

## Statistics Project—The Thumbtack 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 thumbtack from a substantial height onto a planar surface. He/she then records whether or not the thumbtack landed point-up.

**Assumptions:** Assume that successive trials of this experiment are independent, i.e. the probability of landing point-up is the same for the second thumbtack regardless of what happened with the first thumbtack, etc.

**What to do:** Run one hundred trials with nine thumbtacks per trial. All thumbtacks should be of the exact same type. The number of point-up landings per trial is your random variable. Call this random variable  $X_9$ . Make a histogram of your results. Describe the results and answer the following questions:

1. From the theory learned in class your  $X_9$  histogram should approximate what distribution?
2. Based on your data draw the hypothesized  $X_9$  distribution on the same graph as your histogram in 1.
3. Let  $X$  be the underlying random variable that represents the proportion of point-up landings in the continuous case. What type of distribution does  $X$  have?
4. Use your experimental results to estimate the probability  $p$  that a thumbtack will land point-up.
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  $X_{16}$ —one hundred trials with sixteen thumbtacks per trial.

Make sure that your report includes the details of the procedures that you used—the height of the drop, the dimensions of the thumbtack, the landing surface, etc. Include ancillary observations—did the thumbtacks tend to bounce? Did they all have uniform dimensions? etc.

**Extra Credit:** Alter the dimensions of your thumbtack by cutting off a specific amount from the point. Run the  $X_9$  experiment again. Speculate on the correlation between the thumbtack dimensions 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.

