Estimate Spectral Density of a Time Series by a Smoothed Periodogram

Description

`spec.pgram` calculates the periodogram using a fast Fourier transform, and optionally smooths the result with a series of modified Daniell smoothers (moving averages giving half weight to the end values).

Usage

```
spec.pgram(x, spans = NULL, kernel, taper = 0.1,
           pad = 0, fast = TRUE, demean = FALSE, detrend = TRUE,
           plot = TRUE, na.action = na.fail, ...)
```

Arguments

`x`	univariate or multivariate time series.
`spans`	vector of odd integers giving the widths of modified Daniell smoothers to be used to smooth the periodogram.
`kernel`	alternatively, a kernel smoother of class `"tskernel"`.
`taper`	specifies the proportion of data to taper. A split cosine bell taper is applied to this proportion of the data at the beginning and end of the series.
`pad`	proportion of data to pad. Zeros are added to the end of the series to increase its length by the proportion `pad`.
`fast`	logical; if `TRUE`, pad the series to a highly composite length.
`demean`	logical. If `TRUE`, subtract the mean of the series.
`detrend`	logical. If `TRUE`, remove a linear trend from the series. This will also remove the mean.
`plot`	plot the periodogram?
`na.action`	`NA` action function.
`...`	graphical arguments passed to `plot.spec`.

Details

The raw periodogram is not a consistent estimator of the spectral density, but adjacent values are asymptotically independent. Hence a consistent estimator can be derived by smoothing the raw periodogram, assuming that the spectral density is smooth.

The series will be automatically padded with zeros until the series length is a highly composite number in order to help the Fast Fourier Transform. This is controlled by the `fast` and not the `pad` argument.

The periodogram at zero is in theory zero as the mean of the series is removed (but this may be affected by tapering): it is replaced by an interpolation of adjacent values during smoothing, and no value is returned for that frequency.

Value

A list object of class `"spec"` (see `spectrum`) with the following additional components:

`kernel`	The `kernel` argument, or the kernel constructed from `spans`.
`df`	The distribution of the spectral density estimate can be approximated by a (scaled) chi square distribution with `df` degrees of freedom.
`bandwidth`	The equivalent bandwidth of the kernel smoother as defined by Bloomfield (1976, page 201).
`taper`	The value of the `taper` argument.
`pad`	The value of the `pad` argument.
`detrend`	The value of the `detrend` argument.
`demean`	The value of the `demean` argument.

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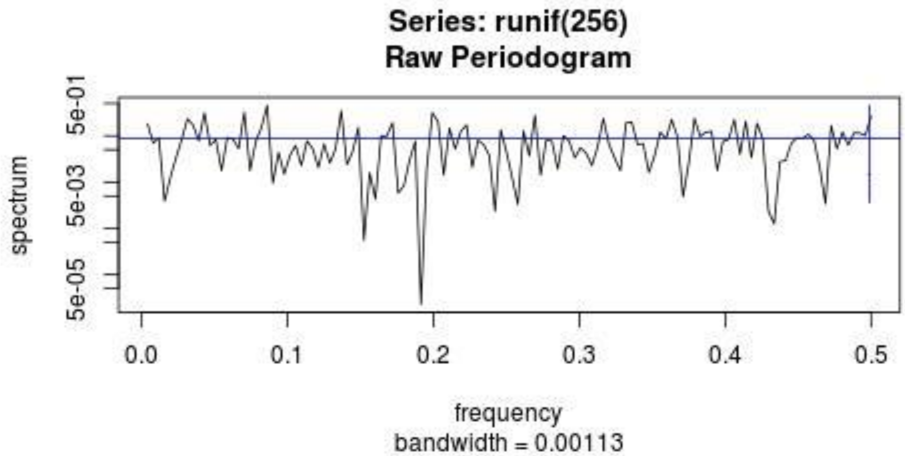
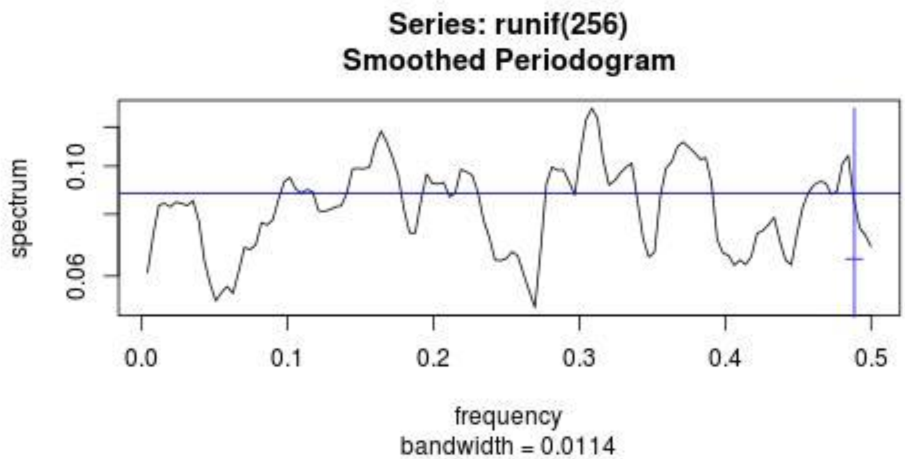
Two uses of empirical power spectrum.

1. Checking random number generator (e,g, for simulations)

2. Examining residuals of an arima fit (Course report)

```
jpeg(file="figspecpgram.jpg")
set.seed=022714
par(mfrow=c(2,1))
junk<-spec.pgram(runif(256),taper=.0,demean=T,detrend=F)
abline(h=mean(junk$spec),col="blue")
spec.pgram(runif(256),taper=.0,demean=T,detrend=F,spans=10)
abline(h=mean(junk$spec),col="blue")
graphics.off()
```


Series: runif(256)
Raw Periodogram
spectrum
5e-01
5e-03
5e-05
0.0
0.1
0.2
0.3
0.4
0.5
frequency
bandwidth = 0.00113


Series: runif(256)
Smoothed Periodogram
spectrum
0.10
0.06
0.0
0.1
0.2
0.3
0.4
0.5
frequency
bandwidth = 0.0114