Multi-Log Transforms Improve Precision in Ecology

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1 Introduction

In ecological studies, the large number of uncontrolled variables involved often leads to levels of uncertainty that seem high compared to those in less interesting fields, such as physics. In some cases, this results in ecologists looking bad, which is not acceptable (Anonymous, 1951).

For example, in pursuit of strict academic honesty, ecologists are frequently reduced to saying things like "the measured density of spruce seedlings in the forest plots ($237/m^2$) and in the cornfield plots ($2/m^2$) were different at the 10% level (Woodward & Bernstein, 1989)." Meanwhile, physicists are always saying things like "the measured value of 2.2310403×10^{-9} differs from the non-linearized quantum gauge approximation (2.2310166×10^{-9}) conclusively[1] proving the existence of the Hale-Gaborone effect (Alpher *et al.*, 1989). They do this purely to annoy us (Anonymous, 1901).

The solution to this problem is the technique of multi-log transforms. Multi-log transforms open up an exciting new world of precision to ecologists.

2 The Fisher Transformation

An example of a multi-log transformation is the Fisher transformation, named to honor R. A. Fisher for his contributions to mathematical biology, but primarily in order to attach a much-needed aura of legitimacy to

[1] We would print our margin of error, but even if rendered in scientific notation, it would occupy several journal pages *(note in original)*.

this approach. The Fisher transformation is defined by:

$$F(x) = 1 + \log(\log(\log(\log(10^{100}x)))).$$

The virtue of this transformation is that it takes values ranging from 1 to 10^{12} and transforms them to a range from 0.4786 to 0.4936, greatly improving precision. For example, the sentence "The difference between the average wing lengths of crows (35 cm) and sparrows (12 cm) in our sample was not statistically significant" can now be written "The difference between the transformed average wing lengths of crows (0.48068) and sparrows (0.48007) in our sample was not statistically significant." The sentence, "We feel the difference in average body mass between males (250 kg) and females (95 kg) is biologically as well as statistically significant" becomes "We feel the difference in transformed average body mass between males (0.48181) and females (0.48126) is biologically as well as statistically significant."

The advantages are obvious. Our level of precision has jumped from no significant figures to three or four.

3 Other transformations

There are two problems with the Fisher transformation. The first is that it is not appropriate for data that may have zeroes. The second, more serious, problem, is that it could look suspicious if all of our numbers started with 0.48.

For this reason, we need more multi-log transformations. For the transformations to achieve widespread use, it will also be necessary for people to state in print that they are useful for particular purposes, so that others can cite these assertions. For example, I hereby suggest that the Fisher transformation is appropriate for rationalizing morphological measurements, such as lengths and masses. I will also suggest that the unnamed transformation below is an appropriate smoothing transformation for 'count' data.

The transformation

$$D(x) = \log(1 + \log(1 + \log(1 + \log(1 + x))))$$

takes numbers ranging from 0 to 10^9 into a range from 0 to 0.1143. I have been unable to think of a name for this transformation; maybe someone else would like to suggest one in print. Ideally, the transform should be named after a pioneer in the field of multi-log transforms.

4 Conclusions

Multi-log transformations open up exciting new possibilities for precision in ecology to rival that in annoying fields like physics. For all we know, physicists have used similar techniques in making their field look so precise. Why would they go around dragging 'imaginary' numbers into all of their papers if they weren't trying to hide something?

We need people to develop more precision-enhancing transformations, and we also need people who are willing to apply these transformations to their data. Techniques like this, combined with the current increasing trend in obfuscatory language, promise to elevate ecology to the plane of the 'hard' sciences within the next few years.

References

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