Fourier analysis with R

Exercise 1 Fourier analysis of the sea surface temperature

We shall study the sea surface temperature averaged over NINO3 region, format= 3F8.2
Data from UKMO GISST2.3 (1871-1996) and Reynolds SST (Jan 1997-)

The data an be downloaded at
`https://raw.githubusercontent.com/chris-torrence/wavelets/master/nino3data.asc`

1. Import the data
2. Names the columns. Visualize the data
   `names(nino) <- c("Year", "SST", "SSA")`
   `plot(nino`$Year, nino$``SST, type = "l")`
3. Plot autocorrelation of the two variables `SST` and `SSA`
4. We now want to identify the harmonics of the signal. The guess is that the following periods (in years) are present in the signal : $1, .5, 3, 3.5, 6 and 0.99$. Can you confirm this guess using a spectral ANOVA?
5. EStimate the periodogram first in a rough way, and thereafter smoothing the signal. Does tapering improve the estimation?

Exercise 2 Bivariate data

We study the dynamic of an epidemy in in Bangkok : the dengue, distinguishing several forms of the ailment. The periodicity (also found in Peru, Bangladesh, etc.) is believed to be due to intrinsic dynamics of the infection, i.e., waxing and waning of susceptible pool. Similar to dynamics of (e.g.) measles in UK (Grenfell et al. 2001).

We can use data made available by the NOAA Dengue Forecasting Project to evaluate the spectral properties of dengue cases in San Juan, Puerto Rico.

The data are available at
`https://dengueforecasting.noaa.gov/`

1. Import the data. Convert it in a `ts` format. Visualize the data
2. Plot the power spectrum for the total cases. Truncate at first 100 values for plotting because spectrum is totally flat for more than about 3 years
3. What can you say about coherence of Dengue 1 and Dengue 2

Exercise 3 Unevenly spaced time series

The Lincoln Near Earth Asteroid Research (LINEAR) project, in existance since 1998, is designed to discover and track near-earth asteroids. Its archive contains several million images of the sky, and its combination of sensitivity and sky coverage has made it a valuable resource to study time-domain astronomy, including variable stars. This dataset provides phased light curves for over 7000 variable stars. We consider a specific star and try to find periodicities in its light curve

1. Import the data. What do you observe?
2. PLot its periodogram taking into ascount the irregular spacing of the time series