

### Exercise 3: Time Series Analysis – Part III

- Regression Analysis -

Group:	Surname, Given Name:	Matriculation number:	Signature*:

\* With my signature I declare that I was involved in the elaboration of this exercise.

**Deadline: 11.12.2025**

### Test Certificate

Received on:

\_\_\_\_\_ Date \_\_\_\_\_

Final Mark

Signature

### Objective

This exercise deals with regression analysis in time series as well as the evaluation of a determined trend using statistical tests.

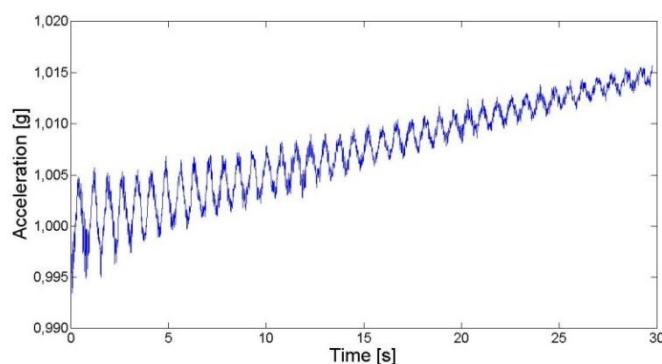


Figure 1: Acceleration measurements

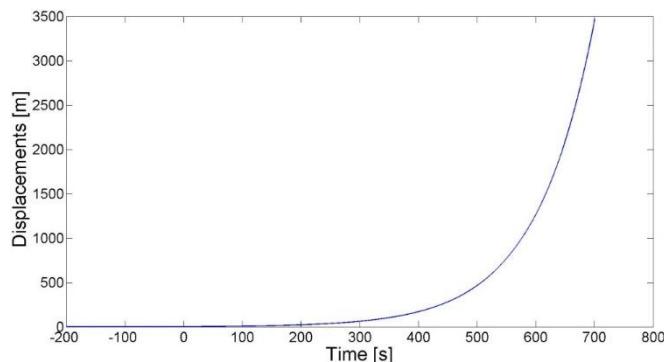


Figure 2: Derived displacements

### **Task 1: linear trend models**

- In the files “Exercise3-1.txt” and “Exercise3-2.txt” two time series are given, where the first column represents the time axis and the second column the  $x(t)$  values, see Figure 1.
- Load and plot both time series.
- Perform a regression analysis and chose an appropriate functional model for each time series while the  $x(t)$  values are equally weighted and uncorrelated measurements and the time  $t$  is regarded as error free.
- Interpret the results.

### **Task 2: linear trend models**

- Load the time series from the file “Exercise3-3.txt”, where the first column represents the time axis and the second column the  $x(t)$  values.
- Plot the time series.
- Perform an adjustment in order to determine the coefficients  $\beta_i$  of a polynomial in such a way that the function fits as good as possible to the time series while the  $x(t)$  values are equally weighted and uncorrelated measurements and the time  $t$  is regarded as error free.
  - Start with a functional model for a straight line:  $x(t) = \beta_1 + \beta_2 t$
  - Create a bar plot for the residuals
  - Evaluate each adjusted coefficients  $\beta_i$  with an appropriate statistical test by using an error probability of  $\alpha = 5\%$
  - Interpret the results
  - In case that all coefficients are significant and systematic effects are left in the residuals, increase the number of coefficients by 1 and repeat all previous steps
- Repeat this procedure until no further systematic effects in the residuals are visible and the newest coefficient is statistically not significant

### **Task 3: nonlinear trend models**

- In the files “Exercise3-4.txt”, “Exercise3-5.txt” and “Exercise3-6.txt” three time series are given, where the first column represents the time axis and the second column the  $x(t)$  values, see Figure 2.
- Load and plot the time series.
- Perform a regression analysis and choose an appropriate model for each time series while the  $x(t)$  values are equally weighted and uncorrelated measurements and the time  $t$  is regarded as error free.
- Remove the nonlinear trend for each time series and plot the resulting detrended time series.
- Interpret the results.

### **Task 4:**

- Compare the resulting detrended time series from “exercise3-5.txt” and “exercise3-6.txt”.
- Calculate the differences between both detrended time series.
- Interpret the differences.
  - Background: The differences should be zero, as the same original time series was used for both examples.