

Statistics Project—The Toothpick Distribution

Understanding natural phenomenon often starts with analyzing the results of simple experiments. This project illustrates many of the principles of the statistics class.

The Random Phenomenon: An experimenter drops a toothpick from a substantial height onto a planar surface that has been ruled with parallel lines separated by a toothpick length. He/she then records whether or not the toothpick touches one of the ruled lines.

Assumptions: Assume that successive trials of this experiment are independent, i.e. the probability of touching a line is the same for the second toothpick regardless of what happened on the first toothpick, etc.

What to do: Run one hundred trials with four toothpicks per trail. The number of lines touched per trial is your random variable. Call this random variable X_4 . Make a histogram of your results. Describe the results and answer the following questions:

1. From the theory learned in class your X_4 histogram should approximate what distribution?
2. Based on your data draw the hypothesized X_4 distribution on the same graph as your histogram in 1.
3. Let X be the underlying random variable that represents the proportion of touches in the continuous case. What type of distribution does X have?
4. Use your experimental results to estimate the probability p that a toothpick will touch a line.
5. Assuming 3 and 4 are correct, graph the resulting distribution for X .
6. Assuming 5 is correct use the Central Limit Theorem to estimate the distribution for X_9 —one hundred trials with nine toothpicks per trial.

Extra credit:

- A. Run the X_9 experiment and compare results with theory.
- B. Change the spacing of the parallel lines and run X_4 again. Speculate on the correlation between the spacing and p .

Report Writing Cautions: Be sure you thoroughly describe the experiment/study to the reader. Remember you are writing this report for the general reader not specifically for your teacher. Try to address any objections that the reader might bring up. Your report should be in a prose format. Be sure to use complete sentences, proper grammar, correct spelling, understandable statements, etc. Clarity of your concepts and presentation is important. If your English composition skills are not so good then make sure that someone in your group with good composition skills goes through your document carefully. If you have extensive tables and graphs consider putting them in an appendix.