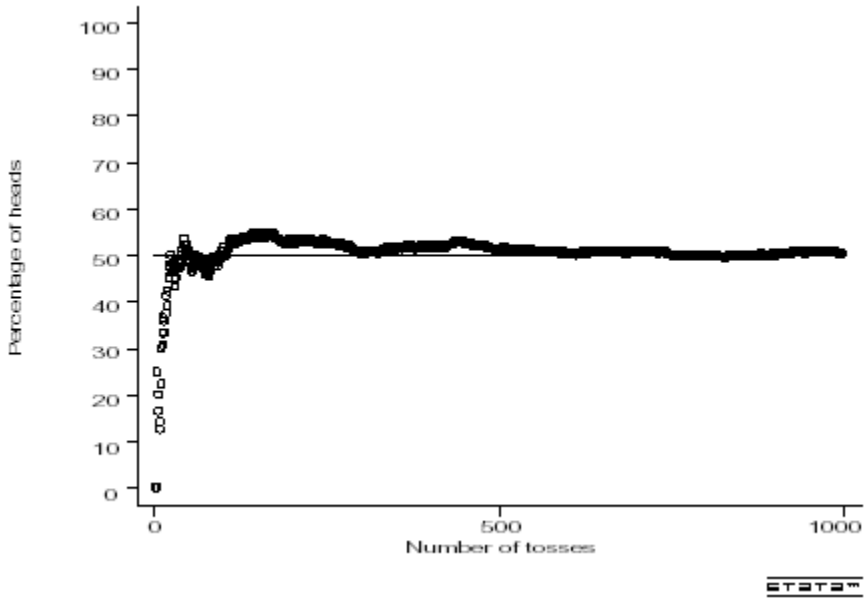
A graph of 10 tosses of a coin



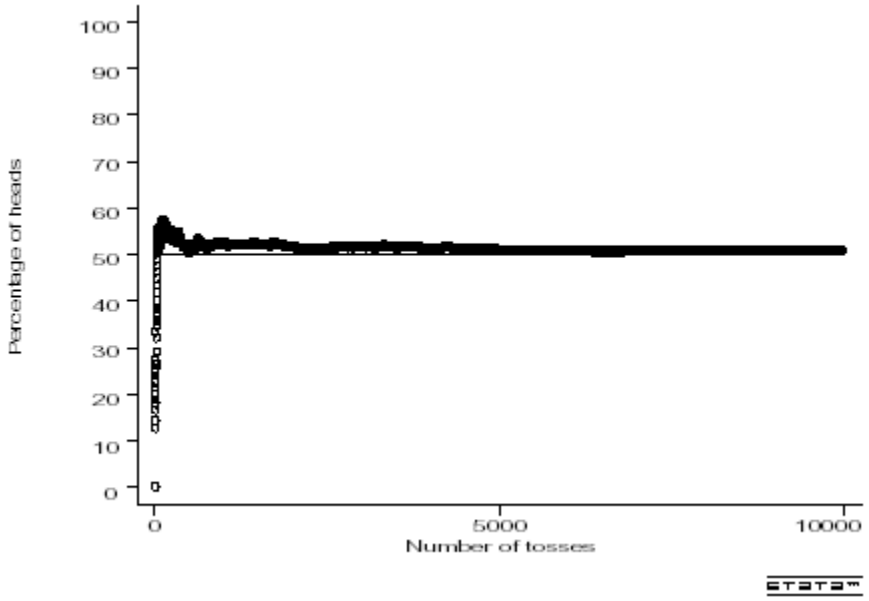
A graph of 100 tosses



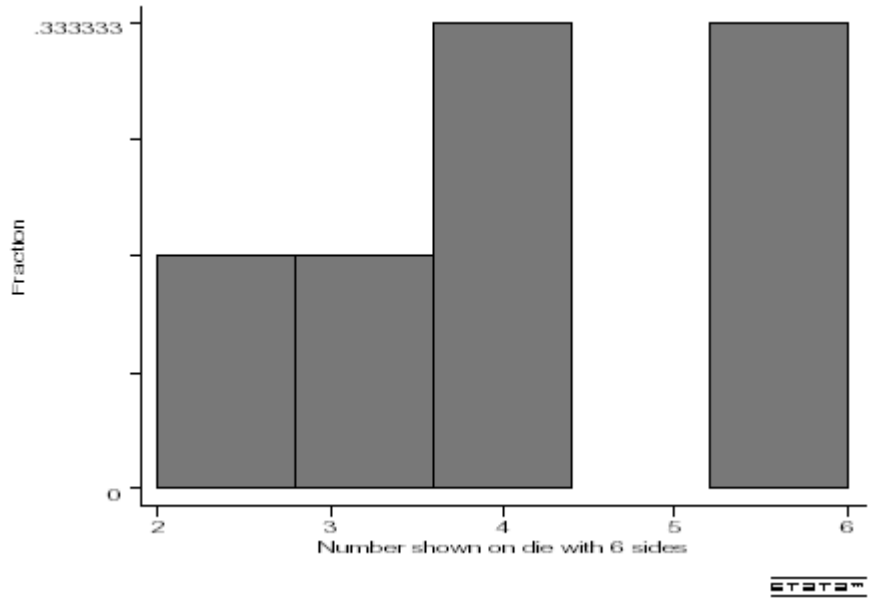
A graph of 1,000 tosses of a coin



A graph of 10,000 tosses of a coin, like the Chapter 16 example:

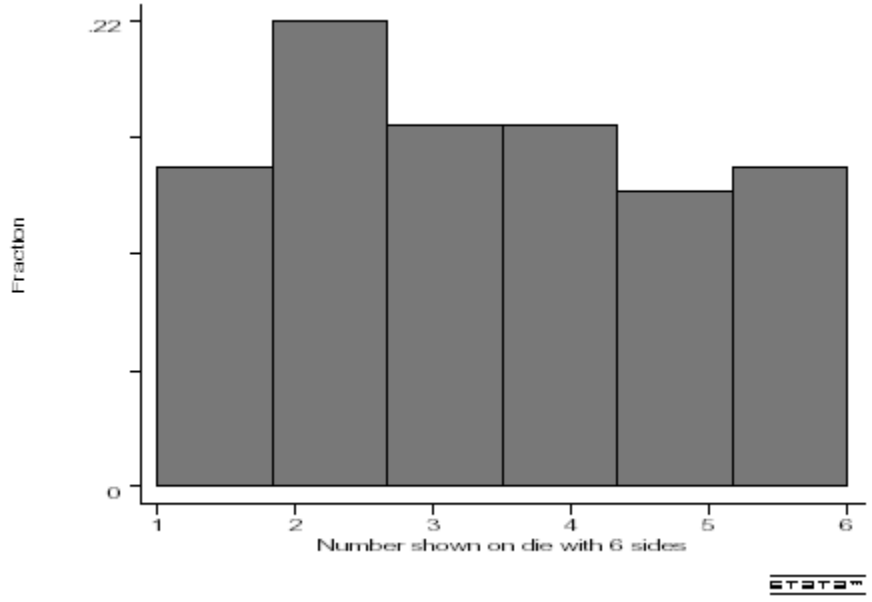


How about a single die, suppose we roll it 6 times, what do you expect to happen?



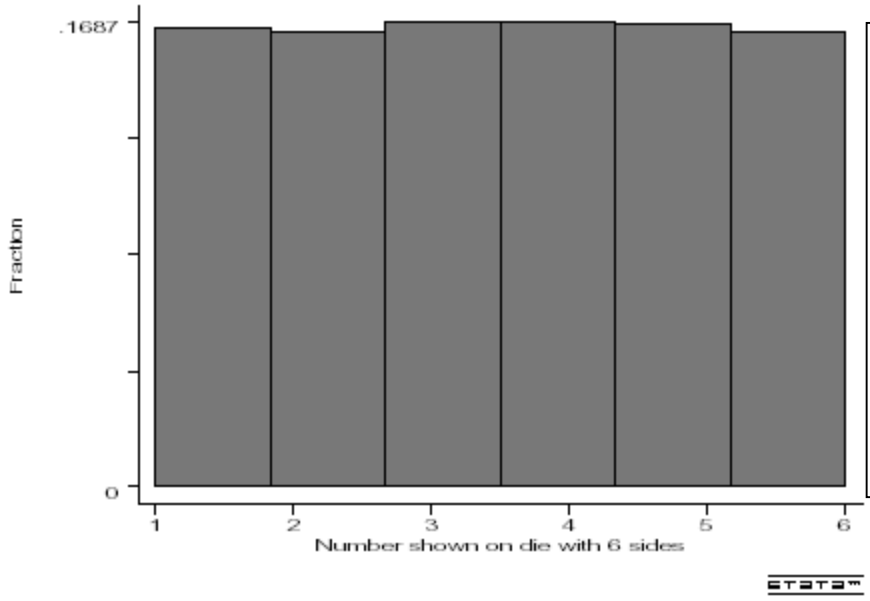
Number shown on die with 6 sides	Freq.	Percent
2	1	16.67
3	1	16.67
4	2	33.33
6	2	33.33
Total	6	100.00

And if we rolled a single die 100 times? What would you expect?



Number shown on die with 6 sides	Freq.	Percent
1	15	15.00
2	22	22.00
3	17	17.00
4	17	17.00
5	14	14.00
6	15	15.00
Total	100	100.00

And what do you think happens if we were to roll it 100,000 times? (Guess and then look at the next page)

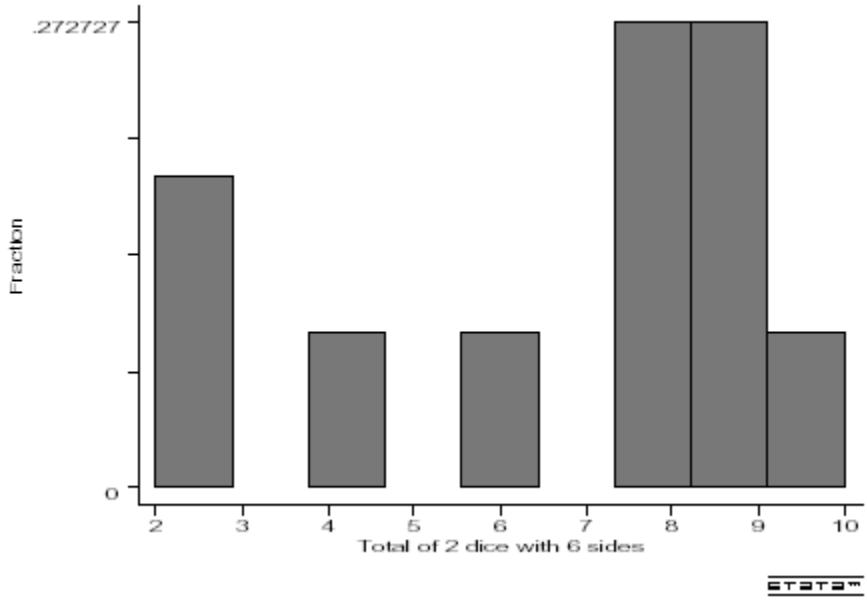


Number shown on die with 6 sides	Freq.	Percent
1	16575	16.58
2	16750	16.75
3	16475	16.48
4	16636	16.64
5	16687	16.69
6	16877	16.88
Total	100000	100.00

The game of "craps" in Las Vegas involves rolling 2 die simultaneously. What are the possible outcomes?

2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

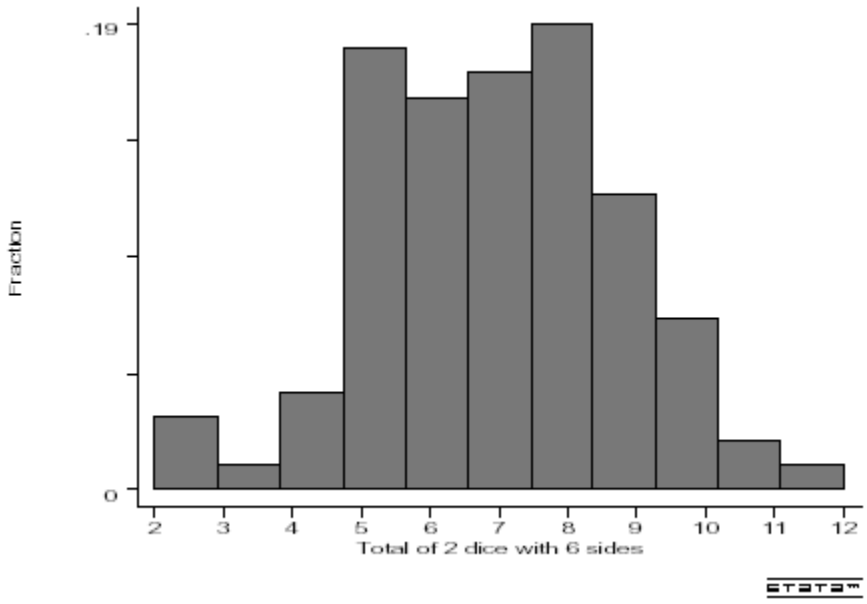
There are 11 possible outcomes. What if I were to roll 2 die 11 times, what would we expect to see?



Total of 2 dice with 6 sides	Freq.	Percent
2	2	18.18
4	1	9.09
6	1	9.09
8	3	27.27
9	3	27.27
10	1	9.09
Total	11	100.00

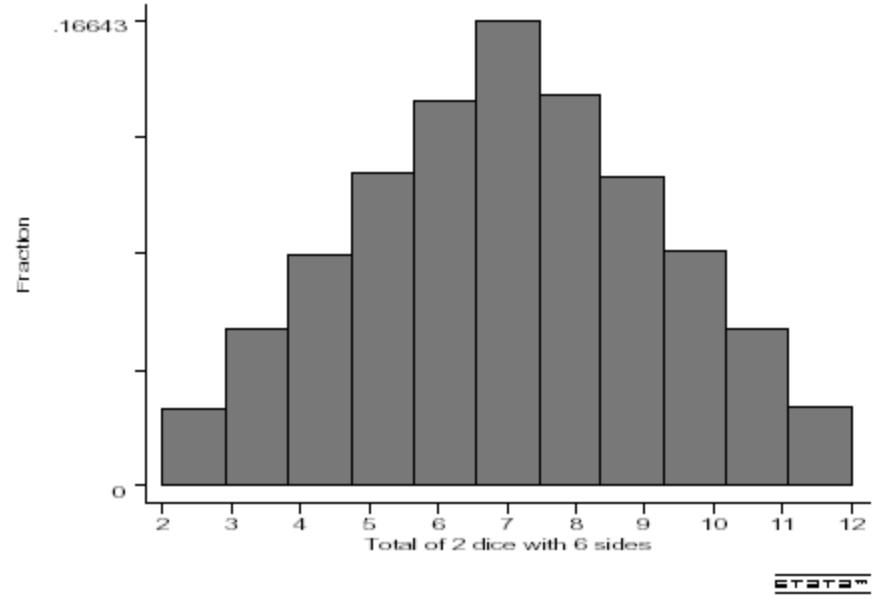
And what if we rolled 100 times? Or 100,000 times (the typical number of rolls in single night in a busy casino in Las Vegas)

100 Rolls of 2 die



Total of 2 dice with 6 sides	Freq.	Percent
2	3	3.00
3	1	1.00
4	4	4.00
5	18	18.00
6	16	16.00
7	17	17.00
8	19	19.00
9	12	12.00
10	7	7.00
11	2	2.00
12	1	1.00
Total	100	100.00

And 100,000 times?



Total of 2 ice with 6 sides	Freq.	Percent
2	2765	2.76
3	5587	5.59
4	8280	8.28
5	11139	11.14
6	13761	13.76
7	16643	16.64
8	13928	13.93
9	11059	11.06
10	8421	8.42
11	5591	5.59
12	2826	2.83
Total	100000	100.00

Take note -- where have you seen something that looks a little bit like this before?