Name(s)	Project Number
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Project Title

Hit or Miss: The Effect of the Number of Trials on the Experimental Value of Pi in Buffon's Needle (Dropping) Experiment

Abstract

Objectives/Goals

The objective is to determine if the experimental value of pi obtained using Buffon#s Needle Experiment approaches the actual value of pi in a consistent and speedy way over the first 1000 trials.

Methods/Materials

Three sets of equally spaced parallel lines were drawn on a large piece of paper. The line spacings were 6.5 cm (green), 8 cm (black), and 10 cm (red). Ten 6.5 cm toothpicks were dropped on the paper, picked up and dropped again until 1000 toothpicks had been dropped. The number of toothpicks out of 10 that crossed a line of each color was recorded. Buffon's formula, which includes pi, as well as toothpick length and line spacing as constants was used to obtain an experimental value for pi on the basis of the first 100 trials, the first 200, etc. up to 1000 cumulative trials. The expected value for the number of crossings is simply replaced with the experimental ratio obtained from the trials. For each line spacing the values for pi, as well as the errors were graphed using an Excel spreadsheet.

Results

The average error (= positive difference between pi and experimental pi) for all three line spacings did improve from 100 trials (E = 0.1616) to 1000 trials (0.1354), but this convergence was not consistent. The average error decreased over only 4 of the 100 trial intervals, while it increased over 5 of them. The average error for 1000 trials was in fact significantly greater than for 200, 300, 400, and marginally greater than for 900 trials. Despite this variability, the variations in the error were much smaller over the later trials than at first.

Conclusions/Discussion

I discovered that after about 50 trials the experimental value for pi converges rather slowly to the actual value using Buffon#s Needle Method. Some physical and human limitations that may have affected the outcome were: 1) the possible misjudgment of whether a toothpick crossed a line or not, 2) the thickness of the lines that made these judgments more difficult, 3) the possibility that some toothpicks were not exactly 6.5 cm long, 4) the possibility that not all lines were perfectly parallel, and therefore not precisely 6.5, 8, or 10 cm apart. Despite these limitations, the numbers I obtained were pretty consistent for the 3 different line spacings. In addition, given the direction my results seemed to be heading, I am confident that doing more trials would have led to a better estimate for pi.

Summary Statement

This project compares estimates of pi obtained using Buffon's Needle Experiment formula for up to 1000 trials.

Help Received

My dad served as my mentor. He also helped me with the Excel spreadsheet and special symbols.