Computer Exercise 4 OAF2

For a proposal to the European Southern Observatory you need to justify the amount of telescope time you request. The goal of the proposal is to measure orbital periods of the binary stars in the field of view via time series photometry of 12 square degrees on the sky. In order to cover the whole 12 square degrees you need 64 separate pointings of the telescope. In total, it takes 3.2 hours to obtain those 64 pointings. Per observing night you can observe each of the 64 fields 3 times.
Assume that the amplitude of the sinusoidal orbital variability that you try to measure is 0.5 magnitudes. The goal is to calculate via Monte Carlo simulations how much of the periodicities you will be able to measure using a Lomb–Scargle method with 10 nights of observing time (hence 30 photometry data points per star) and how much you will be able to measure with 5 nights of observing time. Investigate two test cases; namely the case that the uncertainty on the photometric data points is 0.1 magnitudes and the case that the uncertainty is 0.3 magnitudes.

a: Start by generating a sinusoidal curve with an amplitude of 0.5 magnitudes with a period of 1 day.

b: Generate your simulated data set by sampling the sinusoid generated in **a** according to the sampling dictated by the observational constraints (3 data points per night) and according to the uncertainty on the measurement. I.e. take a random draw from the y-value given by the sinusoid plus or minus the uncertainty of the measurement (for now take 0.1 magnitudes as the variance on the data point) for the y-value of the data point.

c: Run a Lomb-Scargle period search on the light curve that your data set describes. If the Lomb-Scargle has a significant peak within 3 per cent of your input period you can assume that you have recovered the orbital period.

d: Depending on how you device the observations one can obtain 1 data point every 3.2 hours. For instance if you observe field 1 through 64 sequential and after you observed field 64 you start again with field 1 etc. However, what happens to the periodogram if you randomise the order in which you observe each field 1-64 (for instance you first observe field 6 then 9 then 2 then 60 etc, note that you need to observe all fields once in 3.2 hours).

e: Repeat the sequence **a-c** 100 times for a (pseudo) random selection of fields as described by **d**.

f: Repeat **e** for orbital periods ranging between 1 hour and 2 days (take for instance 100 periods in this range). Generate plots of the recovery rate as a function of orbital period, for the 4 cases under study (5 or 10 nights observing, uncertainty on the measurement of 0.1 or 0.3 magnitudes).