GEOG 4140/6140 – Winter 2021
Lab 10: Spatial Interpolation
Due Thursday, April 8th by 11:59 PM

Overview
Spatial interpolation is a method used to "fill in the gaps" in data that are not continuous. Often this means creating a continuous raster from a set of point data, for example a continuous map of precipitation or temperature could be created from data collected at weather stations in a region. Interpolation can also be used to fill gaps in rasters, as is done in some remote sensing products where environmental conditions may prevent continuous data collection. In this lab, you will use several different interpolation methods to create rasters from point datasets in order to understand how the distribution of points, as well as the interpolation method, affect results.

The following resource may be of use in completing this assignment:
An introduction to interpolation methods
Understanding interpolation analysis
Comparing interpolation methods
How IDW works
IDW
How Spline works
Spline
How Kriging works
Kriging
Display a subset of features in a layer or a standalone table
How Raster Calculator works
Raster Calculator
How To: Find raster value differences between two rasters in ArcMap

Required Data (*Sources*)
1. Precipitation feature class (*Lab data on Canvas*)
2. Ripple feature class (*Lab data on Canvas*)
3. Ripple_Rand feature class (*Lab data on Canvas*)

Workflow
1. Open ArcGIS Pro and create a new project titled *Lab10YourLastName* in your working directory for this lab.
    a. Import the three point feature classes into your Lab 10 geodatabase, and add these data to the map.
    b. Turn off the basemap.

2. Before moving ahead, it may be of value to read the ESRI documentation discussing three interpolation methods to be used in this lab: Inverse Distance Weighted (IDW), Spline, and Kriging.
    a. These are a few common interpolation methods, but as you will see throughout the lab, they produce fairly different results.
    b. Unless directed otherwise, fill only the required fields for each of these interpolations.

3. First, we will observe how interpolation methods deal with randomly generated values at our points.
    a. Use **IDW**, **Spline**, and **Kriging** to create 3 rasters from the *Random* column of the *Ripple* feature class.
    b. Export an image of two panels displaying the results from the Kriging and Spline analyses. (Deliverable 1)

4. All of these interpolation methods have various settings that can be changed to influence the output raster.
    a. Use the **IDW** method again as you did in Step 3, but this time change the Power parameter from the default of 2 to a value of 0.5.
    b. Export another two-panel image displaying the results of the IDW analysis with the two different power settings. (Deliverable 2 and 3)

5. Next, use **IDW**, **Spline**, and **Kriging** to create 3 interpolated rasters from the *Value* column of the *Ripple* feature class, and 3 interpolated rasters from the *Value* column of the *Ripple_Rand* feature class. Compare the results. (Deliverable 4)
    a. The *Ripple* feature class will resemble ripples that would form in water if you were to drop a rock in it.
    b. The *Ripple_Rand* will look very similar, but will have a slightly 'fuzzier' appearance due to the addition of some randomness in the *Value* field.

6. Up until now, we have used all of the points in each dataset, which creates a tight, evenly-spaced distribution and, therefore, increases the accuracy of the interpolation methods. Having data like this is very uncommon in real world situations.
    a. To better simulate real world situations, we will limit the number of points used.
        i. Create a **definition query** for each feature class (Precipitation, Ripple, Ripple_Rand), so that we will only use points whose values in the *Random* field are less than or equal to 5.
        ii. Use the **Kriging** method again for the *Ripple* and *Ripple_Rand* feature classes and again use the *Value* field.
    b. Use the **Raster Calculator** to subtract the Kriging results in Step 6a from the Kriging results in Step 5. This will provide a raster displaying the difference in results between the complete dataset and the subset.
    c. Export an image of two panels displaying these two rasters: one for *Ripple* and one for *Ripple_Rand*. (Deliverable 5 and 6)

7. Often, point data are not randomly distributed, but instead the distribution is influenced by other factors. Examples could be air quality sensors being located in cities or weather stations tending to be located in low-lying areas. To simulate this, we will further subset our points in the *Ripple* feature class.
    a. Create another **definition query** to limit the *Long* field to less than or equal to 10 as well as greater than or equal to 40, in addition to the *Random* field being less than or equal to 5.
    b. Repeat the **Kriging** for the *Ripple* feature class as you did in Step 5 with the newly subsetted data.
    c. Use the **Raster Calculator** again to show the difference between this raster and the Kriging result based on the full set of points in the *Ripple* feature class from Step 5.
    d. Export an image of the raster displaying the difference between the complete and subset results. (Deliverable 7)

8. Lastly, we will work with the *Precipitation* feature class.
    a. These data are a rough representation of what average precipitation would look like over an idealized mountain range with its crest at 25° E.
    b. First, use a **Spline** applied the *Value* field, to visualize the spatial variability in the data.
    c. Next, create a subset of the points that satisfies the following conditions:
        i. *Random* less than or equal to 5,
        ii. *Lat* and *Long* less than or equal to 10, or greater than 40.
        iii. This will leave you with just a few points near the corners.
    d. With only these points, use a **Spline** again to create another Raster.
    e. Use the **Raster Calculator** to show the differences between the two outputs from this step.
    f. Export an image of the raster displaying the differences. (Deliverable 8 and 9)

Deliverables

1. Image of the Kriging and Spline results from Step 3. (3 points)

2. Image showing the differences due to power parameter in IDW analysis from Step 4. (3 points)

3. What did changing the power parameter in Step 4 do? How did it change the way in which the IDW interpreted the data? (2 points)

4. What did you notice about the differences in results based on different methods in Step 5? (1 point)

5. Image of differences in Kriging results from subsetting data in Step 6. (3 points)

6. According to your image from Step 6, was the *Ripple* or *Ripple_Rand* feature class more affected by only using a subset of the points? Why might this be? (2 points)

7. Image of differences in Kriging results from limiting the longitudes of data from Step 7. (3 points)

8. Image of Differences in Spline results from Step 8. (3 points)

9. Explain some of the limitations of interpolation that you learned about in this lab. What types of data would be better or worse suited to interpolation? (2 points)