COAL: Coal and Open-pit surface mining impacts on American Lands

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Group 18

CS 462: Senior Capstone Winter 2017
Oregon State University

Introduction

- Team Name: COAL (Coal and Open-pit surface mining impacts on American Lands)
- Team Members: Taylor Alexander Brown, Heidi Ann Clayton, and Xiaomei Wang
- Client: Dr. Lewis John McGibbney
- Organization: Jet Propulsion Laboratory

Infrared imagery of a mine [1]

Goal

- Algorithm
  - Mineral Training and Classification
  - Mine Identification Training and Classification
  - Environmental Correlation
  - Temporal Analysis
- Free Library, Documentation, and Data
- Case Study
- Public Results
  - Website
  - Publication

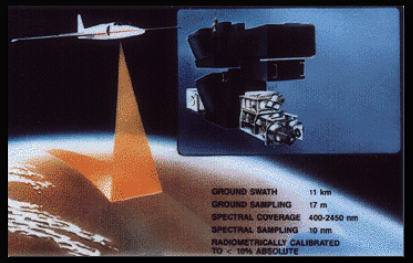
Open-pit mine [2]

What

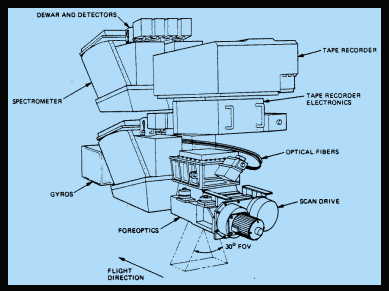
- Input
  - Imaging Spectroscopy Data
  - GIS Environmental Data
- Algorithm processing pipeline
- Output
  - Analyze
  - Visualize

Definitions

- Bitmap
- Imaging Spectroscopy
- AVIRIS: Airborne Visible/Infrared Imaging Spectrometer

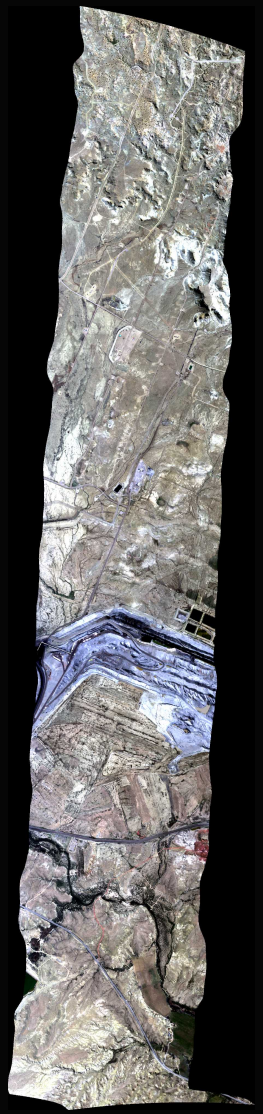


AVIRIS illustration [3]



AVIRIS instrument [4]

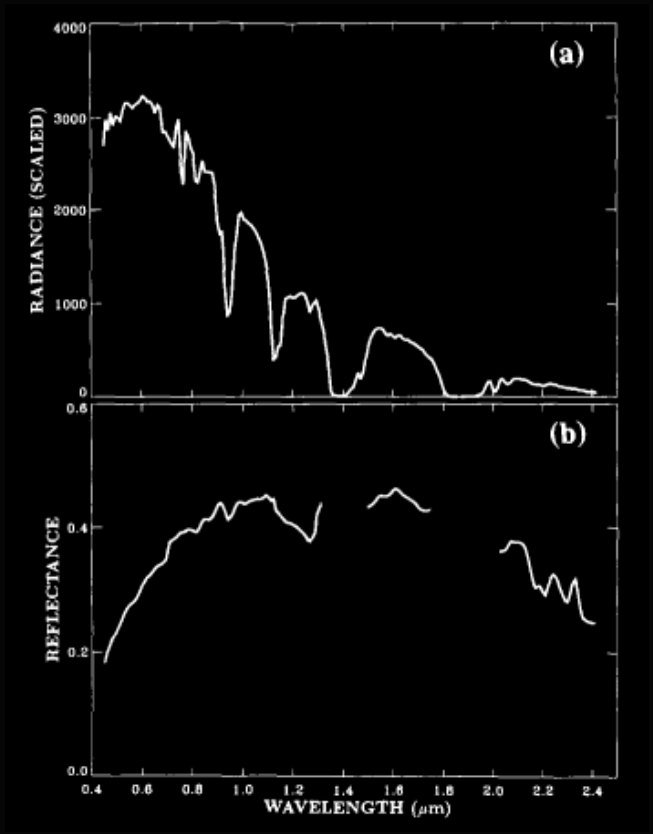
AVIRIS aboard a plane [5]



AVIRIS flight line

Identify Minerals

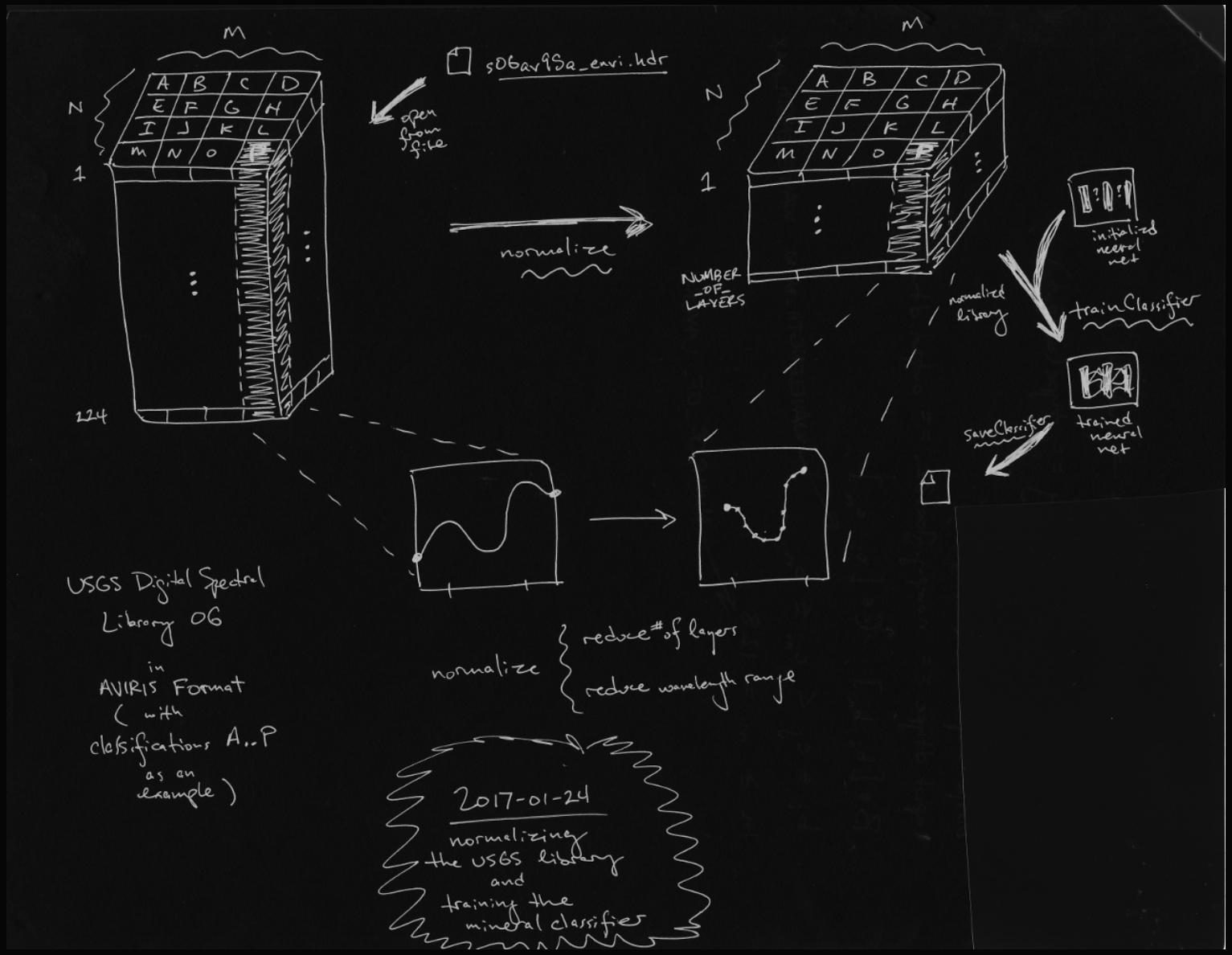
- Minerals have unique signatures
- Spectral Python [6]
- Training with Spectral Libraries
  - USGS Digital Spectral Library 06
  - ASTER
- Classification with Neural Networks



Example AVIRIS mineral spectrum [7]

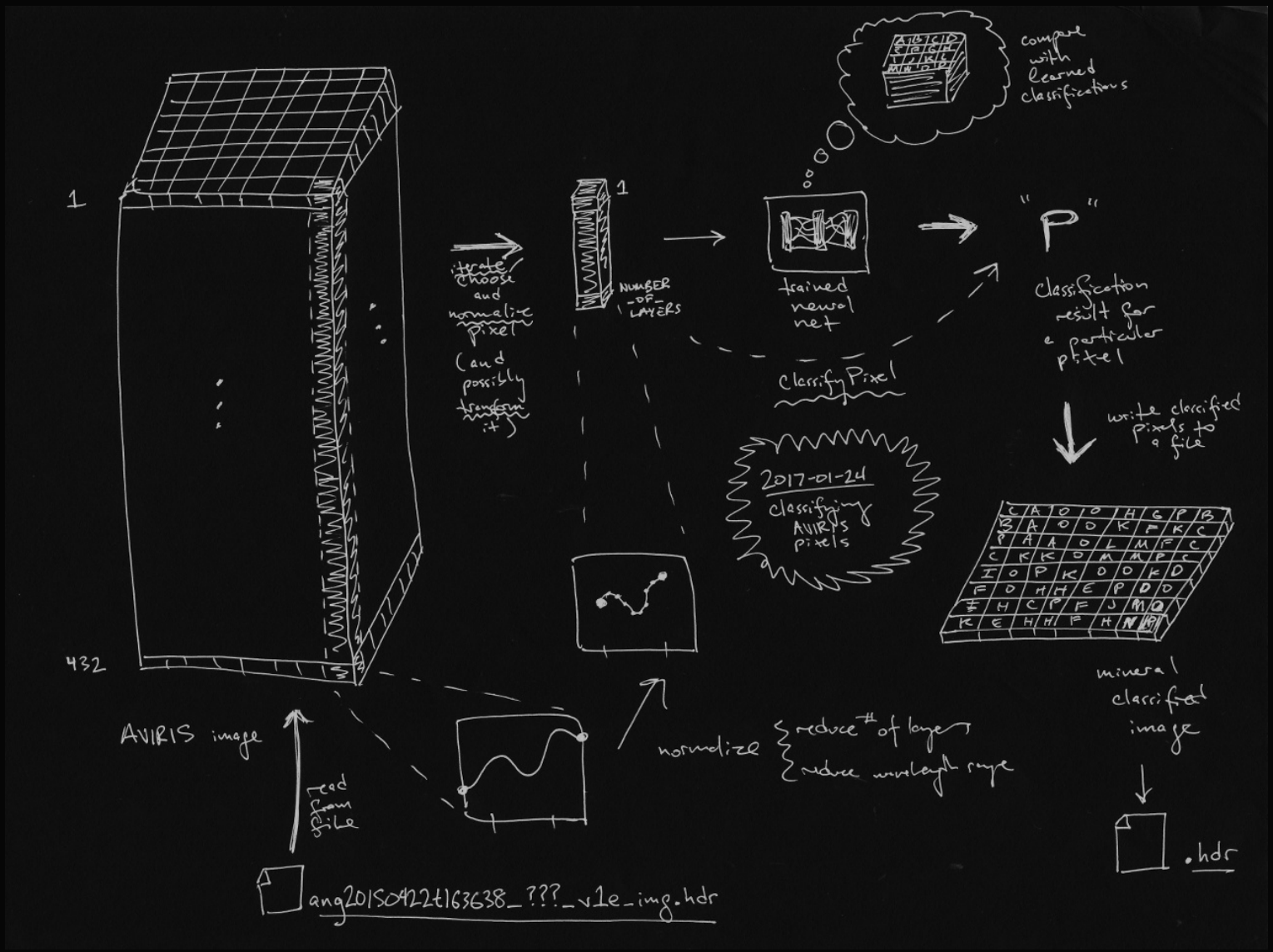
Identify Minerals

Training



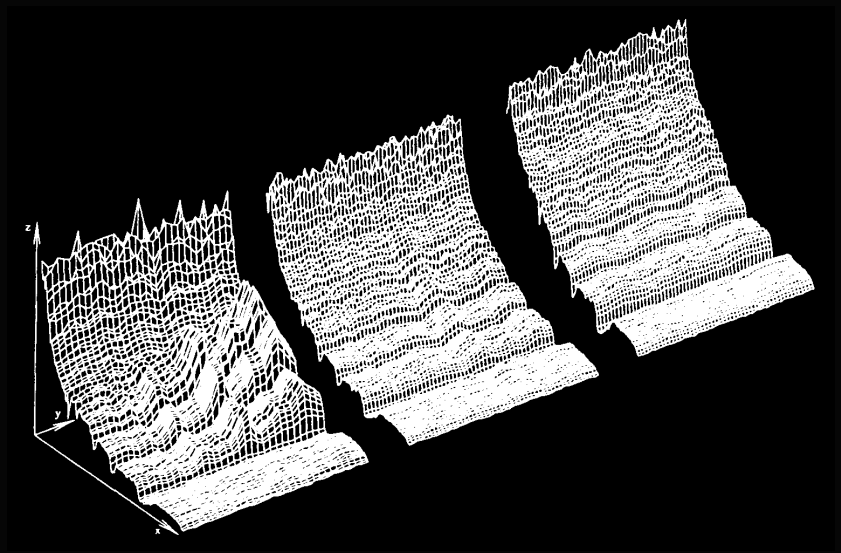
Identify Minerals

Classification



Identify Mining

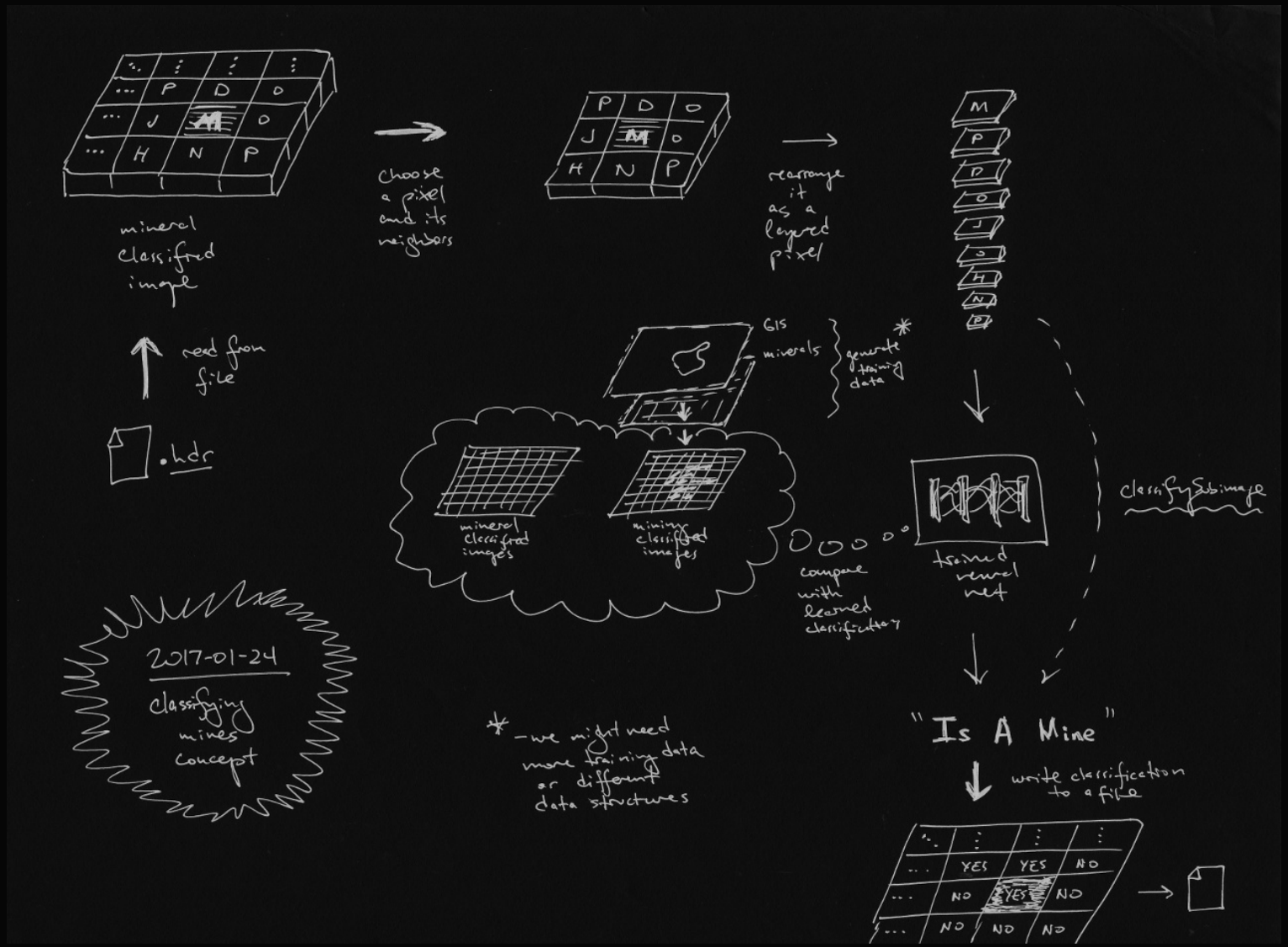
- Use Classified Minerals and Known Mine Data
- Generate Training Data
- Train (and Retrain) the Classifier
- Classifying Mines



Example spectral radiance curves [8]

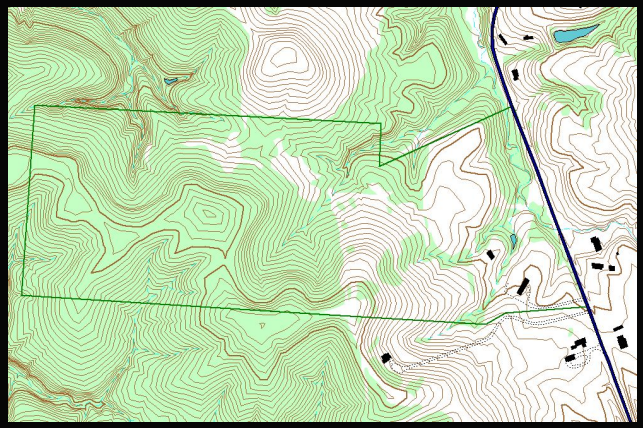
Identify Mining

Training and Classification

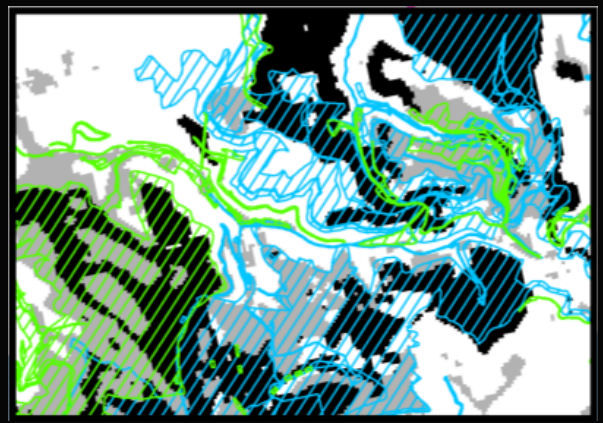


Environmental Impact

- Use Classified Mines
- Use GIS Data on Watersheds and Environmental Monitoring
- Correlate



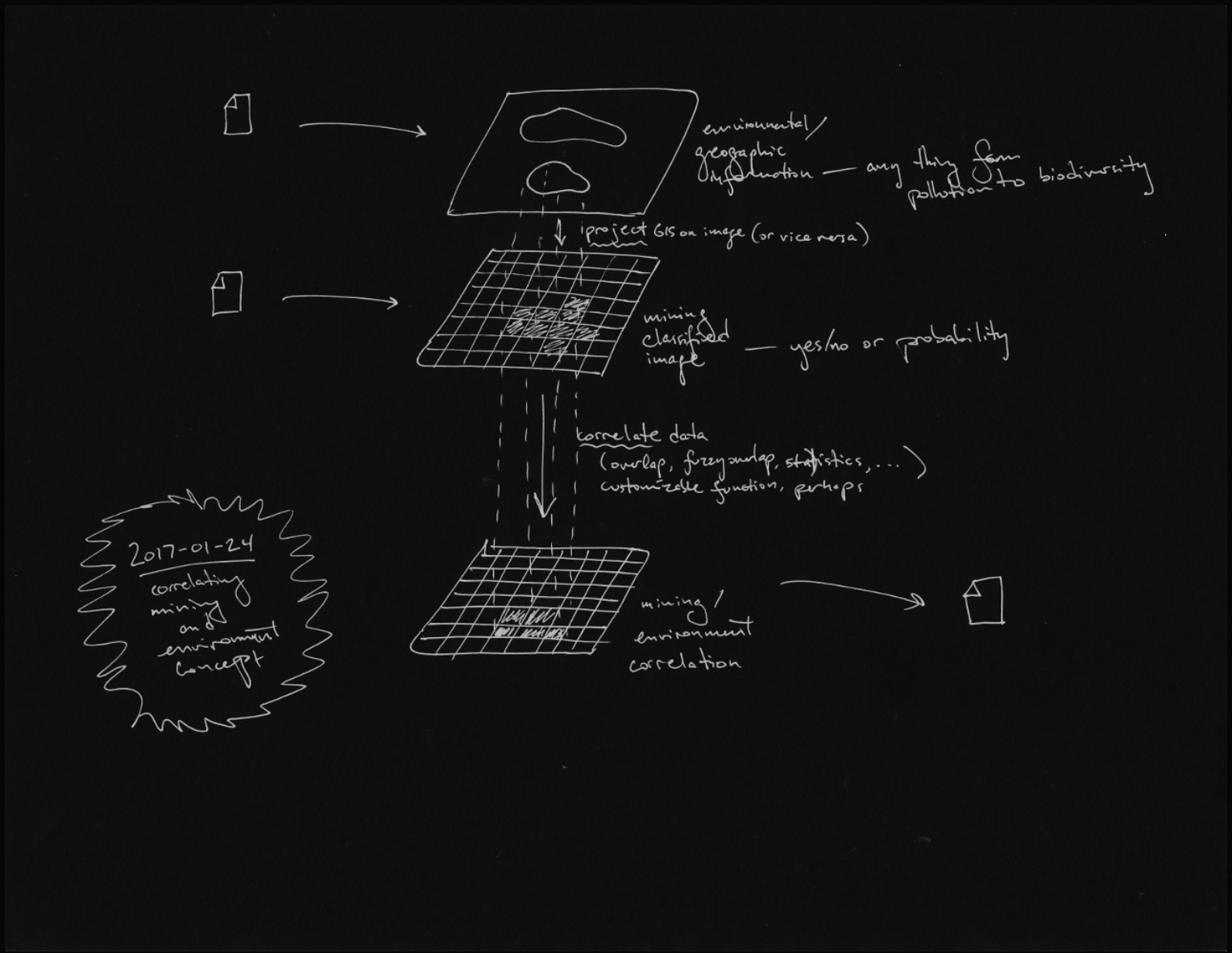
Example GIS data [9]



Comparing mines with permit boundaries [10]

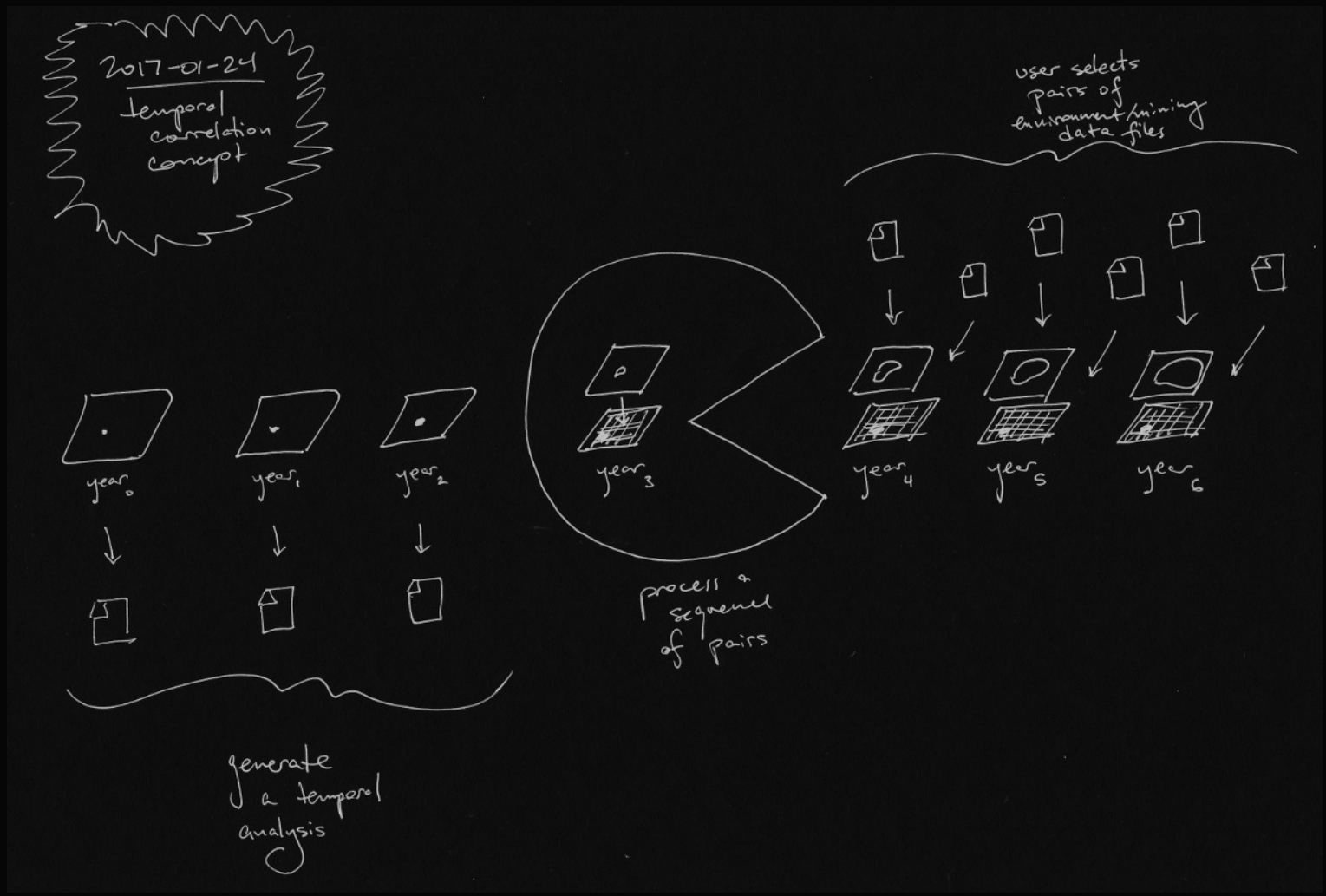
Environmental Impact

Preprocessing and Correlation



Environmental Impact Over Time

- Process Historical Dataset
- Enabling Research
- Visualizing Changes



API Documentation

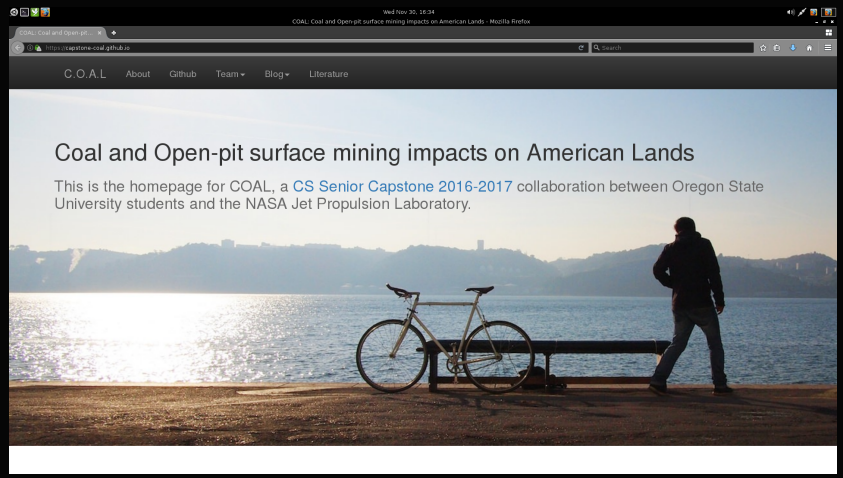
- Sphinx
- Python 2 and 3 support
- Document each library as we go along

```
def trainClassifier(libraryFileName):
    """
    This takes the file name of the library to be used in the training and returns a
    classifier
    Args:
        libraryFileName (str): the name of the training library
    Returns:
        classifier (PerceptronClassifier): trained classifier
    """

    # open the digital spectral library
    # we may need to load it as an image instead
    library = spectral.io.envi.open(libraryFilename)

    # TODO convert units ?
    # see https://groups.google.com/d/msg/coal-capstone/6oordALy0dA/a_6VIuWbBAAJ

    # generate training data
    trainingData = ???(normalize(???(library)))

    # initialize and train a neural network using the training data
    classifier = spectral.classifiers.PerceptronClassifier(???)
    classifier.train(trainingData, ???)
```

A Sphinx docstring in our code for mineral.py

Website

- Content
- Backend: GitHub Pages with Jekyll
- Frontend: Bootstrap



Screenshot of website

Challenges

- Understanding the Problem
  - Machine Learning
  - Data Formats
- Designing the Algorithm
  - Array Processing
  - Machine Learning Training and Classification
  - Geographic Data
- Libraries
  - Confusing Documentation
  - Complex APIs
  - Temporary files for intermediate data

Conclusion

- Develop methods to analyze hyperspectral imagery and geographic information
- Enable environmental data research on effects of mining on waterways
- Publish free library and case study
- Future Work: Continue to Develop Each Module
- GitHub Organization: https://github.com/capstone-coal

References

[1] https://www.nasa.gov/multimedia/imagegallery/image_feature_681.html

[2] https://commons.wikimedia.org/wiki/File:Twincreeksblast.jpg

[3] http://aviris.jpl.nasa.gov/aviris/index.html

[4] http://aviris.jpl.nasa.gov/aviris/instrument.html

[5] http://www.jpl.nasa.gov/missions/airborne-visible-infrared-imaging-spectrometer-aviris/

[6] https://github.com/spectralpython

[7] Gao, Bo-Cai and Goetz, Alexander F. H., "Derivation of scaled surface reflectances from AVIRIS data," Remote Sensing of Environment, July 1993.

[8] J. A. Benediktsson *et al*, "Classification and Feature Extraction of AVIRIS Data," IEEE Trans. on Geoscience and Remote Sensing, Vol. 33, No. 5, September 1995.

[9] https://commons.wikimedia.org/wiki/File:Gislayers.jpg

[10] D. Nally, "Moving Mountaintops: Monitoring Surface Mine Expansion and Reclamation Using Landsat Imagery," Tufts Univ., Spring 2011.