

# Package ‘pcurve’

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**Title** Principal curve analysis

**Author** S original by Trevor Hastie <hastie@stat.stanford.edu> S+  
library by Glenn De’ath <g.death@aims.gov.au> R port by Chris  
Walsh <cwash@unimelb.edu.au>

**Depends** R(>= 1.9.0), mgcv, vegan, MASS, stats

**Description** Fits a principal curve to a numeric multivariate dataset  
in arbitrary dimensions. Produces diagnostic plots.

**Maintainer** Chris Walsh <cwash@unimelb.edu.au>

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pca

*Principal Component Analysis*

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### Description

Calculates principal components from a matrix

### Usage

```
pca(mat, cent = TRUE, scle = FALSE)
```

### Arguments

mat	a numeric matrix.
cent	a logical value referring to center argument in scale.
scle	a logical value referring to scale argument in scale.

### Value

a list containing

pcs	a matrix of principal component loadings
d	a matrix containing the singular value (eigenvalue) of each principal component on its diagonal
v	a matrix of eigenvectors

### Author(s)

R port by Chris Walsh <cwalsh@unimelb.edu.au> from S+ library by Glenn De'ath <g.death@aims.gov.au>.

### Examples

```
data(soilspec)
species <- sqrt(soilspec[,2:9])
specpca <- pca(species)
eqscplot(specpca$pcs[,1], specpca$pcs[,2], type = "n",
         xlab = "Principal component 1",
         ylab = "Principal component 2")
text(specpca$pcs[,1], specpca$pcs[,2],
     soilspec$site)
mtext(paste("Grassland communities in 45 sites"))
```

**Description**

A menu of 12 plots for diagnosis of results from principal curve analysis, pcurve

**Usage**

```
pcdiags.plt(zz, xx, pch = 1, graphics = TRUE)
```

**Arguments**

zz	an object of class principal curve, being the value of the function pcurve.
xx	data.frame or matrix of explanatory (environmental) variables to be used in constrained pcs.
pch	symbol to be used in plots.
graphics	a logical argument of menu indicating whether a graphics menu should be used. Currently unused.

**Details**

Produces a menu of 12 (or thirteen if xx is not missing) options. Once a selection is made, return to the menu by left-mouse clicking on the plot.

0. Exit

1. Residuals plots for each variable on the PC (by the internal function pcres1.plt)

2. Absolute residuals plot for each variable on the PC (by the internal function pcres2.plt)

3. QQ normal residuals plot for each variable (by the internal function pcqqnorm.plt)

4. QQ chi-squared quantile residuals plot (by the internal function pcchisq.plt)

5. Response plot and residual plot for each variable (by the internal function pcresid.plt)

6. Differenced locations: Plot of distances between consecutive locations on the PC (by the internal function pcfinder.plt)

7. Response plots for each variable along the PC (by the internal function pcresp.plt)

8. Flip plots: Plot of the PC projected onto a bi-plot of the first two principal coordinates, showing fitted locations of the variables on the PC. Left-mouse click to scroll through biplots of other principal coordinate combinations. (Right-mouse-click to return to the menu) (Using the internal function pcflip.plt)

9. Fix curve: a utility to break the curve in up to two places (by left mouse-clicks), re-order the segments and rerun the PC analysis with a new start. (using the internal function finder)

10. Scatterplots of Eclidean and Bray-Curtis distances against the PC. (using the internal function pcdist.plt)

11. Histograms of Eclidean and Bray-Curtis distances against the PC. (using the internal function pchist.plt)

12. A toggle to use Case numbers or symbols in plots
13. Env. vars. vs Gradient: if xx is not missing, plots of distance along the PC and explanatory variables (using the internal function pcenv.plt)

### Value

Produces plots

### Author(s)

R port by Chris Walsh <cwalsh@unimelb.edu.au> from S+ library by Glenn De'ath <g.death@aims.gov.au>.

### References

De'ath, G. 1999 Principal Curves: a new technique for indirect and direct gradient analysis. *Ecology* **80**, 2237–2253.

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pcurve

*Principal Curve Analysis*

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### Description

Fits a principal curve to a numeric multivariate dataset in arbitrary dimensions. Produces diagnostic plots.

### Usage

```
pcurve(x, xcan = NULL, start = "ca", rank = FALSE, cv.fit = FALSE,
penalty= 1, cv.all = FALSE, df = "vary", fit.meth = "spline",
canfit = "lm", candf = FALSE, vary.adj = FALSE, subset,
robust = FALSE, lowf = 0.5, min.df, max.df, max.df.cv.fit,
ext.dist = TRUE, ext.dc = 0.9, metric = "bray", latent = FALSE,
plot.pca = TRUE, thresh = 0.001, plot.true = TRUE,
plot.init = FALSE, plot.segs = TRUE, plot.resp = TRUE,
plot.cov = TRUE, maxit = 10, stretch = 2, fits = FALSE,
prnt.fits = TRUE, trace = TRUE, trace.all = FALSE, pch = 1,
row.chk0 = FALSE, col.chk0 = TRUE, use.loc = FALSE)
```

### Arguments

x	numeric data matrix or data.frame.
xcan	data.frame or matrix of explanatory variables to be used in constrained PCs.

start	specifies how to determine the starting configuration (location of points on initial curve): "ca" = correspondence analysis; "pca" = principal components analysis with Euclidan metric; "pca.bc" = principal components analysis with Bray-Curtis metric; "mds" = non-metric multidimensional scaling with Euclidean metric; "mds.bc" = non-metric multidimensional scaling with Bray-Curtis metric; "cs.bc" = classical scaling (metric multidimensional scaling) with Bray-Curtis metric; "ran" = random start. Or if start is numeric and of length $\dim(x)[1]$ a user supplied configuration will be used.
rank	if TRUE starting configuration is transformed to rank
cv.fit	if TRUE a final iteration using cross-validation is done.
penalty	penalty for smoothing spline. A value of 1 corresponds to no penalty with values > 1 giving a less-smoothed fit. Increasing the penalty for small data sets can reduce over-fitting. If penalty = "np", penalty = 1 for $N > 1000$ , penalty = 2 for $N \leq 100$ , and penalty = $4 - \log(N, 10)$ for $N > 100$ and $N \leq 1000$ .
cv.all	if TRUE a cross-validated smoothing spline fit at each iteration.
df	if numeric specifies the df for the smoothing spline.
fit.meth	specifies smoother. "spline" = smooth.spline, "poisson" = poisson general additive model, "binomial" = binomial general additive model, "lowess" = lowess smoother (this argument overridden by robust = TRUE).
canfit	"lm" or "gam", model used to relate pc to xcan.
candf	if canfit = "gam", df for model. May be a single value or a vector of FALSE or positive integers indicating dfs for each explanatory variable in xcan. If FALSE, this is equivalent to $fx=FALSE$ in gam, and d.f. is selected by GCV.UBRE
vary.adj	if FALSE the same df are used for the smooth of each variable, otherwise each variable has its own df.
subset	used to take a subset of x and start (if numeric).
robust	if TRUE uses lowess smooths, if FALSE uses smoothing spline.
lowf	specifies the span of the lowess smooth.
min.df	specifies the min df for the smoothing.
max.df	specifies the max df for smoothing during cross-validation.
max.df.cv.fit	specifies the max df for the smoothing.
ext.dist	if TRUE extended dissimilarities in calculation of initial configuration using the flexible shortest path. If FALSE standard dissimilarities are used (see De'ath, 1999b and stepacross in package vegan).
ext.dc	critical distance, the toolong argument in stepacross.
metric	similarity metric, the method argument in vegdist in package vegan.
latent	if FALSE locations are rescaled after each iteration to give distance along the curve; if TRUE no rescaling is done.
plot.pca	if TRUE the fitting is plotted (assuming plot.true = TRUE) in the first 2 dimensions of PCA space.
thresh	threshold value of difference in cross-validation for ceasing iteration
plot.true	if TRUE the fitting process is plotted.

<code>plot.init</code>	if TRUE the initial fits to each variable are plotted.
<code>plot.segs</code>	if TRUE segments linking the fitted points on the curves to their corresponding data points are plotted.
<code>plot.resp</code>	if TRUE the final response curves are plotted.
<code>plot.cov</code>	if TRUE covariate partial effects are plotted (only if <code>xcan</code> is not null).
<code>maxit</code>	specifies the maximum number of iterations.
<code>stretch</code>	end segments of the curve are stretched by this factor at each iteration.
<code>fits</code>	if TRUE value of <code>pcurve</code> includes diagnostics for each variable.
<code>prnt.fits</code>	statistics on model fits printed.
<code>trace</code>	prints out useful fitting diagnostics at each iteration.
<code>trace.all</code>	if TRUE prints out all curve details at each iteration.
<code>pch</code>	symbol for plots
<code>row.chk0</code>	if TRUE checks for and removes rows of <code>x</code> identically 0.
<code>col.chk0</code>	if TRUE checks for and removes columns of <code>x</code> identically 0.
<code>use.loc</code>	if TRUE pauses during the fitting displays (left mouse-click to progress to next plot).

### Details

See De'ath (1999a) for a full discussion of the functions and their application.

### Value

An object of class principal curve containing a list comprising

<code>s</code>	fitted values
<code>tag</code>	order of points along the curve
<code>lambda</code>	locations along the curve
<code>dist</code>	sum of squared distances of points from the curve
<code>c</code>	call to <code>pcurve</code>
<code>x</code>	data to which the curve was fitted
<code>df</code>	degrees of freedom for the smoothers used in the fit
<code>fit.list</code>	diagnostics for each variable, only included if <code>fits = TRUE</code> .

### Author(s)

R port by Chris Walsh <cwalsh@unimelb.edu.au> from S+ library by Glenn De'ath <g.death@aims.gov.au>. Original S code for principal curve analysis by Trevor Hastie <hastie@stat.stanford.edu>.

## References

- De'ath, G. 1999a Principal Curves: a new technique for indirect and direct gradient analysis. *Ecology* **80**, 2237–2253.
- De'ath, G. 1999b Extended dissimilarity: method of robust estimation of ecological distances with high beta diversity. *Plant Ecology* **144**, 191–199.
- Gittins, R. 1985 *Canonical Analysis. A review with applications in ecology*. Berlin: Springer-Verlag.
- Hastie, T.J and Tibshirani, R.J. 1990 *Generalized additive models*. London: Chapman and Hall.
- Hastie, T.J. and Stuetzle, W. 1989 Principal Curves. *Journal of the American Statistical Association* **84**, 502–516.

## See Also

[pcdiags.plt](#), [vegdist](#), [stepacross](#)

## Examples

```
#a simulated dataset with 4 response variables (taxa 1-4),
#n=100. The response curve is Gaussian and noise is Poisson.
data(sim4var)
sim4fit <- pcurve(sim4var, plot.init = FALSE, use.loc = TRUE)

#Limestone grassland community example worked by De'ath (1999a),
#from data in Gittins (1985)
data(soilspec)
species <- sqrt(soilspec[,2:9])
envvar <- soilspec[,10:12]
#indirect gradient analysis
spec.fit <- pcurve(species, start = "mds.bc", plot.init = FALSE,
                  use.loc = TRUE)
#direct gradient analysis
soilspec.fit <- pcurve(species, xcan = envvar,
                    start = "mds.bc", plot.init = FALSE,
                    fits = TRUE, prnt.fits = TRUE,
                    use.loc = TRUE)
```

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pcurve.data

*Example data for pcurve*

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## Description

Example data sets for pcurve package.

## Usage

```
data(sim4var)
data(sim10var)
data(fish)
data(soilspec)
```

## Details

sim4var.txt

Simulated data. Comprises 4 response variables (Taxa1 - Taxa4) and the generating locations (Location). Number of cases = 100. This example was worked by De'ath (1999). The response curves are Gaussian and noise is Poisson. Most starting configurations are adequate, square root transformation helps.

sim10var.txt

Simulated data. Comprises 10 response variables (Taxa1 - Taxa10) and the generating locations (Location). Number of cases = 100. The response curves are Gaussian and noise is Poisson. The beta-diversity is high and recovering the generating locations is difficult. A more difficult exercise. Transformation is a must (square-root is ok). Many starting configurations fail. CA or MDS-BC succeed with appropriate smoothness.

fish.txt

Comprises counts on 10 families of reef fish (n = 33) and a factor variable IMO denoting the position of the sites across the reef. Log-transformation is effective and a final cross-validation helps improve the fit. The locations vary systematically with cross shelf position (IMO).

soilspec.txt

Comprises data on 8 species of plants and 3 soil characteristics and their interactions. Source Gittins (1985), where a relatively complex canonical analysis was used to model the data. This example was worked by De'ath (1999).

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## References

- De'ath, G. 1999 Principal Curves: a new technique for indirect and direct gradient analysis. *Ecology* **80**, 2237–2253.
- Gittins, R. 1985 *Canonical Analysis. A review with applications in ecology*. Berlin: Springer-Verlag.

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