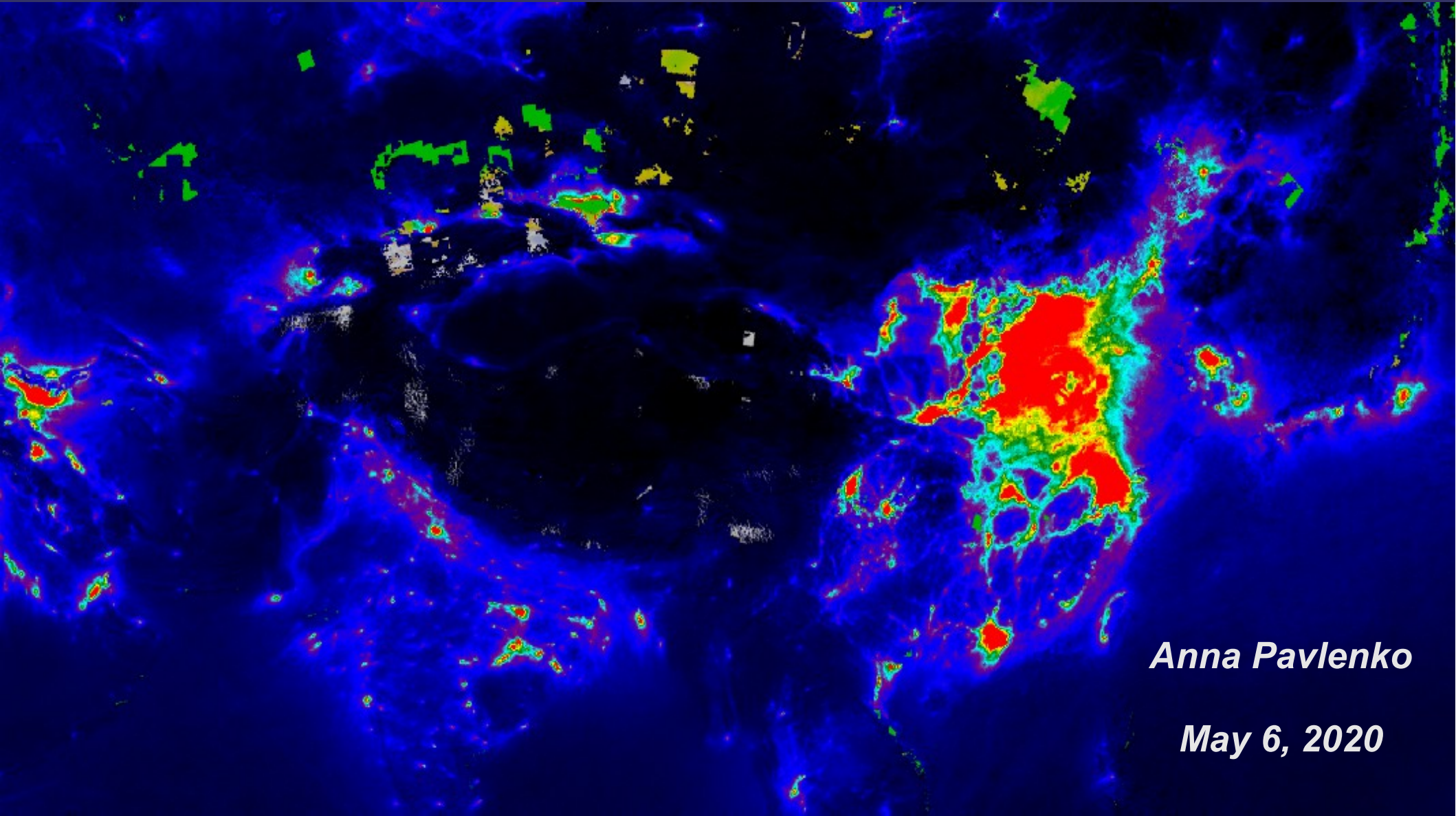


# *Machine Learning of NO2 emissions classification in Google Earth Engine*



*Anna Pavlenko*

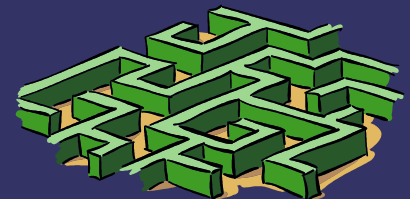
*May 6, 2020*

# Overview

- Summarize the main plans:
  - Data set available
  - Methods used
  - Validation of result
- Explain the long-term course to follow
- Look for the best methods of Machine Learning



# ***Study Area: US, Los Angeles***





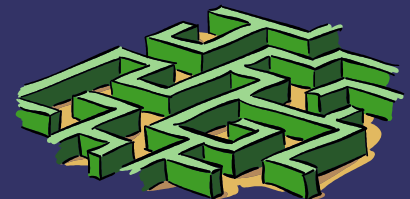
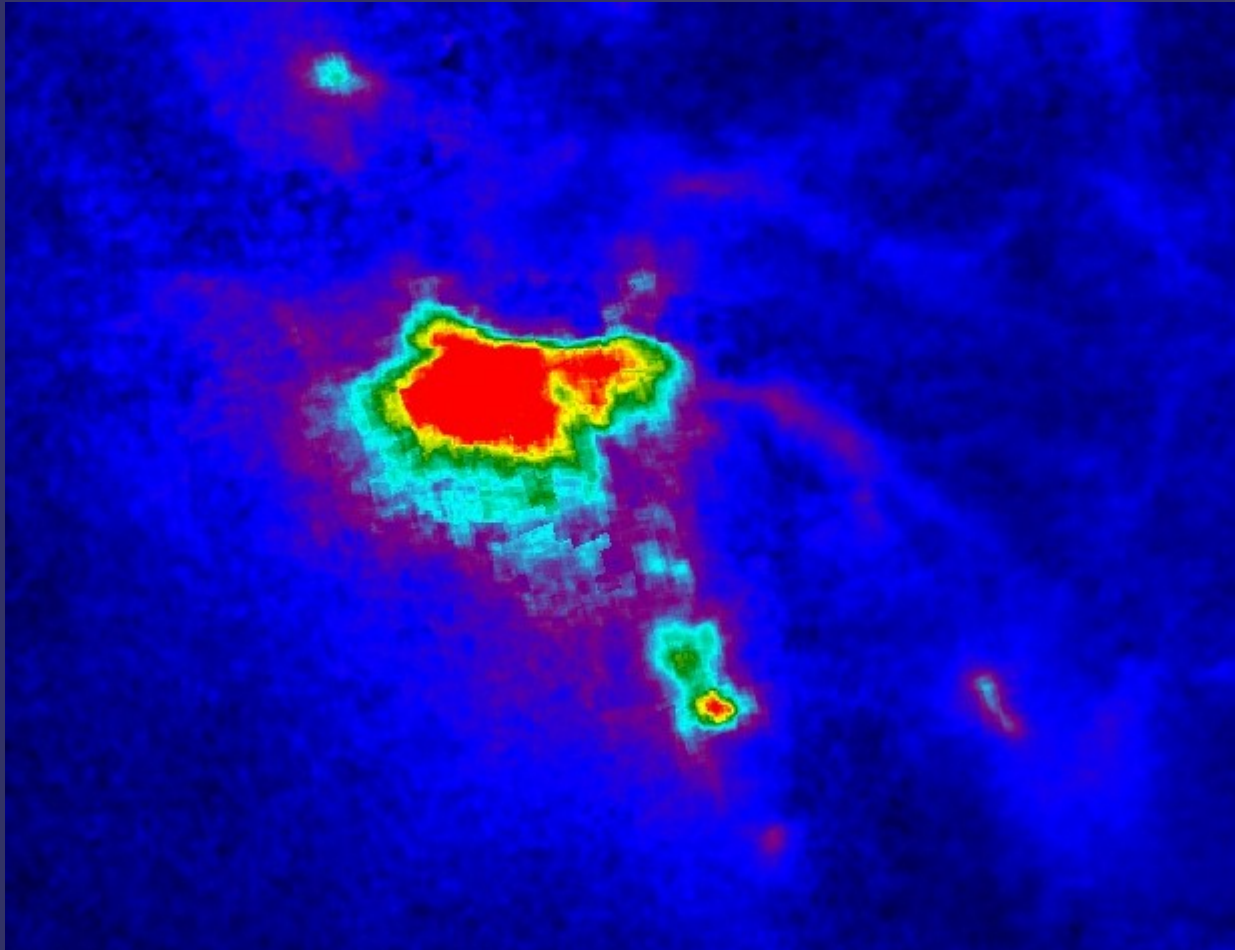
# Sentinel-5P



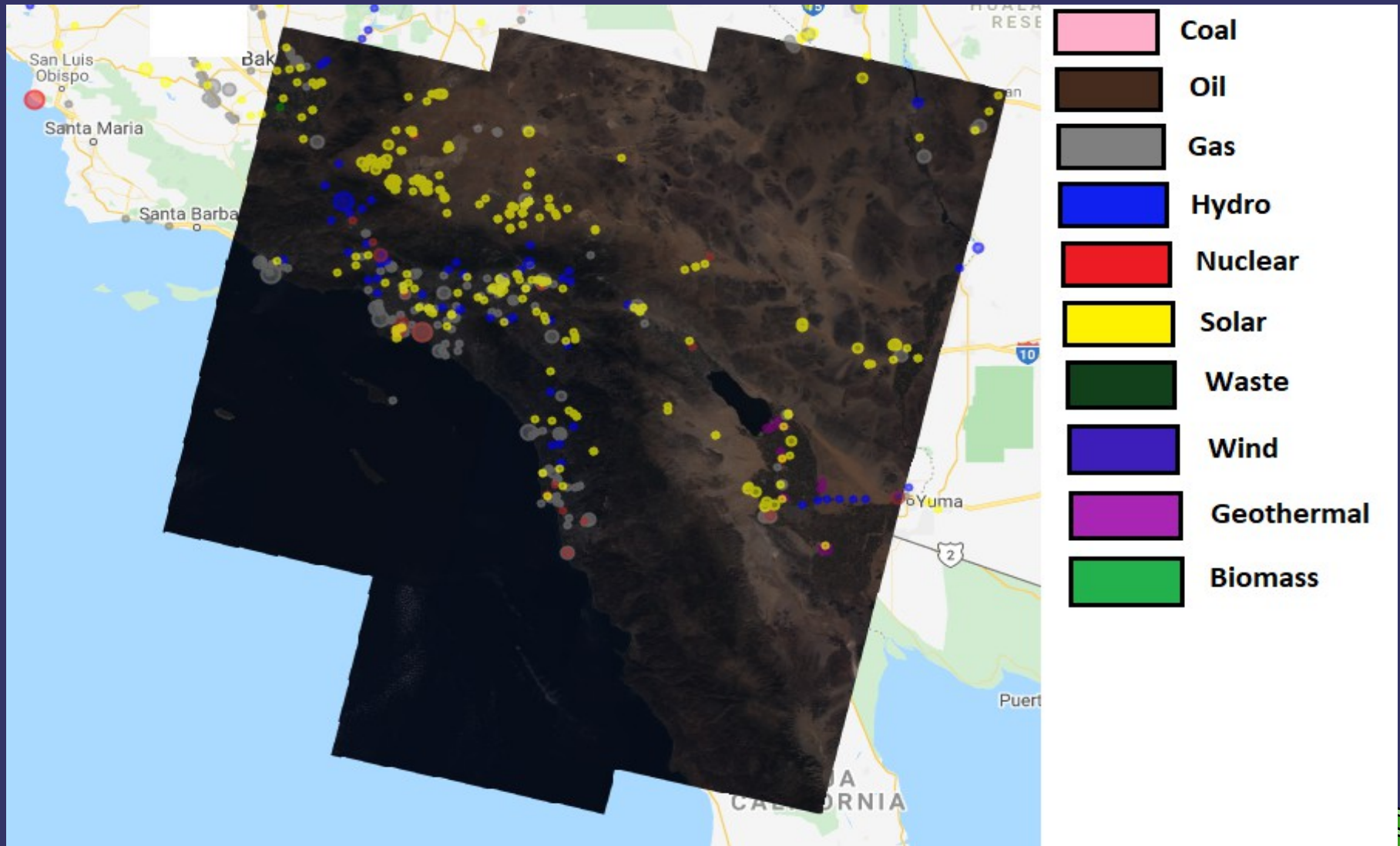
Launched 13 October 2017 by the ESA to monitor air pollution  
The TROPOspheric Monitoring Instrument (TROPOMI) instrument.

Los Angeles, US

OFFL/L3\_NO2:  
. FilterDate  
(`'2019-12-01'`,  
`'2019-12-31'`)



# *LANDSAT 8 and Power Plants Data Set*



# National Land Cover Database (NLCD)

## NLCD 2016 Landcover

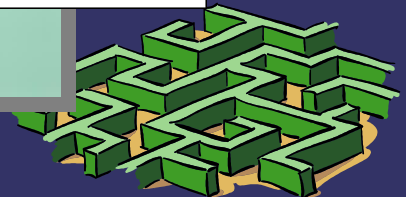


NLCD 2016 Land Cover for the contiguous United States represented as 16 land cover classes.

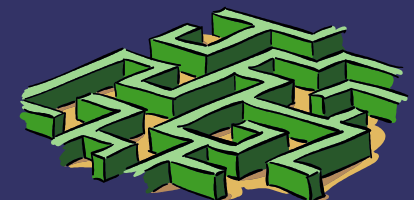
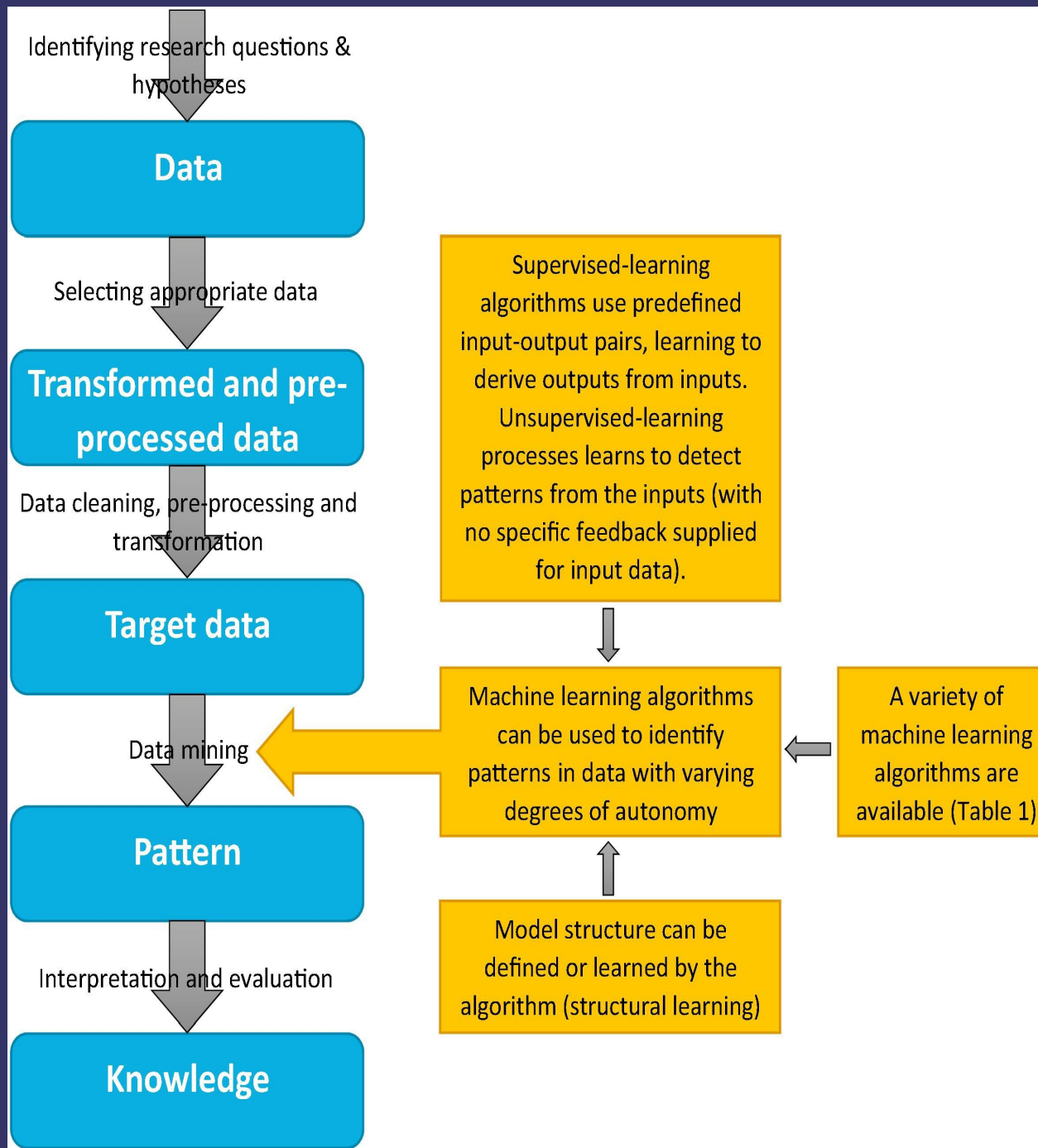
### NLCD Land Cover Classification Legend

- 11 Open Water
- 12 Perennial Ice/ Snow
- 21 Developed, Open Space
- 22 Developed, Low Intensity
- 23 Developed, Medium Intensity
- 24 Developed, High Intensity
- 31 Barren Land (Rock/Sand/Clay)
- 41 Deciduous Forest
- 42 Evergreen Forest
- 43 Mixed Forest
- 51 Dwarf Scrub\*
- 52 Shrub/Scrub
- 71 Grassland/Herbaceous
- 72 Sedge/Herbaceous\*
- 73 Lichens\*
- 74 Moss\*
- 81 Pasture/Hay
- 82 Cultivated Crops
- 90 Woody Wetlands
- 95 Emergent Herbaceous Wetlands

\* Alaska only

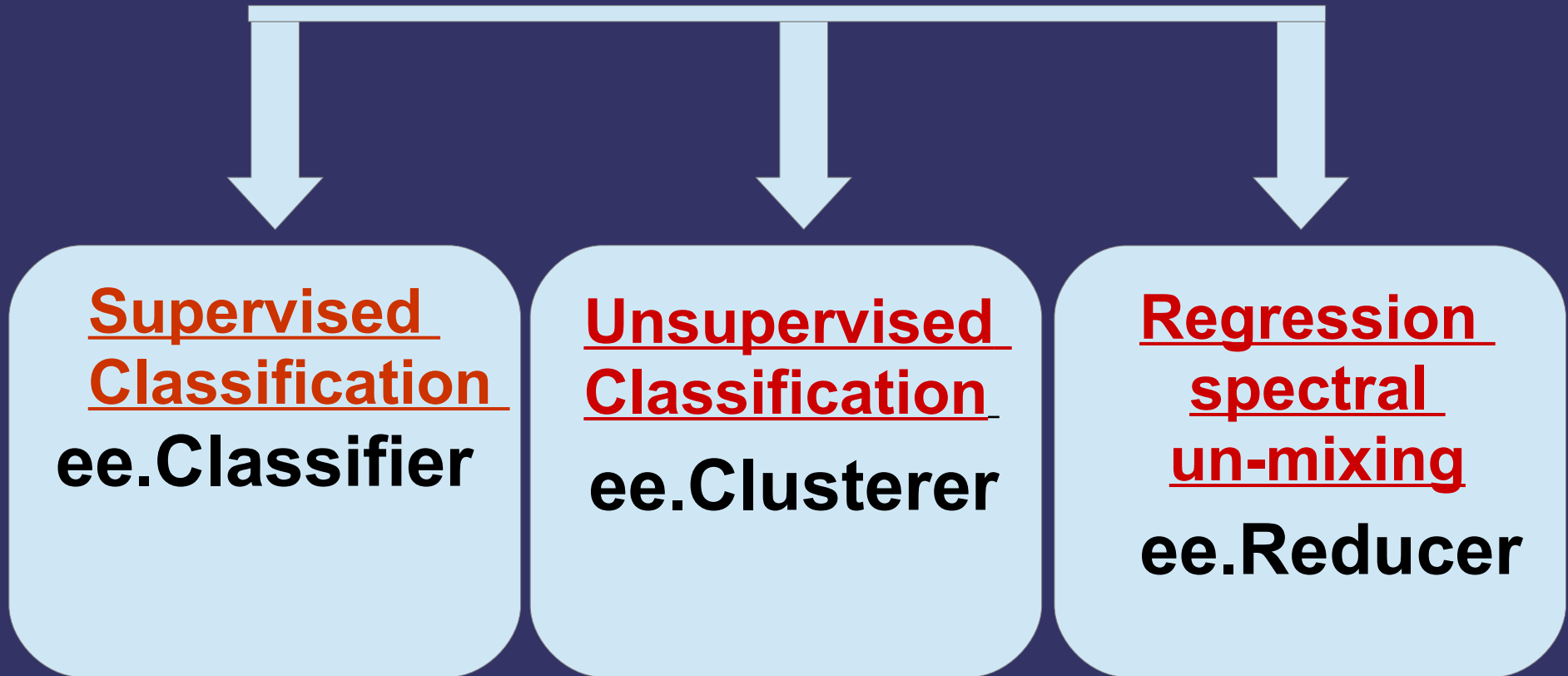


# Remote Sensing Interpretation



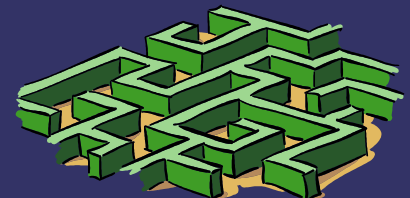
# *Machine Learning in Earth Engine*

## I. EE API Methods



## II. Export/Import functions for TFRecord files

**ee.Model package**





# *Classifiers Overview in this Project:*

Machine learning techniques for Supervised classification

Machine learning techniques for Unsupervised classification

The advanced analysis: spectral Un-mixing



# ***Supervised Classification***

- 1) Creating an ROI from coordinates
- 2) Loading an ImageCollection and filtering to a single image
- 3) Collect Training Data
- 4) Sample Imagery at Training Points to Create Training datasets
- 5) Train the classifier
- 6) Classify the Image & Display the Results
- 7) Assess the Accuracy (confusionMatrix)



# Supervised Classification



The confusionMatrix JSON  
List (12 elements) JSON

- ▶ 0: [15,0,0,0,0,0,0,0,0,0,0,0]
- ▶ 1: [0,15,0,0,0,0,0,0,0,0,0,0]
- ▶ 2: [0,0,15,0,0,0,0,0,0,0,0,0]
- ▶ 3: [0,0,0,15,0,0,0,0,0,0,0,0]
- ▶ 4: [0,0,0,0,15,0,0,0,0,0,0,0]
- ▶ 5: [0,0,0,0,0,15,0,0,0,0,0,0]
- ▶ 6: [0,0,0,0,0,0,15,0,0,0,0,0]
- ▶ 7: [0,0,0,0,0,0,0,15,0,0,0,0]
- ▶ 8: [0,0,0,0,0,0,0,0,15,0,0,0]
- ▶ 9: [0,0,0,0,0,0,0,0,0,15,0,0]
- ▶ 10: [0,0,0,0,0,0,0,0,0,0,17,0]
- ▶ 11: [0,0,0,0,0,0,0,0,0,0,0,15]

Validation error matrix: JSON  
List (12 elements) JSON

- ▶ 0: [10,3,0,0,0,0,0,0,1,0,1,0,0]
- ▶ 1: [0,15,0,0,0,0,0,0,0,0,0,0]
- ▶ 2: [0,0,14,0,0,0,0,0,0,0,0,1]
- ▶ 3: [0,0,0,14,1,0,0,0,0,0,0,0]
- ▶ 4: [0,1,0,2,10,0,0,0,2,0,0,0]
- ▶ 5: [0,0,0,0,2,10,1,3,0,0,0,0]
- ▶ 6: [0,0,0,0,0,3,12,0,0,0,0,0]
- ▶ 7: [0,0,0,3,0,0,0,12,0,0,0,0]
- ▶ 8: [0,0,0,0,0,1,1,0,7,0,5,1]
- ▶ 9: [0,0,0,0,0,0,0,0,0,15,0,0]
- ▶ 10: [0,0,0,0,0,0,2,0,1,0,11,1]
- ▶ 11: [0,0,0,9,4,2,0,1,0,0,0,0]

Validation overall accuracy: JSON  
0.7142857142857143





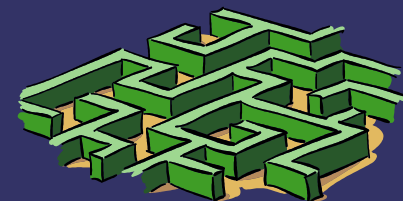
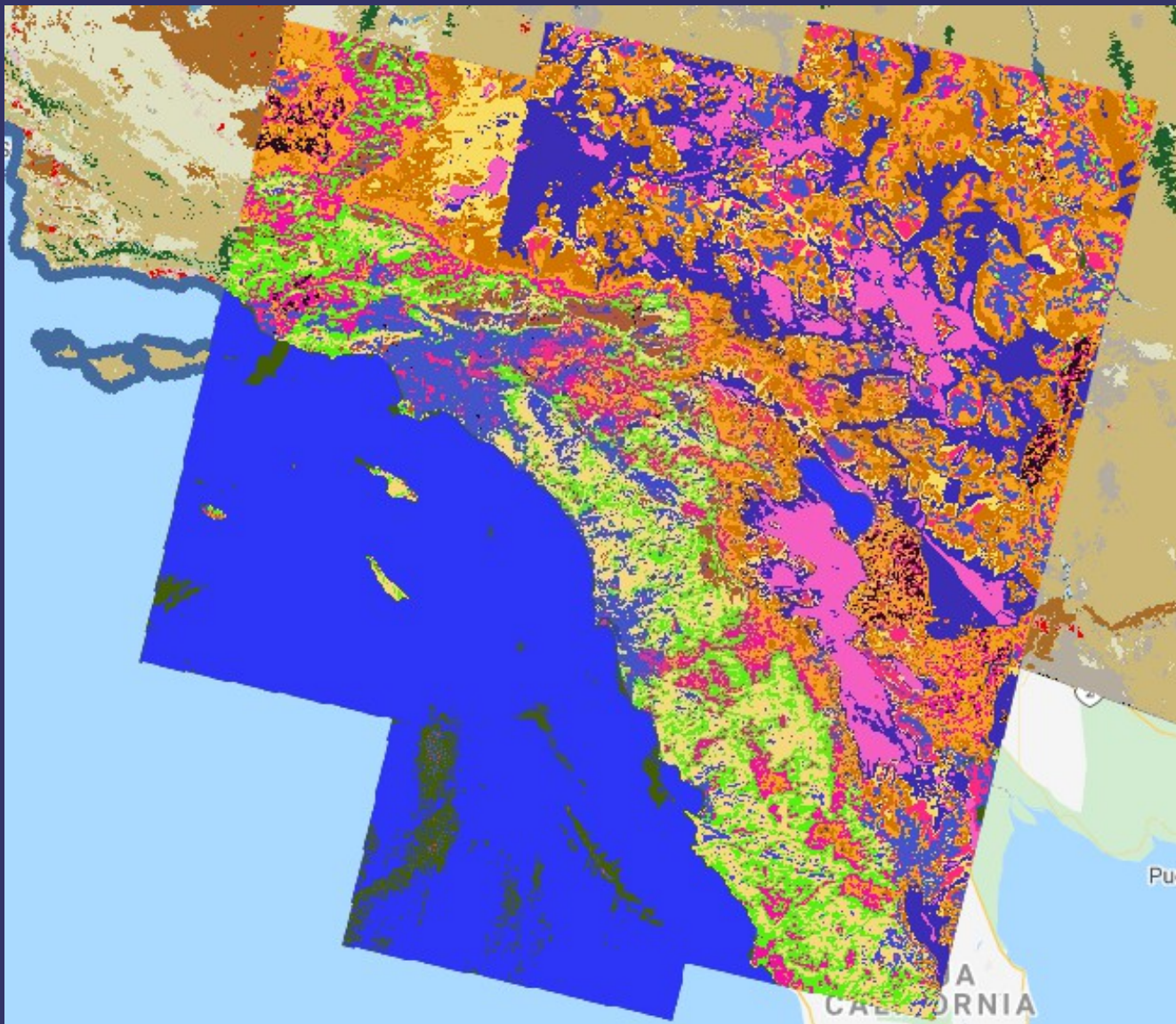
# *Unsupervised Classification (clustering)*

1. Assemble features with numeric properties in which to find clusters.
2. Create a clusterer. Set its parameters if necessary.
3. Train the clusterer using the training data.
4. Apply the clusterer to an image or feature collection.
5. Label the clusters.

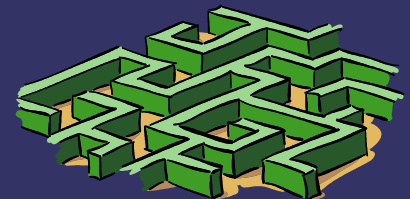
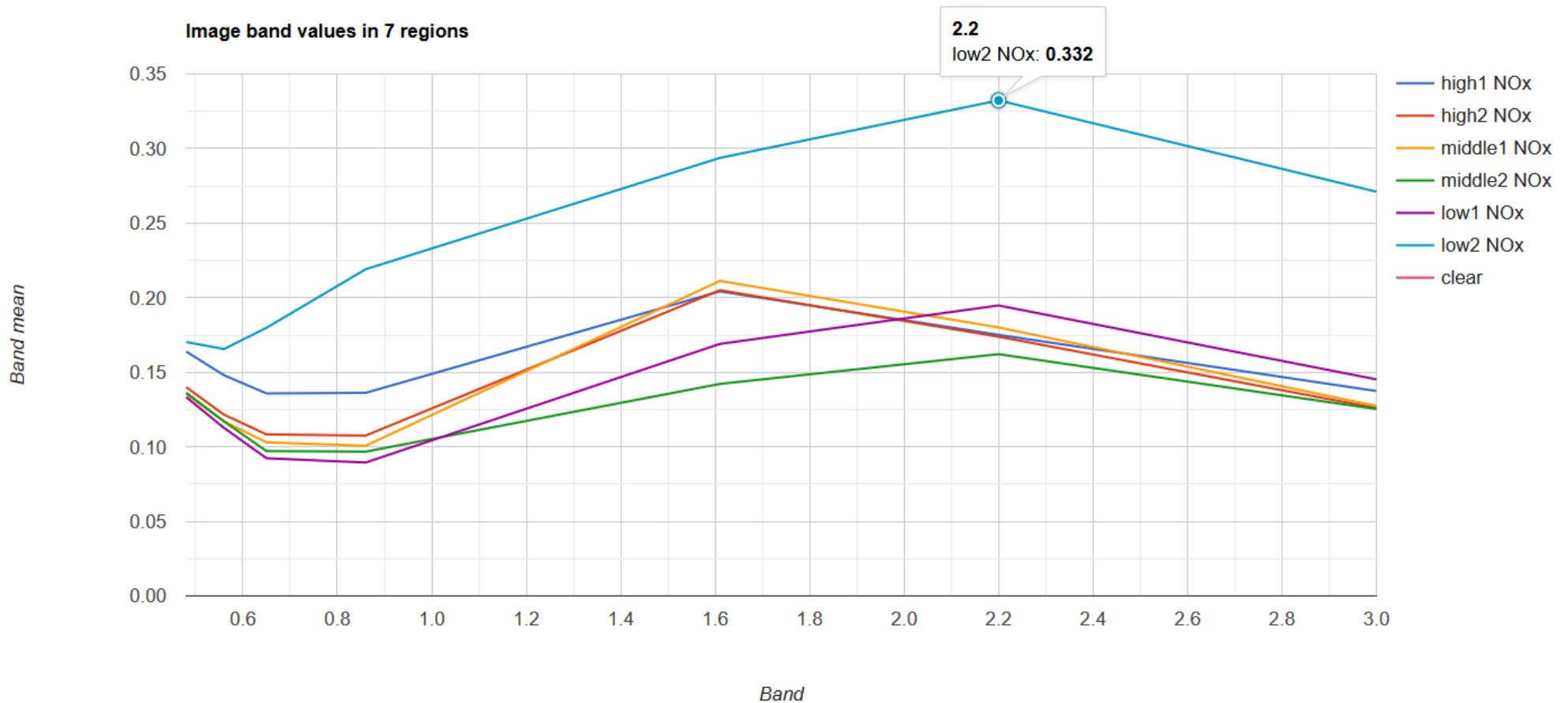




# *Unsupervised Classification (clustering)*

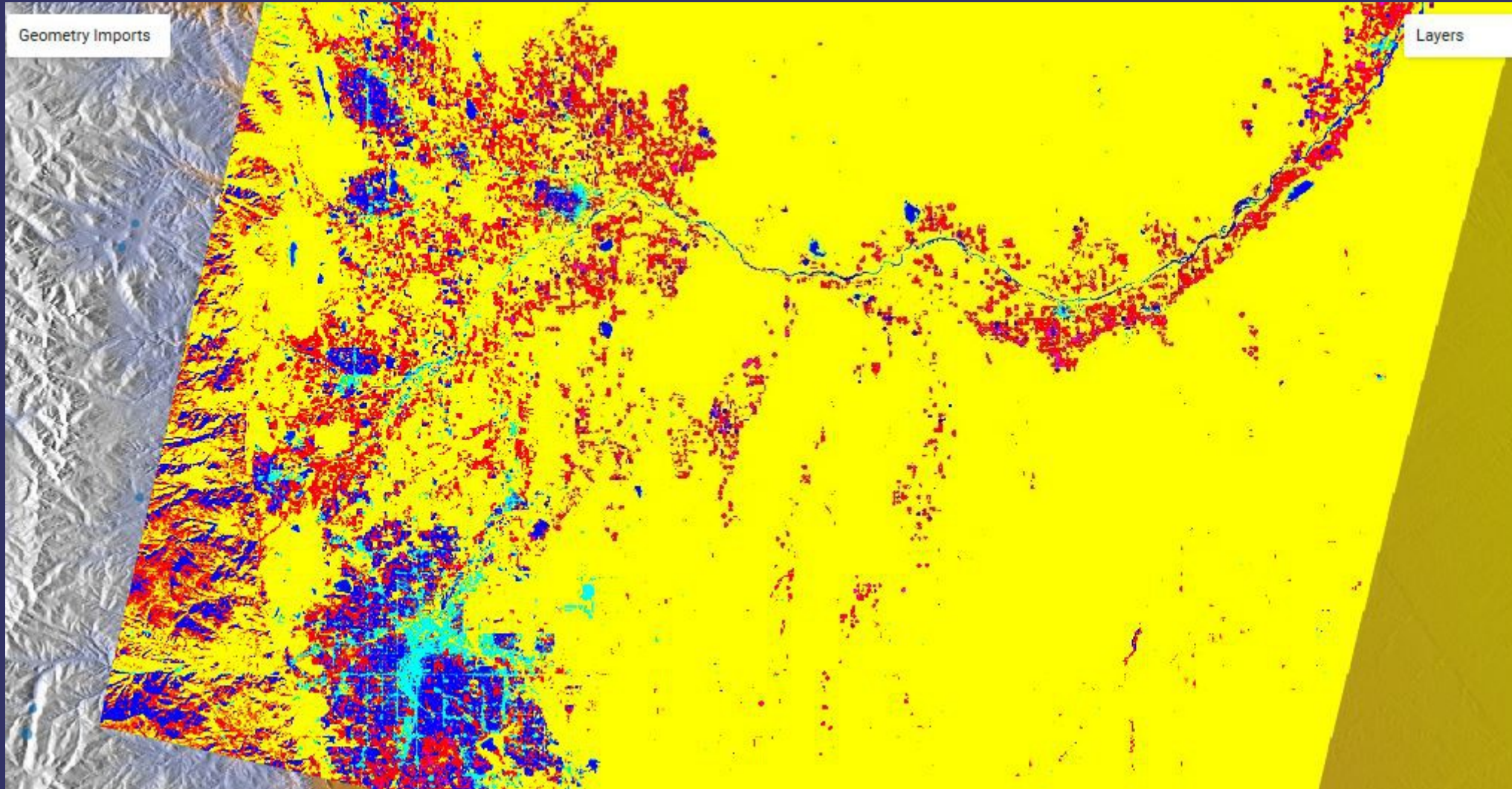


# *The advanced analysis: Spectral Un-mixing*



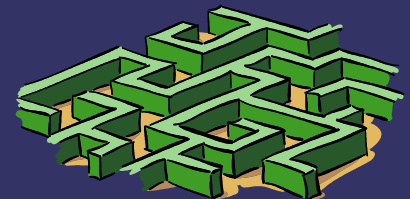


# *Result of Un-mixing on Denver Area*



# *Development in the future*

- 1) Consider 1 Year Time Frame for Landsat / Tropi Data in EE.
- 2) Set a Training Data Set from NAIP imagery (high resolution)
- 3) Work on Deep Machine Learning - TensorFlow model





# *Long-term goal*

## Build Machine Deep Learning Project:

- Creating a TensorFlow Deep Learning VM Instance
- Accuracy validation the TensorFlow compared to Supervised/ Unsupervised Classification

