# Package 'rmaf'

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**Type** Package

**Title** Refined Moving Average Filter

**Version** 2.0

**Date** 2014-03-05

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**Description**
Use refined moving average filter based on the optimal and data-driven moving average lag q to decompose trend, seasonality and irregularity for an univariate time series or univariate data.

**License** GPL (>= 2)

**NeedsCompilation** no

**Repository** CRAN

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## R topics documented:

`rmaf-package` *Refined Moving Average Filter Package*

## Description

A refined moving average filter using the optimal and data-driven moving average lag $q$ to decompose the trend, seasonality and irregularity for an univariate time series or data.

## Details

| | |
|---|---|
| Package: | rmaf |
| Type: | Package |
| Version: | 2.0 |
| Date: | 2014-03-05 |
| License: | GPL (>= 2) |

This package contains a function to determine the optimal and data-driven moving average lag $q$, and function to decompose the trend, seasonality and irregularity for an univariate time series. A dataset of the first differences of annual global surface air temperatures in Celsius from 1880 through 1985 is also included in the package for illustrating the trend decomposition.

For a complete list of functions and dataset, use `library(help = rmaf)`.

## Author(s)

Debin Qiu

Maintainer: Debin Qiu <<debinqiu@uga.edu>>

## References

D. Qiu, Q. Shao, and L. Yang (2013), Efficient inference for autoregressive coeficient in the presence of trend. *Journal of Multivariate Analysis* 114, 40-53.

P.J. Brockwell, R.A. Davis, Time Series: Theory and Methods, second ed., Springer, New York, 1991.

## See Also

`ma.filter`, `qn`

## Examples

```
## The first difference of annual global surface air temperatures from 1880 to 1985 with only trend
data(globtemp)
x <- globtemp[,2]
q.n <- qn(x)
fit <- ma.filter(x)
```

## globtemp — *The First Differences of Annual Golbal Surface Air Temperatures from 1880-1985*

### Description

The first differences of annual global surface air temperatures in Celsius from 1880 through 1985.

### Usage

```
data(globtemp)
```

### Format

A matrix containing 106 observations. The first column is the time from 1880-1985. The second column is the first difference of annual global surface air temperature in celsius.

### Details

The first differences of the annual global surface air temperatures in Celsius from 1880 through 1985.

### Source

http://datamarket.com/data/set/22ku/annual-changes-in-global-temperature-1880-1985#!ds=22ku&display=line

### See Also

qn ma.filter

### Examples

```
data(globtemp)
globtemp
```

## ma.filter — *Refined Moving Average Filter to Decompose Trend, Seasonality and Irregularity*

### Description

Use refined moving average filter to decompose the trend, seasonality and irregularity for an univariate time series.

## Usage

```
ma.filter(xt, data = NULL, seasonal = FALSE, d = NULL, na.action = na.fail, plot = FALSE)
```

## Arguments

| | |
|---|---|
| `xt` | univariate time series to be decomposed. |
| `data` | an optional data frame, list or environment containing the univariate time series. The default is `NULL`. |
| `seasonal` | seasonality. The default is `FALSE` which is to decompose the trend only. When `seasonal` is `TRUE`, the seasonal period `d` should be specified and an additive seasonality is only considered here. |
| `d` | seasonal period. It should be at least 2 and divisor of sample size. The default is `NULL`. |
| `na.action` | action on missing values. The detault is `na.fail`. |
| `plot` | plots of data, trend, seasonality (if seasonal $d$ is specified) and irregularity. The default is `FALSE`. |

## Details

For an univariate time seties $x[t]$, the additive seasonal model is assumed to be

$$x[t] = m[t] + S[t] + R[t],$$

where $m[t], S[t], R[t]$ are trend, seasonality and irregular components, respectively. The trend and seasonality of an univariate time series $x[t]$ are decomposed by using the refined moving average filter. Once we obtain the optimal moving average lag $q$, the trend can be estimated by using the refined moving average

$$mhat[t] = \sum x[t]/(2q + 1),$$

for $q + 1 \le t \le n - q$. If $q + 1 > n - q$, we take $q = min(n - q, q)$. If there is no seasonal component, the irregularity or residual can be obtained by $Rhat[t] = x[t] - mhat[t]$. Otherwise, the seasonality $Shat[t]$ can be decomposed by using the refined moving average on $x[t] - mhat[t]$ and then irregularity or residual is $Rhat[t] = x[t]-mhat[t]-Shat[t]$. For $t < q+1$ and $t > n-q$, the corresponding estimators are based on equation (7) in D. Qiu *et al.* (2013). More details about decomposing trend and seasonality can be seen in Section 1.5 of P.J. Brockwell *et al.* (1991).

For the multiplicative seasonal model

$$x[t] = m[t] * S[t] * R[t],$$

it can be transformed to an additive seasonal model by taking the logarithm on both sides if $x[t] > 0$, i.e.,

$$log(x[t]) = log(m[t]) + log(S[t]) + log(R[t]),$$

and then use the refined moving average filter for the components decomposition as in the additive seasonal model.

## Value

A list of time series decomposition components including:

| | |
|---|---|
| `data` | original univariate time series. |
| `trend` | fitted trend. |
| `season` | fitted seasonality. |
| `remainder` | fitted irregularity or residual. |
| `SSE` | sum of squared errors. |

## Author(s)

Debin Qiu <<debinqiu@uga.edu>>

## References

D. Qiu, Q. Shao, and L. Yang (2013), Efficient inference for autoregressive coeficient in the presence of trend. *Journal of Multivariate Analysis* 114, 40-53.

P.J. Brockwell, R.A. Davis, Time Series: Theory and Methods, second ed., Springer, New York, 1991.

## See Also

qn

## Examples

```
## decompose the trend for the first difference of annual global air temperature from 1880-1985
data(globtemp)
decomp1 <- ma.filter(globtemp[,2], plot = TRUE)

## decompose the trend and seasonality for CO2 data with monthly and additive seasonality
data(co2)
decomp2 <- ma.filter(co2, d = 12, seasonal = TRUE, plot = TRUE)

## decompose the trend and seasonality for monthly airline passenger numbers from 1949-1960
data(AirPassengers)
decomp3 <- ma.filter(AirPassengers, d = 12, seasonal = TRUE, plot = TRUE)

## simulation data: oracally efficient estimation for AR(p) coefficients
d <- 12
n <- d*100
x <- (1:n)/n
y <- 1 + 2*x + 0.3*x^2 + sin(pi*x/6) + arima.sim(n = n,list(ar = 0.2), sd = 1)
fit <- ma.filter(y, d = 12, seasonal = TRUE)
ar(fit$remainder, aic = FALSE, order.max = 1)$ar
```

qn *Optimal and Data-Driven Moving Average Lag q*

## Description

Determine the optimal and data-driven moving average lag $q$ based on the sample size, variance and curvature of an univariate data.

## Usage

```
qn(x, data = NULL, na.action = na.fail)
```

## Arguments

| | |
|---|---|
| `x` | univariate time series or data. |
| `data` | an optional data frame, list or environment containing the univariate data. The default is `NULL`. |
| `na.action` | action on missing values. The default is `na.fail`. |

## Details

For an univariate series $x[t]$, the moving average filter is defined as

$$mhat[t] = \sum x[t]/(2q + 1)$$

for $q + 1 \leq t \leq n + q$. The optimal and data-driven moving average lag $q$ can be determined by using the rule-of-thumb estimator proposed in Section 3 of D. Qiu *et al.* (2013). It is determined by sample size $n$, variance $\gamma(0)$ and curvature $m''$ of the univariate series, where $m''$ is the second derivative of an unknown nonparameteric trend function. To obtain the preliminary estimators of variance $\gamma(0)$ and curvature $m''$, $m$ can be modeled by a cubic polynomial model. See L. Yang and R. Tscherning (1999) for more details. For the case when $q > n$, the optimal moving average lag $q$ is set to be an integer part of $n^{4/5}/2$.

## Value

| | |
|---|---|
| `qn` | returns the moving average lag $q$ which is used to decompose the trend, seasonality and irregularity (or residual). |

## Author(s)

Debin Qiu <`<debinqiu@uga.edu>`>

## References

D. Qiu, Q. Shao, and L. Yang (2013), Efficient inference for autoregressive coeficient in the presence of trend. *Journal of Multivariate Analysis* 114, 40-53.

L. Yang, R. Tscherning (1999), Multivariate bandwidth selection for local linear regression. *Journal of the Royal Statistical Society. Series B. Statistical Methodology* 61, 793-815.

## See Also

ma.filter

## Examples

```
## load the global temperature data:
## first column is time and second column is temperature.
data(globtemp)
q.n <- qn(globtemp[,2])
q.n
```

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