**Team SPECT**
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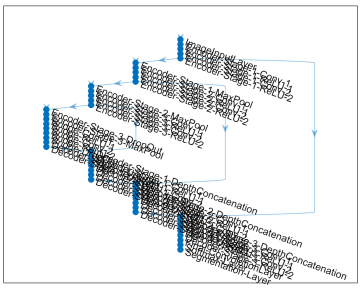
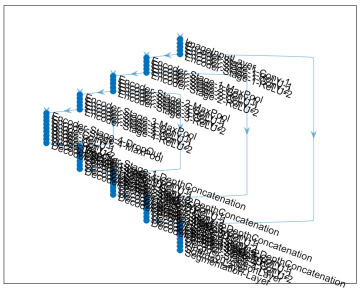
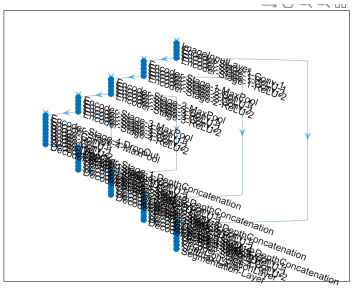
## Creating a U-net Network

| **Case 1**<br>Image size: 480x640x3<br>Classes: 5<br>Encoder Depth:3 | **Case 2**<br>Image size: 480x60x3<br>Classes: 3<br>Encoder Depth: 4 | **Case 3**<br>Image size: 480x60x3<br>Classes: 5<br>Encoder Depth:3 |
|---|---|---|
|  |  |  |

## Training Data

| **Case 1**<br><br>Learning Rate: 1e-2<br>Max Epochs: 30 | Layers: [58×1 nnet.cnn.layer.Layer]<br>Connections: [61×2 table]<br>InputNames: {'ImageInputLayer'}<br>OutputNames: {'Segmentation-Layer'}<br><br>Training on single CPU.<br>Initializing input data normalization.<br>\|=========\|<br>\| Epoch \| Iteration \| Time Elapsed (hh:mm:ss) \| Mini-batch Accuracy \| Mini-batch Loss \| Base Learning Rate \|<br>\|=========\|<br>\| 1 \| 1 \| 00:00:03 \| 75.57% \| 2.4341 \| 0.0100 \|<br>\| 6 \| 6 \| 00:00:18 \| 86.77% \| NaN \| 0.0100 \|<br>\|=========\|<br>Training finished: Training loss is NaN.<br>Warning: Training stopped at iteration 6 because training loss is NaN. Predictions using the output network might contain NaN values. |
|---|---|
| **Case 2**<br><br>Learning Rate: 1e-5<br>Max Epochs: 30 | OutputNames: {'Segmentation-Layer'}<br><br>Training on single CPU.<br>Initializing input data normalization.<br>\|=========\|<br>\| Epoch \| Iteration \| Time Elapsed (hh:mm:ss) \| Mini-batch Accuracy \| Mini-batch Loss \| Base Learning Rate \|<br>\|=========\|<br>\| 1 \| 1 \| 00:00:02 \| 78.79% \| 1.5972 \| 1.0000e-05 \|<br>\| 10 \| 10 \| 00:00:27 \| 82.45% \| 1.3881 \| 1.0000e-05 \|<br>\| 20 \| 20 \| 00:00:55 \| 87.99% \| 1.0551 \| 1.0000e-05 \|<br>\| 30 \| 30 \| 00:01:23 \| 91.65% \| 0.8483 \| 1.0000e-05 \|<br>\|=========\|<br>Training finished: Max epochs completed. |

| Case 3 | |
|---|---|
| Learning Rate: 1e-5<br>Max Epochs: 50 | Training on single CPU.<br>Initializing input data normalization.<br>\|========\|<br>\| Epoch \| Iteration \| Time Elapsed (hh:mm:ss) \| Mini-batch Accuracy \| Mini-batch Loss \| Base Learning Rate \|<br>\|========\|<br>\| 1 \| 1 \| 00:00:02 \| 92.21% \| 1.0396 \| 1.0000e-05 \|<br>\| 10 \| 10 \| 00:00:27 \| 86.42% \| 1.6232 \| 1.0000e-05 \|<br>\| 20 \| 20 \| 00:00:53 \| 91.81% \| 1.0619 \| 1.0000e-05 \|<br>\| 30 \| 30 \| 00:01:20 \| 94.87% \| 0.7159 \| 1.0000e-05 \|<br>\| 40 \| 40 \| 00:01:46 \| 95.16% \| 0.6701 \| 1.0000e-05 \|<br>\| 50 \| 50 \| 00:02:12 \| 95.52% \| 0.6206 \| 1.0000e-05 \|<br>\|========\|<br>Training finished: Max epochs completed. |

**What is the most appropriate number of max epochs you can use? Why?**

From the three cases done, the most appropriate number of epochs used were 50 epochs, and a learning rate of 1e-5. This number of epochs allowed the program to continue optimizing the accuracy of the mini-batch.

**How did the learning rate affect the accuracy?**

The learning rate was the first parameter to be edited. In case 1 the rate was 1e-2, and for the second case it was decreased to 1e-5. In the first case the training was stopped at the 6th iteration because of NaN values, while in the second case the training was completed to the maximum indicated epochs and an accuracy of 92% was achieved.

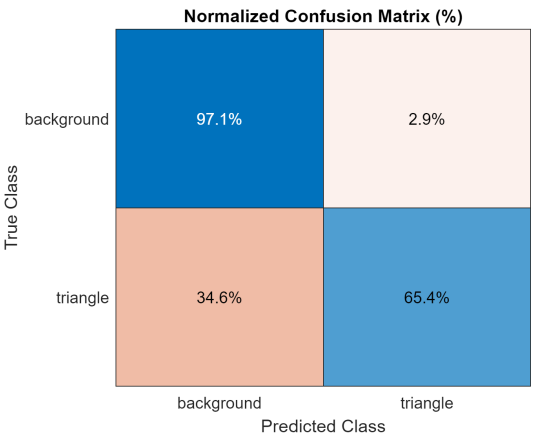
Thus it can be concluded that a decrease in the learning rate allowed for better results.

**2nd part**

**Testing trained U-Net**

```
Evaluating semantic segmentation results
----------------------------------------
* Selected metrics: global accuracy, class accuracy, IoU, weighted IoU, BF score.
* Processed 0 images.
* Processed 29 images.
* Processed 81 images.
* Processed 100 images.
* Finalizing... Done.
* Data set metrics:
```

| GlobalAccuracy | MeanAccuracy | MeanIoU | WeightedIoU | MeanBFScore |
|---|---|---|---|---|
| 0.95618 | 0.81227 | 0.68139 | 0.92956 | 0.60433 |

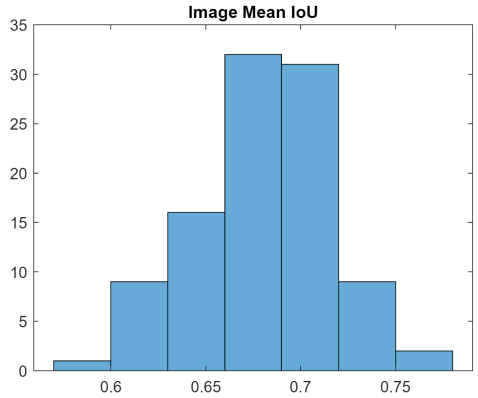



```
ans =

  2×3 table

                Accuracy      IoU      MeanBFScore
                ________    _______    ___________

    triangle     0.6537     0.40797      0.41135
    background   0.97083    0.95482       0.7973
```

```
ans =

  2×2 table

                triangle    background
                ________    __________

    triangle      3092         1638
    background    2849        94821
```

```
ans =
```

```
>>
```



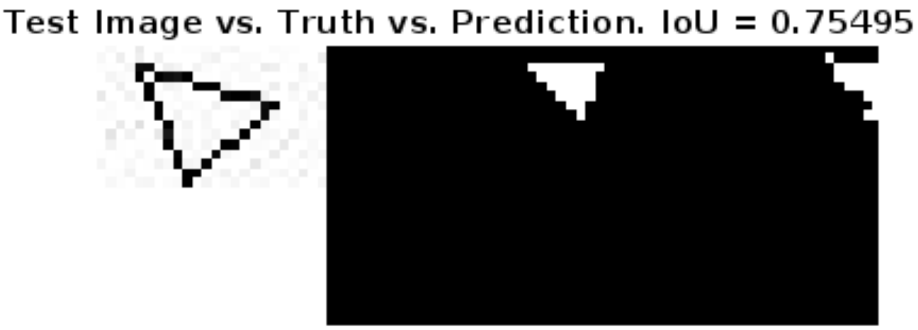

**Include your histogram in the report and answer: what was the most common mean IoU through the images?**

Between 0.66 and 0.69

**Lowest IoU**


st Image vs. Truth vs. Prediction. IoU = 0.59

**Best IoU**


Test Image vs. Truth vs. Prediction. IoU = 0.75495