



Technische Hochschule
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Detecting and counting wheat spike heads from UAV-based images using deep convolutional neural networks

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AI based detection and counting of wheat plants on UAV-based images

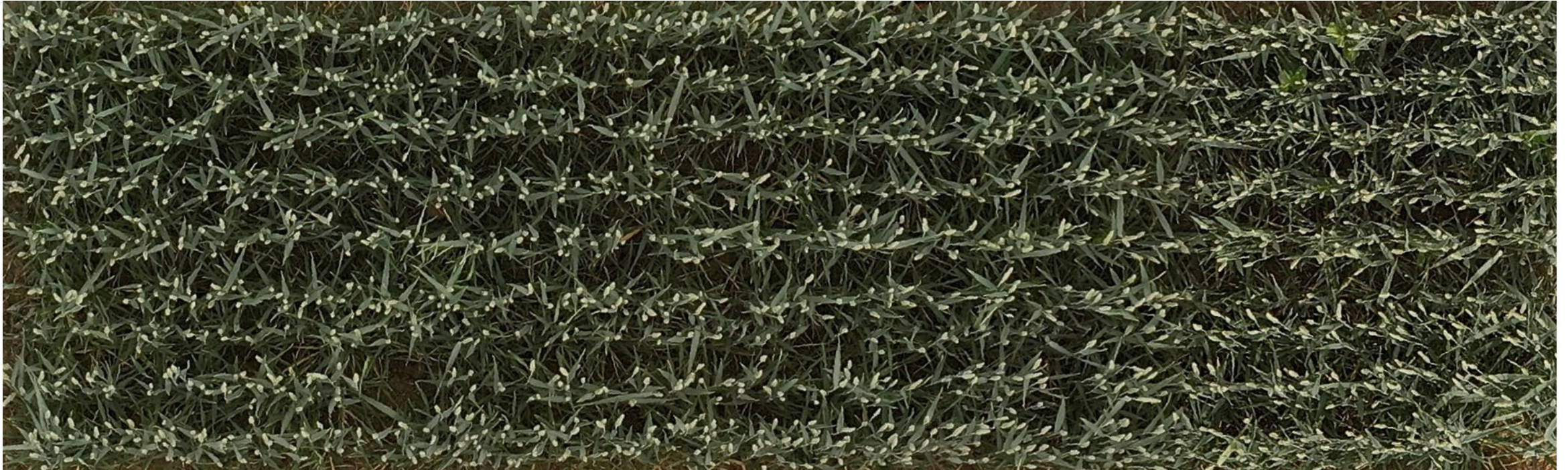
Why?

Spike head counting is mostly done manually by farmers

- time consuming
- labour intensive
- prone to human error

Overview

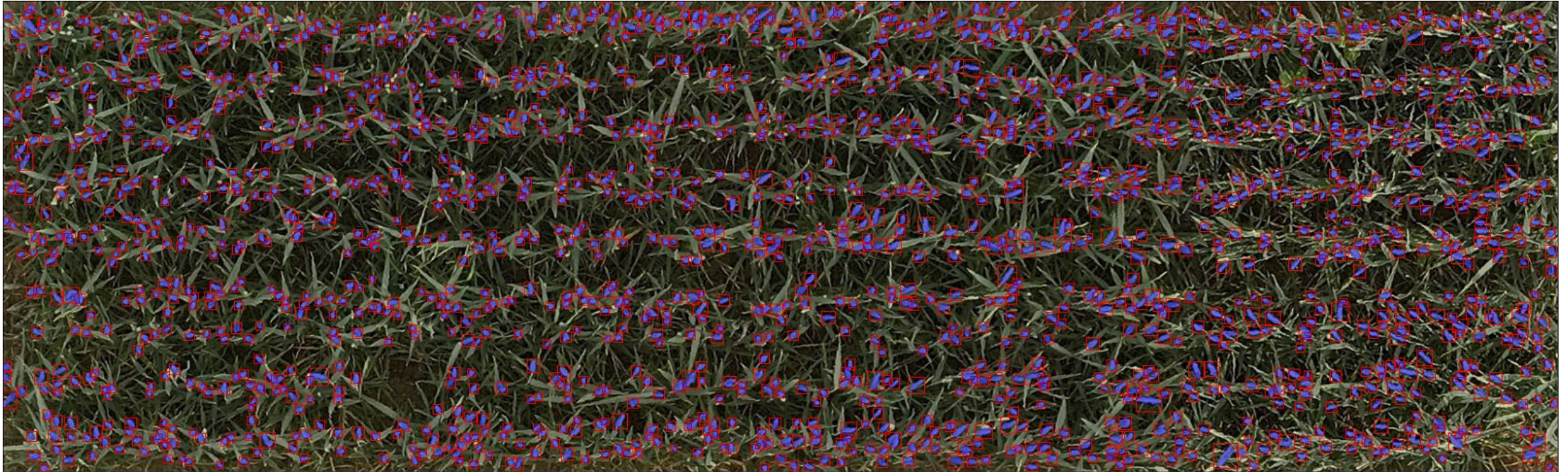
Example: Parcel (clean)



Size: 520 x 1720 pixels / 1.25m x 4.1m

Overview

Example: Parcel (segmented)



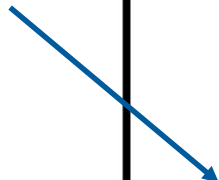
Size: 520 x 1720 pixels / 1.25m x 4.1m

Dataset

Wheat Dataset



510 parcels



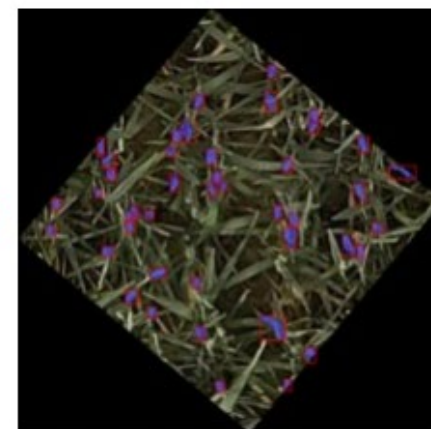
Orthomosaicimage
Size: 14400x110500



Croppedplot
Size: 582x1616

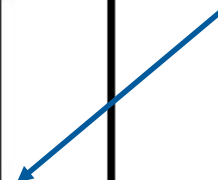


Sub-image
Size: 392x392
Rotation: 39.925degree



Sub-image
Masks and BoundingBoxes

516 sub-parcels



Deep Neural Network Training

Results: Validation set

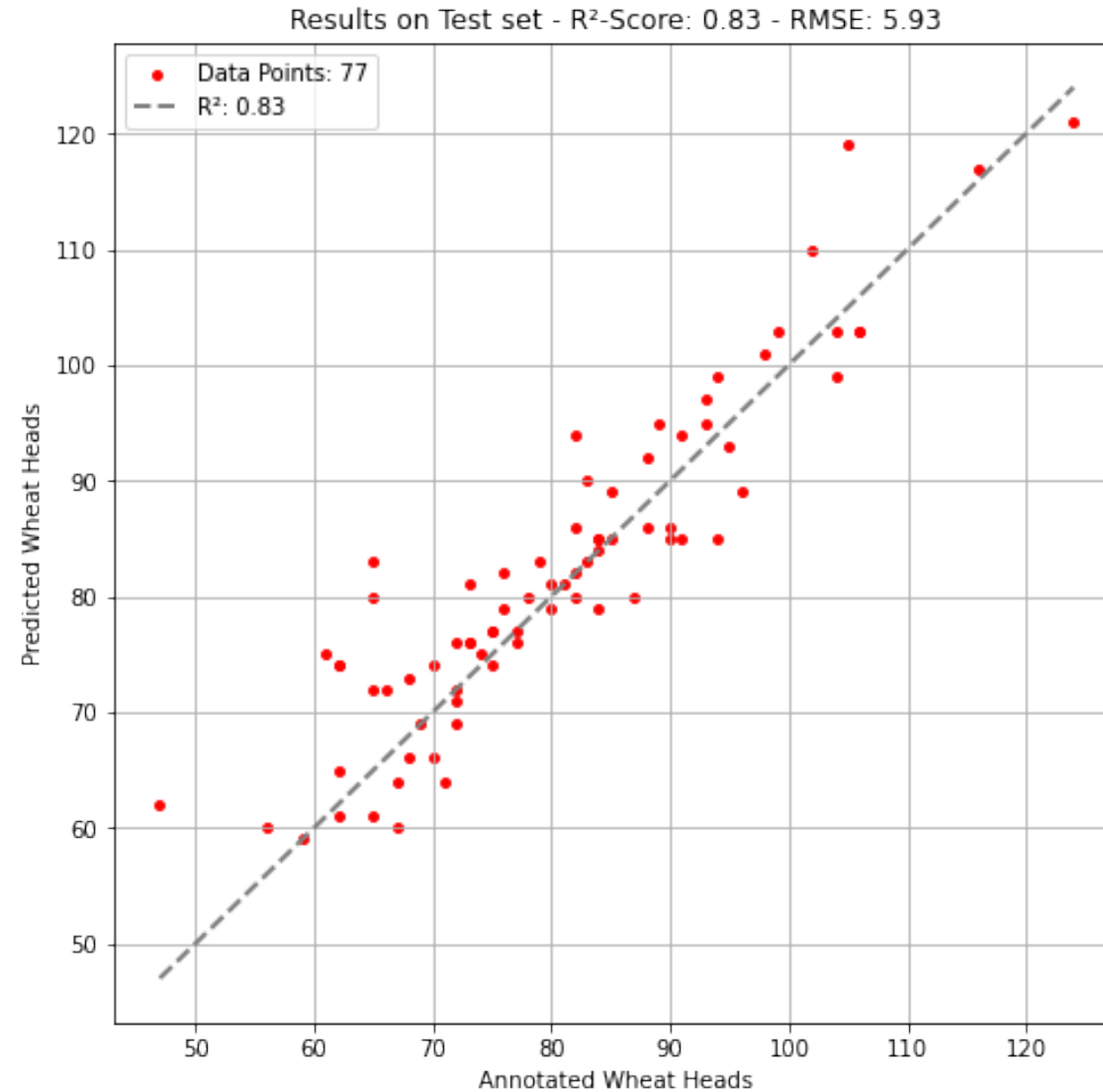


Image number	Ground-Truth	Prediction	Instance difference	Percentual difference
25	82	86	4	0.048780
42	73	76	3	0.041100
53	99	103	4	0.040400
58	88	92	4	0.045450
61	81	81	0	0.000000
63	95	93	-2	-0.021050
66	72	76	4	0.055560
68	105	119	14	0.133330
71	80	79	-1	-0.012500
76	104	103	-1	-0.009620
...
454	85	85	0	0.000000
457	91	85	-6	-0.065930
459	90	86	-4	-0.044440
462	94	85	-9	-0.095740
483	67	60	-7	-0.104480
491	71	64	-7	-0.098590
498	59	59	0	0.000000
500	87	80	-7	-0.080460
504	68	66	-2	-0.029410
505	70	66	-4	-0.057140

Metric	Ground-Truth	Prediction	Instance difference	Percentual difference
Total	6200	6338	138	2.131510
Average	80.519481	82.311688	1.792208	0.027682
Std. dev.	14.426356	13.781467	5.648440	0.081682

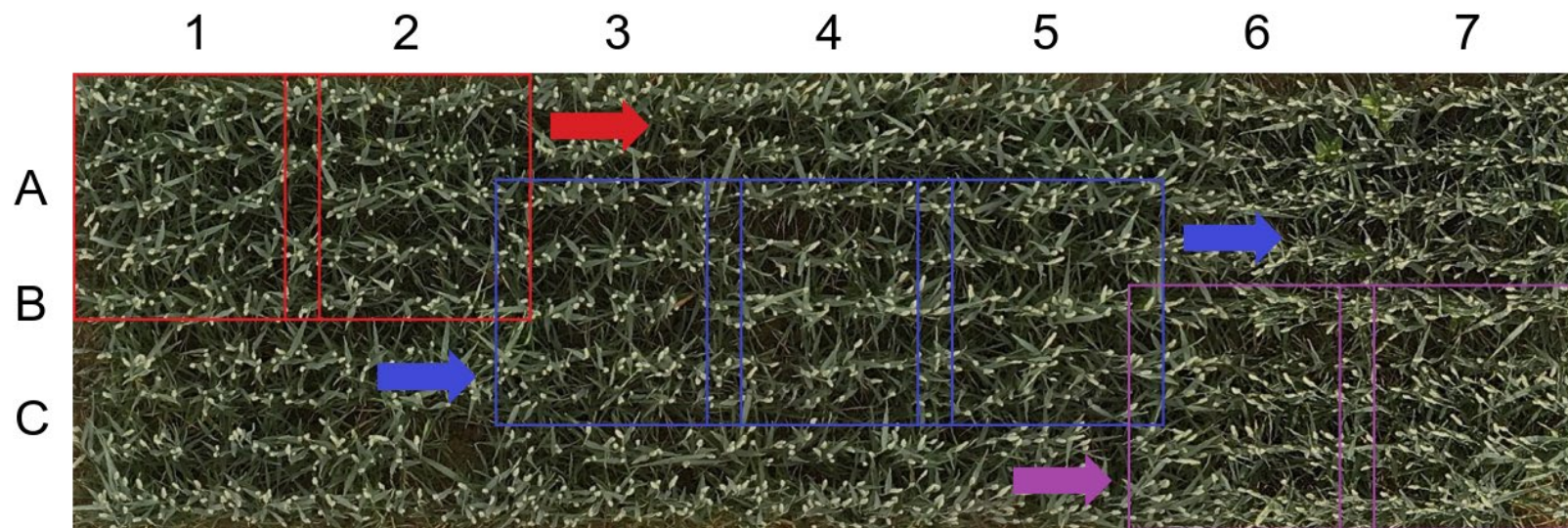
Deep Neural Network Training

Results: Scatterplot

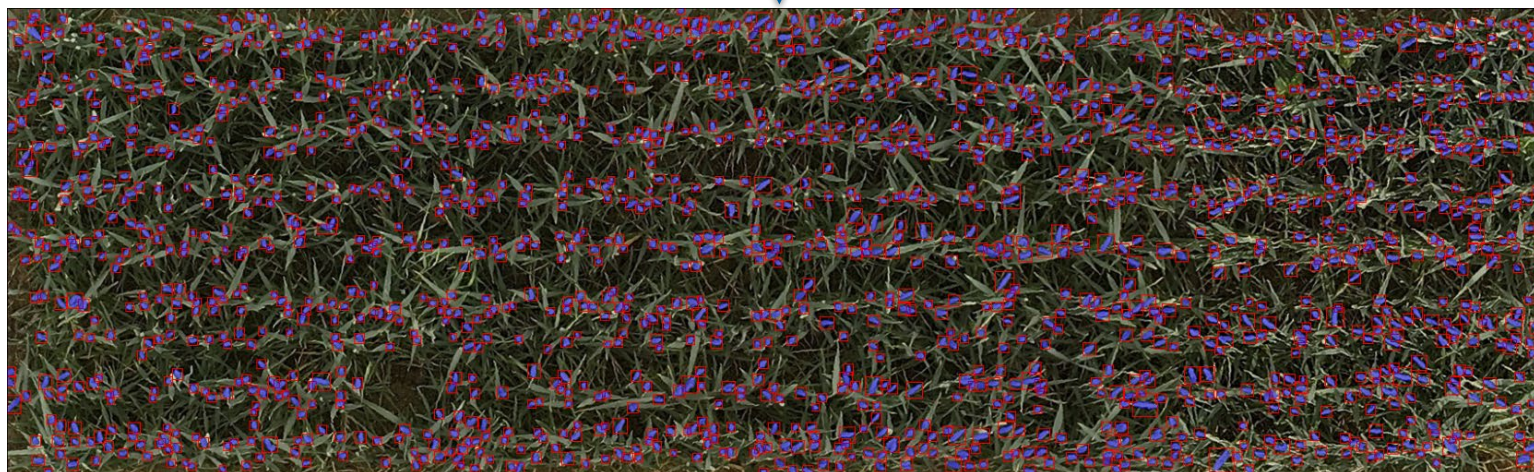


Evaluation

Sliding Window



Mask R-CNN

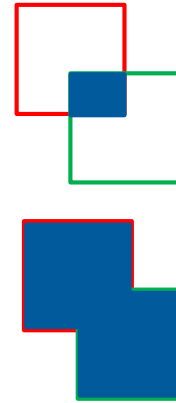


Metric

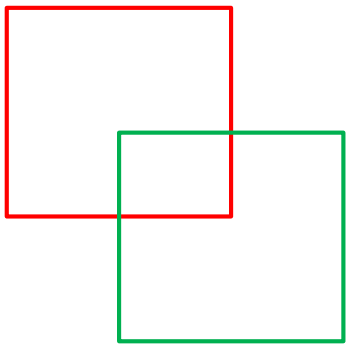
Intersection over Union (IoU)



$$IoU = \frac{\text{Area of Overlap}}{\text{Area of Union}}$$

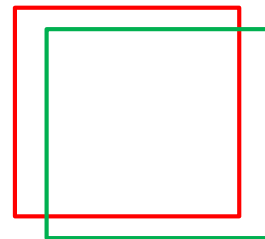


Bad



IoU = 0.2

Good



IoU = 0.7

Perfect

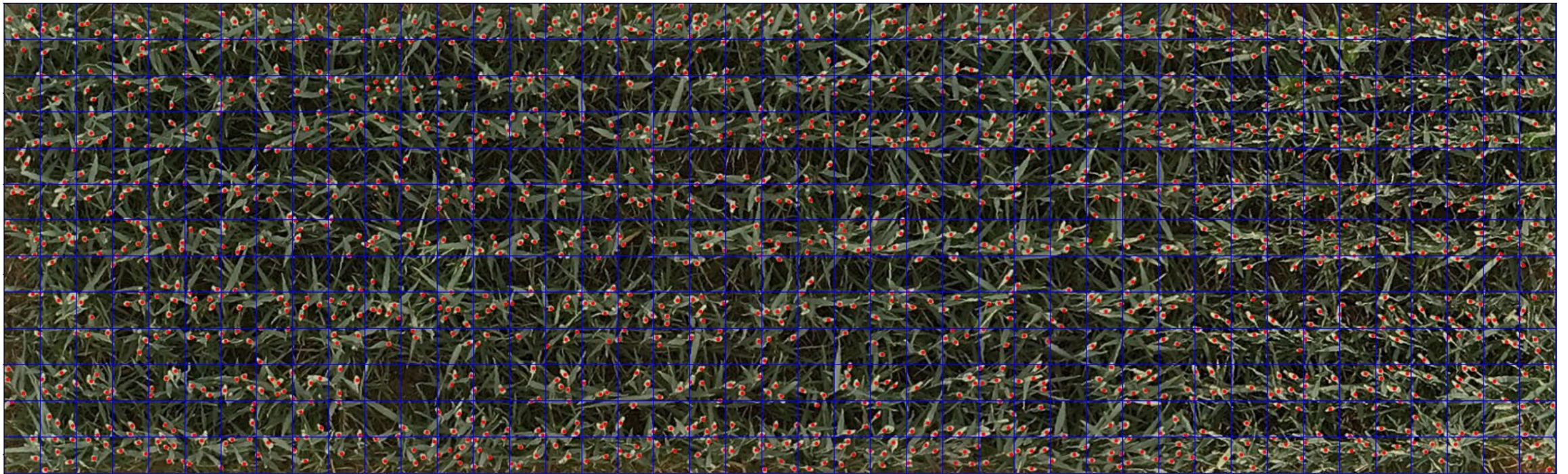


IoU = 1.0

Delete

Results

Heatmap: Grid



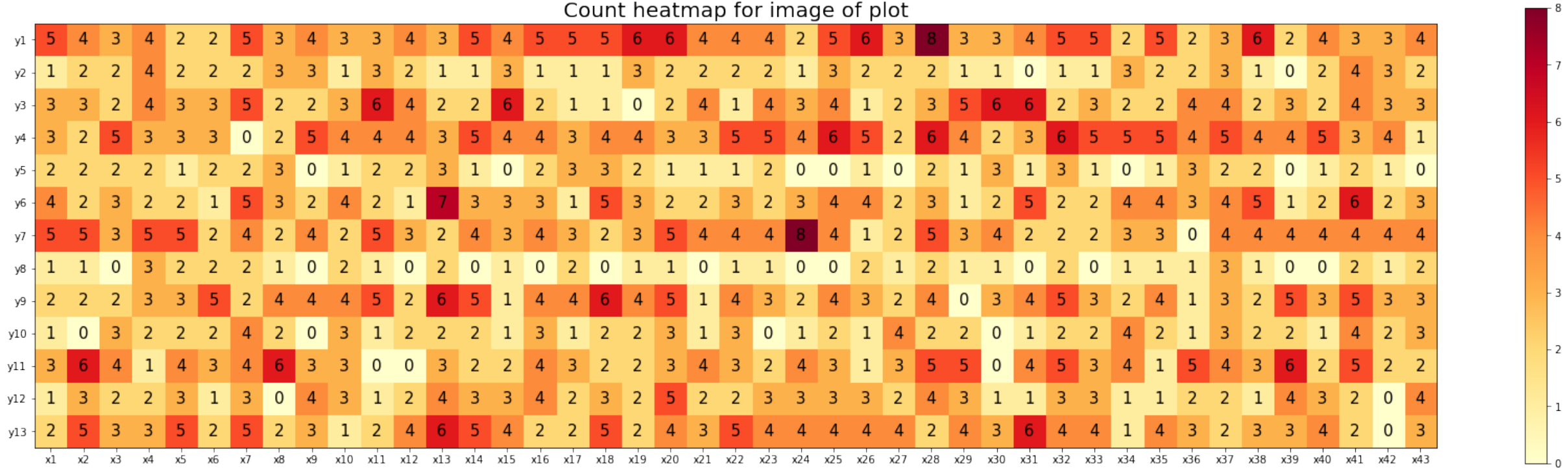
Size: 520 x 1720 pixels / 1.25m x 4.1m

Results

Heatmap: Single parcel



Count heatmap for image of plot



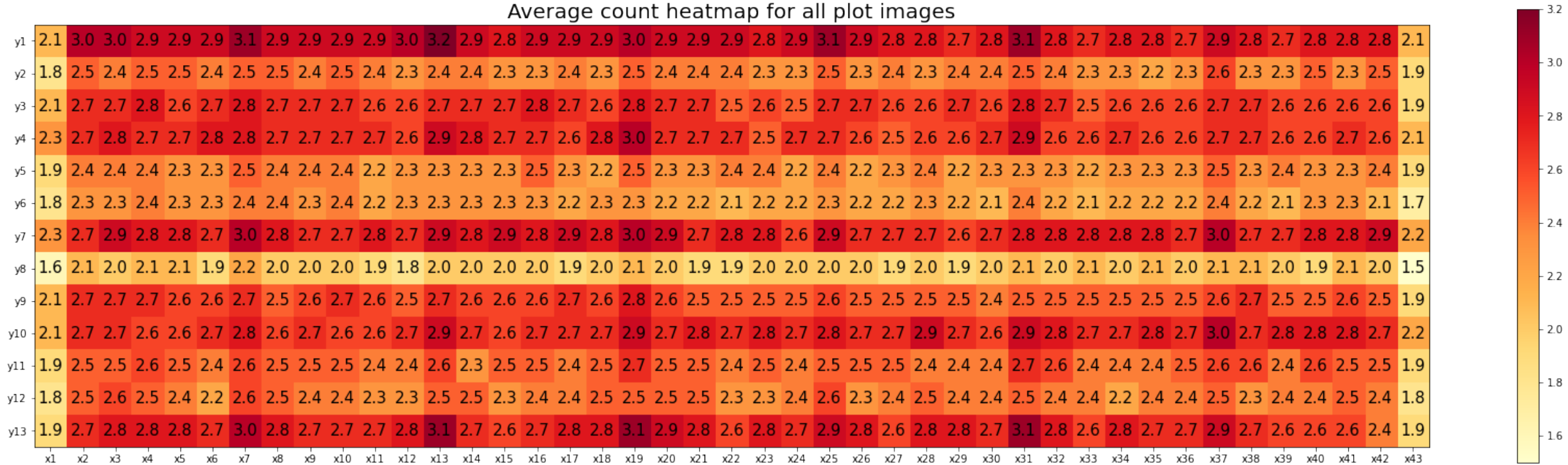
Size: 520 x 1720 pixels / 1.25m x 4.1m

Results

Heatmap: 510 parcels



Average count heatmap for all plot images



Size: 520 x 1720 pixels / 1.25m x 4.1m



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Draw Image



Draw Bounding Boxes

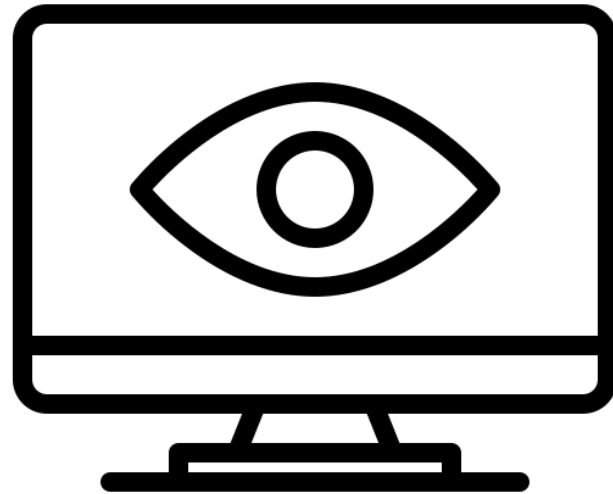


Draw Segmentation Masks

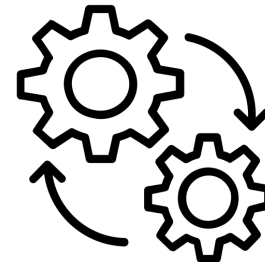
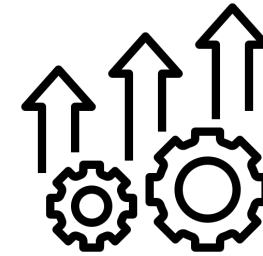


Show Heatmap

Send

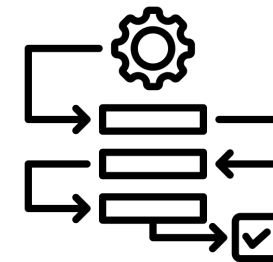


Process improvement



Process automation

Process standardization



End



Thank you for your attention!