Exercise 5: Free Network Adjustment Calculation

- Combined horizontal network -

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

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

Deadline: 10.06.2021

Test Certificate

Received on: _____ _____ _____

Date Grade Signature

Objective

This exercise deals with the free net adjustment of the combined horizontal network depicted in Figure 1. Furthermore different datum definitions will be applied in order to compare the adjusted observations.

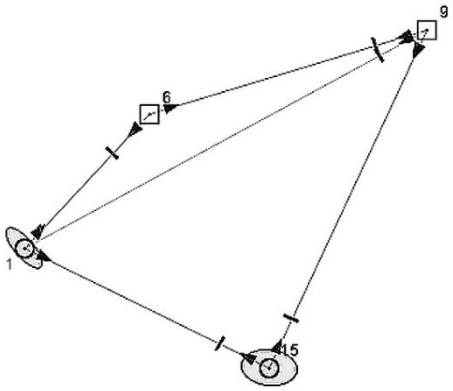

Figure 1: Combined horizontal network

Table 1: Observed distances and directions

From	To	Horizontal directions [gon]	Horizontal distances [m]
1	6	148.0875	
	15	228.9044	
6	1	248.0883	4307.851
	9	81.1917	
9	15	207.9027	
	1	248.4428	10759.852
	6	261.1921	6806.332
15	1	358.9060	6399.069
	9	57.9014	8751.757

Table 2: Gauss-Krueger coordinates for new points

Point No.	Easting [m]	Northing [m]
6	53 17 651.428	49 68 940.373
9	53 24 162.853	49 70 922.160
1	53 14 698.13	49 65 804.18
15	53 20 448.85	49 62 997.53

Task 1:

Initial values for the Gauss-Krueger coordinates of the new points are given in Table 2 and the measurements of the combined horizontal network are listed in Table 1. The observed distances have been performed with a standard deviation of 10 cm and they are already reduced into the Gauss-Krueger projection. The observed directions have been performed with a standard deviation of 1 mgon and all measurements (distances and directions) are uncorrelated.

1. Perform a free net adjustment of the given combined horizontal network while all points are contributing to the datum definition ("Total trace minimisation").
   a. Use the $\mathbf{G}$ matrix containing the eigenvector related to the eigenvalue zero for the extension of $\mathbf{N}_{ext} = \begin{bmatrix} \mathbf{N} & \mathbf{G} \\ \mathbf{G}^{\mathrm{T}} & \mathbf{0} \end{bmatrix}$.
   b. Use the matrix $\mathbf{B}$ for the extension of $\mathbf{N}_{ext} = \begin{bmatrix} \mathbf{N} & \mathbf{B} \\ \mathbf{B}^{\mathrm{T}} & \mathbf{0} \end{bmatrix}$.
2. Perform a free net adjustment of the combined horizontal network while point *6* and *9* are supposed to contribute to the datum definition ("Partial trace minimisation").
3. Perform a free net adjustment of the combined horizontal network while this time point *6* and *1* are supposed to contribute to the datum definition ("Partial trace minimisation").
4. Plot a sketch of the adjusted network of subtasks 1) to 3) to visualise the different effects of each datum definition.
5. **(Homework):** Compare the cofactor matrices of the unknowns of subtasks 1) to 3) with the pseudo inverse $\mathbf{N}^{+}$. Which adjustment method leads to $\mathbf{Q}_{11}$ coinciding with $\mathbf{N}^{+}$ and why does that coincidence occur?

Task 2 (Homework):

During the last lectures you have learned that the values of the Lagrange multipliers can be interpreted as the impact of the constraints on the adjustment.

1. Calculate the Lagrange multiplier k_i for the tasks 1.1 to 1.3.
2. Interpret the values k_i.

Task 3:

This task deals with the transformation of adjusted unknowns $\hat{\mathbf{X}}$ and the cofactor matrix of the adjusted unknowns $\mathbf{Q}_{\hat{\mathbf{X}}\hat{\mathbf{X}}}$ for different datum definitions using the *S*-Transformation.

1. Transform the adjusted unknowns $\hat{\mathbf{X}}$ and the cofactor matrix of the adjusted unknowns $\mathbf{Q}_{\hat{\mathbf{X}}\hat{\mathbf{X}}}$ of task 1.1 into the datum definition of task 1.3.
2. **(Homework):** Transform the adjusted unknowns $\hat{\mathbf{X}}$ and the cofactor matrix of the adjusted unknowns $\mathbf{Q}_{\hat{\mathbf{X}}\hat{\mathbf{X}}}$ of task 1.1 while this time point *1* and *15* are supposed to contribute to the datum definition.

Task 4 (Homework):

Initial values for the Gauss-Krueger coordinates of the new points are listed in Table 3 and Table 4. The measurements of the combined horizontal network are listed in Table 5. The observed distances have been performed with a standard deviation of $1\ \mathrm{mm}$ and are already reduced into the Gauss-Krueger projection. The observed directions have been performed with a standard deviation of $1\ \mathrm{mgon}$ and all measurements (distances and directions) are uncorrelated.

- Perform a free network adjustment of the given combined horizontal network while *all points in Table 3* are contributing to the datum definition.

Table 3: Gauss-Krueger coordinates for new points

ID	Easting [m]	Northing [m]
1000	4590337.390	5820823.642
2000	4589967.526	5820806.067
3000	4590078.021	5820681.807

Table 4: Gauss-Krueger coordinates for new points

ID	Easting [m]	Northing [m]
100	4590159.8	5820727.3
101	4589800.1	5820857.9
102	4590163.2	5820848.7
103	4589956.9	5820700.4

Table 5: Measurements

From	To	Distances [m]	Directions [gon]
1000	100	201.941	269.6980
	102	175.940	310.4634
2000	103	106.177	207.9866
	101	175.288	320.7754
3000	100	93.728	69.2435
	103	122.506	311.3932
100	1000	201.941	69.8977
	102	121.468	3.3149
	2000	207.826	326.2594
	3000	93.727	269.1427
101	103	222.323	151.8806
	2000	175.287	120.8758
102	1000	175.942	110.3651
	100	121.466	203.0060
	2000	200.334	287.5533
103	3000	122.507	111.2898
	2000	106.185	7.8869
	101	222.325	351.6806