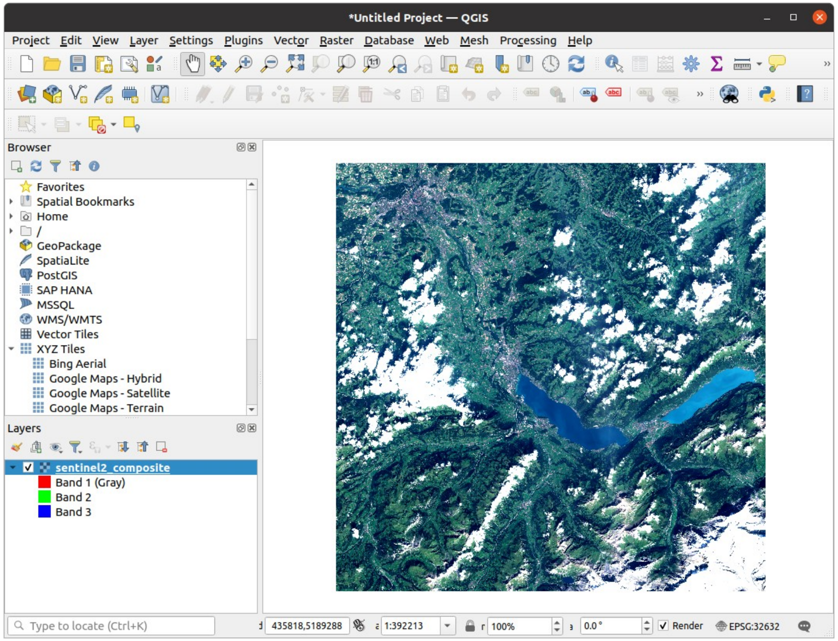
Remote Sensing Lab
Spring Semester 2022

Lab 2 Week 1 (L2W1)
Training Site Development

Rodrigo Daudt
rcayedaudt@ethz.ch
HIL D43.3

General Information

- In Lab 2, different land cover classification techniques will be explored using 10 bands of an Sentinel-2 scene over the Bern/Thun region in Switzerland
- The image was taken on 3rd September 2016.
- Software to be used: QGIS 3.* and Python.



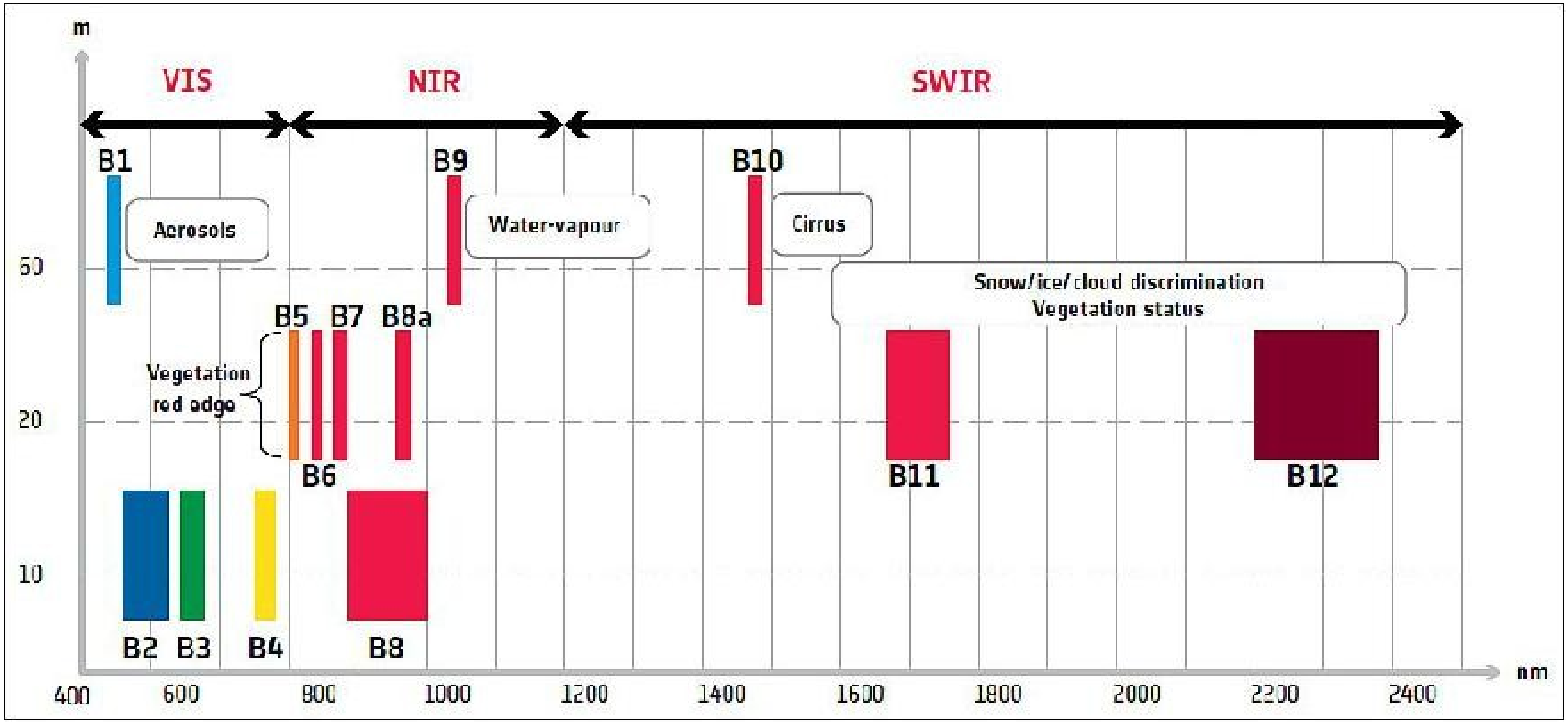
Data

- Sentinel-2 is an Earth observation mission developed by ESA as part of the Copernicus Programme to perform terrestrial observations in support of services such as forest monitoring, land cover changes detection, and natural disaster management.

- It consists of two identical satellites, Sentinel-2A and Sentinel-2B. Images from these satellites are openly available for free.

- Sentinel-2 has 13 channels with 3 different spatial resolutions (10m, 20m, 60m) with a radiometric resolution of 12 bit

Data



- We will only use the 10 m and 20 m resolution channels.
- The 10 m channels are re-sampled to 20 m to equalize the spatial resolution.

Data

Sentinel-2 Bands	Central Wavelength (µm)	Resolution (m)
Band 1 - Coastal aerosol	0.443	60
Band 2 - Blue	0.490	10
Band 3 - Green	0.560	10
Band 4 - Red	0.665	10
Band 5 - Vegetation Red Edge	0.705	20
Band 6 - Vegetation Red Edge	0.740	20
Band 7 - Vegetation Red Edge	0.783	20
Band 8 - NIR	0.842	10
Band 8A - Vegetation Red Edge	0.865	20
Band 9 - Water vapour	0.945	60
Band 10 - SWIR - Cirrus	1.375	60
Band 11 - SWIR	1.610	20
Band 12 - SWIR	2.190	20

Data

- The resampled and selected bands are provided in the *raw_data* folder.

- A true color composite is also provided, which will help you to interpret the image for labeling. The script for generating this composite using *gdal* is provided.

- Such composites can also be generated using QGIS, but we can’t control some of the parameters that way. QGIS uses *gdal* as a back end, so calling *gdal* directly is the better approach here.

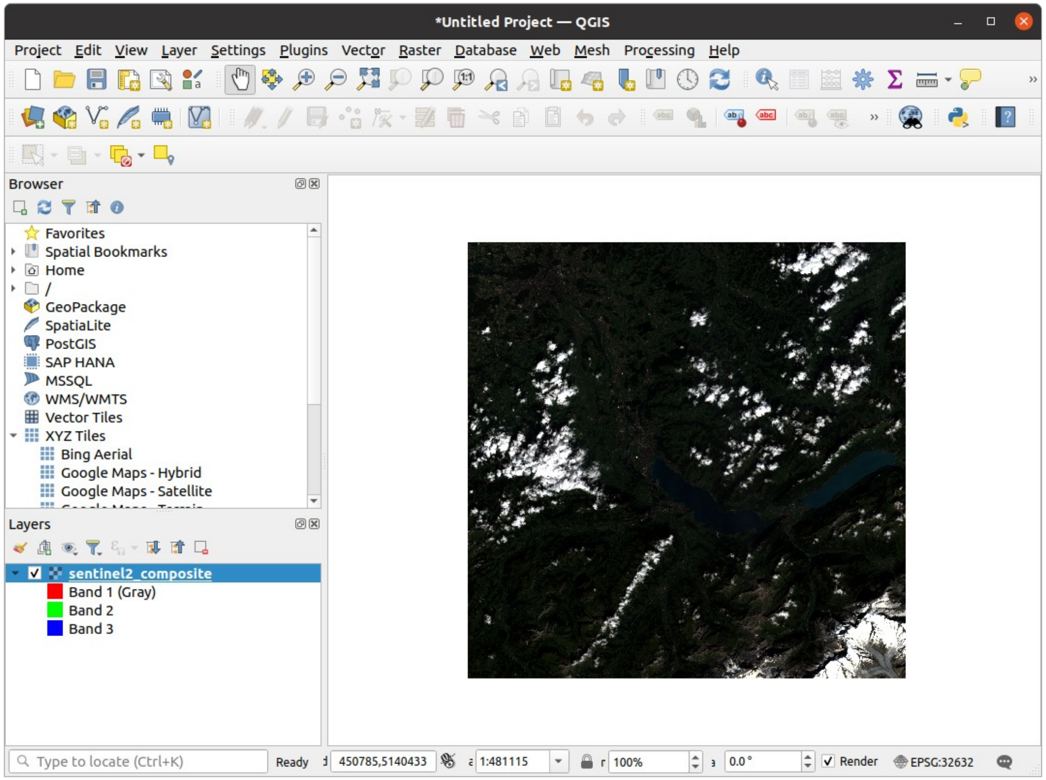
Vector Annotations

- We will be creating a shapefile with vector annotations that mark some example locations of the following classes:

    1) Forest
    2) Water
    3) Clouds
    4) Fields (green)
    5) Fields (brown, harvested)
    6) Man made impervious surfaces (cities)
    7) Snow
    8) Rock

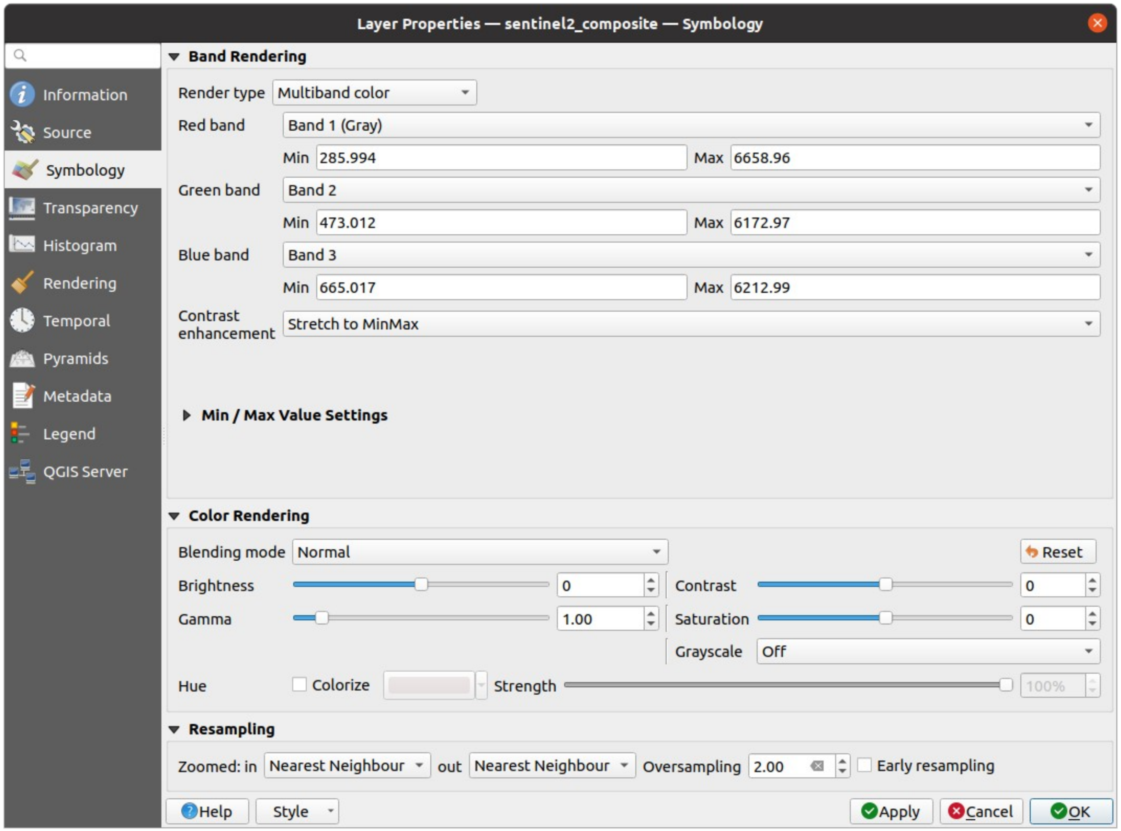
Vector Annotations

- Begin by creating a new project on QGIS 3 and loading the provided *sentinel2_composite.tif* image for guiding the annotation process.



Vector Annotations

- To improve visibility, we need to set appropriate scaling values. Double click the layer to open its settings, then go to the “Symbology” tab.



Layer Properties — sentinel2_composite — Symbology

Band Rendering

Render type: Multiband color

Red band: Band 1 (Gray)
Min 285.994 Max 6658.96

Green band: Band 2
Min 473.012 Max 6172.97

Blue band: Band 3
Min 665.017 Max 6212.99

Contrast enhancement: Stretch to MinMax

Min / Max Value Settings

Color Rendering

Blending mode: Normal

Brightness: 0

Contrast: 0

Gamma: 1.00

Saturation: 0

Grayscale: Off

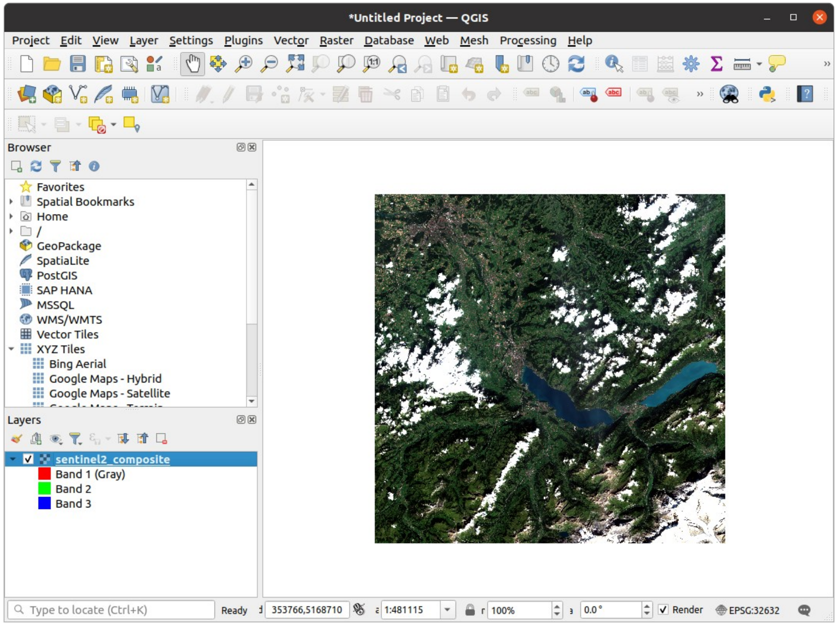
Hue: □ Colorize Strength 100%

Resampling

Zoomed: in Nearest Neighbour out Nearest Neighbour Oversampling 2.00 □ Early resampling

Vector Annotations

- You can either set the min and max values manually (e.g. 400/1500) or use the “Min / Max Value Settings” tool to clip some pixels at either end of the histogram (e.g. 1% / 90%). You may need different values to properly visualize classes with different brightness.



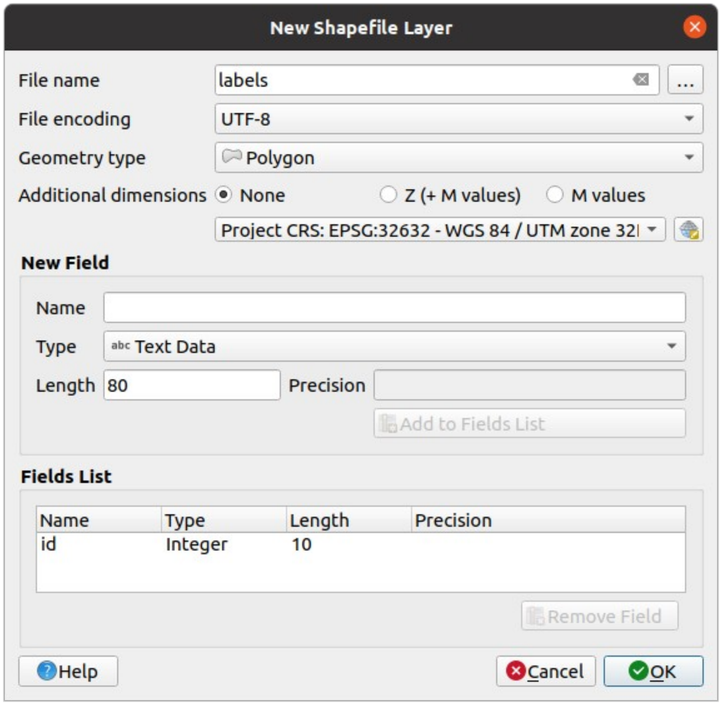
Vector Annotations

- Next, we need to create a vector (shapefile) layer to draw the polygons. Click on Layer → Create Layer → New Shapefile Layer or use the appropriate button as shown in the next slide.

- Set the following parameters (see next slide):
    - File name: labels
    - Geometry type: Polygon
    - CRS: EPSG:32632

- The field named “id” will be used to store the class code (1-8) of the classes listed in slide 7.

Vector Annotations



New Shapefile Layer

File name: labels

File encoding: UTF-8

Geometry type: Polygon

Additional dimensions: ● None ○ Z (+ M values) ○ M values

Project CRS: EPSG:32632 - WGS 84 / UTM zone 32N

New Field

Name:

Type: abc Text Data

Length: 80

Precision:

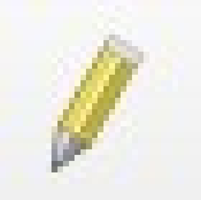
Add to Fields List

Fields List

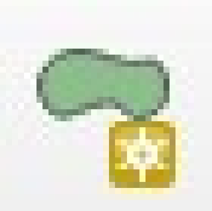
Name	Type	Length	Precision
id	Integer	10	

Vector Annotations

- You should then right click the “labels” layer in the bottom left, then click on “Toggle editing” to enable us to draw new polygons.

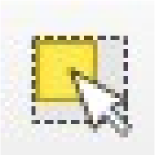


- You can then click on the “Add polygon feature” (icon shown below) to start drawing polygons.



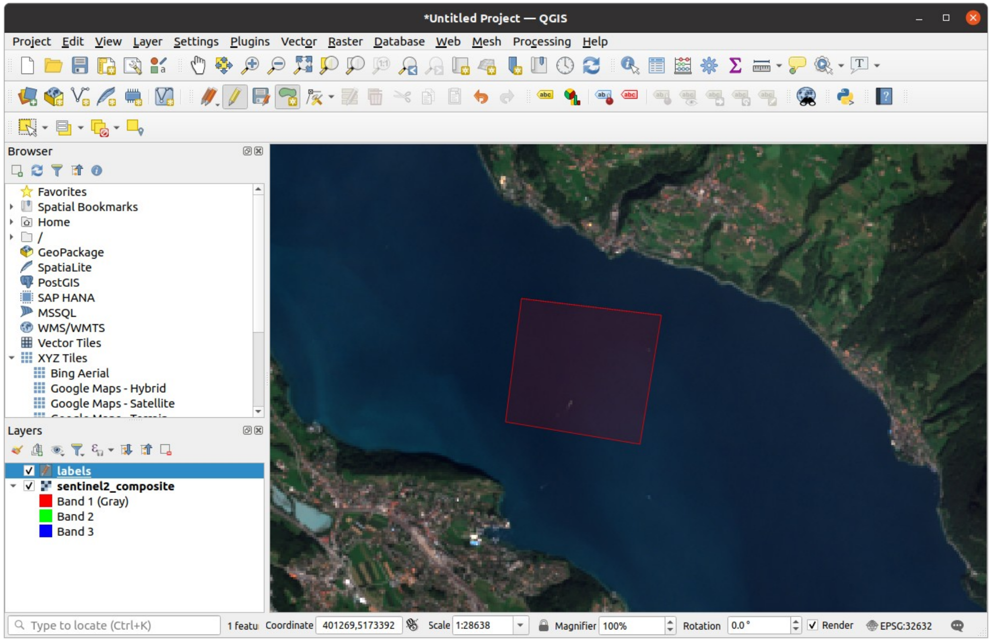
Vector Annotations

- Draw polygons containing varied examples of each of the considered classes.
- Polygons are drawn point by point by left clicking.
- Right click to tell QGIS you have finished drawing the current polygon.
- When you are done drawing each polygon, you will be prompted to assign a value to the “id” field. Input the class number (1-8) following slide 7.
- Class number 0 will be used for unmarked pixels.
- To delete a polygon, click on the “Select Features” button, click on the polygon, then press Del.

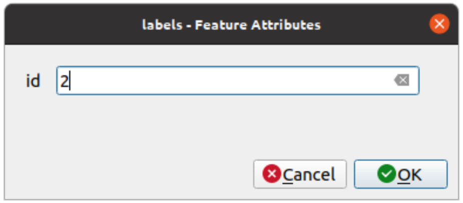


Vector Annotations

- Avoid annotating close to class boundaries to avoid annotating mixed pixels.
- Try to find varied examples of representative regions for each class.



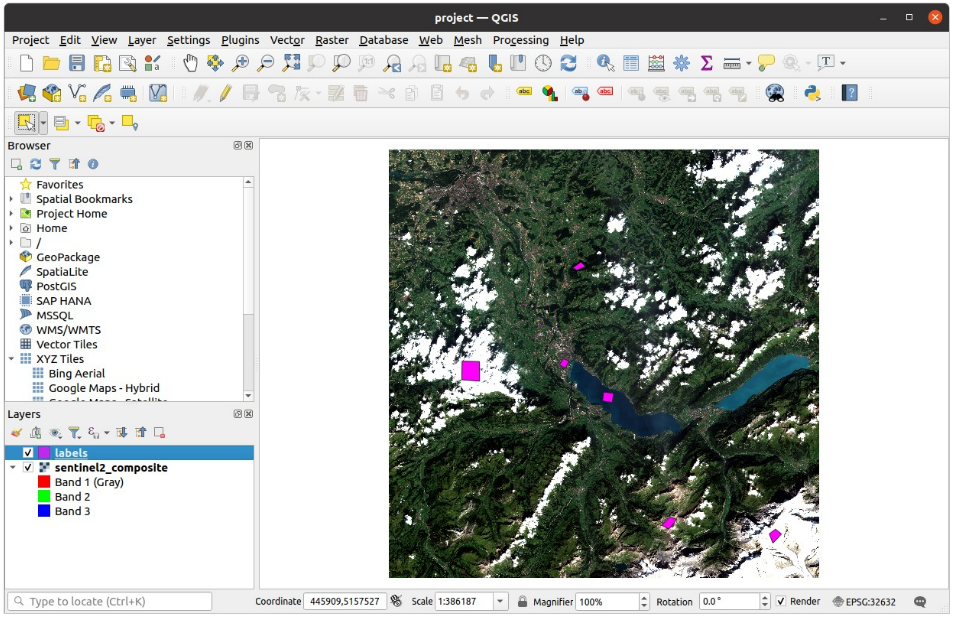
Coordinate 401269,5173392 Scale 1:28638 Magnifier 100% Rotation 0.0 ° ☑ Render EPSG:32632



id 2

Vector Annotations

- Once you are have finished drawing polygons for all the classes, you can toggle layer editing to save the polygons to the shapefile layer.
- It is recommended that you save the QGIS project as you go.

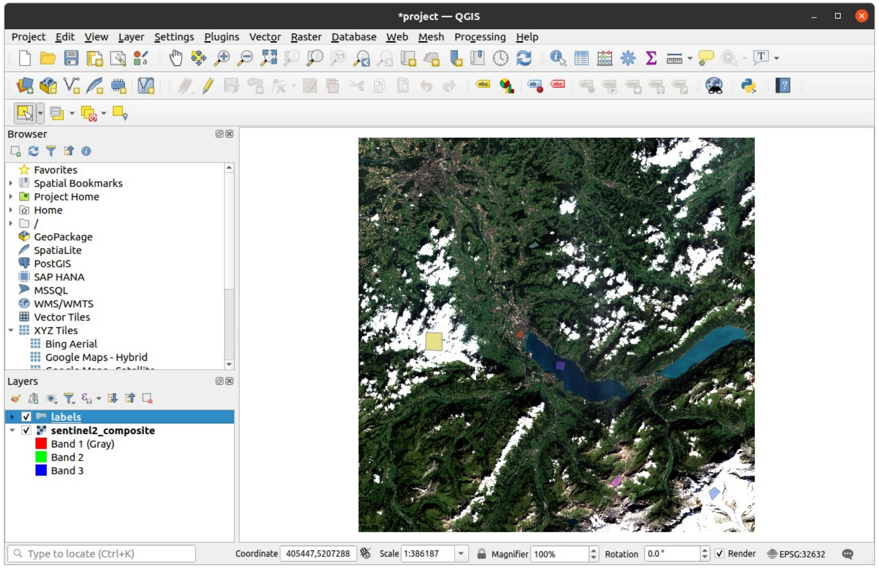


Coordinate 445909,5157527 Scale 1:386187 Magnifier 100% Rotation 0.0 ° ☑ Render EPSG:32632

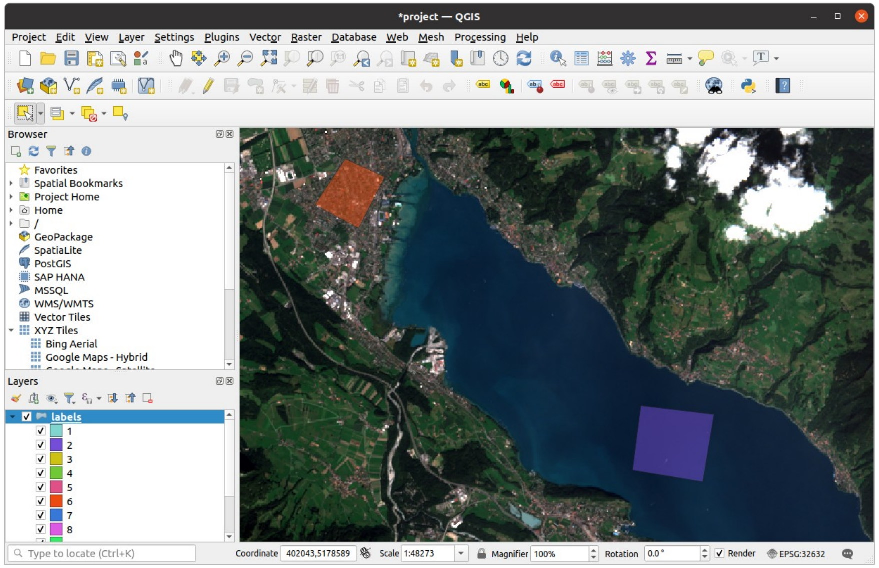
Visualizing Annotations

- To better visualize the polygons’ classes (once there is at least one polygon for each class):
  - Double click the labels layer in the bottom left and go to the Symbology tab
  - Select “Categorized” at the top
  - Set value as “id”
  - Set color ramp as “Random colors”
  - Click on Classify, then Ok
- In the Symbology tab, under “Layer Rendering”, you can also reduce the opacity (e.g. set to 50%)

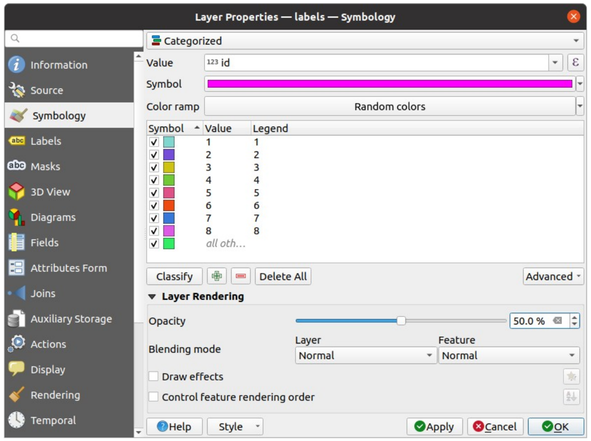
Visualizing Annotations



Coordinate 405447,5207288 Scale 1:386187 Magnifier 100% Rotation 0.0 °



Coordinate 402043,5178589 Scale 1:48273 Magnifier 100% Rotation 0.0 °



Categorized

Value: 123 id

Symbol

Color ramp: Random colors

Symbol	Value	Legend
☑ 🟦	1	1
☑ 🟪	2	2
☑ 🟨	3	3
☑ 🟩	4	4
☑ 🟥	5	5
☑ 🟧	6	6
☑ 🟦	7	7
☑ 🟪	8	8
☑ 🟩	*all oth...*	

Layer Rendering

Opacity 50.0 %

Blending mode: Layer Normal; Feature Normal

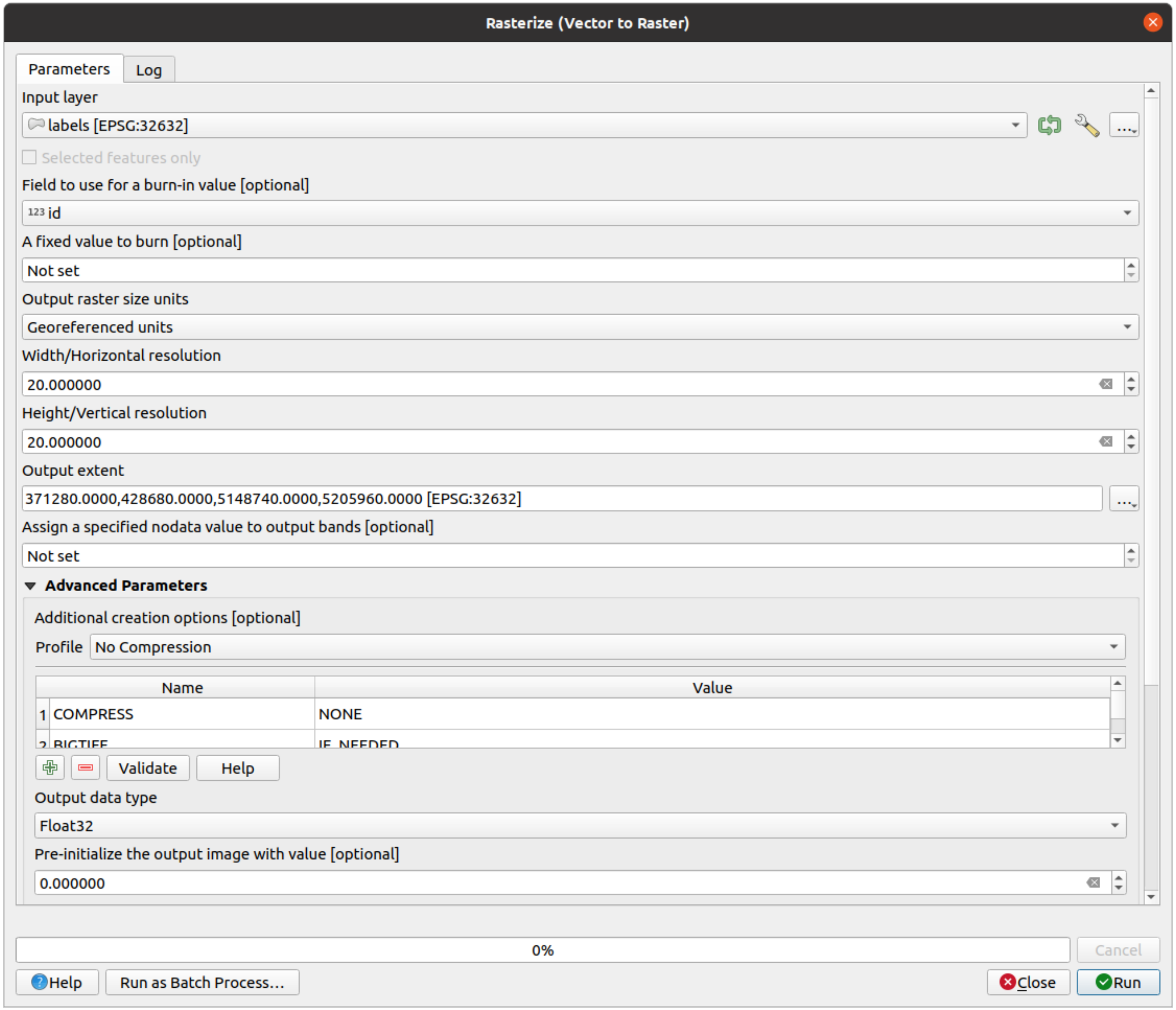
□ Draw effects

□ Control feature rendering order

Rasterizing Annotations

- We now need to rasterize the polygons. Click on Raster → Conversion → Rasterize (Vector to Raster)
- Set the following parameters:
  - Input layer: labels
  - Field to use for a burn-in value: id
  - Output raster size units: Georeferenced units
  - Resolution (width and height): 20
  - Output extent: calculate from sentinel2 layer
  - Assign a specified no data value: Not set
  - (Advanced Parameters) Profile: No Compression
  - Pre-initialize the output image with: 0
  - Rasterized (file name): labels.tif

Rasterizing Annotations



Input layer

labels [EPSG:32632]

□ Selected features only

Field to use for a burn-in value [optional]

123 id

A fixed value to burn [optional]

Not set

Output raster size units

Georeferenced units

Width/Horizontal resolution

20.000000

Height/Vertical resolution

20.000000

Output extent

371280.0000,428680.0000,5148740.0000,5205960.0000 [EPSG:32632]

Assign a specified nodata value to output bands [optional]

Not set

Advanced Parameters

Additional creation options [optional]

Profile No Compression

	Name	Value
1	COMPRESS	NONE
2	BIGTIFF	IF_NEEDED

Output data type

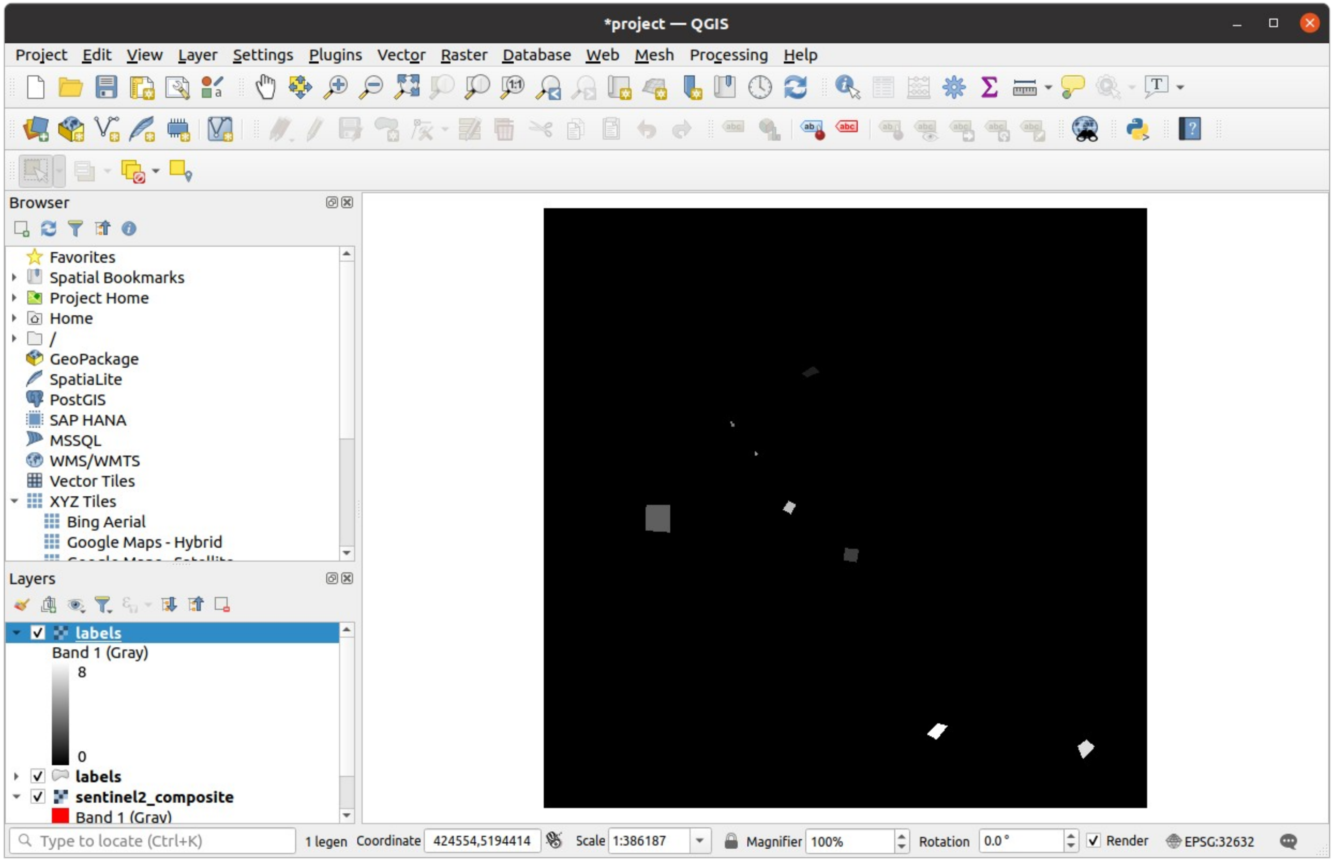
Float32

Pre-initialize the output image with value [optional]

0.000000

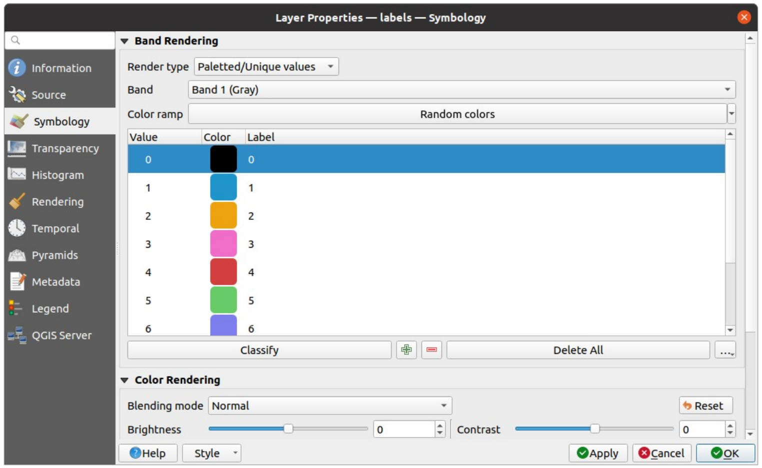
Visualizing Rasters

- After running the rasterization, a new layer (also called labels) is added to the project.



Visualizing Rasters

- To better visualize the results we can once again set random colors to each class:
  - Double click the layer and go into Symbology
  - Set “Render type” to “Paletted/Unique values”
  - Color ramp: Random colors
  - Click on Classify
  - Double click on class 0 and set it to black



Layer Properties — labels — Symbology

Band Rendering

Render type: Paletted/Unique values

Band: Band 1 (Gray)

Color ramp: Random colors

Value	Color	Label
0	⬛	0
1	🟦	1
2	🟧	2
3	🟪	3
4	🟥	4
5	🟩	5
6	🟦	6

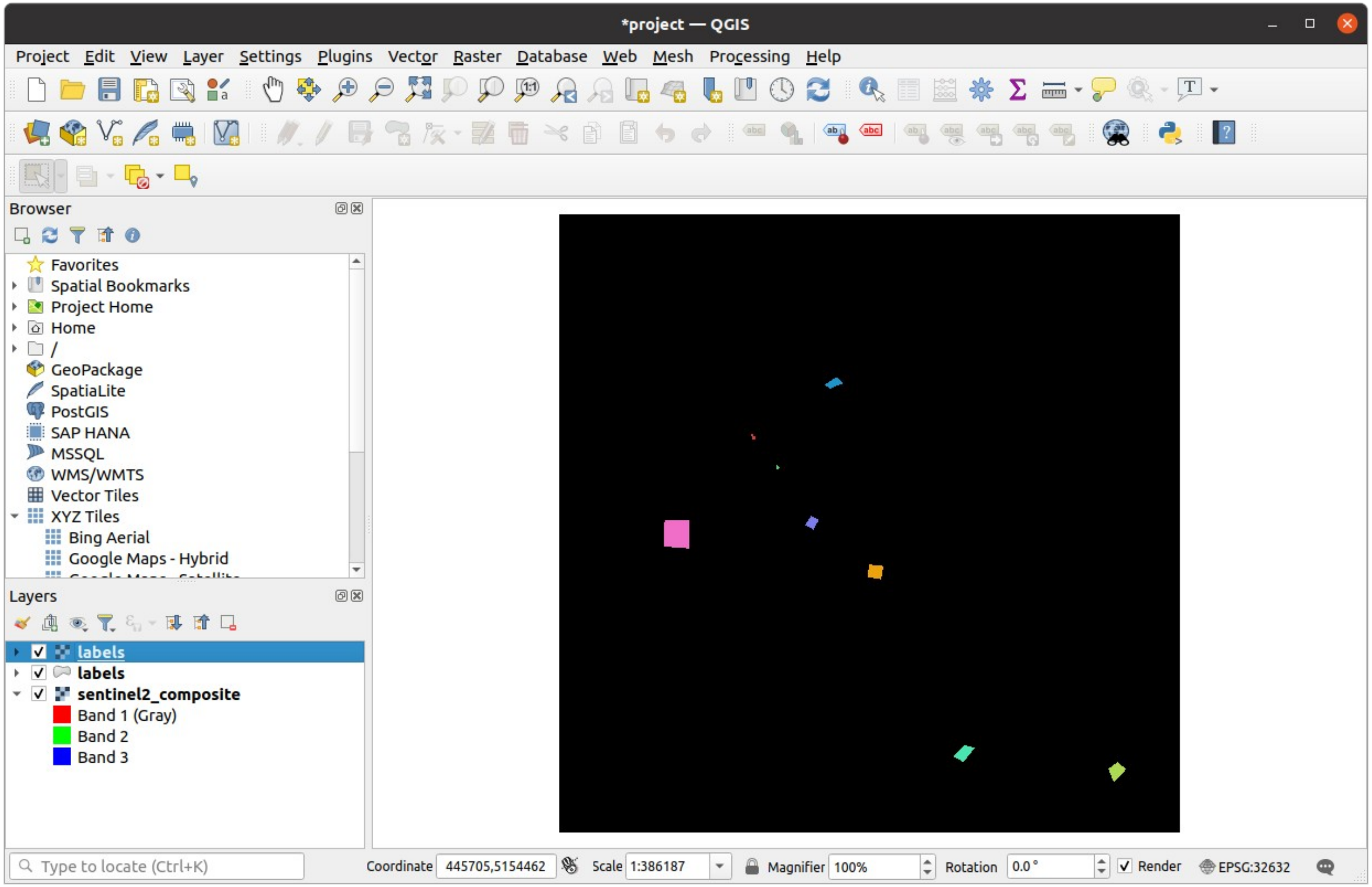
Color Rendering

Blending mode: Normal

Brightness: 0

Contrast: 0

Visualizing Rasters



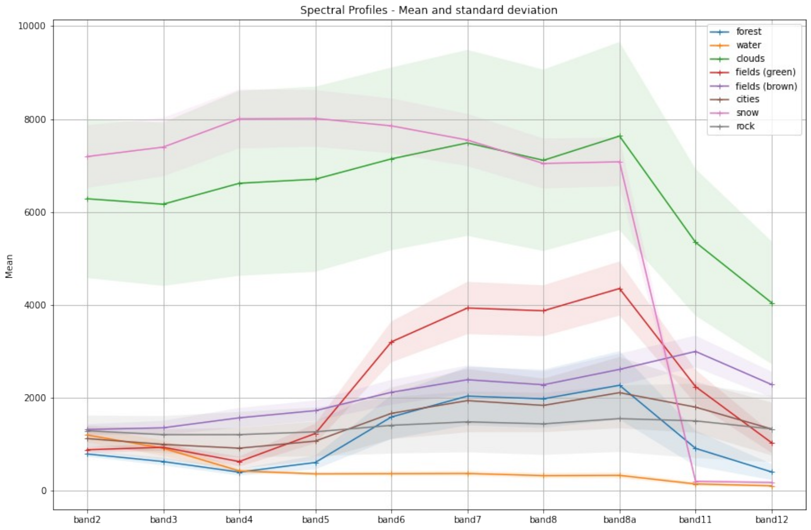
Coordinate 445705,5154462 Scale 1:386187 Magnifier 100% Rotation 0.0 ° ☑ Render EPSG:32632

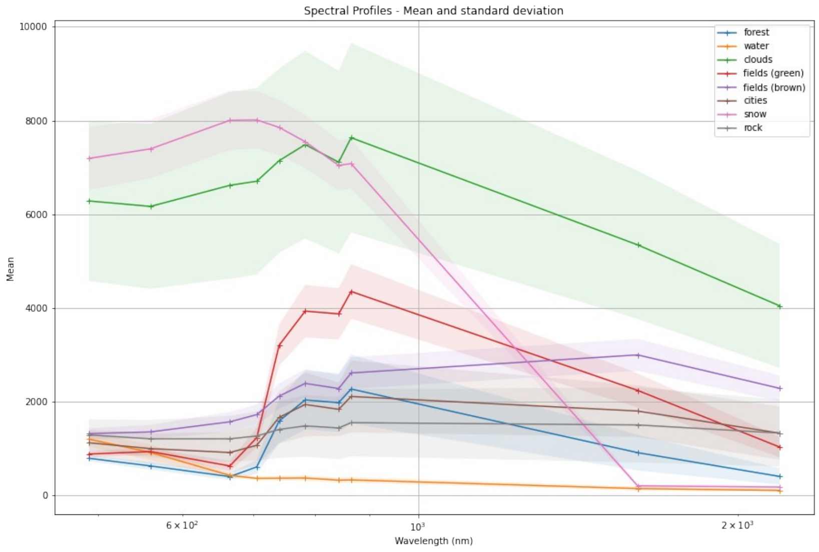
Annotations in this example are deliberately incomplete.

Class Signatures

- Once *labels.tif* has been generated, you can save your project and exit QGIS. The rest of the assignment is done in Python.
- Your first task is to generate spectral class signatures. You should generate signatures using the following features:
    - Mean
    - Standard deviation

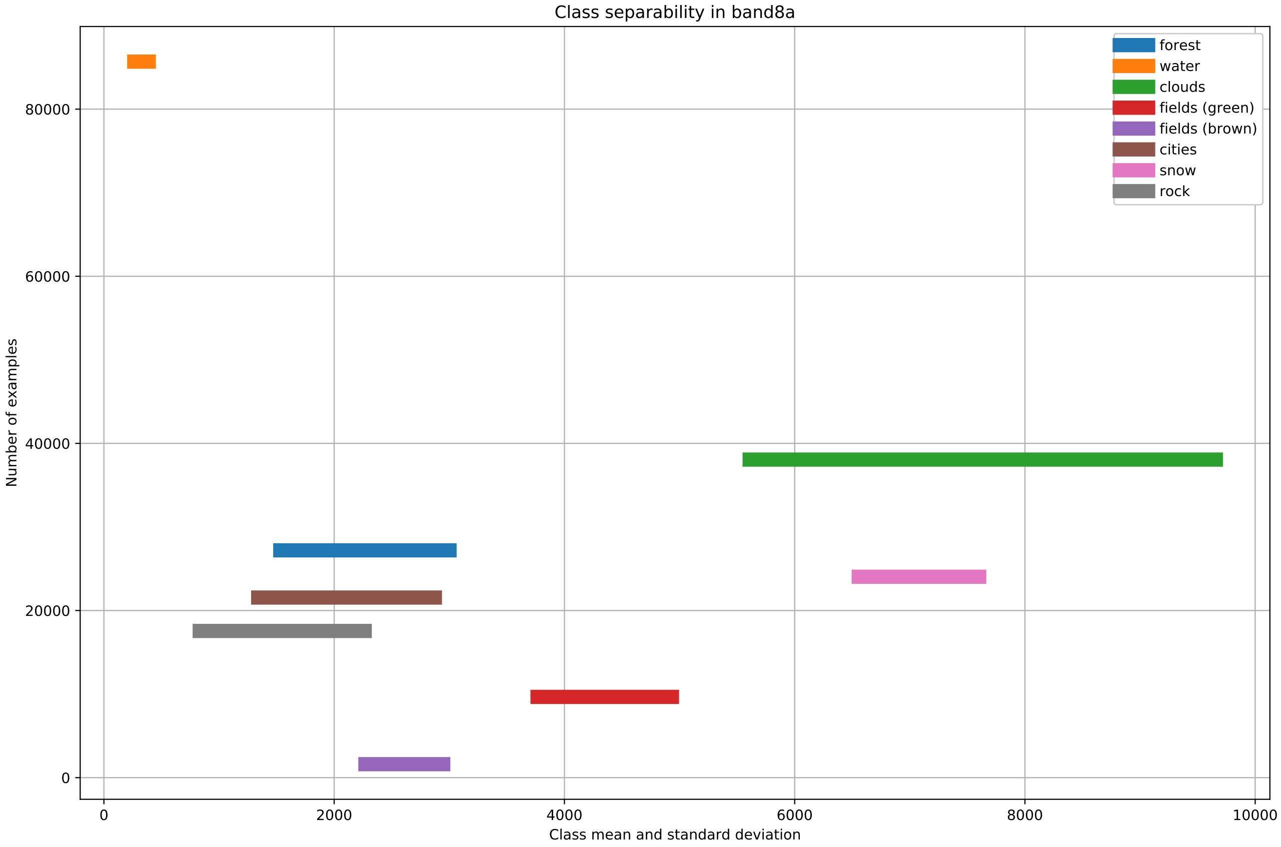
Class Signatures





Class signatures can be plotted per band, as well as using each band’s wavelength.

Class Signatures



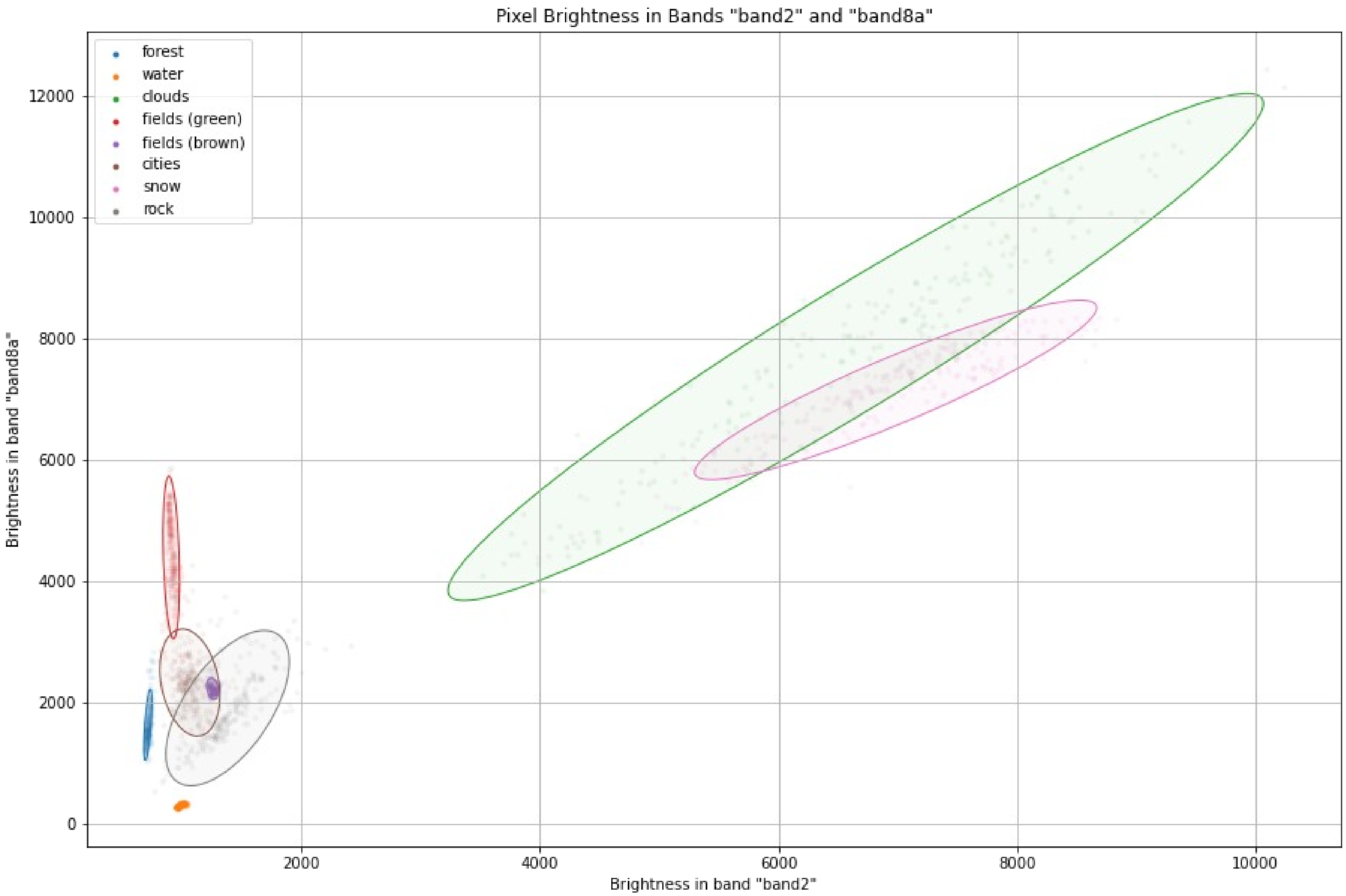
We can check if the classes’ means and standard deviations overlap in each band to see if they are separable.

Class Signatures

- You should then visualize scatter plots that show the class spreads considering two bands.

- There is no programming needed for this, but you should explore different band combinations to see when are class separable (ellipses' overlap is small) and when they aren't (ellipses' overlap is large)

Class Signatures



Deliverables

- Upload your code (L2W1.*), the *labels.*tif file you generated, and your plots on Moodle.

- Answer the quiz on Moodle.

- Deadline for submission and quiz: April 26th 15:45