

# Package ‘stlplus’

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**Type** Package

**Title** Enhanced Seasonal Decomposition of Time Series by Loess

**Version** 0.5.2

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**Maintainer** Ryan Hafen <rhafen@gmail.com>

**Description** Decompose a time series into seasonal, trend, and remainder components using an implementation of Seasonal Decomposition of Time Series by Loess (STL) that provides several enhancements over the STL method in the stats package. These enhancements include handling missing values, providing higher order (quadratic) loess smoothing with automated parameter choices, frequency component smoothing beyond the seasonal and trend components, and some basic plot methods for diagnostics.

**LazyLoad** yes

**NeedsCompilation** yes

**Imports** lattice, yaImpute, stats, Rcpp

**Suggests** testthat

**LinkingTo** Rcpp

**License** BSD\_3\_clause + file LICENSE

**URL** <https://github.com/hafen/stlplus>

**BugReports** <https://github.com/hafen/stlplus/issues>

**Note** This is experimental software distributed free of charge and comes with no warranty! Exercise professional caution.

**RoxygenNote** 7.3.3

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**Repository** CRAN

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plot.stlplus	<i>Lattice plot of the raw, seasonal, trend, and remainder components</i>
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### Description

Lattice plot of the raw, seasonal, trend, and remainder components. If post-trend smoothing was done, these components will be plotted instead of the trend component.

### Usage

```
## S3 method for class 'stlplus'
plot(
  x,
  scales = list(y = list(relation = "sliced")),
  type = "l",
  as.table = TRUE,
  strip = FALSE,
  strip.left = TRUE,
  between = list(y = 0.5),
  layout = NULL,
  ...
)
```

### Arguments

`x` object of class "stlplus".  
`scales`, `type`, `as.table`, `strip`, `strip.left`, `between`, `layout`, ...  
 parameters to be passed to `xyplot`.

### Value

object of class "trellis".

### References

R. B. Cleveland, W. S. Cleveland, J. E. McRae, and I. Terpenning (1990) STL: A Seasonal-Trend Decomposition Procedure Based on Loess. *Journal of Official Statistics*, **6**, 3–73.

**See Also**[stlplus](#)

---

`plot_cycle`*Cycle-Subseries Plot for an stlplus Object*

---

**Description**

Plots the seasonal component by cycle-subseries, with lines emanating from the midmean of the values within each cycle-subseries.

**Usage**

```
plot_cycle(  
  x,  
  layout = c(x$pars$n.p, 1),  
  col = "#0080ff",  
  xlab = "Time",  
  ylab = "Seasonal",  
  panel = function(x, y, ...) {  
    lattice::panel.segments(x, rep(.midmean(y),  
    length(x)), x, y, col = col)  
  },  
  ...  
)
```

**Arguments**

`x` object of class "stlplus".  
`layout`, `col`, `xlab`, `ylab`, `panel`, ...  
parameters to be passed to `xyplot()`.

**Value**

object of class "trellis".

**References**

R. B. Cleveland, W. S. Cleveland, J. E. McRae, and I. Terpenning (1990) STL: A Seasonal-Trend Decomposition Procedure Based on Loess. *Journal of Official Statistics*, **6**, 3–73.

**See Also**[stlplus](#)

---

plot\_rembycycle      *Plot of Remainder Component by Cycle-Subseries*

---

### Description

Plots the remainder component by cycle-subseries with a loess line.

### Usage

```
plot_rembycycle(  
  x,  
  col = "darkgray",  
  locol = "black",  
  lolwd = 2,  
  xlab = "Time",  
  ylab = "Remainder",  
  ...  
)
```

### Arguments

`x`                    object of class "stlplus".  
`col`, `locol`, `lolwd`, `xlab`, `ylab`, ...  
                          parameters to be passed to `xyplot()`. `locol` and `lolwd` are the line color and width for the loess line.

### Value

object of class "trellis".

### References

R. B. Cleveland, W. S. Cleveland, J. E. McRae, and I. Terpenning (1990) STL: A Seasonal-Trend Decomposition Procedure Based on Loess. *Journal of Official Statistics*, **6**, 3–73.

### See Also

[stlplus](#)

---

`plot_seasonal`*Seasonal Diagnostic Plot for an stlplus Object*

---

**Description**

Plots each cycle-subseries of the detrended data (or equivalently, seasonal plus remainder), centered by the mean seasonal component for each subseries. The fitted seasonal component is plotted as a line through the points.

**Usage**

```
plot_seasonal(  
  x,  
  col = c("darkgray", "black"),  
  lwd = 2,  
  xlab = "Time",  
  ylab = "Seasonal + Remainder\n(centered by seasonal mean)",  
  ...  
)
```

**Arguments**

`x` object of class "stlplus".  
`col`, `lwd`, `xlab`, `ylab`, ... parameters to be passed to `xyplot()`.

**Details**

Helps decide how much of the variation in the data other than the trend should go into the seasonal component, and how much in the remainder.

**Value**

object of class "trellis".

**References**

R. B. Cleveland, W. S. Cleveland, J. E. McRae, and I. Terpenning (1990) STL: A Seasonal-Trend Decomposition Procedure Based on Loess. *Journal of Official Statistics*, **6**, 3–73.

**See Also**

[stlplus](#)

---

plot\_trend

*Trend Diagnostic Plot for an stlplus Object*


---

### Description

Plots the trend+remainder with the trend component overlaid, and the remainder component in a separate panel.

### Usage

```
plot_trend(
  x,
  xlab = "Time",
  ylab = "Trend",
  span = 0.3,
  type = c("p", "l"),
  scales = list(y = list(relation = "free")),
  lwd = c(1, 1),
  col = c("darkgray", "black", "darkgray"),
  layout = c(1, 2),
  between = list(y = 0.5),
  strip = FALSE,
  strip.left = TRUE,
  as.table = TRUE,
  ...
)
```

### Arguments

`x` object of class "stlplus".  
`xlab`, `ylab`, `span`, `type`, `scales`, `lwd`, `col`, `layout`  
 parameters to be passed to `xyplot`.  
`between`, `strip`, `strip.left`, `as.table`, ...  
 parameters to be passed to `xyplot`.

### Value

object of class "trellis".

### References

R. B. Cleveland, W. S. Cleveland, J. E. McRae, and I. Terpenning (1990) STL: A Seasonal-Trend Decomposition Procedure Based on Loess. *Journal of Official Statistics*, **6**, 3–73.

### See Also

[stlplus](#)

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`seasonal`*Accessor functions for elements of an stl and stlplus object*

---

**Description**

Retrieves the raw, seasonal, trend, remainder, or time components from an stlplus object. The methods `seasonal.stl`, ... also exist as a convenience for extracting components from R's `stl()`.

**Usage**`seasonal(object)``trend(object)``remainder(object)``getraw(object)`

```
## S3 method for class 'stlplus'  
remainder(object)
```

```
## S3 method for class 'stlplus'  
fitted(object, ...)
```

```
## S3 method for class 'stlplus'  
predict(object, ...)
```

```
## S3 method for class 'stlplus'  
seasonal(object)
```

```
## S3 method for class 'stlplus'  
trend(object)
```

`fc(object, fcnum = 1)`

```
## S3 method for class 'stlplus'  
time(x, ...)
```

```
## S3 method for class 'stl'  
remainder(object)
```

```
## S3 method for class 'stl'  
seasonal(object)
```

```
## S3 method for class 'stl'  
trend(object)
```

```
## S3 method for class 'stl'
time(x, ...)

## S3 method for class 'stl'
predict(object, ...)

## S3 method for class 'stl'
fitted(object, ...)
```

### Arguments

<code>fcnum</code>	number of post-trend smoothing frequency component.
<code>x, object</code>	object of class "stl" or "stlplus".
<code>...</code>	additional parameters

### Value

Returns a vector of either the `getraw` time series, the seasonal, trend, or remainder components, or the time values of the time series. If times are requested but were not supplied in the initial `stlplus` call, the `1:n` vector is returned, where `n` is the number of data points. The `fitted` method returns the sum of the seasonal and trend.

### Note

The `fitted` and `predict` methods are equivalent. For objects of class "stlplus", these functions return the sum of all components but the remainder, including post-trend smoothing components. Note also that the `trend` method for objects of class "stlplus" only returns the trend component from the STL iterations, even when post-trend smoothing is done.

### References

R. B. Cleveland, W. S. Cleveland, J.E. McRae, and I. Terpenning (1990) STL: A Seasonal-Trend Decomposition Procedure Based on Loess. *Journal of Official Statistics*, **6**, 3–73.

### See Also

[stlplus](#)

### Examples

```
co2.stl <- stlplus(co2, t = as.vector(stats::time(co2)), n.p=12, l.window=13,
t.window=19, s.window=35, s.degree=1, sub.labels = substr(month.name, 1, 3))

plot(seasonal(co2.stl))
```

**Description**

Decompose a time series into seasonal, trend and irregular components using loess, acronym STL. A new implementation of STL. Allows for NA values, local quadratic smoothing, post-trend smoothing, and endpoint blending. The usage is very similar to that of R's built-in `stl()`.

**Usage**

```
stlplus(  
  x,  
  t = NULL,  
  n.p,  
  s.window,  
  s.degree = 1,  
  t.window = NULL,  
  t.degree = 1,  
  fc.window = NULL,  
  fc.degree = NULL,  
  fc.name = NULL,  
  l.window = NULL,  
  l.degree = t.degree,  
  s.jump = ceiling(s.window/10),  
  t.jump = ceiling(t.window/10),  
  l.jump = ceiling(l.window/10),  
  fc.jump = NULL,  
  critfreq = 0.05,  
  s.blend = 0,  
  t.blend = 0,  
  l.blend = t.blend,  
  fc.blend = NULL,  
  inner = 2,  
  outer = 1,  
  sub.labels = NULL,  
  sub.start = 1,  
  zero.weight = 0.000001,  
  details = FALSE,  
  ...  
)  
  
## S3 method for class 'ts'  
stlplus(  
  x,  
  t = as.numeric(stats::time(x)),  
  n.p = frequency(x),
```

```

s.window,
s.degree = 1,
t.window = NULL,
t.degree = 1,
fc.window = NULL,
fc.degree = NULL,
fc.name = NULL,
l.window = NULL,
l.degree = t.degree,
s.jump = ceiling(s.window/10),
t.jump = ceiling(t.window/10),
l.jump = ceiling(l.window/10),
fc.jump = NULL,
critfreq = 0.05,
s.blend = 0,
t.blend = 0,
l.blend = t.blend,
fc.blend = NULL,
inner = 2,
outer = 1,
sub.labels = NULL,
sub.start = 1,
zero.weight = 0.000001,
details = FALSE,
...
)

## S3 method for class 'zoo'
stlplus(...)

```

### Arguments

x	vector of time series values, in order of time. If x is a time series object, then t and n.p do not need to be specified, although they still can be.
t	times at which the time series values were observed. Not required.
n.p	periodicity of the seasonal component. In R's stl function, this is the frequency of the time series.
s.window	either the character string "periodic" or the span (in lags) of the loess window for seasonal extraction, which should be odd. This has no default.
s.degree	degree of locally-fitted polynomial in seasonal extraction. Should be 0, 1, or 2.
t.window	the span (in lags) of the loess window for trend extraction, which should be odd. If NULL, the default, <code>nextodd(ceiling((1.5*period) / (1-(1.5/s.window))))</code> , is taken.
t.degree	degree of locally-fitted polynomial in trend extraction. Should be 0, 1, or 2.
fc.window	vector of lengths of windows for loess smoothings for other trend frequency components after the original STL decomposition has been obtained. The smoothing is applied to the data with the STL seasonal component removed. A fre-

quency component is computed by a loess fit with the window length equal to the first element of `fc.window`, the component is removed, another component is computed with the window length equal to the second element of `fc.window`, and so forth. In most cases, the values of the argument should be decreasing, that is, the frequency bands of the fitted components should increase. The robustness weights from original STL are used as weights in the loess fitting if specified.

<code>fc.degree</code>	vector of degrees of locally-fitted polynomial in the loess smoothings for the frequency components specified in <code>fc.window</code> . Values of 0, 1 and 2 are allowed. If the length of <code>fc.degree</code> is less than that of <code>fc.window</code> , the former is expanded to the length of the latter using <code>rep</code> ; thus, giving the value 1 specifies a degree of 1 for all components.
<code>fc.name</code>	vector of names of the post-trend smoothing operations specified by <code>fc.window</code> and <code>fc.degree</code> (optional).
<code>l.window</code>	the span (in lags) of the loess window of the low-pass filter used for each sub-series. Defaults to the smallest odd integer greater than or equal to <code>n.p</code> which is recommended since it prevents competition between the trend and seasonal components. If not an odd integer its given value is increased to the next odd one.
<code>l.degree</code>	degree of locally-fitted polynomial for the subseries low-pass filter. Should be 0, 1, or 2.
<code>s.jump</code> , <code>t.jump</code> , <code>l.jump</code> , <code>fc.jump</code>	integers at least one to increase speed of the respective smoother. Linear interpolation happens between every <code>*.jumpth</code> value.
<code>critfreq</code>	the critical frequency to use for automatic calculation of smoothing windows for the trend and high-pass filter.
<code>s.blend</code> , <code>t.blend</code> , <code>l.blend</code> , <code>fc.blend</code>	vectors of proportion of blending to degree 0 polynomials at the endpoints of the series.
<code>inner</code>	integer; the number of ‘inner’ (backfitting) iterations; usually very few (2) iterations suffice.
<code>outer</code>	integer; the number of ‘outer’ robustness iterations. Default is 0, but Recommended if outliers are present.
<code>sub.labels</code>	optional vector of length <code>n.p</code> that contains the labels of the subseries in their natural order (such as month name, day of week, etc.), used for strip labels when plotting. All entries must be unique.
<code>sub.start</code>	which element of <code>sub.labels</code> does the series begin with. See details.
<code>zero.weight</code>	value to use as zero for zero weighting
<code>details</code>	if TRUE, returns a list of the results of all the intermediate iterations.
<code>...</code>	additional parameters

### Details

The seasonal component is found by *loess* smoothing the seasonal sub-series (the series of all January values, ...); if `s.window = "periodic"` smoothing is effectively replaced by taking the mean.

The seasonal values are removed, and the remainder smoothed to find the trend. The overall level is removed from the seasonal component and added to the trend component. This process is iterated a few times. The remainder component is the residuals from the seasonal plus trend fit.

Cycle-subseries labels are useful for plotting and can be specified through the `sub.labels` argument. Here is an example for how the `sub.labels` and `sub.start` parameters might be set for one situation. Suppose we have a daily series with `n.p=7` (fitting a day-of-week component). Here, `sub.labels` could be set to `c("Sun", "Mon", "Tue", "Wed", "Thu", "Fri", "Sat")`. Now, if the series starts with a Wednesday value, then one would specify `sub.labels=4`, since Wednesday is the fourth element of `sub.labels`. This ensures that the labels in the plots to start the plotting with Sunday cycle-subseries instead of Wednesday.

### Value

returns an object of class "stlplus", containing

<code>data</code>	data frame containing all of the components: raw, seasonal, trend, remainder, weights.
<code>pars</code>	list of parameters used in the procedure.
<code>fc.number</code>	number of post-trend frequency components fitted.
<code>fc</code>	data frame of the post-trend frequency components.
<code>time</code>	vector of time values corresponding to the raw values, if specified.
<code>n</code>	the number of observations.
<code>sub.labels</code>	the cycle-subseries labels.

### Note

This is a complete re-implementation of the STL algorithm, with the loess part in C and the rest in R. Moving a lot of the code to R makes it easier to experiment with the method at a very minimal speed cost. Recoding in C instead of using R's built-in loess results in better performance, especially for larger series.

### Author(s)

Ryan Hafen

### References

R. B. Cleveland, W. S. Cleveland, J. E. McRae, and I. Terpenning (1990) STL: A Seasonal-Trend Decomposition Procedure Based on Loess. *Journal of Official Statistics*, **6**, 3–73.

### See Also

[plot.stlplus](#) for plotting the components, [getraw](#), [seasonal](#), [trend](#), [remainder](#) for accessing the components.

**Examples**

```
co2_stl <- stlplus(
  co2,
  t = as.vector(time(co2)),
  n.p = 12,
  l.window = 13,
  t.window = 19,
  s.window = 35,
  s.degree = 1,
  sub.labels = substr(month.name, 1, 3)
)

plot(co2_stl, ylab = "CO2 Concentration (ppm)", xlab = "Time (years)")
plot_seasonal(co2_stl)
plot_trend(co2_stl)
plot_cycle(co2_stl)
plot_rembycycle(co2_stl)

# post-trend smoothing

co2_stl_pt <- stlplus(
  co2,
  t = as.vector(time(co2)),
  n.p = 12,
  l.window = 13,
  t.window = 19,
  s.window = 35,
  s.degree = 1,
  sub.labels = substr(month.name, 1, 3),
  fc.degree = c(1, 2),
  fc.window = c(201, 35),
  fc.name = c("long-term", "so. osc.")
)

plot(
  co2_stl_pt,
  scales = list(y = list(relation = "free")),
  ylab = "CO2 Concentration (ppm)",
  xlab = "Time (years)",
  aspect = 0.25,
  type = c("l", "g")
)

# with NAs

y <- co2
y[201:224] <- NA

y_stl <- stlplus(
  y,
  l.window = 13,
  t.window = 19,
```

```
s.window = 35,
s.degree = 1,
sub.labels = substr(month.name, 1, 3)
)

plot(
  y_stl,
  ylab = "CO2 Concentration (ppm)",
  xlab = "Time (years)",
  type = c("l", "g")
)
plot_seasonal(y_stl)
plot_trend(y_stl)
plot_cycle(y_stl)
plot_rembycycle(y_stl)

# if you don't want to use a time series object:
y_stl <- stlplus(
  y,
  t = as.vector(time(y)),
  n.p = 12,
  l.window = 13,
  t.window = 19,
  s.window = 35,
  s.degree = 1,
  sub.labels = substr(month.name, 1, 3)
)

# with an outlier
y2 <- co2
y2[200] <- 300

y2_stl <- stlplus(
  y2,
  t = as.vector(time(y2)),
  n.p = 12,
  l.window = 13,
  t.window = 19,
  s.window = 35,
  s.degree = 1,
  sub.labels = substr(month.name, 1, 3),
  outer = 10
)

plot(y2_stl, ylab = "CO2 Concentration (ppm)", xlab = "Time (years)")
plot_seasonal(y2_stl)
plot_trend(y2_stl)
plot_cycle(y2_stl)
plot_rembycycle(y2_stl)

# compare to R's stl

x1 <- stlplus(
```

```
    co2,
    t = as.vector(time(co2)),
    n.p = 12,
    l.window = 13,
    t.window = 19,
    s.window = 11,
    s.degree = 1,
    sub.labels = substr(month.name, 1, 3)
)

x2 <- stl(co2, l.window = 13, t.window = 19, s.window = 11, s.degree = 1)

# will be different due to interpolation differences
plot(seasonal(x1) - seasonal(x2))

# but not if all jump parameters are 1
x1 <- stlplus(
  co2,
  t = as.vector(time(co2)),
  n.p = 12,
  l.window = 13,
  t.window = 19,
  s.window = 11,
  s.degree = 1,
  sub.labels = substr(month.name, 1, 3),
  s.jump = 1,
  t.jump = 1,
  l.jump = 1
)

x2 <- stl(
  co2,
  l.window = 13,
  t.window = 19,
  s.window = 11,
  s.degree = 1,
  s.jump = 1,
  t.jump = 1,
  l.jump = 1
)

plot(seasonal(x1) - seasonal(x2))
```

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