

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.

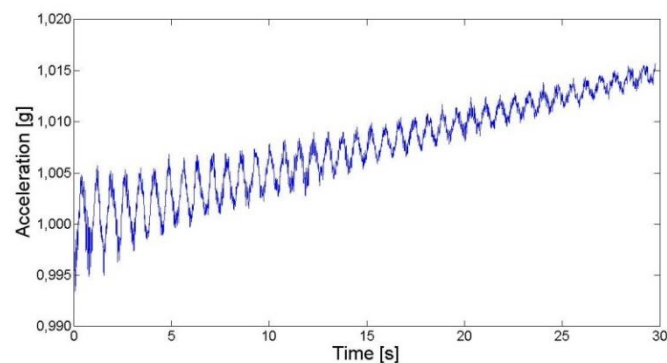


Figure 1: Acceleration measurements

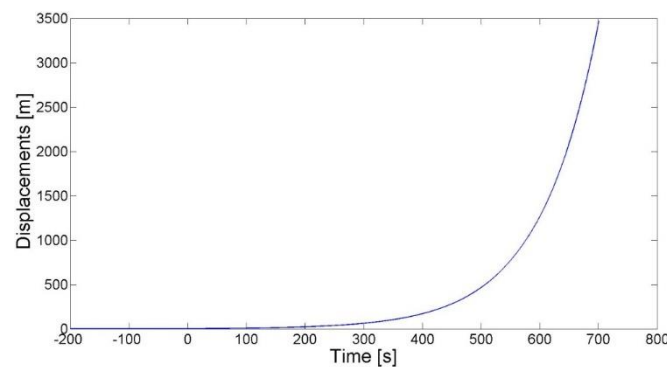


Figure 2: Derived displacements

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 β_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 β_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.