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_	pared to the number of objects.	linear relationships or were restrict-	time. The robustness and quality of	indicated that most computer instal-	
unimodal rela-	om-	analyze such data either assumed	small constant times the reading		and includes
able to detect		Statistical methods available so far to	merely to read the data, or within a		is ready to run
linearity and is	rate sections in the manual. CANOCO	fumber of points in space and time.	is on the order of the data are dured		package which
assumption of	ables, such use is explained in sepa-		prest ricquerity die computing unie		microcomputer
escapes nie	ables Such use is explained in sena-	sition and the external variables at a	nles Frequently the computing time		
	tion to external explanatory vari-	Data are collected on species compo-	ing thousands of species and sam-		
analusis	data or (dis)-similarity data in rela-	pollutants and management regime.	applied to enormous data sets hav-		CEP-PC
respondence	data/compositional data, nominal	such as environmental variables,	load, these CEP programs are readily		See our
canonical cor-	example, to analyze percentage	species respond to external factors	of data. Because of their linear work-	ecologists the labor and expense of	
techniques,	find CANOCO useful as well, for	to discover how a multitude of	cube, or higher power of the amount	hoped that this series will save other	
	Researchers in other fields may	$\mathbf{r}$ ty ecology and ecotoxicology is	have workloads rising as the square,	new programs are completed. It is	
Con of these	nation algorithm.	A common problem in communi-	variate algorithms and programs	ing list of programs is updated as	
	(1988) using a general iterative ordi-		with the amount of data. Most multi-	nation and classification. The follow-	
	(1987a) and Ter Braak and Prentice	Aim	load rises approximately linearly	research, dealing mainly with ordi-	
	niques described in Ter Braak	>	series is that the computing work-	er programs used in our ecology	
	out most of the multivariate tech-	by Cajo J. F. ter Braak	✓ ▲recent programs in the CEP	to make public a number of comput-	
	munity responses. CANOCO can carry	ysis (version 3.1).	$\Delta$ n exceptional feature of several	▲ Ecology Programs (CEP) series is	
	available to ecologists studying com-	nents analysis and redundancy anal-	•	The purpose of the Cornell	
	designed to make these techniques	dence analysis, principal compo-	and includes FORTRAN-77 sourceedj	<b>1</b>	
	computer program CANOCO IS	[detrended] [canonical] correspon-	puter package which is ready to run	Supabound	
	species and external variables. The	community ordination by [partial]	See our CEP-PC MS-DOS IM MICrocom-	J	
	uninoual relationships between	- a FURINAN PROGRAM for Constant	COMPARENT IN THE REAL PROPERTY INTO THE REAL PROPERTY INTOT	(aralog of the Connent Ecology	
	unimodal relationships between	- a EODINA IN ARTAON AND A STOCK	computers [Newer development:		
	tion of linearity and is able to detect		these programs for use with micro-		
	dence analysis, escapes the assump-		work must be expected to convert	Introduction to the Connell Edition	
			listorical Interlude		

species arre 0 variables. related to supplied Test of particular environmental, spatial residual variation in the species data analysis allows one to display the covariables. For the analysis of ranables by specifying the latter as ular environmental variable can be Monte Carlo permutation test variables. The test provided is a related to supplied environmental  $\mathcal{J}$ tically whether the species are sis of data from several locations. nent plot data or for the joint analydence analysis is the appropriate ested in. Partial canonical corresponthe variables one is specifically interand to relate the residual variation to nated from the ordination. A partial or temporal "covariables" are elimiavailable. canonical variates analysis are also Principal coordinates analysis and and site scores for use in the biplot the method of scaling the species tion by species and by sites and for options for centering/standardizato x (Robert and Escoufier, 1976). For reduced-rank regression (Davies and also known under the names of ysis (RDA). Redundancy analysis is analysis (PCA) and the canonical option to restrict the permutation to domized-block experiments or data effects of other (environmental) varitested after elimination of possible (Manly, 1990). The effect of a partictechnique for the analysis of perma-**O**.CANOCO can also carry out "par-Tso, 1982) and PCA of y with respect form of PCA, called redundancy analold O .CANOCO allows one to test statisthese linear methods there are from several locations, there is an Lital" analyses in which the effects <http://www.microcomputerpower.com>

> the Before-After-Control-Impact in-blocks or samples-within-locapermutations among samples-with design. repeated measurement designs, e.g transect and rectangular grids and tions. Valid permutation methods are included for time series, line

variable judge the significance of the selected statistical test can be carried out to data. At each step, a Monte Carlo variables best explain the species **H**selection of environmental variables in order to determine which CANOCO can perform a forward

Uata input

analysis of species data. data as input for a later canonical example, to use principal compoas input for subsequent analyses. graphics programs, but also be used environmental variables and covarinents extracted from environmental analysis cannot only be used for in Cornell condensed format or in This possibility allows one, for full format. The solution file of the ables that are either in free format or →ANOCO uses ASCII files as input. -CANOCO can read species data,

## Uutput options

biplots and triplots on the screen and computers, for CanoDraw<sup>TM</sup> that ordination diagrams or, on MS-DOS CANOPLOT that produces printed produces ordination diagrams, The CANOCO solution file is standard input for the program

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CEP MS-DOS" Microcomputer Package

CANOCO

Cornell Ecology Programs

MS-DOS<sup>™</sup> Microcomputer

Dackage

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grams without reconfiguring your be installed while running the pro-512K of RAM. This choice is a comsystem. dent utilities and device drivers can means that your favorite RAM-resithose of you with 640K or more this expandable to only 512K of RAM. For 640K and the many machines readily promise between the DOS limit of limit of running on a machine with made as large as possible within the computers. Array sizes have been adapted to run on MS-DOS™ microtranslated into FORTRAN-77 and The most popular of the Cornel L Ecology Programs have been

value as your research proceeds furwill likely find the others of real of value to investigators in Ecology the programs for your research, you This handy package provides an If you are interested in any one of L excellent collection of programs

Charles Mohler, totally replaces CON-POSE, described in more detail above RANA, ORDIFLEX, TWINSPAN, and COM-DENSE and provides some of the for this release of the programs by The package includes executable The new utility, COMPOSE, written modules for: COMPCLUS, DECO-

tunctionality of DATAEDIT from the <tech@microcomputerpower.com>

> supplementary manuals which give original mainframe version of the CEP-PCe1 Single License
> CEP-PCea Additional License
> CEP-PCes Site License whichever FORTRAN compiler you point for adapting the programs to COMMON blocks are larger than 64K TRAN-77 for the PC. No arrays or source code we ship is "generic" FORcompiler used different syntax so the blocks is not standardized. Even difspecifications at left). executable modules are larger thar and COMMON blocks larger than 64 DOS<sup>™</sup>. This compiler allows arrays computer version of the programs. specific details for using the microset of printed manuals is included in Sample data sets allow you to run the programs at once. A complete may be using. This should provide a good starting ferent versions of the MICROSOFTTM for using large arrays and COMMON the MS-DOS<sup>™</sup> environment, the syntax Kilobytes and the array sizes in the FORTRAN optimizing compiler for MSthe purchase price along with special Jalso available. Unfortunately, in the common PC limit of 64K (see Ource code for the programs is CEP-PCes Site License L compiled with the MICROSOFTTM The executable modules were MS-DOS" Microcomputer Package Cornell Ecology Programs 0 Programs Ecology ular of the computers "MS-DOS" Cornell adapted to run The most pop nave been

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environmental whether the statistically

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	▲ Lable for MS-DOS computers and		zeros.	
diskette.	eady-to-use versions are avail-	ngular arrays which include	‡ ordiflex stores data as rectangular arrays which include	
gram on a PC or Apple Macintosh		for 2500 clusters.	t competus is also dimensioned for 2500 clusters.	
demonstration version of the pro-	PC and Placintosh	nanual).	* Pseudospecies (see TWINSPAN manual).	
detailed compilation notes and a	])	1,200 27,000	COMPOSE 1,000	
can be supplied together with		270	ORDIFLEX‡ 100	
FORTRAN 77 source code of CANOCO	ordination axes.	5,000 27,000	COMPCLUST 3,000	
tion on VAXen or mainframes, the	<ul> <li>by extracting more than the default four</li> </ul>	500 30,000	TWINSPAN 800*	
frame computers. For implementa-	or to be used in further canonical analyses,	800 38,000	DECORANA 500	
Cimplemented on various main-	to be related to the current ordination axes	Elements	Program	
ANOCO has been successfully	<ul> <li>by reading other environmental variables</li> </ul>	Samples Array	Species Sa	
	turning them into covariables,	Nonzero		
Mainframes and Workstations	<ul> <li>by dropping environmental variables or by</li> </ul>	Executable modules:	Array Dimensions of the E:	
	analysis to a direct gradient analysis,	m machine).	programs on any model MS-DOS <sup>m</sup> machine)	
available at extra cost.	<ul> <li>by changing from an indirect gradient</li> </ul>	uld be no problem running the	• DOS text display (there should be no problem running	
or Macintosh, the source code is also	pursued. e.g.:	will use if present).	• Numeric Coprocessor optional (will use if present).	
within the program. For use on a PC	after inspection the analysis can be		• 512K RAM.	
standard open file dialog box from	can be displayed at the terminal and	Operating System version 2.0 or higher.	• MS-DOS <sup>TM</sup> Operating System ve	
launching from the Finder and the	Canalysis: results of an analysis	Compatibility:	System Requirements and Co	Tower
Macintosh user interface only in file	ANOCO allows interactive data	1987-1991 Microcomputer Power	© 1987-1991 Mic	
Macintosh version supports the		age Specifications:	MS-DOS™ Microcomputer Package	Minoret
ables, (total data size <80000). The	analysis in an ordination diagram.		The Cornell Ecology Programs	
mental variables and 100 covari-	useful for displaying the results of a cluster			
samples, 700 species, 75 environ-	diagram than by arrows. This option is also	with Cornell University. 🕉	sions of the CEP programs:	are propri-
CANOCO 3.1 can analyze at most 1000	played by their centroid in the ordination	independent company in no way associated	Microcomputer Power distributes two ver-	puter versions
or on a standard Apple Macintosh,	mental variables are more naturally dis-	or responsibility. Microcomputer Power is an	r Power.	The microcom-
log. On a PC with math coprocessor	In particular, classes of nominal environ-	express or implied, and with no legal liability	and Hugh Gauch is working with	
itself detailed elsewhere in this cata-	mental variables in the ordination diagram.	of offering these programs with no warranty,	Microcomputer Power, Ithaca, New York,	
ments as the CanoDraw <sup>TM</sup> program	<ul> <li>centroids (weighted averages) of environ-</li> </ul>	Microcomputer Power continues the policy	Distribution has now been undertaken by	
age. It has the same system require-	with the ordination axes,	permission.	ceased to distribute these programs.	
which is included with the PC pack-	<ul> <li>correlations of environmental variables</li> </ul>	should not be copied without express	Cornell University, and at that time Cornell	
requirements is CanoDraw <sup>TM</sup> LITE,	associated t-values,	products of Microcomputer Power and	the Section of Ecology and Systematics of	
demanding in terms of system	cients of environmental variables with	microcomputer versions, are proprietary	As of September, 1986, Hugh Gauch left	
80x87 coprocessor is optional. More	<ul> <li>canonical coefficients or regression coeffi-</li> </ul>	The FORTRAN-77 versions, including the	bility.	
(total data space 45000 reals) An	ples in the ordination,	well as some technical support.	implied, and with no legal liability or responsi-	
environmental and covariable values	<ul> <li>diagnostics for the fit of species and sam-</li> </ul>	customers a convenient source of copies, as	University with no warranty, express or	
number of species occurrences and	accounted for,	purpose. Microcomputer Power merely offers	domain, and have been offered by Cornell	
some additional limitations on the	<ul> <li>eigenvalues and percentages of variance</li> </ul>	domain, may still be copied or used for any	These FORTRAN-IV programs are in the public	
environmental variables, but with	environmental variables,	The original version, being in the public	tributed by Cornell University since 1971.	
500 species, 100 covariables and 58	<ul> <li>means, variances and correlations of</li> </ul>	most popular programs.	series, edited by Hugh Gauch, has been dis-	
CANOCO 3.1 can analyze 500 samples,	CANOCO can also supply:	(2) a revised FORTRAN-77 version of the	The CORNELL ECOLOGY PROGRAMS (CEP)	
PC with 405 Kb free memory,	copy devices.	programs.		
the Apple Macintosh. On an MS-DOS	on some of the most common hard-	(1) the original FORTRAN-IV version of the	Copyright notice/License Terms	
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course appearing on the screen, as sion listing which echoes all dis-

matrix, the program produces a ses-

Samples, 27,000 non-zero array eleinvolve improperly structured data set at run time. Most of the problems checking of the structure of the data space for analyses, they do minimal in the interest of maximizing array is desired. The Cornell Ecology ed condensed format and no editing they have been entered in a restrictin the data and accompanying lists data. ecological transformations to the also apply a variety of statistical and groups of samples. The program can species within a genus), and it can (if, for example, you want to merge a new name to the resulting entity can add together species and assign data sets. It will eliminate species dimensioned for 1,000 Species, 1,200 avoiding such problems. sets. COMPOSE is a valuable tool for people encounter with the programs Programs are quite easy to use, but data sets through COMPOSE even if of names and parameters. For this and samples at the users request. It request it will merge any number of within each sample. At the users ments. reason we recommend that you rur torm composite samples from COMPOSE checks for and flags errors The MS-DOS™ executable module is

sampled repeatedly at several locaeral samples, or when species are

tions. COMPOSE has editing capabili-

ties which can reduce such three

encountered when several attributes

ical applications these are commonly three or more dimensions. In ecolog-Occasionally one may have data of

are measured on each species in sev-

a number of sample locations.

dance values of species measured at such an array will consist of abundimensional data array. Typically

is designed to operate on a two

Ecology Programs series. As with all other programs in the Cornell edits and formats data for use by

**¬**OMPOSE is a data management

by Charles L. Mohler

program which checks errors,

programs in the CEP series, COMPOSE

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References

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MPOSE

COMPOSE has a variety of editing

together all occurrences of a species functions. It automatically adds

PC . It is also available separately as:

all programs in the Cornell Ecology

densed format which is acceptable to verts these to the restricted con-

package. In addition to producing Programs MS-DOS™ microcomputer

the edited and reformatted data

or FoxBase<sup>TM</sup> SDF file. COMPOSE consuch as a Lotus<sup>TM</sup> .PRN file, dBase<sup>TM</sup> ASCII text files with data in columns Matrix and Condensed. These are eties of two basic formats: Full ing with the other programs. sional structure suitable for processdimensional data to a two dimen-

COMPOSE accepts data in many vari-

CEP-PC COMPOSE

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COMPOSE is included with CEP-

CLM-CMe1 COMPOSE program for data preparatior

about the data. well as listing useful information

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- 9 -	<http: www.microcomputerpower.com=""></http:>	<tech@microcomputerpower.com></tech@microcomputerpower.com>	<tech@microcomputerpower.com></tech@microcomputerpower.com>	<http: www.microcomputerpower.com=""></http:>	- 12 -
	<pre>You will control Your graphs: suppress. individual items or force them to appear; edit their labels; assign items to groups on screen or from a file and give them different colors or shadings. To us investigator are the model- ing tools and new types of graphics available in CanoDraw<sup>TM</sup> 3.0. You can model species response curves and graph them. You compatible processor including softer or softwindows on the Mac) . Ms-DOS 3.1 or higher . Ms-DOS 3.0 (LIM EMS) or higher . Beson-rw . Beson</pre>	Draw <sup>TM</sup> 3.0 is ch intelligent ality graphics al output of c sion sports ar ch allows rap eatures, intuit he full versio for CanoDra for CanoDra for CanoDra for CanoDra 16 6 b/w 6 b/w 6 514A 16 1 514A 16 1 514A 16 1	The CEP Series offers two exten- sive files of simulated test data sets that have been presented and analyzed in numerous articles. These simulated data sets vary in several properties, including level of heterogeneity, number of underlying gradients, noise level, sample num- ber and distribution, and the pres- ence of partial or complete disjunc- tion and of outliers of two types. The variety of test data sets includ- ed is deliberately intended to reveal the performance of multivariate methods under a wide variety of cir- cumstances in order to facilitate a balanced assessment of the merits of new multivariate methods. A file with 24 data sets is described in the documentation for ORDIFLEX and is included with both the main- frame and microcomputer versions of that program. A larger group of 30 data sets is included at no charge with any order for the machine readable source of the FORTRAN-IV versions of the CEP programs. For PC users and other interested individuals, these data sets are also available separately. These data sets are of great inter- ate analyses treat various data sets of known underlying structure.		The Simulated Data Sets are of great interest to understand how multivari- ate analyses treat data of known underly- ing structure.
	now sold separately. Open New Vistas as you Explore your Data	$\frac{\bigcirc}{a no \bigcirc raw^{m} 3.0}$ by Petr Smilauer	Database of Simulated Test Data	mon data matrix transformations. Species and samples may be identi- fied by user-supplied 8-character	
	ano Draw		The Cornell Ecology Programs	The Cornell ⊑	

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<http: www.microcomputerpower.com=""></http:>	ньс-р саисh(1982) 🔅		medicine because of the wide appli-	social and political sciences, and	nomics, psychology, education,	other fields such as business, eco-	Some consideration is also given to	1t).	my, and environmental manage-	(forestry, natural resources, agrono-	in ecology and related applied fields	professional researchers, primarily	ate students, graduate students, and	Readership advanced undergradu-	that employs all these programs.	ops an integrated research strategy	TWINGPAN and DATAEDIT—and devel-	OBDIELEX COMPUTIS DECOBANA	The book fields the centration of the centration	The heat treate the alconithme	um of all the methods that have been	rather than presenting a compendi-	variate methods are emphasized,	and applications. Preferred multi-	ples (ecological and mathematical)	This book emphasizes both princi-	Conclusions.	Classification, Applications, and	Gradient Analysis, Ordination,	Introduction, Sampling Methods, Direct	There are 298 pages and 7 chapters:	the Cambridge University Press (1982).	Ecology, by Hugh G. Gauch, Jr., from	of Multivariate Analysis in Community	Programs may also want a copy	Tsers of the Cornell Ecology	hu Huoh G. Gauch	Analysis in Community Ecology		TEXTBOOK: Multivariate		
<tech @="" microcomputerpower.com=""></tech>	to the amount of data; thousands of	computer requirements with respect	DECORANA uses an exceptionally	pute RA scores.	data sets. DECORANA can also com-	particularly for very heterogeneous	the best general purpose ordination,	cipal components analysis, making it	multidimensional scaling, and prin-	DECORANA results are superior to RA,	Our tests indicate that in general	tion of axis ends in RA.							$\mathbf{O}$	of the first axis), and it also scales the	is irequently a quadratic distortion	shoe problem of RA (the second axis	DECORANA avoids the arch or horse-	69:135-152, and Vegetatio 42:47-58)	Ecology 61:237-249, 65:157-174,	analysis are synonyms; Journal of	averaging (RA) and correspondence	rocal averaging (where reciprocal	sis. DECORANA improves upon recip-	for detrended correspondence analy-	DECORANA is a FORTRAN program	MS-DOS <sup>TM</sup> adaptation by Charles L. Mohler	by Mark O. Hill		DECORANA		Tropall Droaname Series	Frograms in the Cornell		Description of The Major	_	
<tech @microcomputerpower.com=""></tech>	elements.	500 Samples, 30,000 non-zero array	The MS-DOSTM executable module is			00101 01011 00101 01011	0000010011111 00000110011111	000000111111	4 JUNC GER 13 1 1111	MAR54	SALI VIR34	6 SALI EUR22-23411 1100 10 SPAR ALT142-135553 1101	ATRI PAT 2313221411	SCIR	SPAR	COM 53415	SOLI	2 198ø763 1245	announn on uara. 11 1	approximately linearly with the	ine computer workload rises	The commuter realized with	obtained by Braun-Blanquet table	The result is similar to that	63:597-603 and 69:537-557).	well as samples (Journal of Ecology	sis in that species are classified as	the original indicator species analy-	TWINSPAN is an improvement upon	two-way indicator species analysis.	TWINSPAN is a FORTRAN program for	MS-DOS <sup>TM</sup> adaptation by Charles L. Mohler	by Mark O. Hill		T₩INSPAN		ments.		The MS-DOS <sup>TM</sup> executable module is	species and samples are practical.		
<a href="http://www.microcomputerpower.com">http://www.microcomputerpower.com</a>	apply elementary editing and com-	matrix is flexible and ORDIFLEX can	each data set. The format of the	select the computations desired for	A simple control line is used to	<ul> <li>reciprocal averaging (RA)</li> </ul>	<ul> <li>principal components analysis (PCA)</li> </ul>	<ul> <li>polar (Bray-Curtis) ordination (PO)</li> </ul>	<ul> <li>weighted averages (wA)</li> </ul>	four ordination techniques:	ORDIFLEX is a flexible program for	MS-DOS <sup>TM</sup> adaptation by Charles L. Mohler	by Hugh G. Gauch				mente	Samples 97 000 pop-zero arrav ele-	dimensioned for 3 000 Species 5 000	The Me north averatable module is	the time required merely to read the	time for clustering is on the order of	ples are practical. The computing	and thousands of species and sam-	with respect to the amount of data,	Computing requirements are linear	ing.	ordination or by hierarchical cluster-	useful for subsequent analysis by	these composite samples are often	average of the samples contained;	ple is produced which is simply the	For each cluster a composite sam-	Vegetatio 42:103-111).	is executed interactively (see	initial clustering of large data sets It	COMPCITIS is a program for ranid	by Hugh G. Gauch	-	COMPCLUS		
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