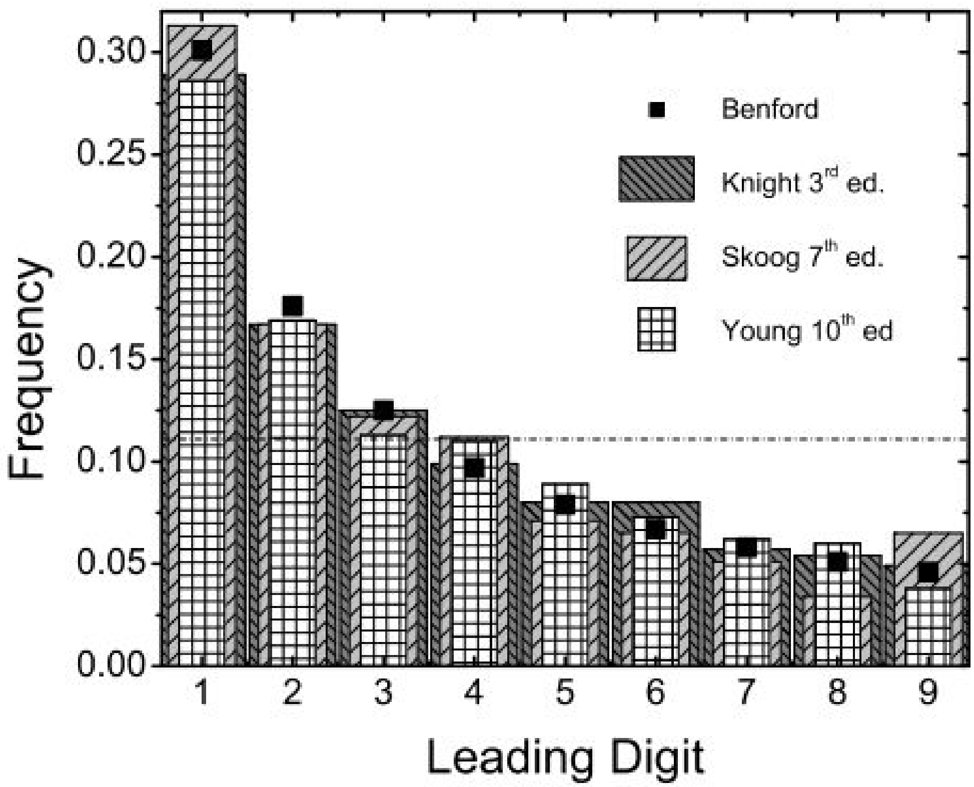
Researchers apply Benford's law to physics exams to see if they can do better than chance

November 29 2013, by Bob Yirka



The distribution of leading digits in end-of-chapter excercise answers from two popular introductory physics text- books (Knight, Young & Freedman) and an analytical chem- istry textbook (Skoog). The dashed horizontal line indi- cates uniform distribution of first digits. Statistical analysis confirms conformation to Benford's Law, overlayed as black squares. Credit: arXiv:1311.4787 [physics.data-an]

(Phys.org) —A team of scientists who specialize in multiple-choice test assessment at Brock and Trent University's in Canada has conducted a study to find out if students could use Benford's law to help them pass multiple-choice physics tests. They have posted a paper describing their results on the preprint server *arXiv*.

Benford's law, named after Frank Benford, a physicist working with probability, says that the numbers 1, 2, and 3 are much more likely to appear at the beginning of multiple digit numbers that are based on real-world measurements of such things as physical constants, the addresses of random people, etc. More specifically, the number 1, the law says, will appear first in a series of digits 30 percent of the time. The number 2 will appear first 18 percent of the time and the number 3 will appear first 13 percent of the time, and so on, with higher numbers appearing less and less often.

This got the team in Canada wondering if physics students taking a multiple-choice test might be able to do better than random guessing if they followed Benford's law instead—theory suggests that if they used Benford's law to answer all of the questions, they should be able to score at least 51 percent correct—a passing mark. To find out, they created their own 500 question multiple-choice (each with three choices) exam along with a dataset of real answers from a real test. Incorrect answers were represented randomly.

To run the test, the researchers chose the lowest possible number for each answer. In analyzing the results, they found that they could indeed score 51 percent on the test, without any knowledge of underlying physics concepts.

But, there was a catch, when the researchers applied the same science to a real physics test, they found they were able to do no better than chance. That was because, they discovered, the wrong answers followed

Benford's law as well.

The research team still can't explain why the incorrect answers followed Benford's law, but can report that clever students seeking to apply the law to their multiple choice tests, likely won't fare any better than chance, which would mean they would fail miserably.

More information: Benford's Law: Textbook Exercises and Multiple-choice Testbanks, arXiv:1311.4787 [physics.data-an]
arxiv.org/abs/1311.4787

Abstract
Benford's Law describes the finding that the distribution of leading (or leftmost) digits of innumerable datasets follows a well-defined logarithmic trend, rather than an intuitive uniformity. In practice this means that the most common leading digit is 1, with an expected frequency of 30.1%, and the least common is 9, with an expected frequency of 4.6%. The history and development of Benford's Law is inexorably linked to physics, yet there has been a dearth of physics-related Benford datasets reported in the literature. Currently, the most common application of Benford's Law is in detecting number invention and tampering such as found in accounting-, tax-, and voter-fraud. We demonstrate that answers to end-of-chapter exercises in physics and chemistry textbooks conform to Benford's Law. Subsequently, we investigate whether this fact can be used to gain advantage over random guessing in multiple-choice tests, and find that while testbank answers in introductory physics closely conform to Benford's Law, the testbank is nonetheless secure against such a Benford's attack for banal reasons.

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