

# Package ‘fAssets’

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**Title** Rmetrics - Analysing and Modelling Financial Assets

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**Description** Environment for teaching  
``Financial Engineering and Computational Finance".

**Depends** R (>= 2.15.1), timeDate, timeSeries, fBasics

**Imports** fMultivar, robustbase, MASS, sn, ecodist, mvnormtest, energy

**Suggests** methods, mnormt, RUnit

**Note** SEVERAL PARTS ARE STILL PRELIMINARY AND MAY BE CHANGED IN THE  
FUTURE. THIS TYPICALLY INCLUDES FUNCTION AND ARGUMENT NAMES, AS  
WELL AS DEFAULTS FOR ARGUMENTS AND RETURN VALUES.

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fAssets-package	<i>Analysing and Modelling Financial Assets</i>
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## Description

The Rmetrics fAssets package is a collection of functions to manage, to investigate and to analyze data sets of financial assets from different points of view.

## Details

Package:	fAssets
Type:	Package
Date:	2014
License:	GPL Version 2 or later
Copyright:	(c) 1999-2014 Rmetrics Association
Repository:	R-FORGE
URL:	<a href="https://www.rmetrics.org">https://www.rmetrics.org</a>

## 1 Introduction

The package fAssets was written to explore and investigate data sets of financial assets

Included are functions to make the the asset selection process easier, to robustify return and covariances for modeling portfolios, to test financial returns for multivariate normality, and to measure in a simple way performance and risk of funds and portfolios.

Beside this many functions for graphs and plots, and for a more sophisticated explorative data analysis are provided. They range from simple time series plots to more elaborated statistical chart

tools: histogram, density, boxplots, and QQ plots; pairs, similarities, and covariance ellipses plots; star plots, and risk/reward graphs.

## 2 Assets Selection

The assets selection chapter contains functions which arrange assets from a data set according to different measures applying ideas from principal component analysis, from hierarchical clustering, or by a user defined statistical measure:

assetsArrange	Rearranges the columns in a data set of assets
pcaArrange	Returns PCA correlation ordered column names
hclustArrange	Returns hierarchical clustered column names
abcArrange	Returns assets sorted by column names
orderArrange	Returns assets ordered by column names
sampleArrange	Returns a re-sampled set of assets
statsArrange	Returns statistically rearranged column names

In addition we have summarized and bundle of distance measure functions to determine the similarity or dissimilarity of individual assets from a set of multivariate financial return series.

assetsDist	Computes the distances between assets
corDist	Returns correlation distance measure
kendallDist	Returns kendalls correlation distance measure
spearmanDist	Returns spearman's correlation distance measure
mutinfoDist	Returns mutual information distance measure
euclideanDist	Returns Euclidean distance measure
maximumDist	Returns maximum distance measure
manhattanDist	Returns Manhattan distance measure
canberraDist	Returns Canberra distance measure
binaryDist	Returns binary distance measure
minkowskiDist	Returns Minkowsky distance measure
braycurtisDist	Returns Bray Curtis distance measure
mahalanobisDist	Returns Mahalanobis distance measure
jaccardDist	Returns Jaccard distance measure
sorensenDist	Returns Sorensen distance measure

A last group of functions allows to select assets by concepts from hierarchical or k-means clustering:

assetsSelect	Selects similar or dissimilar assets
.hclustSelect	Selects due to hierarchical clustering
.kmeansSelect	Selects due to k-means clustering

## 3 Assets Covariance Robustification

We provide several functions to compute robust measures for mean and/or covariance estimates which can be used for example in robustified Markowitz portfolio Optimization.

assetsMeanCov	Estimates mean and variance for a set of assets
.covMeanCov	uses sample covariance estimation
.mveMeanCov	uses "cov.mve" from [MASS]
.mcdMeanCov	uses "cov.mcd" from [MASS]
.studentMeanCov	uses "cov.trob" from [MASS]
.MCDMeanCov	requires "covMcd" from [robustbase]
.OGKMeanCov	requires "covOGK" from [robustbase]
.nnveMeanCov	uses builtin from [covRobust]
.shrinkMeanCov	uses builtin from [corpcor]
.baggedMeanCov	uses builtin from [corpcor]
.arwMeanCov	uses builtin from [mvoutlier]
.donostahMeanCov	uses builtin from [robust]
.bayesSteinMeanCov	uses builtin from Alexios Ghalanos
.ledoitWolfMeanCov	uses builtin from [tawny]
.rmtMeanCov	uses builtin from [tawny]

An additional function allows to detect outliers from a PCA outlier analysis.

assetsOutliers	Detects outliers in multivariate assets sets
----------------	--

#### 4 Testing Assets for Normality

The multivariate Shapiro test and the E-Statistic Energy Test allow to test multivariate Normality of financial returns.

assetsTest	Tests for multivariate Normal Assets
mvshapiroTest	Multivariate Shapiro Test
mvenergyTest	Multivariate E-Statistic (Energy) Test

#### 5 Lower Partial Moments Measures

The computation of Lower partial moments is done by the following two functions:

assetsLPM	Computes asymmetric lower partial moments
assetsSLPM	Computes symmetric lower partial moments

#### 6 Assets Time Series and Density Plot Functions

Dozens of tailored plot functions are included in the fAssets package. This makes it very easy to visualize properties and to perform an explorative data analysis. Starting from simple time series functions.

assetsReturnPlot	Displays time series of individual assets
assetsCumulatedPlot	Displays time series of individual assets
assetsSeriesPlot	Displays time series of individual assets

we can also explore the distributional properties of the returns by histogram, density, boxplots, and QQ Plots:

assetsHistPlot	Displays a histograms of a single asset
assetsLogDensityPlot	Displays a pdf plot on logarithmic scale
assetsHistPairsPlot	Displays a bivariate histogram plot
assetsBoxPlot	Displays a standard box plot
assetsBoxPercentilePlot	Displays a side-by-side box-percentile plot
assetsQQNormPlot	Displays normal qq-plots of individual assets

## 7 Assets Dependency and Structure Plot Functions

Corellation and similarities are another source of information about the dependence structure of individual financial returns. The functions which help us to detect those properties in data sets of financial assets include:

assetsPairsPlot	Displays pairs of scatterplots of assets
assetsCorgramPlot	Displays pairwise correlations between assets
assetsCorTestPlot	Displays and tests pairwise correlations
assetsCorImagePlot	Displays an image plot of a correlations
covEllipsesPlot	Displays a covariance ellipses plot
assetsDendrogramPlot	Displays hierarchical clustering dendrogram
assetsCorEigenPlot	Displays ratio of the largest two eigenvalues

Beside correlations und dependencies also risk/reward graphs give additional insight into the structure of assets.

assetsRiskReturnPlot	Displays risk-return diagram of assets
assetsNIGShapeTrianglePlot	Displays NIG Shape Triangle
assetsTreePlot	Displays a minimum spanning tree of assets

Statistic visualized by star plots is a very appealing tool for characterization and classification of assets by eye:

assetsStarsPlot	Draws segment/star diagrams of asset sets
assetsBasicStatsPlot	Displays a segment plot of basic return stats
assetsMomentsPlot	Displays a segment plot of distribution moments
assetsBoxStatsPlot	Displays a segment plot of box plot statistics
assetsNIGFitPlot	Displays a segment plot NIG parameter estimates

### About Rmetrics:

The fAssets Rmetrics package is written for educational support in teaching "Computational Finance and Financial Engineering" and licensed under the GPL.

---

`assets-arrange`*Rearranging Assets Columnwise*

---

**Description**

Allows to rearrange a set of assets columnwise.

**Usage**

```
assetsArrange(x, method = c("pca", "hclust", "abc"), ...)  
  
pcaArrange(x, robust = FALSE, ...)  
hclustArrange(x, method = c("euclidean", "complete"), ...)  
abcArrange(x, ...)  
orderArrange(x, ...)  
sampleArrange(x, ...)  
statsArrange(x, FUN = colMeans, ...)
```

**Arguments**

<code>x</code>	any rectangular time series object which can be converted by the function <code>as.matrix()</code> into a matrix object, e.g. like an object of class <code>timeSeries</code> , <code>data.frame</code> , or <code>mts</code> .
<code>method</code>	a character string, which method should be applied to rearrange the assets? Either <code>"pca"</code> which arranges the columns by an eigenvalue decomposition, <code>"hclust"</code> which arranges the columns by hierarchical clustering, <code>"abc"</code> which arranges the columns alphabetically, <code>"order"</code> which arranges the columns by the order function, <code>"sample"</code> which arranges the columns randomly, or <code>"stats"</code> which arranges by an statistical strategy.
<code>robust</code>	a logical flag. Should robust statistics applied?
<code>FUN</code>	function name of the statistical function to be applied.
<code>...</code>	optional arguments to be passed.

**Value**

a character vector with the rearranged assets names.

**Author(s)**

Diethelm Wuertz for the Rmetrics port.

**References**

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

## Examples

```
## LPP -
# Load Swiss Pension Fund Data:
LPP <- LPP2005REC[, 1:3]
head(LPP)

## assetsArrange -
# Arrange Assets Columns:
assetsArrange(x=LPP, "pca")
assetsArrange(x=LPP, "hclust")
assetsArrange(x=LPP, "abc")

## Alternative Usage -
pcaArrange(x=LPP, robust=FALSE)
pcaArrange(x=LPP, robust=TRUE)
hclustArrange(x=LPP, method = c("euclidean", "complete"))
abcArrange(x=LPP)
orderArrange(x=LPP)
sampleArrange(x=LPP)
statsArrange(x=LPP, FUN=colMeans)
```

---

assets-distance

*Distance Measures*

---

## Description

Allows to measure the distance or similarity between assets.

## Usage

```
assetsDist(x, method="cor", ...)
```

```
corDist(x)
kendallDist(x)
spearmanDist(x)
```

```
mutinfoDist(x, nbin=10)
```

```
euclideanDist(x)
maximumDist(x)
manhattanDist(x)
canberraDist(x)
binaryDist(x)
minkowskiDist(x)
```

```
braycurtisDist(x)
mahalanobisDist(x)
```

```
jaccardDist(x)
sorensenDist(x)
```

### Arguments

x	any rectangular time series object which can be converted by the function <code>dist()</code> into a distance object.
method	a character string, the method from which to compute the distances. Allowed methods include <code>cor</code> , <code>kendall</code> , <code>spearman</code> , <code>mutinfo</code> , <code>euclidean</code> , <code>maximum</code> , <code>manhattan</code> , <code>canberra</code> , <code>binary</code> , <code>minkowski</code> , <code>braycurtis</code> , <code>mahalanobis</code> , <code>jaccard</code> , <code>difference</code> , or <code>sorensen</code> .
nbin	an integer value, the number of bins, by default 10.
...	optional argument to be passed the distance function.

### Details

`corDist`, `kendallDist`, and `spearmanDist` call the base `cov` function from R.

`mutinfoDist` calls the function `mutinfo` from the contributed R package `bioDist`.

`euclideanDist`, `maximumDist`, `manhattanDist`, `canberraDist`, `binaryDist`, and `minkowskiDist` are functions build on top of R's base package.

`braycurtisDist`, `mahalanobisDist`, `jaccardDist`, and `sorensenDist` call functions from the contributed R package `ecodist`.

### Value

an object of class `dist`.

### References

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

### Examples

```
## LPP -
# Load Swiss Pension Fund Data:
LPP <- LPP2005REC[, 1:6]
head(LPP)

## Returns correlation distance measure
corDist(LPP)

## Returns kendalls correlation distance measure
kendallDist(LPP)

## Returns spearmans correlation distance measure
spearmanDist(LPP)
```



```
## Return mutual information distance measure
mutinfoDist(LPP)

## Return Euclidean distance measure
euclideanDist(LPP)

## Return maximum distance measure
maximumDist(LPP)

## Return Manhattan distance measure
manhattanDist(LPP)

## Return Canberra distance measure
canberraDist(LPP)

## Return binary distance measure
binaryDist(LPP)

## Return Minkowsky distance measure
minkowskiDist(LPP)

## Return Bray Curtis distance measure
braycurtisDist(LPP)

## Return Mahalanobis distance measure
# mahalanobisDist(LPP)

## Return Jaccard distance mesaure
jaccardDist(LPP)

## Return Sorensen distance measure
sorensenDist(LPP)
```

---

assets-lpm

*Computation of Lower Partial Moments of Asset Sets*

---

## Description

Computes lower partial moments from a time series of assets.

## Usage

```
assetsLPM(x, tau, a, ...)
assetsSLPM(x, tau, a, ...)
```

## Arguments

x any rectangular time series object which can be converted by the function `as.matrix()` into a matrix object, e.g. like an object of class `timeSeries`, `data.frame`, or `mts`.

tau            the target return.  
 a              the value of the moment.  
 ...            optional arguments to be passed.

### Value

returns a list with two entries named mu and Sigma. The first denotes the vector of lower partial moments, and the second the co-LPM matrix. Note, that the output of this function can be used as data input for the portfolio functions to compute the LPM efficient frontier.

### Author(s)

Diethelm Wuertz for the Rmetrics port.

### References

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

### Examples

```
## LPP -
# Percentual Returns:
LPP <- 100 * as.timeSeries(data(LPP2005REC))[, 1:6]
colnames(LPP)
```

---

assets-meancov

*Estimation of Mean and Covariances of Asset Sets*

---

### Description

Estimates the mean and/or covariance matrix of a time series of assets by traditional and robust methods.

### Usage

```
assetsMeanCov(x,
  method = c("cov", "mve", "mcd", "MCD", "OGK", "nnve", "shrink", "bagged"),
  check = TRUE, force = TRUE, baggedR = 100, sigmamu = scaleTau2,
  alpha = 1/2, ...)
```

```
getCenterRob(object)
getCovRob(object)
```

**Arguments**

x	any rectangular time series object which can be converted by the function <code>as.matrix()</code> into a matrix object, e.g. like an object of class <code>timeSeries</code> , <code>data.frame</code> , or <code>mts</code> .
method	a character string, which determines how to compute the covariance matrix. If <code>method="cov"</code> is selected then the standard covariance will be computed by R's base function <code>cov</code> , if <code>method="shrink"</code> is selected then the covariance will be computed using the shrinkage approach as suggested in Schaefer and Strimmer [2005], if <code>method="bagged"</code> is selected then the covariance will be calculated from the bootstrap aggregated (bagged) version of the covariance estimator.
check	a logical flag. Should the covariance matrix be tested to be positive definite? By default TRUE.
force	a logical flag. Should the covariance matrix be forced to be positive definite? By default TRUE.
baggedR	when <code>methode="bagged"</code> , an integer value, the number of bootstrap replicates, by default 100.
sigmamu	when <code>methode="OGK"</code> , a function that computes univariate robust location and scale estimates. By default it should return a single numeric value containing the robust scale (standard deviation) estimate. When <code>mu.too</code> is true (the default), <code>sigmamu()</code> should return a numeric vector of length 2 containing robust location and scale estimates. See <code>scaleTau2</code> , <code>s_Qn</code> , <code>s_Sn</code> , <code>s_mad</code> or <code>s_IQR</code> for examples to be used as <code>sigmamu</code> argument. For details we refer to the help pages of the R-package <code>robustbase</code> .
object	a list as returned by the function <code>assetsMeanCov</code> .
alpha	when <code>methode="MCD"</code> , a numeric parameter controlling the size of the subsets over which the determinant is minimized, i.e., $\alpha \cdot n$ observations are used for computing the determinant. Allowed values are between 0.5 and 1 and the default is 0.5. For details we refer to the help pages of the R-package <code>robustbase</code> .
...	optional arguments to be passed to the underlying estimators. For details we refer to the manual pages of the functions <code>cov.rob</code> for arguments <code>"mve"</code> and <code>"mcd"</code> in the R package <code>MASS</code> , to the functions <code>covMcd</code> and <code>covOGK</code> in the R package <code>robustbase</code> .

**Value**

`assetsMeanCov` returns a list with for entries named `center`, `cov`, `mu` and `Sigma`. The list may have a character vector attributed with additional control parameters.

`getCenterRob` extracts the center from an object as returned by the function `assetsMeanCov`.

`getCovRob` extracts the covariance from an object as returned by the function `assetsMeanCov`.

**Author(s)**

Juliane Schaefer and Korbinian Strimmer for R's `corpcov` package,  
Diethelm Wuertz for the `Rmetrics` port.

## References

- Breiman L. (1996); *Bagging Predictors*, Machine Learning 24, 123–140.
- Ledoit O., Wolf. M. (2003); *Improved Estimation of the Covariance Matrix of Stock Returns with an Application to Portfolio Selection*, Journal of Empirical Finance 10, 503–621.
- Schaefer J., Strimmer K. (2005); *A Shrinkage Approach to Large-Scale Covariance Estimation and Implications for Functional Genomics*, Statist. Appl. Genet. Mol. Biol. 4, 32.
- Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

## Examples

```
## LPP -
LPP <- as.timeSeries(data(LPP2005REC))[, 1:6]
colnames(LPP)

## Sample Covariance Estimation:
assetsMeanCov(LPP)

## Shrinked Estimation:
shrink <- assetsMeanCov(LPP, "shrink")
shrink

## Extract Covariance Matrix:
getCovRob(shrink)
```

---

assets-modeling

*Modeling Multivariate Asset Sets*

---

## Description

Fitting and Simulating assets from multivariate asset sets based on modeling skew normal and related distributions.

## Usage

```
assetsFit(x, method = c("st", "sn", "sc"),
         title=NULL, description=NULL, fixed.df=NA, ...)

assetsSim(n, method=c("st", "sn", "sc"),
         model=list(beta=rep(0, 2), Omega=diag(2), alpha=rep(0, 2), nu=4),
         assetNames=NULL)
```

## Arguments

x any rectangular time series object which can be converted by the function `as.matrix()` into a matrix object, e.g. like an object of class `timeSeries`, `data.frame`, or `mts`.

n	a numeric value which represents the number of random vectors to be drawn.
method	a character string with the names of the supported distributions: sn skew normal, st skew Student-t, and sc skew Cauchy
model	a list with the model parameters. beta a numeric vector, representing the location, Omega a symmetric positive-definite matrix (covariance matrix), alpha a numeric vector which regulates the skew of the density, nu a positive value representing the degrees of freedom.
fixed.df	a logical value, should the degrees of freedom fitted or held fixed?
title	an optional project title.
description	an option project description.
assetNames	a character vector with optional asset names.
...	optional arguments passed to the underlying functions.

**Value**

assetsFit returns the fitted parameters, assetsSim returns a simulated (return) series.

**Author(s)**

Diethelm Wuertz for the Rmetrics port.

**References**

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

**Examples**

```
## LPP2005REC -
# Load Swiss Pension Fund Data as Percentual Returns:
LPP <- 100 * LPP2005REC[, 1:3]
head(LPP)

## assetsFit -
# Fit a Skew-Student-t Distribution:
fit <- assetsFit(LPP)
# Extract the Model:
model <- fit@fit$dp
# Show Model Slot:
print(model)

## assetsSim -
# Simulate set with same statistical properties:
set.seed(1953)
LPP.SIM <- assetsSim(n=nrow(LPP), model=model)
colnames(LPP.SIM) <- colnames(LPP)
head(LPP.SIM)
```

---

assets-outliers      *Detection of Outliers in Asset Sets*

---

### Description

Detects multivariate outliers in asset sets.

### Usage

```
assetsOutliers(x, center, cov, ...)
```

### Arguments

x	an object of class <code>timeSeries</code> .
center	a numeric vector, a (robust) estimate of the vector of means of the multivariate time series x.
cov	a numeric matrix, a (robust) estimate of the covariance matrix of the multivariate time series x.
...	optional arguments to be passed.

### Value

returns a list with the following entries: the estimate for the location named `center`, the estimate for the covariance matrix named `cov`, the estimate for the correlation matrix named `cor`, the quantile named `quantile`, the outliers named `outliers`, and the time series named `series`.

### Author(s)

Moritz Gschwandtner and Peter Filzmoser for the original R code from package "mvoutliers", Diethelm Wuertz for the Rmetrics port.

### References

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

### Examples

```
## LPP -
LPP <- as.timeSeries(data(LPP2005REC))[, 1:6]
colnames(LPP)

## assetsOutliers -
assetsOutliers(LPP, colMeans(LPP), cov(LPP))
```

---

 assets-selection      *Selecting Assets from Multivariate Asset Sets*


---

### Description

Select assets from Multivariate Asset Sets based on clustering.

### Usage

```
assetsSelect(x, method = c("hclust", "kmeans"), control = NULL, ...)
```

### Arguments

x	any rectangular time series object which can be converted by the function <code>as.matrix()</code> into a matrix object, e.g. like an object of class <code>timeSeries</code> , <code>data.frame</code> , or <code>mts</code> .
method	a character string, which clustering method should be used? Either <code>hclust</code> for hierarchical clustering of dissimilarities, or <code>kmeans</code> for k-means clustering.
control	a character string with two entries controlling the parameters used in the underlying cluster algorithms. If set to <code>NULL</code> , then default settings are taken: For hierarchical clustering this is <code>method=c(measure="euclidean", method="complete")</code> , and for <code>kmeans</code> clustering this is <code>method=c(centers=3, algorithm="Hartigan-Wong")</code> .
...	optional arguments to be passed. Note, for the k-means algorithm the number of centers has to be specified!

### Details

The function `assetsSelect` calls the functions `hclust` or `kmeans` from R's "stats" package. `hclust` performs a hierarchical cluster analysis on the set of dissimilarities `hclust(dist(t(x)))` and `kmeans` performs a k-means clustering on the data matrix itself.

Note, the hierarchical clustering method has in addition a plot method.

### Value

if `use="hclust"` was selected then the function returns a S3 object of class "hclust", otherwise if `use="kmeans"` was selected then the function returns an object of class "kmeans".

For details we refer to the help pages of `hclust` and `kmeans`.

### Author(s)

Diethelm Wuertz for the Rmetrics port.

### References

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

**Examples**

```
## LPP -
# Load Swiss Pension Fund Data:
LPP <- LPP2005REC
colnames(LPP)

## assetsSelect -
# Hierarchical Clustering:
hclust <- assetsSelect(LPP, "hclust")
plot(hclust)

## assetsSelect -
# kmeans Clustering:
assetsSelect(LPP, "kmeans", control =
  c(centers = 3, algorithm = "Hartigan-Wong"))
```

---

assets-testing

*Testing Normality of Multivariate Asset Sets*


---

**Description**

Tests if the returns of a set of assets are normally distributed.

**Usage**

```
assetsTest(x, method = c("shapiro", "energy"), Replicates = 99)

mvshapiroTest(x)
mvenergyTest(x, Replicates = 99)
```

**Arguments**

x	any rectangular time series object which can be converted by the function <code>as.matrix()</code> into a matrix object, e.g. like an object of class <code>timeSeries</code> , <code>data.frame</code> , or <code>mts</code> .
method	a character string, which allows to select the test. If <code>method="shapiro"</code> then Shapiro's multivariate Normality test will be applied as implemented in R's contributed package <code>mvnormtest</code> . If <code>method="energy"</code> then the E-statistic (energy) for testing multivariate Normality will be used as proposed and implemented by Szekely and Rizzo [2005] using parametric bootstrap.
Replicates	an integer value, the number of bootstrap replicates, by default 100. This value is only used if <code>method="energy"</code> .

**Value**

returns an object of class `htest`.



**Author(s)**

Diethelm Wuertz for this Rmetrics port.

**References**

Rizzo M.L. (2002); *A New Rotation Invariant Goodness-of-Fit Test*, PhD dissertation, Bowling Green State University.

Szekely G.J., Rizzo, M.L. (2005); *A New Test for Multivariate Normality*, Journal of Multivariate Analysis 93, 58–80.

Szekely G.J. (1989); *Potential and Kinetic Energy in Statistics*, Lecture Notes, Budapest Institute of Technology, Technical University.

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

**Examples**

```
## LPP -  
# Load Swiss Pension Fund Data:  
LPP <- LPP2005REC[, 1:6]  
head(LPP)  
  
## assetsTest -  
# Multivariate Shapiro Test -  
assetsTest(LPP, "shapiro")  
  
## assetsTest -  
# Multivariate Energy Test -  
assetsTest(LPP, "energy")
```

---

plot-binning

*Bivariate Histogram Plots of Assets*

---

**Description**

Displays bivariate histogram plots of assets returns.

**Usage**

```
assetsHistPairsPlot(x, bins = 30, method = c("square", "hex"), ...)
```

**Arguments**

**x** any rectangular time series object which can be converted by the function `as.matrix()` into a matrix object, e.g. like an object of class `timeSeries`, `data.frame`, or `mts`.

**bins** an integer value, the number of bins used for the bivariate histogram.

method a character string denoting which type of binning should be used, either "squared" or "hexagonal".

... optional arguments to be passed.

### Author(s)

Diethelm Wuertz for the Rmetrics port.

### References

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

### Examples

```
## LPP2005REC -
# Load Swiss Pension Fund Data:
LPP <- LPP2005REC
head(LPP)

## assetsHistPairsPlot -
# Create a bivariate Binning Plot: assetsHistPairsPlot -
assetsHistPairsPlot(LPP[, c("LMI", "ALT")])

## assetsHistPairsPlot -
# Now with hexagonal Bins:
assetsHistPairsPlot(LPP[, c("LMI", "ALT")], method = "hex")
grid(col="red")
```

---

plot-boxplot

*Displays a Box Plot of Assets*

---

### Description

Displays standard box and box-percentile plots of assets.

### Usage

```
assetsBoxPlot(x, col = "bisque", ...)
assetsBoxPercentilePlot(x, col = "bisque", ...)
```

### Arguments

x any rectangular time series object which can be converted by the function `as.matrix()` into a matrix object, e.g. like an object of class `timeSeries`, `data.frame`, or `mts`.

col a character string, defining the color to fill the boxes.

... optional arguments to be passed.

**Author(s)**

Diethelm Wuertz for the Rmetrics port.

**References**

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

**Examples**

```
## LPP -  
# Load Swiss Pension Fund Data:  
LPP <- LPP2005REC[, 1:6]  
head(LPP)  
  
## assetsBoxPlot -  
# Create a Boxplot: assetsBoxPlot -  
assetsBoxPlot(LPP)  
  
## assetsBoxPercentilePlot -  
# Create a Box Percentile Plot: assetsBoxPercentilePlot -  
assetsBoxPercentilePlot(LPP)  
grid(NA, NULL, col="red")
```

---

plot-ellipses

*Displays a Covariance Ellipses Plot*

---

**Description**

Displays a covariance ellipses plot.

**Usage**

```
covEllipsesPlot(x = list(), ...)
```

**Arguments**

x                    a list of at least two covariance matrices.  
...                  optional arguments to be passed.

**Details**

This plot visualizes the difference between two or more covariance matrices. It is meant to compare different methods of covariance estimation.

## References

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

## Examples

```
## LPP -
# Load Swiss Pension Fund Data:
LPP <- LPP2005REC[, 1:6]
head(LPP)

## assetsMeanCov -
# Compute Robust Covariance Matrix: assetsMeanCov -
Cov <- cov(LPP)
robustCov <- assetsMeanCov(LPP, "MCD")$Sigma

## covEllipsesPlot -
# Create Covariance Ellipse Plot:
covEllipsesPlot(list(Cov, robustCov))
```

---

plot-hist

*Histogram Plots of Assets*

---

## Description

Displays density of assets returns as a histogram and/or as log density plot.

## Usage

```
assetsHistPlot(x, col = "steelblue", skipZeros = FALSE, ...)

assetsLogDensityPlot(x, estimator = c("hubers", "sample", "both"),
  labels = TRUE, ...)
```

## Arguments

x	any rectangular time series object which can be converted by the function <code>as.matrix()</code> into a matrix object, e.g. like an object of class <code>timeSeries</code> , <code>data.frame</code> , or <code>mts</code> .
skipZeros	a logical, should zeros be skipped in the histogram plot of the return series ?
col	a character string, defining the color to fill the boxes.
estimator	a character string naming the type of estimator to fit the mean and variance of the normal density. This may be either "huber", "sample", or "both".
labels	a logical flag, if TRUE then default labels will be used, otherwise the plots will be displayed without labels and the user can add his own labels.
...	optional arguments to be passed.

**Author(s)**

Diethelm Wuertz for the Rmetrics port.

**References**

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

**Examples**

```
## LPP2005REC -
# Load Swiss Pension Fund Data:
x <- LPP2005REC
head(x)

## assetsHistPlot -
# Create Histogram Plot: assetsHistPlot -
# par(mfrow = c(2, 2))
assetsHistPlot(x[, 1:4])

## assetsLogDensityPlot -
#Create Log Density Plot: assetsLogDensityPlot -
# par(mfrow = c(1, 1))
assetsLogDensityPlot(x[, "ALT"], estimator = "both")
```

---

plot-mst

*Assets Tree Plot*


---

**Description**

Creates and displays a minimum spanning tree of assets.

**Usage**

```
assetsTreePlot(x, labels = TRUE, title = TRUE, box = TRUE,
  method = "euclidian", seed = NULL, ...)
```

**Arguments**

x	a multivariate timeSeries object.
labels	a logical flag, if TRUE then default labels will be used, otherwise the plots will be displayed without labels and the user can add his own labels.
title	a logical flag, should a default title be added? By default TRUE.
box	a logical flag, should a box be added around the plot? By default TRUE.
method	a character string, the method used to compute the distance matrix, see function dist.
seed	an integer value setting the seed in the computation of the sample ranks.
...	optional arguments to be passed.

**Author(s)**

Diethelm Wuertz for the Rmetrics port.

**References**

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

**Examples**

```
## LPP2005REC -
# Load Swiss Pension Fund Data:
LPP <- LPP2005REC[, 1:6]
head(LPP)

## assetsTreePlot(LPP) -
# Create Minimum Spanning Tree Graph: assetsTreePlot -
# par(mfrow = c(2, 2))
assetsTreePlot(LPP)
# new seeds ...
for (i in 1:3) assetsTreePlot(LPP)
```

---

plot-pairs

*Assets Pairs Plot*

---

**Description**

Display several aspects of correlation between pairs of assets.

**Usage**

```
assetsPairsPlot(x, ...)
assetsCorgramPlot(x,
  method = c("pie", "shade"), ...)
assetsCorTestPlot(x, ...)
assetsCorImagePlot(x, labels = TRUE, show = c("cor", "test"),
  use = c("pearson", "kendall", "spearman"), abbreviate = 3, ...)
```

**Arguments**

x	any rectangular time series object which can be converted by the function <code>as.matrix()</code> into a matrix object, e.g. like an object of class <code>timeSeries</code> , <code>data.frame</code> , or <code>mts</code> .
labels	a logical flag, if <code>TRUE</code> then default labels will be used, otherwise the plots will be displayed without labels and the user can add his own labels.
method	a character string, the type of graph used in the lower panel.

show	a character string, what should be presented, correlations or results from correlation tests?
use	a character string indicating which correlation coefficient or covariance is to be computed. One of "pearson", the default, "kendall", or "spearman".
abbreviate	allows to abbreviate strings to at least abbreviate characters, such that they remain unique, if they were.
...	optional arguments to be passed.

### Details

assetsPairsPlot  
displays pairs of scatterplots of individual assets,  
assetsCorgramPlot  
displays correlations between assets,  
assetsCorTestPlot  
displays and tests pairwise correlations,  
assetsCorImagePlot  
displays an image plot of a correlations.

### Author(s)

Diethelm Wuertz for the Rmetrics port.

### References

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

### Examples

```
## LPP2005REC -  
# Load Swiss Pension Fund Data:  
LPP <- LPP2005REC[, 1:6]  
head(LPP)  
  
## assetsPairsPlot -  
# Create Pairs Plot:  
assetsPairsPlot(LPP)  
  
## assetsCorgramPlot -  
# Create Corellogram Plot:  
assetsCorgramPlot(LPP, method = "pie")  
assetsCorgramPlot(LPP, method = "shade")  
  
## assetsCorTestPlot -  
# Create Correlation Test Plot:  
assetsCorTestPlot(LPP)  
  
## assetsCorImagePlot -
```

```
# Create Correlation Image Plot:
assetsCorImagePlot(LPP)
```

---

plot-qqplot

*Normal Quantile-Quantile Plots*


---

### Description

Displays a normal quantile-quantile plot

### Usage

```
assetsQQNormPlot(x, col = "steelblue", skipZeros = FALSE, ...)
```

### Arguments

x	any rectangular time series object which can be converted by the function <code>as.matrix()</code> into a matrix object, e.g. like an object of class <code>timeSeries</code> , <code>data.frame</code> , or <code>mts</code> .
col	a character string, defining the color to fill the boxes.
skipZeros	a logical, should zeros be skipped in the histogram plot of the return series?
...	optional arguments to be passed.

### Author(s)

Diethelm Wuertz for the Rmetrics port.

### References

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

### Examples

```
## LPP2005REC -
# Load Swiss Pension Fund Data:
LPP <- LPP2005REC
head(LPP)

## assetsQQNormPlot -
# Create normal Quantile-Quantile Plot:
# par(mfrow = c(2, 2))
assetsQQNormPlot(LPP[, 1:3])
```



---

plot-risk

*Assets Risk Plots*

---

### Description

Displays risk plot from asseets.

### Usage

```
assetsRiskReturnPlot(x, col = "steelblue", percentage = FALSE, scale = 252,  
  labels = TRUE, add = TRUE, ...)
```

```
assetsNIGShapeTrianglePlot(x, labels, col = "steelblue", ...)
```

### Arguments

x	any rectangular time series object which can be converted by the function <code>as.matrix()</code> into a matrix object, e.g. like an object of class <code>timeSeries</code> , <code>data.frame</code> , or <code>mts</code> .
col	a character string, defining the color to fill the boxes.
percentage	a logical flag. Are the returns given by log or percentual log returns?
scale	an integer value, the scale, i.e number of days, in a year. Used by daily data sets.
labels	a logical flag, if TRUE then default labels will be used, otherwise the plots will be displayed without labels and the user can add his own labels.
add	a logical flag, defining the color to fill the boxes.
...	optional arguments to be passed.

### Author(s)

Diethelm Wuertz for the Rmetrics port.

### References

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

### Examples

```
## LPP2005REC -  
# Load Swiss Pension Fund Data:  
LPP <- LPP2005REC  
head(LPP)  
  
## assetsRiskReturnPlot -
```

```
# Create Risk/Return Plot:
# par(mfrow = c(2, 2))
assetsRiskReturnPlot(LPP)

## assetsNIGShapeTrianglePlot -
# Create NIG Shape Triangle Plot:
assetsNIGShapeTrianglePlot(LPP)
```

---

plot-series

*Displays Series Plots of Assets.*

---

## Description

Displays series from sets of assets.

## Usage

```
assetsReturnPlot(x, col = "steelblue", ...)
assetsCumulatedPlot(x, col = "steelblue", ...)
assetsSeriesPlot(x, col = "steelblue", ...)
```

## Arguments

x	an object of class <code>timeSeries</code> .
col	a character string, defining the color to fill the boxes.
...	optional arguments to be passed.

## Author(s)

Diethelm Wuertz for the Rmetrics port.

## References

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

## Examples

```
## LPP2005REC -
# Load Swiss Pension Fund Data:
LPP <- LPP2005REC
head(LPP)

## assetsReturnPlot -
# Create Return Series Plot:
# par(mfrow = c(3, 2))
assetsReturnPlot(LPP[, 1:3])

## assetsCumulatedPlot -
```

```

# Create Cumulated Price/Index Plot:
assetsCumulatedPlot(LPP[, "LPP40"], col = "red")

## assetsSeriesPlot
# Crete Time Series Plot:
assetsSeriesPlot(LPP[, c("LMI", "ALT")],
  col = c("orange", "brown"))

```

---

plot-similarity      *Assets Similarity Plots*

---

## Description

Displays plots of similarities and dissimilarities between data sets of assets.

## Usage

```

assetsDendrogramPlot(x, labels = TRUE, title = TRUE, box = TRUE,
  method = c(dist = "euclidian", clust = "complete"), ...)

assetsCorEigenPlot(x, labels = TRUE, title = TRUE, box = TRUE,
  method = c("pearson", "kendall", "spearman"), ...)

```

## Arguments

box	a logical flag, should a box be added around the plot? By default TRUE.
labels	a logical flag, if TRUE then default labels will be used, otherwise the plots will be displayed without labels and the user can add his own labels.
method	[assetsCorgramPlot] - for the function assetsCorgramPlot a character string, the type of graph used in the lower panel, for the function assetsCorEigenPlot a character string, the method used to compute the correlation matrix. [assetsTreePlot] - a character string, the method used to compute the distance matrix, see function dist.
title	a logical flag, should a default title be added? By default TRUE.
x	any rectangular time series object which can be converted by the function <code>as.matrix()</code> into a matrix object, e.g. like an object of class <code>timeSeries</code> , <code>data.frame</code> , or <code>mts</code> .
...	optional arguments to be passed.

## Details

```

assetsDendrogramPlot
displays a hierarchical clustering dendrogram,

assetsCorEigenPlot
displays ratio plot of the largest two eigenvalues.

```

**Author(s)**

Diethelm Wuertz for the Rmetrics port.

**References**

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

**Examples**

```
## LPP2005REC -
# Load Swiss Pension Fund Data:
LPP <- LPP2005REC
head(LPP)

## assetsDendrogramPlot -
# Display a Dendrogram Plot:
assetsDendrogramPlot(LPP)

## assetsCorEigenPlot -
# Display a Correlation Eigenvalue Ratio Plot:
assetsCorEigenPlot(LPP)
```

---

plot-stars

*Stars Plots of Assets.*

---

**Description**

Displays star plots to compare assets sets.

**Usage**

```
assetsStarsPlot(x, method = c("segments", "stars"), locOffset = c(0, 0),
  keyOffset = c(0, 0), ...)

assetsBoxStatsPlot(x, par = TRUE, oma = c(0,0,0,0), mar = c(4, 4, 4, 4),
  keyOffset = c(-0.65, -0.50), main = "Assets Statistics",
  title = "Assets", titlePosition = c(3, 3.65),
  description = "Box Plot Statistics", descriptionPosition = c(3, 3.50), ...)

assetsBasicStatsPlot(x, par = TRUE, oma = c(0,0,0,0), mar = c(4, 4, 4, 4),
  keyOffset = c(-0.65, -0.50), main = "Assets Statistics",
  title = "Assets", titlePosition = c(3, 3.65),
  description = "Basic Returns Statistics", descriptionPosition = c(3, 3.50), ...)

assetsMomentsPlot(x, par = TRUE, oma = c(0,0,0,0), mar = c(4, 4, 4, 4),
  keyOffset = c(-0.65, -0.50), main = "Assets Statistics",
  title = "Assets", titlePosition = c(3, 3.65),
```

```

description = "Moments Statistics", descriptionPosition = c(3, 3.50), ...)

assetsNIGFitPlot(x, par = TRUE, oma = c(0,0,0,0), mar = c(4, 4, 4, 4),
  keyOffset = c(-0.65, -0.50), main = "Assets Statistics",
  title = "Assets", titlePosition = c(3, 3.65),
  description = "NIG Parameters", descriptionPosition = c(3, 3.50), ...)

```

## Arguments

description	a description string.
descriptionPosition	the position of the description string.
method	a character string from to select the plot method. Either a "star" or a "segment" plot.
keyOffset	a numeric vector of length two, specifying an offset in the legend with respect to x and y direction.
locOffset	a numeric vector of length two, specifying an offset in the location of the stars/circles with respect to x and y direction.
main	to set the main title.
mar	to set the number of lines of margin to be specified on the four sides of the plot. The default is <code>c(5, 4, 4, 2)+0.1</code> .
oma	to set the size of the outer margins in lines of text.
par	a logical flag. Should be internal <code>par()</code> setting be used?
title	a character string, the plot title.
titlePosition	the position of the title string.
x	any rectangular time series object which can be converted by the function <code>as.matrix()</code> into a matrix object, e.g. like an object of class <code>timeSeries</code> , <code>data.frame</code> , or <code>mts</code> .
...	optional arguments to be passed.

## Details

**assetsStarsPlot**  
draws segment or star diagrams of data sets,

**assetsBasicStatsPlot**  
displays a segment plot of box plot statistics,

**assetsMomentsPlot**  
displays a segment plot of distribution moments,

**assetsBoxStatsPlot**  
displays a segment plot of box plot statistics,

**assetsNIGFitPlot**  
displays a segment plot NIG parameter estimates.

**Author(s)**

Diethelm Wuertz for the Rmetrics port.

**References**

Wuertz, D., Chalabi, Y., Chen W., Ellis A. (2009); *Portfolio Optimization with R/Rmetrics*, Rmetrics eBook, Rmetrics Association and Finance Online, Zurich.

**Examples**

```
## LPP2005REC -  
# Load Swiss Pension Fund Data:  
LPP <- LPP2005REC  
head(LPP)  
  
## assetsBasicStatsPlot -  
# Create a basic Stats Plot: assetsBasicStatsPlot -  
# par(mfrow = c(1, 1))  
assetsBasicStatsPlot(LPP, title = "", description = "")  
  
## assetsMomentsPlot -  
# Create a Moments Plot: assetsMomentsPlot -  
assetsMomentsPlot(LPP, title = "", description = "")  
  
## assetsBoxStatsPlot -  
# Create a Box Stats Plot: assetsBoxStatsPlot -  
assetsBoxStatsPlot(LPP, title = "", description = "")  
  
## assetsNIGFitPlot -  
# Create a NIG Fit Plot: assetsNIGFitPlot -  
assetsNIGFitPlot(LPP[, 7:9], title = "", description = "")
```

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