EXERCISES 3 FYSY115, spring 2017

Return as an email attachment to taneli.kalvas@jyu.fi no later than 14 February at 12:15 (before lecture). The email title should include FYSY115/Harjoitus 3. If the exercises are made with a partner include the names of the team.

Make each exercise to its own script/function file.

1.Write a function file, which receives a matrix as an argument. The function calculates a sum of the non-negative elements in the upper triangle of the matrix and returns this value. Tips: The function should go through all the elements of the matrix using two for-loops within each other. If the element (i, j) belongs to the upper triangle (meaning that the row $i <$ column j) and the value of the element is non-negative it will be accumulated to a sum variable.

2. Write a function file, which takes a decimal number n as argument and calculates according to the following algorithm: Repeat as long as n is greater than one. If n is even, halve n ($n = n/2$). If n is odd replace it with $3n + 1$. Print out (on a single line) the numbers of the sequence. The function returns the length of the sequence. Example: If $n = 11$ the function prints out "11 34 17 52 26 13 40 20 10 5 16 8 4 2 1" and returns 15.

3. Unknown flying object has a trajectory

$$x = \tan(\frac{t}{10})$$
$$y = \exp(\frac{-t}{3})\sin(t) - \frac{t^2}{20} + 3,$$

where t is time. A radar gives the objects location every 300 ms at moments of time $t = 0$ s, 0.3 s, 0.6 s, ... The object hits ground at altitude $y = 0$ at about $t = 8$ s. Write a script, which forms location vectors x and y at moments of time defined by the radar. Go though the data points using a loop structure until you find the collision time. The collision happens between data points i and $i+1$ for which $y_i \geq 0$ and $y_{i+1} < 0$. Using coordinates y_i and y_{i+1} find using linear interpolation the moment of impact in seconds. Calculate also using linear interpolation the x-location of impact.

4. The data file `data34.txt` contains a signal waveform recorded with an oscilloscope. Calculate the frequency of the waveform by finding the first two points in time (t_1 and t_2) where

the sign of the signal changes from positive to negative. The frequency can then be calculated as $f = \frac{1}{t_2 - t_1}$. Present the waveform and the time instances t_1 and t_2 in a plot.

5. The noise in the previous data is just small enough for the algorithm to work. Deducing the frequency of the signal in data file `data35.txt` will not work. There is too much noise. In these cases it is useful to do low pass filtering to the signal. The low pass filtered signal can be calculated as

$$y_i = \alpha x_i + (1 - \alpha) y_{i-1},$$

where x is the original signal and the coefficient

$$\alpha = \frac{\Delta_T}{RC + \Delta_T}.$$

Here Δ_T is the sampling period and the time constant RC depends on the filter cut frequency $RC = 1/(2\pi f_c)$. Set the cut frequency as 10 kHz. Present the original signal and the filtered signal in the same figure. Notice that to calculate the first data point y_1 you will refer to the point y_0 which does not exist. You can assume that $y_0 = 0$.