Remote Sensing, Fall 2022
Lab 6: Feature Extraction

Lab goals

Satellite images like air photos can be used for manual interpretation, but because they are digital, we can use image processing techniques to semi-automatically extract vector features. The specific goal in this week's lab is to create vectors for 2-3 class features which you can clearly identify and reduce to a manageable number of polygons.

There are five main steps:
- Generate a clean layer containing the desired features –a bitmap or raster channel from THR or Ratio-Index-Transform or Classification
- SIEVE to create a manageable number (sieve works only on raster channels)
- Generate vectors (raster to vector) –RAS2POLY or BIT2POLY or EXPOLRAS
- Smooth vectors – SMBOYLE or SMMCMASTER
- Examine and clean attribute table - calculate area stats (in Catalyst or GIS)

Features to extract:
- 1. Water
- 2. A vegetation land cover class

1. Set-up

Copy **bowron19aug2016.pix**   from L:\GEOG357

Start Catalyst and open your copy of **bowron19aug2016.pix**

Change display to 654 and enhance (note: this is Landsat 8 = 16 bit data)

2. Extract water from the 2016 multispectral image

We'll first create the water bitmap like you created in lab2 to generate a vector shapefile for water: rivers and lakes. We can then convert this to a vector layer

A. Create a bitmap for water, same method as you did for PG water in lab 2 (THR).
As water does not reflect IR, we use the NIR band to find the threshold value that separates water, though you will have DNs that conflict with shadows – just as in PG, but maybe worse. Note that we'll try to solve this in the next lab. The maximum value for water is just over 7000, maybe 7100. In the THR menu, set the raster band to 5 (NIR) and output to Viewer. Threshold Maximum is 7100 or whatever you decide, and minimum can be 0.

Inevitably you will grab some shadow as well, but it's easier to remove that later, than to go low and miss more water. Once you are satisfied, change output to your .pix file instead of viewer and run. This will create a bitmap layer in the file. You want everything in this one .pix file.

B. EASI modeling to improve water layer

We can reduce the shadow problem when we consider that water is wetter than shadowed rock, and therefore has lower DN values in the SWIR band (6). Highlight the colour composite so that the DNs at bottom show RGB instead of the bitmap or another layer.

Click in the shadows and on the water to see typical DNs in Band 6 (Red Gun). Not perfect but I estimate an approximate boundary at 6200 between water and shadow.

We can add this condition to our identification of water
i.e. Band 5 < 7100 AND Band 6 < 6200

To do this, we need to:
1.Create a new empty bitmap to take the result
Switch from map to files tab
Right-click on the filename -> new -> bitmap layer
it will give you the new bitmap number which should be 3, your water layer was bitmap 2

2.tools-> EASI modeling
In the pop-up box type these lines below: note that a bitmap is coded %% and a band =%

if %%2=1 AND %6<6200 then
%%3 =1
Endif   - then click on 'Run'

This says that if for any pixel bitmap 2 has a water AND Band 6 DN is less than 6200, then that pixel is accepted as water in the new bitmap 3 (otherwise it's not) –
Note the most common errors in EASI modelling is to forget to add 'then' and 'Endif'

You can also save this script for future use .. click on save, and you can name it e.g. water. It will save a file named water,eas in your folder. You can 'load' it again to re-use and not retype.

But nothing has appeared on screen, as you need to add bitmap 3 to the display:
Layer -> Add -> bitmap (and select 3)
You should find it has only reduced the number of shadow pixels but it will do for now.

3. Vectorise the bitmap to create water outlines: BITPOLY

tools-> algorithm library → BIT2POLY
Input: the bitmap layer number (3)
Output: viewer
Params: smooth should be checked   RUN

If you can't see your new vector lines e.g. if they are blue, right-click on the new polygon layer
    in the display listing and change the colour

Now uncheck the smooth vectors box in parameters and run again, output to the viewer, AND to
    your pix file. Compare the result with the smoothed version to see the effect of the
    smoothing algorithm …
Zoom in A LOT to view the difference – the 'staircase' of pixels has been reduced, not removed

You now have two new vector layers, one smoothed (onscreen only), one not smoothed/saved.

We will use a more sophisticated algorithm to smooth the unsmoothed version, written by Ray
Boyle, U. Saskatchewan. It is called SMBOYLE and is found in the Algorithm Library.

 Input your unsmoothed vector layer, output to viewer and the 2016 pix file.
You should find this is a better result - NOT smoothed in BIT2POLY but smoothed by
SMBOYLE. The one smoothed only in BIT2POLY is not as rounded.

*Q1: Catalyst also has a BIT2LINE option – give two examples where you might choose to use
this option instead of BIT2POLY to extract suitable features and under what circumstances..*

4. polygon attribute tables

You can't sieve a bitmap to remove wee bits, only a raster, but we can remove small polygons
either in GIS or Catalyst: right-click on the polygon layer label and pick **Attribute Manager**
The areas may be in square metres as default with UTM coordinates, and if so we can convert to
hectares or square kilometres to reduce 'scientific notation'.

Right-click on the Area column heading, select Table definition, change decimal places to 4 and
display units to Kilometres.   Apply   OK
Deselect Area heading – click on it

Now we can remove small polygons the 'GIS way'.

Select the Record dropdown, then query by -> example

Edit the statement to read: Area < 0.01   (=1 hectare or .01 km^2)
You MUST edit using the menu provided, not your keyboard –
Use the operator button and click on 'entire list' to display all values
– if there isn't an exact 1 hectare value, click on the nearest value (e.g. just above .01)
Click on Insert   Apply   OK

Now all records are gray highlighted if Area < 0.01 km
Right-click on one that is selected in the left column and pick **delete –** deletes all the small ones
You have deleted all the wee polygons smaller than 12 pixels / 1 hectare

Layer-> Save as ,   pick your 2016 pix file and the Polygon Layer

Layer-save as again and this time scan down a few lines to the ArcGIS shapefile, and save as shapefile .. you could name it something like water2012.shp and save in your folder. This can be directly opened in ArcGIS or QGIS – unlike the layer stored in the .pix file.

Click again in the top left column (blank to the left of 'ShapeID', and you should see a summary of stats for the water polygons, including total area (sum) for the polygons.

Q2: a. how many water bodies are in this layer and what is their total area (km^2)
b. What is the area of each of the two largest lakes (km^2) ?

5. Polygon layer for another land cover class - EXPOLRAS

The EXPOLRAS algorithm goes beyond BIT2POLY with multiple steps to extract and refine features by thresholding, sieving and vectorizing in one operation.

First we need a layer to work with – it might be a classification, but we'll settle for the NDVI for this area, and try to extract Avalanche slopes. These are not as easy to extract as water - nothing is ! One can assume they mostly have the highest DN values in the NDVI layer.

Use the Raster calculator to create **NDVI: (NIR-Red)/(NIR+Red)** .. insert band numbers
Remember to write this to a 32-bit channel and as a new layer in your 2016 pix file

Query the DNs in this layer on the avalanche slopes – I found a value of 0.38 was a good minimum, while we don't need a maximum as we assume these are the highest values.

Tools → Algorithm Librarian -> **EXPOLRAS**
Input: your NDVI channel
Output: to viewer and your 2016 pix file
Params:
Threshold Minimum 0.38
Minimum Area: 12 – this is the sieve operation (which may be redundant if done before)
Go to log tab and Run … it should be successful

You now have a polygon layer for avalanche slopes– you don't need to remove small polygons as the minimum did this, though you may still find some small 'donut holes' of non-deciduous in the avalanche slopes etc.. However the high values will also catch many of the regenerating cutblocks. We could use the Bowron lakes park boundary polygon to remove these with a 'clip' as there are no cutblocks inside the park – it is a park !

Smoothing – run **SMBOYLE** and output to Viewer and your .pix file

Q3a: how many smoothing routines are in the Algorithm Library ? (all begin with 'SM')

b. Which one does Catalyst recommend for converted raster data and why
(Note that I am biased as Ray Boyle is Canadian and I met him at U.Sask)

Right-click on the polygon label in the 'maps' tab and open the **Attribute manager**.

convert units to square hectares, and review the total. Save the polygons as a layer in the pix file and also save the vector segment also to a shapefile (e.g. avslope.shp)

Add the Bowron Lakes Park boundary shapefile:
Layer-> add-> vector and browse to ***/home/labs/geog357/shapefiles/bowron-utm.shp***
[remember to do the final click on the VEC link in the bottom window]
Once loaded to view, right-click and also save it to your own folder

You can see all cutblocks are neatly outside the Park – of course, it is a park !
We could clip our avalanche slopes to just get the ones inside the park (see graphic)

CLIP: Catalyst clips rasters but not vectors, so you would better do this in ArcGIS or QGIS. Are you able to do this – let me know if not. Note that you will first need to 'repair geometry' (ArcGIS) or'fix geometry'(QGIS) in the avalanche slopes shapefile, before you can clip.

Q4: what is the area of avalanche slopes inside the park
(accepting our image misses some parts of the park in the north
and southeast). Please give the answer in a. hectares and b.
kilometres.

6. Filters; EDGE and FSHARP

Tools-Algorithm Librarian and Find EDGE
Input your NDVI channel
Output (Magnitude): Viewer-Grayscale
Output- Gradient direction: None (tick off any default)
Log tab and run
Ensure your NDVI layer is also in the maps display list and 'flicker' between that channel and this new layer created by EDGE.

Tools-Algorithm Librarian and Find FSHARP
Input your NDVI channel
Output: Viewer-Grayscale
Log tab and run
Ensure your NDVI layer is also in the maps display list and 'flicker' between that channel and this new layer created by FSHARP.

Q5a: describe the difference in result between EDGE and FSHARP
5b. EDGE almost seems to have identified all lake edges; what are the typical high DN values in the EDGE layer for these ?

Send answers to: [*wheate@unbc.ca*](mailto:wheate@unbc.ca) *by Friday 10pm*

Repeat of all questions:

Q1: Catalyst also has a BIT2LINE option – give two examples where you might choose to use this option instead of BIT2POLY to extract suitable features and under what circumstances..

Q2: a. how many water bodies are in this layer and what is their total area (km^2)
b. What is the area of each of the two largest lakes (km^2) ?

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