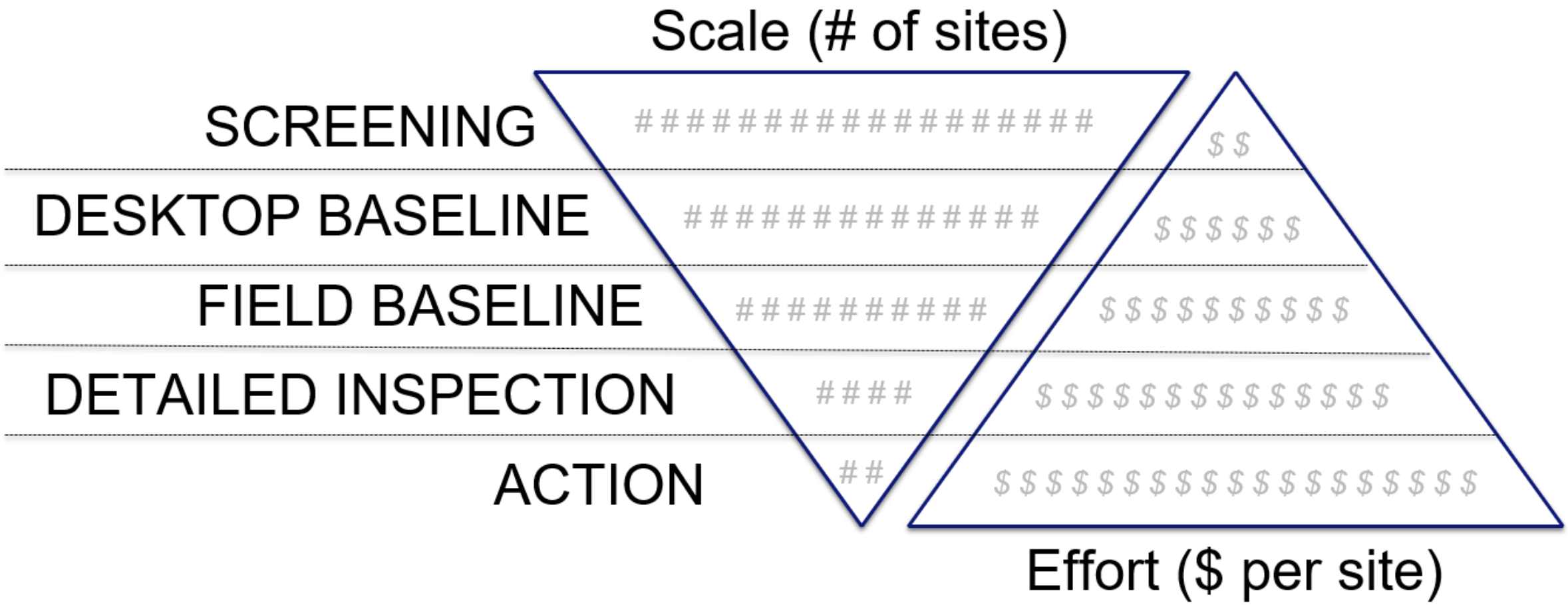
Automated Rock Slope Screening Using Computer Vision

Presented by: Zac Sala

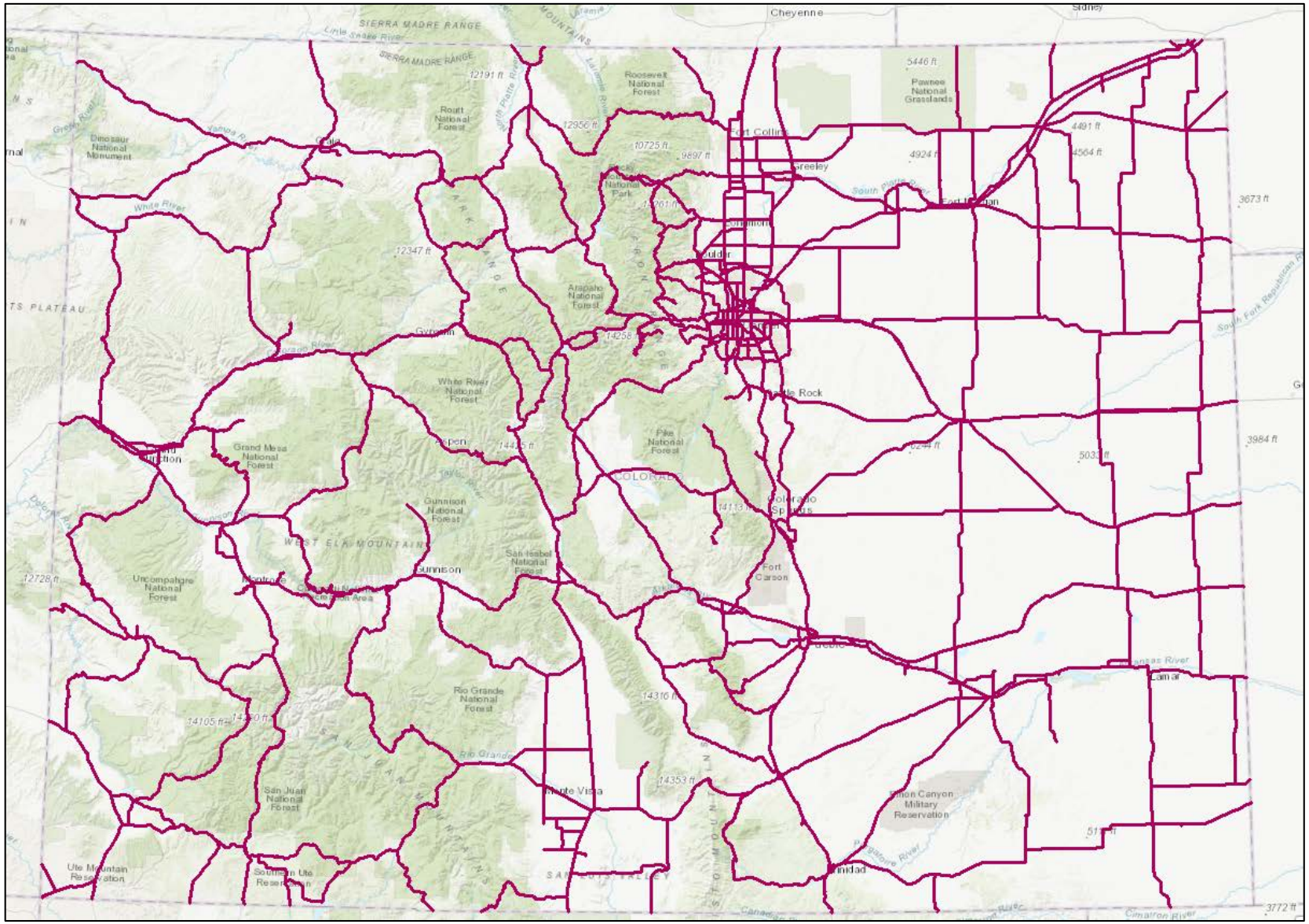
Event: TRB GAM Subcommittee Meeting

Date: January 6, 2021

Risk Management Frameworks



The Scale is BIG!



Colorado is BIG

>9,000 center-line miles

Death by 1000 Rock Slopes

(Images from Google Street View)

The Solution

Python

GeoPandas

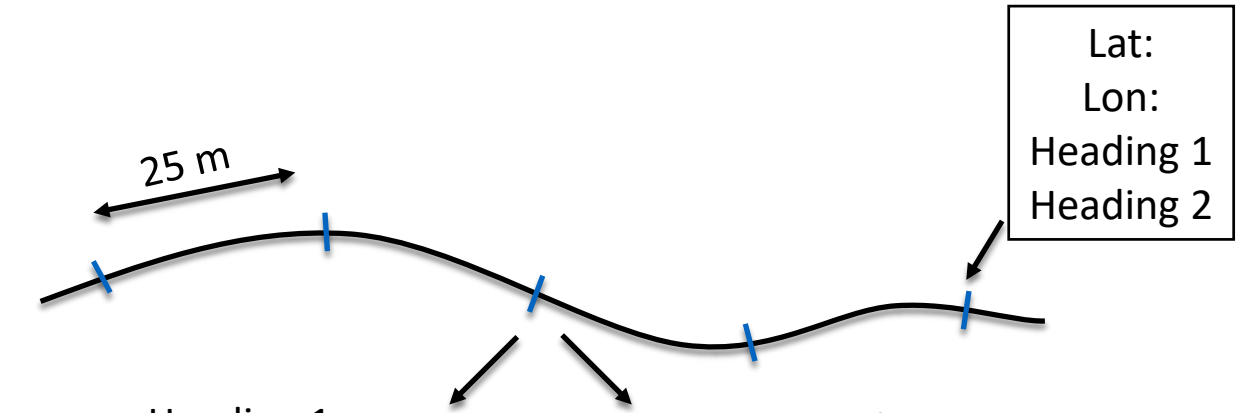
GIS Inputs

Google Street View API

Street View Image Extraction

Google Vision API

Computer Vision Labelling



Heading 1

Labels:

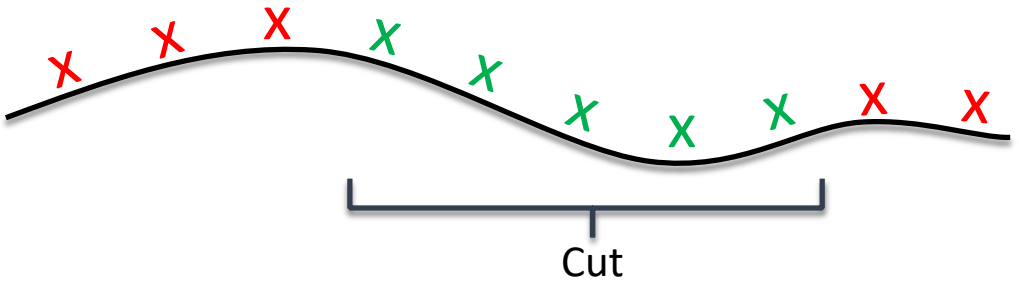
Sky (99%)
Cloud (96%)
Asphalt (92%)
Road (92%)

Heading 2

Labels:

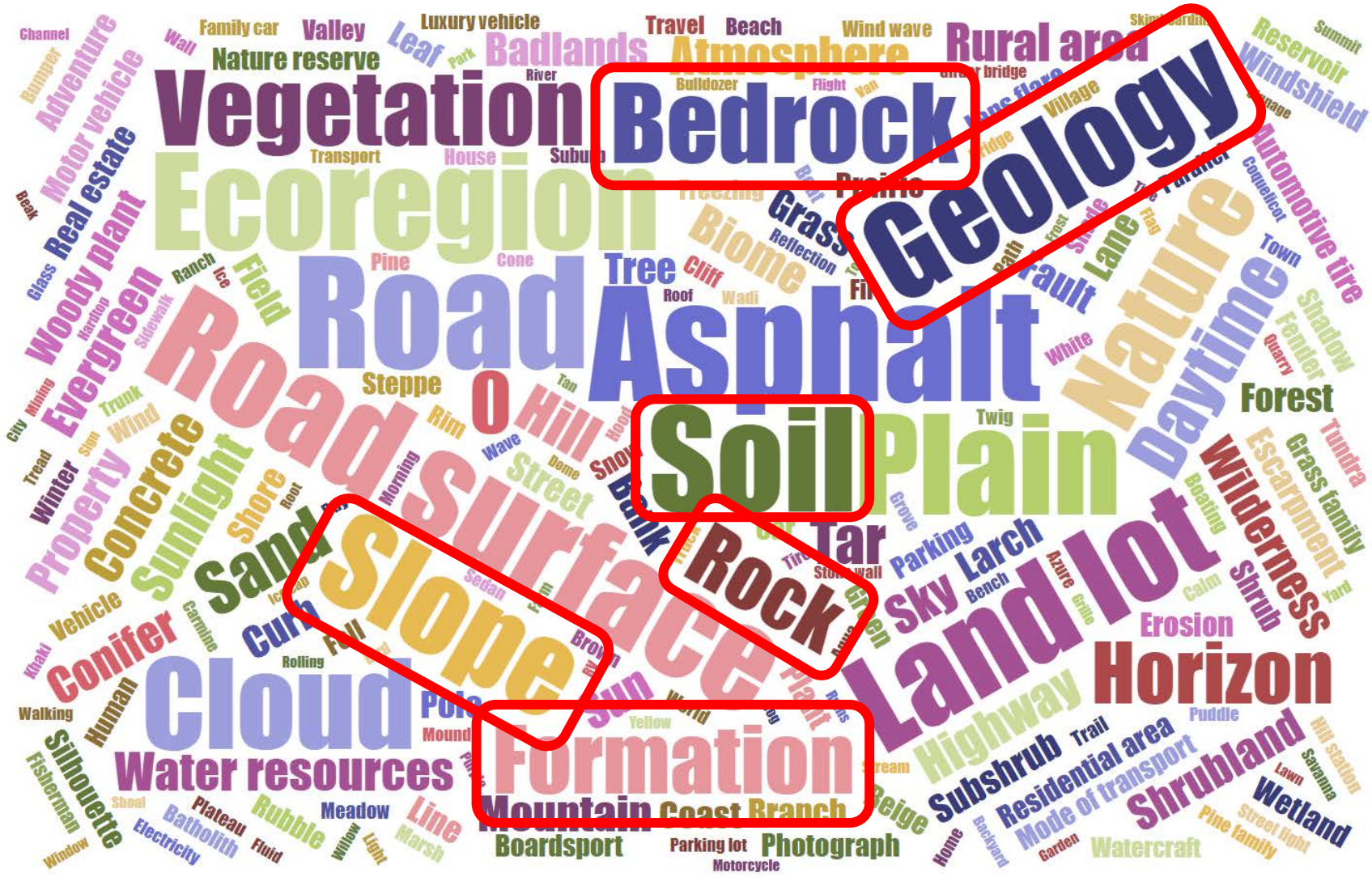
Geological Phenomena *(93%)*
Geology *(83%)*
Sky (82%)
Rock *(78%)*

Defining Cuts



With sufficient photo spacing cuts can be delineated spatially using classification results

How Well Does it Work?



1000 **Rock Cut** Photos

1000 **Not Rock Cut** Photos

Even Google Gets Confused

CARNIVORE – 92%

MISSILE – 62%

Label Performance

Dominant Rock Cut Labels	Dominant Non-Rock Cut Labels
Terrain	Plain
Geology	Land lot
Geological phenomenon	Road
Soil	Asphalt
Bedrock	Landscape
Asphalt	Cloud
Road	Road surface
Formation	Ecoregion
Road surface	Infrastructure
Outcrop	Natural landscape

It’s Working!

Logistic Regression
(90-95% accuracy)

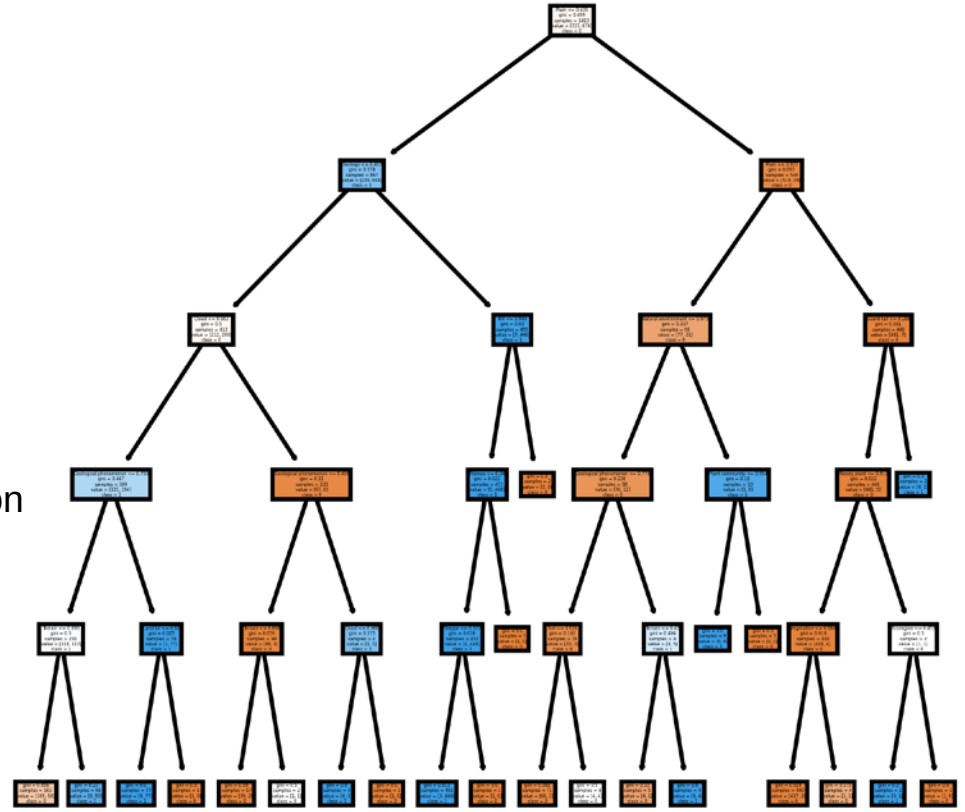
Logit Regression Results

Dep. Variable:	rockbool	No. Observations:	2019
Model:	Logit	Df Residuals:	2006
Method:	MLE	Df Model:	12
Date:	Tue, 08 Dec 2020	Pseudo R-squ.:	0.7612
Time:	21:32:54	Log-Likelihood:	-333.93
converged:	True	LL-Null:	-1398.4
Covariance Type:	nonrobust	LLR p-value:	0.000

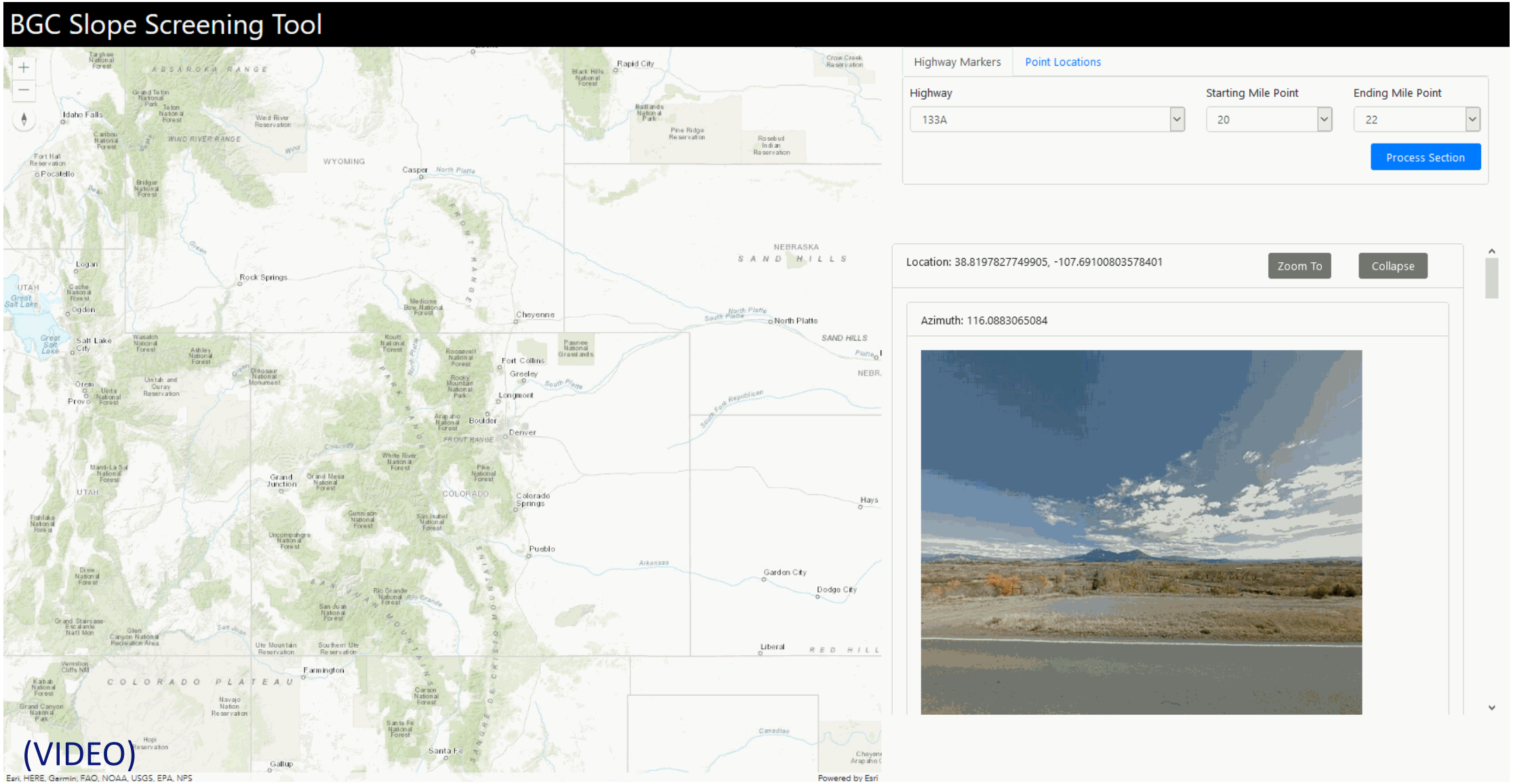
	coef	std err	z	P>|z|	[0.025	0.975]
Plain	-2.0742	0.247	-8.384	0.000	-2.559	-1.589
Terrain	2.8333	0.367	7.716	0.000	2.114	3.553
Geology	2.1309	0.414	5.143	0.000	1.319	2.943
Geological phenomenon	2.5642	0.378	6.789	0.000	1.824	3.305
Slope	1.2001	0.298	4.029	0.000	0.616	1.784
Cloud	-1.7356	0.241	-7.195	0.000	-2.208	-1.263
Landscape	-1.4578	0.315	-4.632	0.000	-2.075	-0.841
Natural landscape	-1.3801	0.317	-4.352	0.000	-2.002	-0.758
Plant community	1.0785	0.297	3.631	0.000	0.496	1.661
Horizon	-2.7693	0.570	-4.859	0.000	-3.886	-1.652
Natural environment	1.6853	0.345	4.878	0.000	1.008	2.362
Daytime	-2.1201	0.571	-3.713	0.000	-3.239	-1.001
Hill	-2.8150	0.507	-5.549	0.000	-3.809	-1.821

Decision Trees
(85-92% accuracy)

Ex:
-Geology
-Plain
-Soil
-Cloud
-Slope
-Hill
-Geological phenomenon
-Landscape
-Terrain
-Prairie
-Landlot

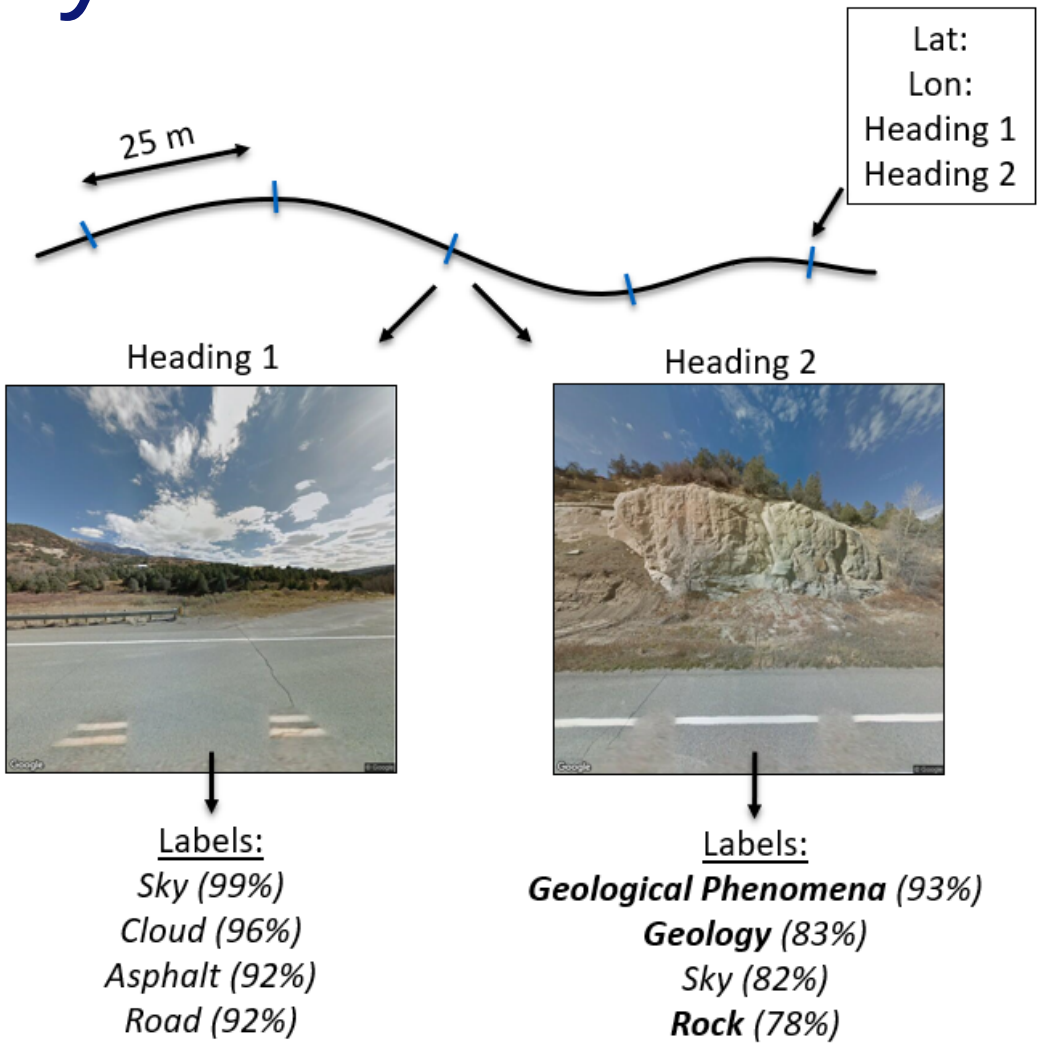


User Interface



Summary

- Using Google's pre-trained machine learning algorithms
- Can be applied to large ubiquitous street level datasets
- Speed up assessment workflow for large # of sites – allowing for multiple iterations, making change detection easier as new data becomes available



Future Work

- Refine photo extraction code for complex highway geometries
- Add image masking/editing methods to remove photo artifacts such as the street view car shadow
- Select final classification scheme
- Test in areas outside of Colorado
- Apply to other street level data, such as State DOT roadway survey databases

(zsala@bgcengineering.ca)