# GIS 5571 Lab 2

**Due**: 3 weeks from the date assigned

## Part 1 Goals

1. Stitch together basic skills in API queries with raster, cube, TIN, and Terrain data transformation steps to create an extract, transfer, and load system for LiDAR data from the Minnesota DNR's FTP server.
2. Use ArcPro to perform side-by-side exploratory spatial data analysis using 2D and Scene views.
3. Use ArcPy to export to a PDF a visualization of LiDAR data

## Part 1 Deliverables

Submit a part 1 lab report on Canvas as a PDF (see report form). Include all your code on GitHub as both .ipynb files and PDFs of the notebooks.

## Part 1 Specifics

For this lab, write a lab report and create code that accomplishes the following:

1. Describe and build an ETL in ArcPro Jupyter Notebooks and arcpy that
   a. Downloads .LAS files from MN DNR [1]
   b. Converts the .LAS file into both a DEM and a TIN
   c. Saves the new DEM and TIN to disk
   d. Exports PDFs of the DEM and TIN with correct visualization (see here)

2. Do side-by-side exploratory data analysis with a 2D map of the .las file on one pane and a 3D Scene of the .las file on another pane. This will be very computationally intensive, so use a small .las file. In your writeup, describe the features provided by ArcGIS for working with 2D and 3D visualization of .las files.

3. Describe and build an ETL in ArcPro Jupyter Notebooks that
   a. Downloads the annual 30-Year Normals .bil files for precipitation from PRISM [2]
   b. Converts the data into a spacetime cube and exports it to disk (see here for example of final conversion step; to get to this point, you will need to go through other transformation steps likely) [3]
   c. Export an animation of the timeseries

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**[1]** DNR FTP server: https://resources.gisdata.mn.gov/pub/data/elevation/lidar/ -- I recommend using their example .las datasets as they're more reasonably sized.

**[2]** PRISM website: https://prism.oregonstate.edu/normals/

**[3]** This blog post will give you some inspiration as to why we are emphasizing spacetime cubes: https://www.esri.com/arcgis-blog/products/arcgis-pro/analytics/explore-your-raster-data-with-space-time-pattern-mining/

**Part 2 Goals**

1. Create an ETL for data to go into a cost surface model
2. Create a cost surface model and justify how you created your cost surface
3. Map the range of cost surfaces given uncertain preferences and model weights

**Part 2 Deliverables**

Submit a separate lab report from part 1 on Canvas as a PDF (see report form). Include all your code on GitHub as both .ipynb files and PDFs of the notebooks. Your lab report should be written to answer the question: what is the optimal route for Dory to take to get to her fly fishing spot near Whitewater State Park in SE Minnesota?

**Part 2 Specifics**

In class, we went through suitability modeling. Specifically, two types of suitability modeling called Boolean suitability analysis and weighted linear combinations. In both cases, Map Algebra drives the model. Here, your objective is to use map algebra and cost modeling to create a cost surface for walking for an imagery person named Dory, and then understand how uncertainty in model weights impacts that cost surface.

*Story*
Dory lives just outside of Whitewater State Park at a farm site. She moved to the area because she loves fly fishing, which she does every day in the spring. Dory enjoys hiking to and from her house to fly fish in the park. Your goal is to create a surface that shows places where Dory would more or less prefer to walk in order to get to the park, and then understand how uncertainty in her preferences might impact this surface.

*Start point:* Her farm can be found on google maps at 44.127985, -92.148796
*End point:* North Picnic area

Include both points in your cost surface.

*Specific preferences to model:* Dory prefers to not walk through any farm fields because they can be muddy in the spring. She also doesn't like crossing water bodies if there isn't a bridge, though sometimes she doesn't mind if she's wearing her waders. Other than that, she just wants to take the path that is the most gradual in terms of slope.

Create a cost surface that represents these preferences using map algebra. Show how different preferences might impact the map outcomes.

*Tips:*
Creating the cost surface should be relatively straight forward using map algebra. The uncertainty analysis is done by incrementally altering each model weight and re-running

the model. This is a good opportunity to use nested loops that try each weight and save the results to disk.   `