Where are sawmills?

Team 4
Forest Carbon Codefest
March 12-14, 2024

What are mills

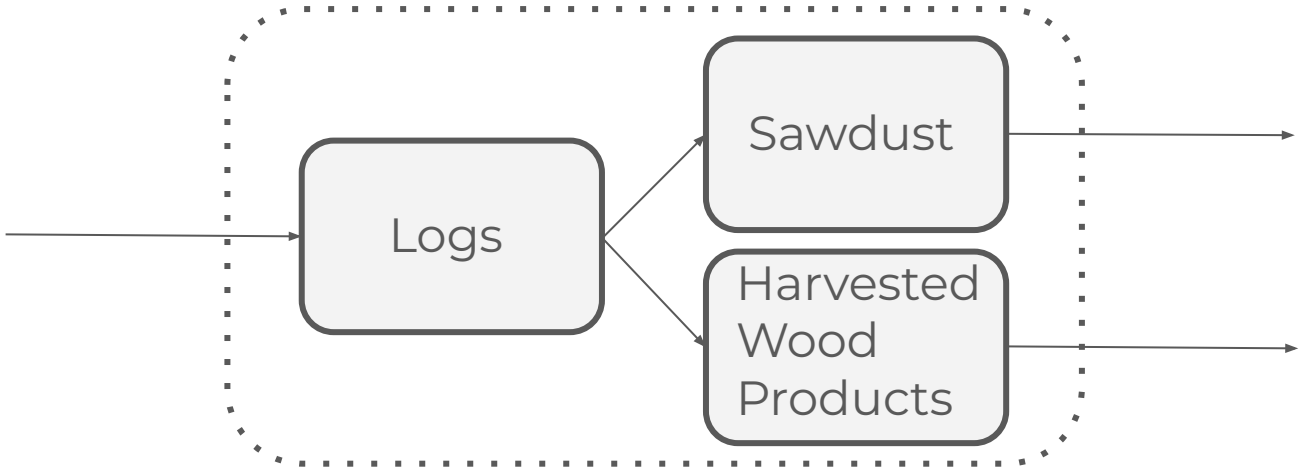
Logs go in, wood products out

There are different kinds

- sawmills make lumber
- pulp mills make pulp (for paper)

September 1945. Berger Bros. Sawmill. Steam power from a Reves 2 cylinder compound. Department of Agriculture. Forest Service. Region 9.

Conceptual model and overarching question



What can we learn about forest carbon fluxes using remote sensing to monitor mills?

Use cases: inventory, regulatory compliance, due diligence, natural climate solutions monitoring (e.g., carbon projects), demand forecasting, Timber Investment Management Organization speculation

Goals

1. **Map known mills**

2. (Stretch) Monitor mills

3. (Stretch) Overlay disturbances

We discovered some mill data

Tuesday findings:

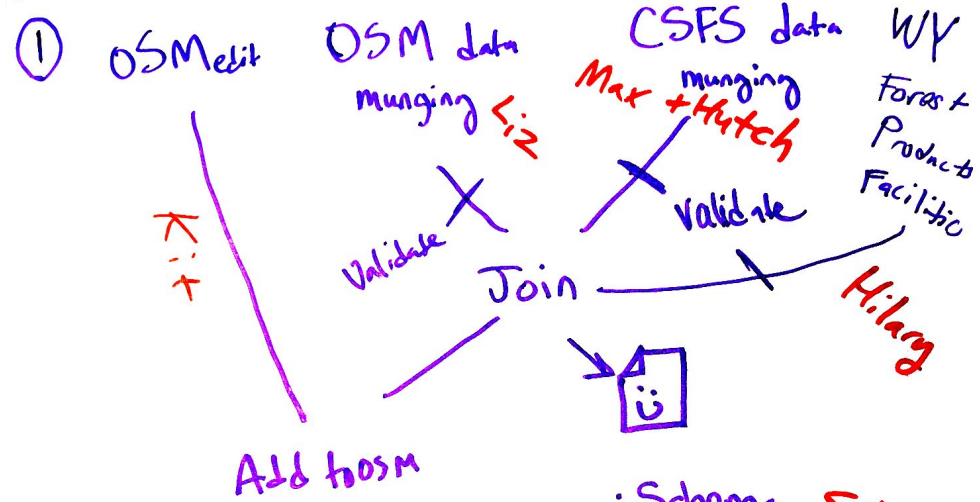
- Colorado Forest Products Database
- Wyoming Forest Products Facilities
- OpenStreetMap (thanks Ty Tuff!)

Questions:

- Are these complete lists?
- Is every record a mill?
- What do the mills look like?

Portable sawmill set up in the woods to saw the logs cut off the area, some of which are shown decked in openings around the mill, being logged in the Schels and Prohaska Sale near Anvil Lake Campground. 1940. Source: Department of Agriculture. Forest Service. Region 9

We distributed work and defined outcomes



Shared Google Sheet

CSV file in GitHub

Visual interpretation: classifying mills and not mills

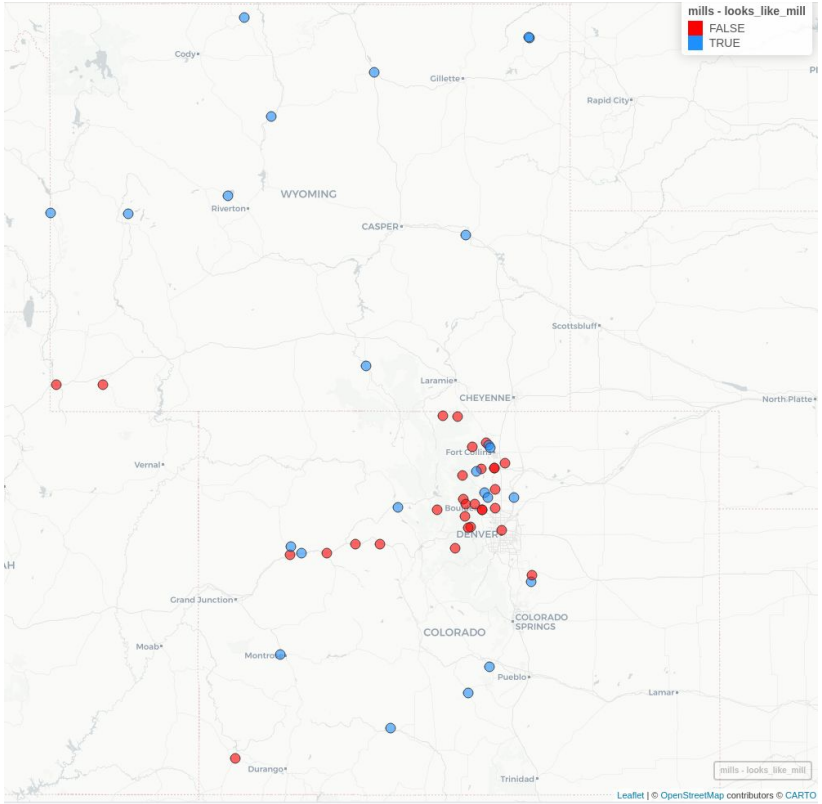
Example industrial sawmill (logs, sawdust):

[Saratoga Forest Management, Saratoga, WY]

Example not mill (housing development):

[BD Timber, Longmont, CO]

Blue dots are confirmed mills (logs/boards/sawdust)



24 confirmed mills total

Source	Confirmed	Unconfirmed
OpenStreetMap (in CyVerse)	0	2
CO Forest Products db	14	25
WY Forest Products Facilities	10	2

Community contribution: adding mills to OpenStreetMap (OSM)

Compile data from other sources

Validate data

Shreiner Enterprises	4719 Arthur Mae Lane Laporte, C(	40.65546507	-105.1469596	yes	Colorado Forest Products	2023-03-12
Morgan Timber Products	2532 County Road 54G Fort Collir	40.62895889	-105.1239956	yes	Colorado Forest Products	2023-03-12
Rocky mountain timber products	11355 Co Rd 15, Del Norte, CO 8	37.7118	-106.47	yes	Colorado Forest Products	2023-03-12
Greenleaf Forestry and wood produc	1500 Co Rd 328, Westcliffe, CO 8	38.084	-105.426	yes	Colorado Forest Products	2023-03-12
Beartooth International	181 Sawmill Rd, Loveland, CO 805	40.38552921	-105.3127181	yes	Colorado Forest Products	2023-03-12
JKC Woods LLC	10713 N 65th St, Longmont, CO 8(	40.16923439	-105.2021808	yes	Colorado Forest Products	2023-03-12
United Wood Products Inc.	7860 Diagonal Hwy. Longmont, C(	40.11911157	-105.1588736	yes	Colorado Forest Products	2023-03-12
Little Man's Services LLC	923 Coyote Canyon, Coal Creek,	38.357	-105.141	yes	Colorado Forest Products	2023-03-12
Frontier Log Homes	60813 Maple Grove Rd., Montrose	38.491	-107.952	yes	Colorado Forest Products	2023-03-12
Mountain Heart Hardwood	26535 Co Rd 21, Elbert, CO 8010	39.2529	-104.575	yes	Colorado Forest Products	2023-03-12
Boone farm	26535 County Road 17/21, Elizab	39.3158	-104.57	no	Colorado Forest Products	2023-03-12
Mountain View Pine Products LLC	8394 U.S. 85, Fort Lupton, CO, USA	40.12206179	-104.8092932	yes	Colorado Forest Products	2023-03-12
Hester's Log & Lumber Co./The M	8178 CO-9, Kremmling, CO 80459	40.02086279	-106.3749181	yes	Colorado Forest Products	2023-03-12
Strong Lumber & Specialty Log Prod	7190 CO-13, Rifle, CO 81650	39.616	-107.814	yes	Colorado Forest Products	2023-03-12
AMS Consolidated Timber Products/	0286 County Road 236 Silt, CO	39.55060531	-107.6711896	yes	Colorado Forest Products	2023-03-12
Saratoga Forest Management		41.455148	-106.801879	yes	Wyoming Forest Products	2021-10-12
Bearlodge Forest Products		44.676264	-104.600584	yes	Wyoming Forest Products	2021-10-12
Buckingham Lumber Co Inc		44.349116	-106.687546	yes	Wyoming Forest Products	2021-10-12
Domek Sawmill and Logging (Fontenelle)		42.974999	-109.989756	yes	Wyoming Forest Products	2021-10-12
Devils Tower Forest Products, Inc		44.680627	-104.608728	yes	Wyoming Forest Products	2021-10-12
Powers Logging		42.765586	-105.456952	yes	Wyoming Forest Products	2021-10-12
Wind River Supply		43.145537	-108.655746	yes	Wyoming Forest Products	2021-10-12
Cowboy Timber		44.869603	-108.430259	yes	Wyoming Forest Products	2021-10-12
Great Divide Forestry		43.920456	-108.067689	yes	Wyoming Forest Products	2021-10-12

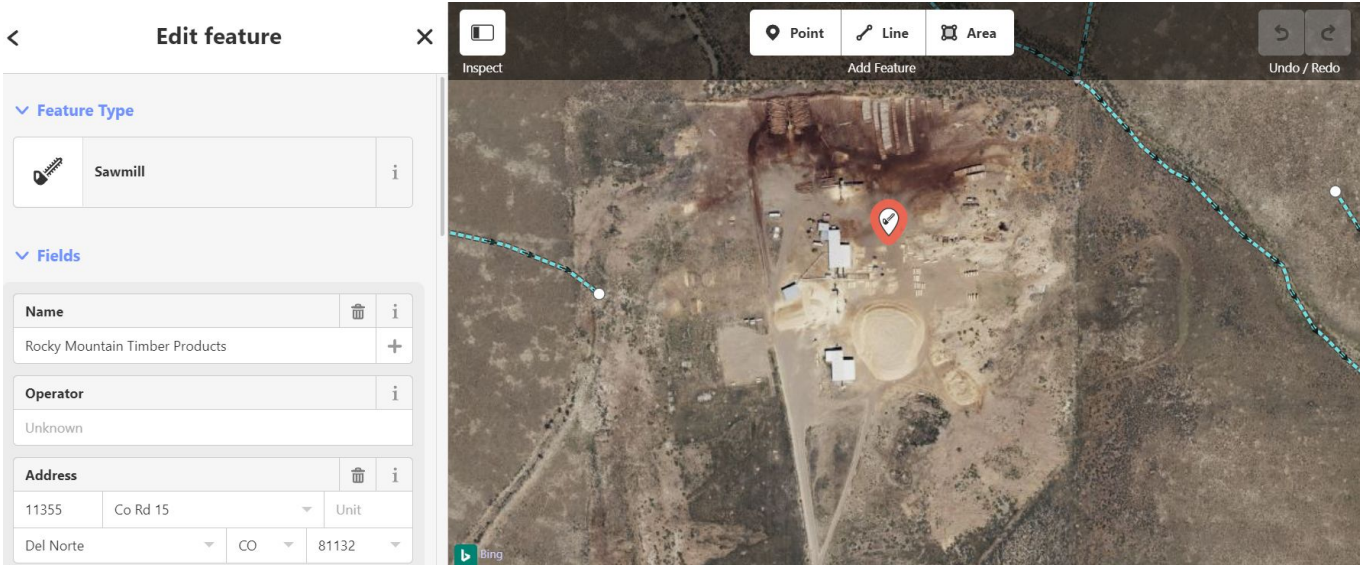
Community contribution: adding mills to OpenStreetMap (OSM)

Create an OSM account

Edit map

Point -> Sawmill

Industrial=sawmill



Goals

1. Map known mills ✅

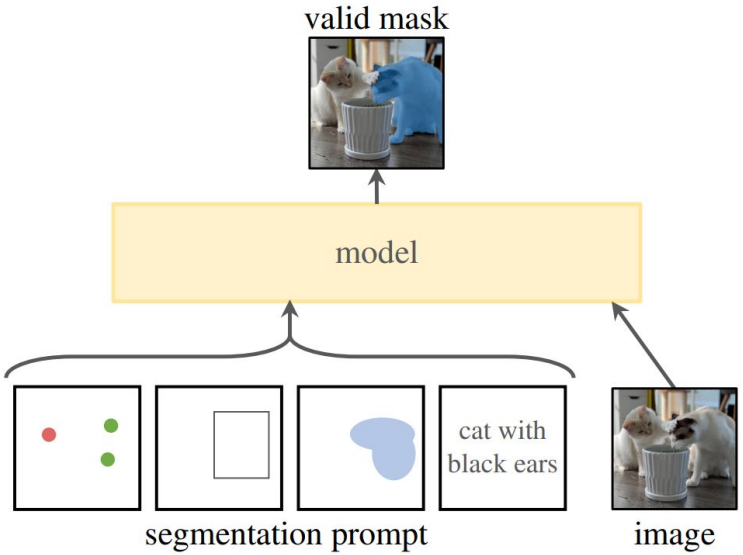
2. **(Stretch) Monitor mills**

3. (Stretch) Overlay disturbances

Log pile detection via promptable segmentation?

Segment Anything

on CyVerse

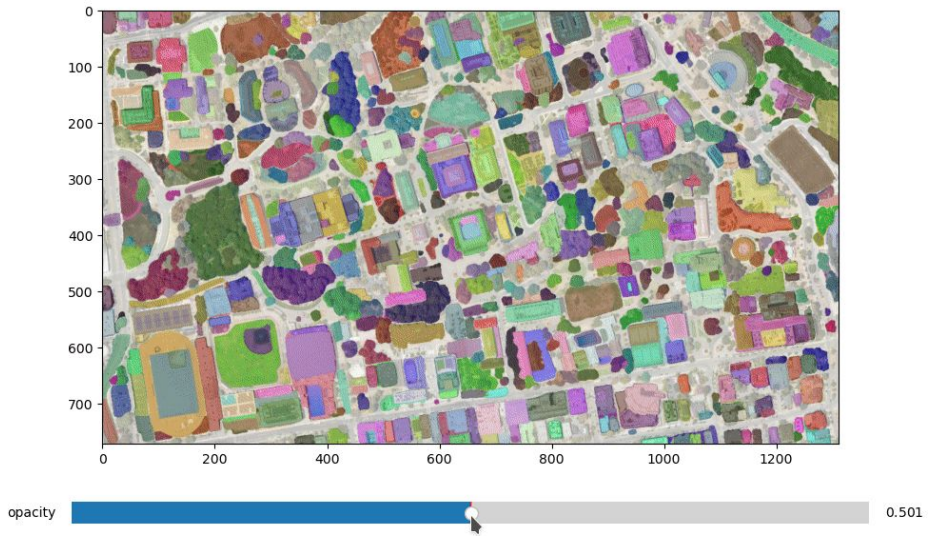


Kirillov, Alexander, et al. "Segment anything." *Proceedings of the IEEE/CVF International Conference on Computer Vision*. 2023.

Quick and dirty experiment: segment-geospatial

samgeo python package

- Text prompting
- Point prompting
- Segment all the things



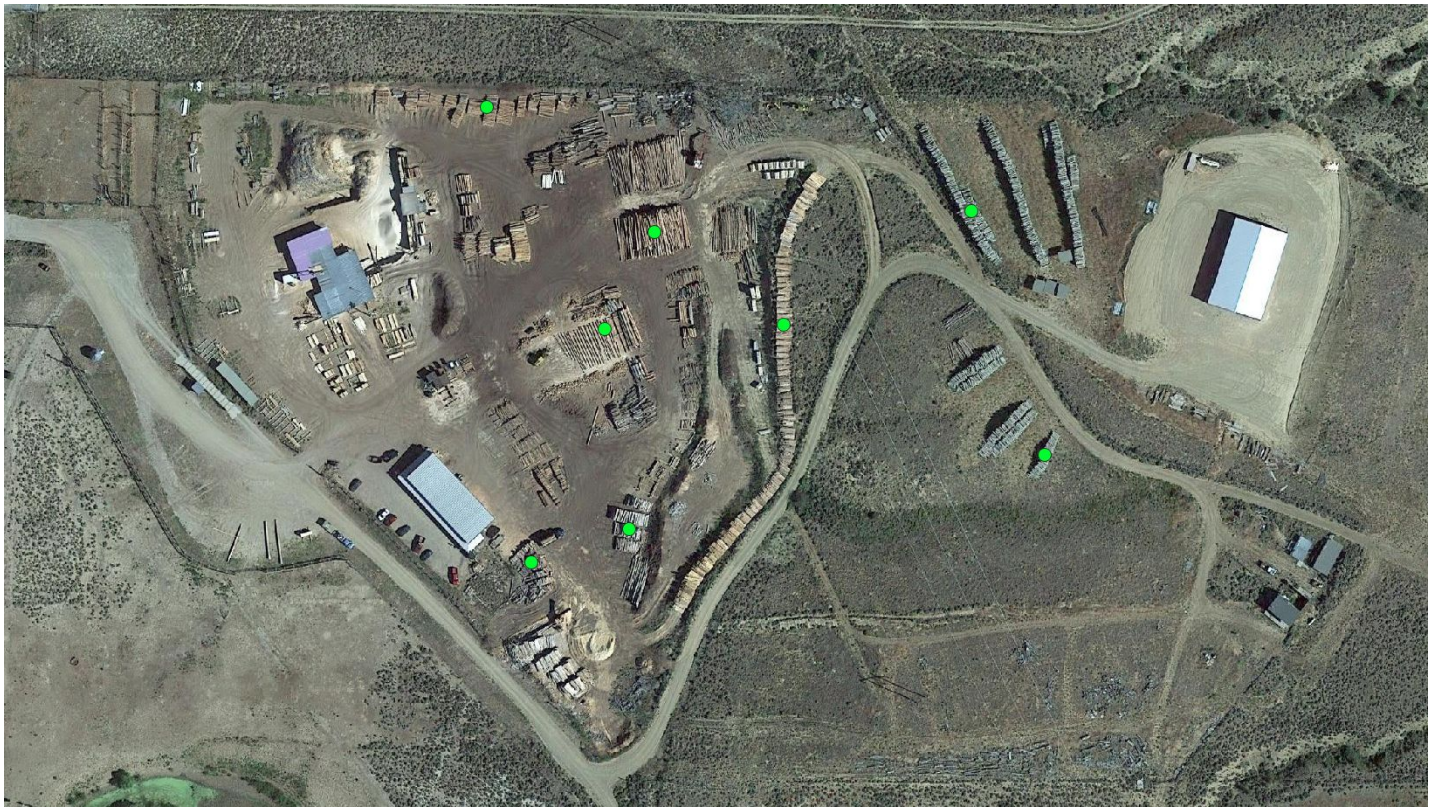
https://samgeo.gishub.org/

Segmentation via text prompts

“find stacks of lumber or stacks of logs”

Segmentation via point-prompting

Segmentation via point-prompting (+ examples only)



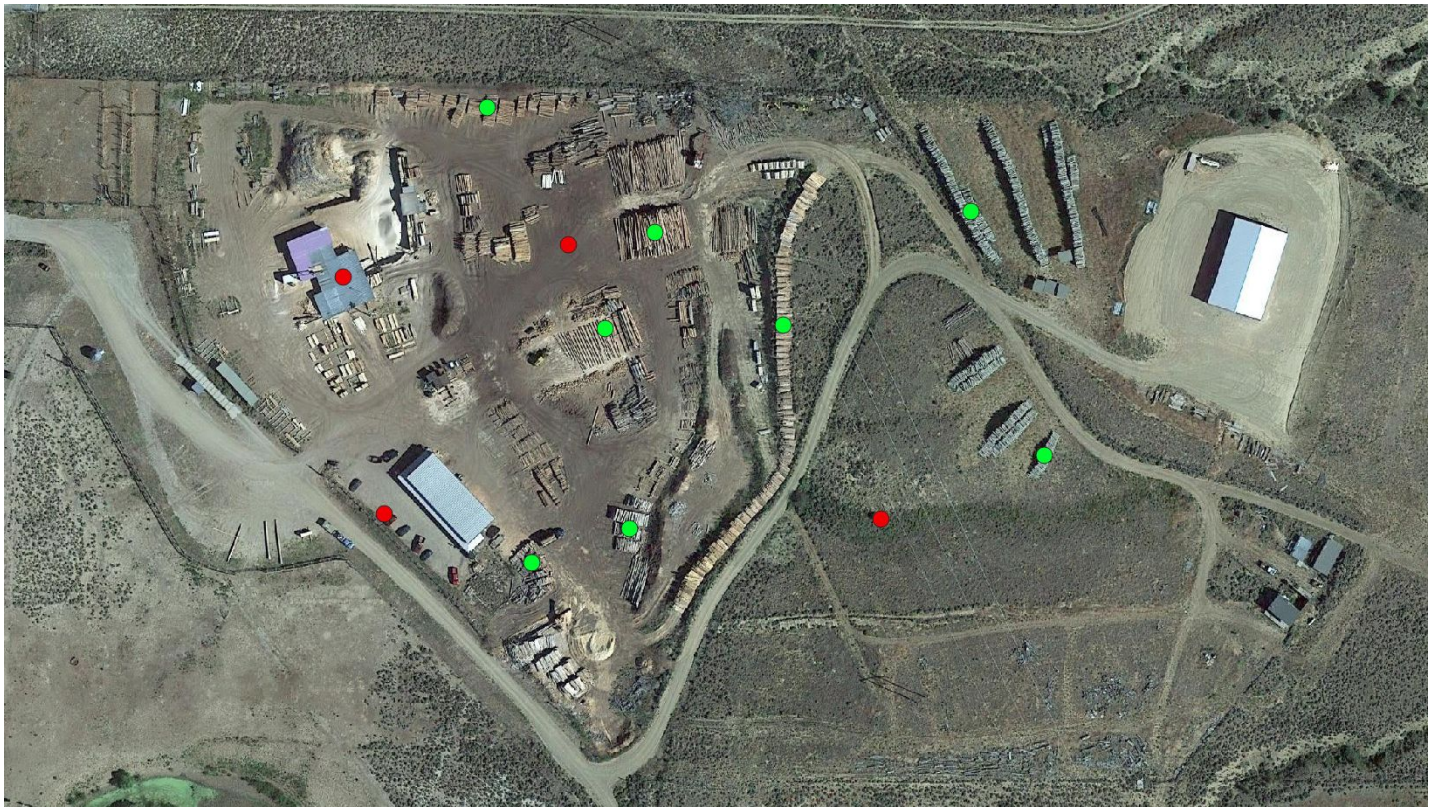
Segmentation via point-prompting (+ examples only)

😬

Segmentation via point-prompting (+ examples only)

😬

Segmentation via point-prompting (+ and - examples)



Segmentation via point-prompting (+ and - examples)

😬

Segmentation via point-prompting (+ and - examples)

🤷

Prompts are hard: try `SamAutomaticMaskGenerator`

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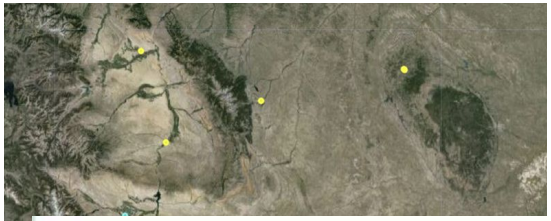
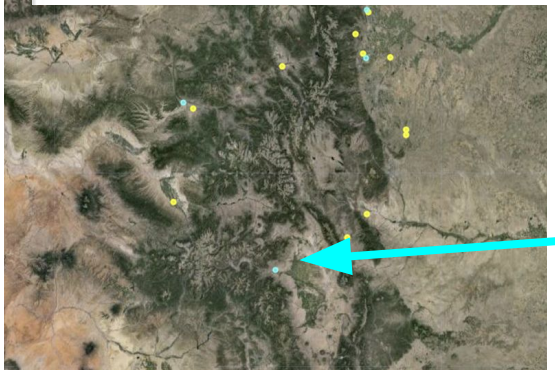
Classification in Google Earth Engine



75% of mills used as training data

Land Use Classification: Layer error: User memory limit exceeded.



25% of mills used for testing

Result?

Using Naive Bayes to Classify Log Piles

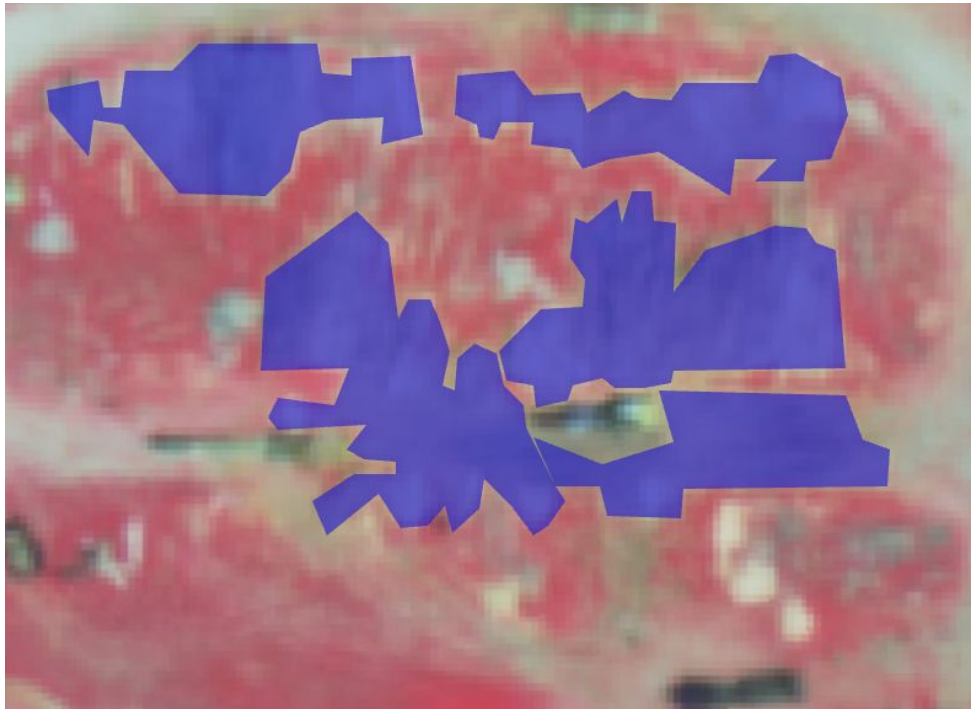
- What is Naive Bayes?

Using Naive Bayes to Classify Log Piles

- What is Naive Bayes?
- Steps:

Using Naive Bayes to Classify Log Piles

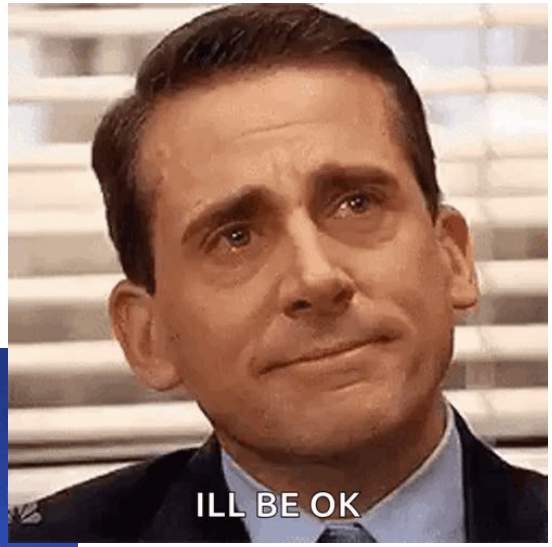
- What is Naive Bayes?
- Steps:
  - Choose Imagery
    - NAIP
  - Make Feature Collection
    - 78 training images
  - Run Test
  - →

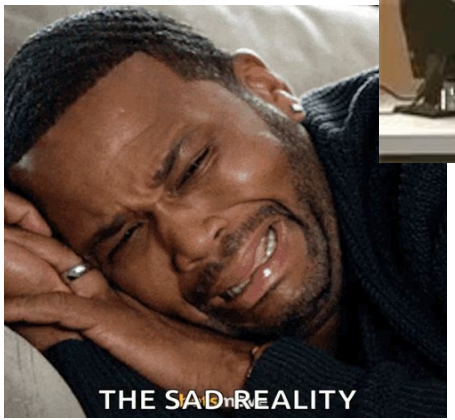


Using Naive Bayes to Classify Log Piles

PLOT TWIST: it failed in the current iteration of the code

One version found rock quarries????





Using Naive Bayes to Classify Log Piles - Improvements

- More Training Data
  - Logs + Not Logs + Additional land type covers (ie sand, rock, similar spectral signatures to differentiate from)
- Different Training Data
  - Whole mills
  - Co-occurrences
- Different Imagery
  - AVIRIS other than NAIP?
- More time

```
Imports (2 entries)
  var Log_piles: Table projects/sawmillclassification/assets/log_pi…
  var Mills1: Table projects/sawmillclassification/assets/SawMill_l…

var logPolygons = Log_piles

var labeledLog_piles = logPolygons.map(function(feature) {
  return feature.set('class', 1);
});

// Adjusting for NAIP imagery
var naipImage = ee.Image(ee.ImageCollection('USDA/NAIP/DOQQ')
  .filterBounds(logPolygons)
  .filterDate('2018-01-01', '2022-12-31')
  .mosaic()) // Create a mosaic of the images
  .select(['R', 'G', 'B', 'N']); // Assuming standard NAIP band names: ad
```

Goals

1. Map known mills ✅

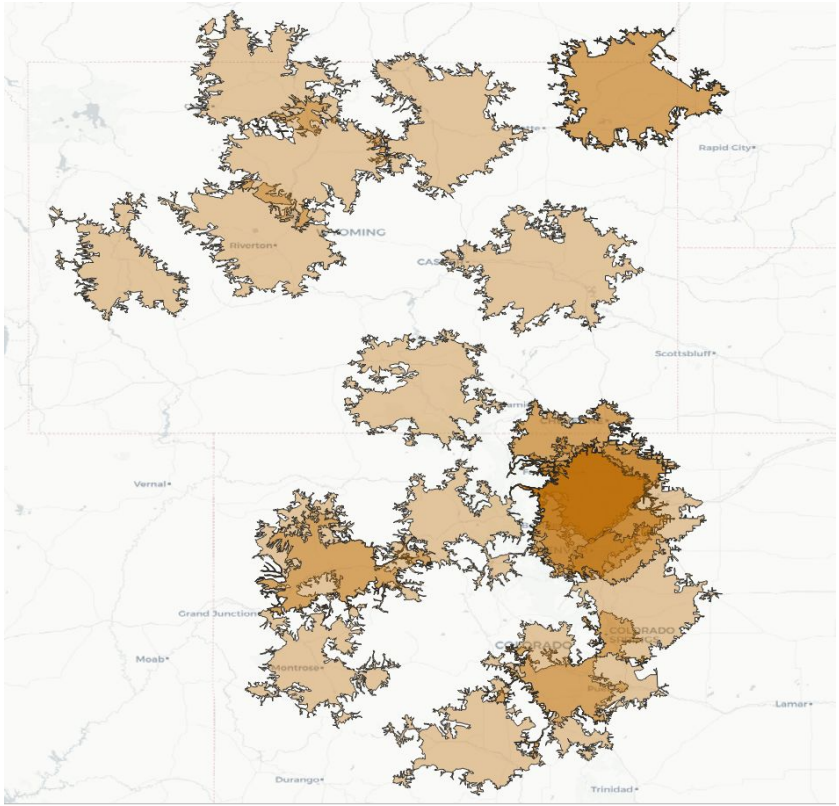
2. (Stretch) Monitor mills 🤷

3. **(Stretch) Overlay disturbances**

Mapping sawmill reachability

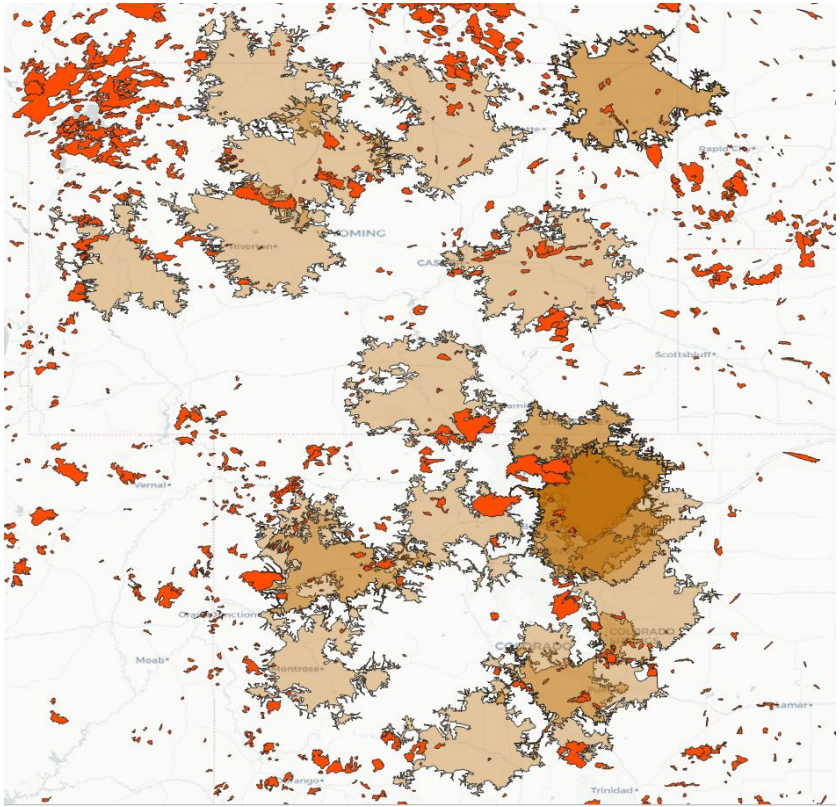
Isochrone: region accessible w/ fixed travel time or distance

If logs get hauled up to 62 miles, where can a mill source logs?



Mapping fires within sawmill isochrones

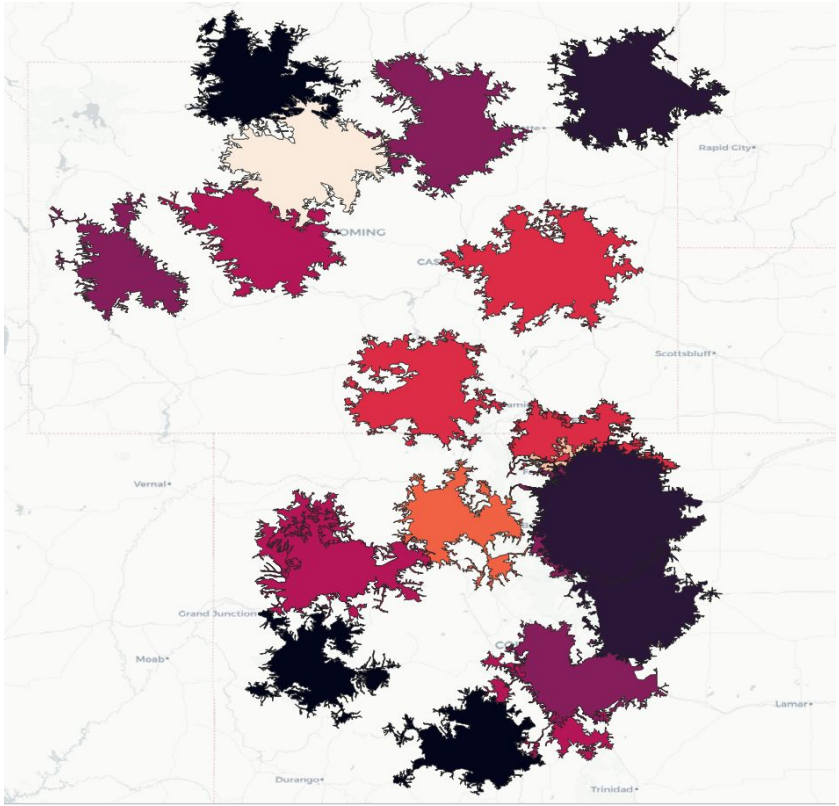
Fire boundaries: Monitoring Trends in Burn Severity



Mapping fraction of isochrone burned since 1984

Fraction of isochrone area burned

- 0.007 - 0.017
- 0.017 - 0.027
- 0.027 - 0.037
- 0.037 - 0.047
- 0.047 - 0.057
- 0.057 - 0.067
- 0.067 - 0.077
- 0.077 - 0.087
- 0.087 - 0.097
- 0.097 - 0.107



FCC24_Group_4 / code / analysis /

 mbjoseph Create README.md

Name	Last commit message
..	
.ipynb_checkpoints	Naive Bayes (doesn't work)
00_analysis_description.txt	Initial commit
GoogleEarthEngineNaiveBayes.txt	Naive Bayes (doesn't work)
README.md	Create README.md
autosegment.ipynb	Adding SAM notebooks and mill isochrone script
mill-isochrones.R	Adding SAM notebooks and mill isochrone script
point-prompts.ipynb	Adding SAM notebooks and mill isochrone script
text-prompts.ipynb	Adding SAM notebooks and mill isochrone script

Future directions

Mapping

- Find unmapped mills (object detection)
- Expand geographic scope (mills in different places look different)

Monitoring

- Explore additional image classification approaches
- Estimate mill productivity (integrate online data and proxy with size of facility and logpiles)
- Estimate impact of sawmill area of influence with forest carbon and biodiversity

New inputs

- Hyperspectral data (more spectrally-specific)

Thank you!