ELEC5690 Assignment 1

Problem 1: Skin Lesion Image Classification

Model used: ResNet50
Loss functions used:

- Cross-entropy loss
- Cross-entropy + focal loss

Model Parameters

Model	Cross-entropy loss only	Cross-entropy + focal loss
Learning Rate	0.001	0.001
Number of epochs trained	15	10
Optimizer function	Adam	Adam
Pre-trained	Yes	Yes

Overall Metrics

Loss Function	Training Loss	Validation Loss	Training Accuracy	Validation Accuracy	Testing Accuracy
Cross-entropy loss only	0.3188	0.7262	88.33%	78.76%	71.16%
Cross-entropy + focal loss	0.0681	0.3373	92.97%	79.27%,	73.94%

Metrics on Test Dataset

1. **Cross-entropy loss only**

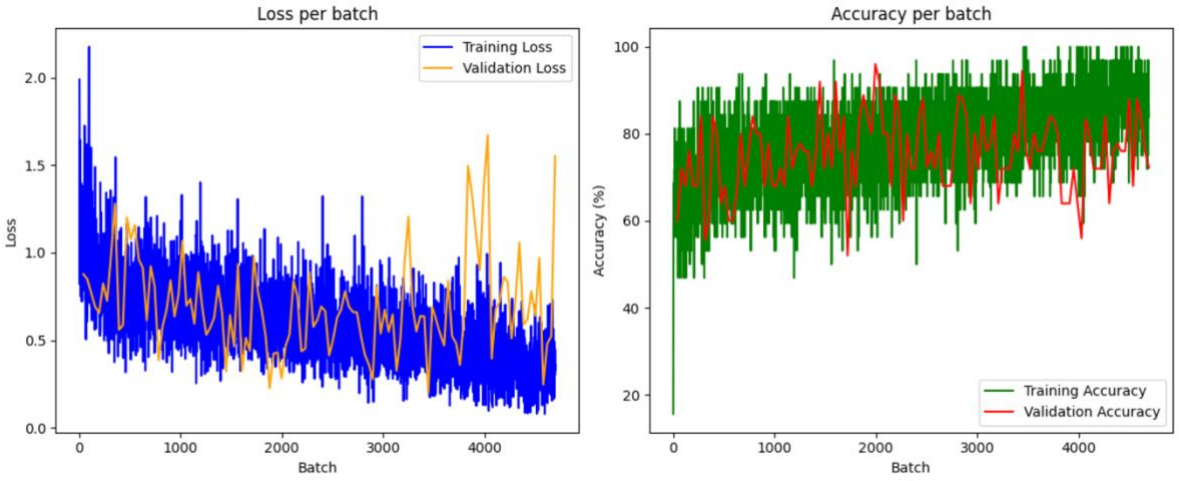
Class	Precision	Recall	F1-score	Support
MEL	0.55	0.44	0.49	171
NV	0.78	0.92	0.85	909
BCC	0.44	0.48	0.46	93
AKIEC	0.32	0.21	0.25	43
BKL	0.64	0.35	0.46	217
DF	0.70	0.16	0.26	44
VASC	0.57	0.74	0.64	35
Accuracy			0.71	1512
Macro Average	0.57	0.47	0.49	1512
Weighted Average	0.69	0.71	0.69	1512

2. **Cross-entropy + Focal loss**

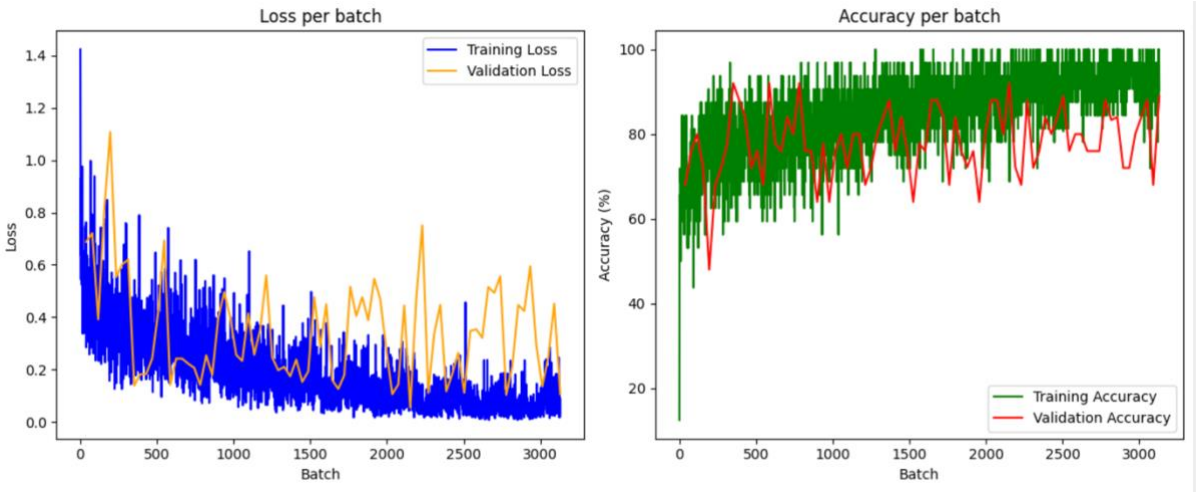
Class	Precision	Recall	F1-score	Support
MEL	0.66	0.23	0.34	171
NV	0.79	0.95	0.86	909
BCC	0.57	0.63	0.60	93
AKIEC	0.35	0.21	0.26	43
BKL	0.62	0.58	0.60	217
DF	1.00	0.09	0.17	44
VASC	0.68	0.60	0.64	35
Accuracy			0.74	1512
Macro Average	0.67	0.47	0.50	1512
Weighted Average	0.73	0.74	0.71	1512

Training and Validation curves

1. **Cross-entropy loss only**

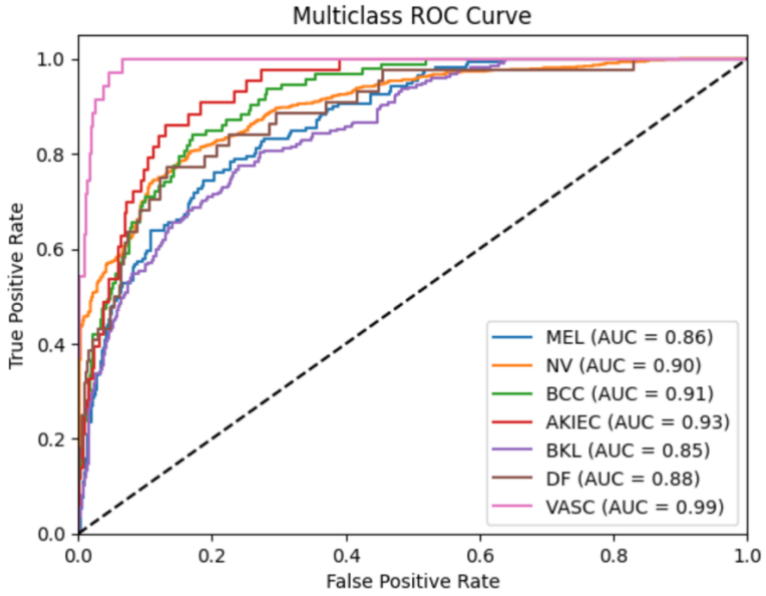


2. **Cross-entropy + Focal loss**



ROC curves

1. **Cross-entropy loss only**



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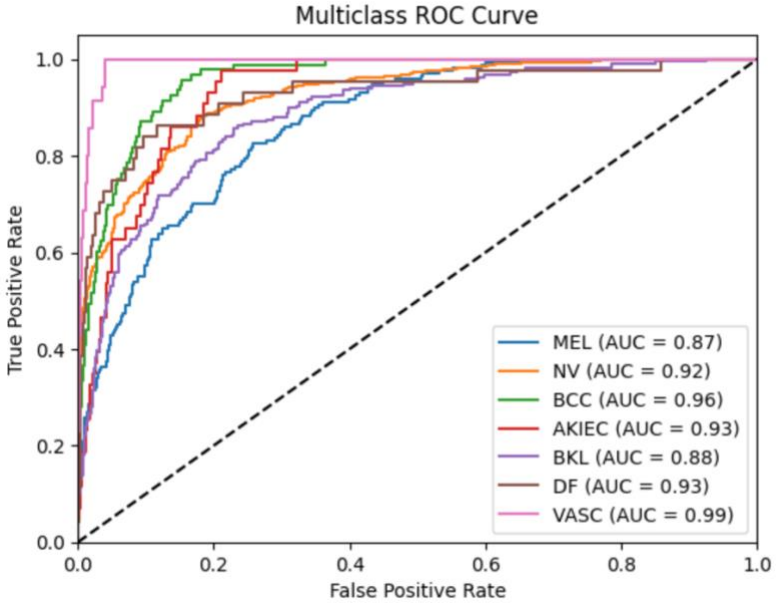
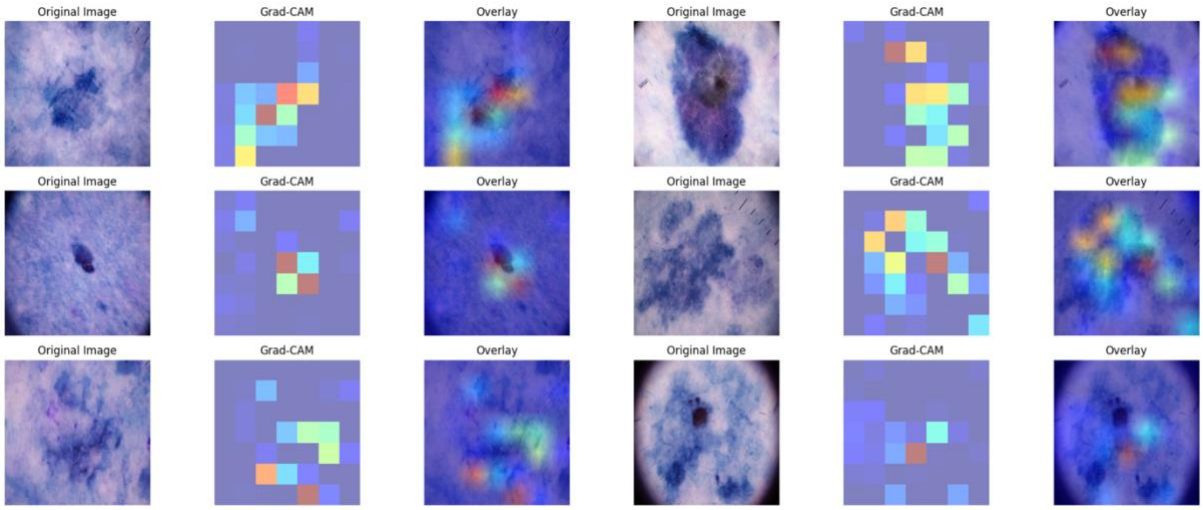
2. **Cross-entropy + Focal loss**



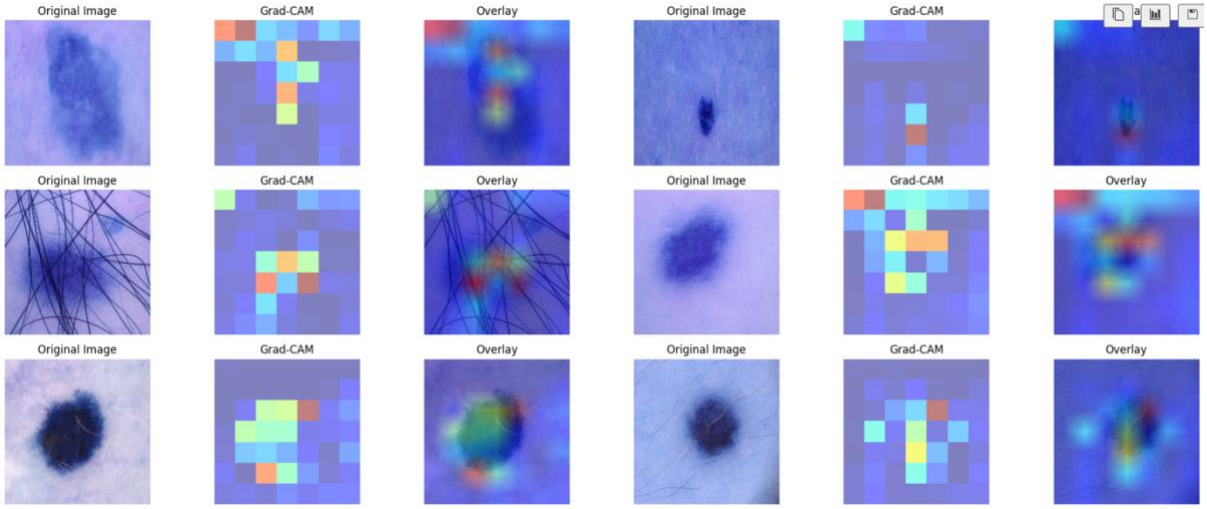
According to the above metrics on test dataset, it is evident that the second model is better, hence we use that model for the below examples.

Gradient class-activation map (Using Cross-entropy + focal loss model)

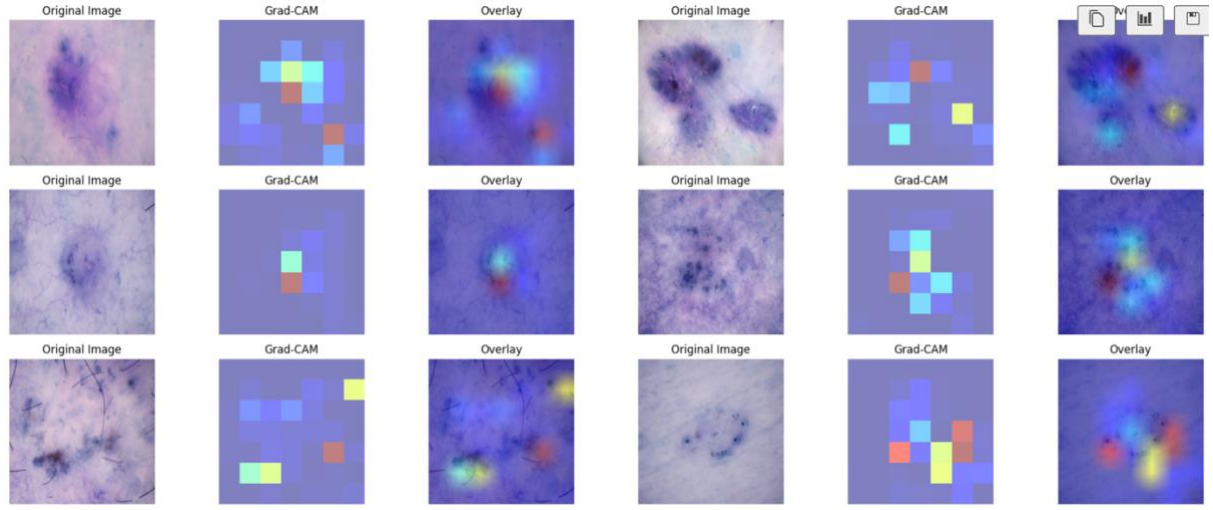
Examples for the first Class – MEL:



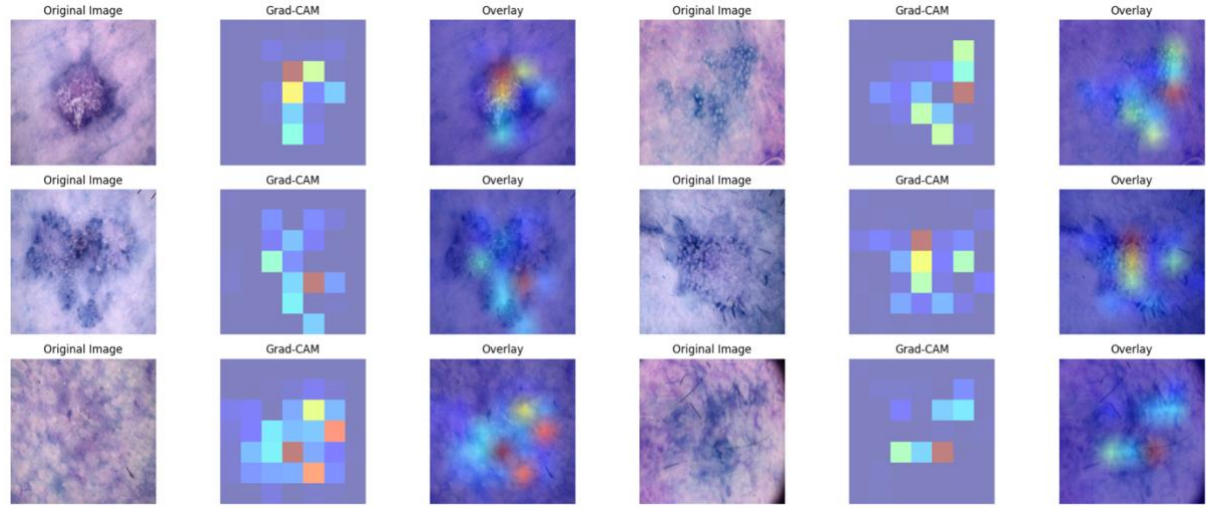
Examples for the second Class – NV:



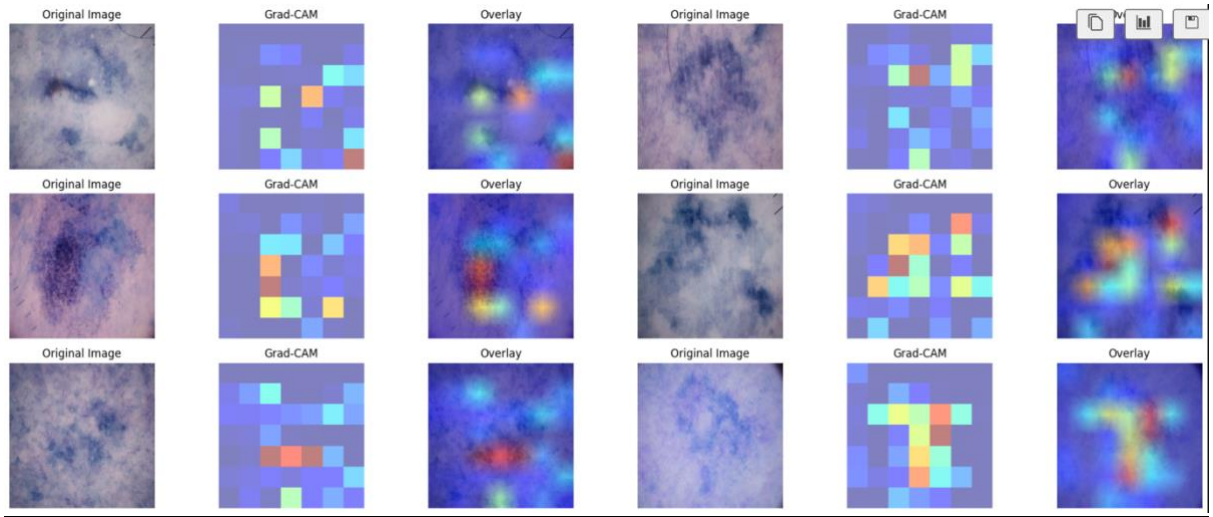
Examples for the third Class – BCC:



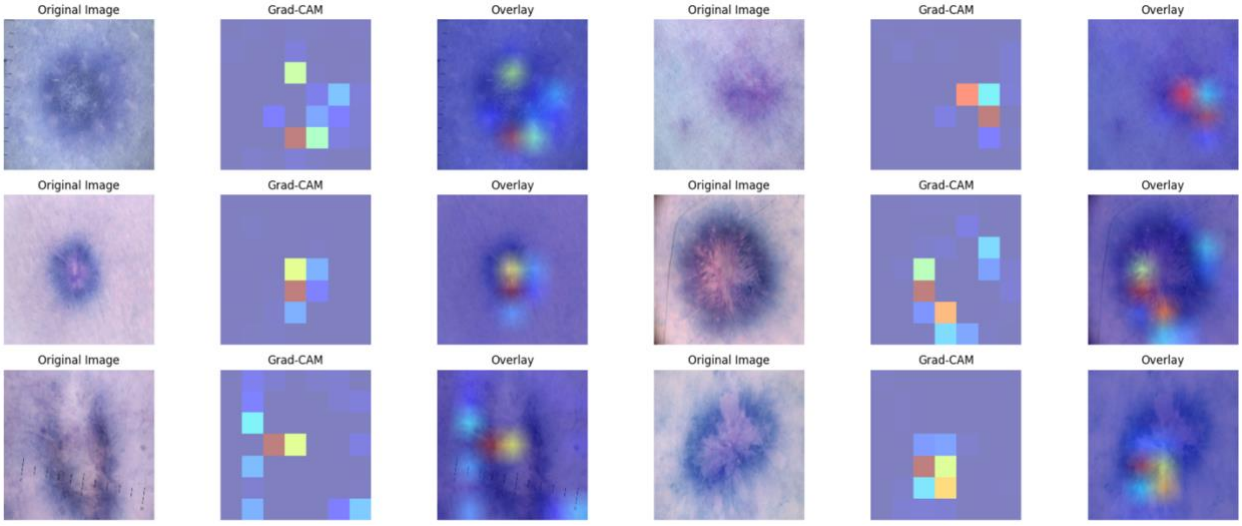
Examples for the fourth Class – AKIEC:



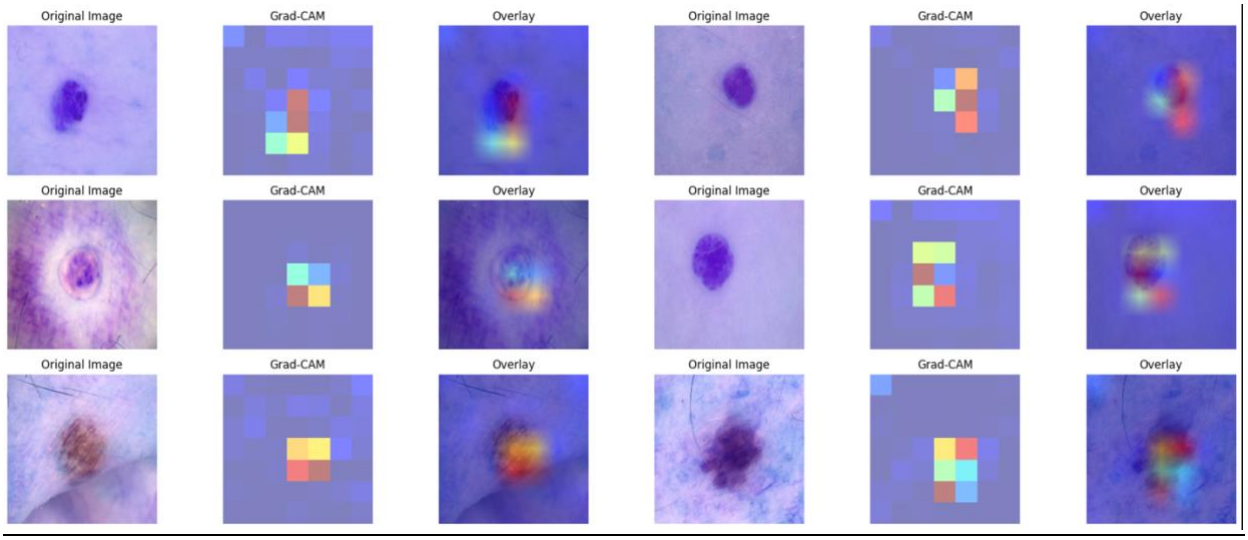
Examples for the fifth Class – BKL:



Examples for the sixth Class – DF:



Examples for the seventh Class – VASC:



Problem 2: 3D medical image segmentation

Model used: 3D Unet
Note: Metrics are rounded to 3 decimal places

First Training Configuration:

Learning rate = 0.001
Optimizer = Adam
Loss function = Binary Cross entropy
Data Augmentations = None
Batch Size = 4
Final Training loss = 0.311
Epoch trained = 50

Metrics on test dataset:
Dice Coefficient: 0.758
Jaccard Index: 0.639
ASD: 1.945
95HD: 8.606

Second Training Configuration:

Learning rate = 0.00001
Optimizer = Adam
Loss function = Dice Loss
Data Augmentations = None
Batch Size = 2
Final Training loss = 0.359
Epochs trained = 75

Metrics on test dataset:
Dice Coefficient: 0.810
Jaccard Index: 0.686
ASD: 0.930
95HD: 6.087

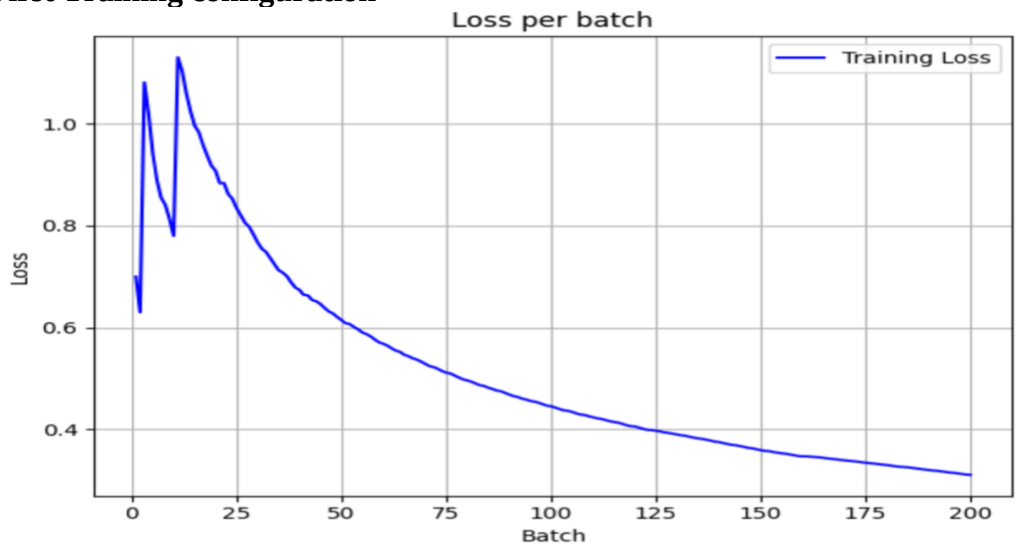
Third Training Configuration:

Learning rate = 0.00001
Optimizer = Adam
Loss function = Dice Loss
Data Augmentations = Random rotate, Random flip
Batch Size = 2
Final Training loss = 0.387
Epochs trained = 75

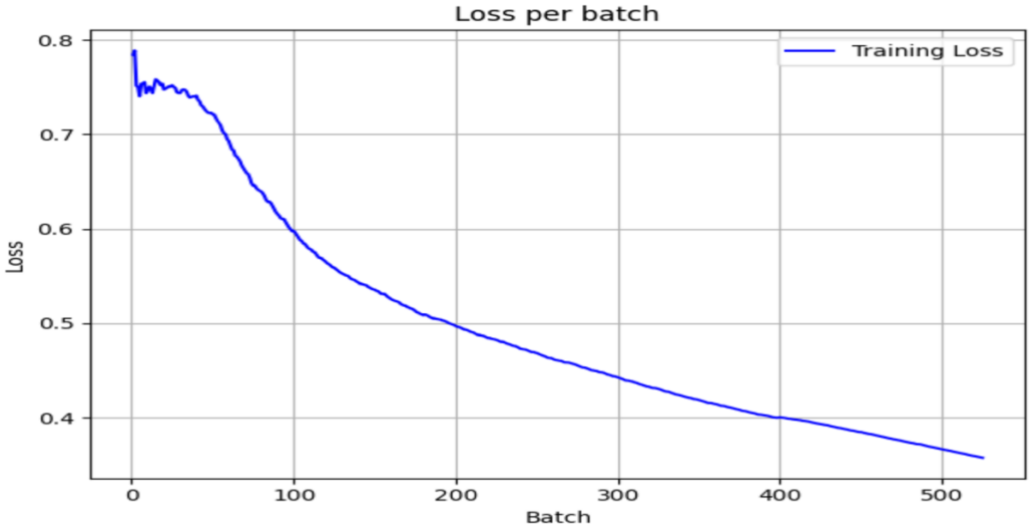
Metrics on test dataset:
Dice Coefficient: 0.737
Jaccard Index: 0.593
ASD: 1.612
95HD: 9.047

Training Loss curves

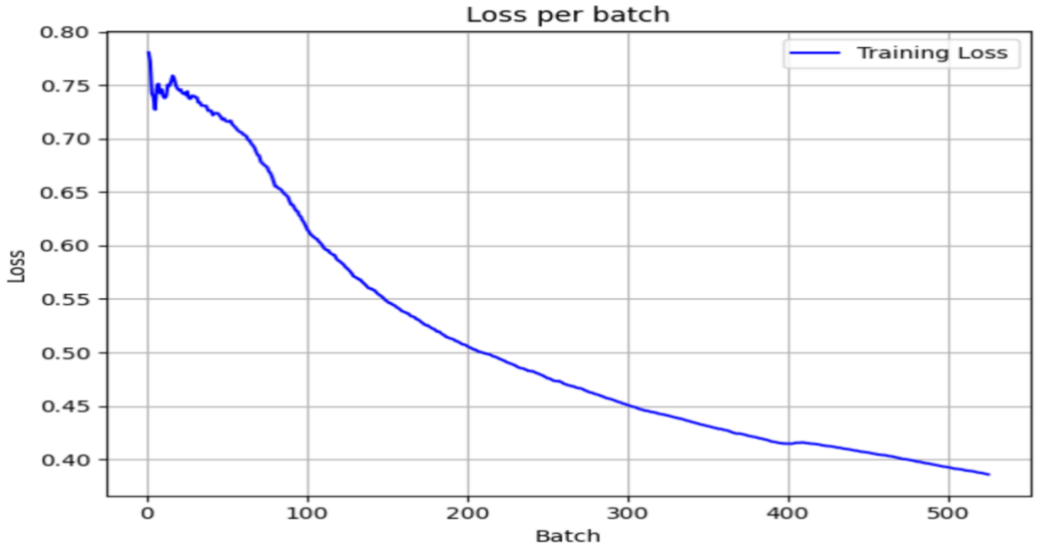
First Training configuration



Second Training configuration

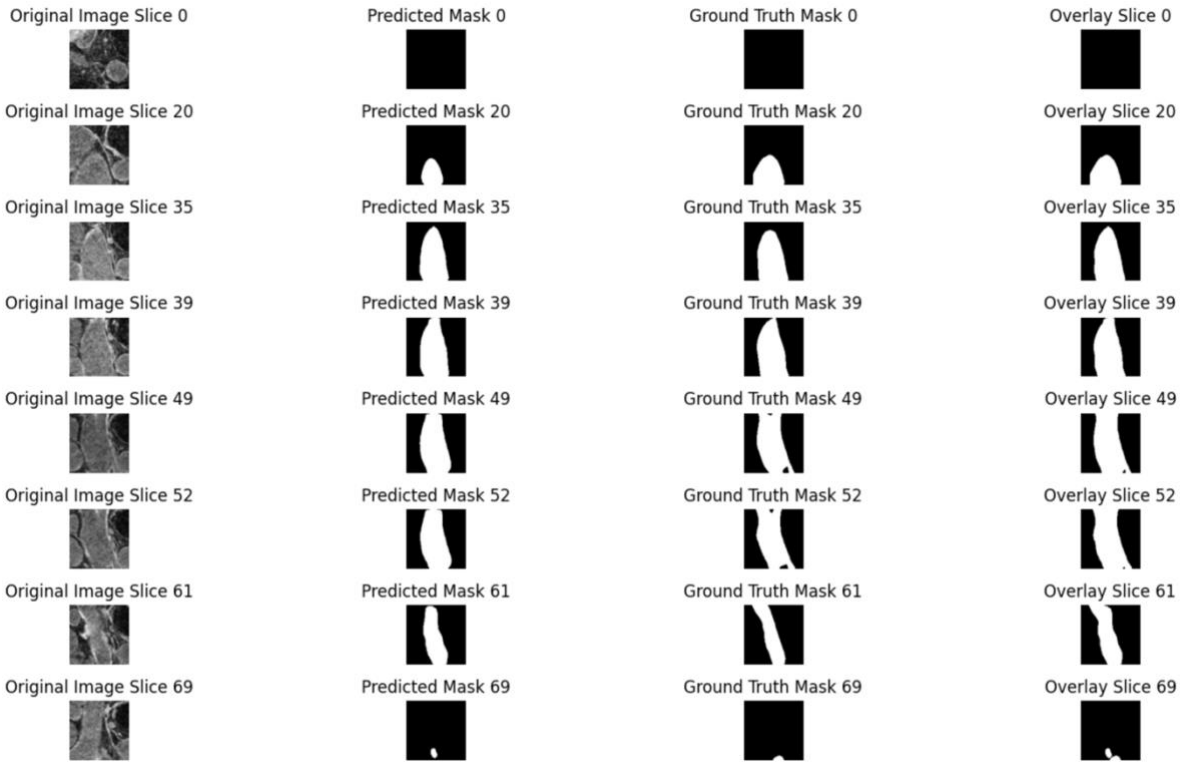


Third Training Configuration



According to the above metrics on test dataset, it is evident that the second training configuration provides the best model, hence we use that model for the below example segmentations.

2D segmentation results compared with ground truth label



Visualising prediction masks in 3D

Ground truth	Prediction