

Package ‘mewAvg’

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Title A Fixed Memory Moving Expanding Window Average

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Depends methods

Description Compute the average of a sequence of random vectors
in a moving expanding window using a fixed amount of memory.

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mewAvg-package

A fixed memory moving expanding window average

Description

This package provides the tools to calculate an average in a moving expanding window (MEW) using a fixed amount of memory.

Details

See the examples for the functions mewMean and mewAvg for the details of use.

References

Levine, Z. H., & Pintar, A. L. (2015). A fixed-memory moving, expanding window for obtaining scatter corrections in x-ray CT and other stochastic averages. *Computer Physics Communications*, 196, 455-459.

mewAccum

Update the class mewTyp

Description

Update an S4 object of class mewTyp with a new data point

Usage

```
mewAccum(xx, av)
```

Arguments

xx (vector double) The vector of data with which to update the MEW aveage
av (class mewTyp) The current state of the MEW average

Details

If av is an S4 object of class mewTyp that contains the current state of the MEW average and xx is a new vector of data, the function mewAccum updates the MEW average with xx.

Value

The updated instance of av

Examples

```
n_iter <- 1000

av <- mewInit(n_bin = 4, n_xx = 1, ff = 0.5)

for (i in 1:n_iter) {

  value <- runif(n=2)
  value[1] <- ((cos(value[1]*2*pi))^2)*(1 - exp(-0.01*i))
  value[2] <- (-((sin(value[2]*2*pi))^2))*(1 - exp(-0.01*i))
  value <- as.double(value)

  av <- mewAccum(xx = value, av = av)
}
```

mewAvg

Convenience wrapper for the MEW process

Description

Packages the process of calling mewInit, looping through the random vectors calling mewAccum for each one and calling mewMean when desired.

Usage

```
mewAvg(f, n.bin, n.xx, ff, n.save = NULL, n.iter = NULL, i.to.save, ...)
```

Arguments

f	(function) A user defined R function. See the 'Details' section for more on defining this function
n.bin	(scalar integer) The fixed number of bins to use to define the moving expanding window
n.xx	(scalar integer) The length of the numeric vector returned by f
ff	(scalar double) The fraction of the samples to included in each window
n.save	(scalar integer OR NULL) The number of estimates to save and return. The default value is NULL since this argument can be derived from i.to.save. The argument is kept for compatibility with older versions of this package
n.iter	(scalar integer OR NULL) The number of times to call f. The default value is NULL since this argument can be derived from i.to.save. The argument is kept for compatibility with older versions of this package
i.to.save	(vector integer length n.iter) A vector of zeros and ones of length n.iter where position i is 1 if an average should be calculated and saved at iteration i, and zero otherwise
...	The initial named arguments to f.

Details

The function `f` should generate the sequence of random vectors one at a time. The returned value from a single call should be a list with at least one element. The first element should be a numeric vector of length `n.xx` (the next vector in the sequence), and the remaining elements should be the updated arguments for the next call to `f`, named appropriately for the argument of `f` to update. The 'Examples' section provides further guidance.

The downfall of this interface is that the user cannot run the algorithm for some number of iterations, pause, assess convergence of the mean and then pick up from where they paused. To accomplish that see the examples associated with the `mewMean` function.

Value

A matrix of dimension `n.save` by `n.xx` containing the saved averages

Examples

```
MyFun <- function (k) {

  value <- runif(n=2)
  value[1] <- ((cos(value[1]*2*pi))^2)*(1 - exp(-0.01*k))
  value[2] <- (-((sin(value[2]*2*pi))^2))*(1 - exp(-0.01*k))

  k <- k + 1

  return(list(value=value, k=k))
}

i.to.save <- seq(from=1, to=1025, by=32)
tmp <- rep(x=0, times=1025)
tmp[i.to.save] <- 1
i.to.save <- tmp

mean.vals <- mewAvg(f=MyFun,
                    n.bin=4,
                    n.xx=2,
                    ff=0.5,
                    n.save=sum(i.to.save),
                    n.iter=length(i.to.save),
                    i.to.save=i.to.save,
                    k=1)

plot(c(1:sum(i.to.save),
      1:sum(i.to.save)),
     c(mean.vals[, 1],
       mean.vals[, 2]),
     type="n",
     xlab="Saved Iter",
     ylab="Mean")
points(1:sum(i.to.save),
       mean.vals[, 1])
points(1:sum(i.to.save),
```

```

        mean.vals[, 2])

## an AR(1) process

ArOne <- function (x.old, phi, sig.eps) {

  value <- phi*x.old + rnorm(n=1, mean=0, sd=sig.eps)

  return(list(value=value, x.old=value))
}

mean.vals.ar1 <- mewAvg(f=ArOne,
                        n.bin=4,
                        n.xx=1,
                        ff=0.5,
                        n.save=sum(i.to.save),
                        n.iter=length(i.to.save),
                        i.to.save=i.to.save,
                        x.old=0,
                        phi=0.5,
                        sig.eps=1)

plot(x=c(1, sum(i.to.save)),
     y=c(-0.5, 0.5),
     xlab="Saved Iter",
     ylab="Mean",
     type="n")
points(x=1:sum(i.to.save),
       y=mean.vals.ar1)
abline(h=0, col="red")

```

mewGetMean

Extract MEW average value

Description

Return the current value of the moving expanding window (MEW) average if it is up-to-date; otherwise, raise an error

Usage

```
mewGetMean(av)
```

Arguments

av The current state of the MEW average

Value

(vector double length `n_xx`) the current value of the MEW average if it is up-to-date

Examples

```
## see the examples for the function \code{mewMean}
```

mewInit

Create an S4 object of class mewTyp

Description

Call this function to create an S4 object of class mewTyp.

Usage

```
mewInit(n_bin, n_xx, ff)
```

Arguments

n_bin	(scalar integer) The fixed number of bins to use to define the moving expanding window
n_xx	(scalar integer) The length of each vector in the sequence to be averaged
ff	(scalar double) The fraction of the samples to included in each window

Details

If it is necessary to directly call mewAccum and mewMean an S4 object of class mewTyp should be created first using this function. The user should never create an S4 object of class mewTyp using the new function provided by the methods package.

Value

An initialized instance of the class mewTyp

Examples

```
av <- mewInit(n_bin = 4, n_xx = 2, ff = 0.5)
```

mewMean

*Update the moving expanding window average***Description**

When desired, the `x_mean` slot in an S4 object of class `mewTyp` may be updated to contain the correct moving expanding window (MEW) average (it is not updated by the function `mewAccum` to save computation). If the slot `know_mean` is unity, the slot `x_mean` is up-to-date; otherwise, it is not.

Usage

```
mewMean(av)
```

Arguments

`av` (class `mewTyp`) the current state of the MEW average

Value

the updated instance of the argument `av`

Examples

```
n_iter <- 100
i_to_print <- 10

results <- matrix(data = double(2*n_iter/i_to_print),
                  nrow = n_iter/i_to_print,
                  ncol = 2)

av <- mewInit(n_bin = 4, n_xx = 2, ff = 0.5)

for (i in 1:n_iter) {
  value <- runif(n=2)
  value[1] <- ((cos(value[1]*2*pi))^2)*(1 - exp(-0.01*i))
  value[2] <- (-((sin(value[2]*2*pi))^2))*(1 - exp(-0.01*i))

  av <- mewAccum(xx = value, av = av)

  if (i%i_to_print == 0) {
    av <- mewMean(av)
    show(av)
    results[i/i_to_print, ] <- mewGetMean(av)
  }
}

## plot the results
```

```

plot(c(1, (n_iter/i_to_print)),
     c(min(results), max(results)),
     type = "n")
points(1:(n_iter/i_to_print), results[, 1])
points(1:(n_iter/i_to_print), results[, 2])

## Now, a larger example, and we pause part way through to assess
## convergence

n_iter <- 1000
av <- mewInit(n_bin = 4, n_xx = 5000, ff = 0.5)
for (i in 1:n_iter) {

  new_samp <- runif(n = 5000)
  av <- mewAccum(xx = new_samp, av = av)
}

av <- mewMean(av = av)

## of course each element of the mean should converge to 0.5. After
## 1000 iterations, the first six elements of the mean vector are
show(av)

## run another 1000 iterations
for (i in 1:1000) {

  new_samp <- runif(n = 5000)
  av <- mewAccum(xx = new_samp, av = av)
}

av <- mewMean(av)

## check the mean of the first six elements again
show(av)

```

mewTyp-class

The state of the moving expanding window average

Description

The class holds the current state of the moving expanding window (MEW) average

Details

The user should never create, update or access an instance of this class themselves. An instance of the class should be created with the function `mewInit` and updated with the functions `mewAccum` and `mewMean`. The user can extract the current value of the MEW average with the function `mewGetMean`, and print the first six elements of the mean vector to the screen with either the `show` or `print` functions.

Slots

i_new (scalar integer) The index of the bin to add the current sample to
i_old (scalar integer) The index of the bin to deweight
know_mean (scalar integer) flag 0: mean not known 1: mean known
n_bin (scalar integer) The number of bins to use in the MEW process
n_bin_use (scalar integer) The number of bins currently in use
n_xx (scalar integer) The length of a vector in the sequence being averaged
n_part (scalar integer) The number of samples in the bins that are not being added to or deweighted
m_sample (vector integer length - *n_bin*) The maximum number of samples allowed in each of the bins
n_sample (vector integer length - *n_bin*) The number of samples currently in each bin
x_mean (vector double length - *n_xx*) The current value of the MEW average (which is up-to-date only if *know_mean* == 1)
x_sum_part (vector double length - *n_xx*) The sum in the bins not being added to or deweighted
xx (matrix dimension - *n_xx* × *n_bin*) The bin sums
ff (scalar double) The fraction of samples to retain in the MEW average
ww (scalar double) The factor of increase in the number of samples from one bin to the next
a_sample (scalar double) The ideal number of samples in a bin (before rounding)

show,mewTyp-method	<i>Print the MEW average to the screen</i>
--------------------	--

Description

Print to the screen the first six elements of the current value (if it is up-to-date) of the moving expanding window (MEW) average. An error is raised if the MEW average is not up-to-date.

Usage

```
## S4 method for signature 'mewTyp'
show(object)
```

Arguments

object (class mewTyp) The current state of the MEW average

Value

Upon successful exit, zero is returned invisibly.

Examples

```
## see the examples for the function mewMean
```

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