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

```r
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.

Two uses of empirical power spectrum.

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

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

```r
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()
```