Apple II programs in circular statistics

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Applications of circular statistics to animal orientation data require calculations that are often tedious. The practical aim of the present article is to propose programs of statistical tests of general use for analysis of directional data (animal orientation or biological rhythms), easily and rapidly accessible to users of microcomputers. Tests for randomness and goodness of fit and other tests allowing development of statistical inference are described.

All the programs are written in Applesoft BASIC. The machine language subroutine CHAIN, which is on the SYSTEM MASTER diskette, is used in the programs to CALL others without losing the results of previous computations. An Apple II with two disk drives connected to slot 6 is required. The programs, including CHAIN, are stored on the same diskette on drive 1; the diskette containing the sequential data file—if data are not entered from the keyboard—is put on drive 2.

For an appropriate utilization of the tests described below, the reader is referred to Batschelet (1981). In the following text, numbered pages cited in parentheses refer to Batschelet.

Circular Statistics. This program computes the mean angle of orientation (equivalent to the mean in the case of a linear distribution), the angular deviation (standard deviation), and the length of the mean vector, R , which indicates the concentration around the mean angle. R has no unit and varies between 0 (minimal concentration) and 1 (maximal concentration). The mean angle and the angular deviation are expressed in degrees (p. 7-15). In the same way, the data used by the programs described in that paper are in degrees.

Once the results are displayed (mean angle of orientation, angular deviation, R , number of data), one can CALL other programs without losing the present data, namely, the Rayleigh's test, the V-test, and the Rao's spacing test.

For all of the following programs, the statistic, its level of significance, and the number of data (N) can be displayed on the monitor or can be printed.

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Rayleigh's Test. In order to define preferred directions of orientation by testing the null hypothesis of a uniform distribution, the Rayleigh's test, in the unimodal case of a circular normal distribution, is powerful for any kind of concentration of the directions on any part of the unit circle (p. 54-58).

V-Test. The V-test ascertains whether a difference exists between a previously expected direction and the experimental results (p. 58-61).

Rao's Spacing Test. The three preceding programs are devoted to normally distributed data. However, the user might be interested in testing the significance of the orientation of a group of subjects in the case of a nonnormal distribution, for example, a multimodal one. The Rao's spacing test is devoted to such problems (p. 66-69).

Watson's U^2 Test. To test whether two samples differ in their directional behavior, the nonparametric Watson's U^2 test is available (p. 114-118). This test is equivalent to the Mann-Whitney test for linear distributions.

Moore's Test. The nonparametric Moore's test is devoted to the study of second-order samples. That is, there are an equal number of observations, n , for each of N subjects, and we want to know whether the orientations of the animals, for instance, are directed or whether they are uniformly distributed (p. 212-213).

Circular-Circular Correlation. It is often necessary to compute a correlation coefficient between two circular variates in orientation studies (e.g., directional flight and time of day). For this purpose, a nonparametric test has been developed (p. 184-189).

Circular-Linear Correlation. There are many cases in which it is of interest to test whether a circular variate, such as a direction, is correlated with a linear one, such as humidity, amount of rain, etc. The researcher may wish to use Mardia's nonparametric correlation coefficient (p. 193-196).

Availability. Requests for reprints and listings may be directed to the authors. In order to obtain a copy of the program, send two diskettes (5¼-in.), one for copying and the other for mailing charges. Apple II is a trademark of Apple Computer, Inc.

REFERENCE

BATSCHULET, E. (1981). *Circular statistics in biology*. London: Academic Press.

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