SIMULATION ILLOGIC REPAIRED

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Simulations are becoming more important in introductory statistics courses because of new emphasis on resampling procedures (which are now included in the US Common Core for high school students). There are many applets (and apps) that will perform simple simulations and resampling. All too often students don't understand what is being done. For example, they ignore the difference between resampling for a confidence interval and resampling for a hypothesis test. More complex simulations require more thinking and capable software. At an introductory level for a probability or statistics class, R (free) or SAS (expensive) are often too complex for students to use effectively. I'll show how simple three- or four-line execs and macros in Minitab can do the job effectively, and further serve to eliminate the "black box" of many applets. Students who can perform these understand the situation!

Simulations are becoming more important in introductory statistics courses partially because of new emphasis on resampling procedures which are now included in the US Common Core for high school students. In Georgia, these requirements are:

MCC9-12.S.IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.

MCC9-12.S.IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. (Georgia Department of Education, undated)

Ideas related to simulations need not be complex, but students often have trouble thinking about how to carry out a simulation so it accurately reflects the situation of interest. For example, consider the following free-response question from the 2014 AP Statistics exam (question 2c) (College Board, 2014):

> Each trial in the simulation consists of rolling three fair, six-sided dice, one die for each of the convention attendees. For each die, rolling a 1, 2, 3, or 4 represents selecting a man; rolling a 5 or 6 represents selecting a woman. After 1,000 trials, the number of times the dice indicate selecting 3 women is recorded.

"An alternative to calculating the exact probability is to conduct a simulation to estimate the probability. A proposed simulation process is described below.

"Does the proposed process correctly simulate the random selection of 3 women from a group of 9 people consisting of 6 men and 3 women? Explain why or why not."

Hopefully, all in attendance will recognize that this does not correctly simulate the situation. The proposed simulation assumes independence of the individuals selected; however, they are not independent. Once a person has been selected, they are no longer in the "pool" to select from further. However, many students thought this was a valid simulation (because it reflected the 2/3 to 1/3 ratios of sex; most of those who thought it did not referred to the fact that numbers 1 – 4 to represent the six men and 5 or 6 to represent the three women was the problem; if a nine-sided die was employed, this would be valid.

There are many applets (and apps) that will perform simple simulations and resampling. All too often students don't understand what is being done. For example, they ignore the difference between resampling for a confidence interval and resampling for a hypothesis test (needed in the

Common Core standards). More complex simulations require more thinking and capable software. At an introductory level for a probability or statistics class, R (free) or SAS (expensive) are often too complex for introductory students to use effectively. Apps such as StatKey or the Rossman-Chance applets are free and easy-to-use, at the expense of understanding the simulation. This presentation will compare and contrast some of the available software and the advantages and disadvantages of each.

Bridging the gap, I'll show how simple three- or four-line execs and macros in Minitab can do the job effectively, and further serve to eliminate the "black box" of many applets. Students who can perform these understand the situation!

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