Lab Report

Title: Lab 0
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Date: 9/12/23

Project Repository: https://github.com/kohle147/GIS5571/
Google Drive Link: Google Drive for ArcGIS Pro Files
Time Spent: 24 hours

Abstract

The purpose of this lab was to compare three different methods of creating a buffer around a road network. These methods included ArcGIS Pro Toolbox, Notebooks in ArcGIS Pro, and Notebooks in ArcGIS Online. The dataset used for this lab was of memorial routes in Minnesota. The three methods are shown in data flows to illustrate the differences in approach. The results are displayed in maps showing each buffer method's output. The differences and similarities between the methods are discussed and showcased in a table. The results are verified by having all three methods in the same environment and comparing the code used. The final section of this lab discusses lessons learned and difficulties with GitHub and the road network buffer methods.

Problem Statement

The ESRI ecosystem has different ways to achieve the same function and result. For this lab, the objective is to compare and contrast the buffer activity on a network dataset, using three different tools: ArcPro, Jupyter Notebooks in ArcPro, and Jupyter Notebooks in ArcOnline.

Table 1. Resources Used

#	Requirement	Defined As	(Spatial) Data	Attribute Data	Dataset	Preparation
1	Road network	Raw data from MnDOT.	Road geometry		MN Memorial Routes	Added folder connection to ArcGIS Pro.
2	ArcPro Toolbox	Creating a buffer around road geometry with ArcPro toolbox.	Road geometry	Buffer distance		Found tool in ArcGIS Pro toolbox.
3	ArcPro Notebook	Creating buffer around road geometry with ArcPy.	Road geometry	Buffer distance		Opened up new notebook in ArcGIS Pro.

4	ArcOnline Notebooks	Creating buffer around road geometry with ArcGIS API for Python.	Road geometry	Buffer distance		Created new notebook in ArcGIS online.

Input Data

The road geometry data is of memorial routes in Minnesota. The data is the centerlines for all public roads in Minnesota designated as memorial routes through a state statute. The data is updated with construction timelines. The projected coordinate system is NAD 1983 UTM Zone 15N.

Table 2. Dataset

#	Title	Purpose in Analysis	Link to Source
1	Memorial Roads	Raw dataset for road centerlines.	MN Memorial Routes

Methods

ArcPro

Each method of creating the network buffer has a slightly different approach. For the ArcGIS Pro toolbox method, it is relatively simple. I opened up the Buffer tool and input values in the user interface, see Figure 1. The input layer was the Memorial_Routes_in_Minnesota shapefile. The distance was set to 5 miles and the rest of the parameters was left to default. The output was named Memorial_Routes_Buffer, which I later renamed to ArcGIS Pro Toolbox Buffer for clarity.

Figure 1 - ArcPro Flow

Jupyter Notebooks in ArcPro

For the ArcGIS Pro Notebook, creating the buffer is more complex (See Figure 2). I obtained the code by sending the code from the Buffer tool to a Jupyter notebook. Once I had this code, I had to set the input feature, which was the name of the layer, Memorial_Routes_in_Minnesota. Next, I had to adjust the various options (i.e. distance, units, dissolve) to create the correct buffer. I set the buffer distance to “5 Miles”, keeping the other values as the default. Finally, I had to specify the new layer location and the name, Memorial_Routes_Buffer_Notebook. This was later renamed to ArcGIS Pro Notebook Buffer for clarity.

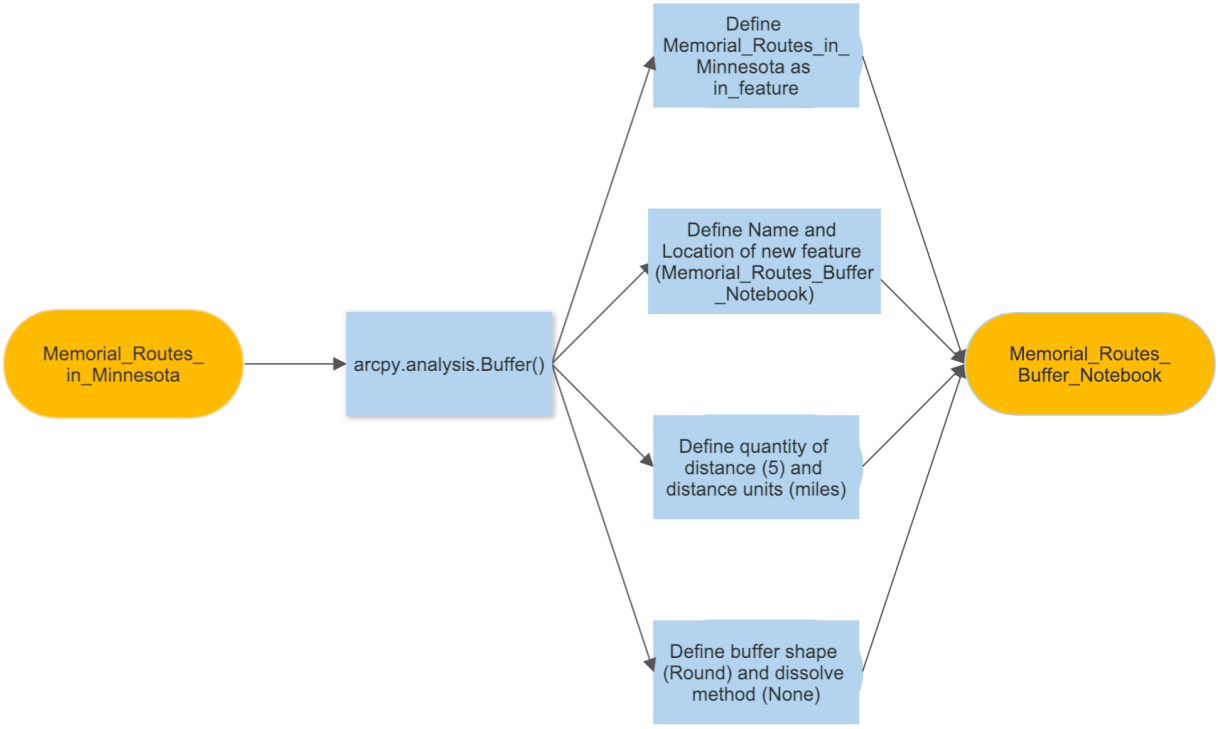

Figure 2 - ArcGIS Pro Notebook Data Flow
(*Esri, n.d.*)

Jupyter Notebooks in ArcOnline

For the ArcGIS Online Notebook, my methods were similar to the ArcGIS Pro Notebook, but not identical (See Figure 3). This method required importing the features function and connecting the notebook to the correct GIS. This method also required connecting the feature layer, this is done with gis.content.get() and using a unique string to identify the feature layer. Next, I had to prepare the function features.use_proximity.create_buffers(). I set the "distances" to 5 and the "units" to miles. The other values are the default values for the function. I set the name of the new feature layer to MN_Memorial_Buffer, which I later renamed ArcGIS Online Notebook Buffer, for clarity.

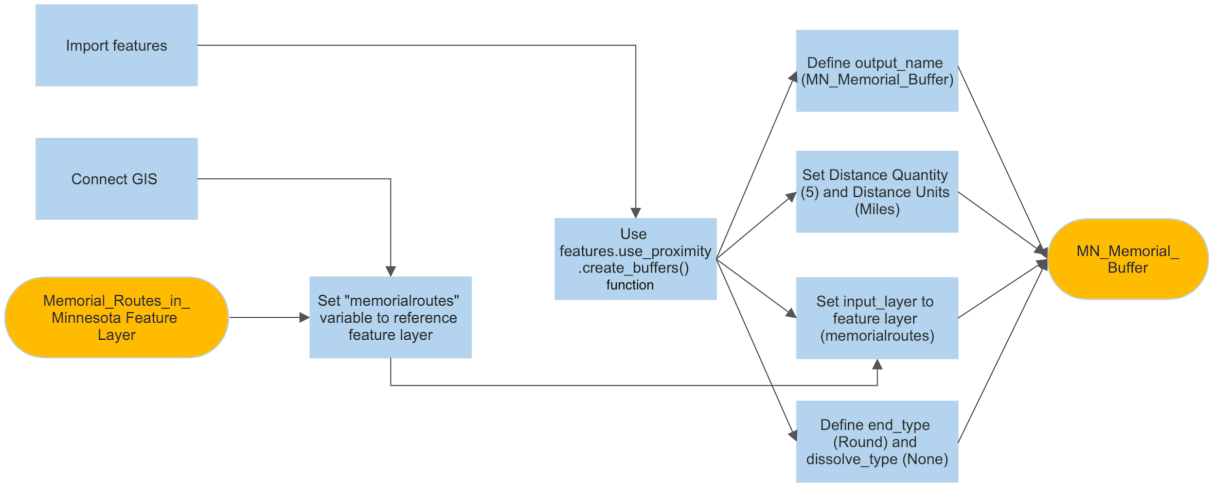

Figure 3 - ArcGIS Online Notebook Flow
(*Arcgis.features.use_proximity Module — Arcgis 1.9 Documentation*, n.d.)

Results

Figure 4 - ArcGIS Pro Toolbox Buffer

Figure 5 - ArcGIS Pro Notebook Buffer

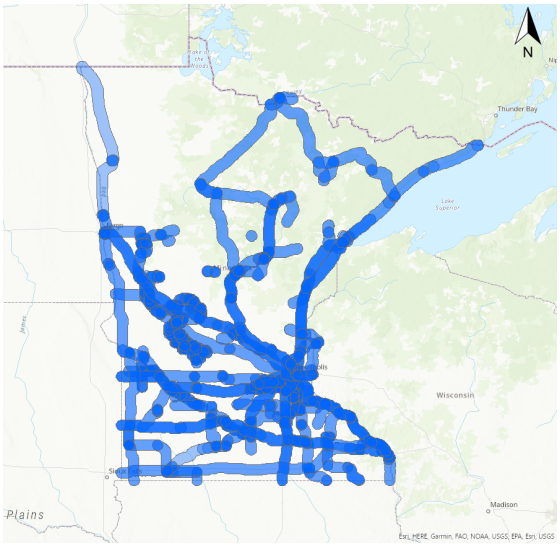

Figure 6 - ArcGIS Online Notebook Buffer

Each method creates a visually identical output. This shows that there are several ways to obtain the same result using different methods available in ArcGIS Pro and ArcGIS Online. The main differences in the results are the methods used and the location of the output files. See Table 3 for a summary of differences and similarities.

Table 3 - Results Comparison

	ArcGIS Pro Toolbox	ArcGIS Pro Notebook	ArcGIS Online Notebook
Create new buffer Layer	Identical	Identical	Identical
Input Feature Layer	Input shapefile selected within interface	Input shapefile name is referenced in code	Online feature layer referenced with git.content.get()
Output Feature Layer	Location and name are selected within interface	Output name and location specified in code	Output feature name is specified in code, a new feature layer is created in ArcGIS Online Content
Projected Coordinate System	NAD 1983 UTM Zone 15N	NAD 1983 UTM Zone 15N	WGS 1984 Web Mercator (auxiliary sphere)
Allows selecting buffer settings (units, distance, method, end shape, dissolve, etc)	Yes	Yes	Yes
Easy to use interface	Yes	Requires coding experience	Requires coding experience
Jupyter Notebooks	No	Yes	Yes
ArcPy	N/A	arcpy.analysis.buffer()	No
Feature module	N/A	No	features.use_proximity.create_buffer()
Allows automation	Limited	Yes	Yes

Note: Methods from (*Arcgis.features.use_proximity Module — Arcgis 1.9 Documentation, n.d.*) and (*Esri, n.d.*)

Results Verification

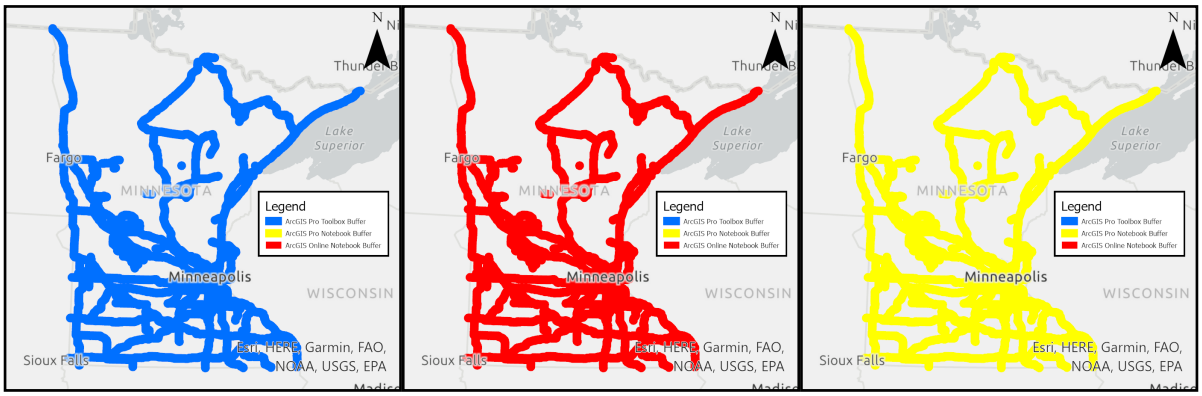

Figure 7 - All Three Layers **Figure 8** - All Three Layers **Figure 9** - All Three Layers

To verify the results qualitatively, we can put all three layers on the same map. With this method, we can see that all three layers are virtually identical in geometry and shape. No matter what order the layers are in, the result is the same. For a qualitative analysis, using the summarize tool in ArcGIS Pro, we can see that the sum of the area of each layer is very similar.

For the buffer layer created by the toolbox, the sum of the area in square miles is 221,432.7. This is the same result for the layer created in the ArcGIS Pro Notebook. For the buffer layer created in ArcGIS Online Notebooks, the sum of all areas is 221,444.3 square miles. There is a slight variation in the total area between the layer created in ArcGIS Online Notebook and the layers created in ArcGIS Pro. This is due to the layer having a different coordinate system. This is the default coordinate system for ArcGIS Online feature layers. Despite this, the code used in the ArcGIS Online Notebooks has the same functionality and the same options as the code used in the ArcGIS Pro Notebook (See Figure 10 and Figure 11).

Buffer Around Routes in Notebooks in ArcPro

```
#ArcPy module for creating a buffer
arcpy.analysis.Buffer(
    in_features="Memorial_Routes_in_Minnesota", #Input Feature Layer
    out_feature_class=r"\\Mac\Home\Documents\ArcGIS\Projects\Lab00\Lab00.gdb\Memorial_Routes_Buffer_Notebook",
    buffer_distance_or_field="5 Miles", #Distance and Units
    line_end_type="ROUND",#Shape of end type
    dissolve_option="NONE", #No dissolve
    method="PLANAR"
)
```

Figure 10 - Code for ArcGIS Pro Notebook Buffer

Add Buffer Around Feature Layer

```
features.use_proximity.create_buffers(input_layer=memorialroutes,
                          distances=[5], #How Many Units of Distance
                          units='Miles', #Units of Distance
                          end_type='Round', #Shape of End of Buffer
                          dissolve_type='None',#No Dissolve
                          output_name='MN_Memorial_Buffer' #Output Feature Name
                          )
```

Figure 11 - Code for ArcGIS Online Notebook Buffer

Discussion and Conclusion

GitHub

The GitHub section of the lab came with some challenges, but it also had elements I felt confident and familiar with. Using my computer's terminal was something I had not done in a while, but it came back to me quickly. One of my first struggles was accessing my GitHub account through my computer terminal. I had to research to figure out I needed to create an access key to log into my GitHub account through Git on my computer terminal *(Managing Your Personal Access Tokens*, n.d.). After I figured this out, I had another challenge pushing my changes to GitHub. I kept getting an error message about my repository not matching the folder on my local disk. After searching, I realized I had accidentally created a new folder in my repository that was not cloned onto my local drive. Once I deleted this, the changes were easily sent to my GitHub repository.

Despite these struggles, I found GitHub to be a powerful tool. Cloning the repository files to my local disk was simple and has a lot of potential. I appreciated being able to make changes on my local drive (i.e. adding a few folders for each lab) and being able to push those to GitHub. It allows users to make edits in multiple ways. This exercise showed me that there are several ways to undo changes. While I was confused at first why there are so many ways to undo changes, I can appreciate that at any stage of adding or committing changes, they can be undone. One of my favorite parts of this exercise was exploring the pull requests. I like the idea of being able to make changes and suggest edits to someone else's work. I appreciate the ability to compare what has been changed and use it to collaborate.

Creating Road Network Buffer in Three Ways

Creating buffers around road networks is a relatively simple task, so I was confident in my abilities. Using the ArcGIS Pro toolbox to create the buffer was simple, and thanks to the ESRI training I was easily able to transfer the Python code from this operation into the Jupyter Notebooks in ArcGIS Pro. The difficult part of this lab for me was using ArcGIS Online notebooks to create the buffer. I am not very familiar with ArcGIS Online, so once I created a new notebook, I had to do some research to figure out what I was doing. I had not realized the code for ArcGIS Online notebooks was so different from the ArcPy code. It utilizes ArcGIS features instead of ArcPy. Once I had figured out my code, referencing (*Arcgis.features.use_proximity Module — Arcgis 1.9 Documentation, n.d.*), my next issue was being able to reference the online feature layer I needed. I discovered this was a built-in tool for the ArcGIS Online notebooks.

Once I had all three layers created, I struggled to discover that ArcGIS Online has a default coordinate system, which was different from the coordinate system that the two other network buffer layers I created used. This created a slight variation in the total area of the layer. Despite this, the code I used for the online notebook was sound and did the equivalent of what the buffer tool does in ArcGIS Pro.

The main thing I will take away from this lab is accepting that there will not always be a right or "perfect" solution. The slight variation in area from the buffer layers was something that held me up, but I eventually settled that the code was correct. I will also take away that there are several different paths to get to the same output. Each path has some pros and cons, so it will be situational which method to use.

References

References

arcgis.features.use_proximity module — arcgis 1.9 documentation. (n.d.). Developers.arcgis.com. https://developers.arcgis.com/python/api-reference/arcgis.features.use_proximity.html

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Self-score

Category	Description	Points Possible	Score
Structural Elements	All elements of a lab report are included **(2 points each)**: Title, Notice: Dr. Bryan Runck, Author, Project Repository, Date, Abstract, Problem Statement, Input Data w/ tables, Methods w/ Data, Flow Diagrams, Results, Results Verification, Discussion and Conclusion, References in common format, Self-score	28	28
Clarity of Content	Each element above is executed at a professional level so that someone can understand the goal, data, methods, results, and their validity and implications in a 5 minute reading at a cursory-level, and in a 30 minute meeting at a deep level **(12 points)**. There is a clear connection from data to results to discussion and conclusion **(12 points)**.	24	23
Reproducibility	Results are completely reproducible by someone with basic GIS training. There is no ambiguity in data flow or rationale for data operations. Every step is documented and justified.	28	26
Verification	Results are correct in that they have been verified in comparison to some standard. The standard is clearly stated **(10 points)**, the method of comparison is clearly stated **(5 points)**, and the result of verification is clearly stated **(5 points)**.	20	16
		100	93