Inter-IIT Tech Meet

The Eye in the Sky

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Problem Statement

- In this challenge, we are required to implement a satellite image segmentation model. So, given an image we have to predict the class of each pixel in image.

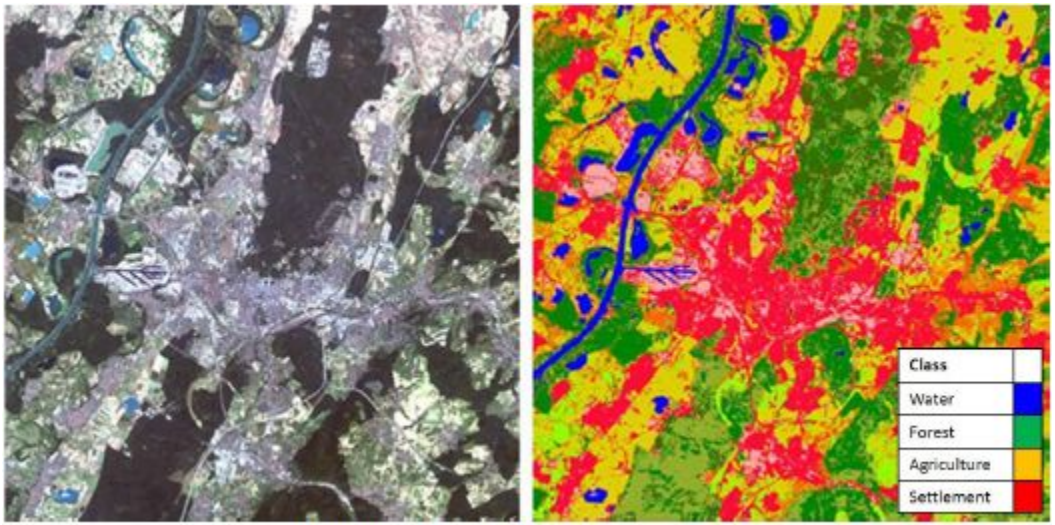


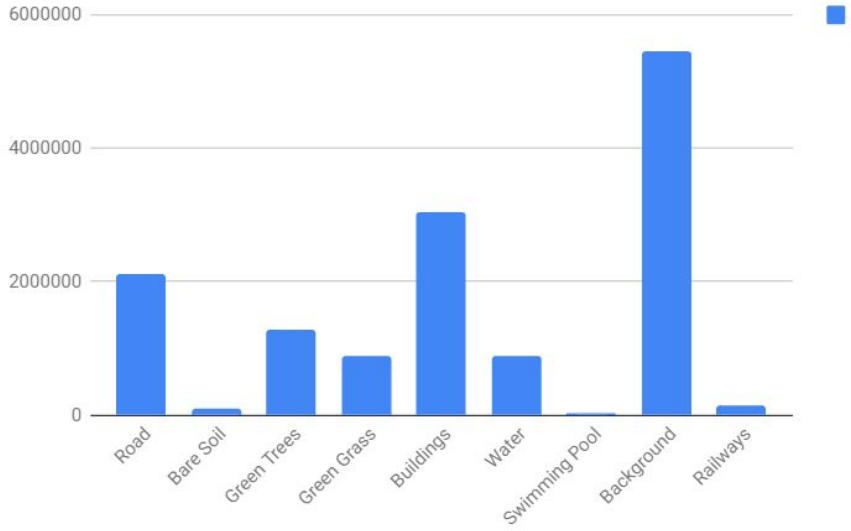
Fig. Example of a Satellite Image Classification

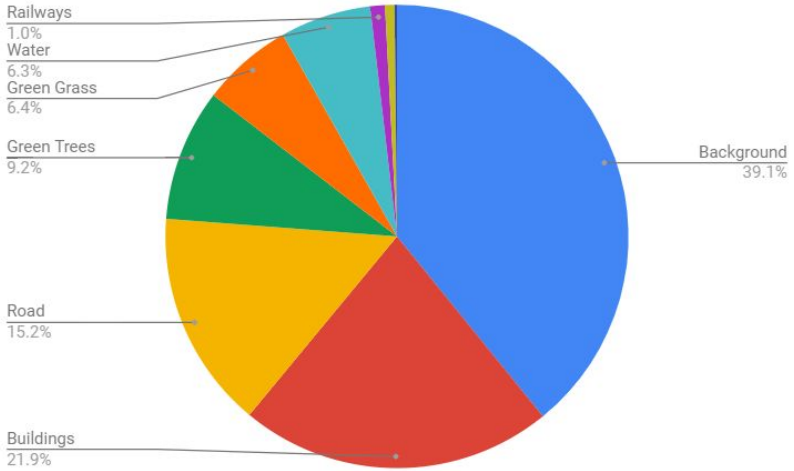
Approach

- Basic approach to this problem was FCN (Fully Convolutional Network).
- FCN uses CNN as a powerful feature extractor while replacing fully connected layers with convolution.
- Modified Version of U-net was used to tackle this segmentation problem.
- Less Amount of Training Data.

Dataset

- The image consists of 8 classes grass, roads, buildings, bare soil, trees, railways, water bodies, swimming pools.
- Unbalanced Classes in the Dataset.





Our Journey

Pre-Processing

- Tried Normalizing between -1 to 1 but it didn't worked out for us.
- Normalizing the data between 0 to 1 using standard normalization technique.
- Generating Patches from a given image, so that the feedforward is less computationally expensive (96×96).
- Padded the image before feeding forward.

Models

Model	Accuracy
U-Net	76

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One vs All Classifiers using U-Net	67

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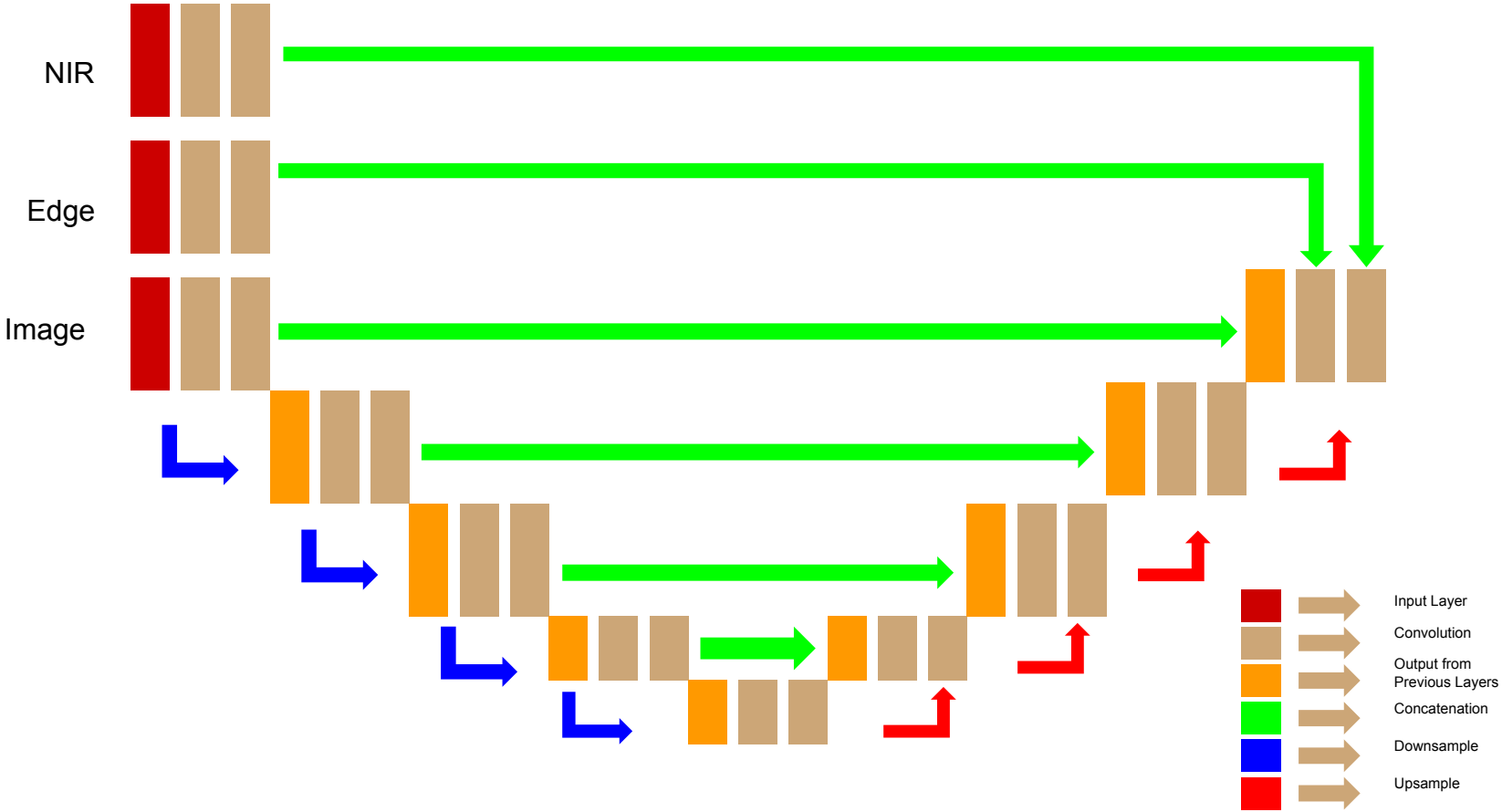
Resnet + U-Net	81

Feature Generation

- Canny Edge Detection was used but the results weren't satisfactory.
- Local Binary Transform was used to detect texture.
- Sobel and Robert Cross Edge Detection was used.
- Resultant Images were used as an extra channel.

Model Architecture



Hyper Parameters

- Activation Functions
  - **ELU**
  - **ReLU**
- Optimizers
  - RMS Prop
  - AdaGrad
  - **Adam**
  - SGD
- Loss Functions
  - **Categorical Cross Entropy**
  - Custom loss function
- Metrics
  - **Accuracy**
  - IOU

Reflectance Indices

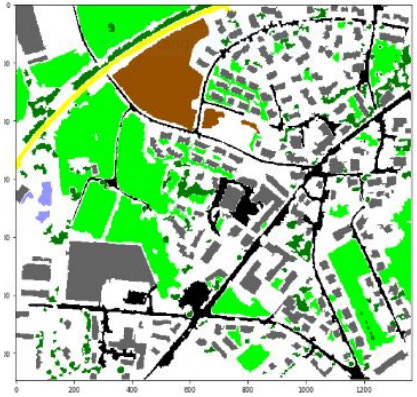
- Used NIR channel to identify some classes solely on the basis of pixel value.
- Due to the reflectance property of water, indices such as NDWI (Normalised Difference Water Index) shows high intensity value for water class.

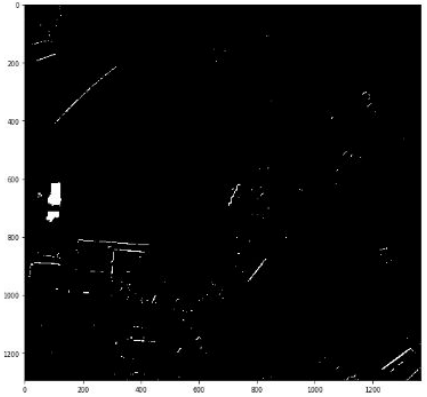
$$\mathrm{NDWI} = \frac{\mathrm{GREEN} - \mathrm{NIR}}{\mathrm{GREEN} + \mathrm{NIR}}$$

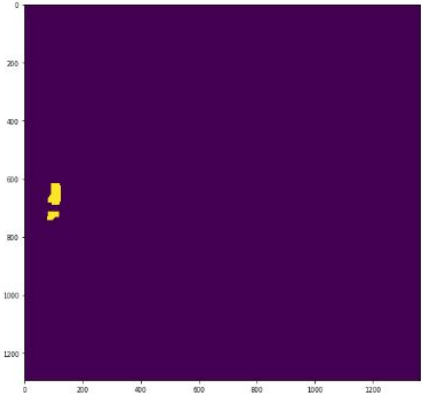
- NDWI values
  - ≥ 0.7511 for swimming pool.
  - 0.576 - 0.7511 for water.

Morphological Transformations

- NDWI index shows *False Positive* for some buildings due to similarity of specific heat of metal roof and water.
- To remove these false positive points we used two morphological transformations
    - Erosion
    - Dilation





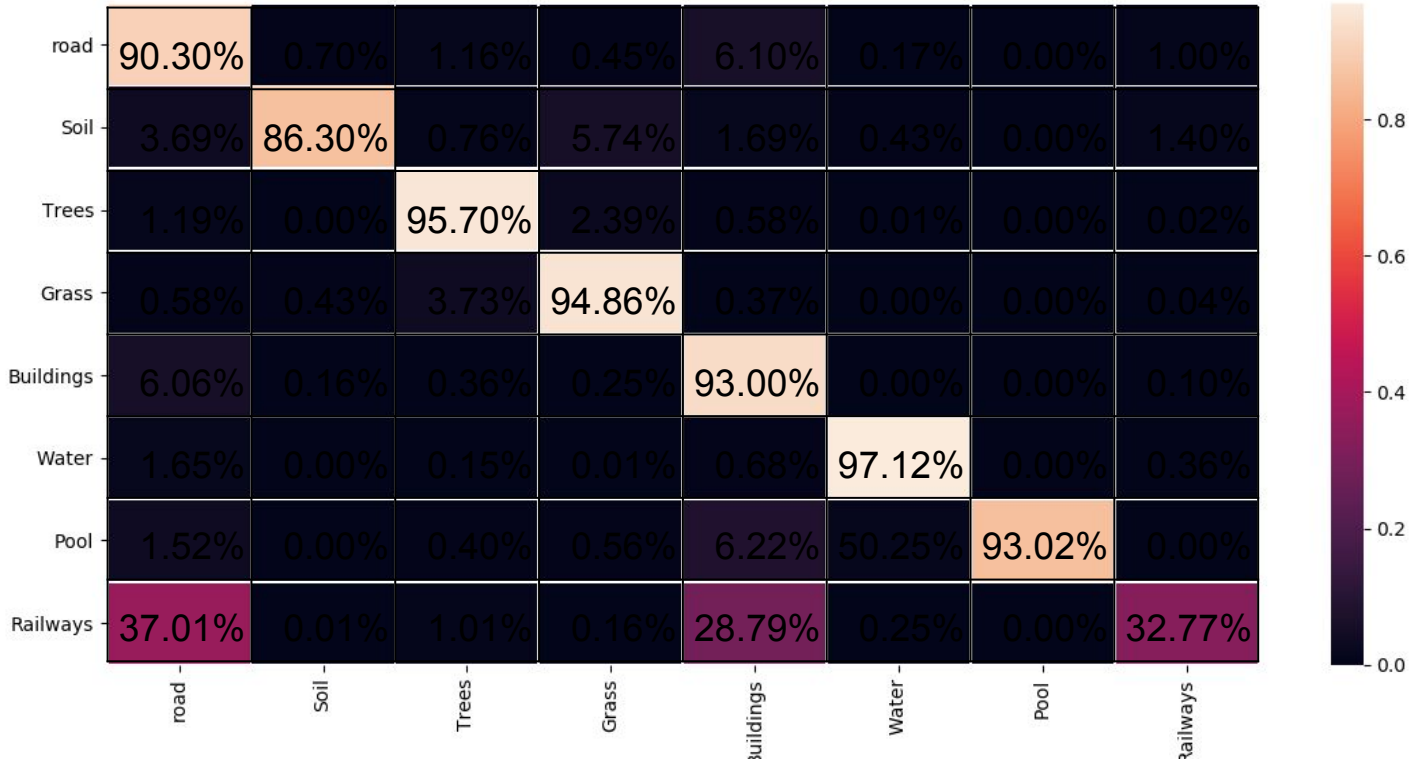


Results

$$OverallAccuracy = \frac{TotalMatchingPixels}{TotalPixels} * 100$$

Kappa Coefficient	0.9028
Overall Accuracy	93% (pixel wise)

HeatMap


road
Soil
Trees
Grass
Buildings
Water
Pool
Railways
90.30%
0.70%
1.16%
0.45%
6.10%
0.17%
0.00%
1.00%
3.69%
86.30%
0.76%
5.74%
1.69%
0.43%
0.00%
1.40%
1.19%
0.00%
95.70%
2.39%
0.58%
0.01%
0.00%
0.02%
0.58%
0.43%
3.73%
94.86%
0.37%
0.00%
0.00%
0.04%
6.06%
0.16%
0.36%
0.25%
93.00%
0.00%
0.00%
0.10%
1.65%
0.00%
0.15%
0.01%
0.68%
97.12%
0.00%
0.36%
1.52%
0.00%
0.40%
0.56%
6.22%
50.25%
93.02%
0.00%
37.01%
0.01%
1.01%
0.16%
28.79%
0.25%
0.00%
32.77%
road
Soil
Trees
Grass
uildings
Water
Pool
ailways
0.8
0.6
0.4
0.2
0.0

Thank You!