

Computer program review

PC-ORD version 5: A user-friendly toolbox for ecologists

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Abstract

Recently, version 5 of PC-ORD, one of the major commercial software packages for multivariate ecological community data analyses, was released. The new version offers a whole range of techniques and methods for analyses of ecological data. It includes modules for different types of ordination and classification, as well as other exploratory techniques such as species-area curve analysis and indicator species analysis. Data are stored in spreadsheets and can be easily manipulated in various ways. In essence, version 5 of PC-ORD offers the user a full toolbox for exploration and analysis of ecological data, packed in a user-friendly environment.

Description

Recently, a new version of PC-ORD, a software package for multivariate analysis of ecological data has been released. This package, developed by Bruce McCune and others (McCune & Grace 2002) is one of the major commercial software packages for multivariate ecological community data analyses. The new version 5 includes both enhancements of existing analyses as well as new features. Among the new features is an extended graph module with possibilities for 3D ordination plots, two-way cluster dendrograms, dominance-diversity curves and frequency-abundance plots, and frequency distributions. The main improvements to the previous graph module are better options for editing graphs, and increased export options. The previous tray of analyses is extended with permutation-based MANOVA with one-way, factorial, nested, and blocked designs, two-way cluster analysis, smoothed univariate frequency distributions, and a function that displays the most important summary features of a data set. The previous analyses are enhanced with randomization tests for PCA, cluster analysis directly from a distance matrix, writing of a distance matrix to spreadsheet or text file, and an option to break down row and column summaries by a variable in the second matrix. To help users to select the appropriate analysis, an advisor wizard, based on a decision tree, is added. Data management and import/export has been improved. Version 5 allows for example simultaneous adjustment of main and second matrices, and filtering rows by a criterion variable.

Review

Once the new user has become acquainted with the somewhat antiquated way of entering data, PC-ORD version 5 offers a wide variety of tools for exploring data and testing hypotheses in community ecology. The software is a collection of classical as well as more novel statistics, used in numerical ecology. In addition to a variety of ordination and classification techniques, the program also includes modules for testing group identity, constructing species-area curves, Mantel tests and non-parametric MANOVA.

The interface is intuitive and easy to understand. It is easy to keep track of different datasets and variables through complex analyses in several steps. There are a number of possibilities for data transformation, manipulation and permutation. In all analyses, results from intermediate calculations as well as final results are written to a results window that can be saved. Additionally, ordination scores are written to a separate file, which facilitates export.

For ecologists, multivariate statistical methods may be divided into hypothesis generating (i.e. exploratory), and hypothesis testing methods (Økland 1996). Version 5 of PC-ORD offers a wide variety of both types. The exploratory, or indirect, type of methods includes traditional analyses such as principal components analysis, correspondence analysis, and detrended correspondence analysis. In addition, there is an array of methods for summarising and inspecting data, including e.g. calculation of diversity indices and outlier analysis. Interesting and useful additional exploratory techniques include species-area curves analysis and indicator species analysis (Dufrêne & Legendre 1997).

The hypothesis testing, or constrained, methods include both multidimensional scaling as well as χ^2 -based methods such as canonical correspondence analysis. There are options for permutation tests of group identity but there is no option for testing the significance of individual explanatory variables prior to a constrained ordination. However, the graph module offers an elegant way of inspecting the contribution of the individual explanatory variables. In ordination, PC-ORD can plot the relationship between an ordination axis and individual species as well as explanatory variables.

For classification, PC-ORD offers a wide variety of

tools. In the modules for both one- and two-way hierarchical classification, a user may choose among many combinations of distance measures and agglomeration techniques. The classical method TWINSpan (Hill 1979) is also included.

A new feature in the current version is a dichotomous decision tree for helping users to select an appropriate method. The intentions behind this tree are obvious, but to be able to answer the sometimes quite complex questions, the user has to be very familiar with multivariate methods. My feeling is that a user who has the experience to be able to answer the questions probably does not need the decision tree. Anyhow, for a user that has just started using these techniques, the tree may be of great help, given that the user knows the nomenclature. A more advanced user may use the tree to explore the capabilities of the program.

Another interesting feature is the possibility of including your own programs as add-in tools. In the standard installation, a program for calculating degree of nestedness (*sensu* Patterson & Atmar 1986) is included. This option may not be the most important feature for a new or intermediate user, but is a means for the more advanced user to personalise the program.

The graph module is easy to use and offers a user to view ordination results in both two and three dimensions. An interesting feature is the possibility of drawing successional vectors in ordination diagrams. Results of classifications are illustrated with dendrograms in one or two dimensions, with scales showing distance, and remaining information along a hierarchical tree.

The graph module is easy to use and offers a user to view ordination results in both two and three dimensions. An interesting feature is the possibility of drawing successional vectors in ordination diagrams. Results of classifications are illustrated with dendrograms in one or two dimensions, with scales showing distance, and remaining information along a hierarchical tree. Produced graphs are of publication quality and can be saved in a number of formats. There are numerous options for personalizing a graph, including varying symbol sizes, labels, vectors, grids, and construction of joint plots.

Documentation of the program is only provided as comprehensive help files obtained from within the program. The content of the help files is sufficient, with both examples as well as theoretical background for the different techniques included in the program. However, many users would probably prefer the documentation as a printed hardcopy

PC-ORD can only be run under the operating system Windows, version Win98 or higher. The program can accept data matrices with more than 500 million elements, or a maximum of 32000 columns or rows. This is probably larger than most ecological datasets. The price for a single user licence is competitive compared to other similar

commercial software. A site licence is on the other hand relatively expensive as the cost increases with the number of users. The website (www.PCORd.com) offers online ordering, but the program cannot be downloaded.

Many of the techniques and modules included in PC-ORD can also be found on the Internet as self-standing freeware. VEGAN (Oksanen 2006) and Ginkgo (Font et al. 2006; see Bouxin 2005) are examples of free software for multivariate techniques, written for ecologists. The PC-ORD module for species-area relationships is a light version of the freeware EstimateS (Colwell 1997). TWINSpan and IndVal which both are included in PC-ORD are also available for free. However, in PC-ORD most necessary techniques for exploring and analysing ecological data are collected in one common frame, with no need for repeated and time-consuming data preparation for several programs.

In summary, PC-ORD offers a wide range of tools for analysing ecological data in a user-friendly environment.

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