Imagery, Automation, and Applications Final Assigment

Welcome to the final assignment for Rasters, Imagery and Automation. This assignment will be different than the previous final assignments in the specialization and will be much more open-ended. While those assignments were meant to ensure you had practice and abilities with specific algorithms, tools, and tasks in GIS, this assignment is meant to ensure that you can get through the entire process. You'll still need to do a few specific things, but the question and answer are up to you and your analysis. This assignment is also designed to be similar to the capstone project - you'll need to come up with a question and get the data to answer it, determine your analysis approach, and then successfully run it. Compared to the capstone project, we'll limit the parameters here significantly though, both the speed up the process and to test specific skills. Now, on to your scenario.

You're an satellite imagery analyst working for the United Nations. Your job is to analyze imagery to determine environmental factors that influence human health, safety, and well-being. Right now, you're working on a pilot project that, after evaluation, may be rolled out for analysis across a large region. This pilot project is open-ended though - to bring in new ideas, the UN is asking its analysts to try their own ideas for a project. Still, in the pilot project, you'll need to acquire, analyze, and publish results on your study so that feasibility of a broader rollout of the study can be determined.

Your project

At its core, this project involves two broad components: A satellite image classification and a ModelBuilder-based analysis. What you study is up to you to decide. You aren't going to be graded on what you choose, but part of your grade will include how well your analysis fits your conclusion, so make sure to pick a topic that is well-informed by satellite imagery, and where the products of your classification are a nice lead-in to an analysis. To help you understand the kinds of options we're thinking of, here are some broad suggestions, and there is a more in depth suggestion further on in case you want or need a little more to work with. With some of these, you may find yourself needing to retrieve another dataset for further analysis - don't make this too hard though - it can be relatively simple, and you can also do an analysis that is only based on the imagery.

The following are some suggestions of potential analyses you can do:

- **Flooding Analysis:** After a natural disaster like a flood, agencies need accurate maps of hazard areas and damage extent in order to allocate resources. Run a classification to

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determine the extent of flooding. As a followup analysis, you could retrieve census data to determine how many people are affected or find major infrastructure inundated by flood.

- **Urban heat island:** Landsat's thermal bands allow for assessment of heat variation. Run a classification to separate out the urban areas from the surrounding areas, then use the classified data to assess variation in heat emitted by urban vs natural areas.
- **Agricultural production analysis:** Agricultural production varies year to year based on climate - In California, we are in year five of a major drought - take landsat scenes for the same location from two consecutive years taken on as close to the same day of the year as possible (for example, on June 23rd, 2015 and June 25th, 2016 - Landsat's 16 day return interval means you won't get the same exact date, but get as close as possible). Run a classification to find agricultural regions, then extract those regions to a new raster and run an NDVI analysis. Determine differences between NDVI in the agricultural regions between the two years - as either some metric you generate, or highlighting areas of significant increase or decrease in vegetation.
- **Recent fire/Active fire:** Fire is a major natural part of many ecosystems, but also a threat to humans and infrastructure. Similar to flooding, reliable information on affected areas enables disaster relief agencies to direct aid and support and set up infrastructure. Using an image classification, find recent fire scars and a current active fire in a landsat scene. You may need to use thermal bands and shortwave infrared bands to see through the smoke to what's currently burning at the time of the image. Determine the extent of the fire's damage, a fire perimeter, and how much land is actively burning (using thermal).
- **Or your own ideas:** these ideas are a starting point - you don't have to follow them all exactly, or even at all - what you need to be able to do is conceptualize an analysis with a research question, gather the data, conduct the analysis, then interpret the results. Feel free to choose something you have expertise in or want to practice more, so long as its informed by image classification. Read the next section before deciding on a topic so you know what requirements you still have to meet.

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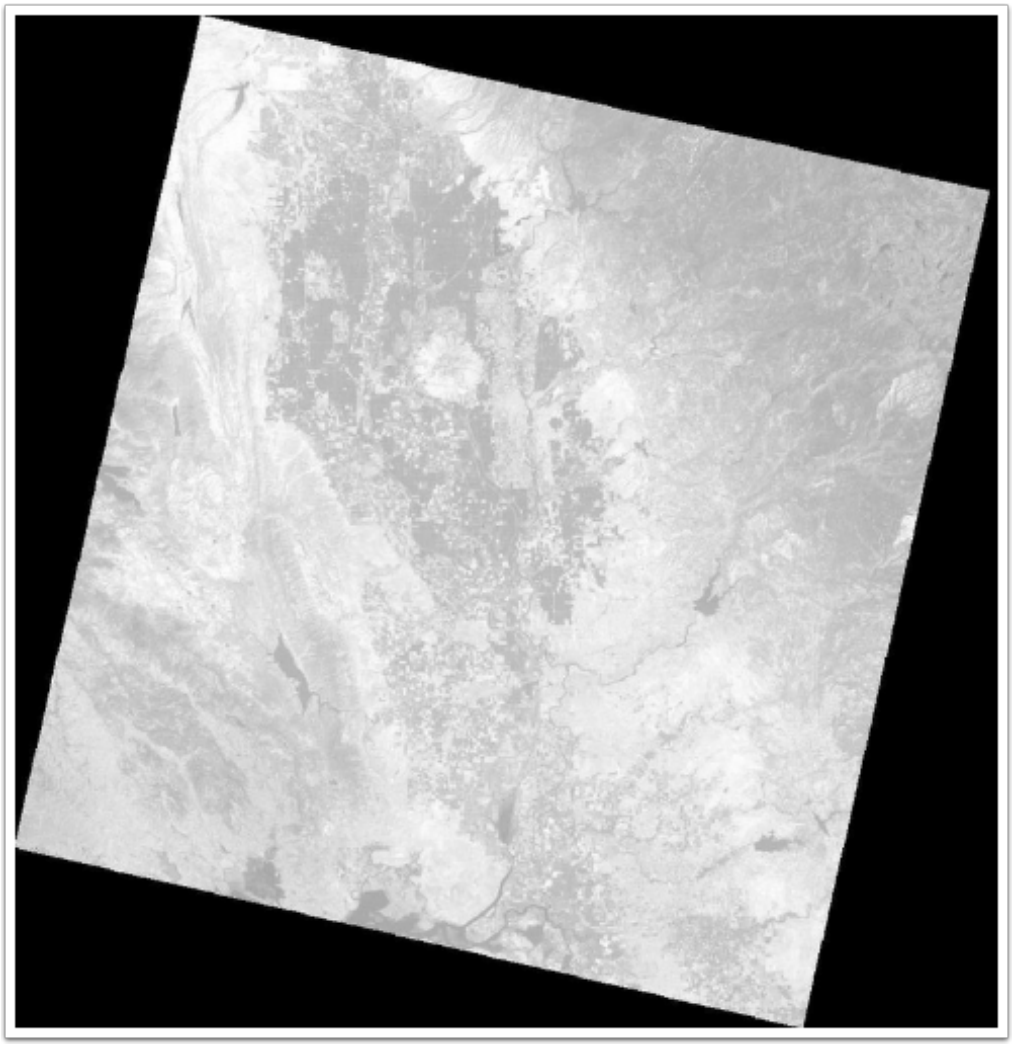

Required Components

Your analysis must involve the following components:

1. You must run a supervised (trained) classification on at least one satellite image in the Landsat series. You are not limited to Landsat 8 as demonstrated in the course, but make sure to still use Landsat imagery of some sort for this analysis. You are also not limited to just a single Landsat image, but doing more than 1 classification won't score you additional points. (Tip: If you do a project that involves multiple images, remember raster mosaics!)
2. Your supervised classification must involve at least 4 classes, even if you don't plan to use all 4 in your analysis.
3. Each class in your classification must have a minimum of 10 training samples (you'll do better to refine it and add more samples, and remove poor quality samples). You will need to submit a

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screenshot of your Training Sample Manager window (similar to picture below) showing all of your samples for grading. You can merge and split samples in the toolbar at the top of that window. If you name a sample after it's merged, it will keep that name once split back out for viewing, which will assist in your grading. Remember, if you need a utility to capture screenshots, Greenshot is excellent and free.

4. You must put your classification results through some sort of analysis in the form of a ModelBuilder model. This model must have at least 5 steps (tools) that run in it, and must take a parameter and be runnable as a geoprocessing tool. The model **does not** need to comprise your entire analysis workflow from start to finish and you can do manual analysis as well. If you'd like, your classification step itself can be part of your tool.
5. A PDF map that includes all basic map components showing either your classified raster or an analysis product.
6. A written summary of your process, your analysis steps, and any conclusions reached in your analysis. Include your original question or hypothesis as part of your write-up. Make sure the analysis supports any conclusions you make and mention potential limitations of your analysis based on the data involved, or potential areas to explore in the future with new data or a broader analysis. There is no length minimum or maximum, just make sure to get in the required parts.

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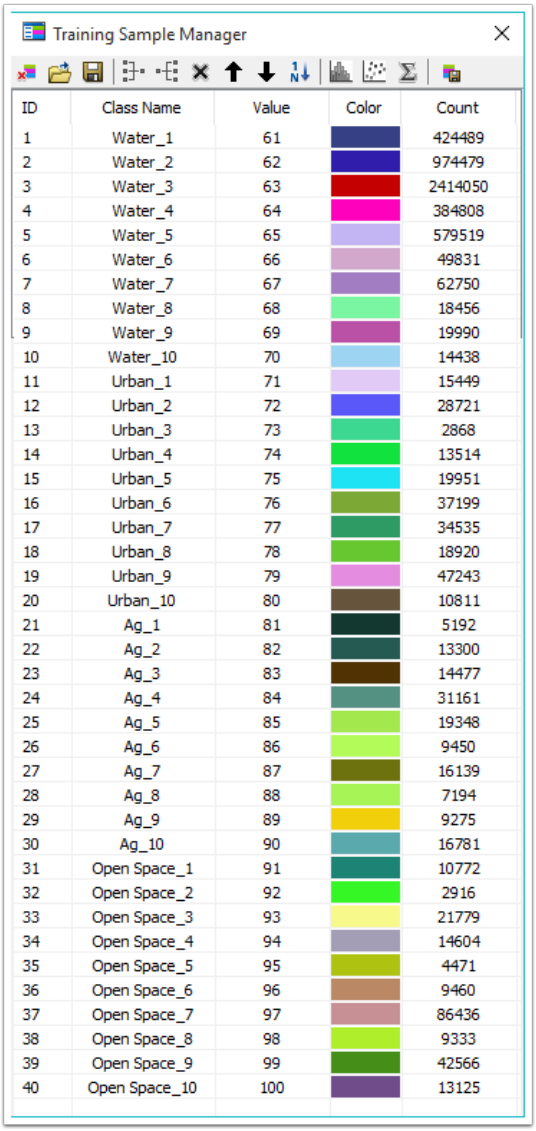

ID	Class Name	Value	Color	Count
1	Water_1	61		424489
2	Water_2	62		974479
3	Water_3	63		2414050
4	Water_4	64		384808
5	Water_5	65		579519
6	Water_6	66		49831
7	Water_7	67		62750
8	Water_8	68		18456
9	Water_9	69		19990
10	Water_10	70		14438
11	Urban_1	71		15449
12	Urban_2	72		28721
13	Urban_3	73		2868
14	Urban_4	74		13514
15	Urban_5	75		19951
16	Urban_6	76		37199
17	Urban_7	77		34535
18	Urban_8	78		18920
19	Urban_9	79		47243
20	Urban_10	80		10811
21	Ag_1	81		5192
22	Ag_2	82		13300
23	Ag_3	83		14477
24	Ag_4	84		31161
25	Ag_5	85		19348
26	Ag_6	86		9450
27	Ag_7	87		16139
28	Ag_8	88		7194
29	Ag_9	89		9275
30	Ag_10	90		16781
31	Open Space_1	91		10772
32	Open Space_2	92		2916
33	Open Space_3	93		21779
34	Open Space_4	94		14604
35	Open Space_5	95		4471
36	Open Space_6	96		9460
37	Open Space_7	97		86436
38	Open Space_8	98		9333
39	Open Space_9	99		42566
40	Open Space_10	100		13125

Suggested Project: Flooding

To suggest one project in depth in case you don't have an idea of your own right now, try a flooding analysis. Flooding is a major issue worldwide, and humanitarian agencies and governments often need rapid maps of affected areas in order to determine hazards and where to deploy resources. There is no shortage of places you can do a flooding analysis for, but if you want to use Landsat imagery, sometimes timing is a problem since Landsat only returns every 16 days. Here are some suggestions for ways you might run the analysis, and some places/times you can use.

Northern California - January 1997.

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In January of 1997, Northern California was indundated with water as part of one of the largest recorded El Niño events in history. This event resulted in widespread flooding, easily seen from Landsat 5's Thematic Mapper instrument on January 14th, 1997. If you analyze this location and event, make sure to select "L4-5 TM" under "Landsat Archive" when selecting datasets in USGS Earth Explorer so you can see imagery from landsat 5. If you want to do a full analysis, consider controls you'd need to make in order to determine flooding extent (such as classifying an image from December 1996 to determine what water is natural or part of agriculture and what water is flooding). An image that definitely shows the flooding is Entity ID LT50440331997014XXX00 from Path 44, Row 33 (WRS2) of Landsat 5. You can use all of this information to find that image and a prior image for this location (you don't have to use the Entity ID, but the path and row, combined with the dates should find it for you in Earth Explorer)

India

Flooding regularly affects vast numbers of individuals in India. See about finding a major flooding event on that link and locating imagery to show the extent of the flooding. Then, run a similar analysis to the one described above

Somewhere else?

Know of somewhere else with flooding? That's great - you can use that instead. Remember, this project is open-ended!

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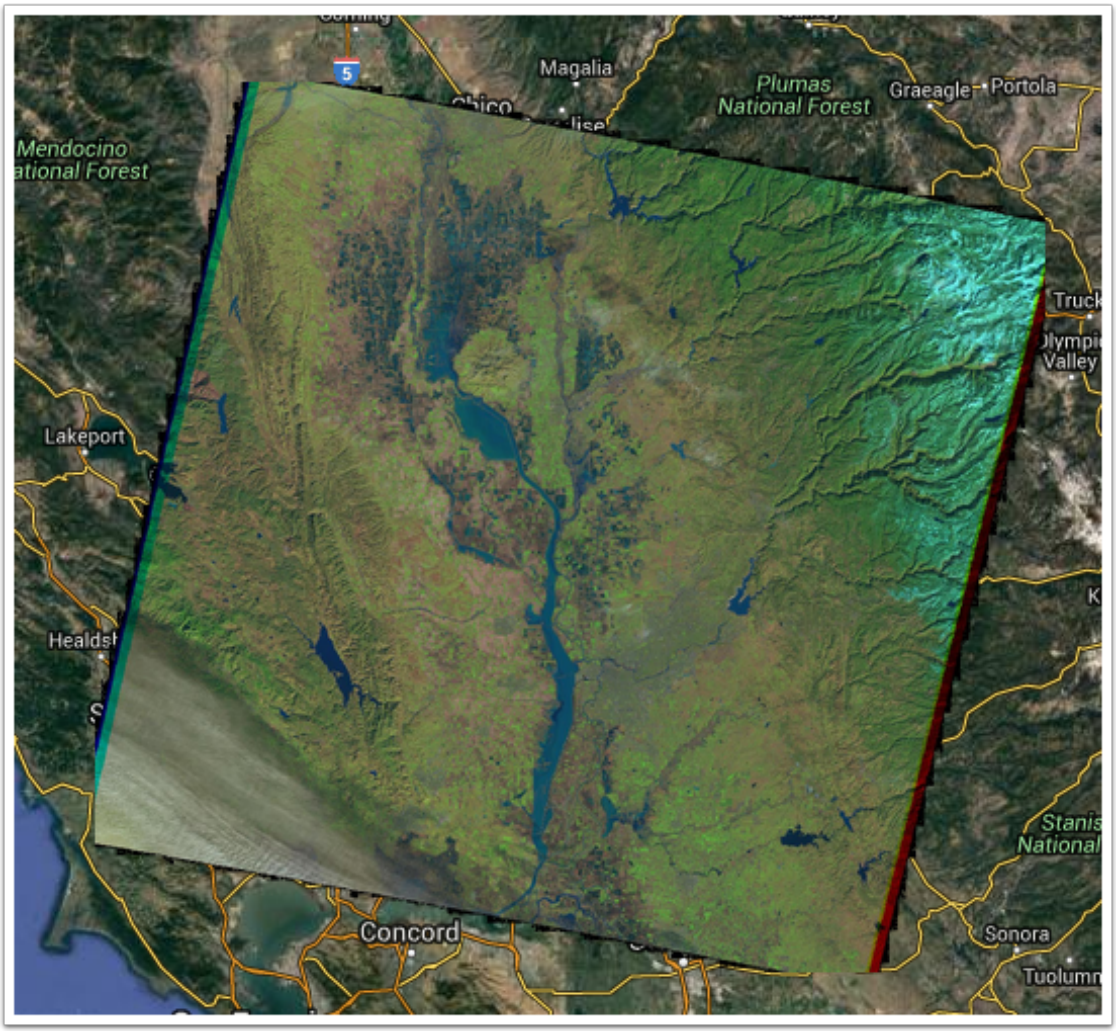

What you'll turn in

You'll turn in the following for grading:

1. Your final PDF map
2. Your toolbox, with your model in it.
3. Your screenshot of your training samples
4. Your writeup of your analysis

Tips

While USGS' Earth Explorer is really powerful for finding the exact image you need, if you're planning to use an image from the last few years (and can therefore use Landsat 8), RemotePixel.ca has an

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excellent interface for exploring and downloading Landsat 8 data. It's freely available at https://remotepixel.ca/projects/satellitesearch.html - you can still get your data from Earth Explorer though, since it has fine-grained controls that allow you to find the exact image and time period you need.

Starting in 2003, Landsat 7 developed a problem that is commonly called the *SLC-off* problem. An instrument on the satellite called the Scan Line Corrector failed and images have black gaps of missing data as a result. If you choose to analyze an image from Landsat 7 after 2003 and before Landsat 8 data is available, you may want to compensate for this problem to get accurate results (you won't be graded on this, but it's a good idea). You can find out more about this failure here and you can find out more details about filling in the holes here and here. For this project, you can also fill in the pixels using a method meant for display rather than scientific analysis. These are non-trivial operations, and if you want to avoid frustration associated with it and still get accurate results, I suggest you choose something prior to SLC-off or that is available in Landsat 8.

Important Notes

If you are using a version of the software newer than ArcGIS 10.3 (for example, 10.4 or 10.5), you will need to export a copy of your toolbox that is compatible with version 10.3 in order to be graded on this assignment. Toolboxes are version locked. ArcGIS can open toolboxes made in older versions of the software, but not newer versions, so the safest way to make sure your peers can view your toolbox and give you a grade is to save a copy of the toolbox that's compatible with ArcGIS 10.3 - then everyone in these courses can open it, and you won't lose functionality.

To do this, simply right click on the toolbox with your model in ArcToolbox, and select *Save As* and then choose *10.3 Toolbox*. Then, upload that newly saved version.

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