

Package ‘apca’

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Type Package

Title Advanced Principal Component Analysis

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Description Provides nine computational algorithms for dimensionality reduction via Principal Component Analysis (PCA), built using an object-oriented (S3) architecture. The package includes classical and modern methods: Singular Value Decomposition (SVD) based on Eckart and Young (1936) <[doi:10.1007/BF02288367](https://doi.org/10.1007/BF02288367)>, Power Iteration based on Hotelling (1933) <[doi:10.1037/h0071325](https://doi.org/10.1037/h0071325)>, QR Algorithm based on Francis (1961) <[doi:10.1093/comjnl/4.3.265](https://doi.org/10.1093/comjnl/4.3.265)>, Jacobi Algorithm based on Jacobi (1846) <[doi:10.1515/crll.1846.30.51](https://doi.org/10.1515/crll.1846.30.51)>, Arnoldi Iteration based on Arnoldi (1951) <[doi:10.1090/qam/42792](https://doi.org/10.1090/qam/42792)>, 'NI-PALS' based on Wold (1975) <[doi:10.1017/S0021900200047604](https://doi.org/10.1017/S0021900200047604)>, Alternating Least Squares (ALS) based on Kolda and Bader (2009) <[doi:10.1137/07070111X](https://doi.org/10.1137/07070111X)>, Probabilistic PCA (PPCA) with EM Algorithm based on Tipping and Bishop (1999) <[doi:10.1111/1467-9868.00196](https://doi.org/10.1111/1467-9868.00196)>, and Generalized Hebbian Algorithm (GHA) based on Sanger (1989) <[doi:10.1016/0893-6080\(89\)90044-0](https://doi.org/10.1016/0893-6080(89)90044-0)>.

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apca	<i>Advanced Principal Component Analysis (APCA)</i>
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Description

Performs PCA using one of nine different computational algorithms. This is the main wrapper function for the apca package.

Usage

```
apca(data, n_components = 2, method = "svd", center = TRUE, scale = FALSE)
```

Arguments

data	A numeric matrix or data frame.
n_components	Integer. Number of principal components to extract.
method	Character. The algorithm to use: "svd", "power", "qr", "nipals", "jacobi", "arnoldi", "als", "ppca", or "gha".
center	Logical. Whether to mean-center the data. Default is TRUE.
scale	Logical. Whether to scale variables to unit variance. Default is FALSE.

Value

An object of class "apca" containing scores, loadings, and variance metrics.

Examples

```
# Run PCA using the classical SVD algorithm
data(mtcars)
res_svd <- apca(mtcars, n_components = 2, method = "svd", scale = TRUE)

# Print basic information
print(res_svd)

# -----
# Extracting specific mathematical components
# -----
# 1. Extract the PCA scores (useful for clustering/regression)
my_scores <- res_svd$scores
head(my_scores)
```

```

# 2. Extract the loadings matrix (variable weights)
my_loadings <- res_svd$loadings
print(my_loadings)

# 3. Extract the eigenvalues
my_eigen <- res_svd$eigenvalues
print(my_eigen)

# Run PCA using the NIPALS algorithm
res_nipals <- apca(mtcars, n_components = 2, method = "nipals", scale = TRUE)

```

plot.apca

Plot Method for APCA Objects

Description

Generates a scatter plot of the principal component scores.

Usage

```

## S3 method for class 'apca'
plot(
  x,
  pc_x = 1,
  pc_y = 2,
  col = "steelblue",
  pch = 16,
  cex = 1.2,
  las = 1,
  ...
)

```

Arguments

x	An object of class "apca".
pc_x	Integer. The principal component to plot on the X-axis (default: 1).
pc_y	Integer. The principal component to plot on the Y-axis (default: 2).
col	Color of the points (default: "steelblue").
pch	Point character (default: 16).
cex	Point size (default: 1.2).
las	Axis label orientation (default: 1).
...	Additional graphical parameters passed to the base plot function.

Value

No return value, called for side effects (plotting).

Examples

```
data(mtcars)
res <- apca(mtcars, n_components = 3, method = "svd", scale = TRUE)

# Plot PC1 vs PC2 (Default)
plot(res)

# Plot PC1 vs PC3 with custom base R graphical parameters
plot(res, pc_x = 1, pc_y = 3, col = "red", pch = 19)
```

summary.apca

Summary Method for APCA Objects

Description

Extracts and calculates cumulative variance metrics from an APCA object.

Usage

```
## S3 method for class 'apca'
summary(object, ...)
```

Arguments

object	An object of class "apca".
...	Additional arguments affecting the summary produced.

Value

A list of class "summary.apca" containing variance explained, cumulative variance, and other specific algorithm metrics (like noise variance).

Examples

```
data(mtcars)
res <- apca(mtcars, n_components = 3, method = "svd", scale = TRUE)

# Display cumulative variance summary
summary(res)
```

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