Remote Sensing, Fall 2020
Lab 7: 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
* Examine and clean attribute table - calculate area stats (in Banff Focus or GIS)

Features to extract:
* 1. Water (twice) – PG and Bowron
* 2. Forests or another class from labs 2 or 3
* 3. Avalanche slopes – Bowron only

1. Set-up and Thermal

Start in the usual way with Banff Focus and open your copy of   **pg11sept1996.pix**
Change display to 543, stretch .. note you are displaying 3 bands (channels) one each in RGB

Let's get Thermal .. as we just did it in lectures – add Band 6 in grayscale
Layer->add ->grayscale ->band 6 .. enhance as needed
Click on RGB Mapper ->Note you are now displaying one band (channel) 3 times in RGB
Some striping is visible, orthogonal to the scanner direction and especially where DNs are low.

Tick the thermal band on and off to see the relation between the landscape and thermal
View the histogram for Band 6: layer-> histogram
The band has less contrast than other bands, one indicator is the lower standard deviation (SD).

Q1: how does the Thermal band SD compare statistically with the visual and IR bands – use any one of 1-3, and 4,5,7 to compare, no need to use all of them.

*Q2: view sample Band 6 DN values for Fields, Water, Urban (use the Bowl) and Forest
Rank them 1-4 Cooler-> warmer, and briefly explain why this is as you would expect.*

2. Extracting water from PG 1996 multispectral image

We'll first use the water bitmap you created in lab2 to generate a vector shapefile for water: rivers and lakes. We can directly convert this to a vector layer using algorithm BIT2POLY

First remind yourself what you have in your .pix file
Files tab: expand and review the bitmaps
If you can't remember which bitmap is water, display it/them to see: Layer-> add → bitmap

tools-> algorithm library → BIT2POLY
Input: the bitmap layer number
Output: viewer and your pix file (click on browse to find your file)
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, again output to the viewer, and 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, one not smoothed.

We will use a more sophisticated algorithm to smooth the unsmoothed version, written by Ray Boyle, U. Saskatchewan who I met in my first year teaching at U of S in the 1970s. It is called SMBOYLE and is found in the Algorithm Library.

 Input your smoothed vector layer, output to viewer and the 1996 pix file.
Repeat using the unsmoothed vector layer and compare them all
You might want to ensure they are all labelled so you know which is which

You should find the best result is the last one - NOT smoothed in BIT2POLY but smoothed by SMBOYLE. The double-smoothed one has some strange edges and bits lost, while the one smoothed only in BIT2POLY is not as rounded as the last one smoothed by SMBOYLE.

Q3: Why is the best result from the Boyle smoothing algorithm when you don't first already smooth (with bit2poly) … read the help 'details' in SSBOYLE to find the answer.

3. 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 Banff: 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 2 and
display units to hectares.   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 < 0.5   (=0.5 hectare)
You MUST edit using the menu provided, not your keyboard – if there isn't an exact 0.5 hectare
value, click on the nearest value
Click on Insert   Apply   OK

Now all records are gray highlighted if Area < 0.5 hectare
Right-click on one that is selected in the left column and pick **delete**

Layer-> Save as , pick your 1996 pix file and the Polygon Layer
You have deleted all the wee polygons smaller than 6 pixels / 0.5 hectare

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 pg1996water.shp and save in your shapefiles
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. But its in hectares –
change to square kilometres using the method near the top of this section, and you will need to
click again in that top left corner of the table. The total area for water should be ~20-30 km^2.

Layer-> add → vector and select the rivers layer used in Lab 1:
home⁄labs/geog357/shapefiles/rivers.shp
they won't match exactly as the river course has changed – shifting sandbars and the city rivers
layer is more detailed as it is digitised from high resolution (1 metre pixels) aerial photography.

4. Polygon layer for a land cover class

Next, we (I mean you) can do a similar process with another land cover class from your (best) classification in Lab 2 or 3.
Layer→ add→ pseudocolor – next – and pick your best (sieved) classification

Technically your supervised classification in Lab 3 should be superior = fewer scattered pixels. In mine, I had two classes (numbered 8 and 9) that between them seemed to cover all the coniferous forest and mixed forest respectively

.Add your classification to the displayed layers:How about yours ? did you have something similar – or perhaps one or two classes that each covered deciduous or fields or urban or industrial? Find a good class to extract.

First we should SIEVE the classification if you haven't already – maybe you did in Lab 3 ? If not, do it now, using a 1 hectare filter (12 pixels) minimum size, and record which new raster is the sieve channel.

We can use the EXPOLRAS algorithm to include several steps: Combine two classes, (sieve*) and vectorise. Pick your best class(es) for this part- I recommend forested if possible.

Note it seems to include sieve, but does not include 'donut holes' in a polygon e.g. small clearings inside forest

Tools → Algorithm Librarian -> **EXPOLRAS**
Input: your sieved classification channel
Output: to viewer and your 1996 pix file
Params:
Threshold Minimum and Maximum are the two adjacent classes – for me, 8 and 9; if your similar classes were not adjacent, then they weren't that similar !
If you are only inputting one class, then that number is the min and max.
Minimum Area: 12 – this is the sieve operation (which may be redundant if done before)
You now have a polygon layer for these forested or fields (whichever you picked) – you don't need to remove small polygons as the minimum did this, though you may still find some small 'donut holes' of non-forest inside the forest etc.. If need be, you can use the method for water to remove small polygons.

Smoothing – run **SMBOYLE** and output to Viewer and your .pix file
Right-click on the polygon label in the 'maps' tab and open the **Attribute manager**.
convert units to square kilometres, and review the total forested (or which class you picked) in the same way you did for water above.
Next, we'll switch to the Bowron Lakes, so a new project. If you want to save this setup, you can use File-> Save project (name it something like pg1996features); this only saves the current layers setup – you may first need to remove any temporary (viewer only) layers.

5. To the mountains and Bowron Lakes

File → New Project
open your 17 August **1992 Bowron Lakes pix** file, and optimize display (543), stretch

a. Create a bitmap for water, same method as you did for PG water (THR).
Find the threshold value that separates water, though you will have higher DNs that conflict with shadows – just as in PG. Note that we'll try to solve this in a later lab. It may not work as well as for Prince George, and possibly it needs the classification option for a good water layer, but this will do for now.

b. algorithm librarian ->   use BITPOLY (convert bitmap to polygon)

Input bitmap: enter the bitmap number from 5a
Input params: smooth vectors box should NOT be checked
output on viewer and your Bowron 1992 .pix file
Run .... how does it look - you may need to check off the bitmap display to see the lines OR change the colour of the lines (right-click on the vector layer name ... colour)

c. SMBOYLE to smooth vectors
Same process as for PG in sections 2 and 4 above

d. Vector clean-up
Right-click the vector layer in the contents, and view the attribute manager. Repeat steps from 3 above. Change units this time to kilometres with 4 decimal places. Right-click on the Area column heading, select Table definition, change decimal places to 4 and display units to kilometres. Click on that top left table spot to get overall stats.

Q4: a. What is the value given for total (sum) of all water ?
b. How many lakes / polygons are > 1 hectare (1 ha = .01 km2 – but you knew that !?)

Layer-save as - and save as layer in the .pix file and also as an Arcview shapefile.
Name it so you know what it is (water)
- – you can also save it using right-click on the polygon layer in the files tab

6. Avalanche slopes

In my job interview for UNBC in 1994, I showed how we used RS to map avalanche slopes in
Yoho National Park, where they had recently seen several grizzly bear – human conflicts
due to humans crossing avalanche slopes -their favourite smorgasbord feeding grounds.

These are not as easy to extract as water - nothing is !
One assumes they generally have the highest DN values in the NDVI layer.
Query the NDVI layer from Lab 4 and determine approximate values for av.slopes
Use THR to check possible minimum threshold values ~ .51, .62, .73 (?)
You decide … it's likely the most similar cover type is recovering cutblocks
We'll have other ways to remove these later

Run **THR** saving the result to your 1992 .pix file

Run **BIT2POLY** to convert – save to your 1992 .pix file
Edit the vector layer as before - change area to hectares, with 1 decimal,

Use the record-> query by -> example option to remove all avalanche slopes less than 2 hectares
and save the vector segment also to a shapefile (e.g. avslope.shp)

The result may include many cutblocks, which all lie outside the park, and could have been
excluded in a classification stage, which allows a mask layer e.g. the park boundary.

If you don't already have the Bowron Lakes park boundary – did we get it in Lab 4 ?
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 shapefiles folder

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

CLIP: Banff clips rasters nicely but not vectors, so open your favourite GIS – and clip the
avslope shapefile to the park, using the park boundary shapefile. * see below for quick note
on slipping in ArcGIS

5a. What is the area of all avalanche slopes inside Bowron Lakes Park in square kilometres ?
b. What is the total number of avalanche polygons ?

CLIP in ArcMap

In Osmotar, start ArcMap (in ArcGIS dropdown)

accept 'blank map' default

Add data (yellow + sign)

You may need to 'connect to folder' .. yellow folder with + sign - select your geog357 folder

Add avalanche slopes and the Bowron park boundary (saved to your folder in Banff-Focus)

Select geoprocessing dropdown → Clip

Input: your avalanche slopes shapefile

Clip features: park boundary

Output: navigate to your folder and name the file e.g. parkslopes.shp

OK .. and it should run .. and display when done

click off the input slopes file that had been clipped so you can see the new result

To find total area:
right-click→ open attribute table
right-click on area heading → statistics …. to see total area (in metres default)
right-click on area heading →calculate geometry …. to change units to sq. km

OR in Banff focus
layer-add- vector → your clipped slopes shapefile

- and view the total area in Banff Focus