ML BASED FEATURE EXTRACTION OF ELECTRICAL SUBSTATIONS

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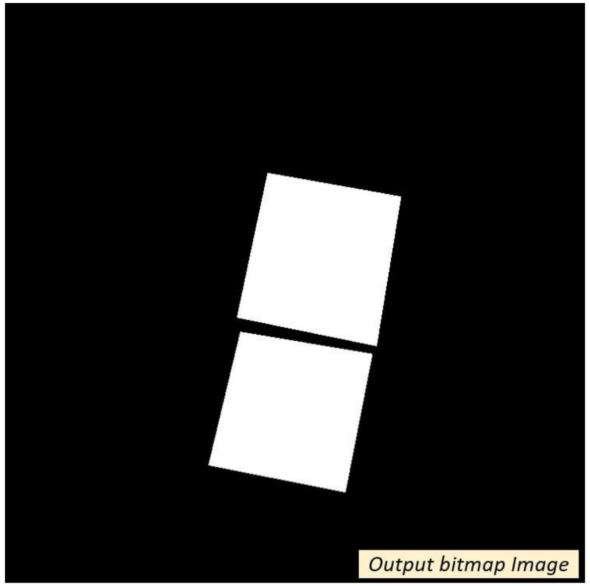
OUTLINE

- Objective
- Methodology
- Challenges
- Results
- Future Scope

Objective

- Extracting Electrical Substations from high resolution satellite images
- Model should be robust enough to cater the input images with varying surrounding information's

- Used **Seg-Net** for Image Segmentation

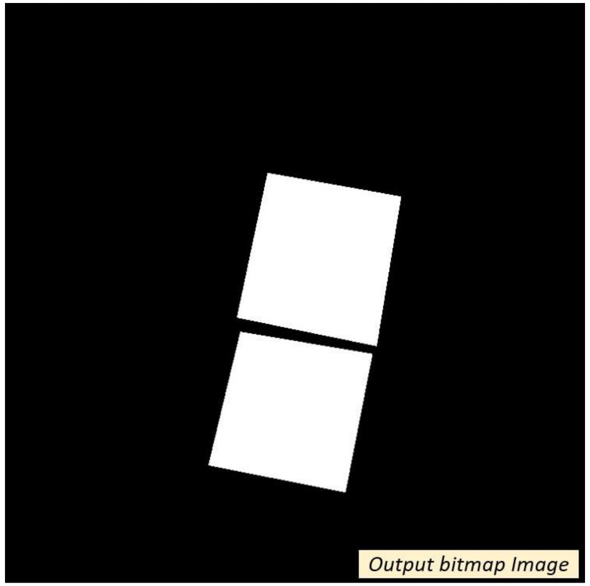


Dataset

- Training Data
  - 100 Images (750 x 750)
  - 100 Polygon AOI in '.csv' format

- Test Data
  - 25 Images (3750 x 3750)

- Output
  - 25 Image masks (3750 x 3750)



Methodology

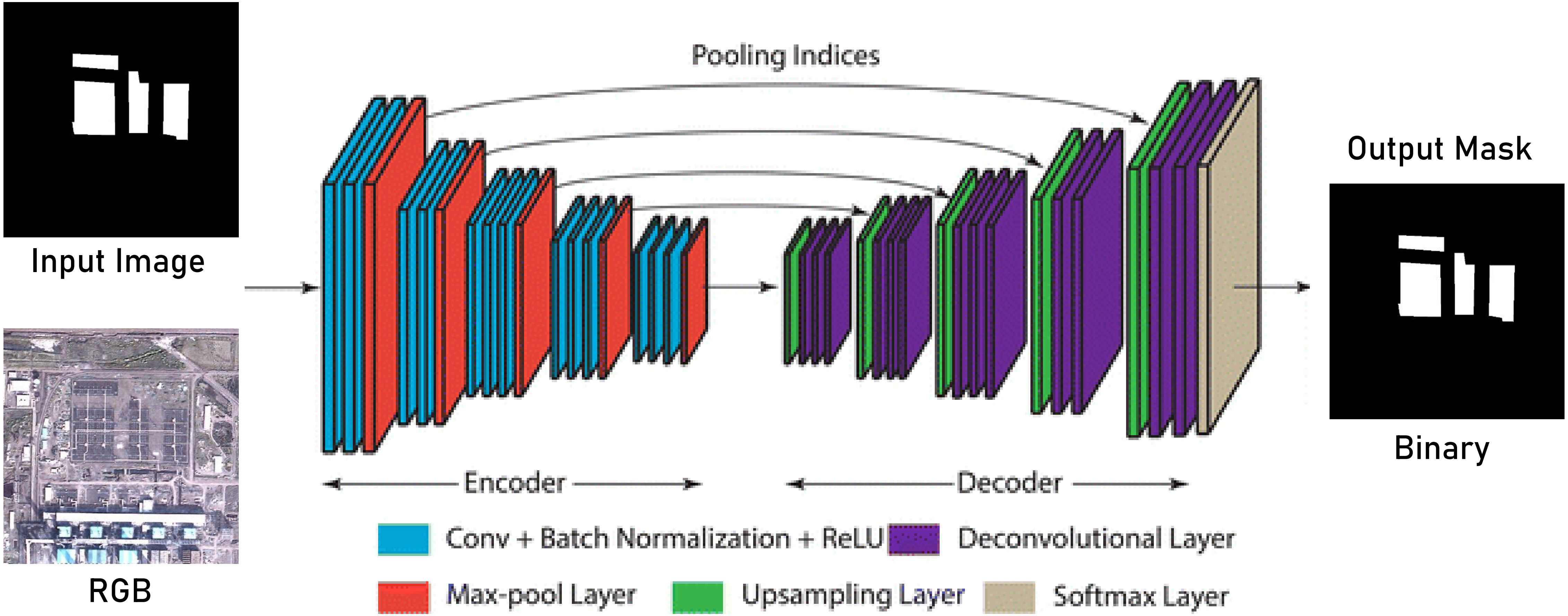
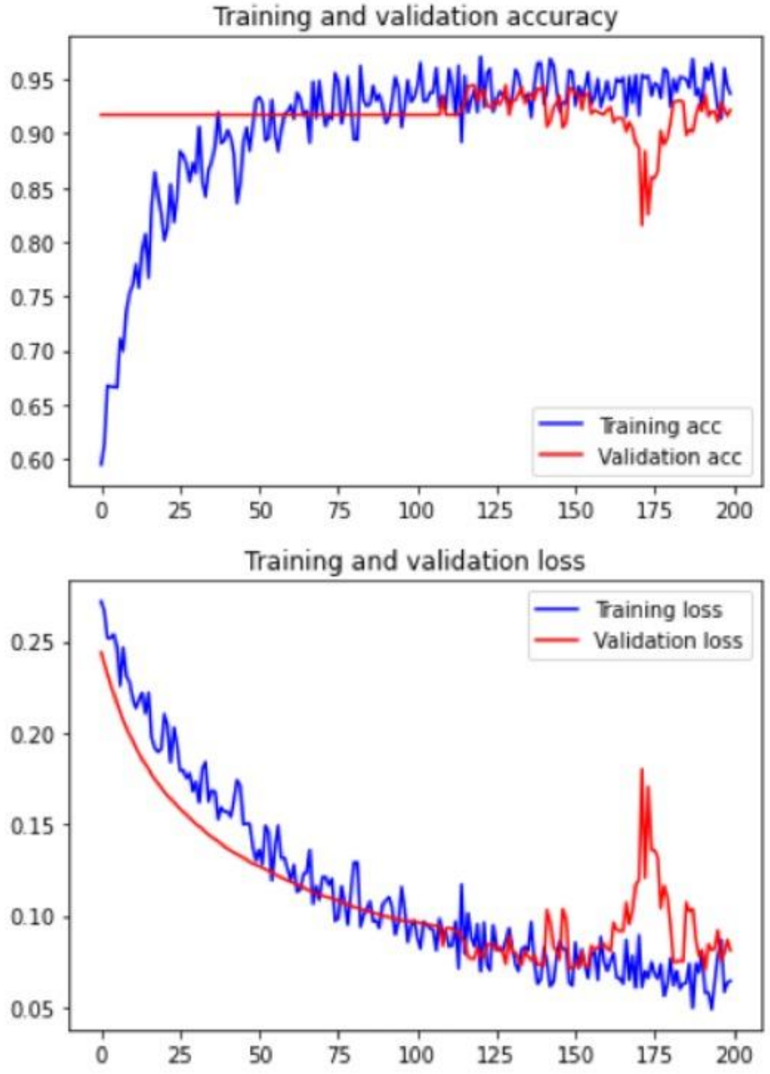


Figure 1: Seg-net Architecture

Optimizing the model

Segnet-Architecture:
Stochastic Training accuracy and validation accuracy was observed

Modification in Architecture:
Vgg-Net was chosen as encoder to combat these challenges.



Why was VGG-19 chosen?

Semantic segmentation using pertained weights:
Due to the similarity with the segnet encoder architecture, the VGG-16 and VGG-19 nets were chosen as candidates to replace the segnet encoder.

Vgg19 vs Vgg16:
The only fundamental difference between the two architectures is the addition of 3 convolutional layers. It made sense to incorporate VGG19 as it performs slightly better than VGG16 at the expense of using a bit more memory.

Model Architecture

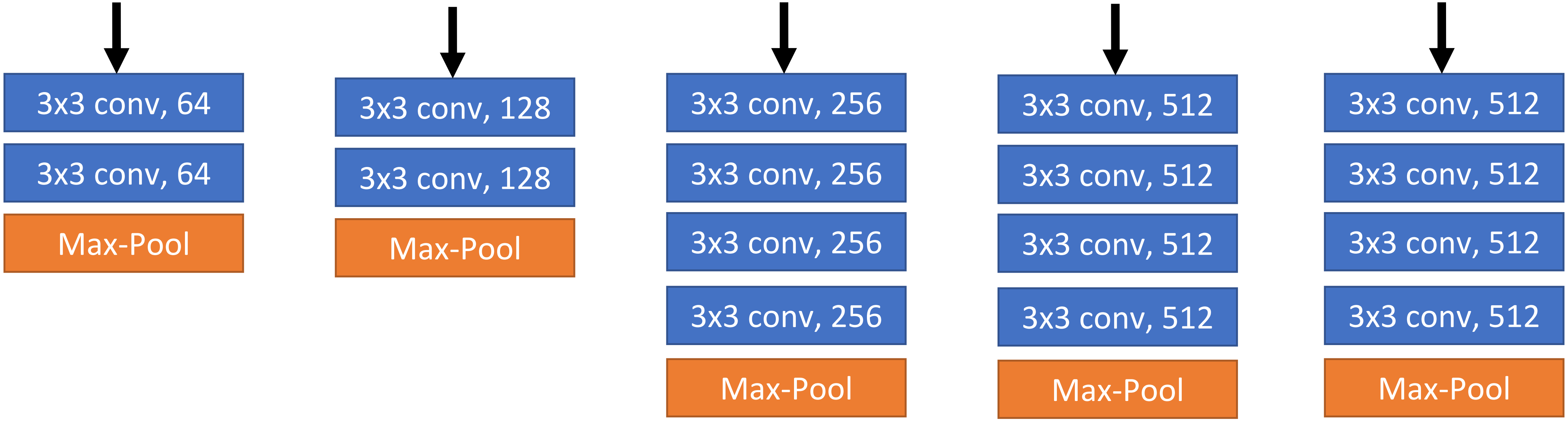


Figure 2: Encoder (VGG-19 architecture)

Model Architecture

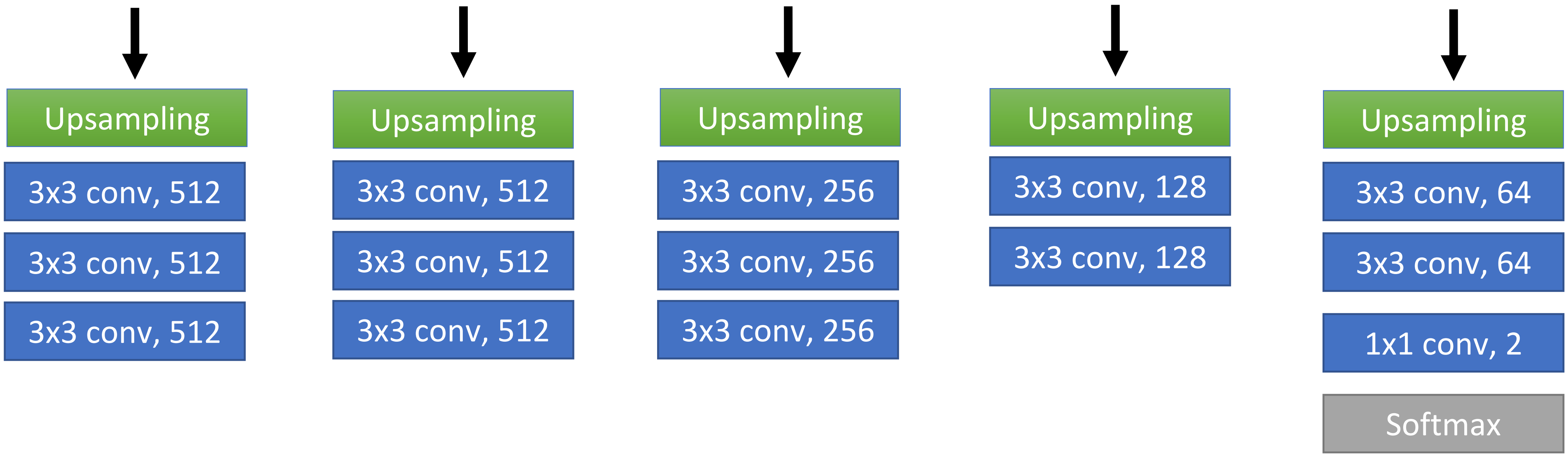


Figure 3: Decoder (Seg-net Decoder)

Challenges

We tried these approaches:

- Random Validation Data – 14 Images

  Outcome – Accuracy was highly fluctuating

- Custom Validation Data – 14 Images

  Outcome – Accuracy Increased & stabilized at 92%

- Pre-trained Weights for all layers

  Outcome – Accuracy increased to 95% - write it as in terms of transfer learning.

- Training Data – 500 Augmented Images + 100 Original Images

  Augmentations – Brightness, Noise, Blur, Perspective Change, Cloudy, Random Flip(up, down, right, left)

  Outcome – Accuracy dropped to 90%

Challenges

- Locked First few layers & End layer was free

  Outcome – Training Accuracy increased to 97%

  Validation Accuracy - 95%

Submission 1

0.64 IoU

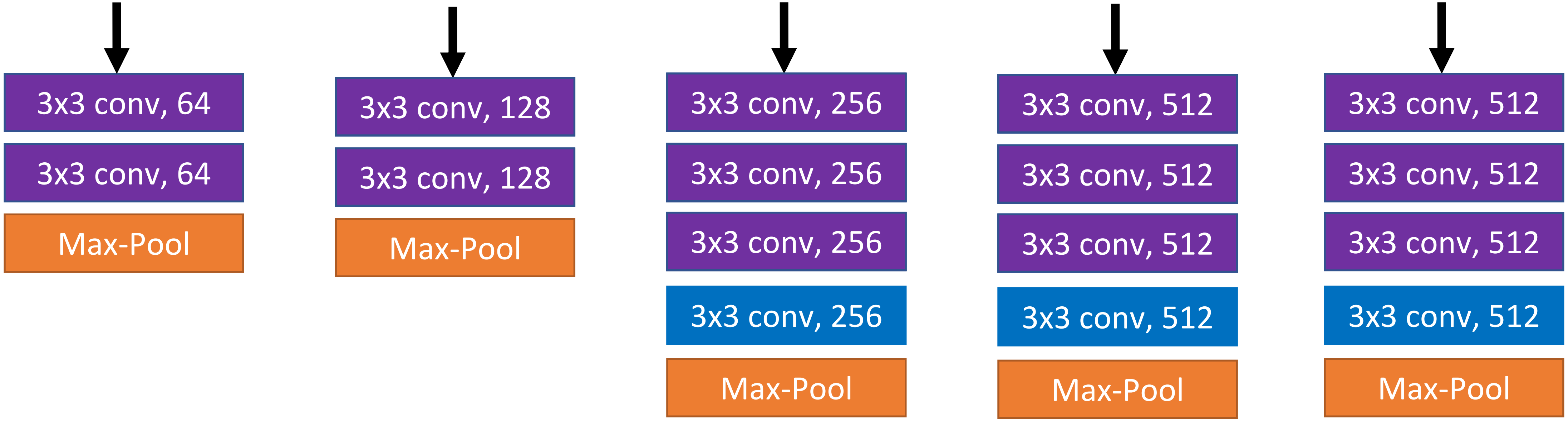


Figure 4: Layers locked in Vgg-19 Encoder

Challenges

- Free First & Last Layers

  Outcome – Training Accuracy increased to 97%

  Validation Accuracy - 95%

Submission 2

0.63 IoU

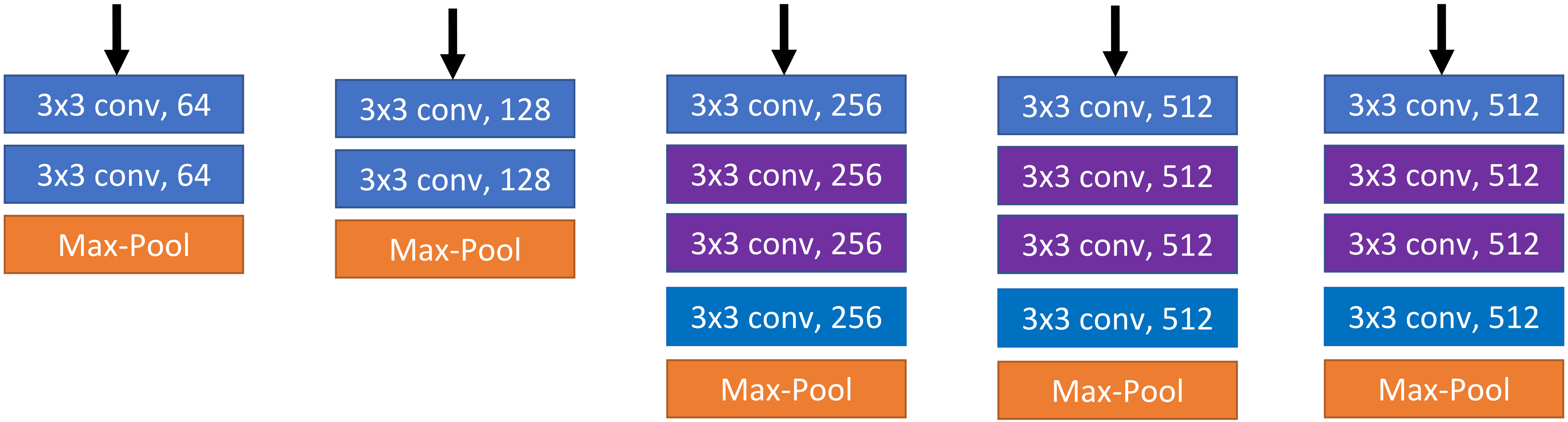


Figure 5: Layers locked in Vgg-19 Encoder

Challenges

- Unlocked all Layers
- Outcome – Training Accuracy Increased to 97%

  Validation Accuracy - 95%

Submission 3
0.68 IoU

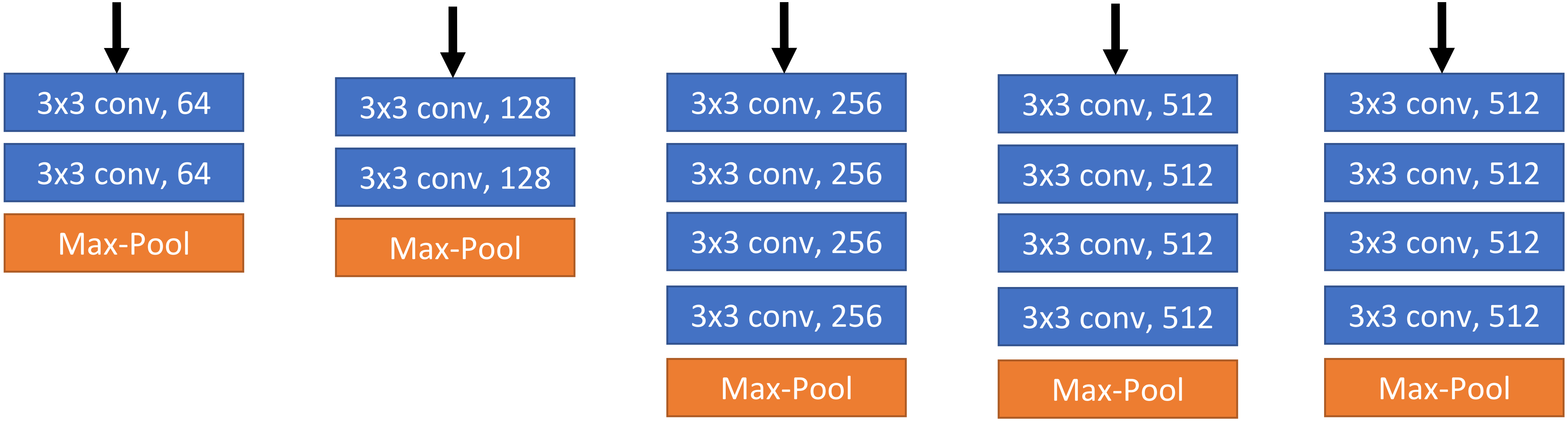


Figure 6: Layers unlocked in Vgg-19 Encoder

Best Model

- Pre-trained Weights
- No Augmented Images
- No Locked Training Layers

Metrics:

Optimizer – SGD
Loss – Mean Squared Error
Evaluation metric – accuracy

Configuration:

Epoch – 200
Steps per epoch – 2
Batch size - 4

Results

Reached

- **97%** training accuracy
- **0.689956 IoU** on test images

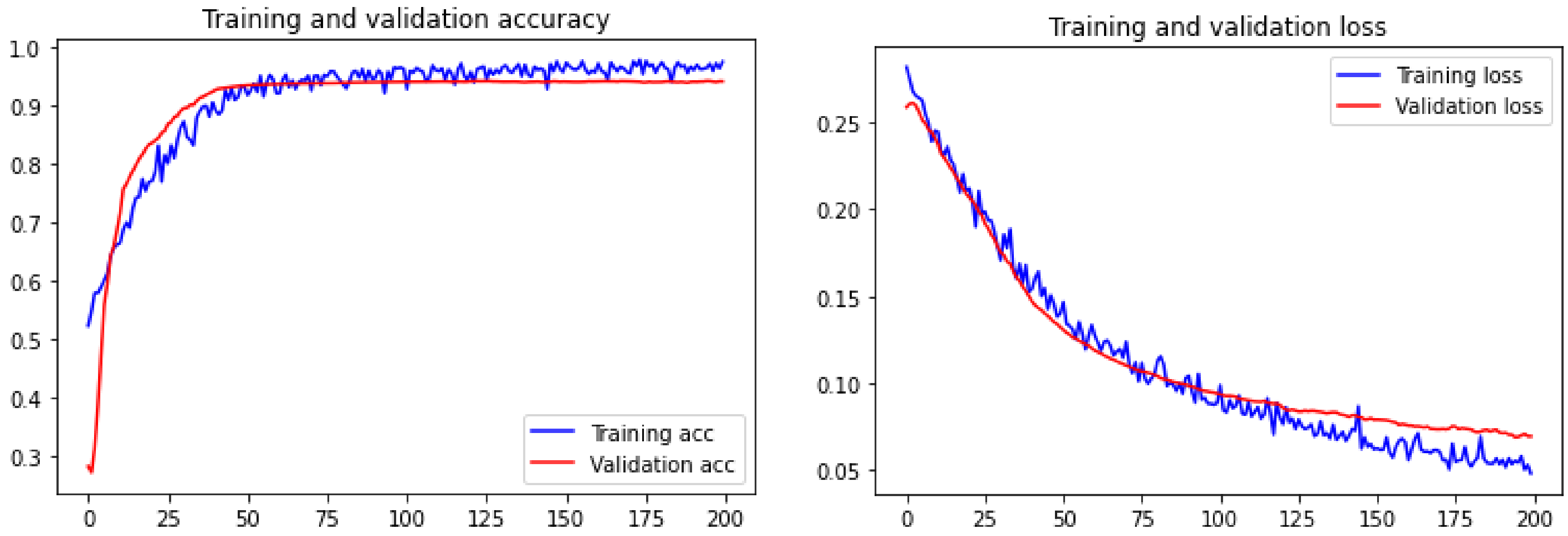


Figure 7: Accuracy over Epoch plot

Output

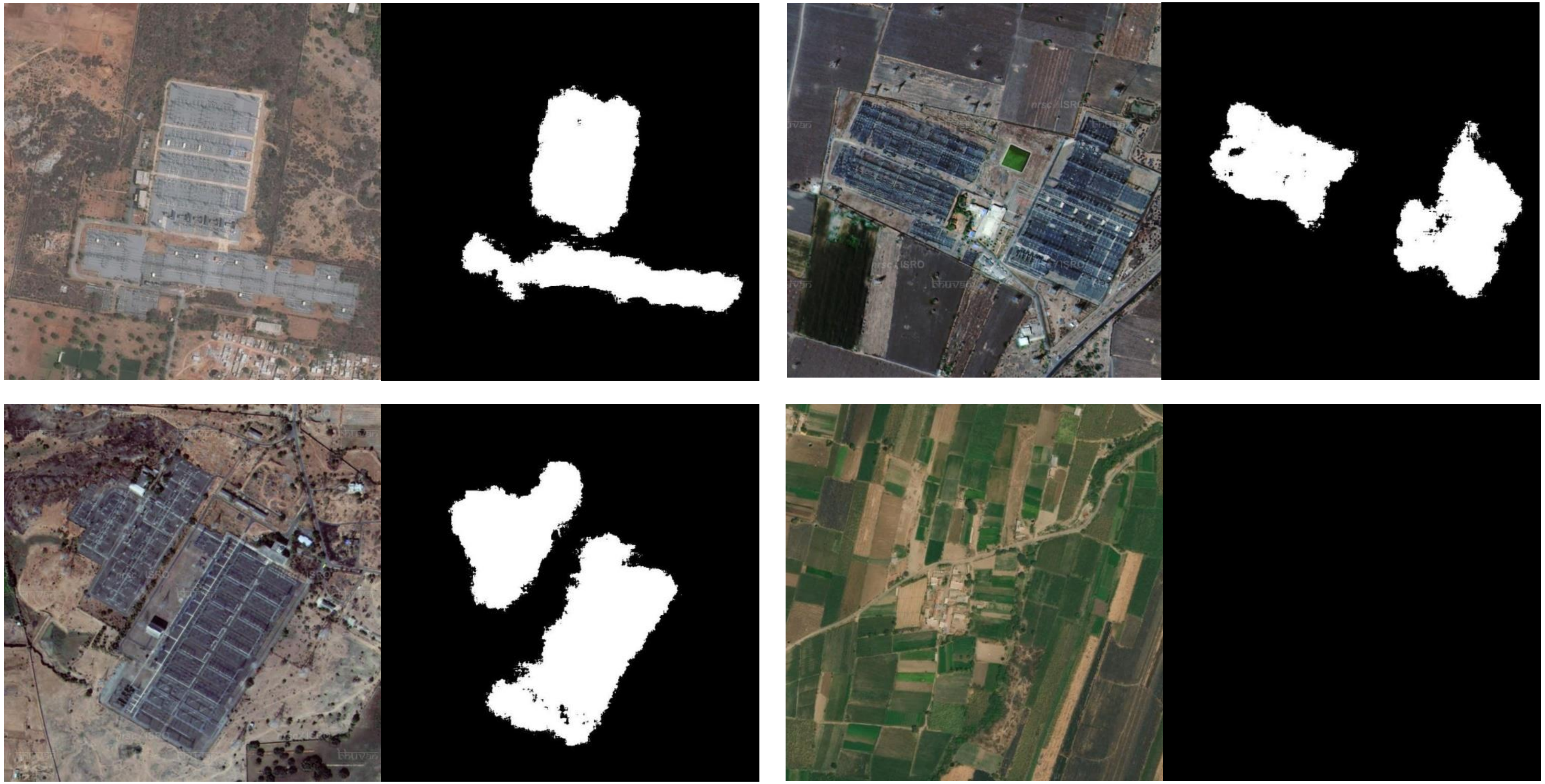


Figure 8: Input Images and its Output binary masks

Output

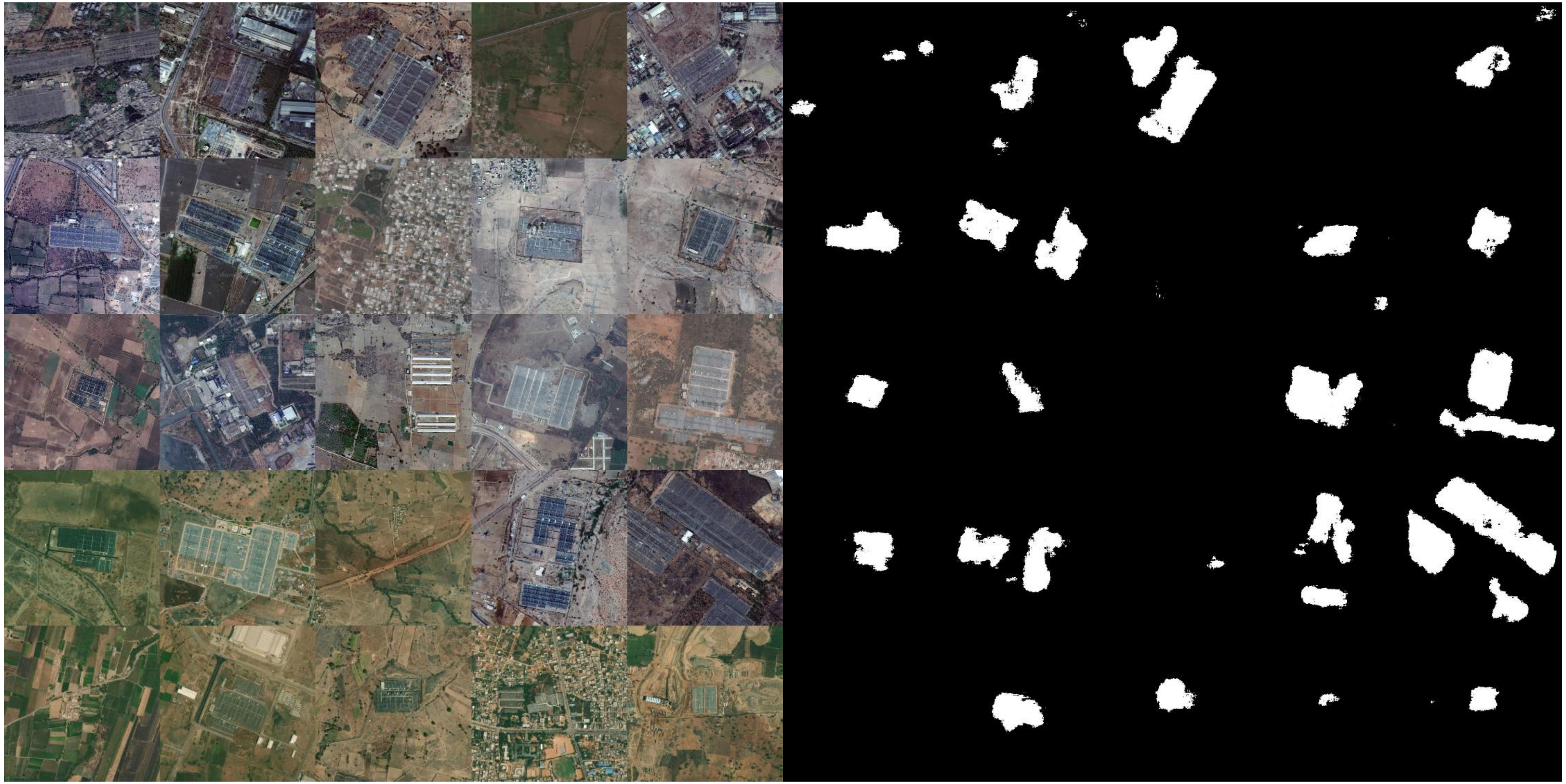


Figure 8: Input Image and its Output binary mask

Future Scope

- Augmentations to increase training samples (blur augmentation)
- Use of different pertained models as encoder i.e., AlexNet, GoogleNet
- Advanced loss function to remove blurred edges in the prediction
- Advanced Architectures – U-net, Mask-RCNN
- Extending from Electrical Substations to extracting Buildings

References

[1] Sajith Variyar, V.V., Soman, K.P., Adarsh Sasidharan. "Real-Time Speed Bump Detection Using Image Segmentation for Autonomous Vehicles." (2020)

[2] Sowmya, V., Anand, R., Vijaykrishna Menon., Gopalakrishnan, A., Soman, K.P. "Modified VGG deep-learning architecture for COVID-19 classification using chest radiography images." (2021)

Thank You...