Technische Universität Berlin

Adjustment Theory I

Chair of Geodesy and
Adjustment Theory

Winter Term 2023/24

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Exercise 3: Propagation of observation errors - part I
- Propagation of variances and covariances -

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

* With my signature I declare that I was involved in the elaboration of this homework.
Submission until: **17.11.2023**

Objective

This exercise deals with the propagation of variances of uncorrelated observations for <u>one</u> unknown parameter.

Task 1:

The sides $a = 15.00$ m and $b = 25.00$ m of a rectangle are determined with a standard deviation of $\sigma_a = 3$ cm and $\sigma_b = 4$ cm.

- Calculate the area of the rectangle and its standard deviation.

Task 2:

The sides $b = 15.00$ m and $c = 25.00$ m as well as the angle $\alpha = 55.0$ gon of the triangle depicted in Figure 1 are determined with a standard deviation of $\sigma_b = 3$ cm, $\sigma_c = 4$ cm and $\sigma_\alpha = 0.1$ gon.

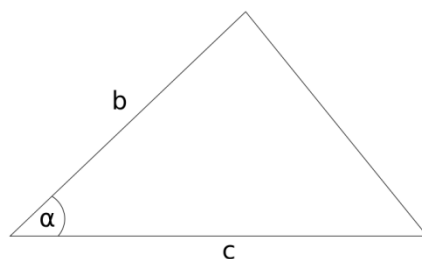- Calculate the area of the triangle and its standard deviation.

Figure 1: Triangle

Task 3:

The radius $r = 100$ m of circle is determined with a standard deviation of $\sigma_r = 1$ cm.

- Calculate the area of the circle and its standard deviation.

Task 4:

The circumference $c = 30$ cm of circle is determined with a standard deviation of $\sigma_c = 1$ mm.

- Calculate the radius of the circle and its standard deviation.

Task 5 (Homework):

The standard deviation of a distance, measured with a 20 m measuring tape, is $\sigma_d = 4$ mm.

- Calculate the standard deviation of a distance of 100 m.

Task 6 (Homework):

During an exercise the students had the task to determine the height of the main building with the usage of a stopwatch. Empirical investigations have shown that one student was able to measure the time of an event with a precision of $s_t = 0.1$ s. Upon the roof, the students took a small but heavy ball and started the time measurements when they dropped the ball and stopped the time measurements when the ball hits the ground. The time measurements are depicted in Figure 2.

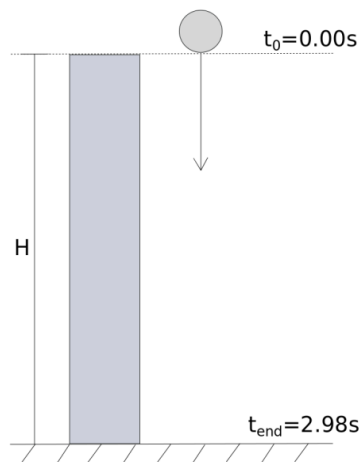- Calculate the height H of the main building and its standard deviation.

Figure 2: Height determination

Task 7 (Homework):

At a starting point with time $t_0 = 0$ s a car is moving with a velocity $v_0 = 15$ $^m/_s$ measured with a standard deviation $\sigma_{v_0} = 0.2$ $^m/_s$. Furthermore, the car is accelerating with $a = 2$ $^m/_{s^2}$ measured with a standard deviation $\sigma_a = 0.1$ $^m/_{s^2}$.

- How much time does the car need to travel 1 km from the starting point $x_0(t = t_0) = 0$?

- How much is its standard deviation?