Install the Requirements

- Install all the python dependencies
- After Installing dependencies, Restart the runtime. If you do not restart the runtime, the python will throw "module not found error"

```
!pip install -r road-detection/TwinLiteNet/requirements.txt
```

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Requirement already satisfied: certifi==2023.7.22 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 1)) (2023.7.22)
Requirement already satisfied: charset-normalizer==3.3.2 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 2)) (3.3.2)
Requirement already satisfied: colorama==0.4.6 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 3)) (0.4.6)
Requirement already satisfied: contourpy==1.2.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 4)) (1.2.0)
Requirement already satisfied: cycler==0.12.1 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 5)) (0.12.1)
Requirement already satisfied: dnspython==2.4.2 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 6)) (2.4.2)
Requirement already satisfied: elephant==0.12.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 7)) (0.12.0)
Requirement already satisfied: filelock==3.13.1 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 8)) (3.13.1)
Requirement already satisfied: fonttools==4.44.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 9)) (4.44.0)
Requirement already satisfied: fsspec==2023.10.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 10)) (2023.10.0)
Requirement already satisfied: idna==3.4 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 11)) (3.4)
Requirement already satisfied: Jinja2==3.1.2 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 12)) (3.1.2)
Requirement already satisfied: joblib==1.2.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 13)) (1.2.0)
Requirement already satisfied: kiwisolver==1.4.5 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 14)) (1.4.5)
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Requirement already satisfied: MarkupSafe==2.1.3 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 15)) (2.1.3)
Requirement already satisfied: matplotlib==3.7.1 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 16)) (3.7.1)
Requirement already satisfied: mpmath==1.3.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 17)) (1.3.0)
Requirement already satisfied: neo==0.12.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 18)) (0.12.0)
Requirement already satisfied: networkx==3.2.1 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 19)) (3.2.1)
Requirement already satisfied: numpy==1.24.3 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 20)) (1.24.3)
Requirement already satisfied: opencv-python==4.7.0.72 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 21)) (4.7.0.72)
Requirement already satisfied: packaging==23.2 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 22)) (23.2)
Requirement already satisfied: Pillow==9.5.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 23)) (9.5.0)
Requirement already satisfied: pyparsing==3.1.1 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 24)) (3.1.1)
Requirement already satisfied: python-dateutil==2.8.2 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 25)) (2.8.2)
Requirement already satisfied: python-etcd==0.4.5 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 26)) (0.4.5)
Requirement already satisfied: PyYAML==6.0.1 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 27)) (6.0.1)
Requirement already satisfied: quantities==0.14.1 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 28)) (0.14.1)
Requirement already satisfied: requests==2.31.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 29)) (2.31.0)
Requirement already satisfied: scikit-learn==1.3.2 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 30)) (1.3.2)
Requirement already satisfied: scipy==1.10.1 in
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/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 31)) (1.10.1)
Requirement already satisfied: six==1.16.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 32)) (1.16.0)
Requirement already satisfied: sympy==1.12 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 33)) (1.12)
Requirement already satisfied: threadpoolctl==3.2.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 34)) (3.2.0)
Requirement already satisfied: torch==2.1.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 35)) (2.1.0)
Requirement already satisfied: torchdata==0.7.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 36)) (0.7.0)
Requirement already satisfied: torchelastic==0.2.2 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 37)) (0.2.2)
Requirement already satisfied: torchtext==0.16.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 38)) (0.16.0)
Requirement already satisfied: torchvision==0.16.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 39)) (0.16.0)
Requirement already satisfied: tqdm==4.66.1 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 40)) (4.66.1)
Requirement already satisfied: typing_extensions==4.8.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 41)) (4.8.0)
Requirement already satisfied: urllib3==2.0.7 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 42)) (2.0.7)
Requirement already satisfied: webcolors==1.13 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 43)) (1.13)
Requirement already satisfied: yacs==0.1.8 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 44)) (0.1.8)
Requirement already satisfied: zipp==3.15.0 in
/usr/local/lib/python3.10/dist-packages (from -r
road-detection/TwinLiteNet/requirements.txt (line 45)) (3.15.0)
Requirement already satisfied: nvidia-cuda-nvrtc-cu12==12.1.105 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (12.1.105)
Requirement already satisfied: nvidia-cuda-runtime-cu12==12.1.105
in /usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r
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road-detection/TwinLiteNet/requirements.txt (line 35)) (12.1.105)
Requirement already satisfied: nvidia-cuda-cupti-cu12==12.1.105 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (12.1.105)
Requirement already satisfied: nvidia-cudnn-cu12==8.9.2.26 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (8.9.2.26)
Requirement already satisfied: nvidia-cublas-cu12==12.1.3.1 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (12.1.3.1)
Requirement already satisfied: nvidia-cufft-cu12==11.0.2.54 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (11.0.2.54)
Requirement already satisfied: nvidia-curand-cu12==10.3.2.106 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (10.3.2.106)
Requirement already satisfied: nvidia-cusolver-cu12==11.4.5.107 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (11.4.5.107)
Requirement already satisfied: nvidia-cusparse-cu12==12.1.0.106 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (12.1.0.106)
Requirement already satisfied: nvidia-nccl-cu12==2.18.1 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (2.18.1)
Requirement already satisfied: nvidia-nvtx-cu12==12.1.105 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (12.1.105)
Requirement already satisfied: triton==2.1.0 in
/usr/local/lib/python3.10/dist-packages (from torch==2.1.0->-r road-
detection/TwinLiteNet/requirements.txt (line 35)) (2.1.0)
Requirement already satisfied: nvidia-nvjitlink-cu12 in
/usr/local/lib/python3.10/dist-packages (from nvidia-cusolver-
cu12==11.4.5.107->torch==2.1.0->-r
road-detection/TwinLiteNet/requirements.txt (line 35)) (12.4.127)
```

Copy Dataset from Repository

- Our repository contains dataset.zip in datasets folder in the repository. copy that zip file to root

```
!cp road-detection/datasets/dataset.zip ./
```

Unzip the file

```
!unzip dataset.zip

Archive:  dataset.zip
   creating: dataset/test/
   creating: dataset/test/images/
```

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  inflating: dataset/test/images/road_image_160.png
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  inflating: dataset/test/images/road_image_162.png
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  inflating: dataset/test/lane/road_image_160.png
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   creating: dataset/train/
   creating: dataset/train/images/
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  inflating: dataset/train/images/road_image_87.png
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  inflating: dataset/train/images/road_image_89.png
  inflating: dataset/train/images/road_image_9.png
  inflating: dataset/train/images/road_image_90.png
  inflating: dataset/train/images/road_image_91.png
  inflating: dataset/train/images/road_image_92.png
  inflating: dataset/train/images/road_image_93.png
  inflating: dataset/train/images/road_image_94.png
  inflating: dataset/train/images/road_image_95.png
  inflating: dataset/train/images/road_image_96.png
  inflating: dataset/train/images/road_image_97.png
  inflating: dataset/train/images/road_image_98.png
  inflating: dataset/train/images/road_image_99.png
   creating: dataset/train/lane/
  inflating: dataset/train/lane/road_image_0.png
  inflating: dataset/train/lane/road_image_1.png
  inflating: dataset/train/lane/road_image_10.png
  inflating: dataset/train/lane/road_image_100.png
  inflating: dataset/train/lane/road_image_101.png
  inflating: dataset/train/lane/road_image_102.png
  inflating: dataset/train/lane/road_image_103.png
  inflating: dataset/train/lane/road_image_104.png
  inflating: dataset/train/lane/road_image_105.png
  inflating: dataset/train/lane/road_image_106.png
  inflating: dataset/train/lane/road_image_107.png
  inflating: dataset/train/lane/road_image_108.png
  inflating: dataset/train/lane/road_image_109.png
  inflating: dataset/train/lane/road_image_11.png
  inflating: dataset/train/lane/road_image_110.png
  inflating: dataset/train/lane/road_image_111.png
  inflating: dataset/train/lane/road_image_112.png
  inflating: dataset/train/lane/road_image_113.png
  inflating: dataset/train/lane/road_image_114.png
  inflating: dataset/train/lane/road_image_115.png
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  inflating: dataset/train/lane/road_image_116.png
  inflating: dataset/train/lane/road_image_117.png
  inflating: dataset/train/lane/road_image_118.png
  inflating: dataset/train/lane/road_image_119.png
  inflating: dataset/train/lane/road_image_12.png
  inflating: dataset/train/lane/road_image_120.png
  inflating: dataset/train/lane/road_image_121.png
  inflating: dataset/train/lane/road_image_122.png
  inflating: dataset/train/lane/road_image_123.png
  inflating: dataset/train/lane/road_image_124.png
  inflating: dataset/train/lane/road_image_125.png
  inflating: dataset/train/lane/road_image_126.png
  inflating: dataset/train/lane/road_image_127.png
  inflating: dataset/train/lane/road_image_128.png
  inflating: dataset/train/lane/road_image_129.png
  inflating: dataset/train/lane/road_image_13.png
  inflating: dataset/train/lane/road_image_130.png
  inflating: dataset/train/lane/road_image_131.png
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  inflating: dataset/train/lane/road_image_14.png
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  inflating: dataset/train/lane/road_image_144.png
  inflating: dataset/train/lane/road_image_145.png
  inflating: dataset/train/lane/road_image_146.png
  inflating: dataset/train/lane/road_image_147.png
  inflating: dataset/train/lane/road_image_148.png
  inflating: dataset/train/lane/road_image_149.png
  inflating: dataset/train/lane/road_image_15.png
  inflating: dataset/train/lane/road_image_150.png
  inflating: dataset/train/lane/road_image_151.png
  inflating: dataset/train/lane/road_image_152.png
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  inflating: dataset/train/lane/road_image_158.png
  inflating: dataset/train/lane/road_image_159.png
  inflating: dataset/train/lane/road_image_16.png
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  inflating: dataset/train/lane/road_image_17.png
  inflating: dataset/train/lane/road_image_18.png
  inflating: dataset/train/lane/road_image_19.png
  inflating: dataset/train/lane/road_image_2.png
  inflating: dataset/train/lane/road_image_20.png
  inflating: dataset/train/lane/road_image_21.png
  inflating: dataset/train/lane/road_image_22.png
  inflating: dataset/train/lane/road_image_23.png
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  inflating: dataset/train/lane/road_image_26.png
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  inflating: dataset/train/lane/road_image_28.png
  inflating: dataset/train/lane/road_image_29.png
  inflating: dataset/train/lane/road_image_3.png
  inflating: dataset/train/lane/road_image_30.png
  inflating: dataset/train/lane/road_image_31.png
  inflating: dataset/train/lane/road_image_32.png
  inflating: dataset/train/lane/road_image_33.png
  inflating: dataset/train/lane/road_image_34.png
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  inflating: dataset/train/lane/road_image_36.png
  inflating: dataset/train/lane/road_image_37.png
  inflating: dataset/train/lane/road_image_38.png
  inflating: dataset/train/lane/road_image_39.png
  inflating: dataset/train/lane/road_image_4.png
  inflating: dataset/train/lane/road_image_40.png
  inflating: dataset/train/lane/road_image_41.png
  inflating: dataset/train/lane/road_image_42.png
  inflating: dataset/train/lane/road_image_43.png
  inflating: dataset/train/lane/road_image_44.png
  inflating: dataset/train/lane/road_image_45.png
  inflating: dataset/train/lane/road_image_46.png
  inflating: dataset/train/lane/road_image_47.png
  inflating: dataset/train/lane/road_image_48.png
  inflating: dataset/train/lane/road_image_49.png
  inflating: dataset/train/lane/road_image_5.png
  inflating: dataset/train/lane/road_image_50.png
  inflating: dataset/train/lane/road_image_51.png
  inflating: dataset/train/lane/road_image_52.png
  inflating: dataset/train/lane/road_image_53.png
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  inflating: dataset/train/lane/road_image_58.png
  inflating: dataset/train/lane/road_image_59.png
  inflating: dataset/train/lane/road_image_6.png
  inflating: dataset/train/lane/road_image_60.png
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  inflating: dataset/train/lane/road_image_61.png
  inflating: dataset/train/lane/road_image_62.png
  inflating: dataset/train/lane/road_image_63.png
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  inflating: dataset/train/lane/road_image_66.png
  inflating: dataset/train/lane/road_image_67.png
  inflating: dataset/train/lane/road_image_68.png
  inflating: dataset/train/lane/road_image_69.png
  inflating: dataset/train/lane/road_image_7.png
  inflating: dataset/train/lane/road_image_70.png
  inflating: dataset/train/lane/road_image_71.png
  inflating: dataset/train/lane/road_image_72.png
  inflating: dataset/train/lane/road_image_73.png
  inflating: dataset/train/lane/road_image_74.png
  inflating: dataset/train/lane/road_image_75.png
  inflating: dataset/train/lane/road_image_76.png
  inflating: dataset/train/lane/road_image_77.png
  inflating: dataset/train/lane/road_image_78.png
  inflating: dataset/train/lane/road_image_79.png
  inflating: dataset/train/lane/road_image_8.png
  inflating: dataset/train/lane/road_image_80.png
  inflating: dataset/train/lane/road_image_81.png
  inflating: dataset/train/lane/road_image_82.png
  inflating: dataset/train/lane/road_image_83.png
  inflating: dataset/train/lane/road_image_84.png
  inflating: dataset/train/lane/road_image_85.png
  inflating: dataset/train/lane/road_image_86.png
  inflating: dataset/train/lane/road_image_87.png
  inflating: dataset/train/lane/road_image_88.png
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  inflating: dataset/train/lane/road_image_9.png
  inflating: dataset/train/lane/road_image_90.png
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  inflating: dataset/train/lane/road_image_93.png
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  inflating: dataset/train/lane/road_image_96.png
  inflating: dataset/train/lane/road_image_97.png
  inflating: dataset/train/lane/road_image_98.png
  inflating: dataset/train/lane/road_image_99.png
   creating: dataset/train/segments/
  inflating: dataset/train/segments/road_image_0.png
  inflating: dataset/train/segments/road_image_1.png
  inflating: dataset/train/segments/road_image_10.png
  inflating: dataset/train/segments/road_image_100.png
  inflating: dataset/train/segments/road_image_101.png
  inflating: dataset/train/segments/road_image_102.png
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  inflating: dataset/train/segments/road_image_103.png
  inflating: dataset/train/segments/road_image_104.png
  inflating: dataset/train/segments/road_image_105.png
  inflating: dataset/train/segments/road_image_106.png
  inflating: dataset/train/segments/road_image_107.png
  inflating: dataset/train/segments/road_image_108.png
  inflating: dataset/train/segments/road_image_109.png
  inflating: dataset/train/segments/road_image_11.png
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  inflating: dataset/train/segments/road_image_112.png
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  inflating: dataset/train/segments/road_image_117.png
  inflating: dataset/train/segments/road_image_118.png
  inflating: dataset/train/segments/road_image_119.png
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  inflating: dataset/train/segments/road_image_120.png
  inflating: dataset/train/segments/road_image_121.png
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  inflating: dataset/train/segments/road_image_127.png
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  inflating: dataset/train/segments/road_image_130.png
  inflating: dataset/train/segments/road_image_131.png
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  inflating: dataset/train/segments/road_image_141.png
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  inflating: dataset/train/segments/road_image_146.png
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  inflating: dataset/train/segments/road_image_148.png
  inflating: dataset/train/segments/road_image_149.png
  inflating: dataset/train/segments/road_image_15.png
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  inflating: dataset/train/segments/road_image_152.png
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  inflating: dataset/train/segments/road_image_19.png
  inflating: dataset/train/segments/road_image_2.png
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  inflating: dataset/train/segments/road_image_4.png
  inflating: dataset/train/segments/road_image_40.png
  inflating: dataset/train/segments/road_image_41.png
  inflating: dataset/train/segments/road_image_42.png
  inflating: dataset/train/segments/road_image_43.png
  inflating: dataset/train/segments/road_image_44.png
  inflating: dataset/train/segments/road_image_45.png
  inflating: dataset/train/segments/road_image_46.png
  inflating: dataset/train/segments/road_image_47.png
  inflating: dataset/train/segments/road_image_48.png
  inflating: dataset/train/segments/road_image_49.png
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  inflating: dataset/train/segments/road_image_5.png
  inflating: dataset/train/segments/road_image_50.png
  inflating: dataset/train/segments/road_image_51.png
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  inflating: dataset/train/segments/road_image_6.png
  inflating: dataset/train/segments/road_image_60.png
  inflating: dataset/train/segments/road_image_61.png
  inflating: dataset/train/segments/road_image_62.png
  inflating: dataset/train/segments/road_image_63.png
  inflating: dataset/train/segments/road_image_64.png
  inflating: dataset/train/segments/road_image_65.png
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  inflating: dataset/train/segments/road_image_67.png
  inflating: dataset/train/segments/road_image_68.png
  inflating: dataset/train/segments/road_image_69.png
  inflating: dataset/train/segments/road_image_7.png
  inflating: dataset/train/segments/road_image_70.png
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  inflating: dataset/train/segments/road_image_73.png
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  inflating: dataset/train/segments/road_image_75.png
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  inflating: dataset/train/segments/road_image_78.png
  inflating: dataset/train/segments/road_image_79.png
  inflating: dataset/train/segments/road_image_8.png
  inflating: dataset/train/segments/road_image_80.png
  inflating: dataset/train/segments/road_image_81.png
  inflating: dataset/train/segments/road_image_82.png
  inflating: dataset/train/segments/road_image_83.png
  inflating: dataset/train/segments/road_image_84.png
  inflating: dataset/train/segments/road_image_85.png
  inflating: dataset/train/segments/road_image_86.png
  inflating: dataset/train/segments/road_image_87.png
  inflating: dataset/train/segments/road_image_88.png
  inflating: dataset/train/segments/road_image_89.png
  inflating: dataset/train/segments/road_image_9.png
  inflating: dataset/train/segments/road_image_90.png
  inflating: dataset/train/segments/road_image_91.png
  inflating: dataset/train/segments/road_image_92.png
  inflating: dataset/train/segments/road_image_93.png
```

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  inflating: dataset/train/segments/road_image_94.png
  inflating: dataset/train/segments/road_image_95.png
  inflating: dataset/train/segments/road_image_96.png
  inflating: dataset/train/segments/road_image_97.png
  inflating: dataset/train/segments/road_image_98.png
  inflating: dataset/train/segments/road_image_99.png
   creating: dataset/validation/
   creating: dataset/validation/images/
  inflating: dataset/validation/images/road_image_180.png
  inflating: dataset/validation/images/road_image_181.png
  inflating: dataset/validation/images/road_image_182.png
  inflating: dataset/validation/images/road_image_183.png
  inflating: dataset/validation/images/road_image_184.png
  inflating: dataset/validation/images/road_image_185.png
  inflating: dataset/validation/images/road_image_186.png
  inflating: dataset/validation/images/road_image_187.png
  inflating: dataset/validation/images/road_image_188.png
  inflating: dataset/validation/images/road_image_189.png
  inflating: dataset/validation/images/road_image_190.png
  inflating: dataset/validation/images/road_image_191.png
  inflating: dataset/validation/images/road_image_192.png
  inflating: dataset/validation/images/road_image_193.png
  inflating: dataset/validation/images/road_image_194.png
  inflating: dataset/validation/images/road_image_195.png
  inflating: dataset/validation/images/road_image_196.png
  inflating: dataset/validation/images/road_image_197.png
  inflating: dataset/validation/images/road_image_198.png
  inflating: dataset/validation/images/road_image_199.png
   creating: dataset/validation/lane/
  inflating: dataset/validation/lane/road_image_180.png
  inflating: dataset/validation/lane/road_image_181.png
  inflating: dataset/validation/lane/road_image_182.png
  inflating: dataset/validation/lane/road_image_183.png
  inflating: dataset/validation/lane/road_image_184.png
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  inflating: dataset/validation/lane/road_image_191.png
  inflating: dataset/validation/lane/road_image_192.png
  inflating: dataset/validation/lane/road_image_193.png
  inflating: dataset/validation/lane/road_image_194.png
  inflating: dataset/validation/lane/road_image_195.png
  inflating: dataset/validation/lane/road_image_196.png
  inflating: dataset/validation/lane/road_image_197.png
  inflating: dataset/validation/lane/road_image_198.png
  inflating: dataset/validation/lane/road_image_199.png
```

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   creating: dataset/validation/segments/
  inflating: dataset/validation/segments/road_image_180.png
  inflating: dataset/validation/segments/road_image_181.png
  inflating: dataset/validation/segments/road_image_182.png
  inflating: dataset/validation/segments/road_image_183.png
  inflating: dataset/validation/segments/road_image_184.png
  inflating: dataset/validation/segments/road_image_185.png
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  inflating: dataset/validation/segments/road_image_187.png
  inflating: dataset/validation/segments/road_image_188.png
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  inflating: dataset/validation/segments/road_image_190.png
  inflating: dataset/validation/segments/road_image_191.png
  inflating: dataset/validation/segments/road_image_192.png
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  inflating: dataset/validation/segments/road_image_195.png
  inflating: dataset/validation/segments/road_image_196.png
  inflating: dataset/validation/segments/road_image_197.png
  inflating: dataset/validation/segments/road_image_198.png
  inflating: dataset/validation/segments/road_image_199.png
```

Import the all the required libraries

```
import torch
import cv2
import torch.utils.data
import torchvision.transforms as transforms
import numpy as np
import os
import random
import math
from matplotlib import pyplot as plt
import torch.nn as nn
```

Image transformation functions

- By paper author

```
def augment_hsv(img, hgain=0.015, sgain=0.7, vgain=0.4):
    """change color hue, saturation, value"""
    r = np.random.uniform(-1, 1, 3) * [hgain, sgain, vgain] + 1  # 
random gains
    hue, sat, val = cv2.split(cv2.cvtColor(img, cv2.COLOR_BGR2HSV))
    dtype = img.dtype  # uint8

    x = np.arange(0, 256, dtype=np.int16)
    lut_hue = ((x * r[0]) % 180).astype(dtype)
    lut_sat = np.clip(x * r[1], 0, 255).astype(dtype)
    lut_val = np.clip(x * r[2], 0, 255).astype(dtype)
```

```
    img_hsv = cv2.merge((cv2.LUT(hue, lut_hue), cv2.LUT(sat, lut_sat),
cv2.LUT(val, lut_val))).astype(dtype)
    cv2.cvtColor(img_hsv, cv2.COLOR_HSV2BGR, dst=img)  # no return
needed

def random_perspective(combination,  degrees=10, translate=.1,
scale=.1, shear=10, perspective=0.0, border=(0, 0)):
    """combination of img transform"""
    # torchvision.transforms.RandomAffine(degrees=(-10, 10),
translate=(.1, .1), scale=(.9, 1.1), shear=(-10, 10))
    # targets = [cls, xyxy]
    img, gray, line = combination
    height = img.shape[0] + border[0] * 2  # shape(h,w,c)
    width = img.shape[1] + border[1] * 2

    # Center
    C = np.eye(3)
    C[0, 2] = -img.shape[1] / 2  # x translation (pixels)
    C[1, 2] = -img.shape[0] / 2  # y translation (pixels)

    # Perspective
    P = np.eye(3)
    P[2, 0] = random.uniform(-perspective, perspective)  # x
perspective (about y)
    P[2, 1] = random.uniform(-perspective, perspective)  # y
perspective (about x)

    # Rotation and Scale
    R = np.eye(3)
    a = random.uniform(-degrees, degrees)
    # a += random.choice([-180, -90, 0, 90])  # add 90deg rotations to
small rotations
    s = random.uniform(1 - scale, 1 + scale)
    # s = 2 ** random.uniform(-scale, scale)
    R[:2] = cv2.getRotationMatrix2D(angle=a, center=(0, 0), scale=s)

    # Shear
    S = np.eye(3)
    S[0, 1] = math.tan(random.uniform(-shear, shear) * math.pi / 180)
# x shear (deg)
    S[1, 0] = math.tan(random.uniform(-shear, shear) * math.pi / 180)
# y shear (deg)

    # Translation
    T = np.eye(3)
    T[0, 2] = random.uniform(0.5 - translate, 0.5 + translate) * width
# x translation (pixels)
    T[1, 2] = random.uniform(0.5 - translate, 0.5 + translate) *
height  # y translation (pixels)
```

```
    # Combined rotation matrix
    M = T @ S @ R @ P @ C  # order of operations (right to left) is
IMPORTANT
    if (border[0] != 0) or (border[1] != 0) or (M != np.eye(3)).any():
# image changed
        if perspective:
            img = cv2.warpPerspective(img, M, dsize=(width, height),
borderValue=(114, 114, 114))
            gray = cv2.warpPerspective(gray, M, dsize=(width, height),
borderValue=0)
            line = cv2.warpPerspective(line, M, dsize=(width, height),
borderValue=0)
        else:  # affine
            img = cv2.warpAffine(img, M[:2], dsize=(width, height),
borderValue=(114, 114, 114))
            gray = cv2.warpAffine(gray, M[:2], dsize=(width, height),
borderValue=0)
            line = cv2.warpAffine(line, M[:2], dsize=(width, height),
borderValue=0)



    combination = (img, gray, line)
    return combination
```

Custom Dataset Class

- This custom dataset class is based on the dataset class written by the author but with slight modifications like path. we have adjusted the path according to the google colab.

```
class MyDataset(torch.utils.data.Dataset):
    '''
    Class to load the dataset
    '''
    def __init__(self, transform=None, valid=False, test=False):
        '''
        :param imList: image list (Note that these lists have been
processed and pickled using the loadData.py)
        :param labelList: label list (Note that these lists have been
processed and pickled using the loadData.py)
        :param transform: Type of transformation. SEe Transforms.py
for supported transformations
        '''

        self.transform = transform
        self.Tensor = transforms.ToTensor()
        self.valid=valid
        if valid:
            self.root='dataset/validation/images'
```

```
            self.names=os.listdir(self.root)
        elif test:
            self.root='dataset/test/images'
            self.names=os.listdir(self.root)
        else:
            self.root='dataset/train/images/'
            self.names=os.listdir(self.root)

    def __len__(self):
        return len(self.names)

    def __getitem__(self, idx):
        '''

        :param idx: Index of the image file
        :return: returns the image and corresponding label file.
        '''
        W_=640
        H_=360
        image_name=os.path.join(self.root,self.names[idx])

        image = cv2.imread(image_name)
        original_image = cv2.imread(image_name)
        label1 =
cv2.imread(image_name.replace("images","segments").replace("jpg","png"
), 0)
        label2 =
cv2.imread(image_name.replace("images","lane").replace("jpg","png"),
0)
        if not self.valid:
            if random.random()<0.5:
                combination = (image, label1, label2)
                (image, label1, label2)= random_perspective(
                    combination=combination,
                    degrees=10,
                    translate=0.1,
                    scale=0.25,
                    shear=0.0
                )
            if random.random()<0.5:
                augment_hsv(image)
            if random.random() < 0.5:
                image = np.fliplr(image)
                label1 = np.fliplr(label1)
                label2 = np.fliplr(label2)

        label1 = cv2.resize(label1, (W_, H_))
        label2 = cv2.resize(label2, (W_, H_))
        image = cv2.resize(image, (W_, H_))
```

```
        _,seg_b1 = cv2.threshold(label1,1,255,cv2.THRESH_BINARY_INV)
        _,seg_b2 = cv2.threshold(label2,1,255,cv2.THRESH_BINARY_INV)
        _,seg1 = cv2.threshold(label1,1,255,cv2.THRESH_BINARY)
        _,seg2 = cv2.threshold(label2,1,255,cv2.THRESH_BINARY)

        seg1 = self.Tensor(seg1)
        seg2 = self.Tensor(seg2)
        seg_b1 = self.Tensor(seg_b1)
        seg_b2 = self.Tensor(seg_b2)
        seg_da = torch.stack((seg_b1[0], seg1[0]),0)
        seg_ll = torch.stack((seg_b2[0], seg2[0]),0)
        image = image[:, :, ::-1].transpose(2, 0, 1)
        image = np.ascontiguousarray(image)

        return original_image, image_name,torch.from_numpy(image),
(seg_da,seg_ll)
```

Intialize a dataloader

- Intialize a dataloader with batch size 8
- Intialize train, test, validation datasets.

```
from torch.utils.data import DataLoader

train_dataloader = DataLoader(MyDataset(), batch_size = 8, shuffle =
True)
test_dataloader = DataLoader(MyDataset(test=True), batch_size = 8,
shuffle = True)
val_dataloader = DataLoader(MyDataset(valid=True), batch_size = 8,
shuffle = True)
```

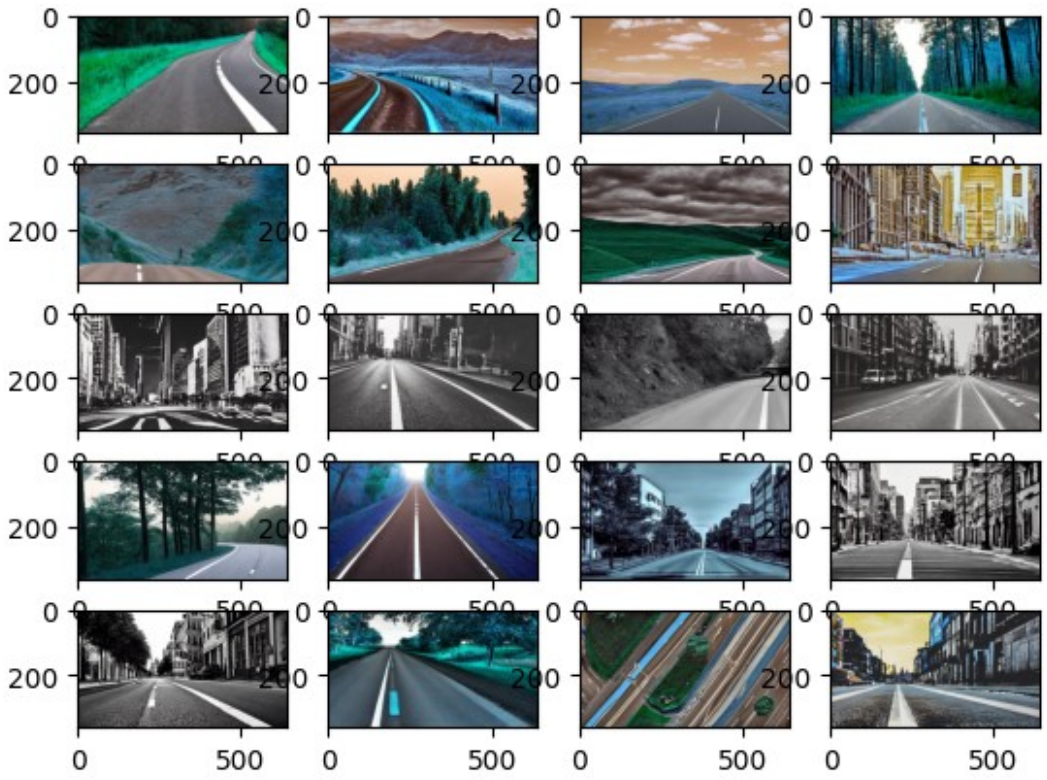
Display images

- Show first sample of each mini-batch with size 8

```
# Printing the first sample of the each minibatch of size 8

plt.figure(figsize = (100, 100))

f, axarr = plt.subplots(5, 4)
i = 0
j = 0

for batch in train_dataloader:
  original_image, image_name, input, target = batch
  print(image_name[0])
  axarr[i, j].imshow(original_image[0])
  j += 1
  if j%4 == 0:
```

```
    i += 1
    j = 0

plt.show()
```

```
dataset/train/images/road_image_61.png
dataset/train/images/road_image_47.png
dataset/train/images/road_image_42.png
dataset/train/images/road_image_0.png
dataset/train/images/road_image_35.png
dataset/train/images/road_image_18.png
dataset/train/images/road_image_81.png
dataset/train/images/road_image_126.png
dataset/train/images/road_image_141.png
dataset/train/images/road_image_123.png
dataset/train/images/road_image_2.png
dataset/train/images/road_image_127.png
dataset/train/images/road_image_5.png
dataset/train/images/road_image_40.png
dataset/train/images/road_image_140.png
dataset/train/images/road_image_155.png
dataset/train/images/road_image_104.png
dataset/train/images/road_image_64.png
dataset/train/images/road_image_157.png
dataset/train/images/road_image_145.png

<Figure size 10000x10000 with 0 Axes>
```



Copy the required files from the repository to Root

```
# Copy pretrained model from repository to root
!cp road-detection/TwinLiteNet/pretrained/best.pth ./

# Copy pytorch Neural Net from repo to root
!cp road-detection/TwinLiteNet/model/TwinLite.py ./

# Copy Loss function pytorch code from repo to root
!cp road-detection/TwinLiteNet/loss.py ./

# Copy all reqired constants from repo to root
!cp road-detection/TwinLiteNet/const.py ./

# Copy all val.py from repo to root
!cp road-detection/TwinLiteNet/val.py ./
```

Load the pretrained model

```
import TwinLite as net


model = net.TwinLiteNet()
model = torch.nn.DataParallel(model)
model = model.cuda()
model.load_state_dict(torch.load('best.pth'))
```

```
<All keys matched successfully>
```

Intialize loss and optimizer.

- This is based on the original code from paper author

```
from tqdm import tqdm
from loss import TotalLoss

lr = 5e-4
optimizer = torch.optim.Adam(model.parameters(), lr, (0.9, 0.999),
eps=1e-08, weight_decay=5e-4)

criteria = TotalLoss()

args = dict()

args["lr"] = lr
args["max_epochs"] = 30
args["onGPU"] = True

args
```

```
{'lr': 7.81e-06, 'max_epochs': 30, 'onGPU': True}
```

Intialize Polynomial Learning Rate Scheduler

- By Paper Author

```
def poly_lr_scheduler(args, optimizer, epoch, power=2):
    lr = round(args["lr"] * (1 - epoch / args["max_epochs"]) ** power,
8)
    for param_group in optimizer.param_groups:
        param_group['lr'] = lr

    return lr
```

Write a trainer function for each epoch

- By Paper Author

```
def train(args, train_loader, model, criterion, optimizer, epoch):
    model.train()

    total_batches = len(train_loader)
    pbar = enumerate(train_loader)
    pbar = tqdm(pbar, total=total_batches, bar_format='{l_bar}{bar:10}
{r_bar}')
    j = 0
    avg_train_loss = 0
    for i, (_, _, input, target) in pbar:
        if args["onGPU"] == True:
```

```
            input = input.cuda().float() / 255.0
        output = model(input)

        # target=target.cuda()
        optimizer.zero_grad()

        focal_loss,tversky_loss,loss = criterion(output,target)
        avg_train_loss += loss.item()

        optimizer.zero_grad()
        loss.backward()
        optimizer.step()
        pbar.set_description(('%13s' * 1 + '%13.4g' * 3) %
                                        (f'{epoch}/{args["max_epochs"] -
1}', tversky_loss, focal_loss, loss.item()))
        j += 1
    return avg_train_loss/j, loss.item()
```

Train the model with custom data and also print the loss

- This loss is based on the paper

```
print("----------------------------------------")
training_loss_last_batch = []
validation_loss_last_batch = []
for epoch in range(0, args["max_epochs"]):
    print(f"Epoch: {epoch + 1}/{args['max_epochs']}")
    poly_lr_scheduler(args, optimizer, epoch)
    for param_group in optimizer.param_groups:
        lr = param_group['lr']
    print("Learning rate: " +  str(lr))
    print()

    # train for one epoch
    model.train()
    avg_train_loss, loss_for_last_batch_train = train( args,
train_dataloader, model, criteria, optimizer, epoch)
    model.eval()

    avg_val_loss = 0
    i = 0
    for batch in val_dataloader:
        _, _, input, target = batch
        if args["onGPU"] == True:
            input = input.cuda().float() / 255.0
        output = model(input)
        focal_loss, tversky_loss, loss = criteria(output, target)
        avg_val_loss += loss.item()
        i += 1
```

```
    print()
    print(f"Average Training Loss: {avg_train_loss}")
    print(f"Average Validation Loss: {avg_val_loss/i}")
    print()
    print(f"Training loss for last batch:
{loss_for_last_batch_train}")
    print(f"Validation loss for last batch: {loss.item()}")
    print("----------------------------------------")
    training_loss_last_batch.append(loss_for_last_batch_train)
    validation_loss_last_batch.append(loss.item())

----------------------------------------
Epoch: 1/30
Learning rate: 7.81e-06


         0/29       0.0602      0.02575      0.08595: 100%|██████████|
20/20 [00:05<00:00,  3.55it/s]


Average Training Loss: 0.16505988352000714
Average Validation Loss: 0.17195375760396323

Training loss for last batch: 0.08595025539398193
Validation loss for last batch: 0.16030383110046387
----------------------------------------
Epoch: 2/30
Learning rate: 7.3e-06


         1/29       0.1232      0.03386       0.1571: 100%|██████████|
20/20 [00:05<00:00,  3.58it/s]


Average Training Loss: 0.15430011823773385
Average Validation Loss: 0.1856925586859385

Training loss for last batch: 0.15708911418914795
Validation loss for last batch: 0.2438523769378662
----------------------------------------
Epoch: 3/30
Learning rate: 6.8e-06


         2/29      0.08851      0.05611       0.1446: 100%|██████████|
20/20 [00:05<00:00,  3.58it/s]


Average Training Loss: 0.14889373779296874
Average Validation Loss: 0.18966013938188553

Training loss for last batch: 0.14462456107139587
```

```
Validation loss for last batch: 0.29650747776031494
----------------------------------------
Epoch: 4/30
Learning rate: 6.33e-06


         3/29      0.08721      0.03725       0.1245: 100%|██████████|
20/20 [00:05<00:00,  3.63it/s]


Average Training Loss: 0.15603391714394094
Average Validation Loss: 0.16158105432987213

Training loss for last batch: 0.12445536255836487
Validation loss for last batch: 0.13932450115680695
----------------------------------------
Epoch: 5/30
Learning rate: 5.87e-06


         4/29      0.08816      0.06617       0.1543: 100%|██████████|
20/20 [00:05<00:00,  3.61it/s]


Average Training Loss: 0.15671782456338407
Average Validation Loss: 0.1615806519985199

Training loss for last batch: 0.15432827174663544
Validation loss for last batch: 0.1095014363527298
----------------------------------------
Epoch: 6/30
Learning rate: 5.42e-06


         5/29      0.04828       0.0326      0.08088: 100%|██████████|
20/20 [00:05<00:00,  3.58it/s]


Average Training Loss: 0.15002040676772593
Average Validation Loss: 0.16637644420067468

Training loss for last batch: 0.08087820559740067
Validation loss for last batch: 0.1705670952796936
----------------------------------------
Epoch: 7/30
Learning rate: 5e-06


         6/29       0.1133      0.07253       0.1859: 100%|██████████|
20/20 [00:05<00:00,  3.62it/s]
```

```
Average Training Loss: 0.14174044989049434
Average Validation Loss: 0.17074661453564963

Training loss for last batch: 0.18586532771587372
Validation loss for last batch: 0.1687607765197754
----------------------------------------
Epoch: 8/30
Learning rate: 4.59e-06


         7/29      0.03796      0.02702      0.06498: 100%|██████████|
20/20 [00:05<00:00,  3.61it/s]


Average Training Loss: 0.1428067024797201
Average Validation Loss: 0.1614452451467514

Training loss for last batch: 0.0649801641702652
Validation loss for last batch: 0.09930221736431122
----------------------------------------
Epoch: 9/30
Learning rate: 4.2e-06


         8/29       0.1223      0.04671       0.1691: 100%|██████████|
20/20 [00:05<00:00,  3.62it/s]


Average Training Loss: 0.14781550765037538
Average Validation Loss: 0.17173205812772116

Training loss for last batch: 0.169050931930542
Validation loss for last batch: 0.16327445209026337
----------------------------------------
Epoch: 10/30
Learning rate: 3.83e-06


         9/29      0.05029      0.03684      0.08712: 100%|██████████|
20/20 [00:05<00:00,  3.62it/s]


Average Training Loss: 0.14172310307621955
Average Validation Loss: 0.15306390076875687

Training loss for last batch: 0.08712434768676758
Validation loss for last batch: 0.07803253084421158
----------------------------------------
Epoch: 11/30
Learning rate: 3.47e-06
```

```
        10/29       0.1494      0.06082       0.2102: 100%|██████████|
20/20 [00:05<00:00,  3.61it/s]


Average Training Loss: 0.15095466040074826
Average Validation Loss: 0.1707787166039149

Training loss for last batch: 0.21020814776420593
Validation loss for last batch: 0.1891394555568695
----------------------------------------
Epoch: 12/30
Learning rate: 3.13e-06


        11/29       0.1207      0.03342       0.1542: 100%|██████████|
20/20 [00:05<00:00,  3.62it/s]


Average Training Loss: 0.14152251407504082
Average Validation Loss: 0.173787588874499

Training loss for last batch: 0.15415552258491516
Validation loss for last batch: 0.2010851949453354
----------------------------------------
Epoch: 13/30
Learning rate: 2.81e-06


        12/29       0.1169      0.07269       0.1896: 100%|██████████|
20/20 [00:05<00:00,  3.62it/s]


Average Training Loss: 0.14255969747900962
Average Validation Loss: 0.17253004014492035

Training loss for last batch: 0.1895551085472107
Validation loss for last batch: 0.1678355634212494
----------------------------------------
Epoch: 14/30
Learning rate: 2.51e-06


        13/29      0.08675      0.06069       0.1474: 100%|██████████|
20/20 [00:05<00:00,  3.60it/s]


Average Training Loss: 0.17735095471143722
Average Validation Loss: 0.1975652277469635

Training loss for last batch: 0.14743605256080627
Validation loss for last batch: 0.2734057307243347
----------------------------------------
```

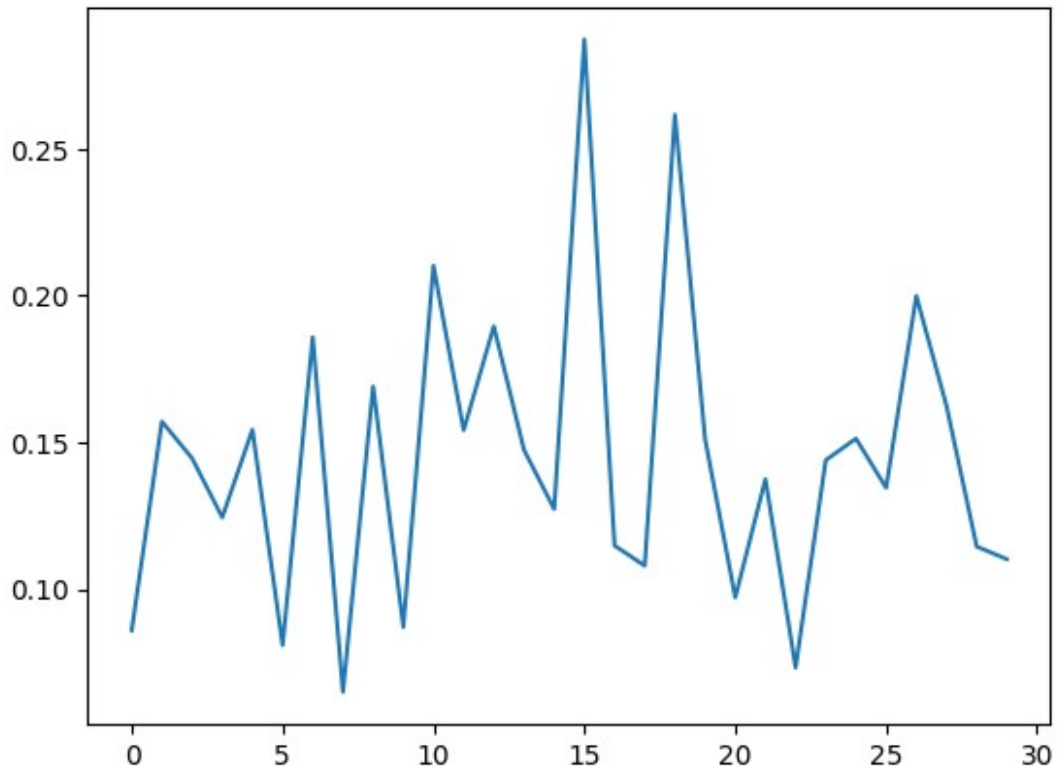
```
Epoch: 15/30
Learning rate: 2.22e-06


        14/29      0.08005      0.04723       0.1273: 100%|██████████|
20/20 [00:05<00:00,  3.62it/s]


Average Training Loss: 0.16895082630217076
Average Validation Loss: 0.1647037168343862

Training loss for last batch: 0.12727907299995422
Validation loss for last batch: 0.14545108377933502
----------------------------------------
Epoch: 16/30
Learning rate: 1.95e-06


        15/29       0.1565       0.1308       0.2873: 100%|██████████|
20/20 [00:05<00:00,  3.63it/s]


Average Training Loss: 0.15768137760460377
Average Validation Loss: 0.17689465483029684

Training loss for last batch: 0.2873290479183197
Validation loss for last batch: 0.20976318418979645
----------------------------------------
Epoch: 17/30
Learning rate: 1.7e-06


        16/29      0.07189      0.04295       0.1148: 100%|██████████|
20/20 [00:05<00:00,  3.63it/s]


Average Training Loss: 0.15491888858377934
Average Validation Loss: 0.19553624590237936

Training loss for last batch: 0.1148422360420227
Validation loss for last batch: 0.2579432725906372
----------------------------------------
Epoch: 18/30
Learning rate: 1.47e-06


        17/29      0.06219      0.04577        0.108: 100%|██████████|
20/20 [00:05<00:00,  3.63it/s]


Average Training Loss: 0.14537633284926416
Average Validation Loss: 0.1745979239543279
```

```
Training loss for last batch: 0.10796540975570679
Validation loss for last batch: 0.18563099205493927
----------------------------------------
Epoch: 19/30
Learning rate: 1.25e-06


        18/29       0.1354       0.1263       0.2617: 100%|██████████|
20/20 [00:05<00:00,  3.61it/s]


Average Training Loss: 0.1669111404567957
Average Validation Loss: 0.1655223270257314

Training loss for last batch: 0.2616710662841797
Validation loss for last batch: 0.16377690434455872
----------------------------------------
Epoch: 20/30
Learning rate: 1.05e-06


        19/29       0.1042      0.04697       0.1512: 100%|██████████|
20/20 [00:05<00:00,  3.63it/s]


Average Training Loss: 0.14424048736691475
Average Validation Loss: 0.17499233782291412

Training loss for last batch: 0.15116432309150696
Validation loss for last batch: 0.1368386298418045
----------------------------------------
Epoch: 21/30
Learning rate: 8.7e-07


        20/29      0.05865      0.03851      0.09716: 100%|██████████|
20/20 [00:05<00:00,  3.57it/s]


Average Training Loss: 0.14654355086386203
Average Validation Loss: 0.1619397054115931

Training loss for last batch: 0.09716343134641647
Validation loss for last batch: 0.1206551045179367
----------------------------------------
Epoch: 22/30
Learning rate: 7e-07


        21/29      0.07364      0.06382       0.1375: 100%|██████████|
20/20 [00:05<00:00,  3.64it/s]
```

```
Average Training Loss: 0.142802831530571
Average Validation Loss: 0.17672798037528992

Training loss for last batch: 0.1374579668045044
Validation loss for last batch: 0.21600624918937683
----------------------------------------
Epoch: 23/30
Learning rate: 5.6e-07


        22/29      0.04075      0.03252      0.07327: 100%|██████████|
20/20 [00:05<00:00,  3.58it/s]


Average Training Loss: 0.14292535781860352
Average Validation Loss: 0.18264439702033997

Training loss for last batch: 0.07327256351709366
Validation loss for last batch: 0.09688904881477356
----------------------------------------
Epoch: 24/30
Learning rate: 4.3e-07


        23/29      0.07689      0.06706       0.1439: 100%|██████████|
20/20 [00:05<00:00,  3.62it/s]


Average Training Loss: 0.1439155165106058
Average Validation Loss: 0.17290428280830383

Training loss for last batch: 0.143948033452034
Validation loss for last batch: 0.19821098446846008
----------------------------------------
Epoch: 25/30
Learning rate: 3.1e-07


        24/29      0.09233      0.05896       0.1513: 100%|██████████|
20/20 [00:05<00:00,  3.61it/s]


Average Training Loss: 0.15240162312984468
Average Validation Loss: 0.19096715251604715

Training loss for last batch: 0.15129002928733826
Validation loss for last batch: 0.257914662361145
----------------------------------------
Epoch: 26/30
Learning rate: 2.2e-07
```

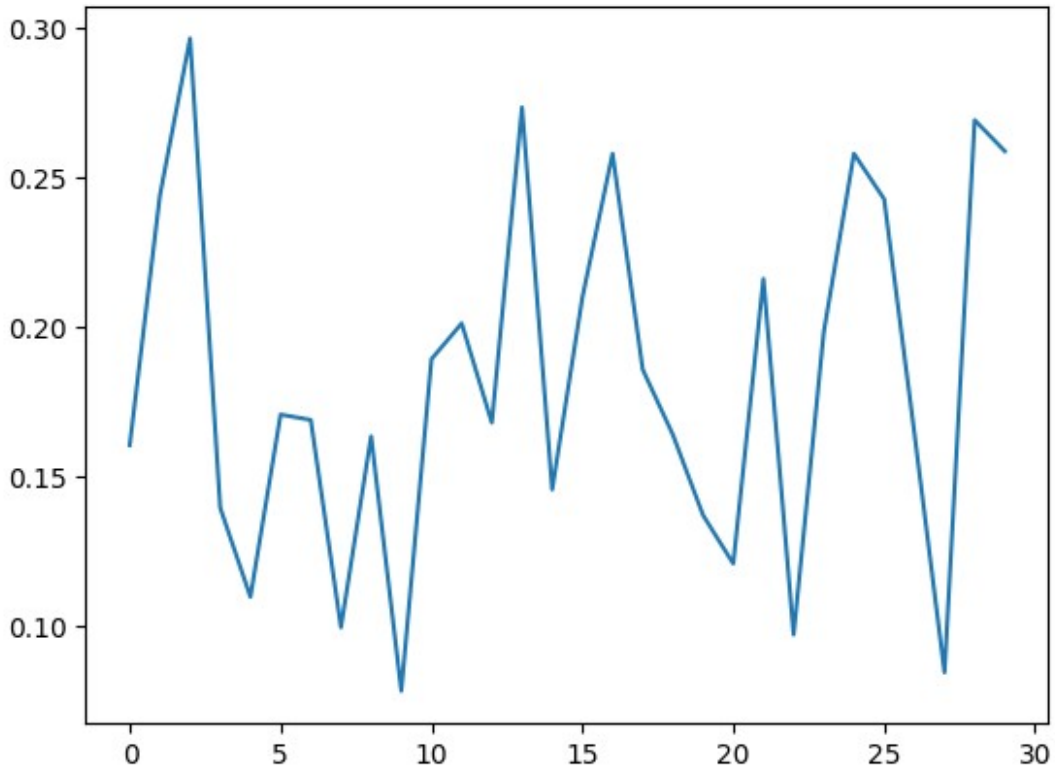
```
        25/29      0.08906      0.04546       0.1345: 100%|██████████|
20/20 [00:05<00:00,  3.60it/s]


Average Training Loss: 0.14428124949336052
Average Validation Loss: 0.2000656525293986

Training loss for last batch: 0.13452312350273132
Validation loss for last batch: 0.2426987588405609
----------------------------------------
Epoch: 27/30
Learning rate: 1.4e-07


        26/29       0.1107      0.08925       0.1999: 100%|██████████|
20/20 [00:05<00:00,  3.59it/s]


Average Training Loss: 0.14430663473904132
Average Validation Loss: 0.17565027872721353

Training loss for last batch: 0.19992004334926605
Validation loss for last batch: 0.16456827521324158
----------------------------------------
Epoch: 28/30
Learning rate: 8e-08


        27/29      0.08643      0.07602       0.1625: 100%|██████████|
20/20 [00:05<00:00,  3.61it/s]


Average Training Loss: 0.16076706908643246
Average Validation Loss: 0.15946287165085474

Training loss for last batch: 0.16245479881763458
Validation loss for last batch: 0.08424156159162521
----------------------------------------
Epoch: 29/30
Learning rate: 3e-08


        28/29      0.05481      0.05972       0.1145: 100%|██████████|
20/20 [00:05<00:00,  3.59it/s]


Average Training Loss: 0.15822646245360375
Average Validation Loss: 0.19661131501197815

Training loss for last batch: 0.11452271789312363
Validation loss for last batch: 0.26914864778518677
----------------------------------------
```

```
Epoch: 30/30
Learning rate: 1e-08


        29/29      0.06289      0.04731       0.1102: 100%|██████████|
20/20 [00:05<00:00,  3.64it/s]


Average Training Loss: 0.13972755856812
Average Validation Loss: 0.18667576710383096

Training loss for last batch: 0.11020036041736603
Validation loss for last batch: 0.25874409079551697
----------------------------------------

%matplotlib inline
import matplotlib.pyplot as plt

x = list(range(len(training_loss_last_batch)))
y = training_loss_last_batch

plt.plot(x, y)

[<matplotlib.lines.Line2D at 0x7804ac113700>]
```



```
%matplotlib inline
import matplotlib.pyplot as plt

x = list(range(len(validation_loss_last_batch)))
y = validation_loss_last_batch

plt.plot(x, y)
```

```
[<matplotlib.lines.Line2D at 0x7804a4293e80>]
```



Calculating loss on Test data

```
avg_test_loss = 0
i = 0
for batch in test_dataloader:
    _, _, input, target = batch
    if args["onGPU"] == True:
        input = input.cuda().float() / 255.0
    output = model(input)
    focal_loss, tversky_loss, loss = criteria(output, target)
    avg_test_loss += loss.item()
    i += 1

print("-------------------------------------------")
print(f"Average Testing Loss: {avg_test_loss/i}")
```

```
print(f"Testing loss for last batch: {loss.item()}")
print("-----------------------------------------")
```

```
-----------------------------------------
Average Testing Loss: 0.23437678317228952
Testing loss for last batch: 0.19679684937000275
-----------------------------------------
```

Defining functions to calculate Pixel Accuracy and Intersection of Union

- by paper author

```
class SegmentationMetric(object):
    '''
    imgLabel [batch_size, height(144), width(256)]
    confusionMatrix [[0(TN),1(FP)],
                     [2(FN),3(TP)]]
    '''
    def __init__(self, numClass):
        self.numClass = numClass
        self.confusionMatrix = np.zeros((self.numClass,)*2)

    def pixelAccuracy(self):
        # return all class overall pixel accuracy
        # acc = (TP + TN) / (TP + TN + FP + TN)
        acc = np.diag(self.confusionMatrix).sum() /
self.confusionMatrix.sum()
        return acc


    def classPixelAccuracy(self):
        # return each category pixel accuracy(A more accurate way to
call it precision)
        # acc = (TP) / TP + FP
        classAcc = np.diag(self.confusionMatrix) /
(self.confusionMatrix.sum(axis=0) + 1e-12)
        return classAcc

    def meanPixelAccuracy(self):
        classAcc = self.classPixelAccuracy()
        meanAcc = np.nanmean(classAcc)
        return meanAcc

    def meanIntersectionOverUnion(self):
        # Intersection = TP Union = TP + FP + FN
        # IoU = TP / (TP + FP + FN)
        intersection = np.diag(self.confusionMatrix)
```

```
        union = np.sum(self.confusionMatrix, axis=1) +
np.sum(self.confusionMatrix, axis=0) - np.diag(self.confusionMatrix)
        IoU = intersection / union
        IoU[np.isnan(IoU)] = 0
        mIoU = np.nanmean(IoU)
        return mIoU

    def IntersectionOverUnion(self):
        intersection = np.diag(self.confusionMatrix)
        union = np.sum(self.confusionMatrix, axis=1) +
np.sum(self.confusionMatrix, axis=0) - np.diag(self.confusionMatrix)
        IoU = intersection / union
        IoU[np.isnan(IoU)] = 0
        return IoU[1]

    def genConfusionMatrix(self, imgPredict, imgLabel):
        # remove classes from unlabeled pixels in gt image and predict
        # print(imgLabel.shape)
        mask = (imgLabel >= 0) & (imgLabel < self.numClass)
        label = self.numClass * imgLabel[mask] + imgPredict[mask]
        count = np.bincount(label, minlength=self.numClass**2)
        confusionMatrix = count.reshape(self.numClass, self.numClass)
        return confusionMatrix

    def Frequency_Weighted_Intersection_over_Union(self):
        # FWIOU =     [(TP+FN)/(TP+FP+TN+FN)] *[TP / (TP + FP + FN)]
        freq = np.sum(self.confusionMatrix, axis=1) /
np.sum(self.confusionMatrix)
        iu = np.diag(self.confusionMatrix) / (
                np.sum(self.confusionMatrix, axis=1) +
np.sum(self.confusionMatrix, axis=0) -
                np.diag(self.confusionMatrix))
        FWIoU = (freq[freq > 0] * iu[freq > 0]).sum()
        return FWIoU


    def addBatch(self, imgPredict, imgLabel):
        assert imgPredict.shape == imgLabel.shape
        self.confusionMatrix += self.genConfusionMatrix(imgPredict,
imgLabel)

    def reset(self):
        self.confusionMatrix = np.zeros((self.numClass,
self.numClass))

class AverageMeter(object):
    """Computes and stores the average and current value"""
    def __init__(self):
        self.reset()
```

```
    def reset(self):
        self.val = 0
        self.avg = 0
        self.sum = 0
        self.count = 0

    def update(self, val, n=1):
        self.val = val
        self.sum += val * n
        self.count += n
        self.avg = self.sum / self.count if self.count != 0 else 0

@torch.no_grad()
def val(val_loader, model):

    model.eval()


    DA=SegmentationMetric(2)
    LL=SegmentationMetric(2)

    da_acc_seg = AverageMeter()
    da_IoU_seg = AverageMeter()
    da_mIoU_seg = AverageMeter()

    ll_acc_seg = AverageMeter()
    ll_IoU_seg = AverageMeter()
    ll_mIoU_seg = AverageMeter()
    total_batches = len(val_loader)

    total_batches = len(val_loader)
    pbar = enumerate(val_loader)
    pbar = tqdm(pbar, total=total_batches)
    for i, (_, _,input, target) in pbar:
        input = input.cuda().float() / 255.0
            # target = target.cuda()

        input_var = input
        target_var = target

        # run the mdoel
        with torch.no_grad():
            output = model(input_var)

        out_da,out_ll=output
        target_da,target_ll=target

        _,da_predict=torch.max(out_da, 1)
        _,da_gt=torch.max(target_da, 1)

        _,ll_predict=torch.max(out_ll, 1)
```

```
        _,ll_gt=torch.max(target_ll, 1)
        DA.reset()
        DA.addBatch(da_predict.cpu(), da_gt.cpu())


        da_acc = DA.pixelAccuracy()
        da_IoU = DA.IntersectionOverUnion()
        da_mIoU = DA.meanIntersectionOverUnion()

        da_acc_seg.update(da_acc,input.size(0))
        da_IoU_seg.update(da_IoU,input.size(0))
        da_mIoU_seg.update(da_mIoU,input.size(0))


        LL.reset()
        LL.addBatch(ll_predict.cpu(), ll_gt.cpu())


        ll_acc = LL.pixelAccuracy()
        ll_IoU = LL.IntersectionOverUnion()
        ll_mIoU = LL.meanIntersectionOverUnion()

        ll_acc_seg.update(ll_acc,input.size(0))
        ll_IoU_seg.update(ll_IoU,input.size(0))
        ll_mIoU_seg.update(ll_mIoU,input.size(0))

    da_segment_result =
(da_acc_seg.avg,da_IoU_seg.avg,da_mIoU_seg.avg)
    ll_segment_result =
(ll_acc_seg.avg,ll_IoU_seg.avg,ll_mIoU_seg.avg)
    return da_segment_result,ll_segment_result
```

Evaluating metrics

```
model.eval()
example = torch.rand(1, 3, 360, 640).cuda()
model = torch.jit.trace(model, example)
da_segment_results,ll_segment_results = val(test_dataloader, model)

msg =  'Driving area Segment: Acc({da_seg_acc:.3f})    IOU
({da_seg_iou:.3f})    mIOU({da_seg_miou:.3f})\n' \
                    'Lane line Segment: Acc({ll_seg_acc:.3f})    IOU
({ll_seg_iou:.3f})  mIOU({ll_seg_miou:.3f})'.format(

da_seg_acc=da_segment_results[0],da_seg_iou=da_segment_results[1],da_s
eg_miou=da_segment_results[2],

ll_seg_acc=ll_segment_results[0],ll_seg_iou=ll_segment_results[1],ll_s
eg_miou=ll_segment_results[2])
```

```
100%|██████████| 3/3 [00:04<00:00,  1.39s/it]
```

```
print(msg)
```

```
Driving area Segment: Acc(0.963)    IOU (0.778)    mIOU(0.868)
Lane line Segment: Acc(0.984)    IOU (0.209)  mIOU(0.597)
```

Metrics

- Evaluation metrics are pixel accuracy and IoU(Intersection over Union).
- We have achieved an accuracy of 96.3% for Driving area segment
- We have achieved an accuracy of 98.4% for Lane Line segment.

Saving the model

```
torch.save(model.state_dict(), "fine-tuned-model.pth")
```

```
model = net.TwinLiteNet()
model = torch.nn.DataParallel(model)
model = model.cuda()
model.load_state_dict(torch.load('fine-tuned-model.pth'))
```

```
<All keys matched successfully>
```

```
import torch
import numpy as np
import shutil
from tqdm.autonotebook import tqdm
import os
import os
import torch
import TwinLite as net


model = net.TwinLiteNet()
import cv2

def Run(model,img):
    img = cv2.resize(img, (640, 360))
    img_rs=img.copy()

    img = img[:, :, ::-1].transpose(2, 0, 1)
    img = np.ascontiguousarray(img)
    img=torch.from_numpy(img)
    img = torch.unsqueeze(img, 0)  # add a batch dimension
    img=img.cuda().float() / 255.0
    img = img.cuda()
    with torch.no_grad():
```

```
        img_out = model(img)
    x0=img_out[0]
    x1=img_out[1]

    _,da_predict=torch.max(x0, 1)
    _,ll_predict=torch.max(x1, 1)

    DA = da_predict.byte().cpu().data.numpy()[0]*255
    LL = ll_predict.byte().cpu().data.numpy()[0]*255
    img_rs[DA>100]=[255,0,0]
    img_rs[LL>100]=[0,255,0]

    return img_rs


model = net.TwinLiteNet()
model = torch.nn.DataParallel(model)
model = model.cuda()
model.load_state_dict(torch.load('fine-tuned-model.pth'))
model.eval()

#img = cv2.imread("dataset/test/images/road_image_160.png")
img = cv2.imread("/content/unh.jpg")
img = Run(model, img)
cv2.imwrite("unh1.jpg", img)
```

```
True
```

```
from PIL import Image


# Blue area is drivable area, green lines are lanes
Image.open("unh1.jpg")
```