**Geodetic Exercise 02**

**Input data:**

* A table of 9 points with Geographic coordinates in a source datum (ED50) and in a target datum (WGS84). Coordinates are in the format of degrees, minutes, and seconds (DMS).
* Datums’ parameters: “source: https://epsg.io/1311”
  + ED50: a = 6378388, f = 1.0 / 297
  + WGS84: a= 6378137, f=1.0/298.257223563

**Requirements:**

* Read the input data
* Calculate the 7-transformation parameter between the 2 systems.

**References for calculations:**

* EPSG Guidance Note 7-2 Coordinate conversions and transformations including formulas

**Steps:**

* Create 2 comma-separated text files for both source and target coordinates.
* Change from (DMS) format into the degrees format and save it into text files.
* Transform the coordinates from the geographic format into the cartesian format and save them into text files.
* Formulate the formulas between the 2 coordinate systems and use the least squares to solve for the 7 transformation parameters. (please find the equation in handwriting at the end of the document Fig.2 and Fig. 3).
* Matrices are populated using the 9 common points in the 2 systems.
* Note: when using the 9 points, the residuals were very big and the final transformation parameters were not accurate. However, when omitting point (8), the results were satisfying as shown in table (1). Perhaps, further check for this point is needed.

Table 1: the differences in calculating the seven parameters when using 8 and 9 points

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Dx | Dy | Dz | Rx | Ry | Rz | scale |
| With 9 points | 1566.917682 | 73.052551 | 2131.797471 | 0.000095 | -0.000028 | 0.000167 | -0.000438 |
| With 8 points | -89.687860 | -93.799149 | -123.355869 | 0.000000 | 0. 000000 | 0. 000001 | 0.000001 |

* Export the derived transformation parameters into a text file.
* Display the matrices A and b and the residuals and the computed target coordinates using the derived parameters on the screen to go through the steps visually.
* For further steps, the standard deviation for each derived parameter could be calculated. Additionally, the indirect transformation from XYX to Lat, Long, h could be done so that when we have geographic coordinates in ED50, we could use the transformation parameters to transform to the geographic coordinates in WGS 84.
* Figure 1 shows a screenshot of the program running.

**Program architecture:**

* In the Geodetic.Exercise.Shared, there are 2 classes (Geographic and Cartesian). The Geographic class contains some operations on the geographic data such as loading from files(which is being used in Ex01 and Ex02), converting DMS into degrees and Cartesians, etc.
* In Geodetic.Exercise.2, there is the program.cs and the Parameters class which contains all the operations of calculating the 7 parameters.

A screen shot of a computer

Description automatically generated**A screenshot of a computer

Description automatically generated**

Fig.1: A screen shot of the running program

A white sheet with math equations

Description automatically generated

Fig.2: Least squares formula

A white paper with red writing

Description automatically generated

Fig.3: Matrix population for one point