GIS-4: INTERPOLATION

GOAL:

- Import point data given as (x, y)-coordinates
- Interpolate to a continuous surface (elevation) using several interpolation methods
- Find an optimal interpolation method for thaw depth/snow cover
- Analyse the continuous surfaces

DATA:

Create a new folder named "GIS4" in \\hypatia.uio.no\lh-mn-geofag-felles\kurs\GEO3460 *"your username"*. The files we are going to use for this assignment are saved in the folder \\hypatia.uio.no\lh-mn-geofag-felles\kurs\GEO3460\GIS4 ". **Copy the two data sets listed in the table below to your working folder.** Note that shapefile (.shp) requires additional files to work properly, i.e. you also need to copy: Elevation_Jotun.cpg, Elevation_Jotun.dbf and so on.

Dataset	Description of the data
Elevation_Jotun.shp	Elevation points for a mountain area in Jotunheimen.
monthly_thaw_snow.dbf	Monthly thaw and snow measurements, Adventsdalen, Svalbard

PART 1: INTERPOLATION OF ELEVATION

- Open ArcGIS Pro and save the project in your working directory.

PART 1: INTERPOLATION OF ELEVATION

In this part of the exercise, you are going to interpolate elevation in the Jotunheimen using various interpolation methods and analyze the difference between them.

1) FIND GEOSTATISTICAL ANALYST TOOLBAR AND LOAD DATASET:

- Load the "Elevation_Jotun.shp" into ArcGIS Pro from the "GIS4-folder.
- **Note:** The Elevation_Jotun.shp has a stratified random sampling.

BEFORE YOU START:

- Process all interpolation methods listed below, and, for each, write down minimum and maximum predicted values and the Root-mean-Square value (RMS) (except for the Thiessen polygons).

- Note: the layers resulting from the interpolation processes are temporary map layers. To make them permanent (i.e. keep them as rasters once you close your project) you have to save them to disk: right-click on layer → Export Layer → To Rasters (use ".tif" Extension to save it as TIFF, e.g. "Kriging.tif"). Note that you cannot save .tif directly in a File Geodatabase (.gdb), so make sure your path in the field "Output raster" doesn't contain any ".gdb". Use output cell size= 100

THIESSEN POLYGONS:

1) Make Thiessen polygons from the dataset: Toolboxes → Analysis Tools → Proximity → Create Thiessen Polygons

2) Set "Input Features" as "Elevation_Jotun.shp", Output Feature Class: "Thiessen_hoyde.shp", Output Fields: "All fields". Change "Color Ramp" if you want to.

3) Define color for the shapefile by selecting Appearance → Symbology → Graduated colors. Field: HOEYDE (elevation). Method: Quantile. Choose any color scheme and number of classes.

4) The use of Thiessen polygons is a way to relate point data to space. What kind of geographical observations listed here is meaningful to represent with Thiessen polygons?
   - 1) Rainfall, 2) Meteorological stations, 3) Temperature

GLOBAL INTERPOLATION OF 2^{ND} AND 6^{TH} ORDER:

1) Analysis → Geostatistical Wizard  .

   Step 1: Method = Global Polynomial interpolation, Input data = Elevation_Jotun, Data Field = HOEYDE → Next

2) Step 2: Change the order of polynomial. Observe how the colours change. What do they mean? Why do we get this pattern? Choose order 2 → Next

3) Step 3: What do the values and the chart mean? Write down the minimum and maximum predicted values from the Table and the Root-Mean-Square (RMS) from the Summary. → Finish and export to raster (right-click → Export Layer → To Rasters), and repeat the same for a 6^{th} order polynomial.

LOCAL INTERPOLATION OF 2^{ND} AND 6^{TH} ORDER:

1) Analysis → Geostatistical Wizard  .

   Step 1: Method = Local Polynomial Interpolation, Input data = Elevation_Jotun, Data Field = HOEYDE → Next

2) Step 2: It is possible to choose the size of the neighborhood of the interpolation (Exploratory Trend Surface Analysis) from 100 % local (Value=100, small neighborhood) to

100% global (Value=0, the whole area is included in the neighborhood). Study the effect of changing these settings. Set the Order of Polynomial to 2. Write down the number of percentage in the “Exploratory Trend Surface Analysis”

3) Step 3: Write down the minimum and maximum predicted values from the table and the RMS-value. → Finish and export to raster, and repeat the same for a 6th order polynomial.

INVERSE DISTANCE WEIGHTING (IDW):

1) Analysis → Geostatistical Wizard .

1) Choose Inverse distance weighting, and datasets as before.

2) Step 2: Try out different numbers of neighbours (maximum/minimum), choosing a combination that produces a good result and write down the number of neighbours.

3) Step 3: Study the prediction map and the errors and write down the minimum and maximum predicted values from the table and the RMS-value. Finish the process and export to raster.

INTERPOLATE WITH KRIGING:

1) Analysis → Geostatistical Wizard → Kriging/CoKriging

2) Step 1: Datasets and attributes as before. Input Dataset 2 should be <none>. → Next

3) Step 2: Choose Ordinary kriging (first on the list) and Prediction (Later you can also try other types of kriging to explore the differences)

    a) Try first without removing any trend (Order of trend removal = None)

    b) Try to find out if there is a trend by studying the semivariogram and semivariogram map. If there is a trend, go back to step 2 and try a first order removal of trend. If there is still a trend, try a second order trend removal. Write down the nugget, range and sill sizes for the different settings you use (given in step 4 of 6). These can be used to explain the result.

4) The next window (step 5 of 6) shows how many neighbors the interpolation includes.

5) The last window shows the prediction map and errors.

3D

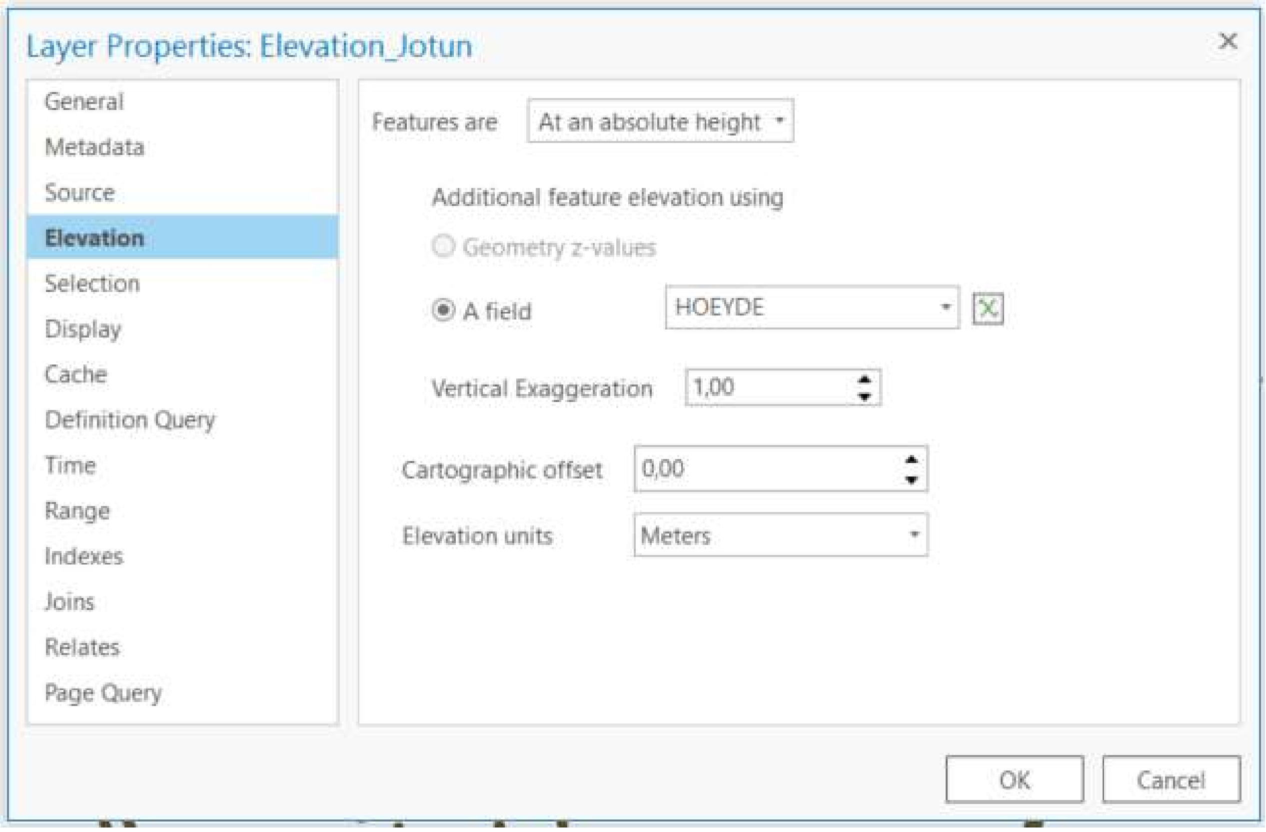
It is possible to look at the interpolations in 3D together with the correct elevation points. We want to compare these interpolation methods:

1) Global interpolation (2nd polynomial and 6th polynomial)
2) Local interpolation (2nd polynomial)

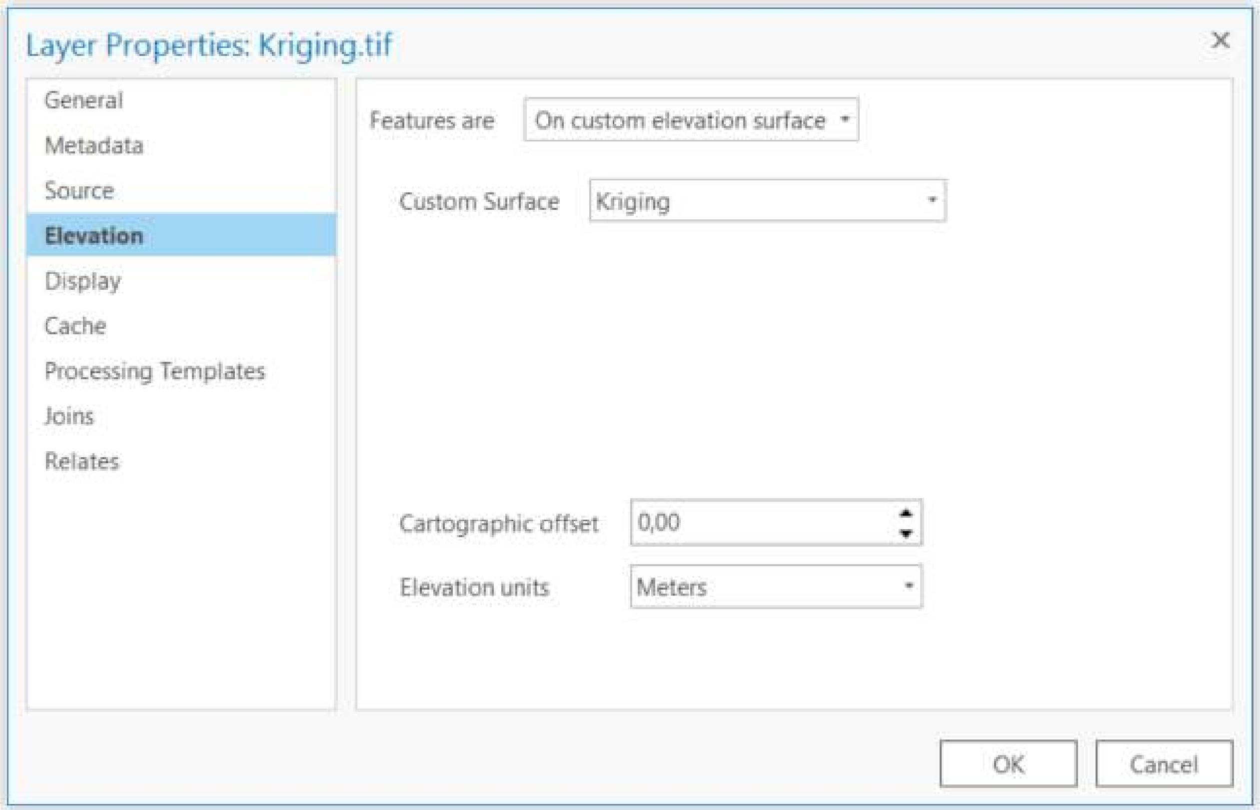
3) Inverse distance weighting (IDW)
4) Kriging

Go to Insert →New Map →New Local Scene. Local Scene allows displaying data in 3D.

1) Add “Elevation_Jotun.shp”. It will be added as “2D Layers”. We have to add more information so it will be shown as 3D layer. There are two ways:
    a) Alternative 1: Click on the layer name. Go to Appearance, Click on Type in the Extrusion group. Choose “Absolute Height”. Next to it, you should choose Field: “HOEYDE”.
    b) Alternative 2: Right-click on the layer name. Choose “Properties”, and go to “Elevation”. Modify the parameters as shown below. Move the layer from “2D Layers” to “3D Layers”.



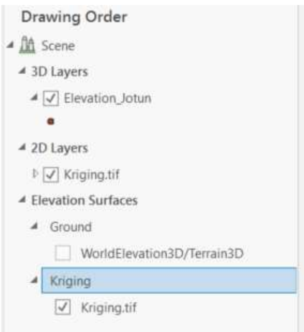
2) Right-click on “Elevation Surfaces” in the “Contents” pane. Choose “Create surfaces from sources”. Find a raster with interpolated data. This adds merely elevation data without any raster layer. Therefore, now you can add the same raster again using “Add Data” . After you add the raster, it will not float in 3D yet. Right-click on the raster name. Choose “Properties” and “Elevation”, change “Features are”: “On custom elevation surface”. Adjust custom surface.



3) Do this for all raster interpolations listed above.

NOTE! You can exaggerate the values so it is easier to visually interpret the results.
If you chose the Alternative 1: Click on the “Elevation_Jotun.shp” → ribbon with “Appearance”
→ Next to “Field” choose “Extrusion expression” = “$feature.HOEYDE*5” for Arcade or “[HOEYDE]*5” for VBScript.
If you chose the Alternative 2: Right-click on “Elevation_Jotun.shp”. Choose “Properties”, and go to “Elevation”. Modify “Vertical Exaggeration” to e.g. 5,00.

Only the points are exaggerated now. You can also exaggerate each interpolated raster by clicking on the group name in the “Contents” pane under “Elevation Surfaces”, i.e. the layer above .tif file:



A ribbon with "Appearance" should show, there you can choose "Vertical exaggeration". Choose 5,00 if you chose 5 for the points.

TASK PART 1:

Find out which interpolation methods that is local/global and exact/not exact. Together with the minimum, maximum and RMS-values, lists some advantages and disadvantages for the different interpolation methods. Which method seems to give the best result?

PART 2: INTERPOLATION OF THE ACTIVE LAYER AND SNOW SURFACE

In the data set "monthly_thaw_snow.dbf", both snow and thaw depth is sampled in a grid (regular sampling) every 10 meter (121 points) and the total size is 100x100m.

HOW TO IMPORT POINT FILES:

- Add the dataset to your project using "Add Data"
- In the Contents pane, right-click on the dataset and choose "Display XY Data" to add the point data as a layer.
- Load "month_thaw_snow.dbf": Column XM is the X- and column XY is the Y-coordinates in all three files. In the Z Field you can choose between:
  - SNOW200705 – Snow depth in May 2007
  - THAW200705 to 200709 – Active layer thaw depth in May – September 2007

Note: The data we use in this part of the assignment do not have a spatial reference. The point is to get to know different interpolation techniques and analyse the results.

Interpolate the data (same procedure as in part 1), and make analyses so that you can answer the questions below. Use the raster calculator (View → Geoprocessing → Toolboxes → Spatial Analyst Tools → Map Algebra → Raster Calculator) and excel to do the analysis. **Remember to use the same interpolation algorithm every time you interpolate if you want to compare two rasters!**

TASK PART 2:

- Which interpolation method did you choose and why?
- Is there a trend in mean thaw depth throughout summer of 2007? If so, what is the reason for this?
- Is there a relation between snow depth in May and the difference in active layer depth between May and September? Do a regression analysis or visually interpret the result.

- Note:
    1. For this analysis use raster calculator to subtract one raster from the other.
    2. Create a random point dataset using “Create Random Points” (View → Geoprocessing → Toolboxes → Data Management Tools → Sampling → Create Random Points). Use one of the layers as “Constraining Feature Class” and “Number of points = 100”.
    3. Use “Sample” (View → Geoprocessing → Toolboxes → Spatial Analyst Tools → Extraction → Sample) on the interpolation result and extract values from the random points.
    4. From this you get a table that you can import in excel and make a regression analysis.

Report for this lab

Part 2 in this exercise is the basis for the lab report. Include introduction, methods and data, results, discussion and conclusion. Add also a flow chart of the process in part 2 on the relation between snow depth and active layer. Make a figure of the difference in active layer depth between May and September and the result from the regression analysis.