Technische Universität Berlin

Chair of Geodesy and
Adjustment Theory

Adjustment Theory I

Winter Term 2023/24

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Exercise 2: Fundamentals of statistics
- Frequency functions, probability density and distribution function -

Group:	Surname, First name:	Matriculation number:	Signature*:

* With my signature I declare that I was involved in the elaboration of this homework.
Submission until: **10.11.2023**

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.
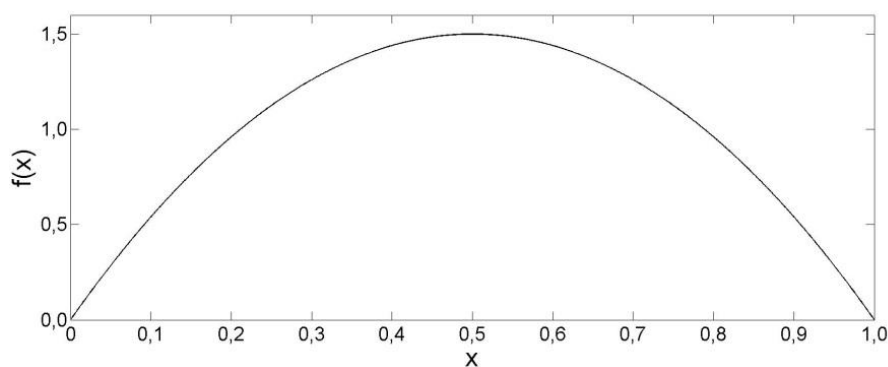

Figure 1: Probability density function

Task 1:

Figure 1 is showing a probability density function

$$f(x) = 6x - 6x^2 \quad x \in [0,1]$$

for a random variable X. Use this function to calculate the following parameters.

- 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
$$P(x > 1.1)$$
  that is bigger than 1.1?
- What is the probability for a realisation x of a random variable X
$$P(x = 0.35)$$
  that is equal 0.35?
- What is the probability for a realisation x of a random variable X
$$P(0 \leq x \leq 0.5)$$
  that falls into the interval $[0, 0.5]$?

Task 2 (Homework):

In Figure 2, a probability density function for a random variable $\boldsymbol{X}$ is described by a triangle. Use the graph to calculate the following parameters.

- 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
$$P(x < 0)$$
  that is smaller than 0?
- What is the probability for a realisation x of a random variable X
$$P(x = 3)$$
  that is equal 3?
- What is the probability for a realisation x of a random variable X
$$P(4 \leq x \leq 5)$$
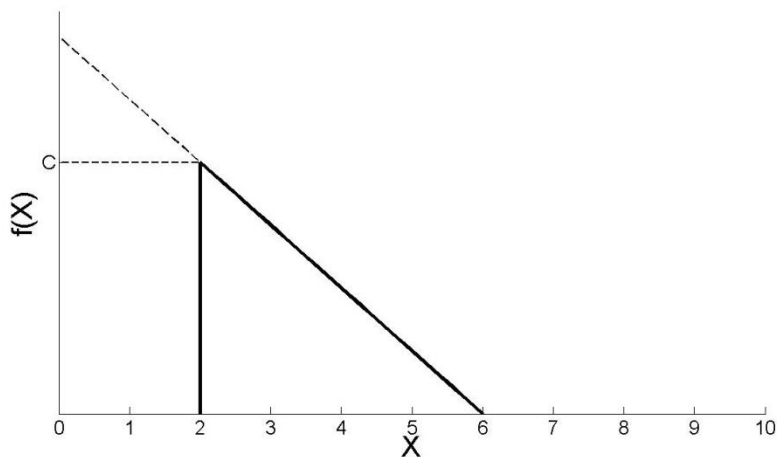 that falls into the interval $[4, 5]$?

Figure 2: Probability density function

Task 3 (Homework):
During a survey the students measured one side of a triangle. So, the expectation is unknown. The measurements are stored in the file "*distances.txt*".
- 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.
- 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 a precision for the arithmetic mean of $s_{\bar{l}} \leq 0.1$ mm?