

# Package ‘TTR’

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---

adjRatios

*Split and dividend adjustment ratios*


---

### Description

Create split and dividend adjustment ratio vectors.

### Usage

```
adjRatios(splits, dividends, close)
```

**Arguments**

<code>splits</code>	Split series that is coercible to xts.
<code>dividends</code>	Dividend series that is coercible to xts.
<code>close</code>	Close price series that is coercible to xts.

**Details**

- If only `splits` is provided, the resulting object will only have as many observations as `splits`.
- If `splits` and `close` are provided, the resulting object will have as many observations as `max(NROW(splits), NROW(close))`.
- `close` is required if `dividends` is provided.

**Value**

A xts object containing the columns:

**Split** The split adjustment ratio.

**Div** The dividend adjustment ratio.

**Author(s)**

Joshua Ulrich

---

 ADX

---

*Welles Wilder's Directional Movement Index*


---

**Description**

Directional Movement Index; developed by J. Welles Wilder.

**Usage**

```
ADX(HLC, n = 14, maType, ...)
```

**Arguments**

<code>HLC</code>	Object that is coercible to xts or matrix and contains High-Low-Close prices.
<code>n</code>	Number of periods to use for DX calculation (not ADX calculation).
<code>maType</code>	A function or a string naming the function to be called.
<code>...</code>	Other arguments to be passed to the <code>maType</code> function.

**Details**

The `DIp/DIn` (positive/negative) is the percentage of the true range that is up/down.

**Value**

A object of the same class as HLC or a matrix (if `try.xts` fails) containing the columns:

**DIp** The positive Direction Index.

**DI<sub>n</sub>** The negative Direction Index.

**DX** The Direction Index.

**ADX** The Average Direction Index (trend strength).

**Note**

A buy/sell signal is generated when the  $+/-DI$  crosses up over the  $-/+DI$ , when the  $DX/ADX$  signals a strong trend. A high/low  $DX$  signals a strong/weak trend.  $DX$  is usually smoothed with a moving average (i.e. the  $ADX$ ).

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/DI.htm>

<http://www.fmlabs.com/reference/DX.htm>

<http://www.fmlabs.com/reference/ADX.htm>

<http://www.fmlabs.com/reference/ADXR.htm>

<https://www.metastock.com/Custom/Resouces/TAAZ/?p=49>

<https://www.linsoft.com/techind/directional-indicator-diplus-diminus>

<https://www.linsoft.com/techind/adx-avg-directional-movement>

<https://www.linsoft.com/techind/adxr-avg-directional-movement-rating>

[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:average\\_directional\\_index\\_adx](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:average_directional_index_adx)

**See Also**

See [EMA](#), [SMA](#), etc. for moving average options; and note Warning section. The  $DX$  calculation uses [ATR](#). See [aroon](#), [CCI](#), [TDI](#), [VHF](#), [GMMA](#) for other indicators that measure trend direction/strength.

**Examples**

```
data(ttrc)
dmi.adx <- ADX(ttrc[,c("High", "Low", "Close")])
```

---

aroon

*Aroon*

---

### Description

The Aroon indicator attempts to identify starting trends. The indicator consists of up and down lines, which measure how long it has been since the highest high/lowest low has occurred in the last  $n$  periods. Developed by Tushar Chande in 1995.

### Usage

```
aroon(HL, n = 20)
```

### Arguments

HL	Object that is coercible to xts or matrix and contains either a High-Low price series, or a Close price series.
n	Number of periods to use in the calculation.

### Details

Aroon up (down) is the elapsed time, expressed as a percentage, between today and the highest (lowest) price in the last  $n$  periods. If today's price is a new high (low) Aroon up (down) will be 100. Each subsequent period without another new high (low) causes Aroon up (down) to decrease by  $(1 / n) \times 100$ .

### Value

A object of the same class as HL or a matrix (if `try.xts` fails) containing the columns:

**aroonUp** The Aroon up indicator.  
**aroonDn** The Aroon down indicator.  
**oscillator** The Aroon oscillator (`aroonUp - aroonDn`).

### Note

If High-Low prices are given, the function calculates the max/min using the high/low prices. Otherwise the function calculates the max/min of the single series.

Up (down) trends are indicated when the `aroonUp(Dn)` is between 70 and 100. Strong trends are indicated when when the `aroonUp(Dn)` is above 70 while the `aroonDn(Up)` is below 30. Also, crossovers may be useful.

### Author(s)

Joshua Ulrich

## References

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/Aroon.htm>

<http://www.fmlabs.com/reference/AroonOscillator.htm>

<https://www.linsoft.com/techind/aron-arn>

[http://stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:aron](http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:aron)

## See Also

See [CCI](#), [ADX](#), [TDI](#), [VHF](#), [GMMA](#) for other indicators that measure trend direction/strength.

## Examples

```
## Get Data and Indicator ##
data(ttrc)
trend <- aroon( ttrc[,c("High", "Low")], n=20 )
```

---

ATR

*True Range / Average True Range*

---

## Description

True range (TR) is a measure of volatility of a High-Low-Close series; average true range (ATR) is a Welles Wilder's style moving average of the TR. Developed by J. Welles Wilder in 1978.

## Usage

```
ATR(HLC, n = 14, maType, ...)
```

## Arguments

HLC	Object that is coercible to xts or matrix and contains High-Low-Close prices.
n	Number of periods for moving average.
maType	A function or a string naming the function to be called.
...	Other arguments to be passed to the maType function.

## Details

TR incorporates yesterday's close in the calculation (high minus low). E.g. if yesterday's close was higher than today's high, then the TR would equal yesterday's close minus today's low.

The ATR is a component of the Welles Wilder Directional Movement Index (DX, ADX).

**Value**

A object of the same class as HLC or a matrix (if `try.xts` fails) containing the columns:

**tr** The true range of the series.

**atr** The average (as specified by `ma`) true range of the series.

**trueHigh** The true high of the series.

**trueLow** The true low of the series.

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/TR.htm>

<http://www.fmlabs.com/reference/ATR.htm>

<https://www.metastock.com/Custom/Resouces/TAAZ/?p=35>

<https://www.linsoft.com/techind/true-range-tr>

[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:average\\_true\\_range\\_atr](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:average_true_range_atr)

**See Also**

See [EMA](#), [SMA](#), etc. for moving average options; and note Warning section. See [DX](#), which uses true range. See [chaikinVolatility](#) for another volatility measure.

**Examples**

```
data(ttrc)
atr <- ATR(ttrc[,c("High", "Low", "Close")], n=14)
```

---

BBands

*Bollinger Bands*

---

**Description**

Bollinger Bands are a way to compare a security's volatility and price levels over a period of time. Developed by John Bollinger.

**Usage**

```
BBands(HLC, n = 20, maType, sd = 2, ...)
```

**Arguments**

HLC	Object that is coercible to xts or matrix and contains High-Low-Close prices. If only a univariate series is given, it will be used. See details.
n	Number of periods for moving average.
maType	A function or a string naming the function to be called.
sd	The number of standard deviations to use.
...	Other arguments to be passed to the maType function.

**Details**

Bollinger Bands consist of three lines:

The middle band is generally a 20-period SMA of the typical price ( $(\text{high} + \text{low} + \text{close})/3$ ). The upper and lower bands are sd standard deviations (generally 2) above and below the MA.

The middle band is usually calculated using the typical price, but if a univariate series (e.g. Close, Weighted Close, Median Price, etc.) is provided, it will be used instead.

**Value**

A object of the same class as HLC or a matrix (if `try.xts` fails) containing the columns:

- dn** The lower Bollinger Band.
- mavg** The middle Moving Average (see notes).
- up** The upper Bollinger Band.
- pctB** The %B calculation.

**Note**

Using any moving average other than SMA will result in inconsistencies between the moving average calculation and the standard deviation calculation. Since, by definition, a rolling standard deviation uses a simple moving average.

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/Bollinger.htm>  
<http://www.fmlabs.com/reference/BollingerWidth.htm>  
<https://www.metastock.com/Custom/Resources/TAAZ/?p=36>  
<https://www.linsoft.com/techind/bollinger-bands>  
[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:bollinger\\_bands](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:bollinger_bands)  
[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:bollinger\\_band\\_width](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:bollinger_band_width)



**See Also**

See [EMA](#), [SMA](#), etc. for moving average options; and note Warning section.

**Examples**

```
## The examples below show the differences between using a
## High-Low-Close series, and just a close series when
## calculating Bollinger Bands.
data(ttrc)
bbands.HLC <- BBands( ttrc[,c("High","Low","Close")] )
bbands.close <- BBands( ttrc[, "Close"] )
```

---

CCI

*Commodity Channel Index*


---

**Description**

The Commodity Channel Index (CCI) attempts to identify starting and ending trends.

**Usage**

```
CCI(HLC, n = 20, maType, c = 0.015, ...)
```

**Arguments**

HLC	Object that is coercible to xts or matrix and contains High-Low-Close prices. If only a univariate series is given, it will be used. See details.
n	Number of periods for moving average.
maType	A function or a string naming the function to be called.
c	Constant to apply to the mean deviation.
...	Other arguments to be passed to the maType function.

**Details**

CCI relates the current price and the average of price over n periods. The CCI usually falls in a channel of -100 to 100. A basic CCI trading system is: Buy (sell) if CCI rises above 100 (falls below -100) and sell (buy) when it falls below 100 (rises above -100).

CCI is usually calculated using the typical price, but if a univariate series (e.g. Close, Weighted Close, Median Price, etc.) is provided, it will be used instead.

**Value**

A object of the same class as HLC or a vector (if try.xts fails) containing the CCI values.

**Note**

If HLC is a High-Low-Close matrix, then typical price will be calculated. If HLC is a vector, then those values will be used instead of the typical price.

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/CCI.htm>

<https://www.metastock.com/Custom/Resources/TAAZ/?p=42>

<https://www.linnsoft.com/techind/cci-commodity-channel-index>

[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:commodity\\_channel\\_index\\_cci](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:commodity_channel_index_cci)

**See Also**

See [EMA](#), [SMA](#), etc. for moving average options; and note Warning section. See [aroon](#), [ADX](#), [TDI](#), [VHF](#), [GMMA](#) for other indicators that measure trend direction/strength.

**Examples**

```
data(ttrc)
cci <- CCI(ttrc[,c("High", "Low", "Close")])
```

---

chaikinAD

*Chaikin Accumulation / Distribution*

---

**Description**

The Chaikin Accumulation / Distribution (AD) line is a measure of the money flowing into or out of a security. It is similar to On Balance Volume (OBV). Developed by Marc Chaikin.

**Usage**

```
chaikinAD(HLC, volume)
```

**Arguments**

HLC                    Object that is coercible to xts or matrix and contains High-Low-Close prices.  
volume                Vector or matrix of volume observations corresponding to the HLC object.

**Details**

The AD line is similar to OBV; the difference is that OBV sums volume multiplied by +/- 1 if the close is higher/lower than the previous close, while the AD line multiplies volume by the close location value (CLV).

**Value**

A object of the same class as HLC and volume or a vector (if `try.xts` fails) containing the accumulation / distribution values.

**Note**

The Accumulation/Distribution Line is interpreted by looking for a divergence in the direction of the indicator relative to price.

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/AccumDist.htm>

<https://www.metastock.com/Custom/Resources/TAAZ/?p=27>

<https://www.linsoft.com/techind/accumulation-distribution>

[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:accumulation\\_distribution\\_line](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:accumulation_distribution_line)

**See Also**

See [OBV](#), and [CLV](#).

**Examples**

```
data(ttrc)
ad <- chaikinAD(ttrc[,c("High","Low","Close")], ttrc[,"Volume"])
```

---

chaikinVolatility

*Chaikin Volatility*

---

**Description**

Chaikin Volatility measures the rate of change of the security's trading range. Developed by Marc Chaikin.

**Usage**

```
chaikinVolatility(HL, n = 10, maType, ...)
```

**Arguments**

HL	Object that is coercible to xts or matrix and contains High-Low prices.
n	Number of periods for moving average.
maType	A function or a string naming the function to be called.
...	Other arguments to be passed to the maType function.

**Details**

The Chaikin Volatility indicator defines volatility as an increase in the difference between the high and low.

**Value**

A object of the same class as HL or a vector (if `try.xts` fails) containing the Chaikin Volatility values.

**Note**

A rapid increase in Chaikin Volatility indicates an approaching bottom. A slow decrease in Chaikin Volatility indicates an approaching top.

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/ChaikinVolatility.htm>

<https://www.metastock.com/Custom/Resourses/TAAZ/?p=120>

**See Also**

See [EMA](#), [SMA](#), etc. for moving average options; and note Warning section. See [TR](#) for another volatility measure.

**Examples**

```
data(ttrc)
volatility <- chaikinVolatility(ttrc[,c("High","Low")])
```

---

CLV	<i>Close Location Value</i>
-----	-----------------------------

---

**Description**

The Close Location Value (CLV) relates the day's close to its trading range.

**Usage**

CLV(HLC)

**Arguments**

HLC                    Object that is coercible to xts or matrix and contains High-Low-Close prices.

**Details**

The CLV will fall in a range of -1 to +1. If the CLV is +/-1, the close is at the high/low; if the CLV is 0, the close is directly between the high and low.

**Value**

A object of the same class as HLC or a vector (if `try.xts` fails) containing the Close Location Values of a High-Low-Close price series.

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:

[http://stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:accumulation\\_distribution\\_line](http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:accumulation_distribution_line)

**See Also**

See [chaikinAD](#), which uses CLV.

**Examples**

```
data(ttrc)
clv <- CLV(ttrc[,c("High", "Low", "Close")])
```

---

CMF

*Chaikin Money Flow*

---

### Description

Chaikin Money Flow compares total volume over the last  $n$  time periods to total volume times the Close Location Value (CLV) over the last  $n$  time periods. Developed by Marc Chaikin.

### Usage

CMF(HLC, volume, n = 20)

### Arguments

HLC	Object that is coercible to xts or matrix and contains High-Low-Close prices.
volume	Vector or matrix of volume observations corresponding to the HLC object.
n	Number of periods to use.

### Details

Chaikin Money Flow is calculated by taking dividing the sum of the Chaikin Accumulation / Distribution line over the past  $n$  periods by the sum of volume over the past  $n$  periods.

### Value

A object of the same class as HLC and volume or a vector (if `try.xts` fails) containing the Chaikin Money Flow values.

### Note

When Chaikin Money Flow is above/below  $\pm 0.25$  it is a bullish/bearish signal. If Chaikin Money Flow remains below zero while the price is rising, it indicates a probable reversal.

### Author(s)

Joshua Ulrich

### References

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/ChaikinMoneyFlow.htm>

<https://www.linsoft.com/techind/chaikin-money-flow-cmf>

[http://stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:chaikin\\_money\\_flow\\_cmf](http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:chaikin_money_flow_cmf)

**See Also**

See [CLV](#), and [chaikinAD](#).

**Examples**

```
data(ttrc)
cmf <- CMF(ttrc[,c("High","Low","Close")], ttrc[, "Volume"])
```

---

CMO

*Chande Momentum Oscillator*

---

**Description**

The Chande Momentum Oscillator (CMO) is a modified RSI. Developed by Tushar S. Chande.

**Usage**

```
CMO(x, n = 14)
```

**Arguments**

x	Price, volume, etc. series that is coercible to xts or matrix.
n	Number of periods to use.

**Details**

The CMO divides the total movement by the net movement ( $[\text{up} - \text{down}] / [\text{up} + \text{down}]$ ), where RSI divides the upward movement by the net movement ( $\text{up} / [\text{up} + \text{down}]$ ).

**Value**

A object of the same class as x or a vector (if `try.xts` fails) containing Chande Momentum Oscillator values.

**Note**

There are several ways to interpret the CMO:

1. Values over/under +/- 50 indicate overbought/oversold conditions.
2. High CMO values indicate strong trends.
3. When the CMO crosses above/below a moving average of the CMO, it is a buy/sell signal.

**Author(s)**

Joshua Ulrich

## References

The following site(s) were used to code/document this indicator:  
<http://www.fmlabs.com/reference/CMO.htm>

## See Also

See [RSI](#).

## Examples

```
data(ttrc)
cmo <- CMO(ttrc[, "Close"])
```

---

DonchianChannel	<i>Donchian Channel</i>
-----------------	-------------------------

---

## Description

Donchian Channels were created by Richard Donchian and were used to generate buy and sell signals for the Turtle Trading system.

## Usage

```
DonchianChannel(HL, n = 10, include.lag = FALSE)
```

## Arguments

HL	Object that is coercible to xts or matrix and contains High-Low prices.
n	Number of periods for moving average.
include.lag	Should values be lagged so that today's prices are not included in the calculation? See Note.

## Details

Donchian Channels consist of two (sometimes three) lines:

The top line is the highest high of the past  $n$  periods. The bottom line is the lowest low of the past  $n$  periods. The middle line is the average of the top and bottom lines.

## Value

A object of the same class as HL or a matrix (if try. xts fails) containing the columns:

**high** The highest high series.  
**mid** The average of high and low.  
**low** The lowest low series.



**Note**

The default of `include.lag=FALSE` makes `DonchainChannel` consistent with other **TTR** functions, in that it includes the current period in the calculation.

The default is different than the original calculation, which would calculate the indicator using periods  $t-1$  through  $t-n$ . Setting `include.lag=TRUE` will return the result of the original calculation.

The default of this argument may change in the future.

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:

<https://www.linsoft.com/techind/donchian-channels>

**See Also**

See [BBands](#).

**Examples**

```
data(ttrc)
dc <- DonchianChannel( ttrc[,c("High","Low")] )
```

---

DPO

*De-Trended Price Oscillator*

---

**Description**

The Detrended Price Oscillator (DPO) removes the trend in prices - or other series - by subtracting a moving average of the price from the price.

**Usage**

```
DPO(x, n = 10, maType, shift = n/2 + 1, percent = FALSE, ...)
```

**Arguments**

<code>x</code>	Price, volume, etc. series that is coercible to xts or matrix.
<code>n</code>	Number of periods for moving average.
<code>maType</code>	A function or a string naming the function to be called.
<code>shift</code>	The number of periods to shift the moving average.

percent            logical; if TRUE, the percentage difference between the slow and fast moving averages is returned, otherwise the difference between the respective averages is returned.

...                Other arguments to be passed to the maType function.

### Details

The Detrended Price shows cycles and overbought / oversold conditions.

### Value

A object of the same class as `x` or a vector (if `try.xts` fails) containing the DPO values.

### Note

DPO does not extend to the last date because it is based on a displaced moving average. The calculation shifts the results `shift` periods, so the last `shift` periods will be zero. As stated above, the DPO can be used on any univariate series, not just price.

### Author(s)

Joshua Ulrich

### References

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/DPO.htm>

<https://www.metastock.com/Customr/Resources/TAAZ/?p=48>

[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:detrended\\_price\\_osci](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:detrended_price_osci)

### See Also

See [EMA](#), [SMA](#), etc. for moving average options; and note Warning section. See [MACD](#) for a general oscillator.

### Examples

```
data(ttrc)
priceDPO <- DPO(ttrc[, "Close"])
volumeDPO <- DPO(ttrc[, "Volume"])
```

---

DVI

*DV Intermediate Oscillator*

---

### Description

The DV Intermediate oscillator (DVI) is a very smooth momentum oscillator that can also be used as a trend indicator. Created by David Varadi.

### Usage

```
DVI(price, n = 252, wts = c(0.8, 0.2), smooth = 3, magnitude = c(5, 100, 5), stretch = c(10, 100, 2), exact.multiplier = 1)
```

### Arguments

price	Price series that is coercible to xts or matrix.
n	Number of periods for the percent rank.
wts	The weight given to the smoothed returns (magnitude) component and the up/down days (stretch) component, respectively.
smooth	The number of periods to smooth price.
magnitude	A set of 3 periods used to smooth magnitude.
stretch	A set of 3 periods used to smooth stretch.
exact.multiplier	The weight applied to identical values in the window. See runPercentRank.

### Details

The DVI combines smoothed returns over different time windows and the relative number of up versus down days (stretch) over different time windows.

### Value

A object of the same class as price or a vector (if try.xts fails) containing the DVI values.

### Author(s)

Joshua Ulrich

### References

The following site(s) were used to code/document this indicator:

<http://cssanalytics.wordpress.com/2009/12/13/what-is-the-dvi/>

<http://marketsci.wordpress.com/2010/07/27/css-analytics%E2%80%99-dvi-indicator-revealed/>

**Examples**

```
data(ttrc)
dvi <- DVI(ttrc[, "Close"])
```

---

 EMV

*Arms' Ease of Movement Value*


---

**Description**

Arms' Ease of Movement Value (EMV) emphasizes days where the security moves easily and minimizes days where the security does not move easily. Developed by Richard W. Arms, Jr.

**Usage**

```
EMV(HL, volume, n = 9, maType, vol.divisor = 10000, ...)
```

**Arguments**

HL	Object that is coercible to xts or matrix and contains High-Low prices.
volume	Vector or matrix of volume observations corresponding to the HL object.
n	Number of periods for moving average.
maType	A function or a string naming the function to be called.
vol.divisor	An increment to make the results larger and easier to work with.
...	Other arguments to be passed to the maType function.

**Details**

The EMV is calculated by dividing the midpoint ( $(\text{high} + \text{low})/2$ ) move by the 'Box Ratio' (volume divided by the high minus low).

**Value**

A object of the same class as HL and volume or a matrix (if `try.xts` fails) containing the columns:

**emv** The ease of movement values.

**maEMV** The smoothed (as specified by `ma`) ease of movement values.

**Note**

A buy/sell signal is generated when the EMV crosses above/below zero. When the EMV hovers around zero, there are small price movements and/or high volume, and the price is not moving easily.

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/ArmsEMV.htm>

<https://www.metastock.com/Custom/Resouces/TAAZ/?p=51>

<https://www.linsoft.com/techind/arms-ease-movement>

**See Also**

See [EMA](#), [SMA](#), etc. for moving average options; and note Warning section.

**Examples**

```
data(ttrc)
emv <- EMV(ttrc[,c("High","Low")], ttrc[, "Volume"])
```

---

GMMA

*Guppy Multiple Moving Averages*

---

**Description**

Calculate the Guppy Multiple Moving Average of a series.

**Usage**

```
GMMA(x, short = c(3, 5, 8, 10, 12, 15), long = c(30, 35, 40, 45, 50, 60),
      maType)
```

**Arguments**

x	Price, volume, etc. series that is coercible to xts or matrix.
short	Vector of short-term periods.
long	Vector of long-term periods.
maType	Either: <ol style="list-style-type: none"><li>1. A function or a string naming the function to be called.</li><li>2. A <i>list</i> with the first component like (1) above, and additional parameters specified as <i>named</i> components. See Examples.</li></ol>

**Details**

The Guppy Multiple Moving Average signals a changing trend when the short and long groups of moving averages intersect. An up/down trend exists when the short/long-term moving averages are greater than the long/short-term averages.

**Value**

A object of the same class as `x` or `price` or a vector (if `try.xts` fails) containing the Guppy Multiple Moving Average.

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:

<http://www.investopedia.com/terms/g/guppy-multiple-moving-average.asp>

**See Also**

See [aroon](#), [CCI](#), [ADX](#), [VHF](#), [TDI](#) for other indicators that measure trend direction/strength.

**Examples**

```
data(ttrc)
gmma <- GMAA(ttrc[, "Close"])
```

---

KST

*Know Sure Thing*

---

**Description**

The Know Sure Thing (KST) is a smooth, summed, rate of change indicator. Developed by Martin Pring.

**Usage**

```
KST(price, n = c(10, 10, 10, 15), nROC = c(10, 15, 20, 30), nSig = 9,
     maType, wts = 1:NROW(n), ...)
```

**Arguments**

price	Price series that is coercible to xts or matrix.
n	A vector of the number of periods to use in the MA calculations.
nROC	A vector of the number of periods to use in the ROC calculations.
nSig	The number of periods to use for the KST signal line.
maType	Either: <ol style="list-style-type: none"> <li>1. A function or a string naming the function to be called.</li> <li>2. A <i>list</i> with the first component like (1) above, and additional parameters specified as <i>named</i> components. See Examples.</li> </ol>
wts	A vector the same length as n, of the weight for each period (need not sum to one).
...	Other arguments to be passed to the maType function in case (1) above.

**Details**

For each day (week, month, etc.), the KST calculates the ROC over several periods. Those ROCs are smoothed using the given moving averages, then multiplied by their respective weighting values. The resulting values are summed for each day (month, week, etc.).

**Value**

A object of the same class as price or a vector (if `try.xts` fails) containing the Know Sure Thing values.

**Note**

The KST indicates bullish/bearish momentum as it crosses above/below its moving average. Because the KST tends to lead price action, look for trend confirmation in the price.

The default arguments are for the daily KST. There is also the Long-Term KST, with arguments: `n=c(9, 12, 18, 24)` - where the periods are months, not days - and the moving average periods are 6, 6, 6, and 9 months, respectively.

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:

[https://web.archive.org/web/20110715112957/http://www.pring.com/movieweb/daily\\_kst.htm](https://web.archive.org/web/20110715112957/http://www.pring.com/movieweb/daily_kst.htm)  
[https://web.archive.org/web/20100101162707/http://www.pring.com/movieweb/KST\\_MCM.htm](https://web.archive.org/web/20100101162707/http://www.pring.com/movieweb/KST_MCM.htm)

**See Also**

See [EMA](#), [SMA](#), etc. for moving average options; and note [Warning](#) section. See [ROC](#) for the rate-of-change function. See [MACD](#) for a generic oscillator.

**Examples**

```
data(ttrc)
kst <- KST(ttrc[, "Close"])

kst4MA <- KST(ttrc[, "Close"],
  maType=list(list(SMA), list(EMA), list(DEMA), list(WMA)))
```

---

 lags

---

*Miscellaneous Tools*


---

**Description**

Various functions that may be useful in designing technical trading rules.

**Usage**

```
lags(x, n = 1)

growth(price, signals, ...)

naCheck(x, n = 0)
```

**Arguments**

x	Object that is coercible to xts or matrix.
n	Number of periods to use.
price	Price series that is coercible to xts or matrix.
signals	Signals to use (defaults to vector of ones). Use '0' for no position, '1' for long position, and '-1' for short position.
...	Further arguments to be passed from or to other methods.

**Details**

growth calculates the growth of an investment using given prices and signals.

lags calculates the lags of a given series.

**Value**

growth returns a vector of the growth of the investment.

lags returns a matrix of lagged values of the original vector.



**Note**

In growth you can specify the number of periods and type of compounding to use when calculating returns of the price series via the '...' argument.

**Author(s)**

Joshua Ulrich

---

 MACD

---

*MACD Oscillator*


---

**Description**

The MACD was developed by Gerald Appel and is probably the most popular price oscillator. The MACD function documented in this page compares a fast moving average (MA) of a series with a slow MA of the same series. It can be used as a generic oscillator for any univariate series, not only price.

**Usage**

```
MACD(x, nFast = 12, nSlow = 26, nSig = 9, maType, percent = TRUE, ...)
```

**Arguments**

x	Object that is coercible to xts or matrix; usually price, but can be volume, etc.
nFast	Number of periods for fast moving average.
nSlow	Number of periods for slow moving average.
nSig	Number of periods for signal moving average.
maType	Either: <ol style="list-style-type: none"> <li>1. A function or a string naming the function to be called.</li> <li>2. A <i>list</i> with the first component like (1) above, and additional parameters specified as <i>named</i> components. See Examples.</li> </ol>
percent	logical; if TRUE, the percentage difference between the fast and slow moving averages is returned, otherwise the difference between the respective averages is returned.
...	Other arguments to be passed to the maType function in case (1) above.

**Details**

The MACD function either subtracts the fast MA from the slow MA, or finds the rate of change between the fast MA and the slow MA.

**Value**

A object of the same class as `x` or a matrix (if `try.xts` fails) containing the columns:

**macd** The price (volume, etc.) oscillator.

**signal** The oscillator signal line (a moving average of the oscillator).

**Note**

The MACD is a special case of the general oscillator applied to price. The MACD can be used as a general oscillator applied to any series. Time periods for the MACD are often given as 26 and 12, but the original formula used exponential constants of 0.075 and 0.15, which are closer to 25.6667 and 12.3333 periods.

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:

Moving Average Convergence/Divergence (MACD):

<http://www.fmlabs.com/reference/MACD.htm>

<https://www.metastock.com/Custom/Resouces/TAAZ/?p=66>

<https://www.linnsoft.com/techind/macd>

[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:moving\\_average\\_convergence\\_divergence\\_macd](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:moving_average_convergence_divergence_macd)

Price Oscillator:

<http://www.fmlabs.com/reference/PriceOscillator.htm>

<http://www.fmlabs.com/reference/PriceOscillatorPct.htm>

<https://www.metastock.com/Custom/Resouces/TAAZ/?p=94>

[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:price\\_oscillators\\_ppo](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:price_oscillators_ppo)

Volume Oscillator:

<http://www.fmlabs.com/reference/PV0.htm>

<https://www.metastock.com/Custom/Resouces/TAAZ/?p=122>

**See Also**

See [EMA](#), [SMA](#), etc. for moving average options; and note Warning section.

**Examples**

```
data(ttrc)
```

```
macd <- MACD( ttrc[, "Close"], 12, 26, 9, maType="EMA" )
```

```
macd2 <- MACD( ttrc[, "Close"], 12, 26, 9,  
              maType=list(list(SMA), list(EMA, wilder=TRUE), list(SMA)) )
```

---

MFI

*Money Flow Index*

---

### Description

The MFI is a ratio of positive and negative money flow over time.

### Usage

```
MFI(HLC, volume, n = 14)
```

### Arguments

HLC	Object that is coercible to xts or matrix and contains High-Low-Close prices. If only a univariate series is given, it will be used. See details.
volume	Vector or matrix of volume observations corresponding to HLC object.
n	Number of periods to use.

### Details

Money Flow (MF) is the product of price and volume. Positive/negative MF occur when today's price is higher/lower than yesterday's price. The MFI is calculated by dividing positive MF by negative MF for the past  $n$  periods. It is then scaled between 0 and 100.

MFI is usually calculated using the typical price, but if a univariate series (e.g. Close, Weighted Close, Median Price, etc.) is provided, it will be used instead.

### Value

A object of the same class as HLC and volume or a vector (if `try.xts` fails) containing the MFI values.

### Note

Divergence between MFI and price can be indicative of a reversal. In addition, values above/below 80/20 indicate market tops/bottoms.

### Author(s)

Joshua Ulrich

## References

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/default.htm?url=MoneyFlowIndex.htm>

<https://www.linsoft.com/techind/money-flow-index-mfi>

[http://stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:money\\_flow\\_index\\_mfi](http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:money_flow_index_mfi)

## See Also

See [OBV](#) and [CMF](#).

## Examples

```
data(ttrc)
mfi <- MFI(ttrc[,c("High", "Low", "Close")], ttrc[, "Volume"])
```

---

OBV

*On Balance Volume (OBV)*

---

## Description

On Balance Volume (OBV) is a measure of the money flowing into or out of a security. It is similar to Chaikin Accumulation / Distribution.

## Usage

```
OBV(price, volume)
```

## Arguments

price	Price series that is coercible to xts or matrix.
volume	Volume series that is coercible to xts or matrix, that corresponds to price object.

## Details

OBV is calculated by adding (subtracting) each day's volume to a running cumulative total when the security's price closes higher (lower).

## Value

A object of the same class as price and volume or a vector (if `try.xts` fails) containing the OBV values.

**Note**

OBV is usually compared with the price chart of the underlying security to look for divergences/confirmation.

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/OBV.htm>

<https://www.metastock.com/Custom/Resources/TAAZ/?p=82>

<https://www.linsoft.com/techind/balance-open-interest>

[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:on\\_balance\\_volume\\_obv](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:on_balance_volume_obv)

**See Also**

See [chaikinAD](#).

**Examples**

```
data(ttrc)
obv <- OBV(ttrc[, "Close"], ttrc[, "Volume"])
```

---

PBands	<i>Construct (optionally further smoothed and centered ) volatility bands around prices</i>
--------	---

---

**Description**

John Bollinger's famous adaptive volatility bands most often use the typical price of an HLC series, or may be calculated on a univariate price series (see [BBands](#)).

**Usage**

```
PBands(prices, n = 20, maType = "SMA", sd = 2, ..., fastn = 2,
       centered = FALSE, lavg = FALSE)
```

**Arguments**

prices	A univariate series of prices.
n	Number of periods to average over.
maType	A function or a string naming the function to be called.
sd	The number of standard deviations to use.
...	any other pass-thru parameters, usually for function named by maType.
fastn	Number of periods to use for smoothing higher-frequency 'noise'.
centered	Whether to center the bands around a series adjusted for high frequency noise, default FALSE.
lavg	Whether to use a longer ( $n*2$ ) smoothing period for centering, default FALSE.

**Details**

This function applies a second moving average denoted by `fastn` to filter out higher-frequency noise, making the bands somewhat more stable to temporary fluctuations and spikes.

If `centered` is TRUE, the function also further smoothes and centers the bands around a centerline adjusted to remove this higher frequency noise. If `lavg` is also TRUE, the smoothing applied for the middle band (but not the volatility bands) is doubled to further smooth the price-response function.

If you have multiple different price series in `prices`, and want to use this function, call this functions using `lapply(prices, PBands, ...)`.

**Value**

A object of the same class as `prices` or a matrix (if `try.xts` fails) containing the columns:

- dn** The lower price volatility Band.
- center** The smoothed centerline (see details).
- up** The upper price volatility Band.

**Author(s)**

Brian G. Peterson

**See Also**

[BBands](#)

**Examples**

```
data(ttrc)
pbands.close <- PBands( ttrc[, "Close"] )
```

---

ROC

*Rate of Change / Momentum*

---

### Description

Calculate the (rate of) change of a series over n periods.

### Usage

```
ROC(x, n = 1, type = c("continuous", "discrete"), na.pad = TRUE)
```

```
momentum(x, n = 1, na.pad = TRUE)
```

### Arguments

x	Price, volume, etc. series that is coercible to xts or matrix.
n	Number of periods to use.
type	Compounding type; either "continuous" (the default) or "discrete".
na.pad	Should periods prior to n be appended? Default is TRUE.

### Details

The ROC indicator provides the percentage difference of a series over two observations, while the momentum indicator simply provides the difference.

### Value

A object of the same class as x or a vector (if `try.xts` fails) containing the rate-of-change (or return) values for ROC or a vector containing the differenced price series for momentum.

### Author(s)

Joshua Ulrich

### Examples

```
data(ttrc)
roc <- ROC(ttrc[, "Close"])
mom <- momentum(ttrc[, "Close"])
```

---

rollSFM *Analysis of Running/Rolling/Moving Windows*

---

**Description**

Various functions to analyze data over a moving window of periods.

**Usage**

```
rollSFM(Ra, Rb, n = 60)
```

**Arguments**

Ra	Object coercible to xts or matrix, containing the excess return for an individual security
Rb	Object coercible to xts or matrix, containing the market / benchmark return
n	Number of periods to use in the window

**Value**

A object of the same class as Ra (and Rb?) or a vector (if `try.xts` fails).

**rollSFM** returns single-factor model parameters and R-squared over a n-period moving window.

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator: [http://en.wikipedia.org/wiki/Simple\\_linear\\_regression](http://en.wikipedia.org/wiki/Simple_linear_regression)

---

RSI *Relative Strength Index*

---

**Description**

The Relative Strength Index (RSI) calculates a ratio of the recent upward price movements to the absolute price movement. Developed by J. Welles Wilder.

**Usage**

```
RSI(price, n = 14, maType, ...)
```



**Arguments**

price	Price series that is coercible to xts or matrix.
n	Number of periods for moving averages.
maType	Either: <ol style="list-style-type: none"> <li>1. A function or a string naming the function to be called.</li> <li>2. A <i>list</i> with the first component like (1) above, and additional parameters specified as <i>named</i> components. See Examples.</li> </ol>
...	Other arguments to be passed to the maType function in case (1) above.

**Details**

The RSI calculation is  $RSI = 100 - 100 / (1 + RS)$ , where RS is the smoothed ratio of 'average' gains over 'average' losses. The 'averages' aren't true averages, since they're divided by the value of n and not the number of periods in which there are gains/losses.

**Value**

A object of the same class as price or a vector (if `try.xts` fails) containing the RSI values.

**Note**

The RSI is usually interpreted as an overbought/oversold (over 70 / below 30) indicator. Divergence with price may also be useful. For example, if price is making new highs/lows, but RSI is not, it could indicate a reversal.

You can calculate a stochastic RSI by using the function `stoch` on RSI values.

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:

Relative Strength Index:

<http://www.fmlabs.com/reference/RSI.htm>

<https://www.metastock.com/Custom/Resources/TAAZ/?p=100>

<https://www.linsoft.com/techind/relative-strength-index-rsi>

[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:relative\\_strength\\_index\\_rsi](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:relative_strength_index_rsi)

Stochastic RSI:

<http://www.fmlabs.com/reference/StochRSI.htm>

[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:stochrsi](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:stochrsi)

**See Also**

See [EMA](#), [SMA](#), etc. for moving average options; and note [Warning](#) section. See [CMO](#) for a variation on RSI.

**Examples**

```
data(ttrc)
price <- ttrc[,"Close"]

# Default case
rsi <- RSI(price)

# Case of one 'maType' for both MAs
rsiMA1 <- RSI(price, n=14, maType="WMA", wts=ttrc[,"Volume"])

# Case of two different 'maType's for both MAs
rsiMA2 <- RSI(price, n=14, maType=list(maUp=list(EMA, ratio=1/5),
                                       maDown=list(WMA, wts=1:10)))
```

---

runPercentRank	<i>Percent Rank over a Moving Window</i>
----------------	--

---

**Description**

This function computes a running/rolling percentage rank.

**Usage**

```
runPercentRank(x, n = 260, cumulative = FALSE, exact.multiplier = 0.5)
```

**Arguments**

x	Object coercible to xts or matrix.
n	Number of periods to use in the window or, if <code>cumulative=TRUE</code> , the number of observations to use before the first result is returned. Must be between 1 and <code>nrow(x)</code> , inclusive.
cumulative	Logical, use from-inception calculation?
exact.multiplier	The weight applied to identical values in the window. Must be between 0 and 1, inclusive. See details.

**Details**

The computation for a percentage rank can vary depending on the weight given to values in the window identical to the value being ranked. This weight can be set using the `exact.multiplier` argument which defaults to 0.5.

**Value**

A object of percent ranks over a n-period moving window of the same class as x and y or a vector (if try.xts fails).

**Note**

It may be important to note that this computation is different from the one used in Microsoft Excel's PERCENTRANK formula. Excel's computation is rather strange and gives inconsistent results as it uses interpolation to rank values that are not found within the lookback window.

**Author(s)**

Charlie Friedemann

**References**

The following site(s) were used to code/document this indicator:

[http://en.wikipedia.org/wiki/Percentile\\_rank](http://en.wikipedia.org/wiki/Percentile_rank)

---

runSum

*Analysis of Running/Rolling/Moving Windows*

---

**Description**

Various functions to analyze data over a moving window of periods.

**Usage**

```
runSum(x, n = 10, cumulative = FALSE)
```

```
runMin(x, n = 10, cumulative = FALSE)
```

```
runMax(x, n = 10, cumulative = FALSE)
```

```
runMean(x, n = 10, cumulative = FALSE)
```

```
runMedian(x, n = 10, non.unique = "mean", cumulative = FALSE)
```

```
runCov(x, y, n = 10, use = "all.obs", sample = TRUE, cumulative = FALSE)
```

```
runCor(x, y, n = 10, use = "all.obs", sample = TRUE, cumulative = FALSE)
```

```
runVar(x, y = NULL, n = 10, sample = TRUE, cumulative = FALSE)
```

```
runSD(x, n = 10, sample = TRUE, cumulative = FALSE)
```

```
runMAD(x, n = 10, center = NULL, stat = "median", constant = 1.4826,
       non.unique = "mean", cumulative = FALSE)
```

```
wilderSum(x, n = 10)
```

### Arguments

x	Object coercible to xts or matrix.
n	Number of periods to use in the window or, if cumulative=TRUE, the number of observations to use before the first result is returned. Must be between 1 and nrow(x), inclusive.
cumulative	Logical, use from-inception calculation?
non.unique	One of 'mean', 'max', or 'min'; which compute their respective statistics for the two middle values of even-sized samples.
y	Object coercible to xts or matrix.
use	Only "all.obs" currently implemented.
sample	Logical, sample covariance if TRUE (denominator of n-1)
center	The values to use as the measure of central tendency, around which to calculate deviations. The default (NULL) uses the median.
stat	Statistic to calculate, one of 'median' or 'mean' (e.g. median absolute deviation or mean absolute deviation, respectively.)
constant	Scale factor applied to approximate the standard deviation.

### Value

A object of the same class as x and y or a vector (if try.xts fails).

**runSum** returns sums over a n-period moving window.

**runMin** returns minimums over a n-period moving window.

**runMax** returns maximums over a n-period moving window.

**runMean** returns means over a n-period moving window.

**runMedian** returns medians over a n-period moving window.

**runCov** returns covariances over a n-period moving window.

**runCor** returns correlations over a n-period moving window.

**runVar** returns variances over a n-period moving window.

**runSD** returns standard deviations over a n-period moving window.

**runMAD** returns median/mean absolute deviations over a n-period moving window.

**wilderSum** returns a Welles Wilder style weighted sum over a n-period moving window.

### Author(s)

Joshua Ulrich

---

SAR

*Parabolic Stop-and-Reverse*

---

### Description

The Parabolic Stop-and-Reverse calculates a trailing stop. Developed by J. Welles Wilder.

### Usage

```
SAR(HL, accel = c(0.02, 0.2))
```

### Arguments

HL                    Object that is coercible to xts or matrix and contains High-Low prices.  
accel                accel[1]: Acceleration factor.  
                      accel[2]: Maximum acceleration factor.

### Details

The calculation for the SAR is quite complex. See the URLs in the references section for calculation notes.

The SAR assumes that you are always in the market, and calculates the Stop And Reverse point when you would close a long position and open a short position or vice versa.

### Value

A object of the same class as HL or a vector (if try.xts fails) containing the Parabolic Stop and Reverse values.

### Author(s)

Joshua Ulrich

### References

The following site(s) were used to code/document this indicator:

<https://www.linsoft.com/techind/parabolic-sar-sar>

<http://www.fmlabs.com/reference/SAR.htm>

[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:parabolic\\_sar](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:parabolic_sar)

<https://www.metastock.com/Custom/Resourses/TAAZ/?p=87>

### See Also

See [ATR](#) and [ADX](#), which were also developed by Welles Wilder.

**Examples**

```
data(ttrc)
sar <- SAR(ttrc[,c("High","Low")])
```

SMA

*Moving Averages***Description**

Calculate various moving averages (MA) of a series.

**Usage**

```
SMA(x, n = 10, ...)
```

```
EMA(x, n = 10, wilder = FALSE, ratio = NULL, ...)
```

```
DEMA(x, n = 10, v = 1, wilder = FALSE, ratio = NULL)
```

```
WMA(x, n = 10, wts = 1:n, ...)
```

```
EVWMA(price, volume, n = 10, ...)
```

```
ZLEMA(x, n = 10, ratio = NULL, ...)
```

```
VWAP(price, volume, n = 10, ...)
```

```
VMA(x, w, ratio = 1, ...)
```

```
HMA(x, n = 20, ...)
```

```
ALMA(x, n = 9, offset = 0.85, sigma = 6, ...)
```

**Arguments**

x	Price, volume, etc. series that is coercible to xts or matrix.
n	Number of periods to average over. Must be between 1 and nrow(x), inclusive.
...	any other passthrough parameters
wilder	logical; if TRUE, a Welles Wilder type EMA will be calculated; see notes.
ratio	A smoothing/decay ratio. ratio overrides wilder in EMA, and provides additional smoothing in VMA.
v	The 'volume factor' (a number in [0,1]). See Notes.

<code>wts</code>	Vector of weights. Length of <code>wts</code> vector must equal the length of <code>x</code> , or <code>n</code> (the default).
<code>price</code>	Price series that is coercible to <code>xts</code> or <code>matrix</code> .
<code>volume</code>	Volume series that is coercible to <code>xts</code> or <code>matrix</code> , that corresponds to price series, or a constant. See Notes.
<code>w</code>	Vector of weights (in $[0,1]$ ) the same length as <code>x</code> .
<code>offset</code>	Percentile at which the center of the distribution should occur.
<code>sigma</code>	Standard deviation of the distribution.

### Details

SMA calculates the arithmetic mean of the series over the past `n` observations.

EMA calculates an exponentially-weighted mean, giving more weight to recent observations. See Warning section below.

WMA is similar to an EMA, but with linear weighting if the length of `wts` is equal to `n`. If the length of `wts` is equal to the length of `x`, the WMA will use the values of `wts` as weights.

DEMA is calculated as:  $DEMA = (1 + v) * EMA(x, n) - EMA(EMA(x, n), n) * v$  (with the corresponding `wilder` and `ratio` arguments).

EVWMA uses volume to define the period of the MA.

ZLEMA is similar to an EMA, as it gives more weight to recent observations, but attempts to remove lag by subtracting data prior to  $(n-1)/2$  periods (default) to minimize the cumulative effect.

VWMA and VWAP calculate the volume-weighted moving average price.

VMA calculate a variable-length moving average based on the absolute value of `w`. Higher (lower) values of `w` will cause VMA to react faster (slower).

HMA a WMA of the difference of two other WMAs, making it very reponsive.

ALMA inspired by Gaussian filters. Tends to put less weight on most recent observations, reducing tendency to overshoot.

### Value

A object of the same class as `x` or `price` or a vector (if `try.xts` fails) containing the columns:

**SMA** Simple moving average.

**EMA** Exponential moving average.

**WMA** Weighted moving average.

**DEMA** Double-exponential moving average.

**EVWMA** Elastic, volume-weighted moving average.

**ZLEMA** Zero lag exponential moving average.

**VWMA** Volume-weighted moving average (same as VWAP).

**VWAP** Volume-weighted average price (same as VWMA).

**VWA** Variable-length moving average.

**HMA** Hull moving average.

**ALMA** Arnaud Legoux moving average.

**Warning**

Some indicators (e.g. EMA, DEMA, EVWMA, etc.) are calculated using the indicators' own previous values, and are therefore unstable in the short-term. As the indicator receives more data, its output becomes more stable. See example below.

**Note**

For EMA, `wilder=FALSE` (the default) uses an exponential smoothing ratio of  $2/(n+1)$ , while `wilder=TRUE` uses Welles Wilder's exponential smoothing ratio of  $1/n$ . The EMA result is initialized with the  $n$ -period sample average at period  $n$ . The exponential decay is applied from that point forward.

Since WMA can accept a weight vector of length equal to the length of  $x$  or of length  $n$ , it can be used as a regular weighted moving average (in the case `wts=1:n`) or as a moving average weighted by volume, another indicator, etc.

Since DEMA allows adjusting  $v$ , it is technically Tim Tillson's generalized DEMA (GD). When  $v=1$  (the default), the result is the standard DEMA. When  $v=0$ , the result is a regular EMA. All other values of  $v$  return the GD result. This function can be used to calculate Tillson's T3 indicator (see example below). Thanks to John Gavin for suggesting the generalization.

For EVWMA, if `volume` is a series,  $n$  should be chosen so the sum of the volume for  $n$  periods approximates the total number of outstanding shares for the security being averaged. If `volume` is a constant, it should represent the total number of outstanding shares for the security being averaged.

**Author(s)**

Joshua Ulrich, Ivan Popivanov (HMA, ALMA)

**References**

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/ExpMA.htm>  
<http://www.fmlabs.com/reference/WeightedMA.htm>  
<http://www.fmlabs.com/reference/DEMA.htm>  
<http://www.fmlabs.com/reference/T3.htm>  
<https://www.linsoft.com/techind/evwma-elastic-volume-weighted-moving-average>  
<http://www.fmlabs.com/reference/ZeroLagExpMA.htm>  
<http://www.fmlabs.com/reference/VIDYA.htm>  
<http://www.traderslog.com/hullmovingaverage>  
<http://www.arnaudlegoux.com/>

**See Also**

See `wilderSum`, which is used in calculating a Welles Wilder type MA.

**Examples**

```
data(ttrc)
ema.20 <- EMA(ttrc[, "Close"], 20)
```



```

sma.20 <- SMA(ttrc[, "Close"], 20)
dema.20 <- DEMA(ttrc[, "Close"], 20)
evwma.20 <- EVWMA(ttrc[, "Close"], ttrc[, "Volume"], 20)
zlema.20 <- ZLEMA(ttrc[, "Close"], 20)
alma <- ALMA(ttrc[, "Close"])
hma <- HMA(ttrc[, "Close"])

## Example of Tim Tillson's T3 indicator
T3 <- function(x, n=10, v=1) DEMA(DEMA(DEMA(x,n,v),n,v),n,v)
t3 <- T3(ttrc[, "Close"])

## Example of short-term instability of EMA
## (and other indicators mentioned above)
x <- rnorm(100)
tail( EMA(x[90:100],10), 1 )
tail( EMA(x[70:100],10), 1 )
tail( EMA(x[50:100],10), 1 )
tail( EMA(x[30:100],10), 1 )
tail( EMA(x[10:100],10), 1 )
tail( EMA(x[ 1:100],10), 1 )

```

---

 SNR

*Signal to Noise Ratio*


---

### Description

The n-day SNR for a given market is calculated by taking the absolute price change over an n-day period and dividing it by the average n-day volatility.

### Usage

```
SNR(HLC, n, ...)
```

### Arguments

HLC	Object that is coercible to xts or matrix and contains High-Low-Close prices.
n	Number of periods for moving average.
...	Other arguments to be passed to <a href="#">ATR</a> .

### Details

$$SNR_n = \frac{|C_t - C_{t-n}|}{ATR_n}$$

Using average true range as the volatility measure captures more of the intraday and overnight volatility in a way that a measurement of Close-to-Close price change does not.

The interpretation is then relatively intuitive: an SNR value of five indicates that the market has moved five times the volatility (average true range) over the given look-back period.

**Value**

A object of the same class as HLC or a matrix (if try.xts fails) containing the signal to noise ratio.

**Author(s)**

Peter Carl

**References**

Skeggs, James and Hill, Alex (2015). Back in Black Part 2: The Opportunity Set for Trend Following.

---

stoch

*Stochastic Oscillator / Stochastic Momentum Index*

---

**Description**

The stochastic oscillator is a momentum indicator that relates the location of each day's close relative to the high/low range over the past  $n$  periods. Developed by George C. Lane in the late 1950s. The SMI relates the close to the midpoint of the high/low range. Developed by William Blau in 1993.

**Usage**

```
stoch(HLC, nFastK = 14, nFastD = 3, nSlowD = 3, maType, bounded = TRUE,
      smooth = 1, ...)
```

```
SMI(HLC, n = 13, nFast = 2, nSlow = 25, nSig = 9, maType,
     bounded = TRUE, ...)
```

**Arguments**

HLC	Object that is coercible to xts or matrix and contains High-Low-Close prices. If only a univariate series is given, it will be used. See details.
nFastK	Number of periods for fast %K (i.e. the number of past periods to use).
nFastD	Number of periods for fast %D (i.e. the number smoothing periods to apply to fast %K).
nSlowD	Number of periods for slow %D (i.e. the number smoothing periods to apply to fast %D).
maType	Either: <ol style="list-style-type: none"> <li>1. A function or a string naming the function to be called.</li> <li>2. A <i>list</i> with the first component like (1) above, and additional parameters specified as <i>named</i> components. See Examples.</li> </ol>
bounded	Logical, should current period's values be used in the calculation?

smooth	Number of internal smoothing periods to be applied before calculating FastK. See Details.
...	Other arguments to be passed to the maType function in case (1) above.
n	Number of periods to use.
nFast	Number of periods for initial smoothing.
nSlow	Number of periods for double smoothing.
nSig	Number of periods for signal line.

### Details

If a High-Low-Close series is provided, the indicator is calculated using the high/low values. If a vector is provided, the calculation only uses that series. This allows stochastics to be calculated for: (1) series that have no HLC definition (e.g. foreign exchange), and (2) stochastic indicators (e.g. stochastic RSI - see examples).

The smooth argument is the number of periods of internal smoothing to apply to the differences in the high-low-close range before calculating Fast K. Thanks to Stanley Neo for the suggestion.

### Value

A object of the same class as HLC or a matrix (if try.xts fails) containing the columns:

**fastK** Stochastic Fast %K

**fastD** Stochastic Fast %D

**slowD** Stochastic Slow %D

**SMI** Stochastic Momentum Index

**signal** Stochastic Momentum Index signal line

### Note

The calculation for William's %R is similar to that of stochastics' fast %K.

The value for fast %K will be 0.5 whenever the highest high and lowest low are the same over the last n periods.

The stochastic oscillator and SMI calculate relative value of the close versus the high/low range and the midpoint of the high/low range, respectively.

The stochastic oscillator and the stochastic momentum index are interpreted similarly. Readings below 20 (above 80) are considered oversold (overbought). However, readings below 20 (above 80) are not necessarily bearish (bullish). Lane believed some of the best sell (buy) signals occurred when the oscillator moved from overbought (oversold) back below 80 (above 20).

For the stochastic oscillator, buy (sell) signals can also be given when %K crosses above (below) %D. Crossover signals are quite frequent however, which may result in whipsaws.

### Author(s)

Joshua Ulrich

## References

The following site(s) were used to code/document these indicators:

Stochastic Oscillator:

<http://www.fmlabs.com/reference/StochasticOscillator.htm>

<https://www.metastock.com/Customer/Resources/TAAZ/?p=106>

<https://www.linsoft.com/techind/stochastics>

[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:stochastic\\_oscillator\\_fast\\_slow\\_and\\_full](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:stochastic_oscillator_fast_slow_and_full)

SMI:

<http://www.fmlabs.com/reference/default.htm?url=SMI.htm>

## See Also

See [EMA](#), [SMA](#), etc. for moving average options; and note Warning section. See [WPR](#) to compare it's results to fast %K.

## Examples

```
data(ttrc)
stochOSC <- stoch(ttrc[,c("High", "Low", "Close")])
stochWPR <- WPR(ttrc[,c("High", "Low", "Close")])

plot(tail(stochOSC, "fastK"), 100, type="l",
     main="Fast %K and Williams %R", ylab="",
     ylim=range(cbind(stochOSC, stochWPR), na.rm=TRUE) )
lines(tail(stochWPR, 100), col="blue")
lines(tail(1-stochWPR, 100), col="red", lty="dashed")

stoch2MA <- stoch( ttrc[,c("High", "Low", "Close")],
                 maType=list(list(SMA), list(EMA, wilder=TRUE), list(SMA)) )

SMI3MA <- SMI(ttrc[,c("High", "Low", "Close")],
              maType=list(list(SMA), list(EMA, wilder=TRUE), list(SMA)) )

stochRSI <- stoch( RSI(ttrc[, "Close"]) )
```

---

stockSymbols

*Fetch Internet Data*

---

## Description

Get investment data from the internet.

**Usage**

```
stockSymbols(exchange = c("AMEX", "NASDAQ", "NYSE"), sort.by = c("Exchange",
  "Symbol"), quiet = FALSE)
```

```
getYahooData(symbol, start, end, freq = "daily", type = "price",
  adjust = TRUE, quiet = FALSE)
```

**Arguments**

exchange	Character vector of exchange names on which desired instrument symbols are traded.
sort.by	Character vector of columns by which returned data will be sorted. Must be one or more of "Name", "Symbol", "Market.Cap", or "Exchange".
quiet	Logical; if TRUE, status messages will be printed to the console.
symbol	Yahoo! Finance instrument symbol.
start	Numeric; first date of desired data, in YYYYMMDD format. Default is first date of series.
end	Numeric; last date of desired data, in YYYYMMDD format. Default is last date of series.
freq	Desired data frequency. One of "daily", "weekly", "monthly".
type	Type of data to return. One of "price", or "split". type="split" will return both split and dividend data.
adjust	Logical; if TRUE, the Open, High, Low, and Close prices will be adjusted for dividends and splits, and Volume will be adjusted for dividends.

**Details**

getYahooData fetches individual stock data from the Yahoo! Finance website. It also adjusts price for splits and dividends, and volume for splits. See the Warning section, and note that it is deprecated in favor of getSymbols in the quantmod package.

stockSymbols fetches instrument symbols from the nasdaq.com website, and adjusts the symbols to be compatible with the Yahoo! Finance website.

**Value**

getYahooData returns an xts object containing the columns:

stockSymbols returns a character vector containing all the listed symbols for the given exchanges.

**Date** Trade date, in CCYYMMDD format.

**Open** Open price.

**High** High price.

**Low** Low price.

**Close** Close price.

**Volume** Volume.

**Warning**

As of TTR 0.23-2, `getYahooData` has been patched to work with changes to Yahoo Finance, which also included the following changes to the raw data:

- The adjusted close column appears to no longer include dividend adjustments
- The open, high, and low columns are adjusted for splits, and
- The raw data may contain missing values.
- The raw data may contain errors.

**Note**

The symbols returned by `stockSymbols` may not be in the format necessary to retrieve data using `getYahooData`.

`getYahooData` has only been tested on daily data. It isn't known if the function correctly adjusts data for any other frequency.

**Author(s)**

Joshua Ulrich

**Examples**

```
### Note: you must have a working internet
### connection for these examples to work!
ge <- getYahooData("GE", 19990404, 20050607, adjust = FALSE)

nyse.symbols <- stockSymbols("NYSE")
```

---

TDI

*Trend Detection Index*

---

**Description**

The Trend Detection Index (TDI) attempts to identify starting and ending trends. Developed by M. H. Pee.

**Usage**

```
TDI(price, n = 20, multiple = 2)
```

**Arguments**

<code>price</code>	Price series that is coercible to xts or matrix.
<code>n</code>	Number of periods to use.
<code>multiple</code>	Multiple used to calculate (2).

### Details

The TDI is the (1) absolute value of the n-day sum of the n-day momentum, minus the quantity of (2) multiple\*n-day sum of the absolute value of the n-day momentum, minus (3) n-day sum of the absolute value of the n-day momentum.

I.e.  $TDI = (1) - [(2) - (3)]$

The direction indicator is the sum of the n-day momentum over the last n days.

See URL in references section for further details.

### Value

A object of the same class as price or a matrix (if `try.xts` fails) containing the columns:

**tdi** The Trend Detection Index.

**di** The Direction Indicator.

### Note

Positive/negative TDI values signal a trend/consolidation. A positive/ negative direction indicator signals a up/down trend. I.e. buy if the TDI and the direction indicator are positive, and sell if the TDI is positive while the direction indicator is negative.

### Author(s)

Joshua Ulrich

### References

The following site(s) were used to code/document this indicator:

<https://www.linsoft.com/techind/trend-detection-index-tdi>

### See Also

See [aroon](#), [CCI](#), [ADX](#), [VHF](#), [GMA](#) for other indicators that measure trend direction/strength.

### Examples

```
data(ttrc)
tdi <- TDI(ttrc[, "Close"], n=30)
```

---

 TRIX

*Triple Smoothed Exponential Oscillator*


---

**Description**

The TRIX indicator calculates the rate of change of a triple exponential moving average. Developed by Jack K. Hutson.

**Usage**

```
TRIX(price, n = 20, nSig = 9, maType, percent = TRUE, ...)
```

**Arguments**

price	Price series that is coercible to xts or matrix.
n	Number of periods for moving average.
nSig	Number of periods for signal line moving average.
maType	Either: <ol style="list-style-type: none"> <li>1. A function or a string naming the function to be called.</li> <li>2. A <i>list</i> with the first component like (1) above, and additional parameters specified as <i>named</i> components. See Examples.</li> </ol>
percent	logical; if TRUE, the rate of change is calculated using the ROC function, otherwise the momentum function is used.
...	Other arguments to be passed to the maType function in case (1) above.

**Details**

The TRIX is calculated as follows:  
 $3MA = MA(MA(MA(price)))$   
 $trix = 100 * [ 3MA(t) / 3MA(t-1) - 1 ]$

**Value**

A object of the same class as price or a vector (if `try.xts` fails) containing the TRIX values.

**Note**

Buy/sell signals are generated when the TRIX crosses above/below zero. A nine-period EMA of the TRIX is used as a default signal line. Buy/sell signals are generated when the TRIX crosses above/below the signal line and is also above/below zero.

**Author(s)**

Joshua Ulrich



## References

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/default.htm?url=TRIX.htm>

<https://www.metastock.com/Custom/Resources/TAAZ/?p=114>

<https://www.linsoft.com/techind/trix-triple-smoothed-exponential-oscillator>

[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:trix](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:trix)

## See Also

See [EMA](#), [SMA](#), etc. for moving average options; and note Warning section.

## Examples

```
data(ttrc)
trix <- TRIX(ttrc[, "Close"])
trix4 <- TRIX(ttrc[, "Close"],
maType=list(list(SMA), list(EMA, wilder=TRUE), list(SMA), list(DEMA)))
```

---

TTR

*Functions to create Technical Trading Rules (TTR)*

---

## Description

This package contains many of the most popular technical analysis functions, as well as functions to retrieve U.S. stock symbols, and data from Yahoo Finance.

## Details

Users will probably be most interested in the following functions:

[ADX](#)

[BBands](#)

[changes](#)

[MovingAverages](#)

[MACD](#)

[RSI](#)

[runFun](#)

[stoch](#)

[VWAP](#)

[WebData](#)

**Author(s)**

Joshua Ulrich

Maintainer: Joshua Ulrich

**References**

The following sites were used to code/document this package:

<http://www.fmlabs.com/reference/default.htm>

<https://www.metastock.com/Custom/Resourses/TAAZ/>

<https://www.linnsoft.com/indicators>

[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators)

**Examples**

```
data(ttrc)

# Bollinger Bands
bbands <- BBands( ttrc[,c("High", "Low", "Close")] )

# Directional Movement Index
adx <- ADX(ttrc[,c("High", "Low", "Close")])

# Moving Averages
ema <- EMA(ttrc[, "Close"], n=20)
sma <- SMA(ttrc[, "Close"], n=20)

# MACD
macd <- MACD( ttrc[, "Close"] )

# RSI
rsi <- RSI(ttrc[, "Close"])

# Stochastics
stochOsc <- stoch(ttrc[,c("High", "Low", "Close")])

### Note: you must have a working internet connection
### for the examples below to work!

# Fetch U.S. symbols from the internet
nyseSymbols <- stockSymbols("NYSE")

# Fetch Yahoo! Finance data from the internet
ge <- getYahooData("GE", 19990404, 20050607, adjust = FALSE)
```

---

ttrc	<i>Technical Trading Rule Composite data</i>
------	--

---

**Description**

Historical Open, High, Low, Close, and Volume data for the periods January 2, 1985 to December 31, 2006. Randomly generated.

**Format**

The format is:

Date:	Class 'Date'	5480 5481 5482 5485 5486 ...
Open:	num	3.18 3.09 3.11 3.09 3.10 ...
High:	num	3.18 3.15 3.12 3.12 3.12 ...
Low:	num	3.08 3.09 3.08 3.07 3.08 ...
Close:	num	3.08 3.11 3.09 3.10 3.11 ...
Volume:	num	1870906 3099506 2274157 2086758 2166348 ...

**Details**

These data do not represent an actual security. They are provided so examples do not necessitate an internet connection.

**Source**

Randomly generated.

**Examples**

```
data(ttrc)
plot(tail(ttrc[,"Close"],100), type="l")
```

---

ultimateOscillator	<i>The Ultimate Oscillator</i>
--------------------	--------------------------------

---

**Description**

The Ultimate Oscillator is a momentum oscillator designed to capture momentum across three different time frames.

**Usage**

```
ultimateOscillator(HLC, n = c(7, 14, 28), wts = c(4, 2, 1))
```

**Arguments**

HLC	Object that is coercible to xts or matrix and contains High-Low-Close prices.
n	A vector of the number of periods to use for each average calculation.
wts	The weights applied to each average.

**Details**

Created by Larry Williams in 1976.

**Author(s)**

Ivan Popivanov

**References**

The following site(s) were used to code/document this indicator:

[http://stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:ultimate\\_oscillator](http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:ultimate_oscillator)

**Examples**

```
data(ttrc)
ult.osc <- ultimateOscillator(ttrc[,c("High", "Low", "Close")])
```

---

VHF

*Vertical Horizontal Filter*

---

**Description**

The Vertical Horizontal Filter (VHF) attempts to identify starting and ending trends. Developed by Adam White.

**Usage**

```
VHF(price, n = 28)
```

**Arguments**

price	Object that is coercible to xts or matrix and contains a Close price series, or a High-Low-Close price series.
n	Number of periods to use.

**Details**

The VHF is calculated by subtracting the n-period lowest low from the n-period highest high and dividing that result by the n-period rolling sum of the close price changes.

**Value**

A object of the same class as price or a vector (if `try.xts` fails) containing the VHF values.

**Note**

If Close prices are given, the function calculates the max/min using only those prices (the default). If HLC prices are given, the function calculates the max/min using the high/low prices (added for flexibility).

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:  
<http://www.metastock.com/Customer/Resources/TAAZ/#119>

**See Also**

See [aroon](#), [CCI](#), [ADX](#), [TDI](#), [GMA](#) for other indicators that measure trend direction/strength.

**Examples**

```
data(ttrc)
vhf.close <- VHF(ttrc[, "Close"])
vhf.hilow <- VHF(ttrc[, c("High", "Low", "Close")])
```

---

volatility

*Volatility*

---

**Description**

Selected volatility estimators/indicators; various authors.

**Usage**

```
volatility(OHLC, n = 10, calc = "close", N = 260, mean0 = FALSE, ...)
```

**Arguments**

OHLC	Object that is coercible to xts or matrix and contains Open-High-Low-Close prices (or only Close prices, if <code>calc="close"</code> ).
n	Number of periods for the volatility estimate.
calc	The calculation (type) of estimator to use.
N	Number of periods per year.
mean0	Use a mean of 0 rather than the sample mean.
...	Arguments to be passed to/from other methods.

**Details**

- Close-to-Close Volatility (`calc="close"`)

$$\sigma_{cl} = \sqrt{\frac{N}{n-2} \sum_{i=1}^{n-1} (r_i - \bar{r})^2}$$

$$\text{where } r_i = \log\left(\frac{C_i}{C_{i-1}}\right)$$

$$\text{and } \bar{r} = \frac{r_1 + r_2 + \dots + r_{n-1}}{n-1}$$

- OHLC Volatility: Garman and Klass (`calc="garman.klass"`)

The Garman and Klass estimator for estimating historical volatility assumes Brownian motion with zero drift and no opening jumps (i.e. the opening = close of the previous period). This estimator is 7.4 times more efficient than the close-to-close estimator.

$$\sigma = \sqrt{\frac{N}{n} \sum \left[ \frac{1}{2} \left( \log \frac{H_i}{L_i} \right)^2 - (2 \log 2 - 1) \left( \log \frac{C_i}{O_i} \right)^2 \right]}$$

- High-Low Volatility: Parkinson (`calc="parkinson"`)

The Parkinson formula for estimating the historical volatility of an underlying based on high and low prices.

$$\sigma = \sqrt{\frac{N}{4n \times \log 2} \sum_{i=1}^n \left( \log \frac{H_i}{L_i} \right)^2}$$

- OHLC Volatility: Rogers and Satchell (`calc="rogers.satchell"`)

The Roger and Satchell historical volatility estimator allows for non-zero drift, but assumed no opening jump.

$$\sigma = \sqrt{\frac{N}{n} \sum \left[ \log \frac{H_i}{C_i} \times \log \frac{H_i}{O_i} + \log \frac{L_i}{C_i} \times \log \frac{L_i}{O_i} \right]}$$

- OHLC Volatility: Garman and Klass - Yang and Zhang (calc="gk.yz")  
This estimator is a modified version of the Garman and Klass estimator that allows for opening gaps.

$$\sigma = \sqrt{\frac{N}{n} \sum \left[ \left( \log \frac{O_i}{C_{i-1}} \right)^2 + \frac{1}{2} \left( \log \frac{H_i}{L_i} \right)^2 - (2 \times \log 2 - 1) \left( \log \frac{C_i}{O_i} \right)^2 \right]}$$

- OHLC Volatility: Yang and Zhang (calc="yang.zhang")  
The Yang and Zhang historical volatility estimator has minimum estimation error, and is independent of drift and opening gaps. It can be interpreted as a weighted average of the Rogers and Satchell estimator, the close-open volatility, and the open-close volatility.  
Users may override the default values of  $\alpha$  (1.34 by default) or  $k$  used in the calculation by specifying alpha or k in . . . , respectively. Specifying k will cause alpha to be ignored, if both are provided.

$$\begin{aligned} \sigma^2 &= \sigma_o^2 + k\sigma_c^2 + (1-k)\sigma_{rs}^2 \\ \sigma_o^2 &= \frac{N}{n-1} \sum \left( \log \frac{O_i}{C_{i-1}} - \mu_o \right)^2 \\ \mu_o &= \frac{1}{n} \sum \log \frac{O_i}{C_{i-1}} \\ \sigma_c^2 &= \frac{N}{n-1} \sum \left( \log \frac{C_i}{O_i} - \mu_c \right)^2 \\ \mu_c &= \frac{1}{n} \sum \log \frac{C_i}{O_i} \\ \sigma_{rs}^2 &= \frac{N}{n} \sum \left( \log \frac{H_i}{C_i} \times \log \frac{H_i}{O_i} + \log \frac{L_i}{C_i} \times \log \frac{L_i}{O_i} \right) \\ k &= \frac{\alpha}{1 + \frac{n+1}{n-1}} \end{aligned}$$

### Value

A object of the same class as OHLC or a vector (if try.xts fails) containing the chosen volatility estimator values.

### Author(s)

Joshua Ulrich

### References

The following sites were used to code/document these indicators. All were created by Thijs van den Berg under the GNU Free Documentation License and were retrieved on 2008-04-20. The original links are dead, but can be accessed via internet archives.

Close-to-Close Volatility (calc="close"):

<https://web.archive.org/web/20100421083157/http://www.sitmo.com/eq/172>

OHLC Volatility: Garman Klass (calc="garman.klass"):

<https://web.archive.org/web/20100326172550/http://www.sitmo.com/eq/402>

High-Low Volatility: Parkinson (calc="parkinson"):

<https://web.archive.org/web/20100328195855/http://www.sitmo.com/eq/173>

OHLC Volatility: Rogers Satchell (calc="rogers.satchell"):

<https://web.archive.org/web/20091002233833/http://www.sitmo.com/eq/414>

OHLC Volatility: Garman Klass - Yang Zhang (calc="gk.yz"):

<https://web.archive.org/web/20100326215050/http://www.sitmo.com/eq/409>

OHLC Volatility: Yang Zhang (calc="yang.zhang"):

<https://web.archive.org/web/20100326215050/http://www.sitmo.com/eq/409>

### See Also

See [TR](#) and [chaikinVolatility](#) for other volatility measures.

### Examples

```
data(ttrc)
ohlc <- ttrc[,c("Open", "High", "Low", "Close")]
vClose <- volatility(ohlc, calc="close")
vClose0 <- volatility(ohlc, calc="close", mean0=TRUE)
vGK <- volatility(ohlc, calc="garman")
vParkinson <- volatility(ohlc, calc="parkinson")
vRS <- volatility(ohlc, calc="rogers")
```

---

williamsAD

*Williams Accumulation / Distribution*

---

### Description

The Williams Accumulation / Distribution (AD) line is a measure of market momentum. Developed by Larry Williams.

### Usage

```
williamsAD(HLC)
```

### Arguments

HLC                    Object that is coercible to xts or matrix and contains High-Low-Close prices.

### Details

The Williams AD line differs from OBV and chaikinAD in that it doesn't take volume into account.



**Value**

A object of the same class as HLC or a vector (if `try.xts` fails) containing the accumulation / distribution values.

**Note**

The Accumulation/Distribution Line is interpreted by looking for a divergence in the direction of the indicator relative to price.

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/WilliamsAD.htm>

<http://www.metastock.com/Custom/Resourses/TAAZ/#125>

**See Also**

See [OBV](#), [chaikinAD](#), and [ATR](#).

**Examples**

```
data(ttrc)
ad <- williamsAD(ttrc[,c("High", "Low", "Close")])
```

---

WPR

*William's %R*

---

**Description**

William's % R.

**Usage**

```
WPR(HLC, n = 14)
```

**Arguments**

HLC	Object that is coercible to xts or matrix and contains High-Low-Close prices. If only a univariate series is given, it will be used. See details.
n	Number of periods to use.

**Details**

If an High-Low-Close series is provided, the indicator is calculated using the high/low values. If a vector is provided, the calculation only uses that series.

**Value**

A object of the same class as HLC or a vector (if try . xts fails) containing the William's %R values.

**Note**

The William's %R calculation is similar to stochastics' fast %K.

The value for William's %R will be 0.5 whenever the highest high and lowest low are the same over the last n periods.

**Author(s)**

Joshua Ulrich

**References**

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/WilliamsR.htm>

<http://www.metastock.com/Custom/Resouces/TAAZ/#126>

<https://www.linsoft.com/techind/williams-r-wpr>

[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:williams\\_r](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:williams_r)

**See Also**

See [stoch](#).

**Examples**

```
data(ttrc)
stochOsc <- stoch(ttrc[,c("High", "Low", "Close")])
stochWPR<- WPR(ttrc[,c("High", "Low", "Close")])

plot(tail(stochOsc["fastK"], 100), type="l",
     main="Fast %K and Williams %R", ylab="",
     ylim=range(cbind(stochOsc, stochWPR), na.rm=TRUE) )
lines(tail(stochWPR, 100), col="blue")
lines(tail(1-stochWPR, 100), col="red", lty="dashed")
```

---

ZigZag

*Zig Zag*

---

### Description

Zig Zag highlights trends by removing price changes smaller than change and interpolating lines between the extreme points.

### Usage

```
ZigZag(HL, change = 10, percent = TRUE, retrace = FALSE,  
lastExtreme = TRUE)
```

### Arguments

HL	Object that is coercible to xts or matrix and contains either a High-Low price series, or a Close price series.
change	Minimum price movement, either in dollars or percent (see percent).
percent	Use percentage or dollar change?
retrace	Is change a retracement of the previous move, or an absolute change from peak to trough?
lastExtreme	If the extreme price is the same over multiple periods, should the extreme price be the first or last observation?

### Details

The Zig Zag is non-predictive. The purpose of the Zig Zag is filter noise and make chart patterns clearer. It's more a visual tool than an indicator.

### Value

A object of the same class as HL or a vector (if `try.xts` fails) containing the Zig Zag indicator.

### Note

If High-Low prices are given, the function calculates the max/min using the high/low prices. Otherwise the function calculates the max/min of the single series.

### Author(s)

Joshua Ulrich

## References

The following site(s) were used to code/document this indicator:

<http://www.fmlabs.com/reference/default.htm?url=ZigZag.htm>

<https://www.linsoft.com/techind/zig-zag-indicator-zig-zzo>

<https://www.linsoft.com/techind/zig-zag-oscillator-indicator-zzo>

<http://www.metastock.com/Custom/Resourses/TAAZ/#127>

[http://www.stockcharts.com/school/doku.php?id=chart\\_school:technical\\_indicators:zigzag](http://www.stockcharts.com/school/doku.php?id=chart_school:technical_indicators:zigzag)

## Examples

```
## Get Data and Indicator ##  
data(ttrc)  
zz <- ZigZag( ttrc[,c("High", "Low")], change=20 )
```

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