Visual Computing Lab Mini Project 3
## Nitish Bhardwaj
B21AI056

➢ **Problem Statement:** Designing a convolutional neural network for performing segmentation task on road images using the Cityscapes Dataset, while transforming the masks to a definite number of classes of color encoding.

➢ **Dataset Details:**

○ **Regular Dataset:** Cityscapes dataset is used which consist of actual road images along with their corresponding masks. The dataset consists of masks in RGB format and the number of segmented classes is not fixed. Therefore, color encoding is being done using kmeans classifier. Now the number of classes is 12.
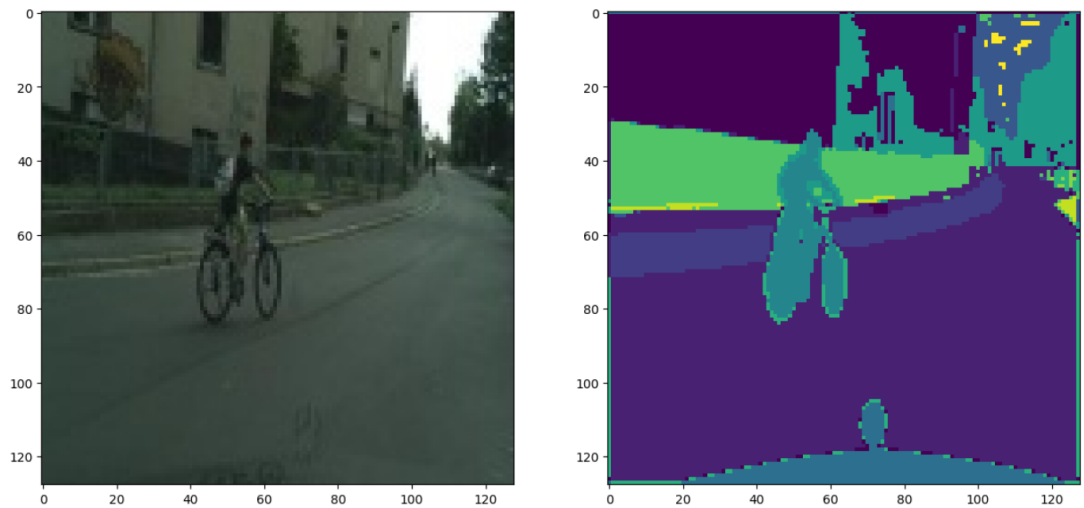

○ In order to handle changes in image capturing due to vehicular movement, random rotation in the range 0-25 degree was applied to dataset images and masks by the same amount, and gaussian noise of noise level 0.1 (on a scale of 1) was added to images. These changes were made to the dataset using two different libraries viz. Albumentations and OpenCV. Even with applying the same changes, the output images from these two libraries were quite different, hence dataset made using both libraries were used for training new model.

○ **Modified Dataset1**: Rotation and Noise changes applied using Albumentation library. Noise applied could be seen as a light red dot spread across the image. Image and mask rotated covered the whole frame.
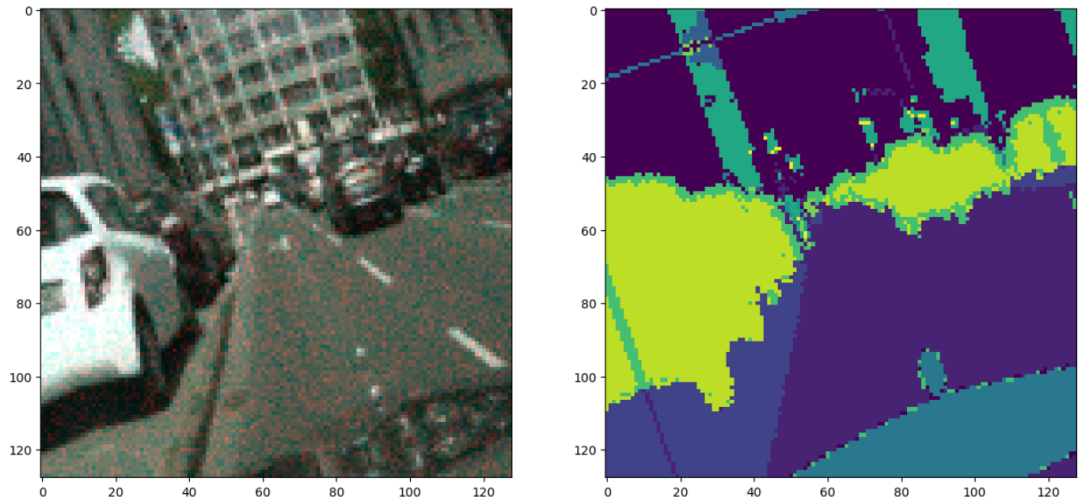
Using Albumentation

- ○ **Modified Dataset 2**: Rotation and Noise changes applied using OpenCV library. Noise applied can be seen as light bluish dots spread across the image. Images and masks rotated leaves black portion in the corners of the frames. (This dataset validation set is shared with the instructor as said in the instruction)
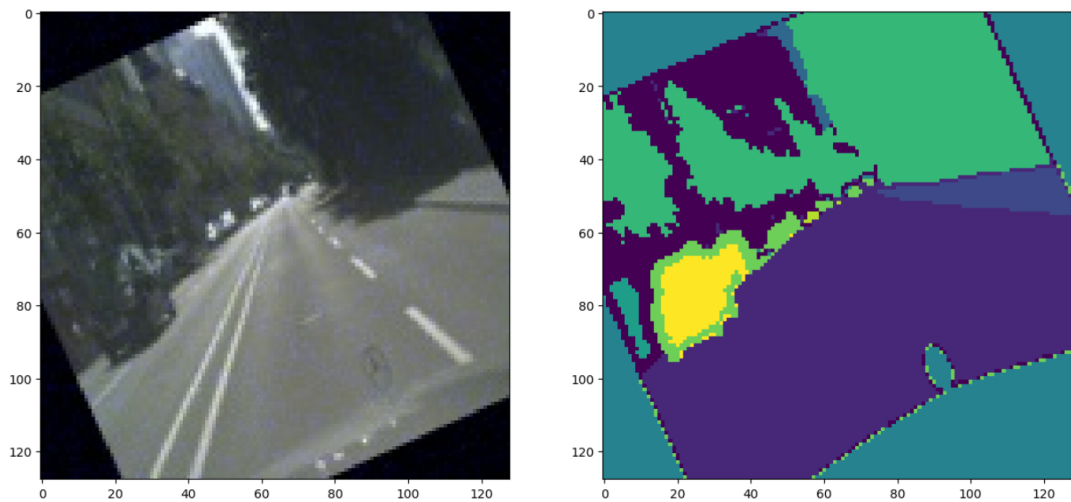
Using OpenCV

- ➤ **Accuracies and strategies reports**
  - ○ Regular model trained on regular dataset, modified model 1 trained on modified dataset1 and modified model 2 trained on modified dataset 2.
  - ○ **Validation IOU Accuracy for regular model on regular dataset:** 47.63%
  - ○ **Validation IOU Accuracy for regular model on modified dataset 1:** 25.68%

- **Validation IOU Accuracy for regular model on modified dataset 2:** 25.31%
- **Validation IOU Accuracy for modified model 1 on regular dataset:** 38.49%
- **Validation IOU Accuracy for modified model 1 on modified dataset 1:** 40.51%
- **Validation IOU Accuracy for modified model 2 on regular dataset:** 34.14%
- **Validation IOU Accuracy for modified model 2 on modified dataset 2:** 48.84%
- **Strategy used:** For both modified models, each model was trained from scratch on their respective modified datasets, without using learned weights of previous models, for the same number of 15 epochs as initial. In addition, for increasing the performance of the model, the batch size was reduced from 8 to 4 and SGD optimizer was used instead of Adams.
- In addition, an ensemble model of all three models described above was also tested. This model was found more robust to real life scenarios as could be seen in the performance chart below.
- **Performance chart**:

	Regular Model	Modified Model 1	Modified Model 2	Ensemble Model
Regular Dataset	47.63 %	38.49 %	34.14 %	45.33 %
Modified Dataset 1	25.68 %	40.51 %	16.79 %	30.51 %
Modified Dataset 2	25.31 %	22.12 %	48.84 %	42.10 %

All the models and modified dataset can be accessed at the link given below:
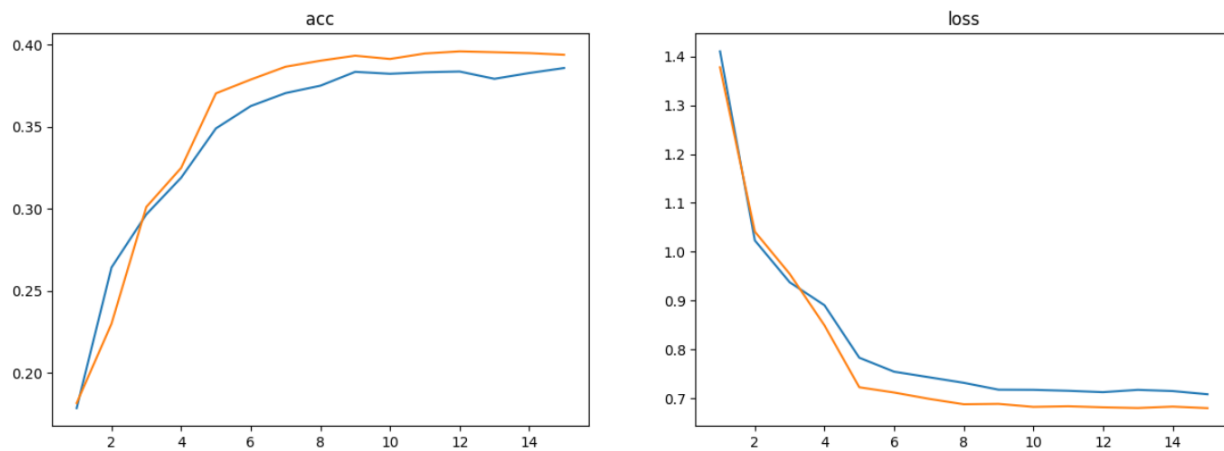
https://drive.google.com/drive/folders/14g77X0fYFhJOj4Rb2fX9ff2s68Kd20ai?usp=drive_link

➢ **Training and Validation Loss and IOU Accuracies**
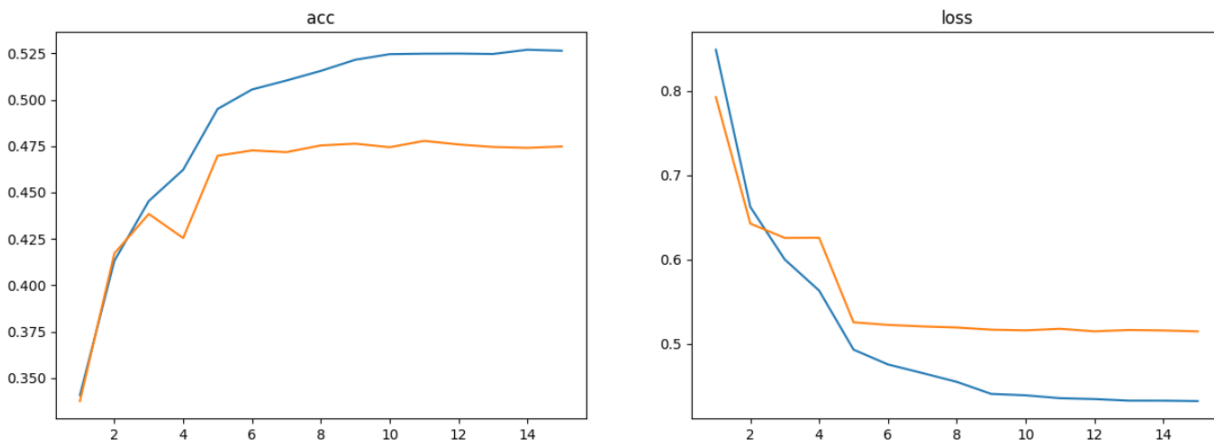 ○ **Regular model trained on Regular dataset**
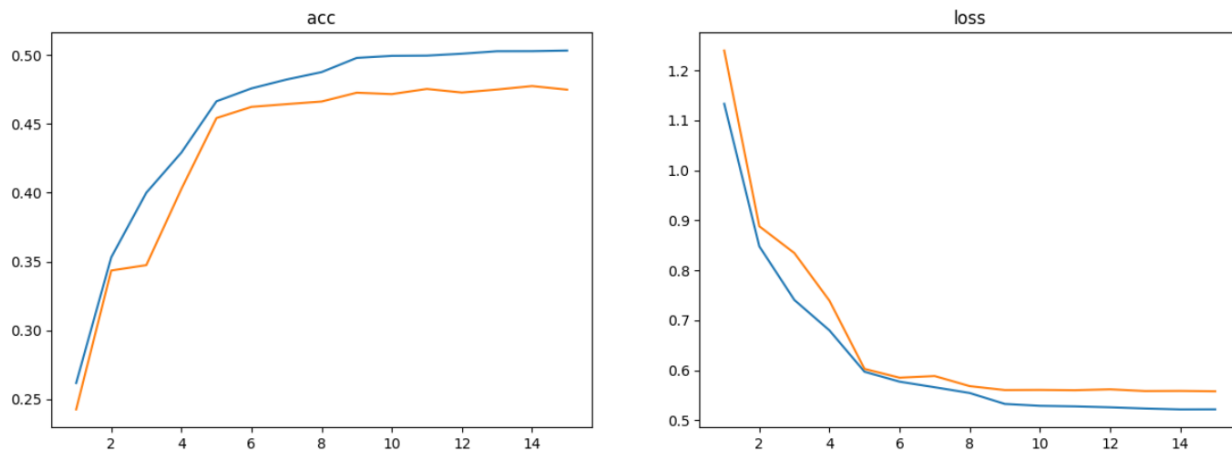
  ○ **Modified model 1 trained on modified dataset 1**

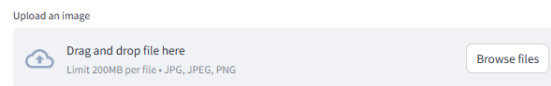 ○ **Modified model 2 trained on modified dataset 2**

(blue -train, orange -val)

➢ **Web Deployed model before and after predictions**
   ○ Models deployed on streamlit.
   ○ The segmentation application will give results of segmentation of all four models we discussed above.
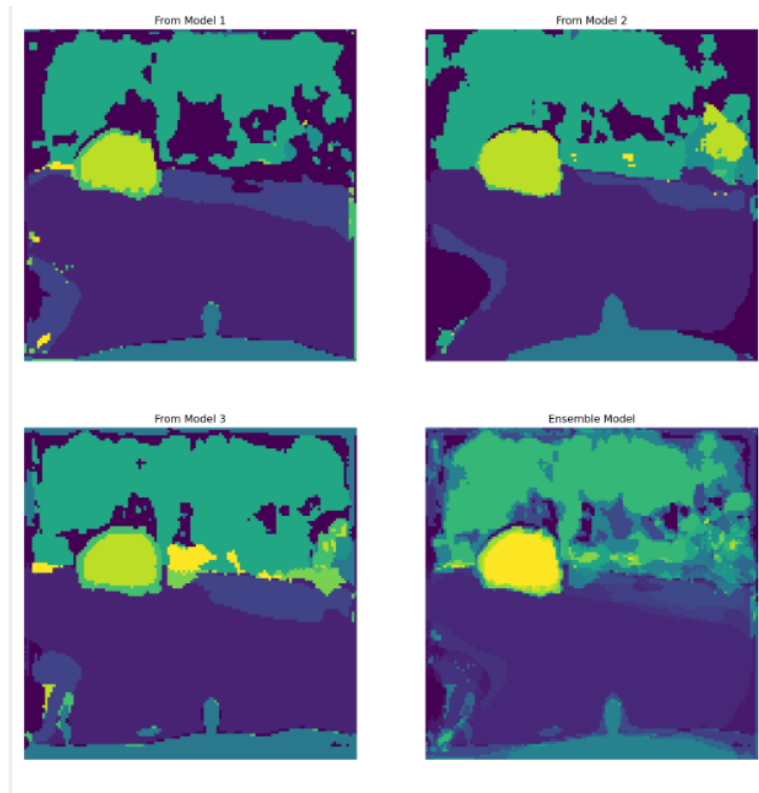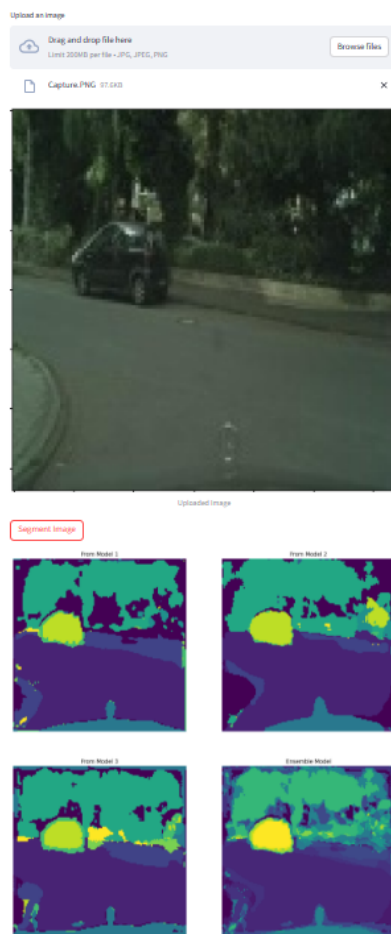   ○ **Before Prediction:**

   ○ **After Prediction:**

(Showing segmentation results)