Steel Segmentation

2023 Apr 12

Rundown

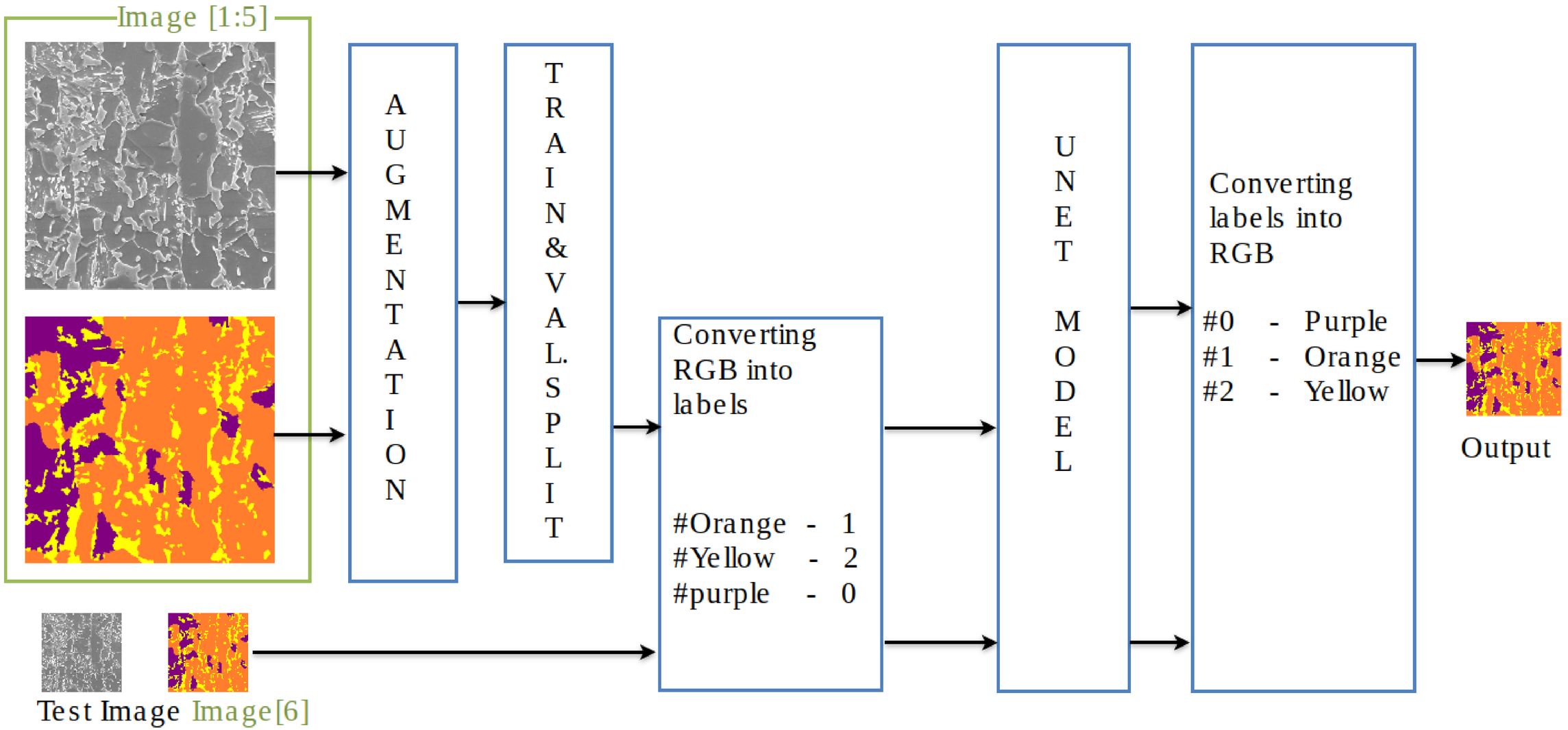
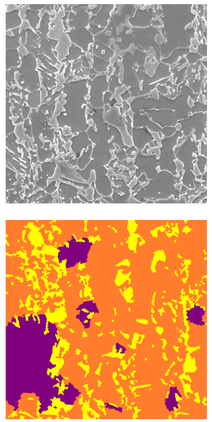


Image [1:5]
AUGMENTATION
TRAIN&VAL. SPLIT
Converting RGB into labels
#Orange - 1
#Yellow - 2
#purple - 0
UNET MODEL
Converting labels into RGB
#0 - Purple
#1 - Orange
#2 - Yellow
Output
Test Image
Image[6]

Model Outlook



Input Images

Convert to corresponding labels of {0, 1, 2}

reshape

- Set Model
- Set Optimizer
- Set Loss

Loop on Epoch

- Train
- Calculate Loss
- Optimize

Run Validation

If val_acc[i]> val_acc[i-1]

- Save Model State
- Calculate Metrics

Model	UNET
Optimizer	Adam
Loss	Focal (0.25)

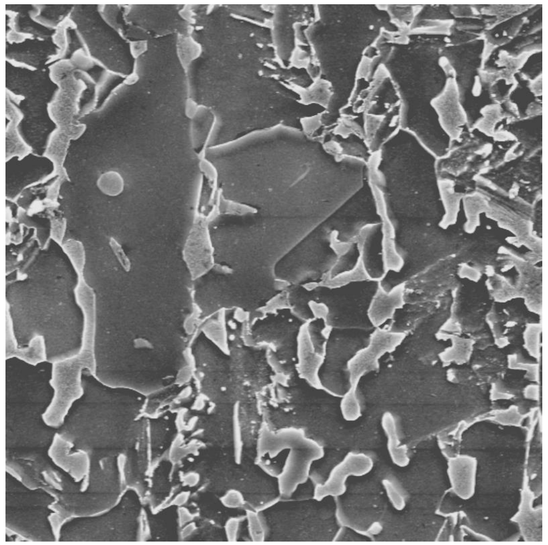
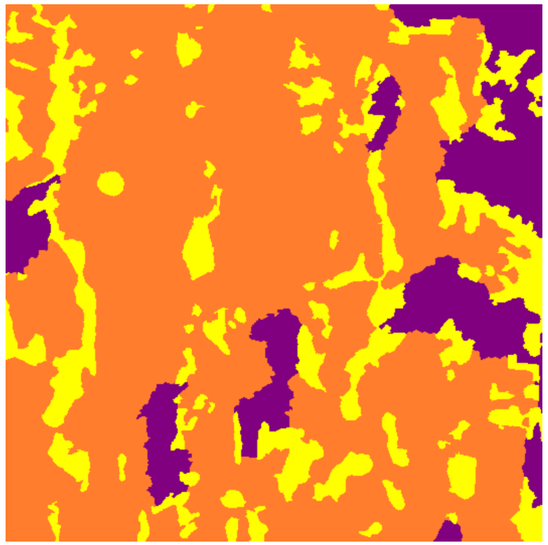
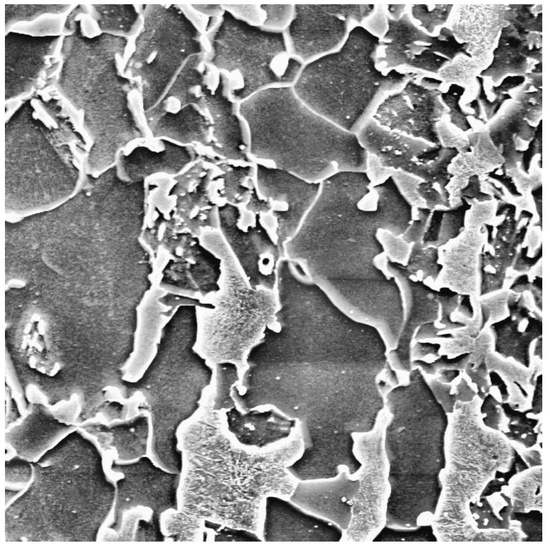
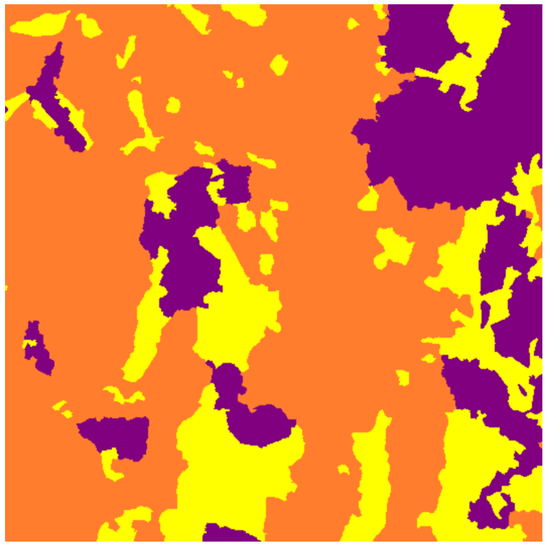
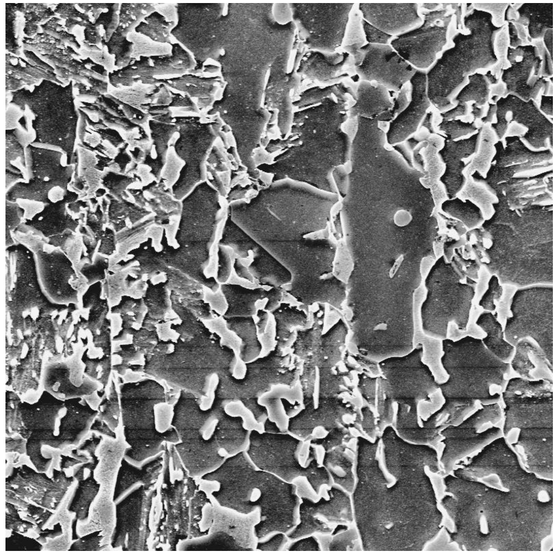
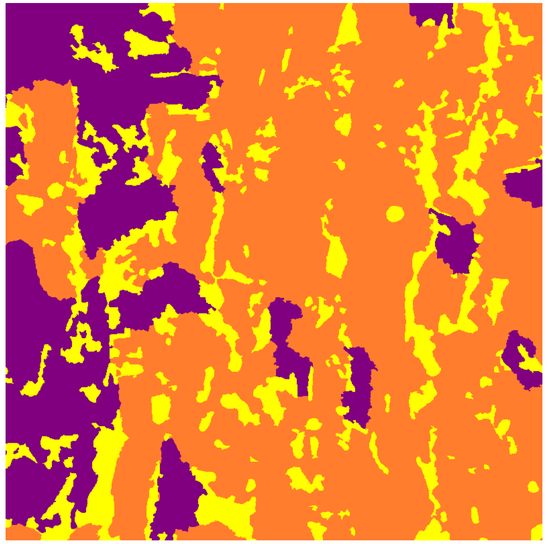
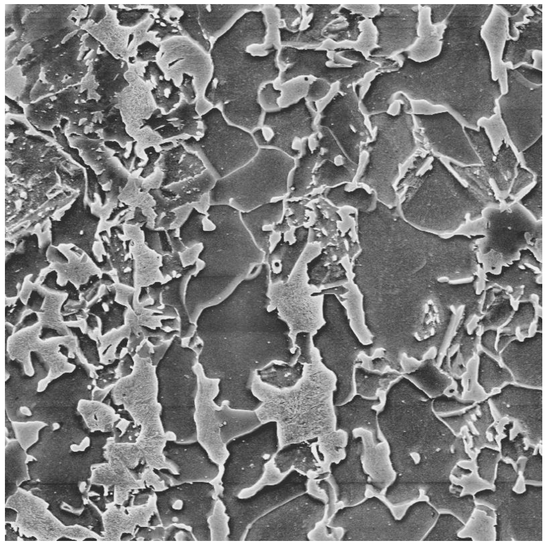
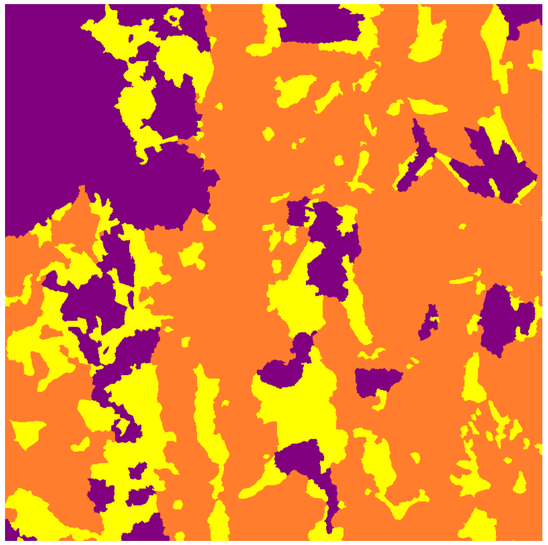
Setup

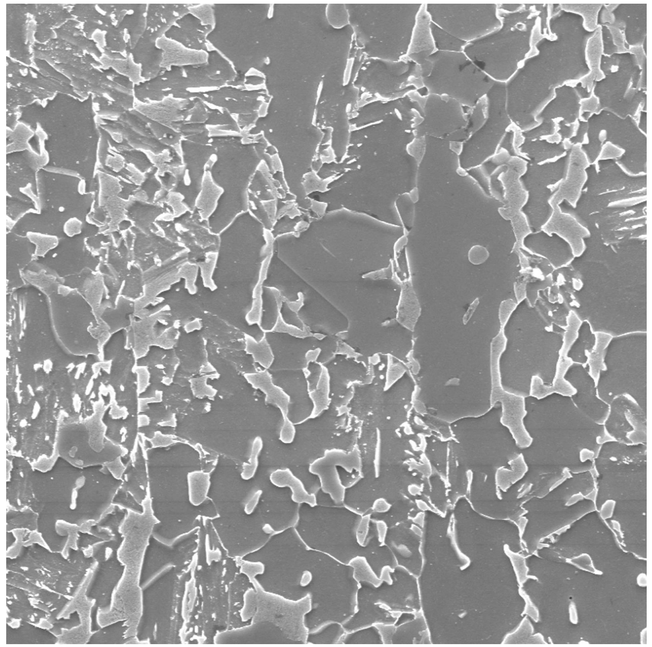
- kernel size - 3
- Batch Size - 16
- Learning Rate - 0.00001
- Channel - 16
- Depth - 4

Metrics

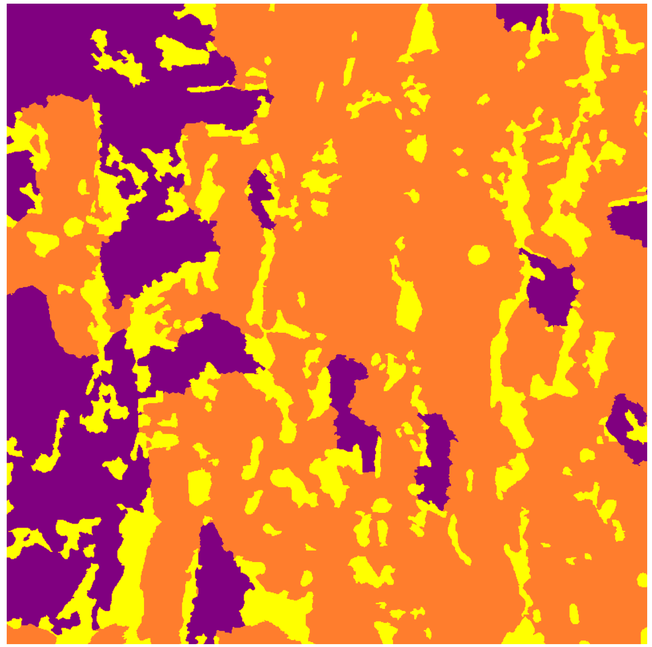
Loss, Confusion Matrix, mIoU, Accuracy

Sample Augmented Images

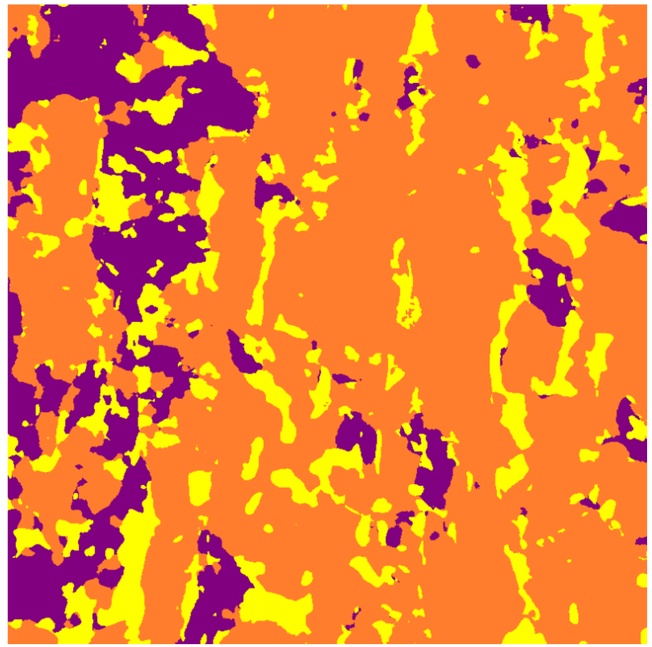











Original



Label



Prediction

Test Image - 6.bmp

Siren

None

Validation mIOU - 0.4684
Validation Acc - 95.31
Test Accuracy - 86.98
Dice Coefficient - 0.8509
Training mIOU -
Training Accuracy- 91.68

Siren

None

	Avg (10)	Avg (8)	(1)	(1)	(1)
	x3000	**x5000**	**test1 A type**	**test2 D3 type**	**test3 H2 type**
Current Model	86.12 (85.3)	89.77 (89.18)	74.87 (75.05)	40.02 (42.61)	69.8 (70.89)
Prev. Model	75.81	79.29	74.83	55.71	67.52

Accuracy Percentage (Old Acc with black bar)

Epochs - 200
Train Image Size - 800x800
Test Image Size - 1280x1024

Siren

None

	Avg (10)	Avg (8)	(1)	(1)	(1)
	x3000	**x5000**	**test1 A type**	**test2 D3 type**	**test3 H2 type**
Current Model	0.8487 (0.8405)	0.8852 (0.8793)	0.7383 (0.7380)	0.3998 (0.4236)	0.6955 (0.6964)
Prev. Model	0.7514	0.7845	0.7324	0.5944	0.6252

Dice Coefficient (with black bar)

Epochs - 200
Train Image Size - 800x800
Test Image Size - 1280x1024

Siren

None

	Avg (10)	Avg (8)	(1)	(1)	(1)
	x3000	**x5000**	**test1 A type**	**test2 D3 type**	**test3 H2 type**
Current Model	86.12 (85.3)	89.77 (89.18)	74.87 (75.05)	40.02 (42.61)	69.8 (70.89)
Yellow Accuracy	63.72	66.22	47.56	60.69	72.51
Orange Accuracy	96.44	97.78	90.92	67.79	90.25
Purple Accuracy	31.28	34.78	58.72	33.98	24.6

Epochs - 200
Train Image Size - 800x800
Test Image Size - 1280x1024

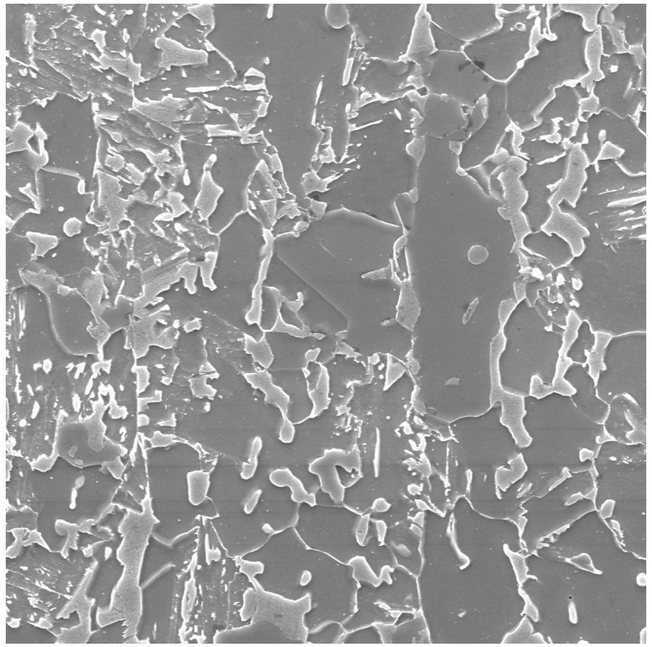
(Old Acc with black bar)

Inference Images

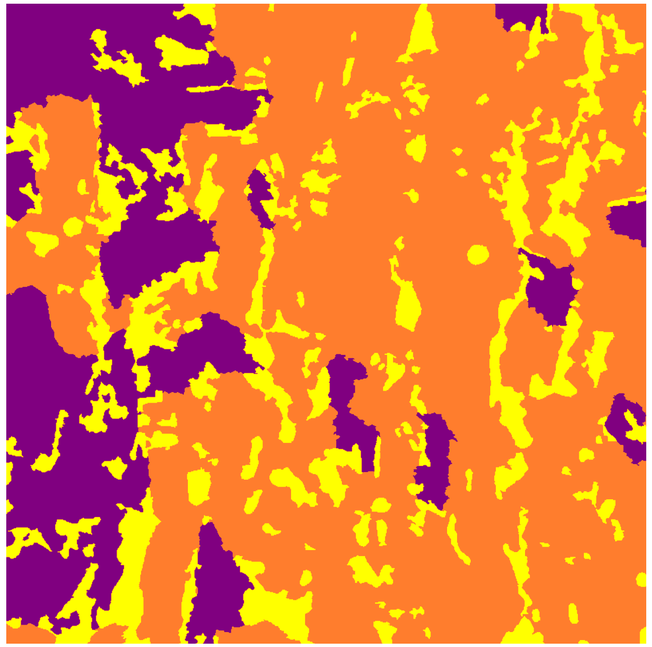
Test Image Siren

image 6.bmp None

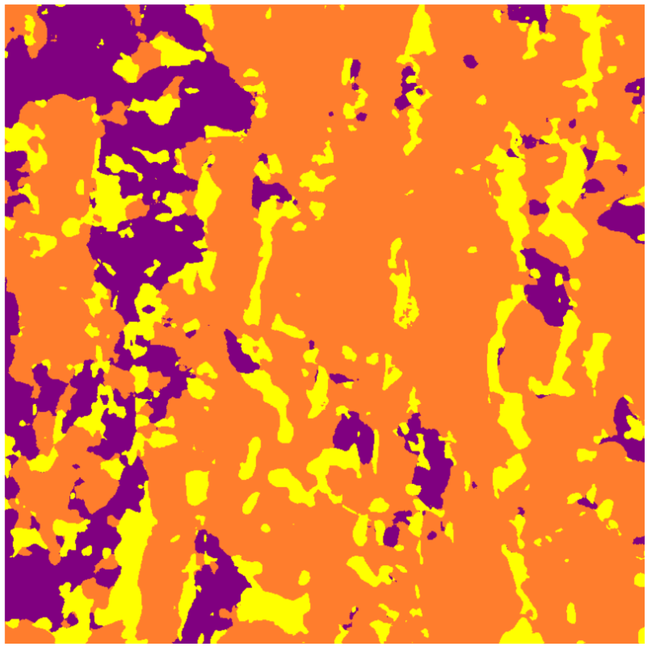
Original



Label



Prediction



Accuracy - 86.98

Inference Images

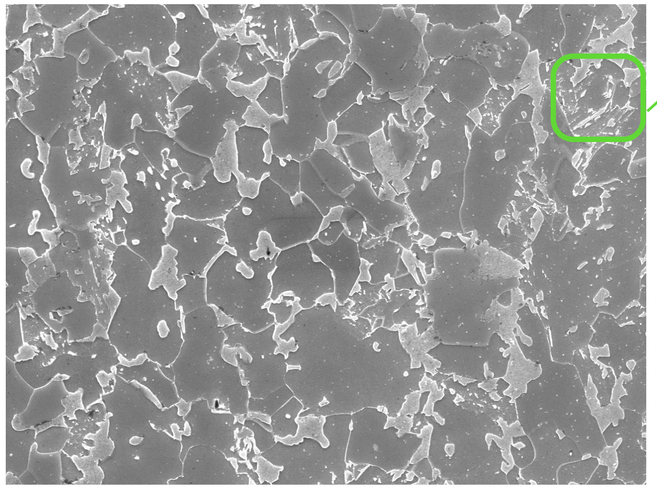
x3000

image 4.bmp

Siren

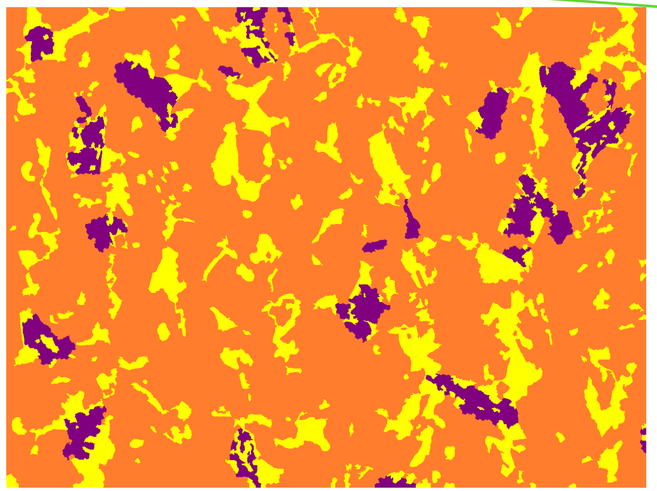
None

Original

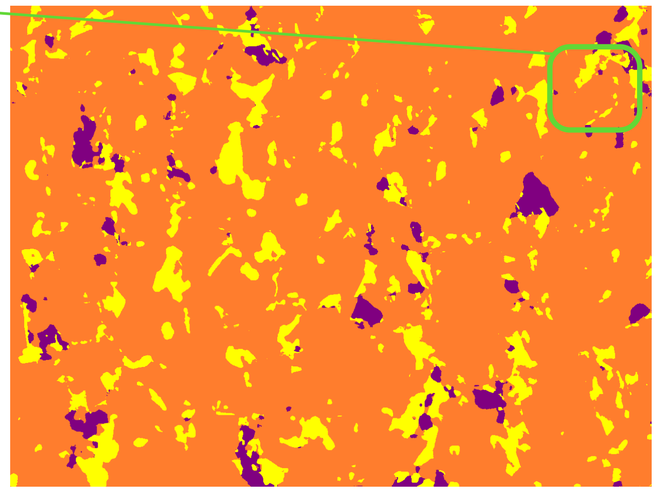


Label

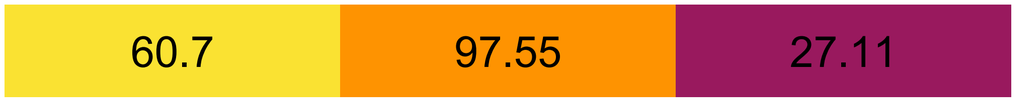
Finer Detailed structures are ignored



Prediction



Accuracy - 86.4 (With Black Bar - 86.1)



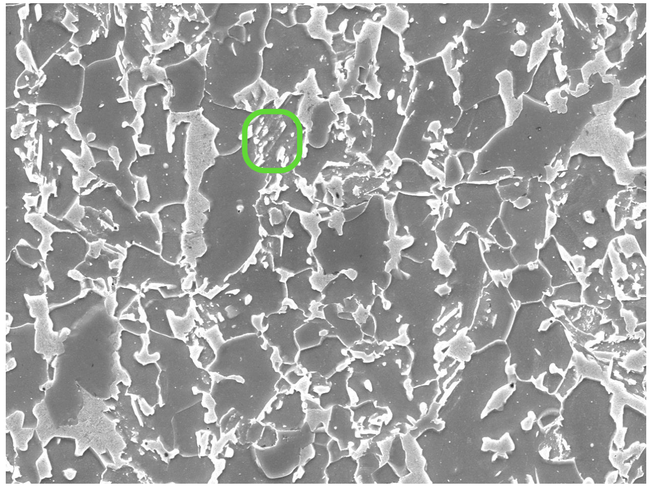
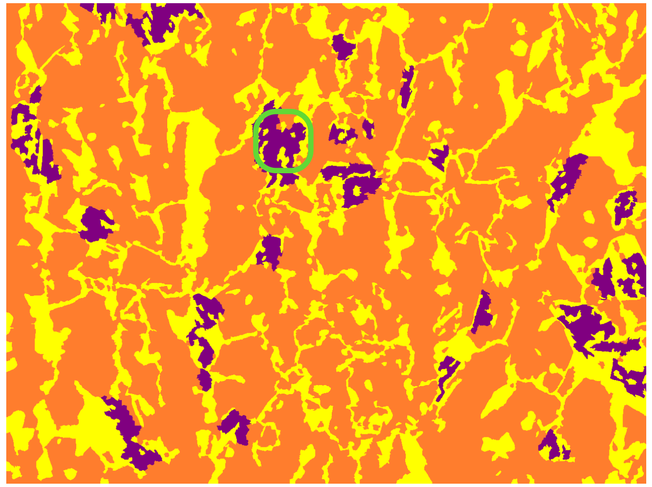
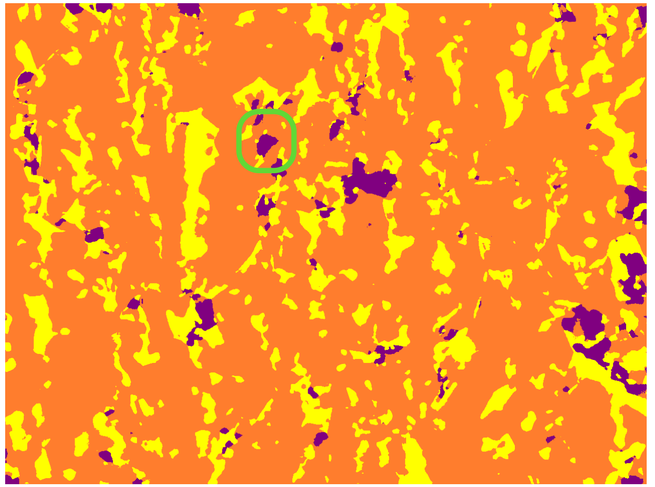
Inference Images

x3000

Siren

image 6.bmp

None

Original	Label	Prediction
		

Accuracy - 85.9 (With Black Bar - 85.8)

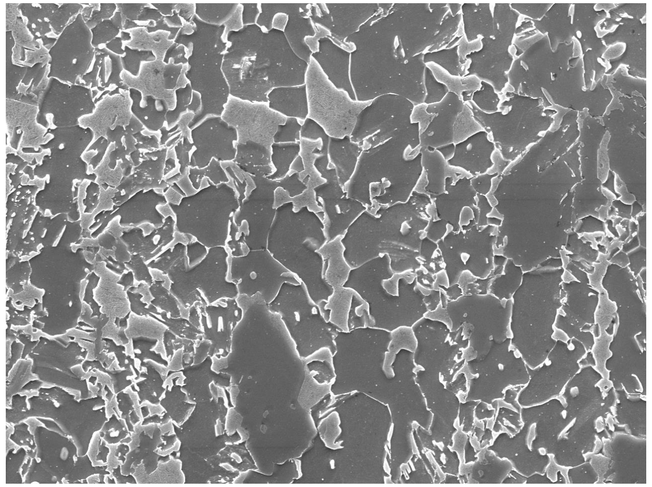
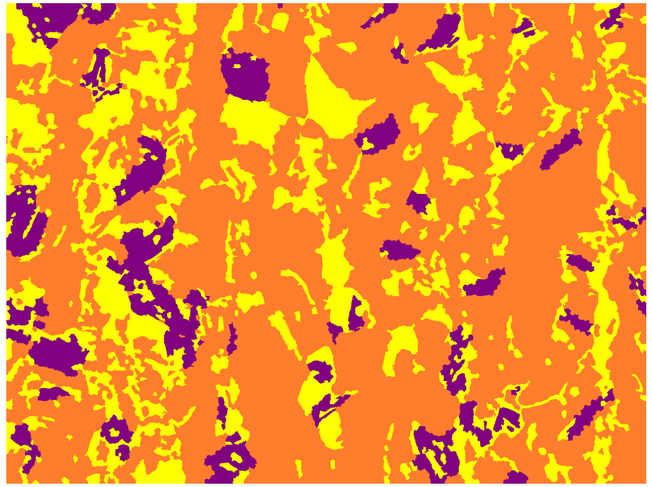
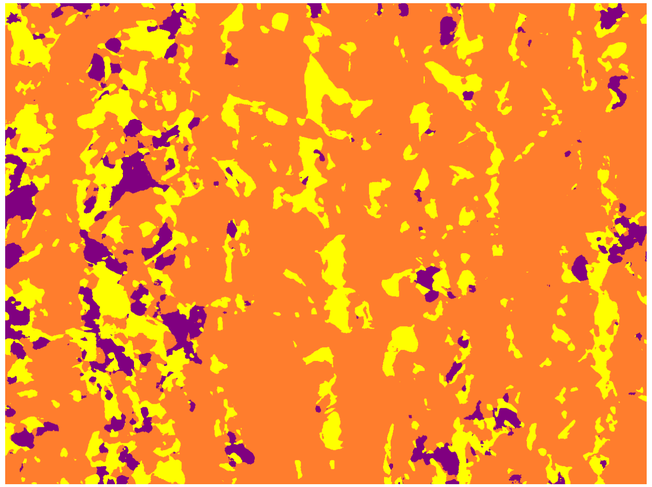
Inference Images

x3000

Siren

image 2.bmp

None

Original	Label	Prediction
		

Accuracy - 81.3 (With Black Bar - 81.1)

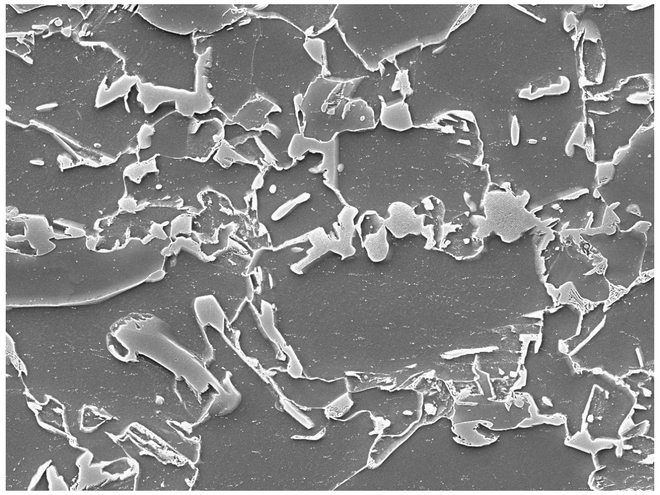
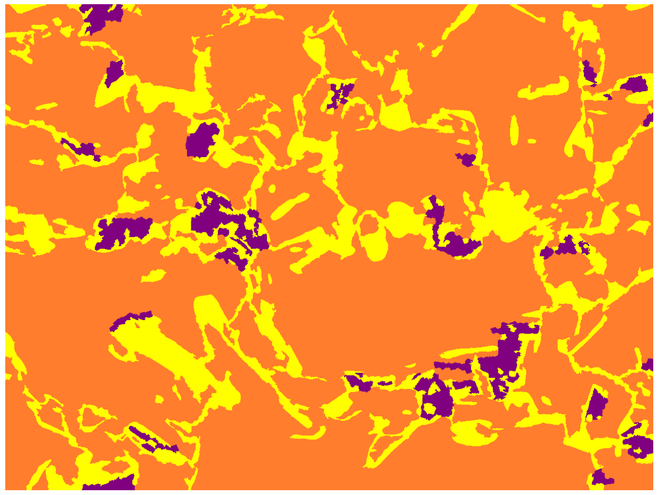
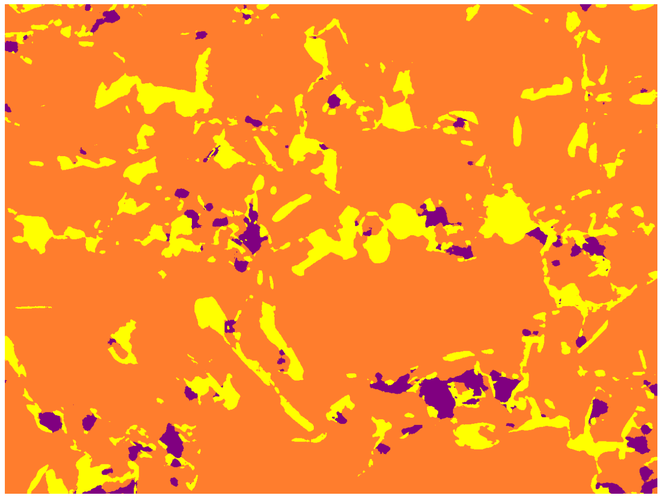
Inference Images

x5000

Siren

image 2.bmp

None

Original	Label	Prediction
		

Accuracy - 88.3 (With Black Bar - 85.3)

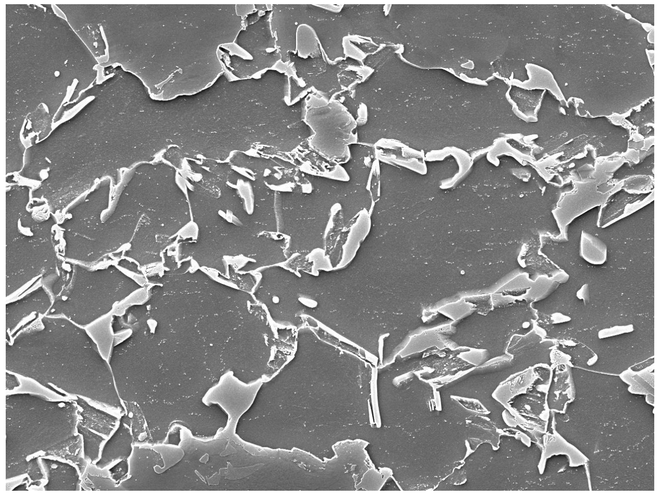
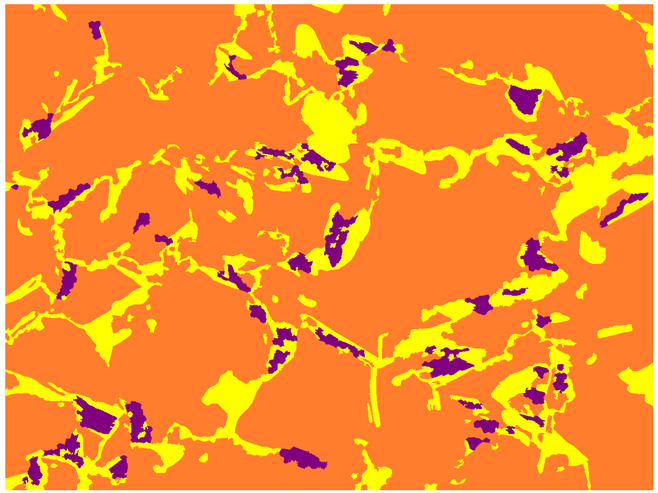
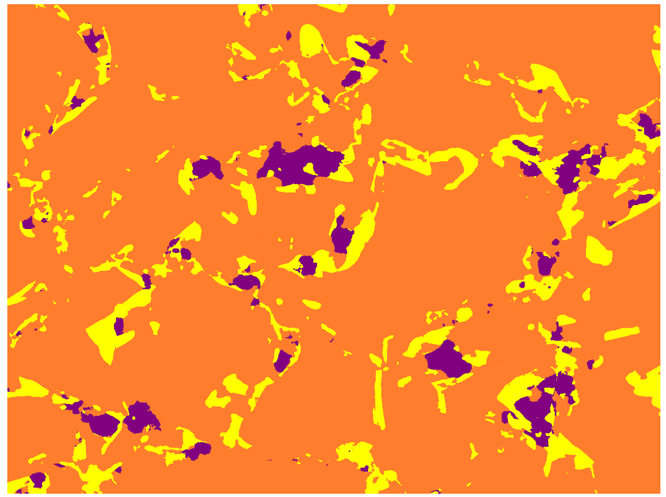
Inference Images

x5000

Siren

image 1.bmp

None

Original	Label	Prediction
		

Accuracy - 88.5 (With Black Bar - 88.3)

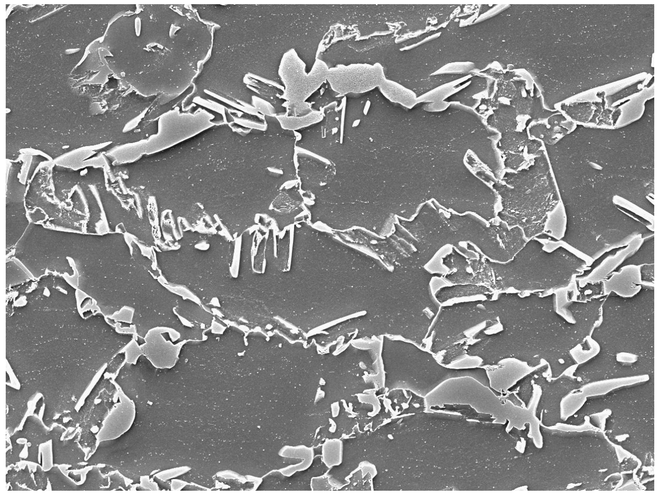
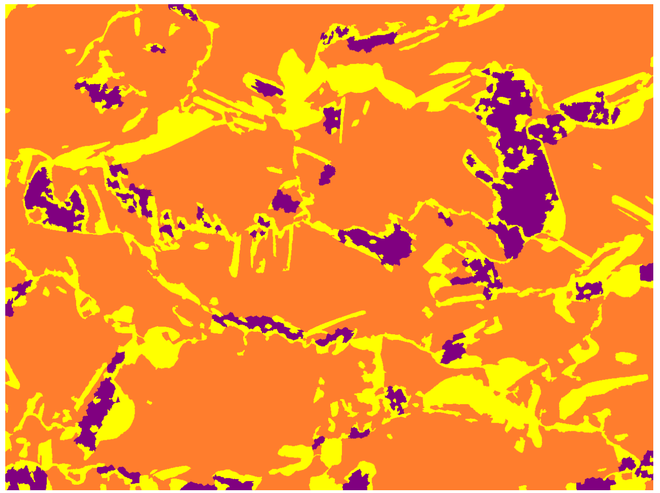
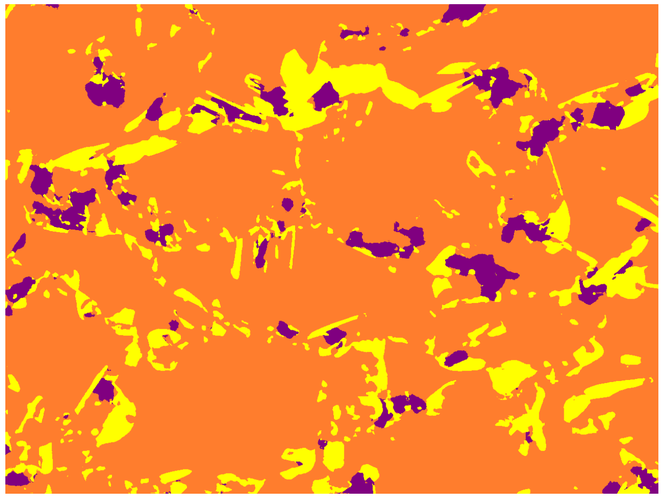
Inference Images

x5000

Siren

image 3.bmp

None

Original	Label	Prediction
		

Accuracy - 86.5 (With Black Bar - 82.1)

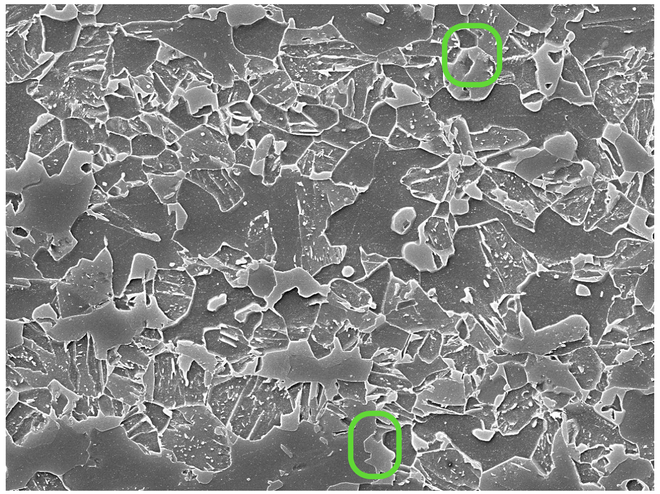
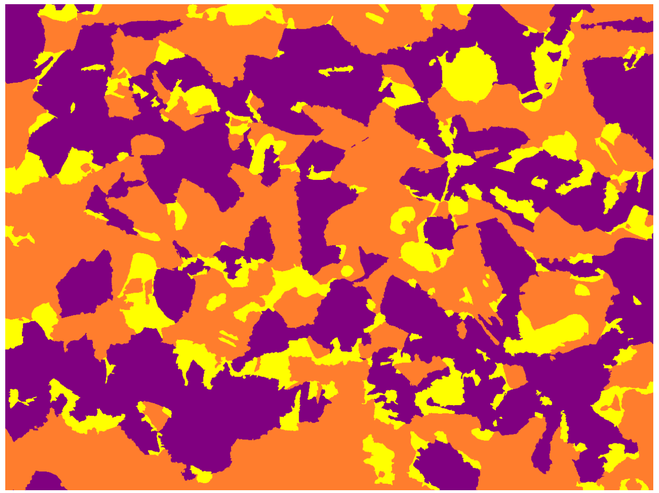
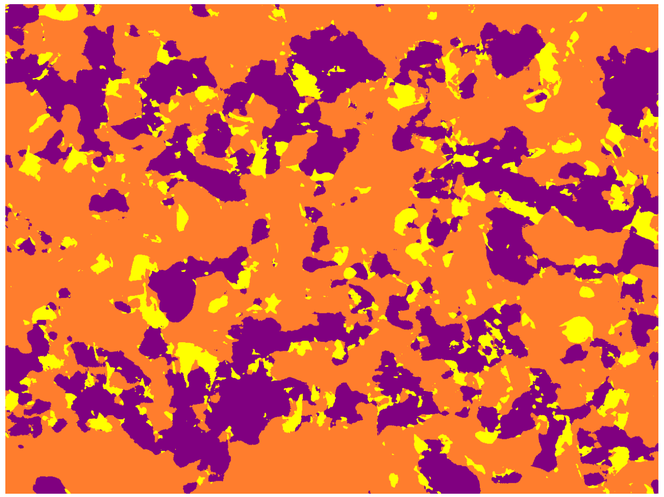
65.53	97.39	35.72

Inference Images

test1 A type

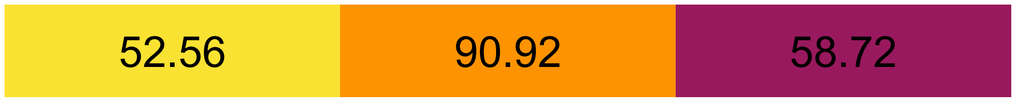
Siren

None

Original	Label	Prediction
		

Similar structure but look different

Accuracy - 74.8 (With Black Bar - 75.05)

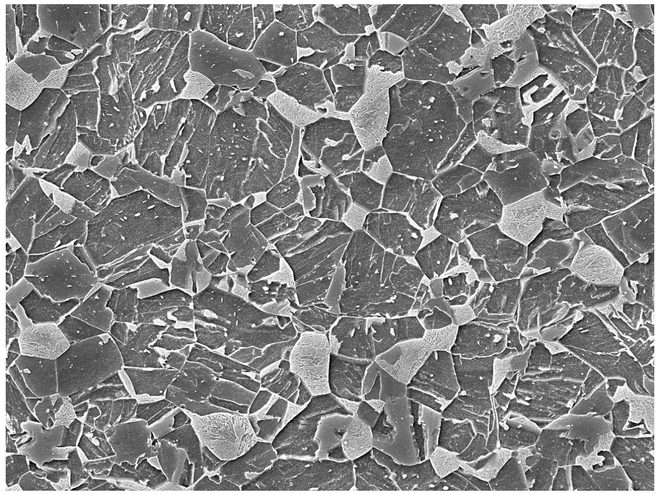
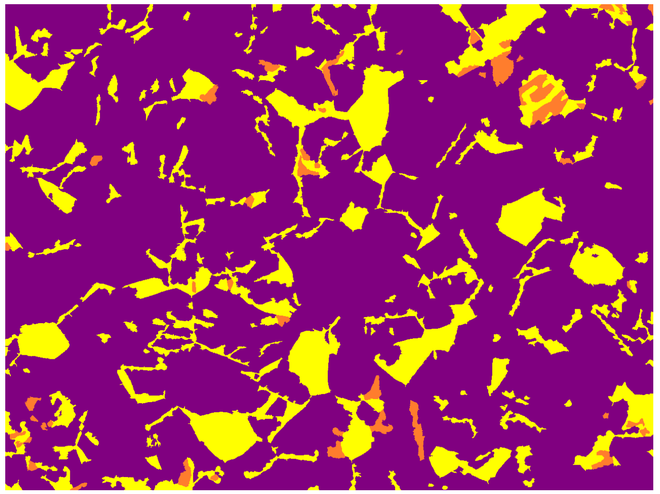
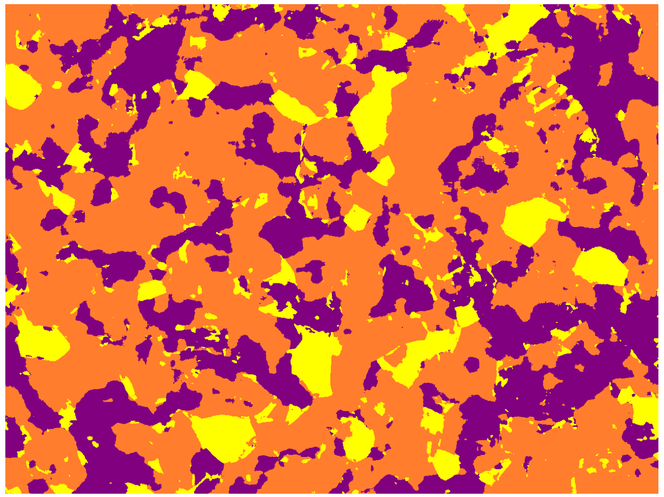


Inference Images

test2 D3 type

Siren

None

Original	Label	Prediction
		

The composition of this Image varies a lot from the trained images

Accuracy - 40.2 (With Black Bar - 42.61)

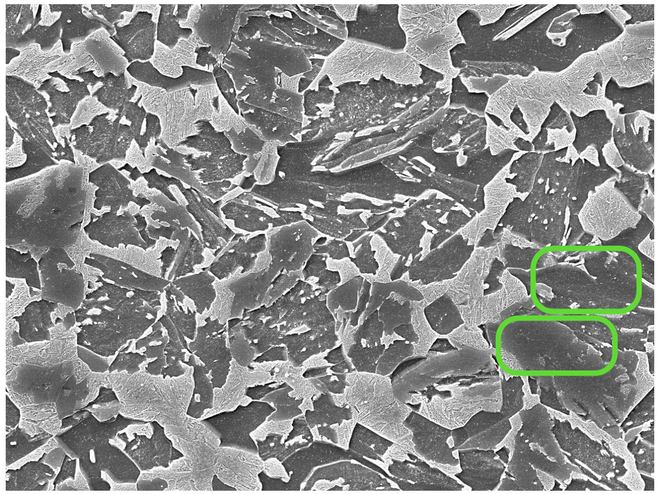
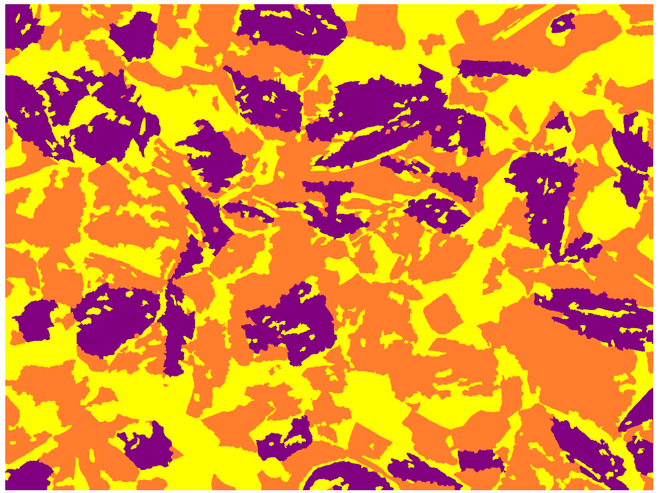
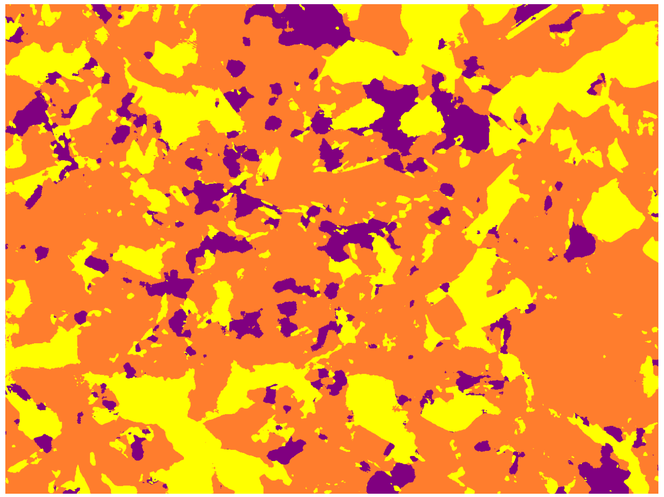
61.69	67.79	33.98

Inference Images

test3 H2 type

Siren

None

Original	Label	Prediction
		

Different Structures but look similar

Accuracy - 69.8 (With Black Bar - 70.8)

Siren

Blur Pooling	x3000	x5000	test1 A type	test2 D3 type	test3 H2 type
	Avg (10)	Avg (8)	(1)	(1)	(1)
None	86.12 (85.3)	89.77 (89.18)	74.87 (75.05)	40.02 (42.61)	69.8 (70.89)
	63.72 96.44 31.28	66.23 97.78 34.78	47.56 90.92 58.72	60.69 67.79 33.98	72.51 90.25 24.6
Down	84.81 (84.48)	90.01 (90.64)	75.25 (76.23)	47.18 (48.77)	71.1 (71.87)
	75.82 91.3 21.6	80.53 97.18 39.78	60.86 84.51 61.47	72.81 57.87 40.18	81.45 80.56 37.8
Up	82.16 (81.52)	89.88 (89.23)	61.53 (62.23)	41.33 (42.76)	70.4 (71.5)
	49.89 96.67 11.54	68.7 97.21 17.55	60.34 91.63 31.84	74.95 65.85 29.81	76.15 86.93 30.63
Down + Up	83.4 (83.39)	89.91 (89.8)	62.44 (63.7)	44.76 (46.2)	69.86 (70.6)
	51.48 96.27 13.86	77.91 96.36 19.52	66.9 85.18 38.2	80.91 51.54 36.81	82.15 79.38 33.54

Accuracy (with black bar)

Siren

	Avg (10)	Avg (8)	(1)	(1)	(1)
Blur Pooling	**x3000**	**x5000**	**test1 A type**	**test2 D3 type**	**test3 H2 type**
None	0.8587	0.8952	0.7462	0.3977	0.6955
Down	0.8456	0.8976	0.75	0.4693	0.7085
Up	0.8191	0.8963	0.6128	0.4108	0.7015
Down + Up	0.8315	0.8966	0.6219	0.4451	0.6961

DICE

Inference Images

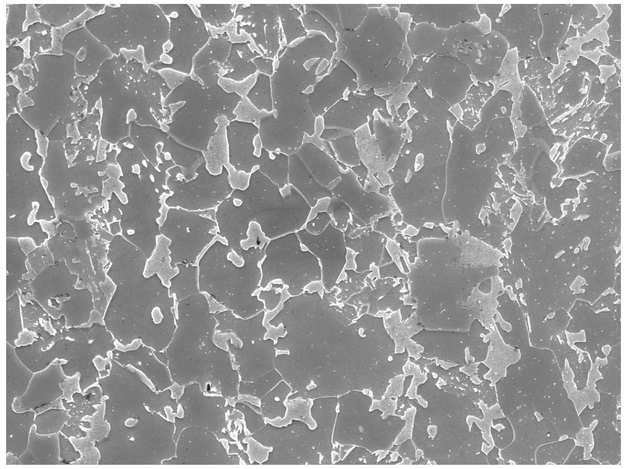
x3000

Siren

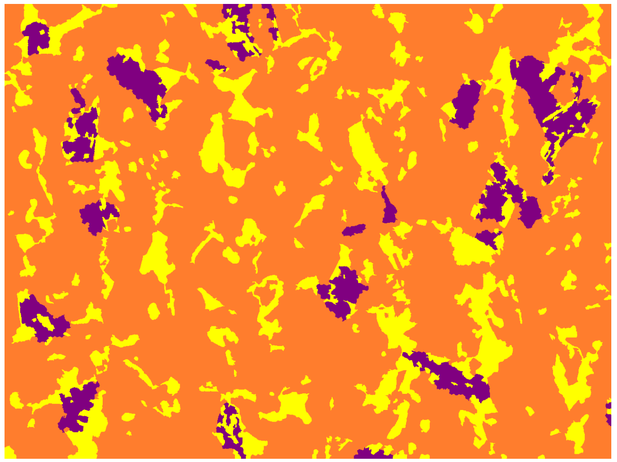
image 4.bmp

None

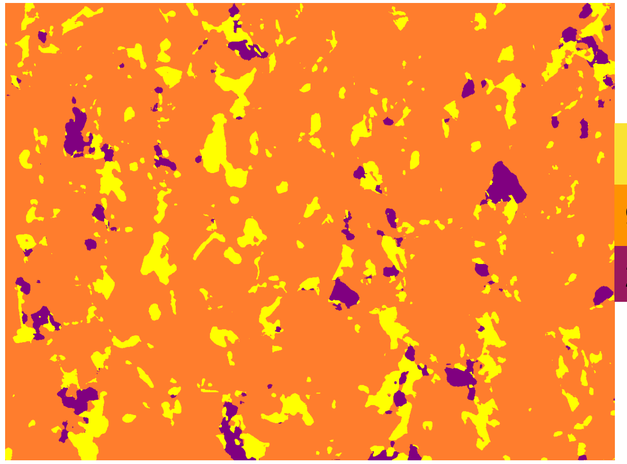
Original



Label



Prediction



60.7

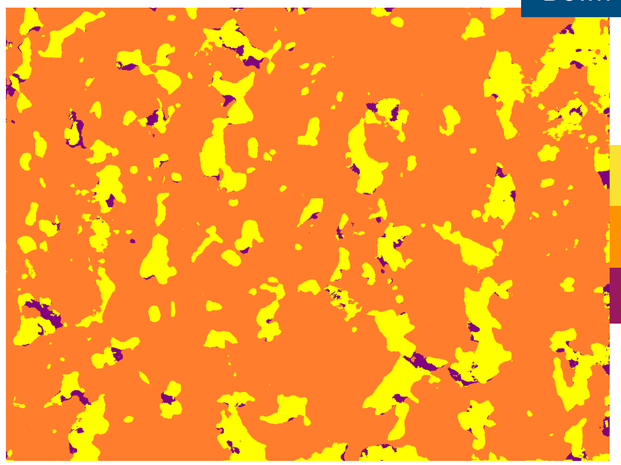
97.55

27.11

Accuracy - 86.4

Prediction

Down



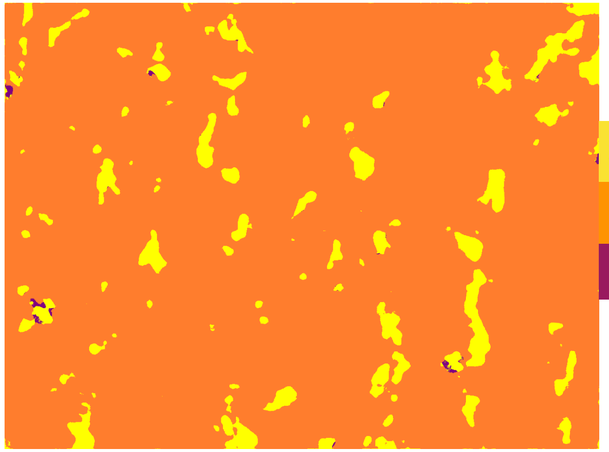
57.3

96.09

8.45

Accuracy - 84.8 (83.31)

Up



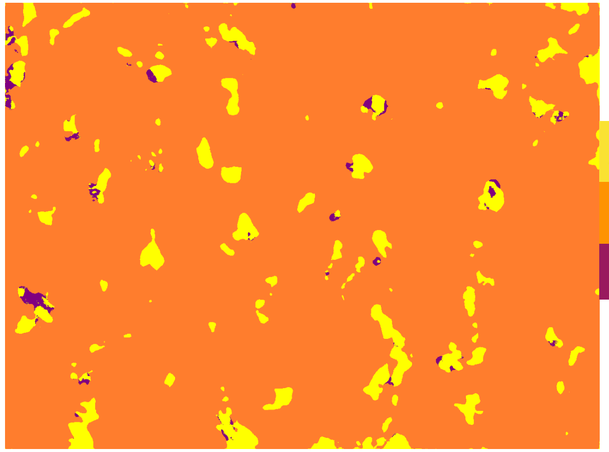
34.14

99.2

2.31

Accuracy - 81.2 (80.8)

DownUp



28.75

98.52

4.28

Accuracy - 80.0 (79.6)

Inference Images

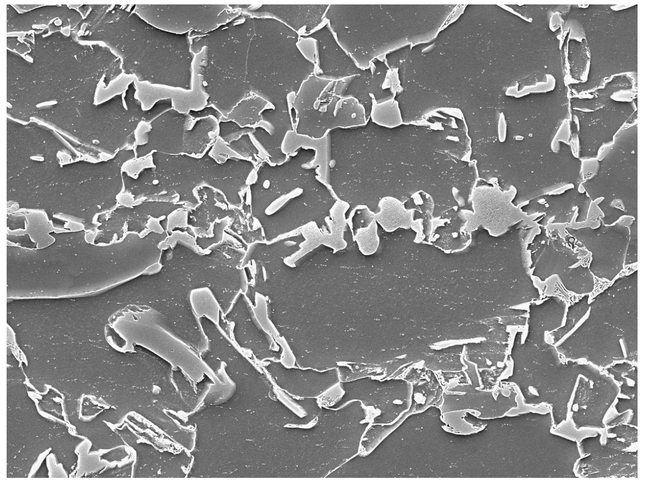
x5000

Siren

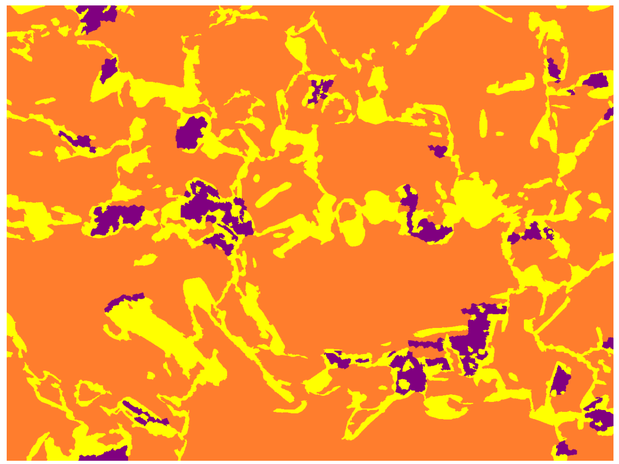
None

image 2.bmp

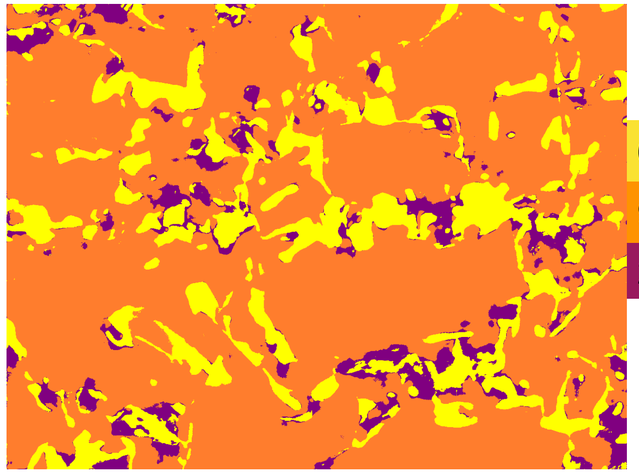
Original



Label



Prediction

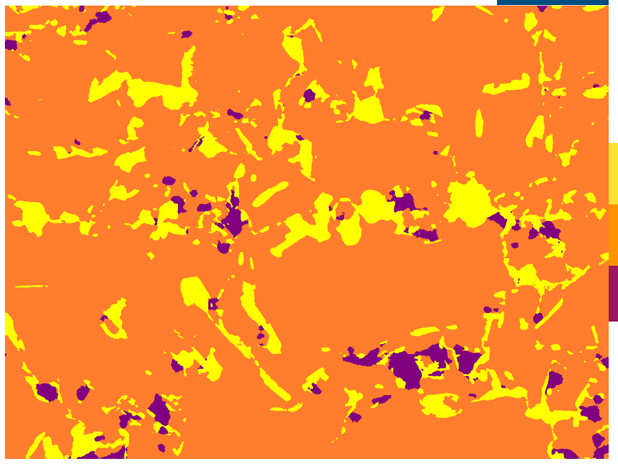


64.29
98.03
29.51

Accuracy - 87.7

Prediction

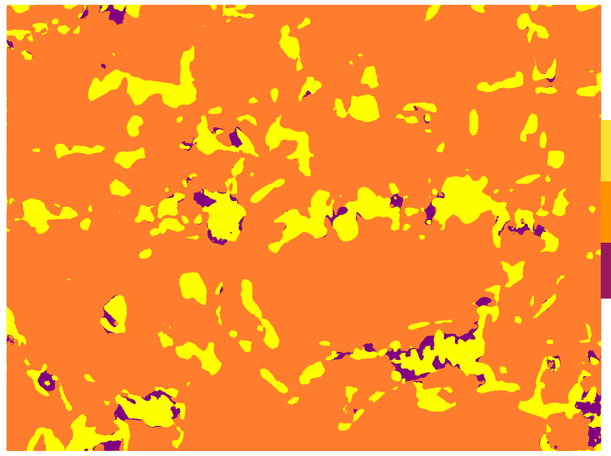
Down



78.51
91.03
39.66

Accuracy - 88.3 (86.02)

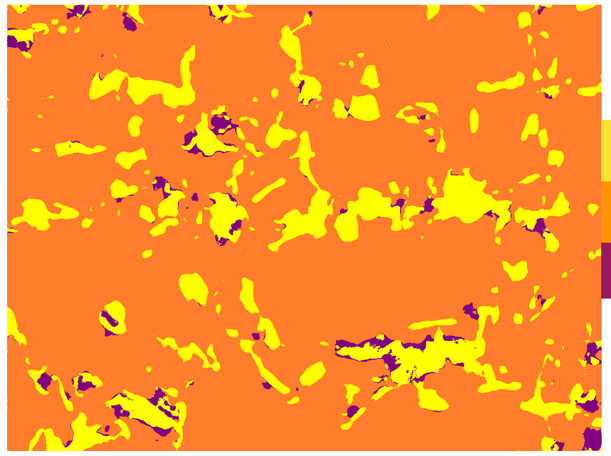
Up



65.19
97.32
18.21

Accuracy - 87.4 (83.52)

DownUp



66.04
95.85
11.54

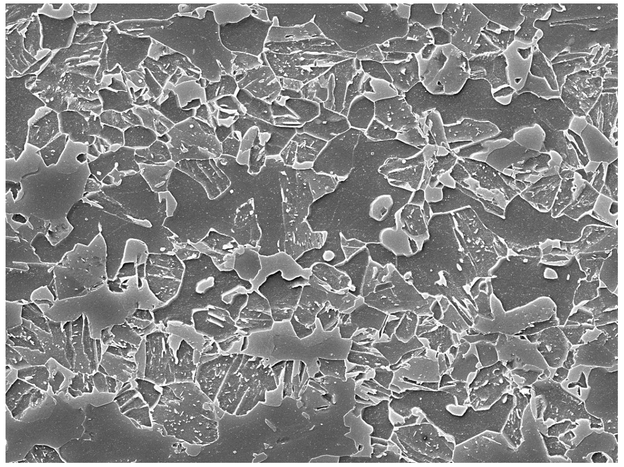
Accuracy - 86.2 (86.1)

Inference Images

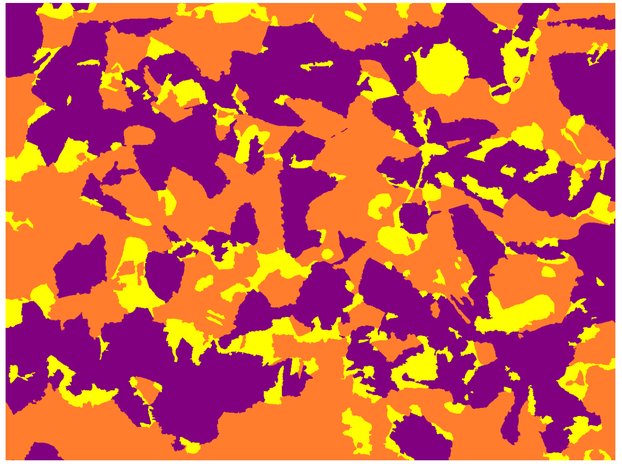
test1 A type Siren

image 0.bmp None

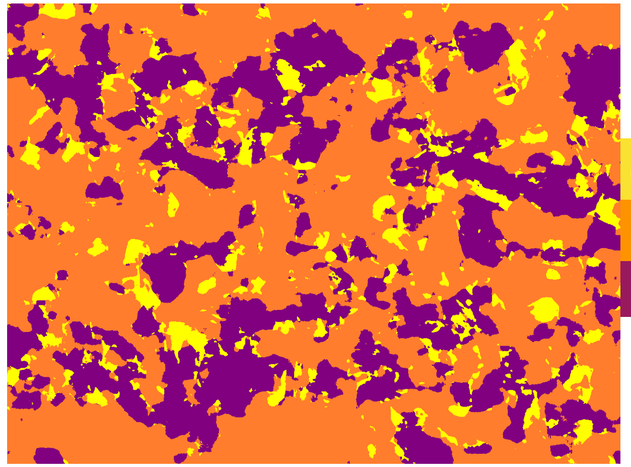
Original



Label



Prediction

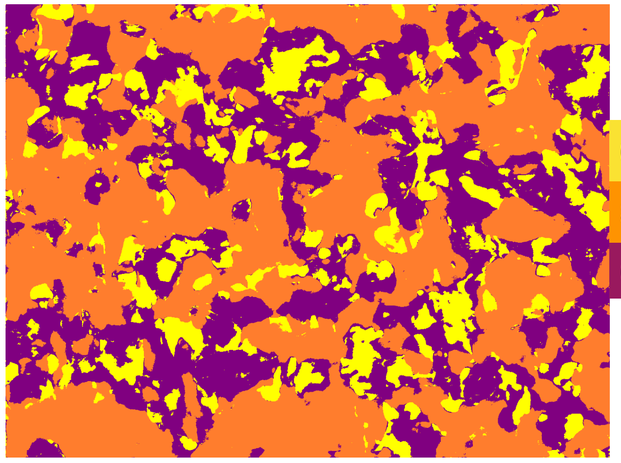


47.51
90.92
58.72

Accuracy - 74.8

Prediction

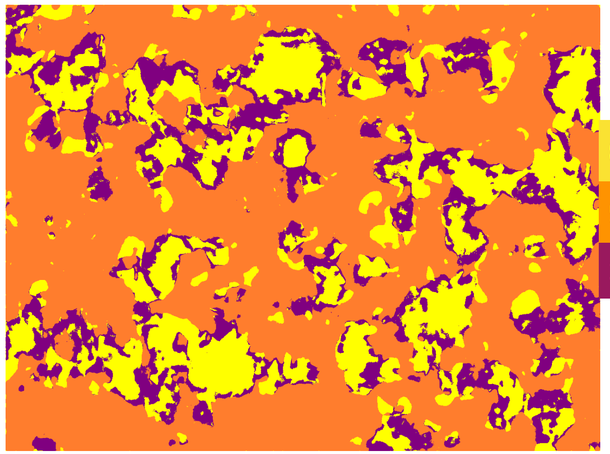
Down



60.86
84.51
61.49

Accuracy - 75.25 (76.23)

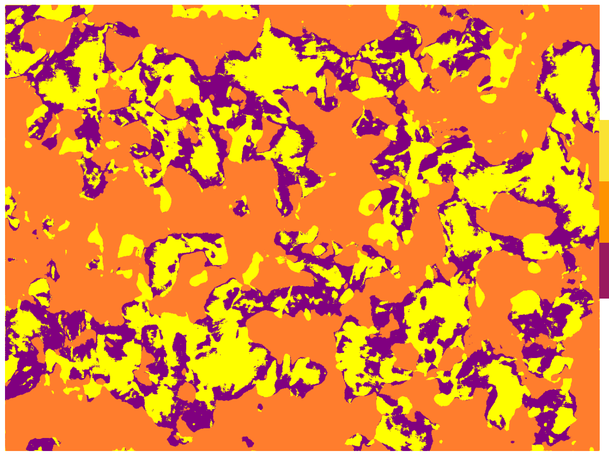
Up



60.34
91.63
31.84

Accuracy - 61.5 (62.5)

DownUp



66.9
85.18
38.2

Accuracy - 62.4 (63.7)

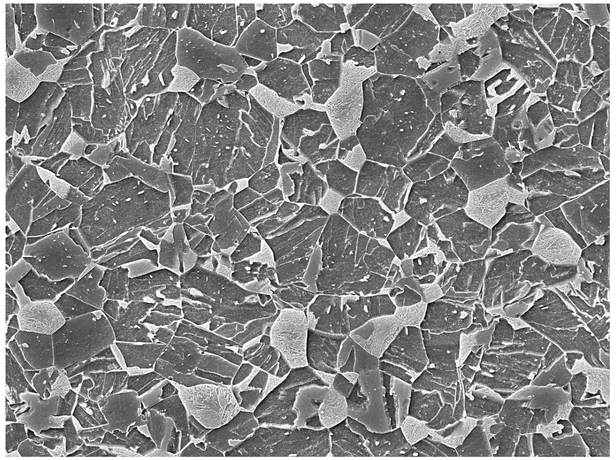
Inference Images

test2 D3 type Siren

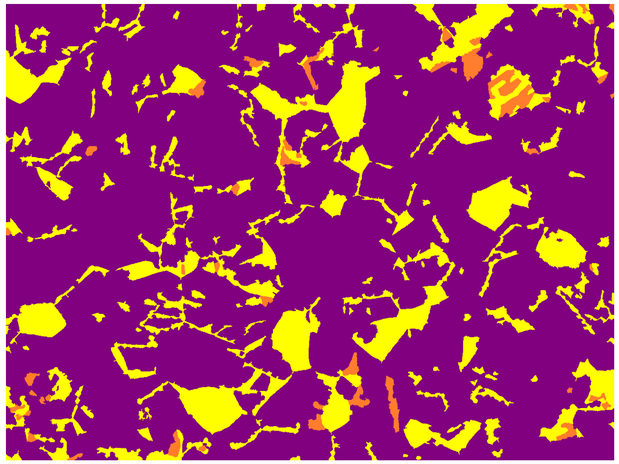
image 0.bmp

None

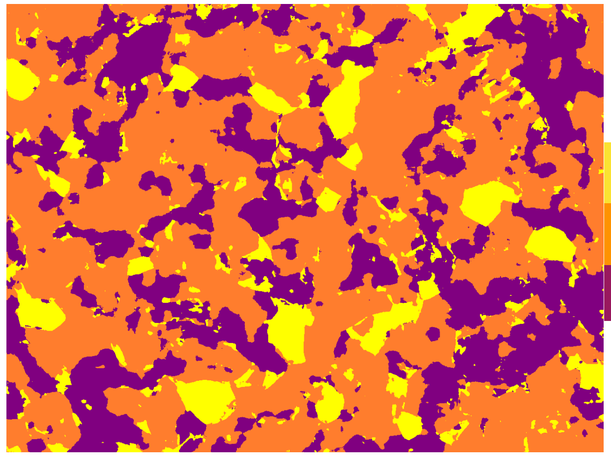
Original



Label



Prediction

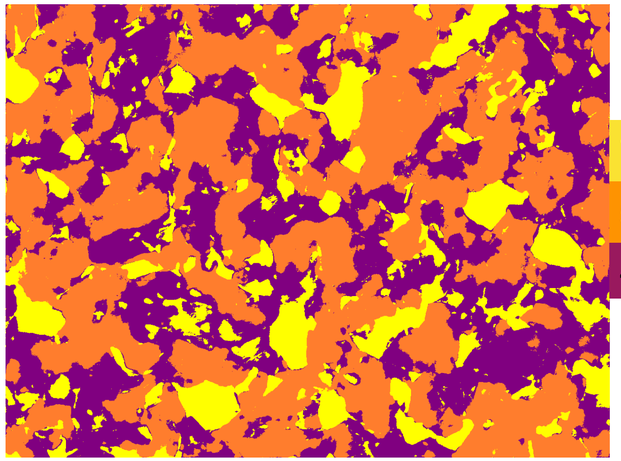


60.69
67.79
33.98

Accuracy - 40.2

Prediction

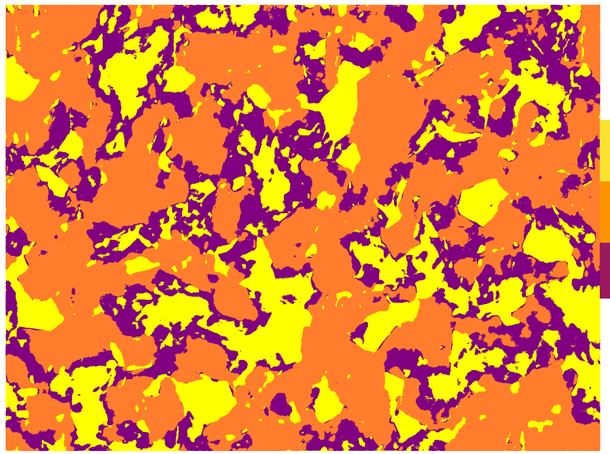
Down



72.81
57.87
40.18

Accuracy - 47.18

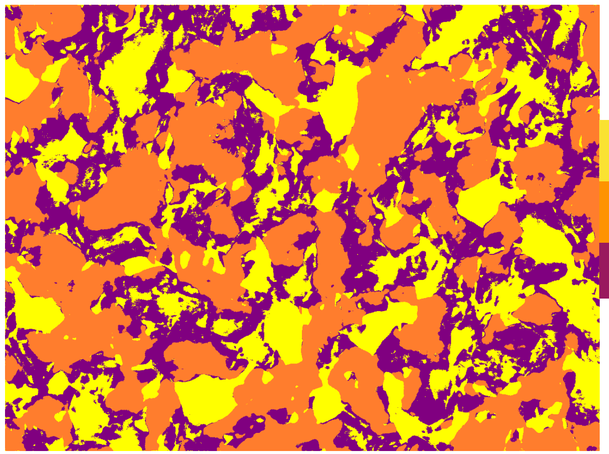
Up



74.95
65.85
29.81

Accuracy - 41.33 (42.7)

DownUp



80.91
51.54
36.81

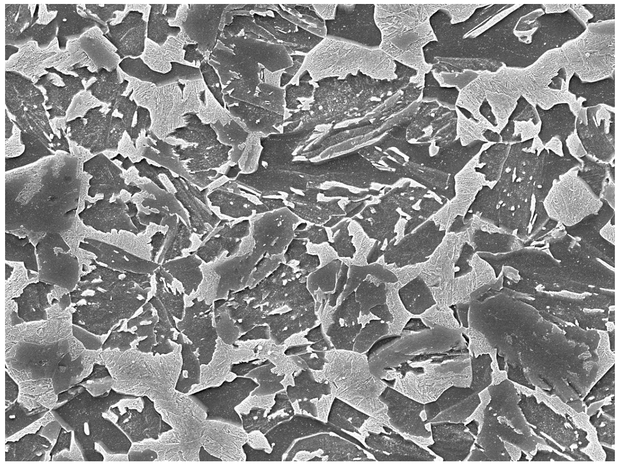
Accuracy - 44.76 (46.2)

Inference Images

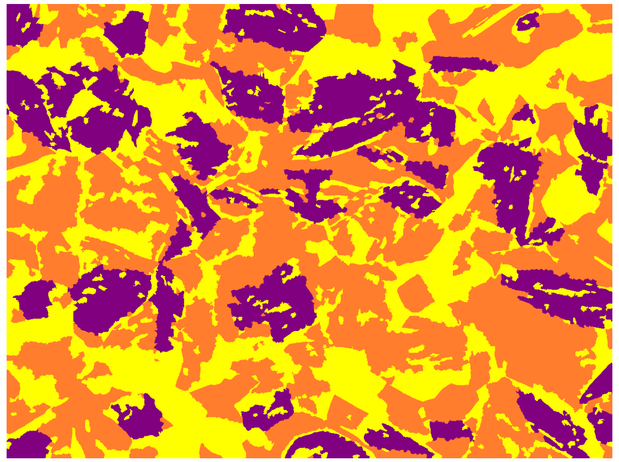
test3 H2 type Siren

image 0.bmp None

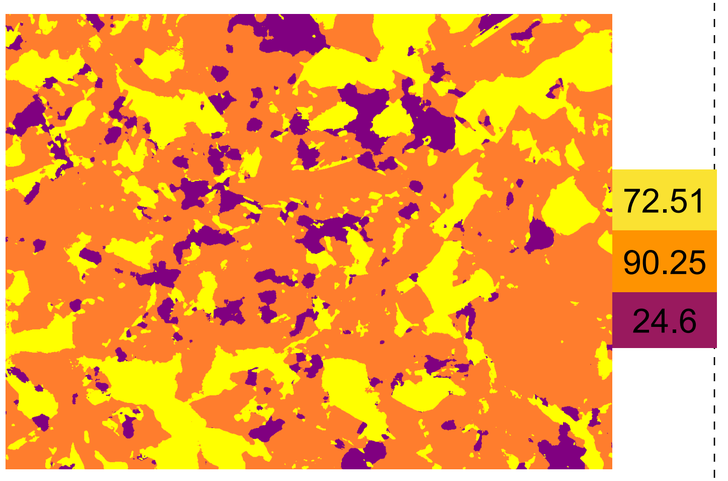
Original



Label



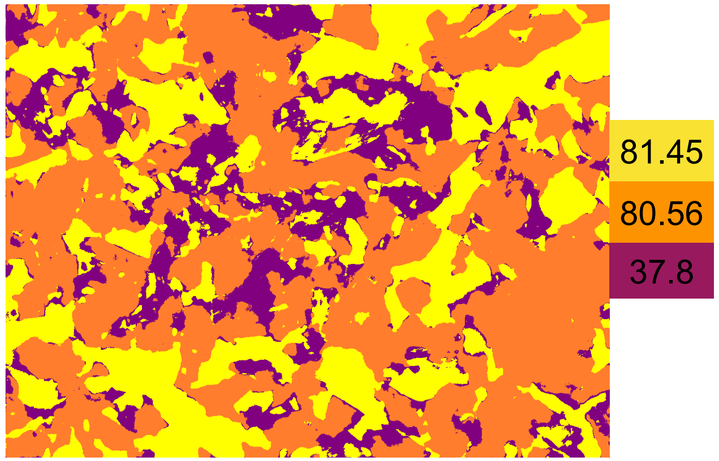
Prediction



Accuracy - 69.8

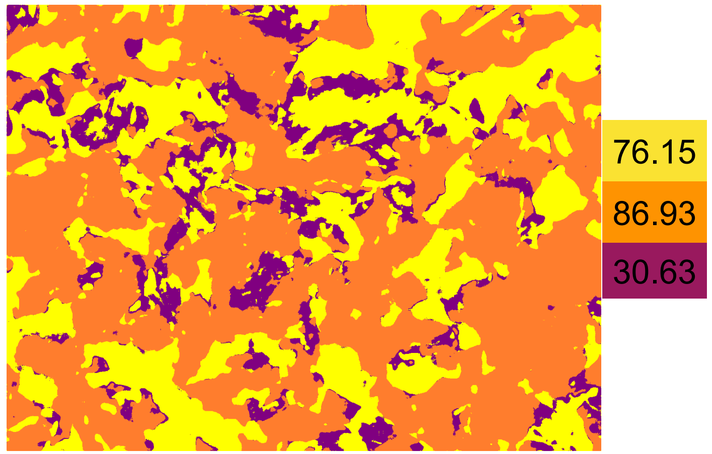
Prediction

Down



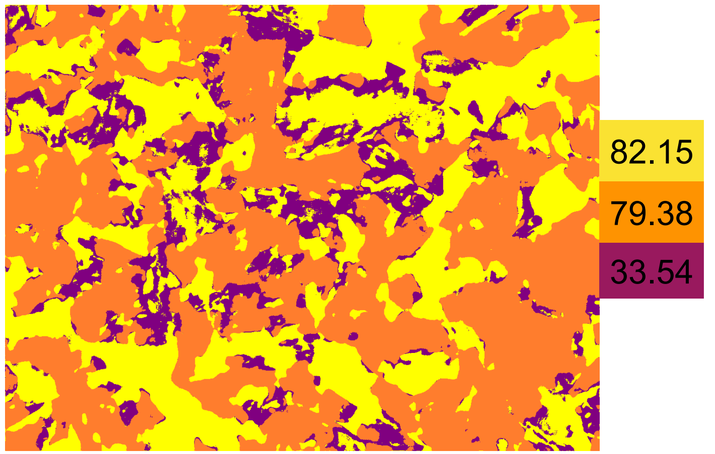
Accuracy - 71.1 (71.8)

Up



Accuracy - 70.4 (71.5)

DownUp



Accuracy - 69.86 (70.6)

None

Siren Vs ReLU Activation Function

	x3000	x5000	test1 A type	test2 D3 type	test3 H2 type
	Avg (10)	Avg (8)	(1)	(1)	(1)
Siren	86.12 (85.3)	89.77 (89.18)	74.87 (75.05)	40.02 (42.61)	69.8 (70.89)
	63.72 96.44 31.28	66.23 97.78 34.78	47.56 90.92 58.72	60.69 67.79 33.98	72.51 90.25 24.6
ReLU	83.97 (82.12)	90.01 (87.96)	77.41 (77.67)	64.75 (63.1)	73.89 (74.73)
	60.91 91.41 55.1	74.33 94.19 62.19	49.97 81.79 82.27	73.98 32.14 63.51	81.51 73.96 62.44

Accuracy Percentage (with black bar)

None

Siren Vs ReLU Activation Function

	Avg (10)	Avg (8)	(1)	(1)	(1)
	x3000	**x5000**	**test1 A type**	**test2 D3 type**	**test3 H2 type**
Siren	0.8487	0.8852	0.7383	0.3998	0.6955
ReLU	0.8372	0.8976	0.7716	0.645	0.7364

Dice

ReLU

Blur Pooling	x3000	x5000	test1 A type	test2 D3 type	test3 H2 type
	Avg (10)	Avg (8)	(1)	(1)	(1)
None	83.97 (82.12) 60.91 91.41 55.1	90.01 (87.96) 74.33 94.19 62.19	77.41 (77.67) 49.97 81.79 82.27	64.75 (63.1) 73.98 32.14 63.51	73.89 (74.73) 81.51 73.96 62.44
Down	83.53 (81.9) 60.94 95.16 42.59	87.69 (84.48) 61.7 97.14 38.38	70.83 (71.1) 39.52 93.37 58.82	52.5 (51.3) 68.16 56.58 49.1	68.02 (69.6) 61.95 90.87 33.89
Up	84.41 (84.18) 65.54 94.72 47.2	87.93 (83.52) 62.26 96.91 43.96	76.73 (77.2) 47.76 89.86 73.47	45.04 (42.1) 64.73 67 40.3	69.0 (70.5) 65.77 89.5 35.05
Down + Up	84.3 (83.9) 64.93 94.63 44.15	87.51 (83.39) 61.05 97.46 33.51	74.5 (74.7) 44.11 90.72 68.56	40.24 (39.8) 62.47 75.92 24.87	66.78 (68.5) 60.87 90.34 31.09

Accuracy (with black bar)

ReLU

	Avg (10)	Avg (8)	(1)	(1)	(1)
Blur Pooling	**x3000**	**x5000**	**test1 A type**	**test2 D3 type**	**test3 H2 type**
None	0.8372	0.8976	0.7716	0.645	0.7364
Down	0.8328	0.8744	0.7058	0.5225	0.6777
Up	0.8416	0.8768	0.7648	0.4479	0.6875
Down + Up	0.8405	0.8726	0.7425	0.3999	0.6653

Dice

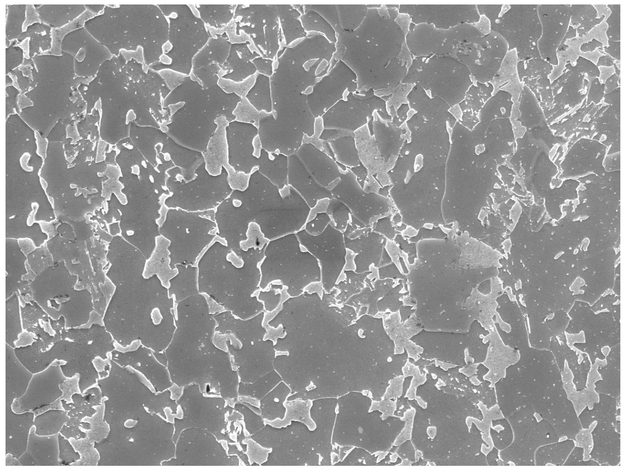
Inference Images

x3000

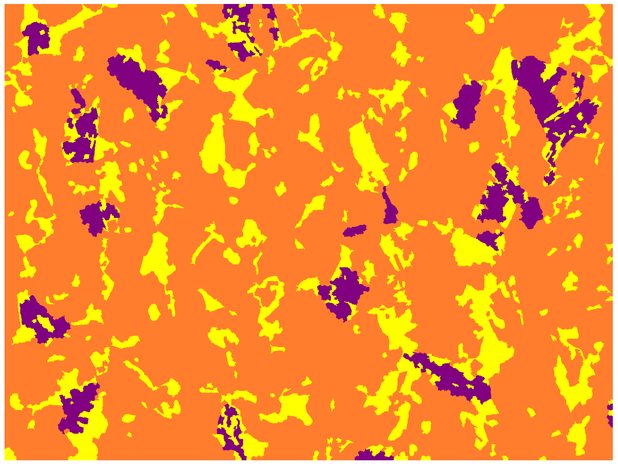
image 4.bmp

Siren | None

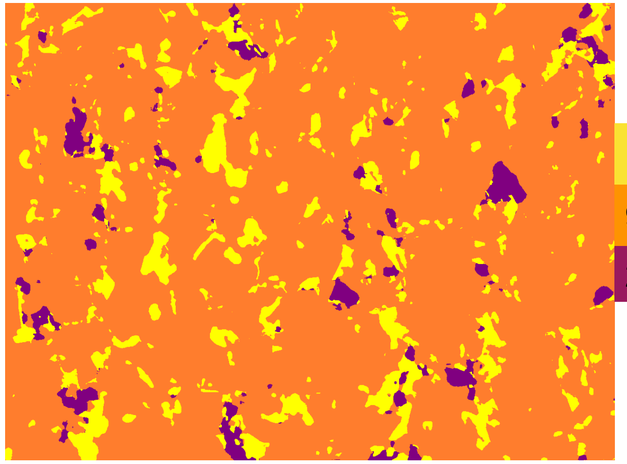
Original



Label



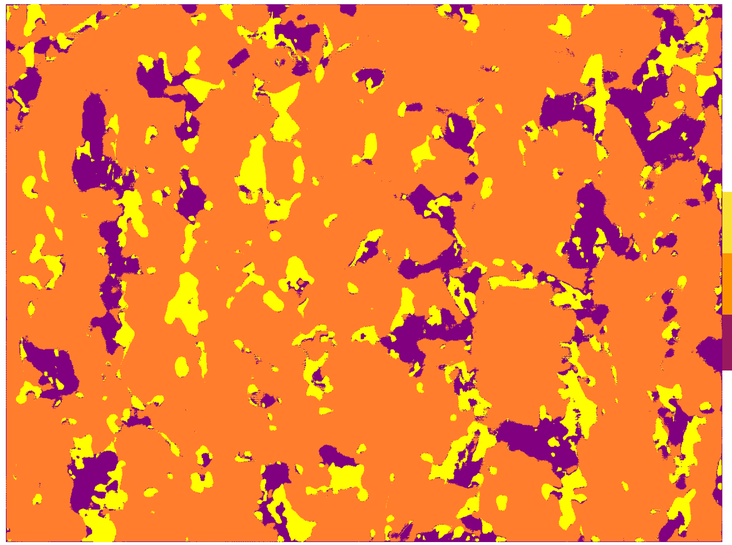
Prediction



60.7
97.55
27.11

Accuracy - 86.4

ReLU | None



59.71
91.6
65.57

Accuracy - 84.2

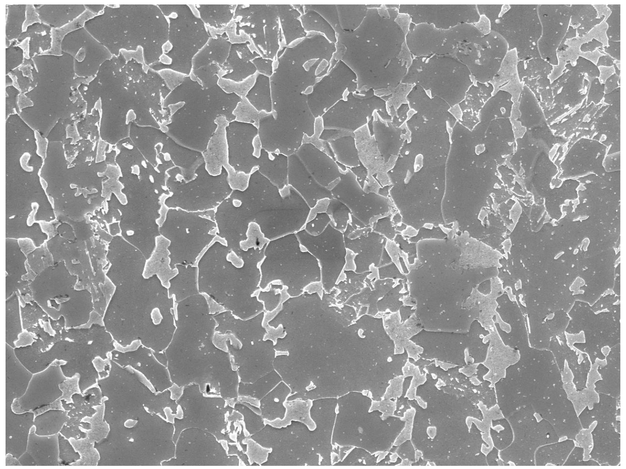
Inference Images

x3000

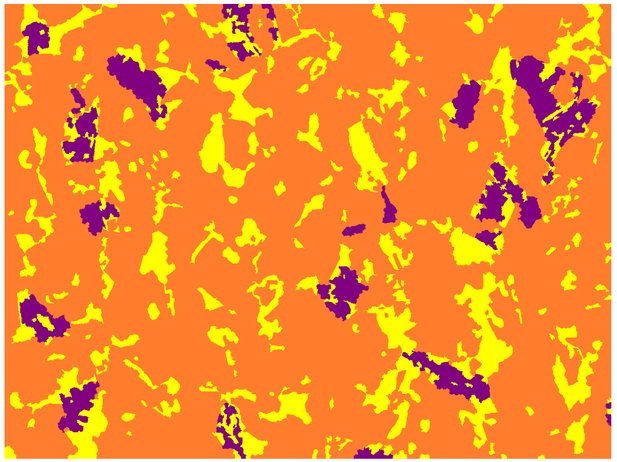
image 4.bmp

ReLU | None

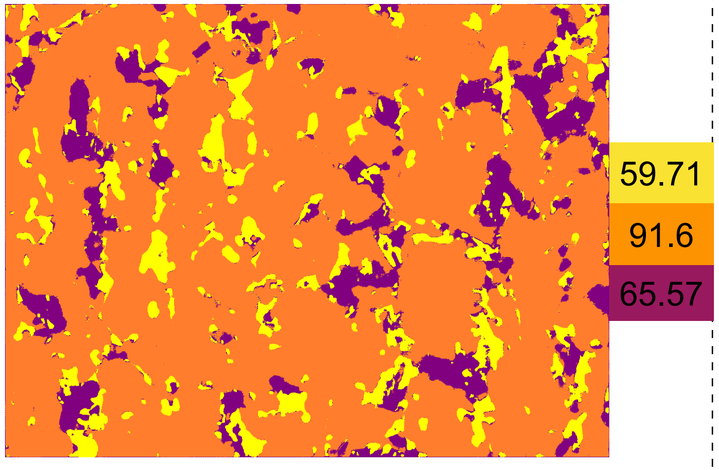
Original



Label



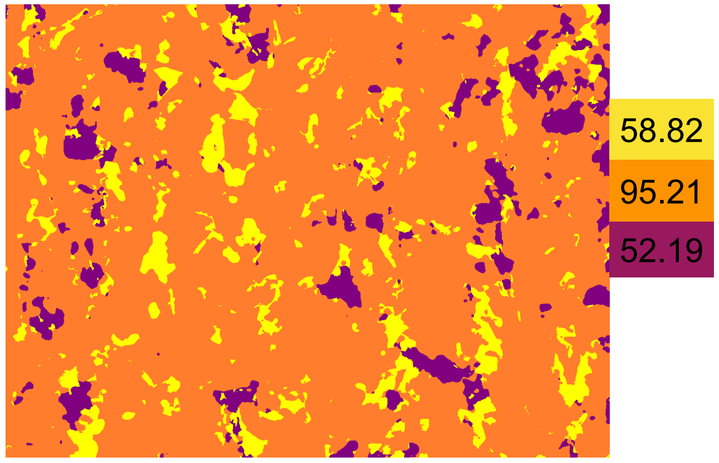
Prediction



Accuracy - 84.2

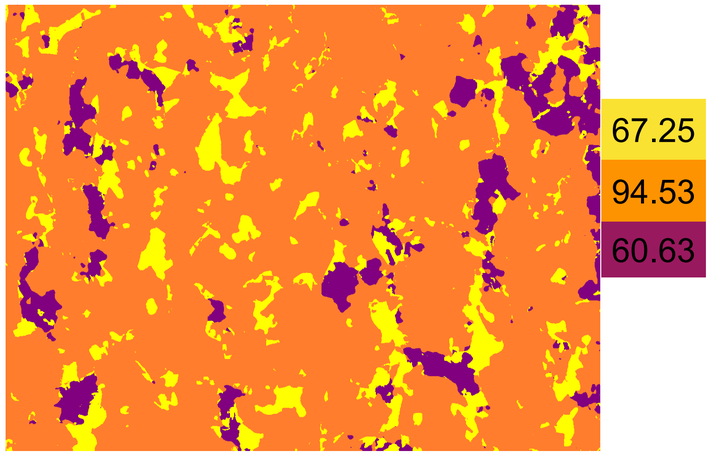
Prediction

Down



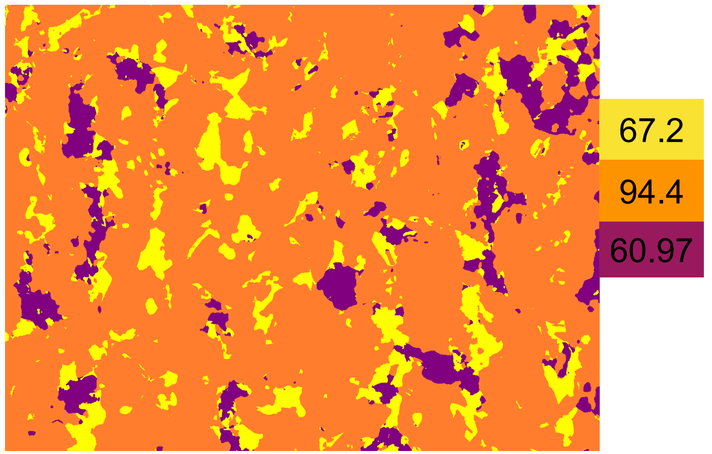
Accuracy - 85.9 (84.8)

Up



Accuracy - 87.5 (86.6)

DownUp



Accuracy - 87.4 (86.5)

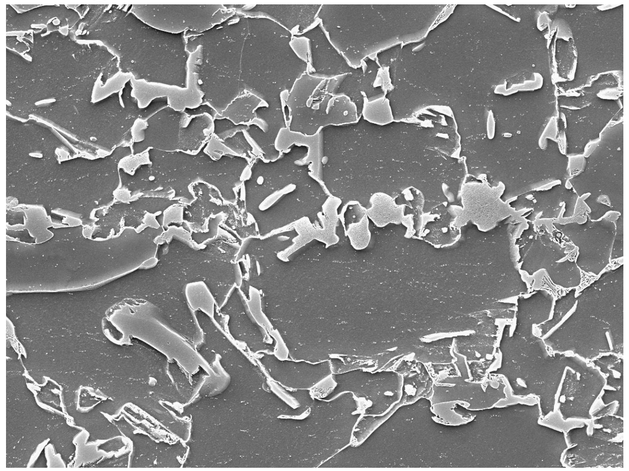
Inference Images

x5000

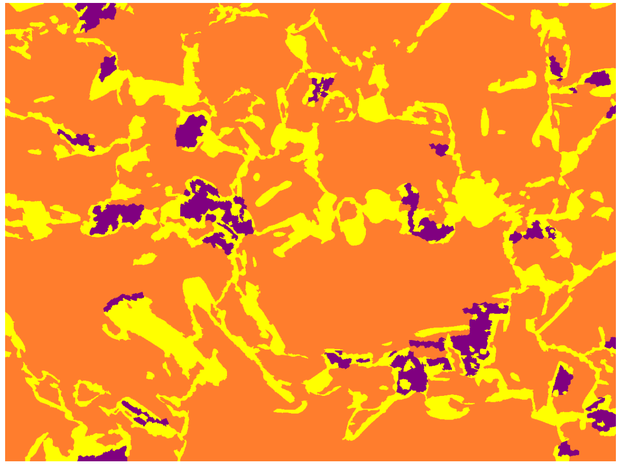
image 2.bmp

Siren | None

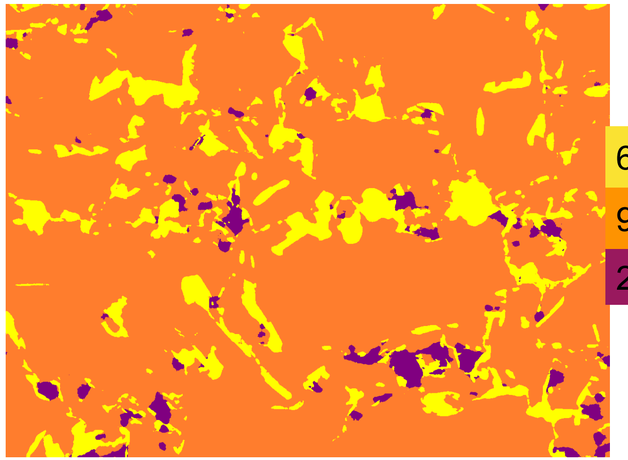
Original



Label



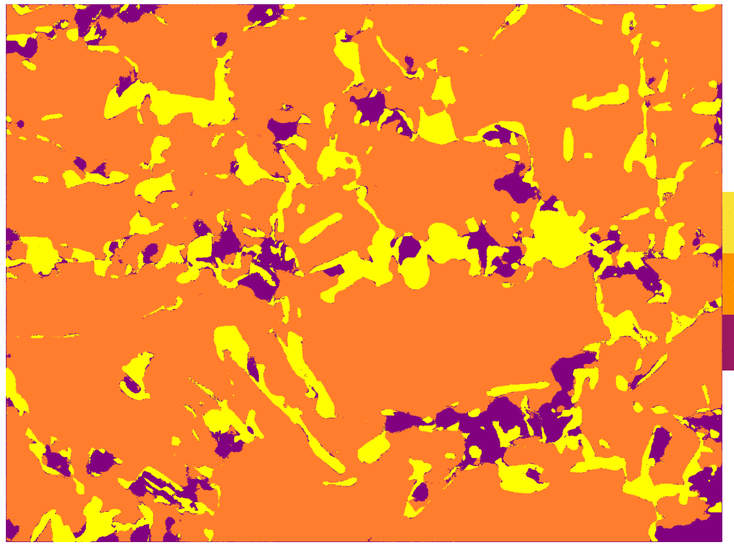
Prediction



64.29
98.03
29.51

Accuracy - 88.3

ReLU | None



71.57
94.36
57.32

Accuracy - 88.1

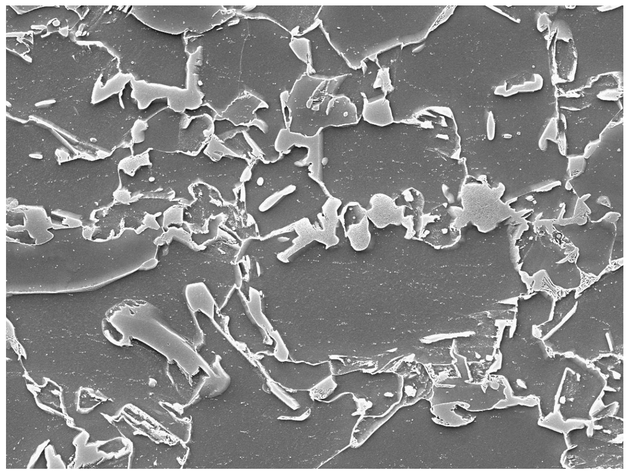
Inference Images

x5000

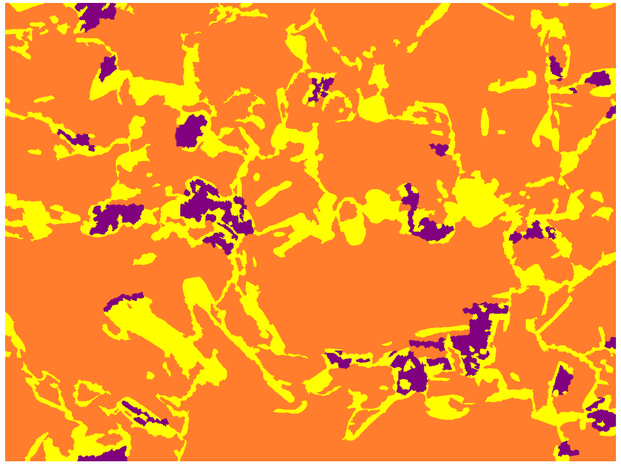
image 2.bmp

ReLU | None

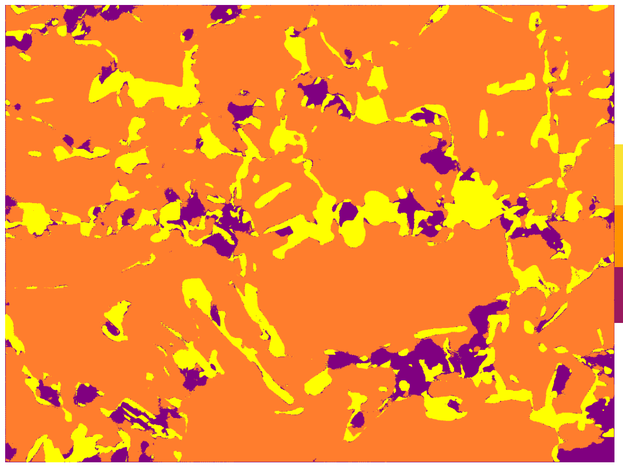
Original



Label



Prediction

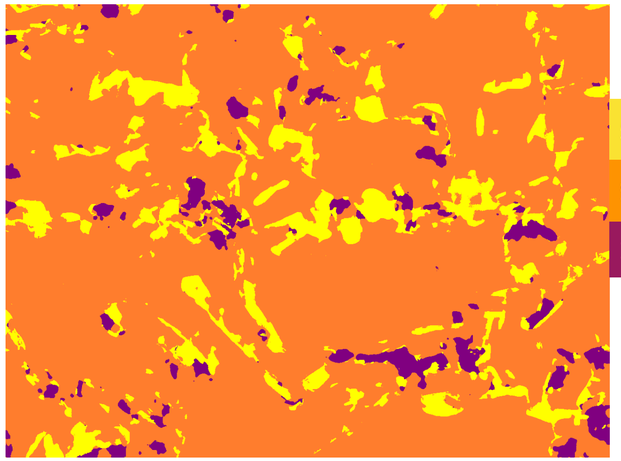


71.57
94.36
57.32

Accuracy - 88.1

Prediction

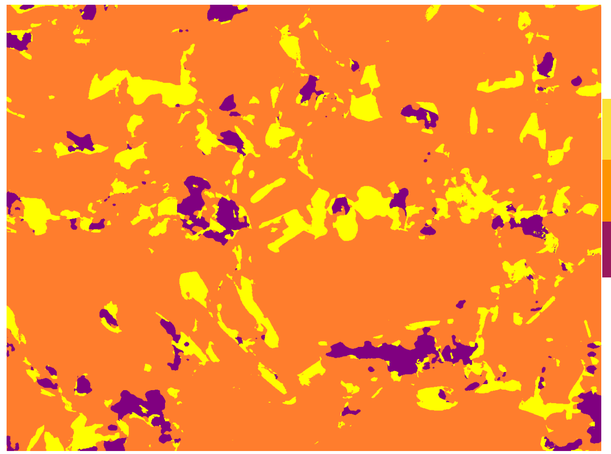
Down



59.73
97.57
38.94

Accuracy - 87.5 (86.8)

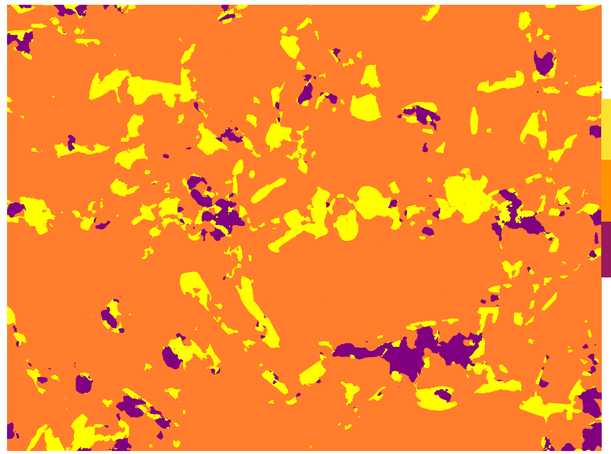
Up



59.04
97.27
40.64

Accuracy - 87.2 (87.3)

DownUp



57.2
97.61
31.89

Accuracy - 86.7 (86.6)

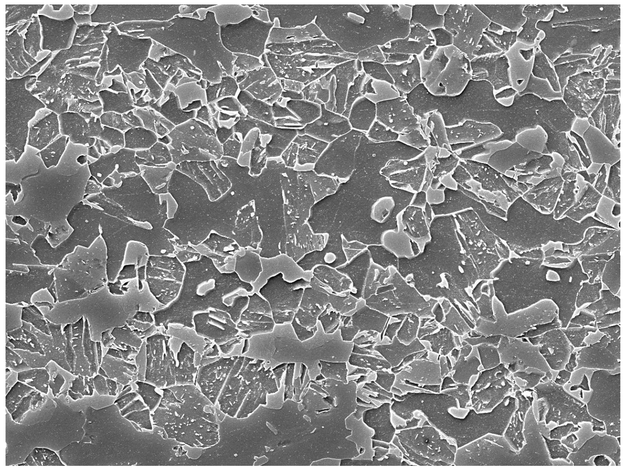
Inference Images

test1 A type

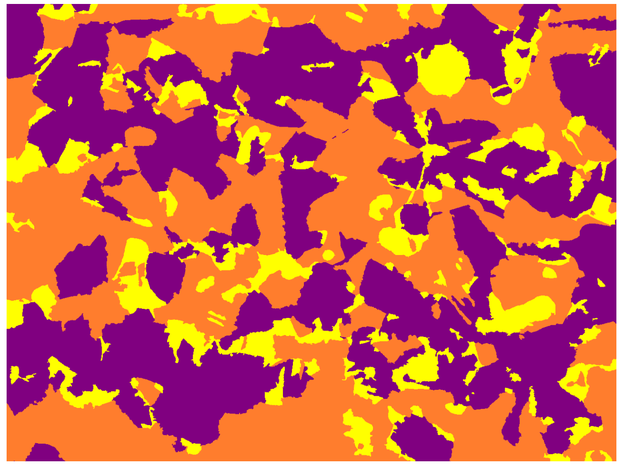
image 0.bmp

Siren | None

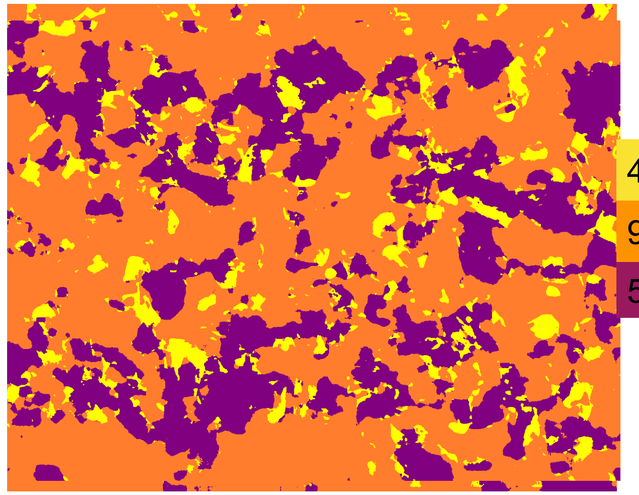
Original



Label



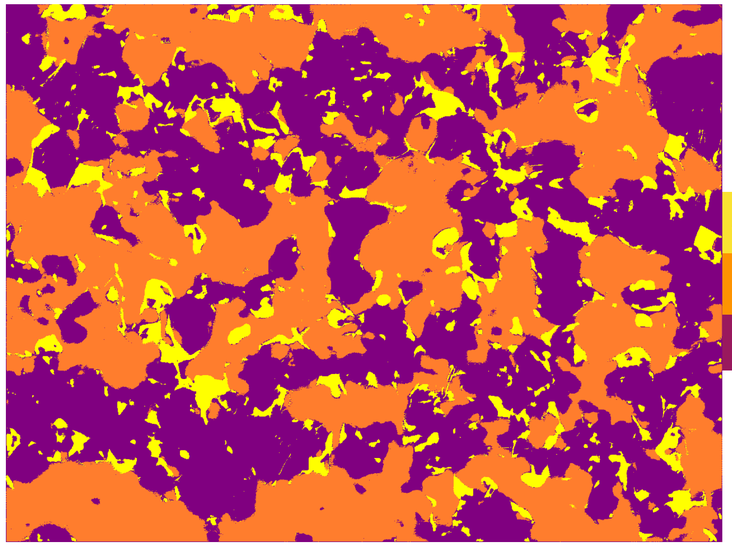
Prediction



47.51
90.92
58.72

Accuracy - 74.8

ReLU | None



49.97
81.79
82.27

Accuracy - 77.4

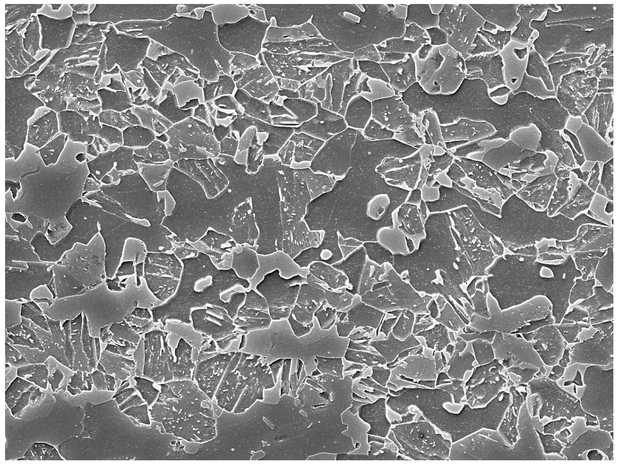
Inference Images

test1 A type

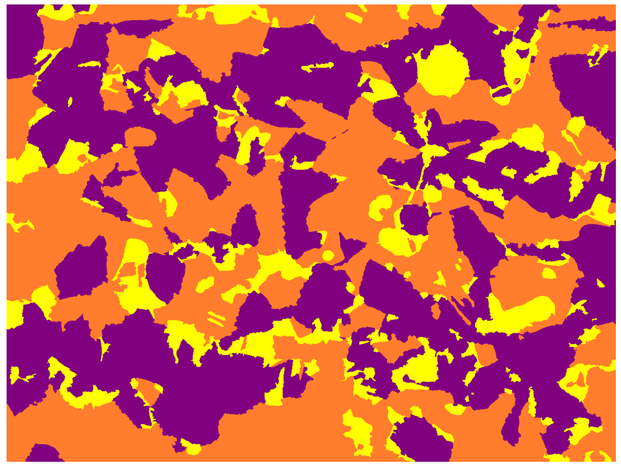
image 0.bmp

ReLU None

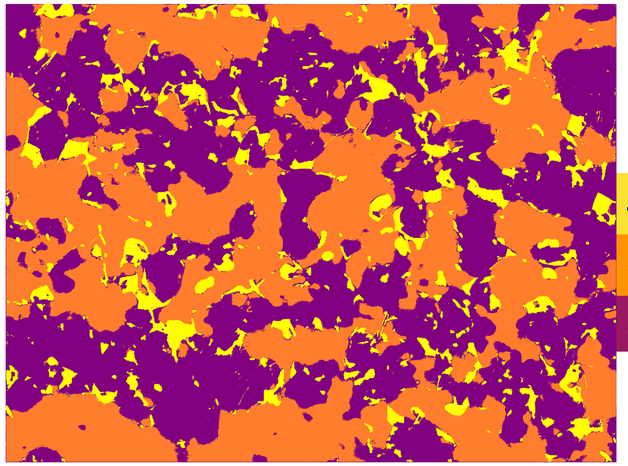
Original



Label



Prediction

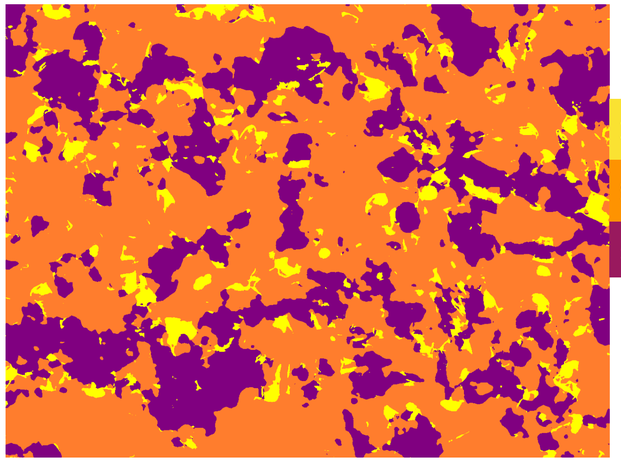


49.97
81.79
82.27

Accuracy - 77.4

Prediction

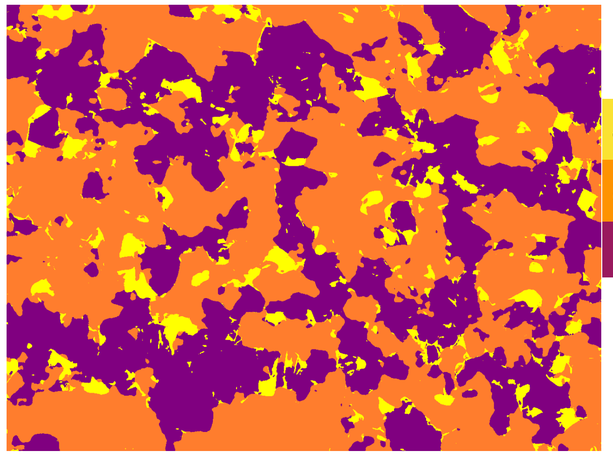
Down



39.52
93.37
58.82

Accuracy - 70.8 (71.1)

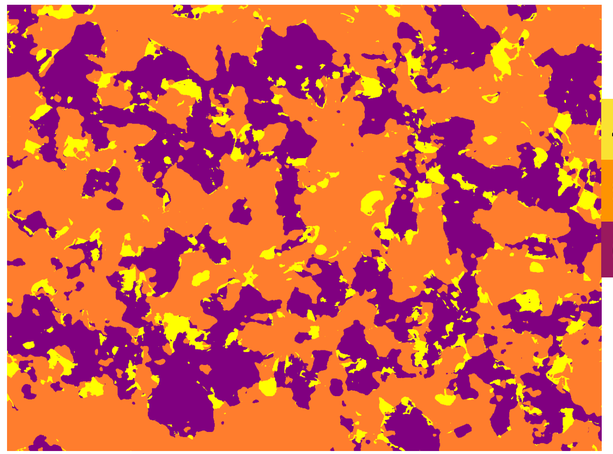
Up



47.46
89.86
73.47

Accuracy - 76.7 (77.2)

DownUp



44.11
90.72
68.56

Accuracy - 74.5 (74.7)

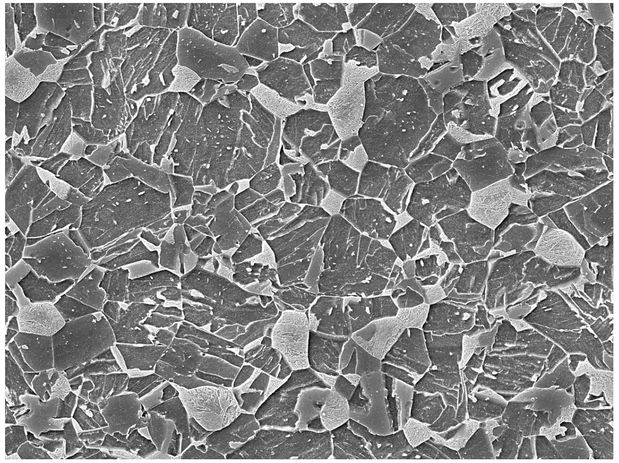
Inference Images

test2 D3 type

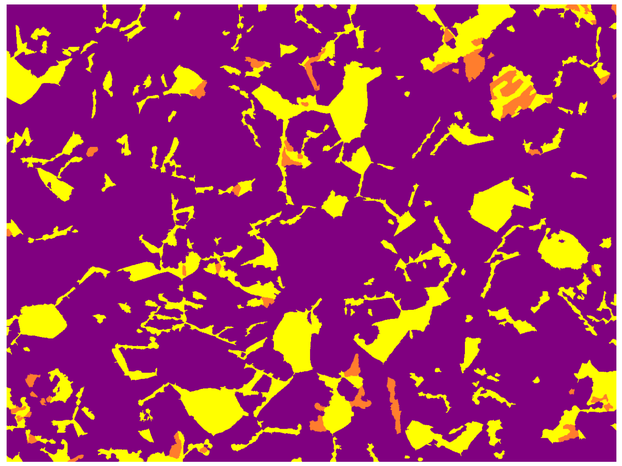
image 0.bmp

Siren None

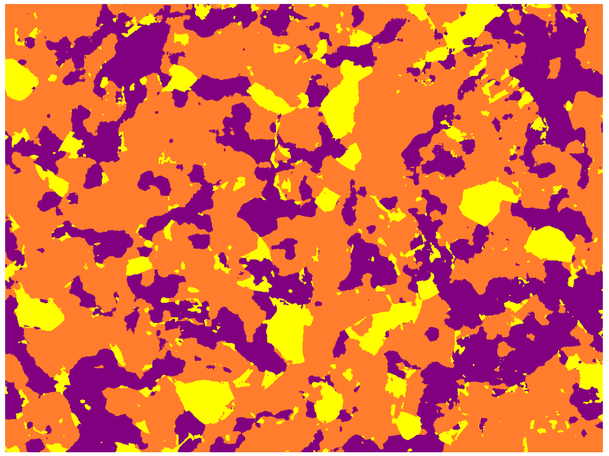
Original



Label



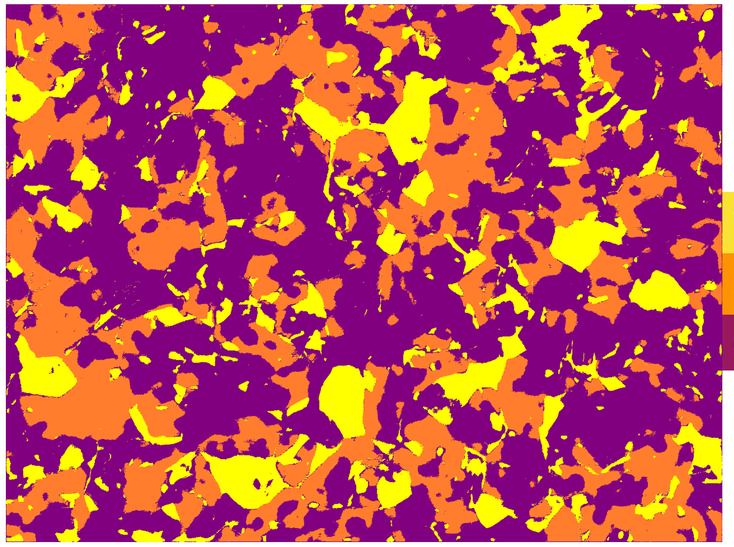
Prediction



60.69
67.79
33.98

Accuracy - 40.2

ReLU
None



73.98
32.14
63.51

Accuracy - 64.75

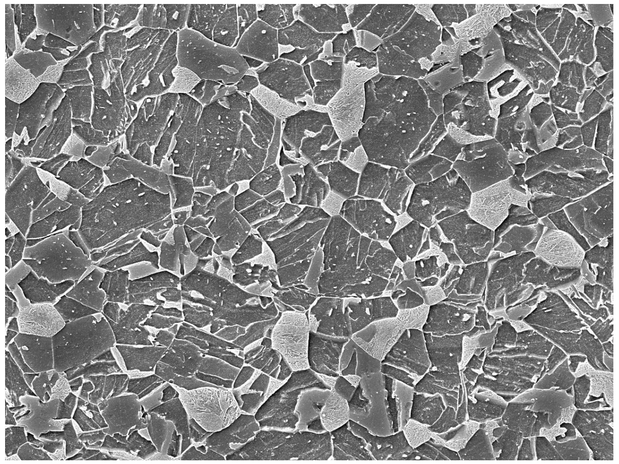
Inference Images

test2 D3 type

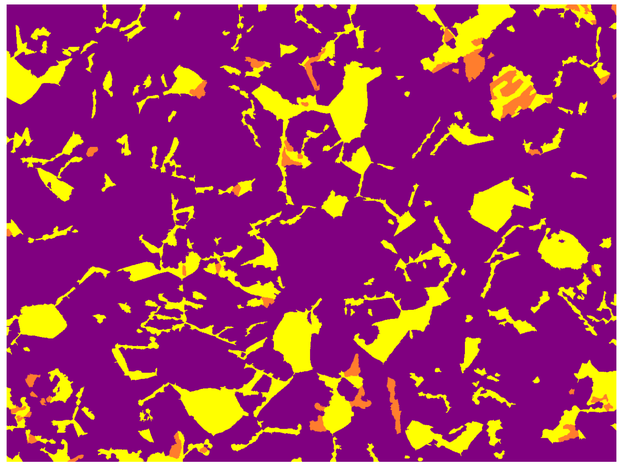
image 0.bmp

ReLU None

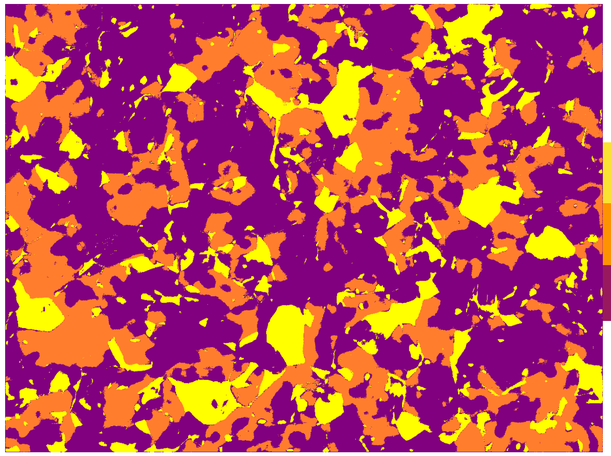
Original



Label



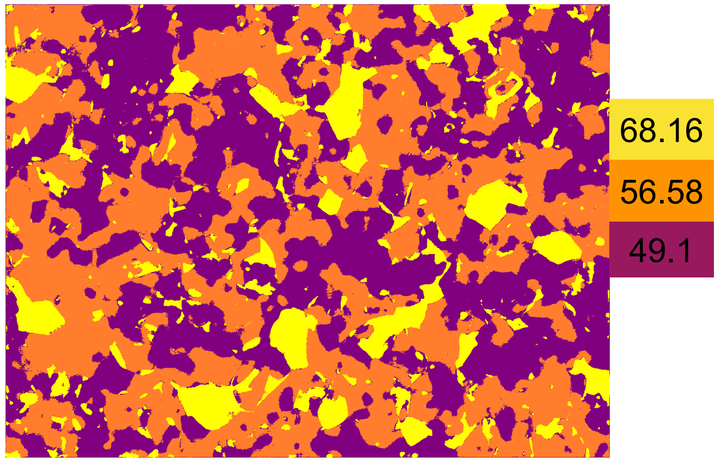
Prediction



Accuracy - 64.75

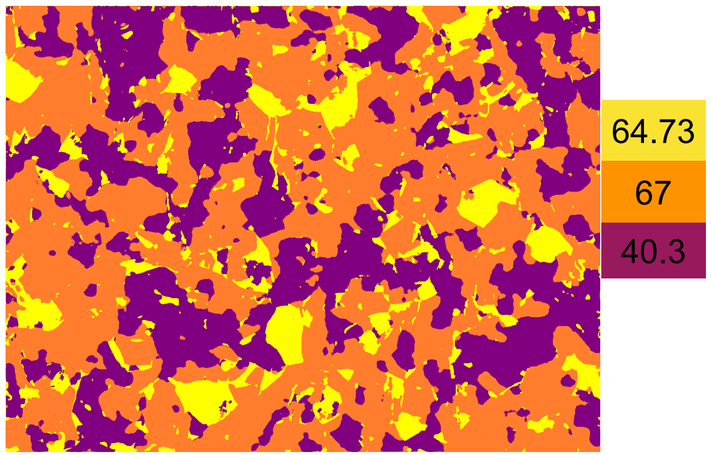
Prediction

Down



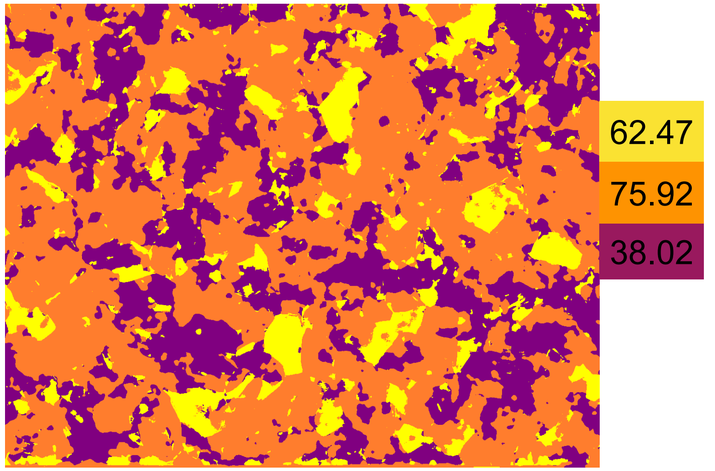
Accuracy - 52.5 (51.3)

Up



Accuracy - 45.04 (42.1)

DownUp



Accuracy - 40.24 (41.8)

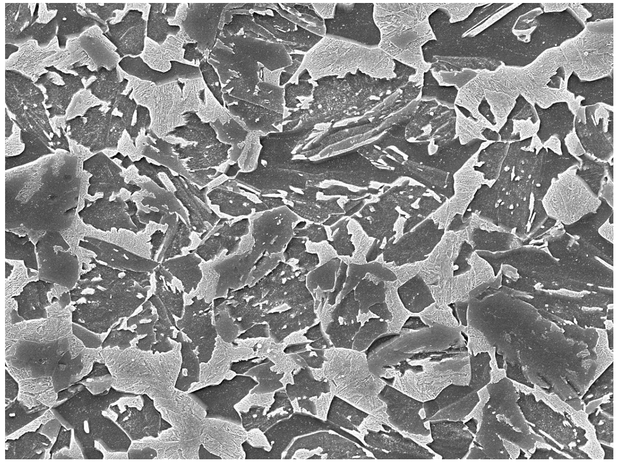
Inference Images

test3 H type

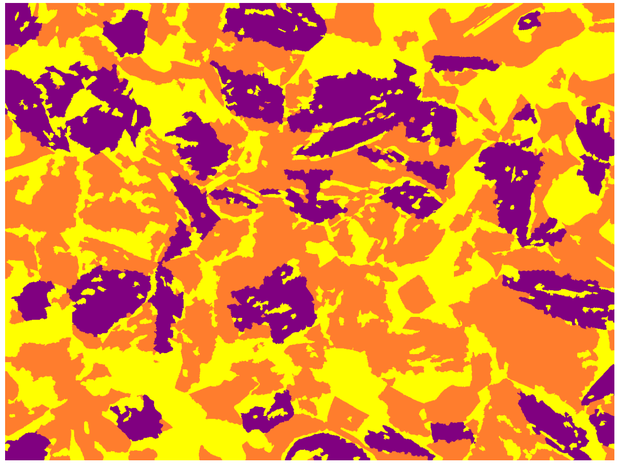
Siren None

image 0.bmp

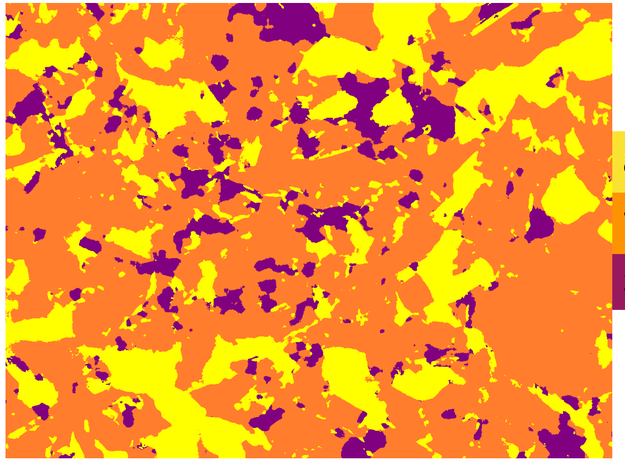
Original



Label



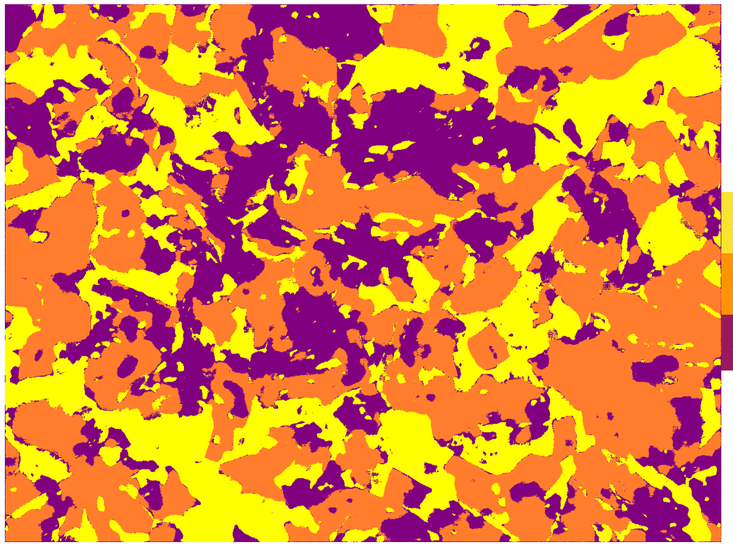
Prediction



82.15
79.38
33.54

Accuracy - 69.8

ReLU
None



81.51
73.96
62.44

Accuracy - 73.89

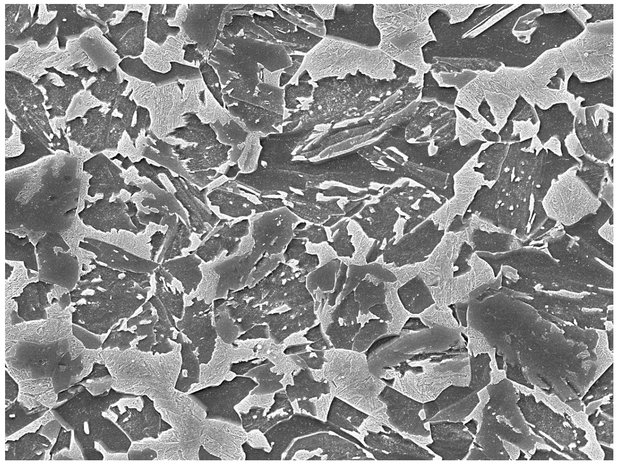
Inference Images

test3 H type

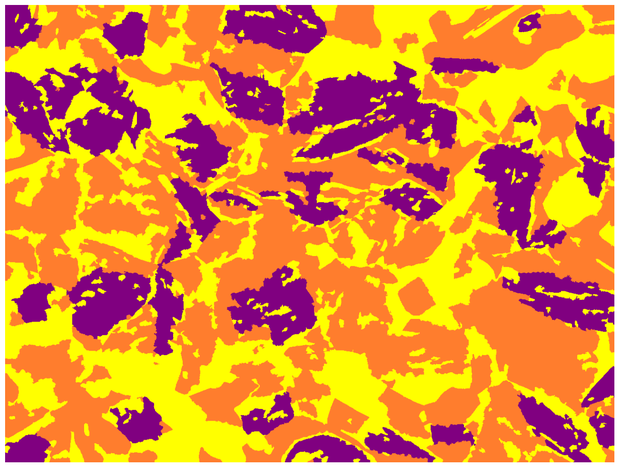
image 0.bmp

ReLU None

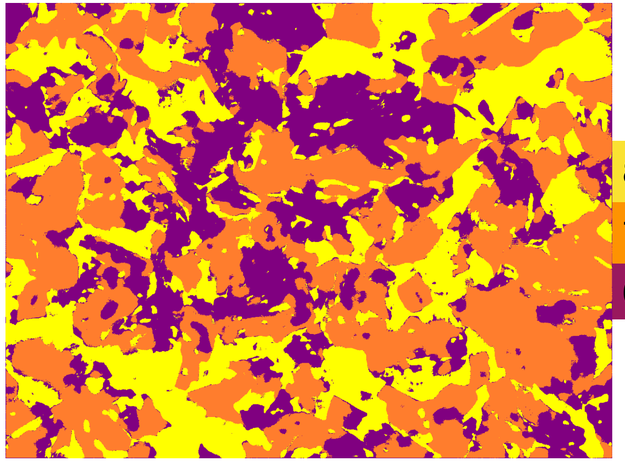
Original



Label



Prediction

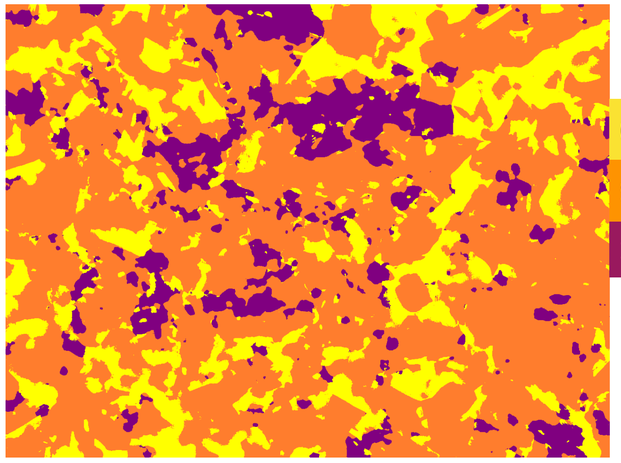


81.51
73.96
62.44

Accuracy - 73.89

Prediction

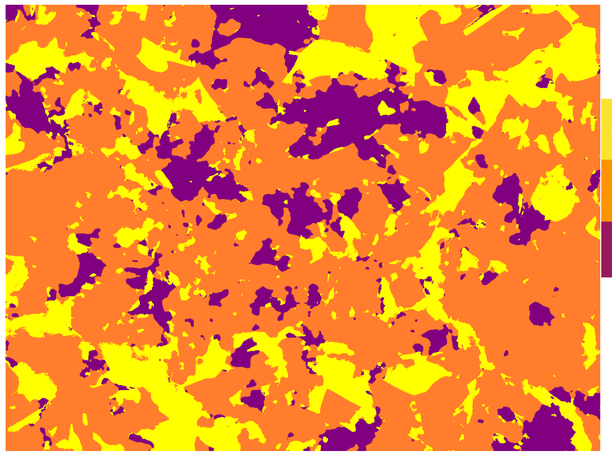
Down



61.95
90.87
33.89

Accuracy - 68.02 (69.6)

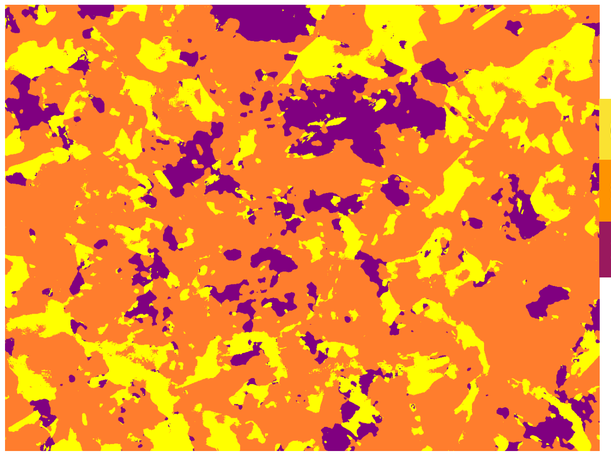
Up



65.77
89.5
35.02

Accuracy - 69.0 (70.5)

DownUp



60.87
90.34
31.09

Accuracy - 66.78 (68.5)

None

Siren Vs ReLU Activation Function

	x3000	x5000	test1 A type	test2 D3 type	test3 H2 type
	Avg (10)	Avg (8)	(1)	(1)	(1)
Siren	86.12 (85.3)	89.77 (89.18)	74.87 (75.05)	40.02 (42.61)	69.8 (70.89)
	63.72 96.44 31.28	66.23 97.78 34.78	47.56 90.92 58.72	60.69 67.79 33.98	72.51 90.25 24.6
ReLU	83.97 (82.12)	90.01 (87.96)	77.41 (77.67)	64.75 (63.1)	73.89 (74.73)
	60.91 91.41 55.1	74.33 94.19 62.19	49.97 81.79 82.27	73.98 32.14 63.51	81.51 73.96 62.44

Accuracy Percentage (with black bar)

Comparison with Jaccard Loss

None

	Avg (10)	Avg (8)	(1)	(1)	(1)
	x3000	**x5000**	**test1 A type**	**test2 D3 type**	**test3 H2 type**
Siren + Focal After 200 epochs	86.12 63.72 96.44 31.28	89.77 66.23 97.78 34.78	74.87 47.56 90.92 58.72	40.02 60.69 67.79 33.98	69.8 72.51 90.25 24.6
ReLU + Focal After 200 epochs	84.8 60.91 91.41 55.1	89.71 74.33 94.19 62.19	73.68 49.97 81.79 82.27	43.43 73.98 32.14 63.51	69.33 81.51 73.96 62.44
Siren+Jaccard After 200 epochs	83.92 70.21 83.12 57.19	89.43 79.3 82.35 50.74	72.87 49.98 89.08 59.62	56.08 77.16 38.84 52.16	70.78 86.39 71.72 45.61
ReLU + Jaccard After 200 epochs	84.11 68.11 93.77 45.33	89.29 70.87 96.57 41.73	74.78 51.04 92.11 65.45	68.32 79.64 24.41 66.89	73.32 78.52 88.11 37.62

Remarks [Updated]

Model With Siren-

- **Down BlurPooling - increased accuracy of yellow and purple regions**
- **Up BlurPooling - while it increased accuracy of orange labels it significantly decreased the accuracy of other labels**
- **Down and Up BlurPooling - Increased accuracy compared to Up blurpooling but it is insignificant when compared with down Blurpooling**

Model With ReLU-

- **Model with ReLU showed better performance than with Siren.**
- **Model had no improvements in addition of BlurPooling layers, rather there were only decrease in performance in most cases. Where as, Model with Siren activation function, had many improvements in addition of BlurPooling Layers, the model performed well especially in Down pooling.**

Model With Jaccard-

- **Model with Jaccard Loss - increased performance when compared with Focal Loss**
- **Model with Jaccard and ReLU showed better performance than Model with Jaccard and Siren.**

Conclusion

Removing Noise and Blur and and controlling the augmentation parameters during augmentation increased model performance.

Usage of "Down" sampling method increases the performance in some cases compared to no sampling, Up sampling and both down and up sampling.

Using ReLU activation increases performance of the model compared to Siren activation function.

Using Jaccard loss instead on Focal Loss increased performance

Revised Schedule

Ad-hoc Training of Purple Regions with Jaccard	**Apr 27**
Accuracy of Images in PPT	**Apr 27**
Jaccard+Siren+Blur / Jaccard+ReLU+Blue	**Apr 28**
Training Model with 4-Class classification	**Apr 29**
Sliding Window detection for Purple Region	
Multi-Parts Presence paper - Complete Draft (Except Reference)	**Apr 30**
Steel Segmentation with nnUNET	