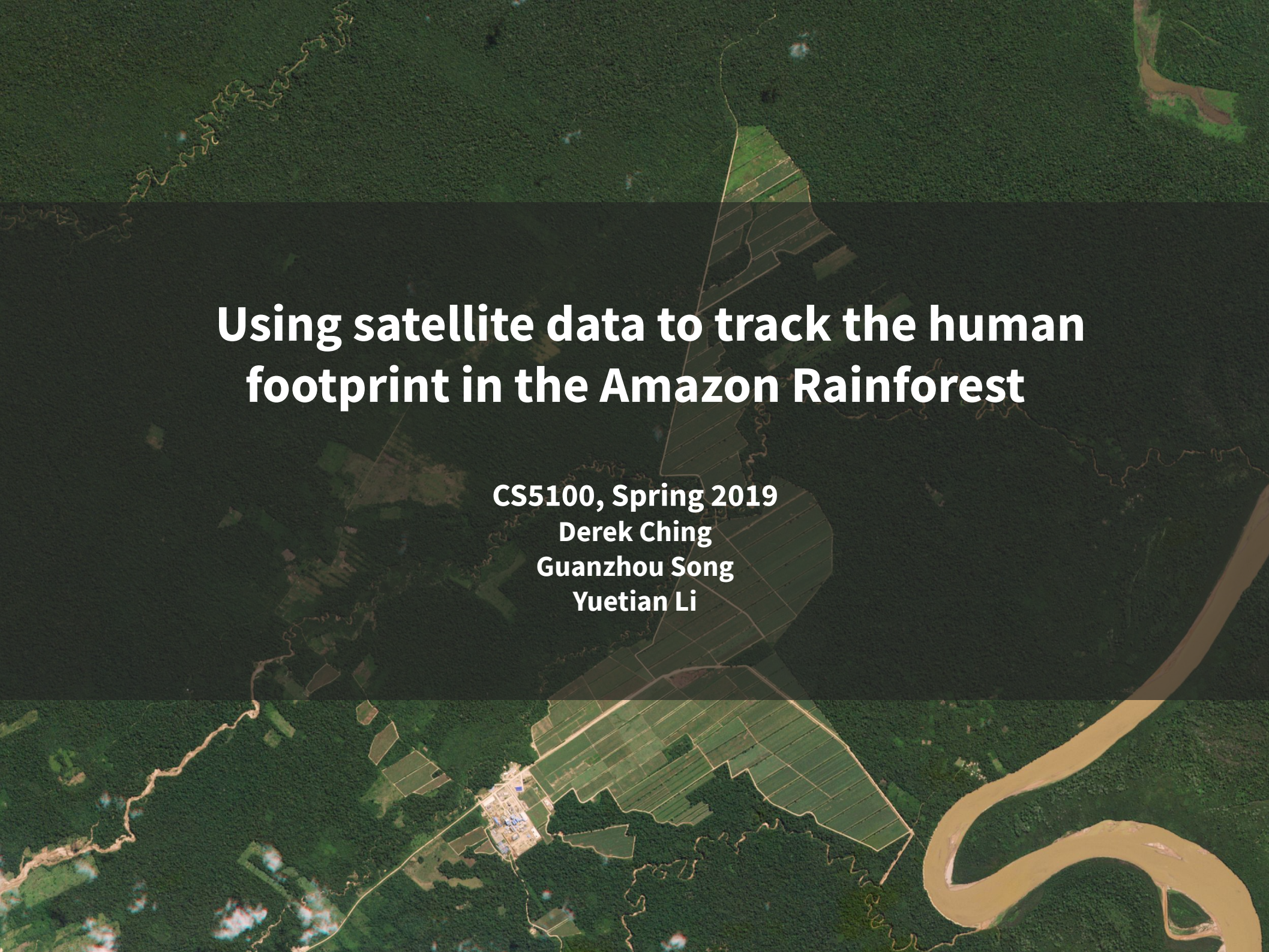


Using satellite data to track the human footprint in the Amazon Rainforest

CS5100, Spring 2019

Derek Ching

Guanzhou Song

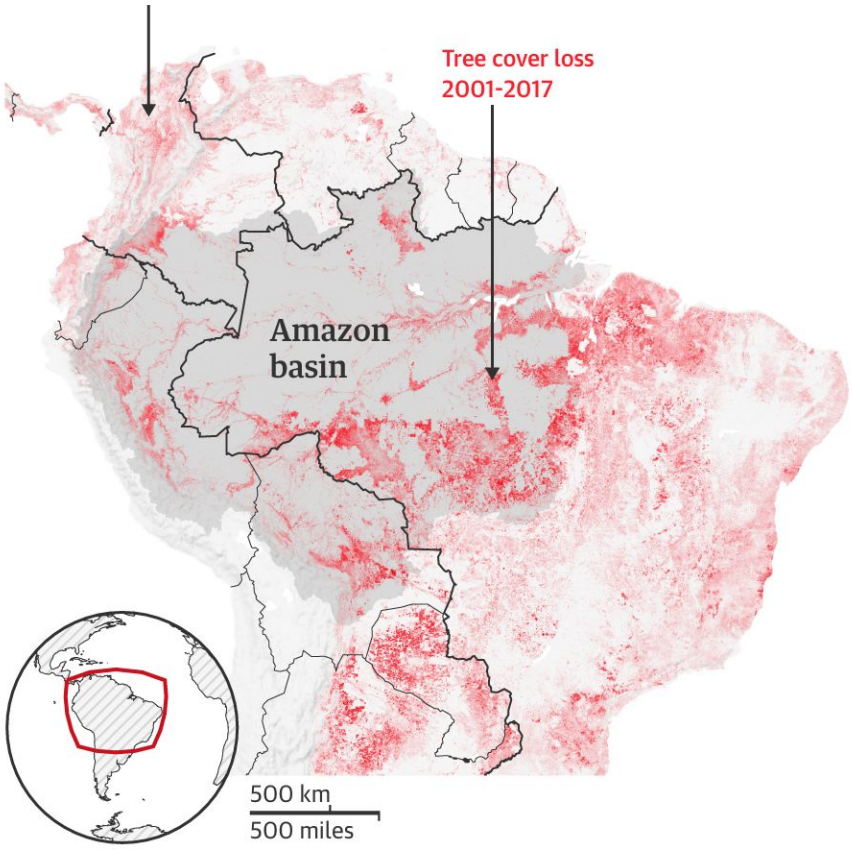
Yuetian Li

Introduction

- **Problem Statement**
- **Image Processing Techniques**
- **Feature Prediction Results based on:**
  - Decision Tree
  - Random Forest
  - CNN
- **Conclusion / Remaining Tasks**

Problem Statement

“Every minute, the world loses an area of forest the size of 48 football fields. ” [1]

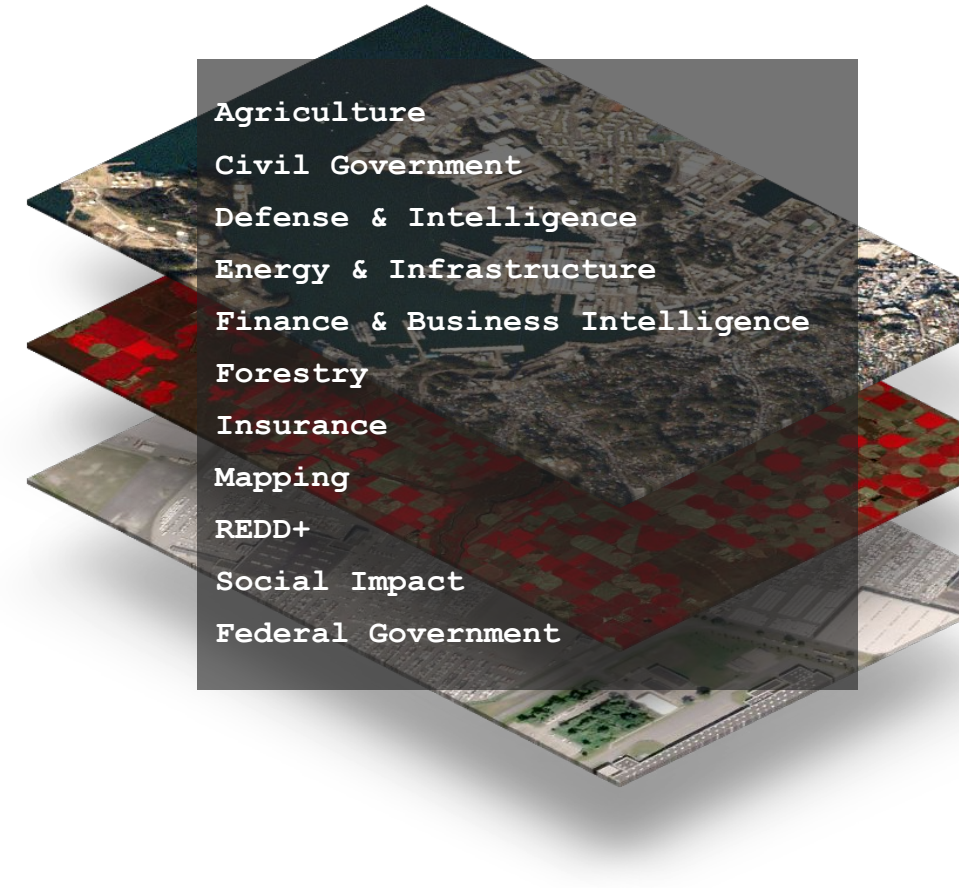


Our Goal

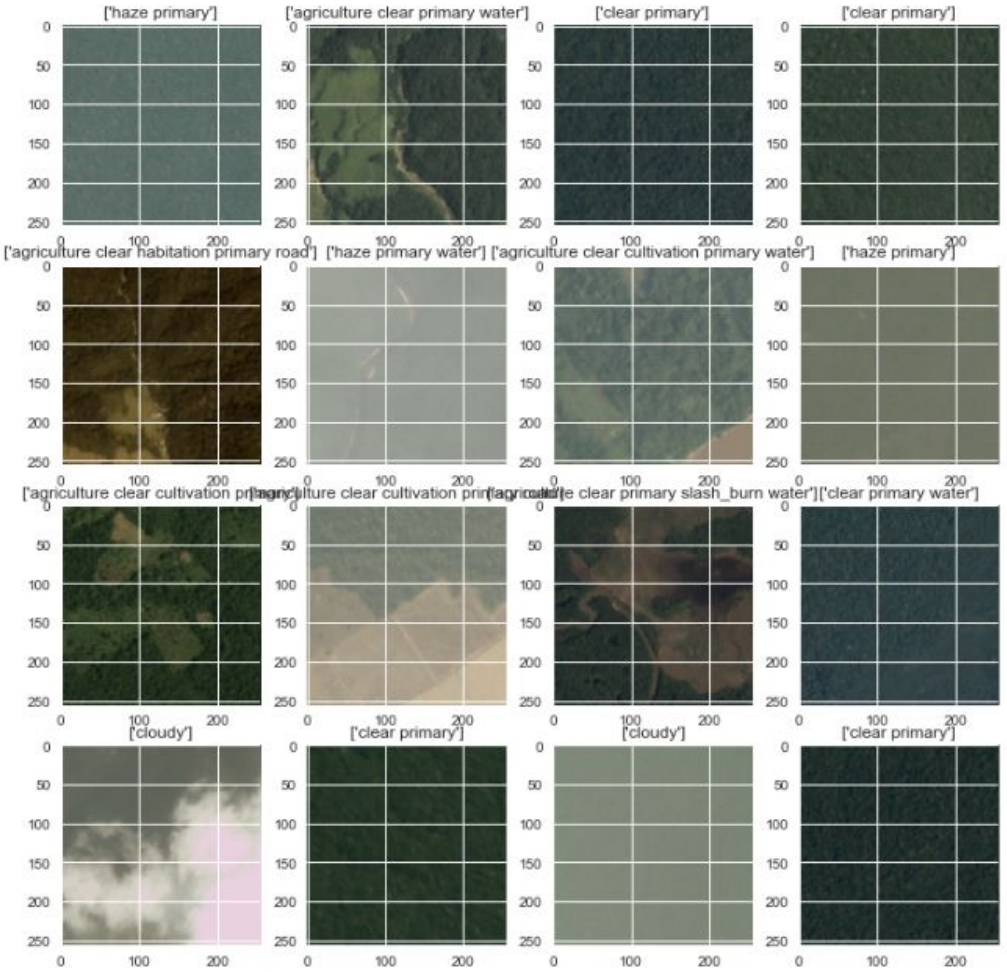
Figuring out which regions of the Amazon Rainforest are deteriorating the fastest.

Problem Statement

- Given **60,000** satellite images. provided by planet.
- Each satellite image contain multiple combinations of **labels**.
- **TRAIN** and **PREDICT.**



Problem Statement



- **Weather Labels**

  Clear, Cloudy, Partly Cloudy, Haze

- **Land Labels**

  Habitation, Bare Ground, Cultivation, Agriculture, Conventional Mine …

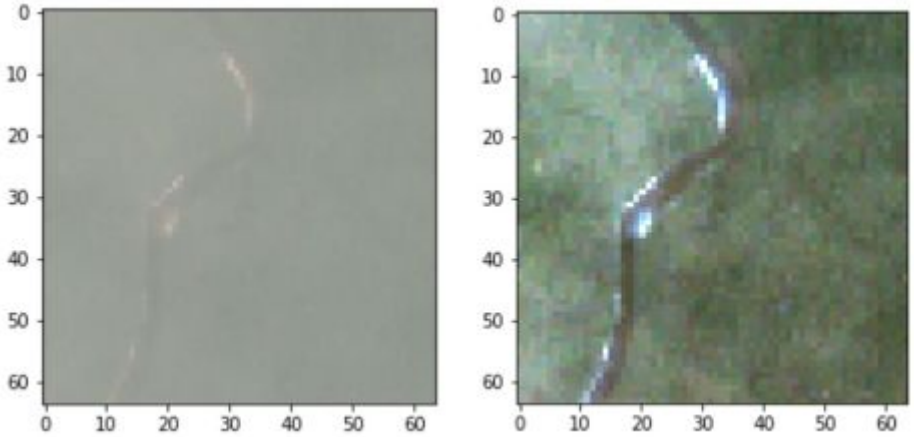
  - **Total 28**
  - **We have a lot of labels !**

How we plan to solve it?

- Image Processing
  - Import Labels and Satellite Image Data
  - Applying filtering/removal techniques for Haze
  - Label categorization
  - Color Intensity
  - Image Edge Analysis
- Apply Image Classifier Algorithms for weather and land

Haze Removal

- The dark channel prior is a kind of statistics of the haze-free outdoor images.
- It is based on the idea that most haze-free outdoor images contain some pixels which have very low intensities in at least one color channel.
- Using this prior with the haze imaging model, we can directly estimate the thickness of the haze and recover a high quality haze-free image.
  - (Taken from [Single image haze removal using dark channel prior])



Label Categorization

- In our previous slide we mentioned the following labels:
  - Weather Labels: Clear, Cloudy, Partly Cloudy, Haze
  - Land Labels: Habitation, Bare Ground, Cultivation, Agriculture, Blow Down, Conventional Mine, Selective Logging, Slash Burn, Artisinal Mine, Blooming, Primary, Water, and None
- Because there are so many land labels, we can simplify the problem if we categorize the land label as Primary, Water, “Other”, and None.

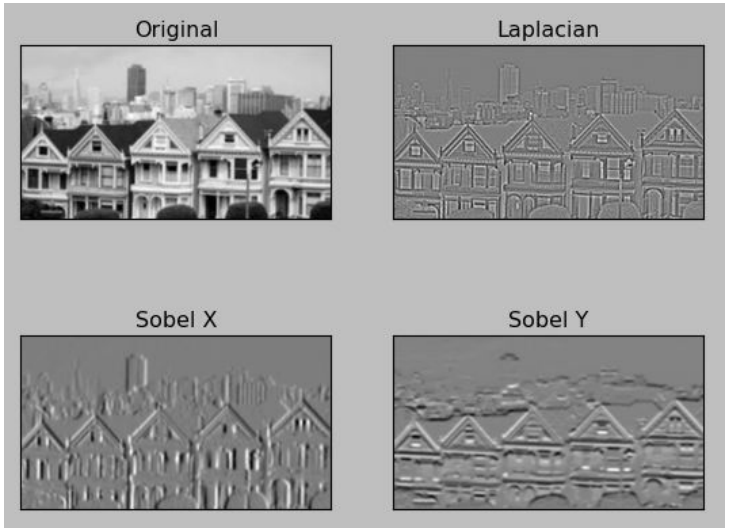
Color Intensity Analysis

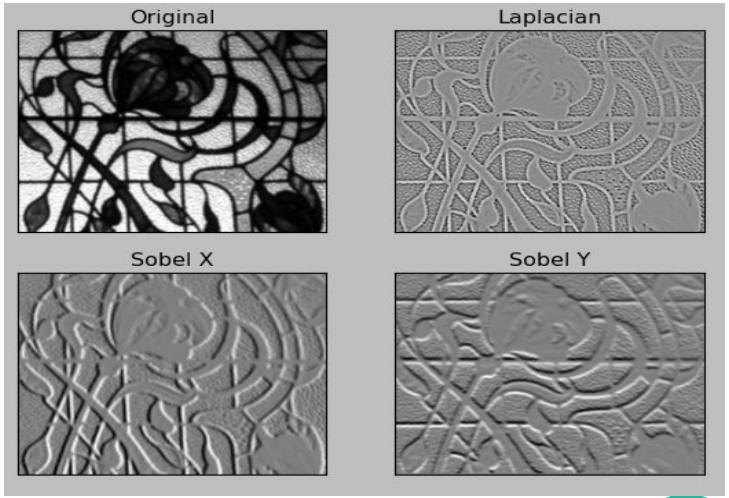
- JPG is good for providing RGB Analysis
  - Water means lots of blue, forest means lots of green, clouds means lots of white
- TIF is good for Infrared Analysis
  - We can identify features that can't be split through natural light.
  - Differentiation between water and forests.
    - Water index = (Blue - Infrared Light) / (Blue + Infrared Light)
    - Forest index = (Infrared Light - Red) / (Red + Infrared Light)

Image Edge Detection

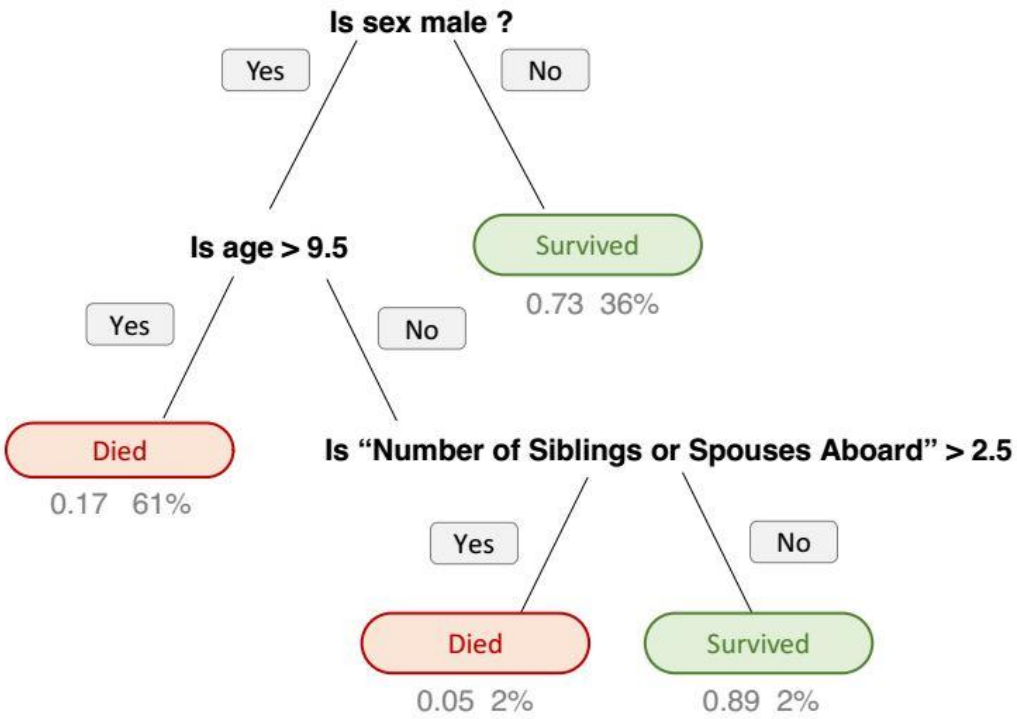
- Sobel calculates first order derivatives
  - We see that Sobel has a Sobel X and Sobel Y.
- Laplacian calculates second order derivatives
  - We are essentially taking the derivatives of the first-order derivative Sobel, and adding them together.

$$\Delta src = \frac{\partial^2 src}{\partial x^2} + \frac{\partial^2 src}{\partial y^2}$$



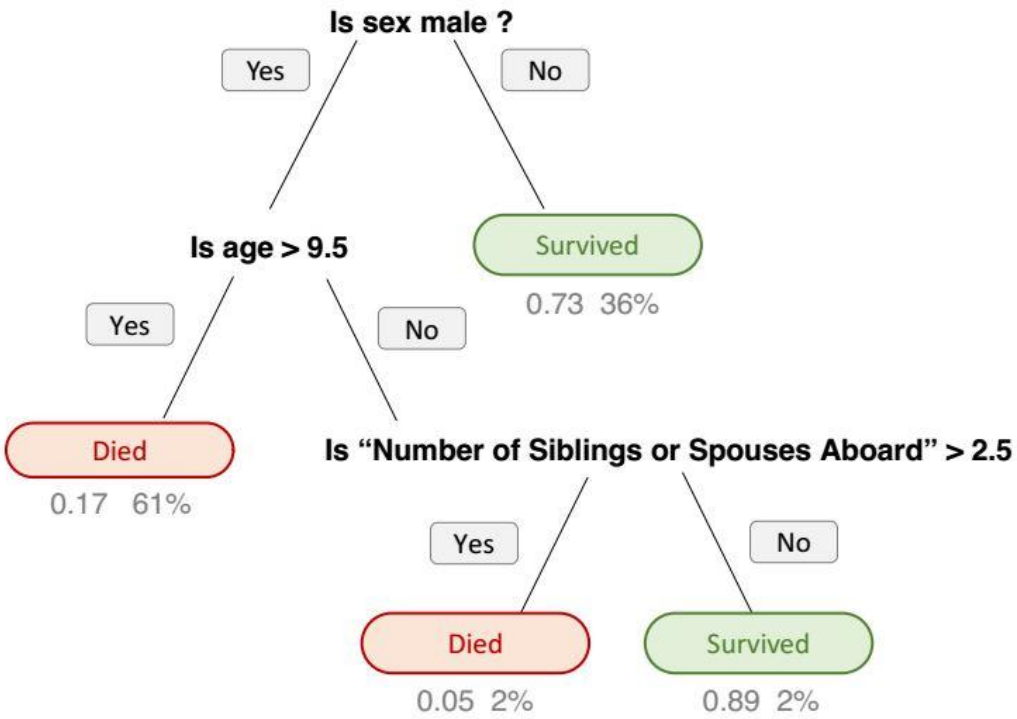


Feature Prediction Results
Decision Tree



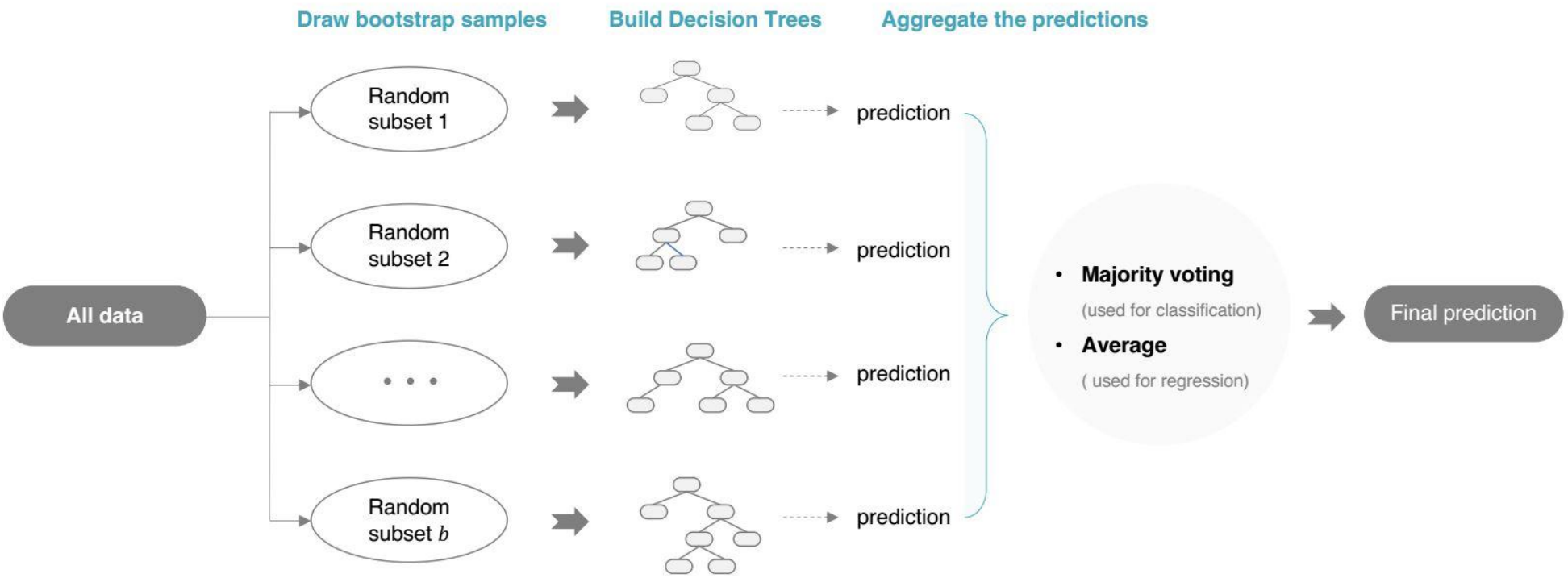
- **A tree-like graph of decisions and their possible consequences.**
- **Takes a vector of attribute values as input and returns a decision as output.**

Feature Prediction Results
Decision Tree



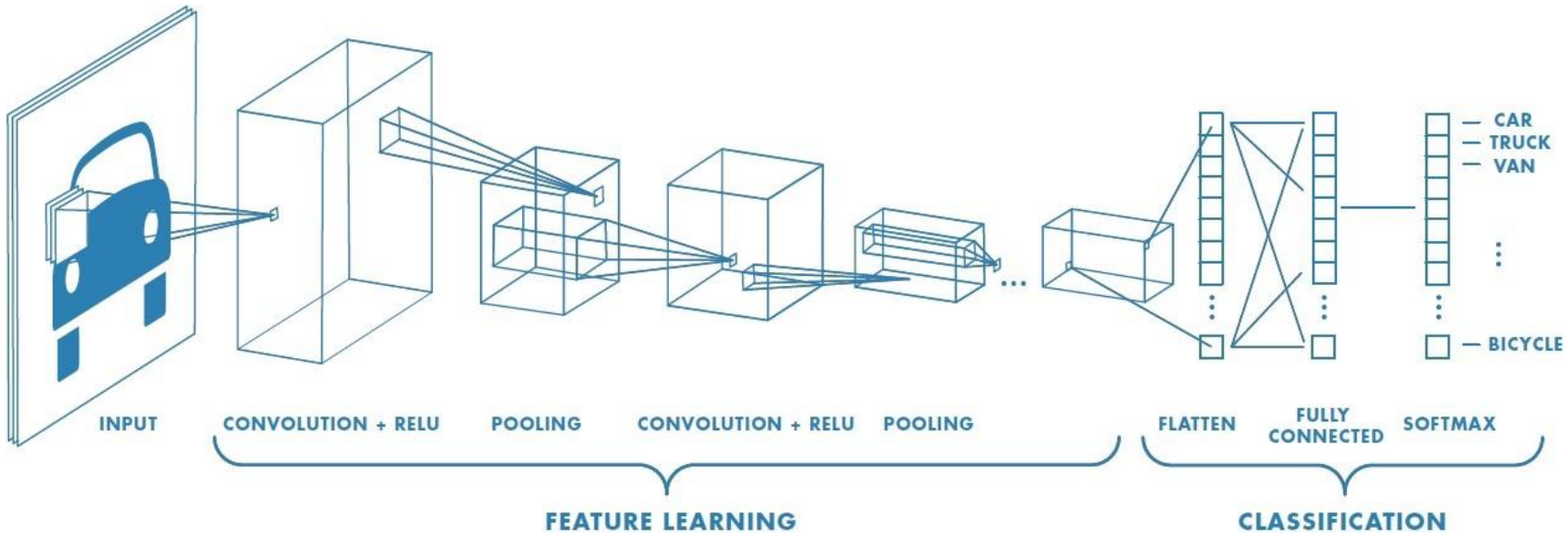
- **Straightforward, easy to understand.**
- **White-box. Examples can be explained by boolean logic if its features are observable in the model. (Unlike some black-box models like neural network)**

Feature Prediction Results
Random Forest



- **Upgrading Decision Tree: Constructing multiple decision tree from one dataset by splitting the dataset into different subsets**
- **In each subset, randomly pick different *data* and *features*.**

Feature Prediction Results
Deep Convolutional Neural Network



- Input layer
- Output layer
- Hidden layers

- Hidden layers
  - Convolutional layers
  - RELU layer
  - Pooling layers
  - Fully connected layers
  - Normalization layers

CNN Layers

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 26, 26, 32)	320
max_pooling2d (MaxPooling2D)	(None, 13, 13, 32)	0
conv2d_1 (Conv2D)	(None, 11, 11, 64)	18496
max_pooling2d_1 (MaxPooling2	(None, 5, 5, 64)	0
conv2d_2 (Conv2D)	(None, 3, 3, 64)	36928
flatten (Flatten)	(None, 576)	0
dense (Dense)	(None, 64)	36928
dense_1 (Dense)	(None, 10)	650

What We have

Random Forest

	Precision	recall	F1
none	0.83	0.73	0.77
other	0.85	0.82	0.83
Primary	0.97	0.99	0.98
Water	0.82	0.59	0.69
Ave/Total	0.92	0.89	0.9

Total Accuracy: 0.77

Decision Tree

	Precision	recall	F1
none	0.7	0.69	0.7
other	0.8	0.78	0.79
Primary	0.97	0.98	0.98
Water	0.64	0.57	0.61
Ave/Total	0.88	0.87	0.88

Total Accuracy: 0.69

CNN (basic, 5-layer): **Total Accuracy: 0.75**

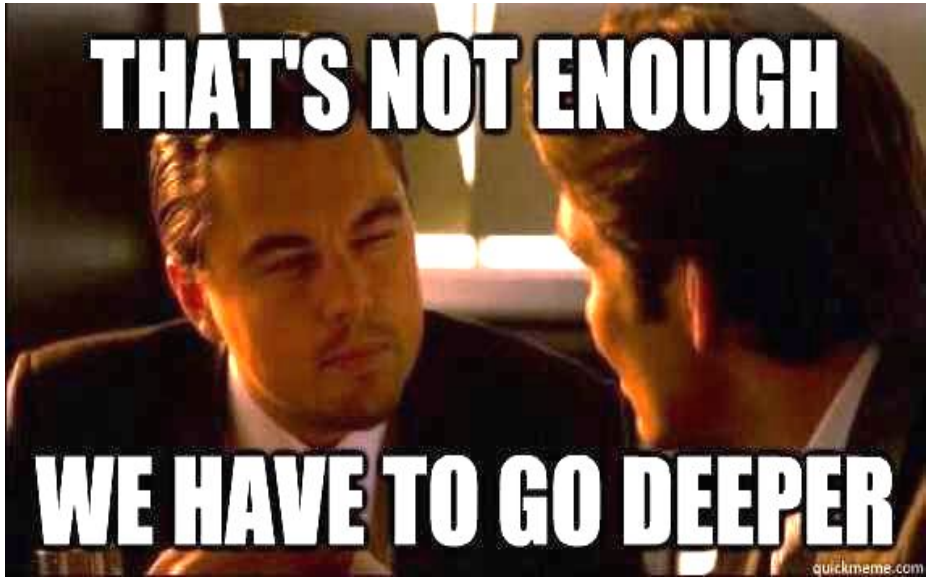
CNN (GoogLeNet): ??? >0.8

CNN(ResNet): ??? >0.8

……

What’s Next

- **Data Process**
  - Picture distortion
    - Prevent overfitting
  - Edge Detection
    - Extract more data
    - Remove noise
- **Algorithm**
    - GoogLeNet
    - ResNet
    - DenseNet



Thank You！

Reference

- Retrieved May 31 2019, from https://www.kaggle.com/c/planet-understanding-the-amazon-from-space
- Zhu Q, Mai J, Shao L. A fast single image haze removal algorithm using color attenuation prior[J]. IEEE transactions on image processing, 2015, 24(11): 3522-3533.
- Planet Company website: https://www.planet.com/company/