CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
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Project Number
S1223

Project Title
When Does Randomness End?

Abstract

Objectives/Goals
The objective of this experiment is to determine whether multiplication, exponentiation, or addition will force a set of random numbers [0,1] to conform to Benford's Law (a most-significant-digit law for natural, social, or mathematically-manipulated numbers) with a statistical significance level of 0.05 by Chi-square testing.

Methods/Materials
Java was used to create random number sets [0,1] (proven not to conform to Benford's Law) then perform operations on this set with additional random number sets. The results from these programs were analyzed in Microsoft Excel and placed into charts and graphs. Error bars on these graphs were calculated using a poisson distribution. Chi-square values of each calculation were calculated and compared to the statistical significance level of 0.05.

Results
When multiplying with sets of random numbers, their conformity to Benford's Law becomes 0.05 significant after one multiplication and becomes much more significant with more multiplications. When random sets are added, the conformity is not significant. As the number of additions increases, the set becomes less significant. When random sets are used in exponentials their conformity is much better than 0.05 significance.

Conclusions/Discussion
Some mathematical operations on random number sets converge rapidly to a Benford's Law distribution. The number of operations can range from one to a few depending on the operation, but a general trend can often be detected after those first few operations. This rapid convergence can explain why numbers in calculations such as income tax returns can conform to Benford's Law.

Summary Statement
This project attempts to determine which operations (multiplication, addition, and/or exponentiation) used on a set of random numbers will cause that set to conform to Benford's law with a 0.05 (or lower) statistical significance level.

Help Received
Mr. Teachworth provided facilities to meet with mentor; Dr. Groce encouraged and provided guidance; Mr. Volger instructed on how to write the computer programs; Mother provided materials