

Practical Stats Newsletter for January 2008

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1. Software reviews

As discussed in our last (November 2007)'s newsletter, we are in the process of evaluating low and moderate cost statistical software. Several of these are add-ons to Microsoft Excel. We will discuss our findings in an upcoming newsletter later this year. If you would like to request that we evaluate your favorite, send us an email at ask@practicalstats.com. We are looking at software priced at below \$600 for an individual license.

2. Permutation Tests

Environmental statistics has benefited in recent years from tests now feasible because of the increased availability of computing power – permutation tests. Permutation tests provide two advantages over standard parametric methods such as the t-test: they avoid the assumption that data follow a known distribution such as the normal (Gaussian) distribution, and they permit results of methods without a closed-form solution to be computed. Permutation tests have been implemented in software such as PRIMER, the multivariate environmental package, and are discussed in our *Applied Environmental Statistics* course (see #3 in this newsletter). These tests work by either compiling all the possible outcomes for a given test statistic with the available observations, or computing a sufficiently large number of them to estimate the probability (p-value) of obtaining the observed test statistic.

Consider the familiar situation where a two-sample t-test might be employed. Two independent groups of data are compared with the intent of determining whether their mean values are identical or not. Group A has 5 observations, while Group B has 10 observations. The classic parametric t-test assumes that data within each group follows a normal distribution and that the variances of each group are the same. Both assumptions are impossible to verify with such small data sets. Often the scientist is forced to “hope” in the Central Limit Theorem (CLT), which states that even though data are not normal, the distribution of a sample (observed) mean around its true population value is Gaussian, and this is sufficient to run the test. However, the CLT is valid only when there is an ample amount of data, say around 50 or more observations within each group for commonly skewed environmental data sets. So the CLT can help with non-normal but large data sets, but offers little hope for smaller data sets.

Instead, run a permutation test. If the null hypothesis is true, the 5 observations in Group A are there only by chance -- any 5 of the 15 observations could have ended up in that group. The group assignment is arbitrary, because if there is no difference the two

groups of data have the same characteristics. The observed assignment is just 1 of 3003 possible assignments of 5 and 10 observations into two groups. The p-value for the test of difference in the two means is obtained by computing all 3003 possible assignments, and determining how unusual it is to have obtained the one observed pattern. This is done without resorting to any assumptions about the shape of either group's data.

Permutation tests are currently the best way to test many inferences for the small, skewed data sets common to environmental studies, data sets that violate most of the standard assumptions of classical statistical tests. Look for software that computes them, and look for training courses (like *AES*) that explain them.

3. Upcoming courses

You can register for either online at

http://www.practicalstats.com/new_classes/classes.html

Applied Environmental Statistics

May 12-16, 2008

Rutgers University Eco-Complex

Trenton, New Jersey

Textbook and software on CD included.

\$1395 through April 21, 2008. \$1495 after.

Nondetects and Data Analysis

March 10- 11, 2008

Colorado School of Mines

Golden, Colorado

\$795 without, \$895 with course textbook.

Hope to see you at one of these in the not-too distant future.

'Til next time,

Practical Stats

-- Make sense of your data