Cover sheet

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Course Name: Selected-2 In Computer Science

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Lightweight Gaussian-Based Model for Fast Detection and Classification of Moving Objects

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Dataset: Kitti The KITTI Vision Benchmark Suite (cvlibs.net)

The implemented algorithms:

paper includes (TRG-NET, Faster R-CNN, SSD-Lite, Retina NET)

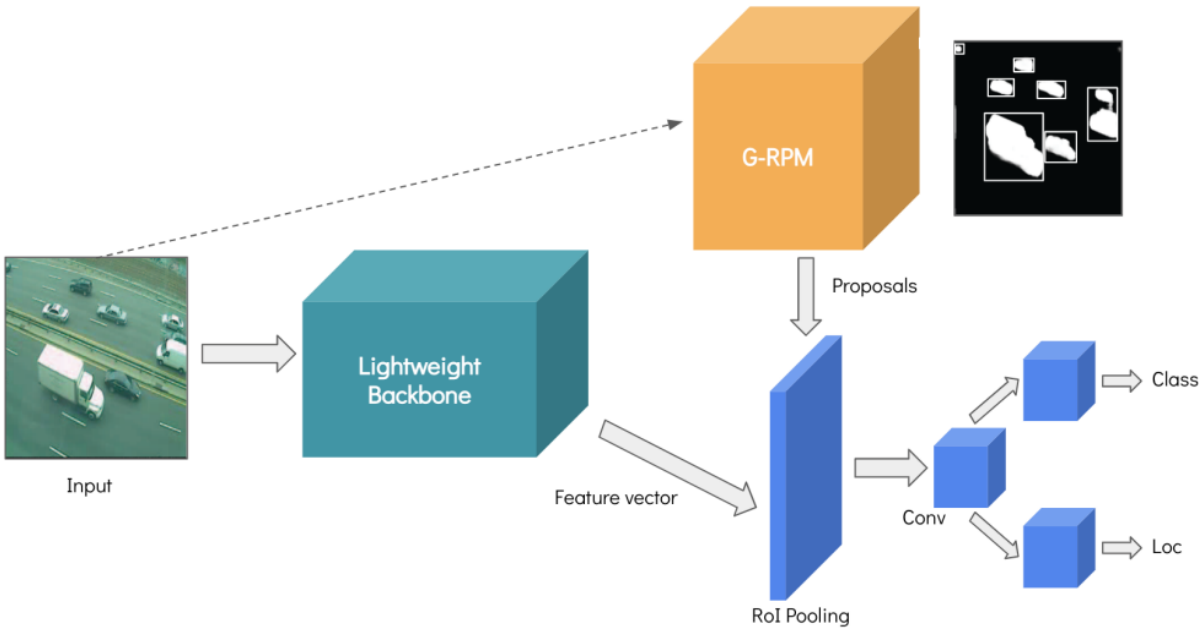
In our project we used (TRG-NET, Faster R-CNN)

TRG-NET: a unified model that can be executed on computationally limited devices to detect and classify just moving objects.

This proposal is based on the Faster R-CNN architecture, MobileNetV3 as a feature extractor, and a Gaussian mixture model for a fast search of Regions of Interest based on motion.

TRG-Net reduces the inference time by unifying moving object detection and image classification tasks, and by limiting the regions of interest to the number of moving objects.

TRG-Net uses two-stage architecture to generate region proposals first and then classify each proposal into their respective categories.



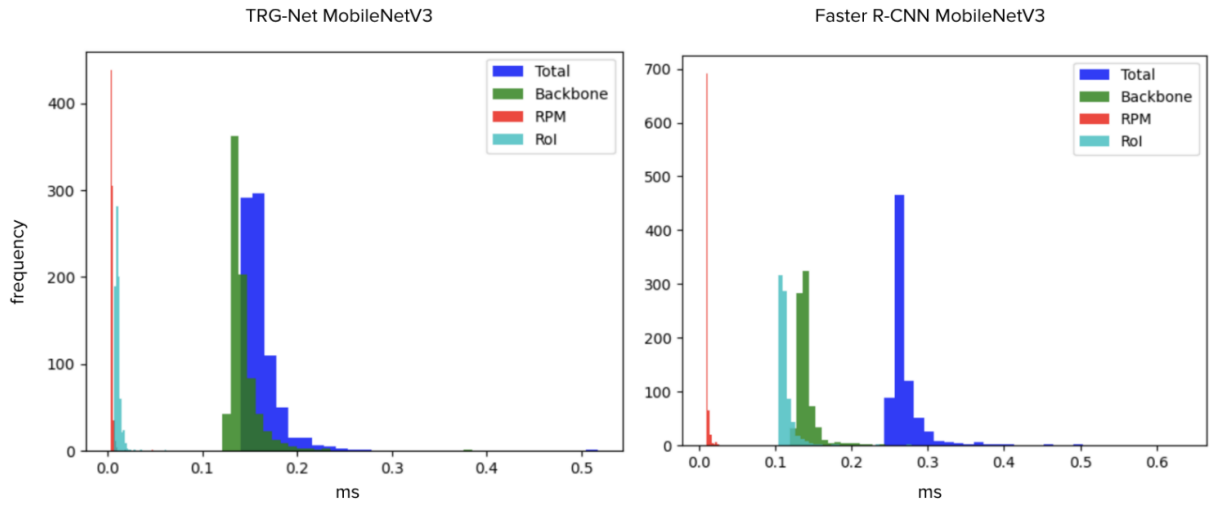
TRG-Net architecture. During inference, the input image passes through a backbone to obtain its feature vector. Then, the same input trains the G-RPM model that returns a list of region proposals. The previous two outputs pass through a pooling layer and fully connected layers that return the classes and locations of the moving objects.

Faster R-CNN:

- The TRG-NET model is inspired by Faster R-CNN.
- The most widely used two-stage architecture is Faster R-CNN
- Faster R-CNN is a deep convolutional network used for object detection, that appears to the user as a single, end-to-end, unified network. The network can accurately and quickly predict the locations of different objects.

- Faster R-CNN is based on MobileNetV3 as feature extractor

Mobile-NET V3:

- It is a backbone for TRG-NET & Faster R-CNN
- Mobile-NET is used to obtain feature vectors.
- Faster R-CNN with MobileNetV3 and TRG-net is due to the use of a traditional method to discover regions of interest.
- 

- We have another backbone called RES-NET50. When we use the RES-NET 50 we get the highest Average precision BUT nevertheless we get the highest inference time, so we decided to use the Mobile-NET cause there is a balance between average precision and inference time.

G-RPM:

- TRG-Net uses a G-RPM, which provides regions of interest based on motion.
- Using a GRPM would cause loss of information,This is because the number of training objects is reduced when considering only moving objects,So to use a G-RPM, we would need the bounding boxes and labels of all the moving objects within a video.

Result:

Model	Backbone	AP	# Parameters	Inference Time
TRG-Net (ours)	MobileNetV3	0.423	18.30 M	0.138 s
Faster R-CNN	MobileNetV3	0.423	18.91 M	0.221 s
	ResNet50	**0.519**	41.53 M	4.702 s
SSD Lite	MobileNetV3	0.283	**6.96 M**	**0.098 s**
RetinaNet	ResNet50	0.492	33.8 M	4.501 s

General information on the selected dataset:

The name of the dataset:Self-Driving Cars

Link: Self-Driving Cars | Kaggle

Total number of samples: 165K

The dimension of images: 300*480

Number of classes: 5 classes ->cars

-> trucks

->pedestrian

->bicyclist

->light

Implementation details:

Ratio that used for training : 70%

Ratio that used for validation : 15%

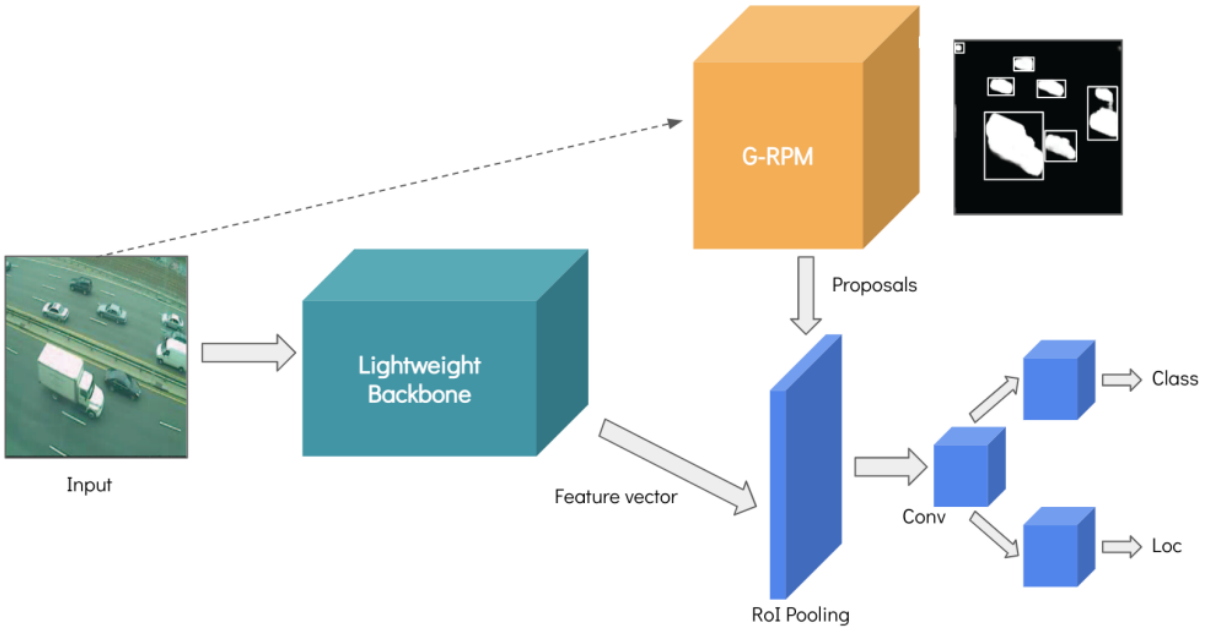
Ratio that used for testing : 15%

Number of images in training set : **952**

Number of images in validation set: **133**

Number of images in testing set: **133**

A block diagram of our implemented model :



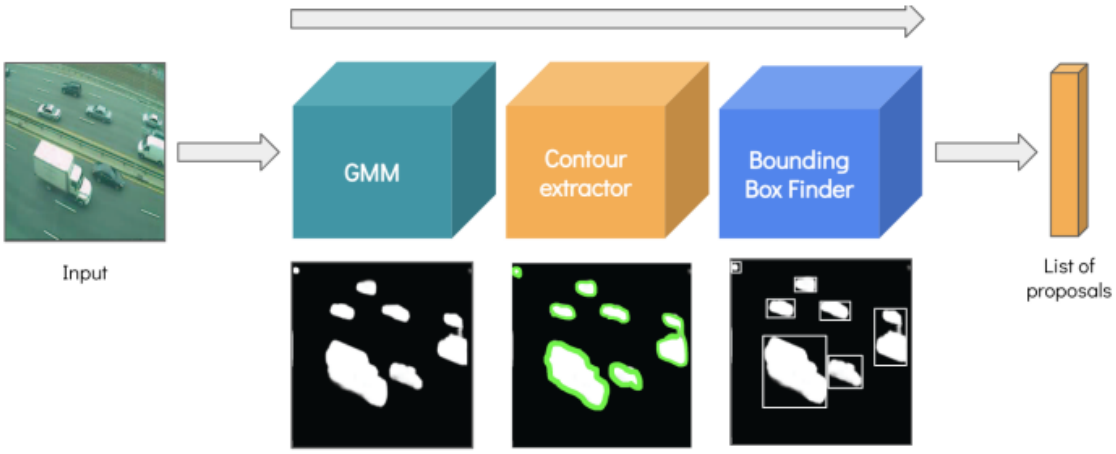


Figure 2: Gaussian-based Region Proposal Model.

Specify any hyperparameters used in our model:

Lr = 0.005

momentum=0.9

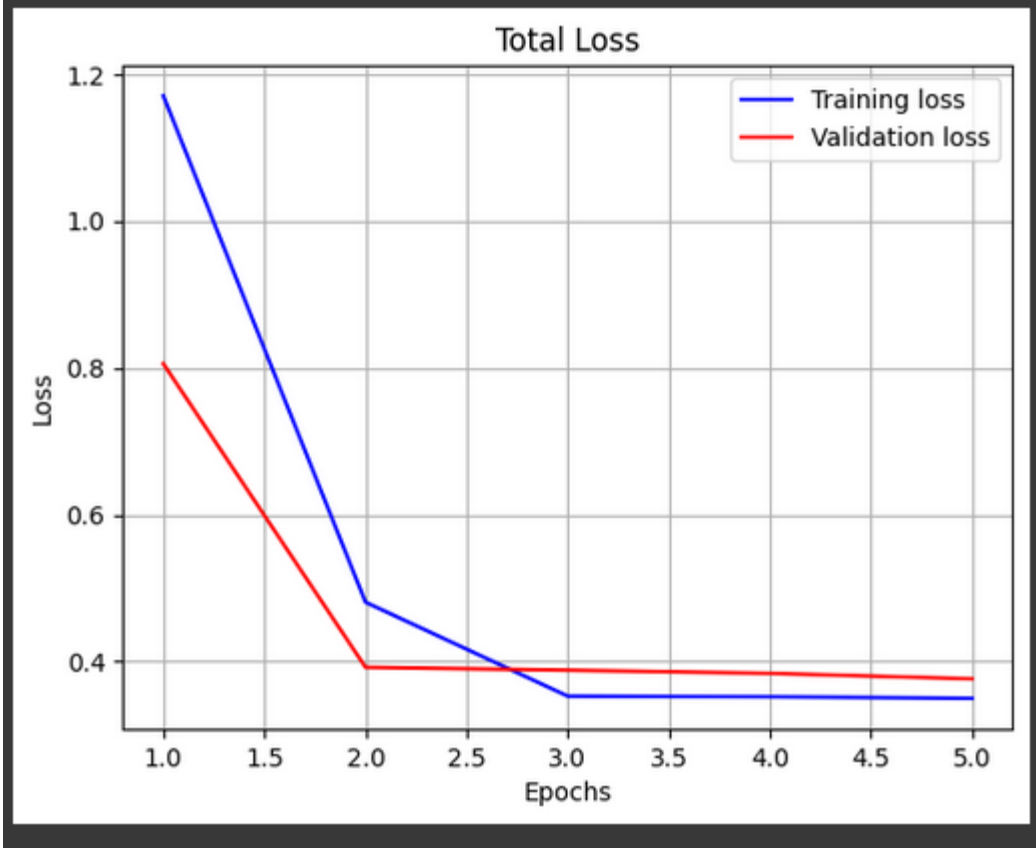
weight_decay=0.0005

Results details:

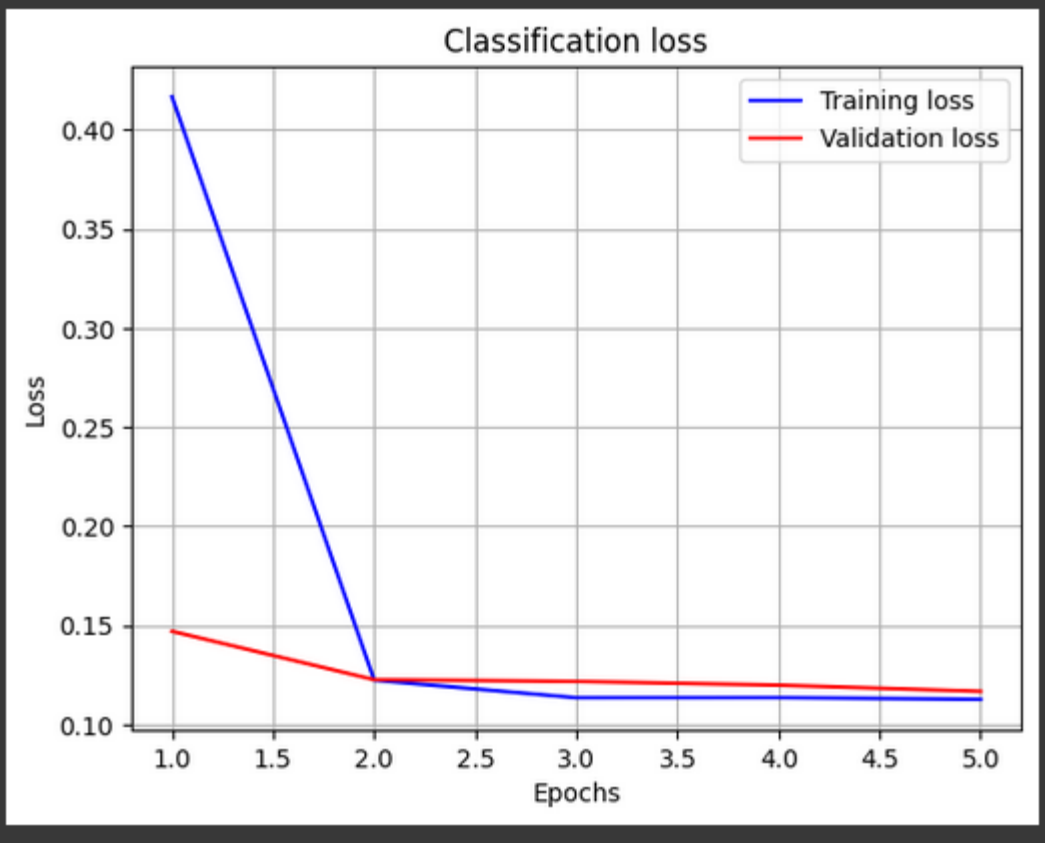
```
EPOCH 1
Training - Total Loss 1.17042 | Classification Loss 0.41674 | Regression Loss 0.03985  | Object Loss 0.62067 | RPN Loss 0.09315
Validation - Total Loss 0.80557 | Classification Loss 0.14701 | Regression Loss 0.03910  | Object Loss 0.52468 | RPN Loss 0.09479
Testing - Total Loss 0.80570 | Classification Loss 0.14702 | Regression Loss 0.03910  | Object Loss 0.52480 | RPN Loss 0.09479
================================================================================ Done

EPOCH 2
Training - Total Loss 0.48084 | Classification Loss 0.12235 | Regression Loss 0.02446  | Object Loss 0.26640 | RPN Loss 0.06763
Validation - Total Loss 0.39219 | Classification Loss 0.12260 | Regression Loss 0.01681  | Object Loss 0.18100 | RPN Loss 0.07179
Testing - Total Loss 0.39086 | Classification Loss 0.12259 | Regression Loss 0.01681  | Object Loss 0.17967 | RPN Loss 0.07179
================================================================================ Done

EPOCH 3
Training - Total Loss 0.35294 | Classification Loss 0.11348 | Regression Loss 0.01597  | Object Loss 0.16507 | RPN Loss 0.05841
Validation - Total Loss 0.38827 | Classification Loss 0.12172 | Regression Loss 0.01824  | Object Loss 0.17620 | RPN Loss 0.07211
Testing - Total Loss 0.38917 | Classification Loss 0.12171 | Regression Loss 0.01824  | Object Loss 0.17710 | RPN Loss 0.07211
================================================================================ Done

EPOCH 4
Training - Total Loss 0.35204 | Classification Loss 0.11351 | Regression Loss 0.01772  | Object Loss 0.16280 | RPN Loss 0.05801
Validation - Total Loss 0.38395 | Classification Loss 0.11983 | Regression Loss 0.01752  | Object Loss 0.17443 | RPN Loss 0.07217
Testing - Total Loss 0.38527 | Classification Loss 0.11982 | Regression Loss 0.01752  | Object Loss 0.17576 | RPN Loss 0.07217
================================================================================ Done

EPOCH 5
Training - Total Loss 0.34997 | Classification Loss 0.11268 | Regression Loss 0.01772  | Object Loss 0.16193 | RPN Loss 0.05764
Validation - Total Loss 0.37649 | Classification Loss 0.11672 | Regression Loss 0.01542  | Object Loss 0.17244 | RPN Loss 0.07191
Testing - Total Loss 0.37822 | Classification Loss 0.11674 | Regression Loss 0.01542  | Object Loss 0.17415 | RPN Loss 0.07191
================================================================================ Done

                ********** Training Completed **********
```

```
[48] print(f'Total Time Taken : {total_time} seconds')

     Total Time Taken : 204.25330543518066 seconds
```

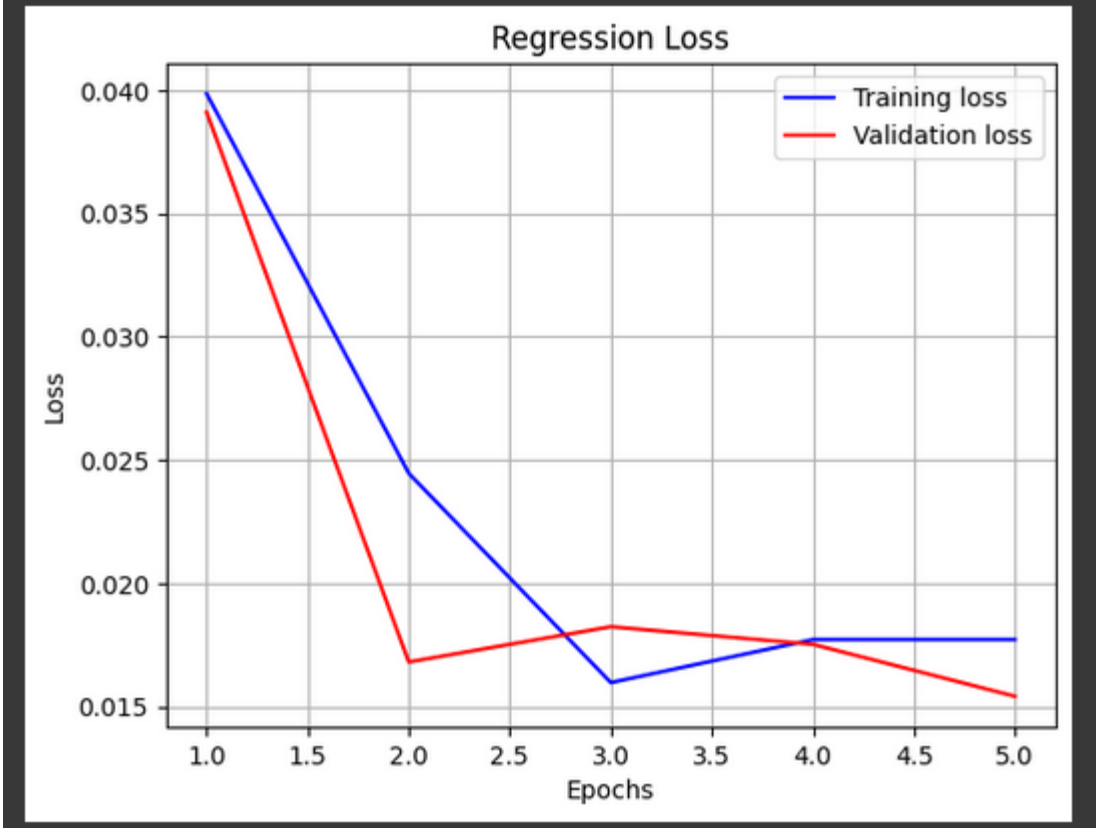
```
plot_pf(train_tl, val_tl, "Total Loss")
```



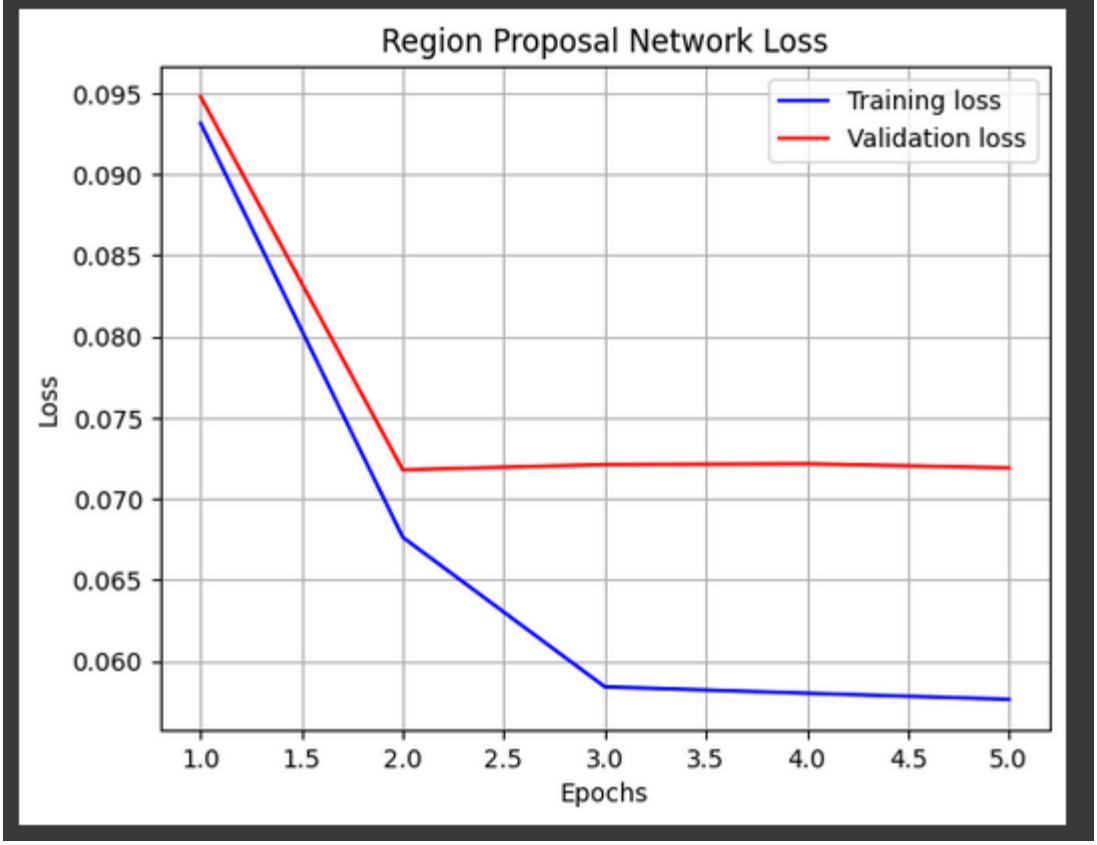
```
plot_pf(train_cl, val_cl, 'Classification loss')
```



```
plot_pf(train_rl, val_rl, "Regression Loss")
```



```
plot_pf(train_rpnl, val_rpnl, "Region Proposal Network Loss")
```



```
plot_pf(train_ol, val_ol, "Object Loss")
```