

## Homework 1: Fundamentals of statistics

- Frequency functions, probability density and distribution function -

Surname, Given Name:	Matriculation number:	Deadline: <b>17.11.2016</b>
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### Test Certificate

1. Received on: \_\_\_\_\_  
Date Signature

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☐ Resubmission not later than: \_\_\_\_\_  
Date Signature, Date

2. Received on: \_\_\_\_\_  
Date Signature

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☐ Finally unacknowledged \_\_\_\_\_  
Signature, Date

### Objective

This exercise is based on the knowledge about absolute, relative and cumulative frequency function as well as the determination of variance and standard deviation of a series of measurements. In addition it will focus on the determination of distribution and probability density functions as well as expectation, mean value and standard deviation. Furthermore the correlation of two random variables has to be determined and the variance-covariance matrix for given correlations has to be set up.

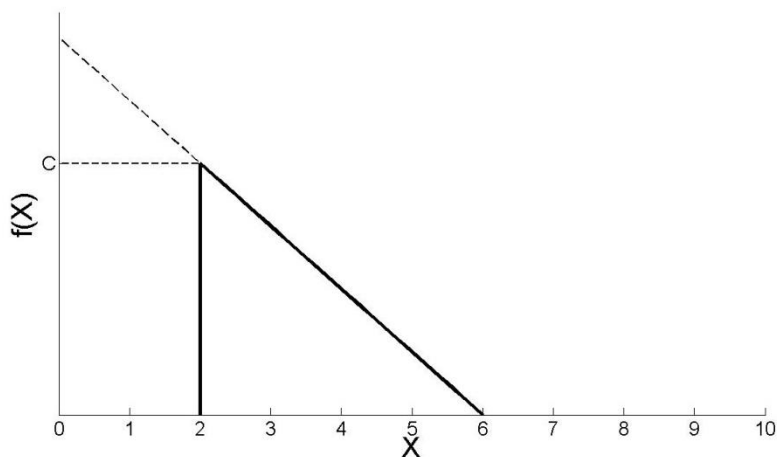


Figure 1: Probability density function

In addition to the surveyed angles from exercise 2 one side of the triangle has been measured too. In this case the expectation is unknown. The distance measurements can be found in “distances.txt”.

#### Tasks 1:

- Load the measurements from “distances.txt”
- Plot the following graphs for the given distances
  - Absolute frequency function / polygon
  - relative frequency function / polygon
  - cumulative frequency function / polygon
- Comment the graphs
- Calculate the mean value, variance and standard deviation of a single observation as well as for the arithmetic mean
- Question: How often do you have to measure this distance with the previously determined standard deviation in order to obtain an accuracy for the arithmetic mean of  $s_{\bar{L}} \leq 0.1 \text{ mm}$ ?

A sketch of an observed levelling network is depicted in Figure 2 whereas the measured height differences  $L_1$  to  $L_8$  from forward and return levelling are stored in “levelling.txt”.

#### Tasks 2:

- Load the measurements from “levelling.txt”
- Calculate the difference for each height difference between forward and return levelling
- Calculate the standard deviation of a single observation as well as for arithmetic mean from forward and return measurements

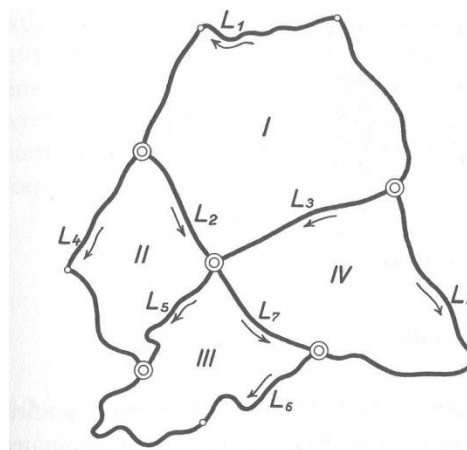


Figure 2: Sketch of a leveling network

#### Tasks 3:

- Calculate and interpret the correlation coefficient from the following variance-covariance matrix

$$\Sigma_{LL} = \begin{bmatrix} 0.01 & 0.0135 \\ 0.0135 & 0.09 \end{bmatrix}$$

- Set up the variance-covariance matrix for the following given standard deviations and correlation coefficient
  - $\sigma_1 = 0.01 \text{ m}, \sigma_2 = 0.025 \text{ m}, \rho_{12} = 0.85$
  - $\sigma_1 = 1.0 \text{ mgon}, \sigma_2 = 0.025 \text{ m}, \rho_{12} = -0.50$

**Tasks 4:**

- Determine the coefficient  $c$
- Describe the graphical representation of the probability density function in an analytical form
- What is the distribution function  $F(X)$  for a random variable  $X$ ?
- Calculate the expectation  $E(X)$
- Calculate the standard deviation for a random variable  $X$
- What is the probability for a realisation  $x$  of a random variable  $X$  that is smaller than 0?  
$$p(x < 0)$$
- What is the probability for a realisation  $x$  of a random variable  $X$  that is equal 3?  
$$p(x = 3)$$
- What is the probability for a realisation  $x$  of a random variable  $X$  that falls into the interval  $[4, 5]$ ?

$$p(4 \leq x \leq 5)$$