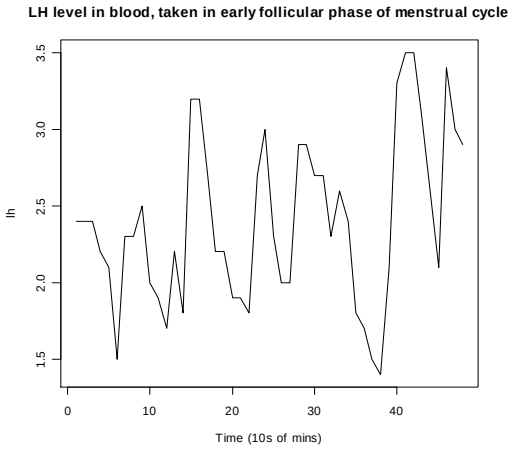
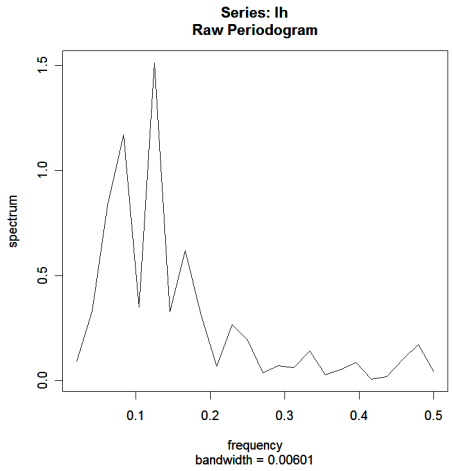
Activity Solution: Periodogram Example

Recall the lh data, which gives the luteinizing hormone in blood samples at ten–minute intervals from a woman over an eight–hour time period. Here $N = 48$ and the data are plotted below:



1. Do the data appear to exhibit a cyclical effect? If so, how many cycles would you say were completed over the eight–hour time period?
   The plot does look somewhat cyclical, and perhaps completes six cycles over the course of the data.

2. Below is the raw periodogram for the data:



With the spectrum defined by `speclh`, R gives the following output when the variable `speclh$spec` is requested:
[1] 0.0911898 0.3314097 0.8361633 1.1675191 0.3503261 1.5100681
[7] 0.3276504 0.6176052 0.3195217 0.0674837 0.2672661 0.1930028
[13] 0.0387230 0.0720544 0.0622593 0.1421169 0.0293408 0.0516868
[19] 0.0870812 0.0081209 0.0193492 0.1008816 0.1725781 0.0437020
Which frequency has the largest contribution to the spectrum? What is the wavelength of this frequency?
The largest value occurs at the 6th harmonic, so this is at frequency

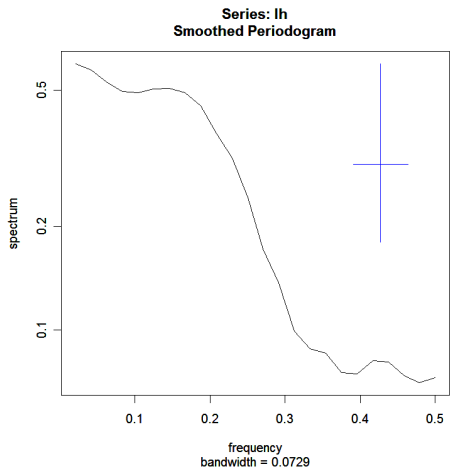
$$f_6 = \frac{6}{48} = \frac{1}{8}$$

cycles per unit time, where "unit time" here is ten minutes. This suggests a wavelength of around eighty minutes, completing six cycles over the course of the series.

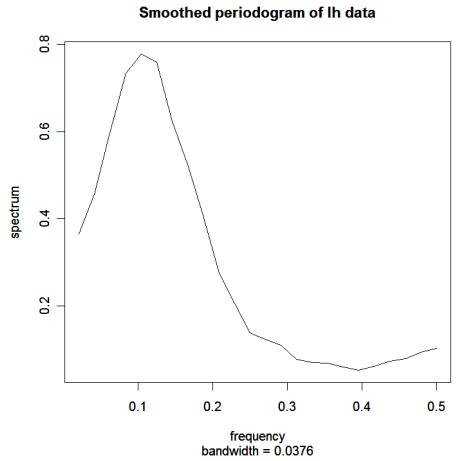
3. Are the data consistent with a series having a frequency component that is exactly sinusoidal? Explain your answer.
No, the cyclical component is not behaving like a simple sinusoidal model, since there are non-negligible periodogram values at other frequencies that contribute to the variation in the data.

4. Which of the following do you think is the better smoothed periodogram?

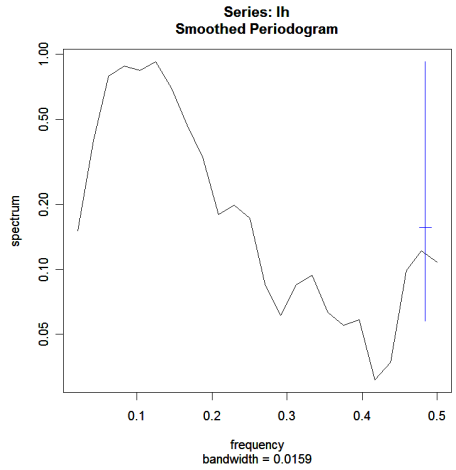
   (a) `speclh <- spec.pgram(lh, spans=12)`



(b) `specl h <- spec.pgram(lh, spans=6)`



(c) `specl h <- spec.pgram(lh, spans=3)`



The choice (b) looks best of the three given, (a) being oversmoothed and (c) somewhat undersmoothed.