Strategies for Quantitative Research
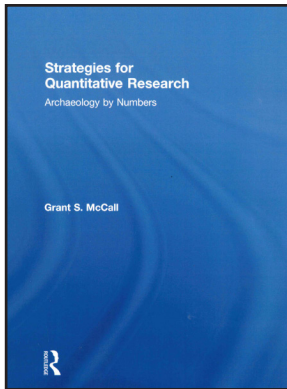
Archaeology by Numbers

Grant S. McCall

ROUTLEDGE

Contents

Strategies for Quantitative Research: Archaeology by Numbers

Grant S. McCall. Routledge. 2018. xx+224 pp., 50 figures, 43 tables, references, index. $155.00 (Hardback), $41.95 (Paper), $20.98 (eBook).

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Grant McCall's new statistics text is specifically aimed at archaeologists, not at a more general audience of anthropologists or other social scientists. This gives him warrant to cover topics such as clustering and principal components analysis that are rarely used in other parts of anthropology, and he illustrates the methods he describes with examples that are exclusively archaeological. The coverage is similar to Shennan's *Quantifying Archaeology* (2nd ed., 1997, Edinburgh Univ. Press). Carlson's *Quantitative Methods in Archaeology Using R* (2017, Cambridge Univ. Press) covers the same ground, but devotes at least as much space to programming in R as it does to the analytic methods. Drennan's *Statistics for Archaeologists* (2nd ed., 2010, Springer) is a more introductory text, though it does cover subjects such as sampling about which the other books are mute. McCall does not devote much space to equations because, as he correctly notes, the widespread availability of statistical software means hardly anyone ever does these calculations by hand. He also notes that easy-to-use software is easy to misuse.

One of McCall's principal goals is to steer archaeologists away from doing inappropriate analyses. Many sets of archaeological data do not have normal or even symmetrical distributions, and thus many classic statistical methods (t tests, ANOVA, Pearson's correlation, linear regression, any multivariate technique that relies on sums of squared deviations) are inappropriate. McCall presents the usual lineup of nonparametric (aka model-free) alternatives, such as Mann-Whitney U, Kruskal-Wallis, Spearman's rho. Given his emphasis on avoiding misuse of methods, I was surprised that he does not reference the now substantial body of research on the limitations of these nonparametric tests. With some sets of data, use of these well-known nonparametric tests is almost as problematic as use of their parametric cousins. For example, many of the nonparametric tests can yield misleading results when sample sizes are highly unequal, or when the samples have considerably different spreads or ranges (the "Behrens-Fisher problem"). Alternatives have been developed to deal with many such scenarios, but you will not learn of them in this book, or even that such problems are known.

At 220 pages of text, the book covers a lot of ground, and phrases such as "without going into the details" appear frequently. In addition to the methods mentioned above, readers will learn about generalized linear models (GLM) as an alternative to nonparametric regression, ARIMA for time-series analysis, multiple regression, and partial correlation.

The chapter (7) on multivariate techniques for data reduction covers factor analysis, principal component analysis, and correspondence analysis, but does not describe nonmet-

ric multidimensional scaling. The discussion of factor analysis has a particularly good discussion of the difference between varimax and biquartimax rotation, but does not mention that one difference between factor analysis and principal component analysis is that the former attributes some of the positioning of data points in n-dimensional space to error variance, while the latter does not assume any error variance. Whether you think one of those data models is more appropriate than the other is a philosophical question, but it is an issue that is worth considering.

The chapter on clustering presents hierarchical agglomerative clustering, k-means, correspondence analysis, and discriminant functions. The discussion of single-linkage hierarchical clustering fails to note its tendency for "chaining," and the discussion of complete linkage clustering does not mention that this algorithm usually creates hyperspherical clusters. The chapter downplays the usefulness of k-means, suggesting that it is rarely used except for spatial analysis. In my experience it has been used in many other settings. The text also suggests that a drawback of k-means is that the analyst must specify *a priori* how many clusters to distinguish. That's true, but there is no mention of the use of scree plots to help the analyst decide what the optimal number of clusters is, in exactly the same way that "percent of variance accounted for" is used to decide how many principal components or factors adequately describe multidimensional patterning. The final part of this chapter deals with discriminant functions, and I found the discussion lucid except for one surprising omission. In the example of discriminant function analysis in a flint sourcing study using elemental abundances obtained from pXRF, McCall says his first step was to look for clustering of the elemental abundances in the sample of known-source items. I would have expected that the first step would have been to examine histograms of elemental abundances for evidence of normal vs. nonnormal distributions and outliers. Elemental abundance data are so frequently skewed that some researchers apply log transforms as a matter of routine, and McCall's text notes that DFA is "very rigid" in terms of requiring normally distributed data. McCall is entirely correct to emphasize repeatedly in this book that it is important to examine your data carefully before you (mis)apply analytical methods, and I would like to have seen this caution highlighted in this example of the use of discriminant functions.

Finally, and importantly, McCall's book is readable. Many archaeologists, and students, do not wish to wade through a morass of equations, and will not profit much from the attempt. It is not easy to write about statistics in prose that is intelligible (I speak from experience). McCall's prose style struck me as cautious and while it was sometimes didactic it was never hectoring. There are more amusing texts out there, e.g., Andy Field's *Discovering Statistics Using [SPSS/SAS/R] and Sex and Drugs, and Rock 'N' Roll* series (Sage), which is a remarkably thorough and sophisticated text written in the style of *Hitchhiker's Guide to the Galaxy*. None of them, however, focus on the quantitative methods used by archaeologists. McCall covers most of the things I'd like to see covered in a book at this level, and it is astonishing that he was able to do that in 220 pages. Obviously, this is not a specialist's reference text, but more an introductory text aimed at archaeology students and professionals who need a general guide to good practice.