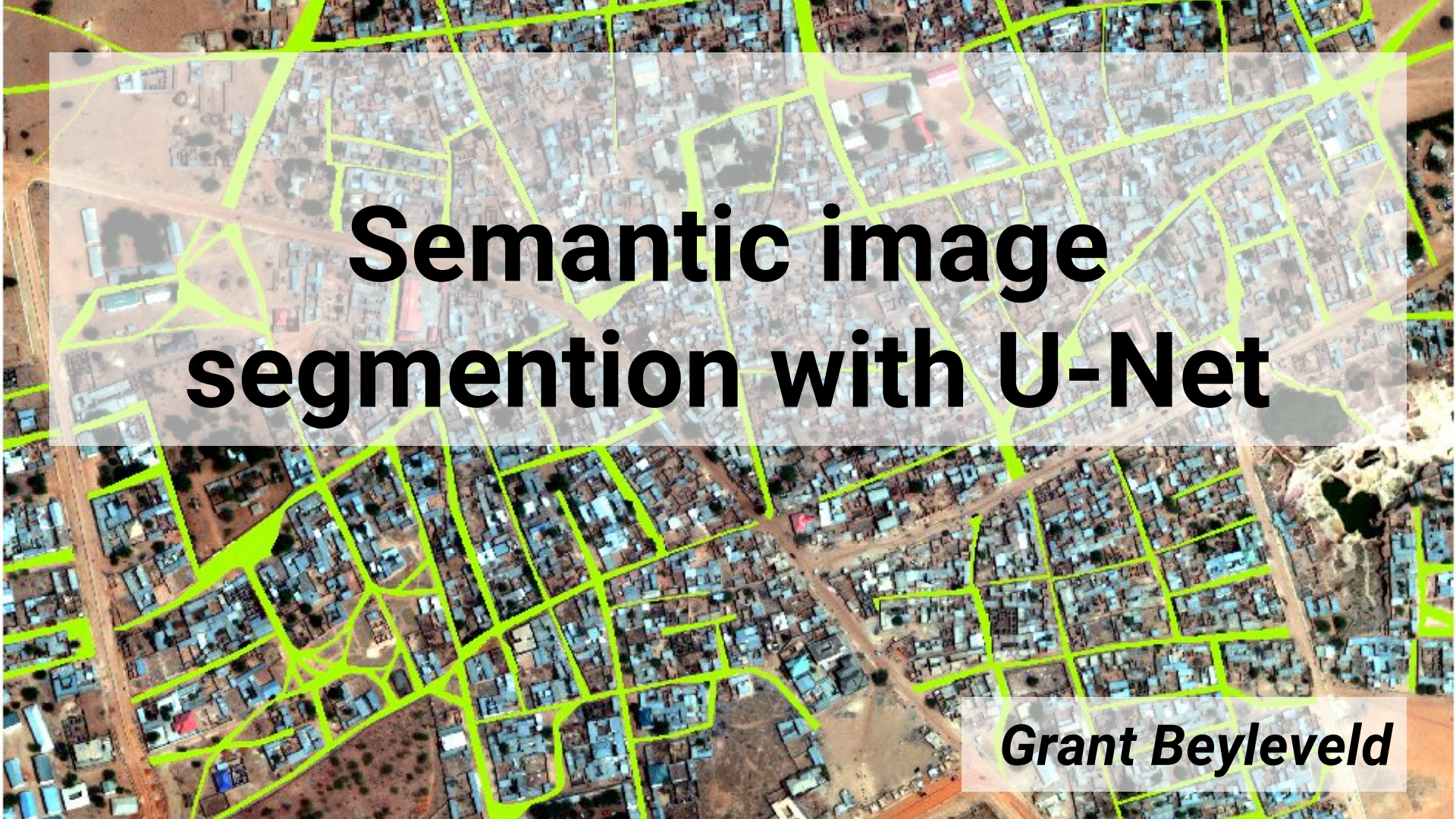
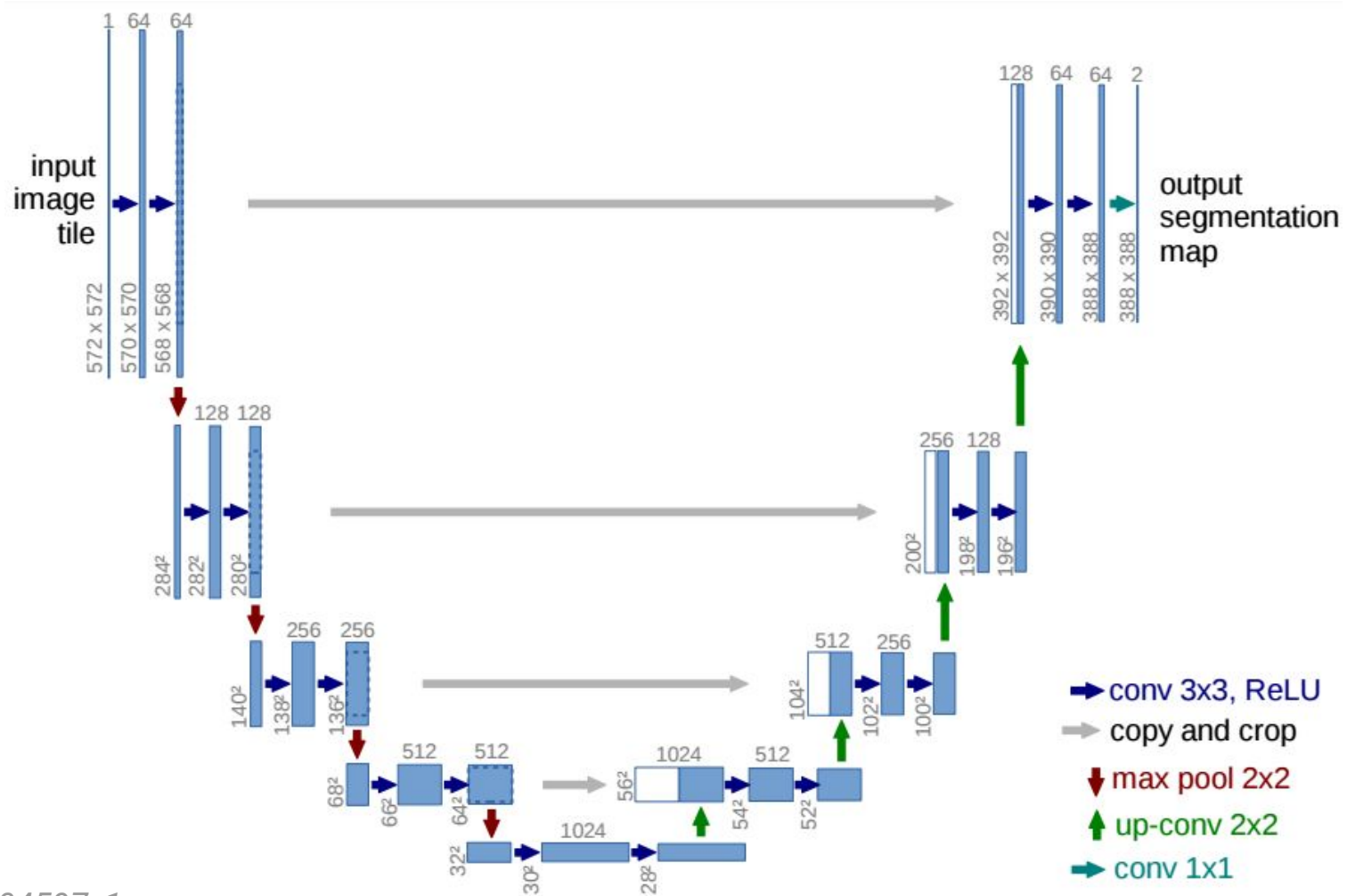


Semantic image segmention with U-Net

Grant Beyleveld

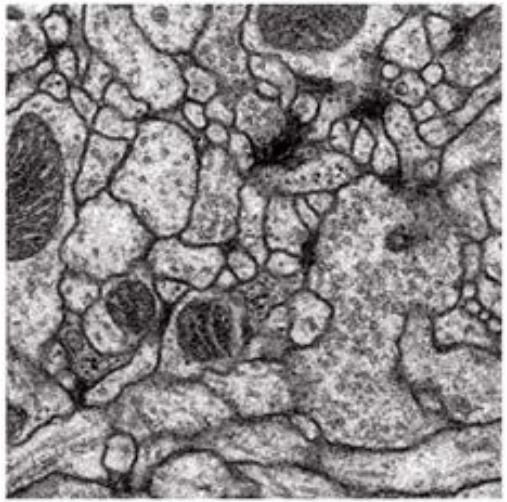


U-Net achieves state-of-the-art results in various competitions

ISBI EM segmentation challenge:

- Serial section TEM images of Drosophila first instar larva ventral nerve cord
- Goal: segment cells / membranes
- Winner in 2015 based on warping error

Input image



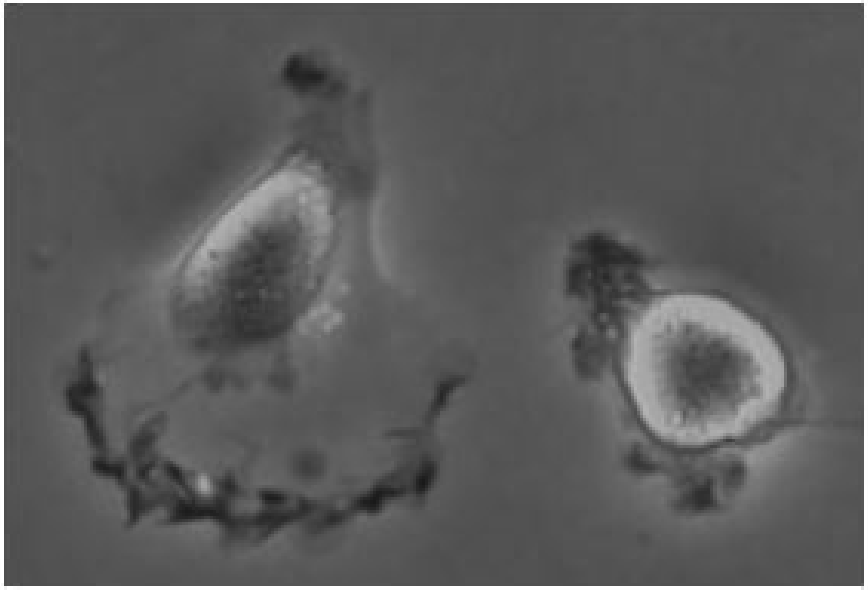
Ground-truth

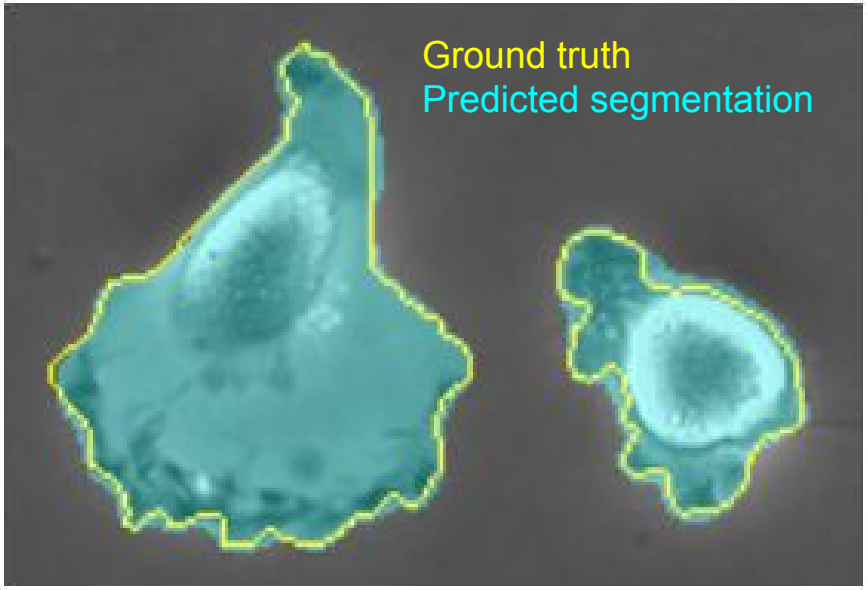
Generated segmentation

U-Net achieves state-of-the-art results in various competitions

Light microscopy images

- PhC-U373 data set - Glioblastoma-astrocytoma U373 cells
- Achieved ~10% advantage over 2nd place in 2015 and >40% over 2014 winner



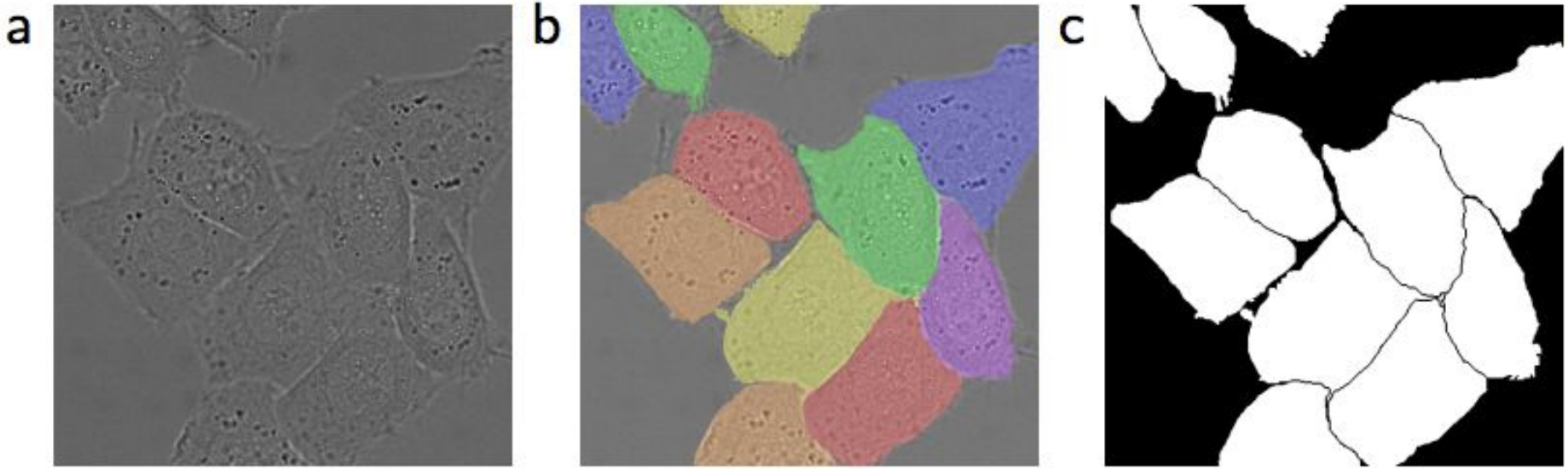


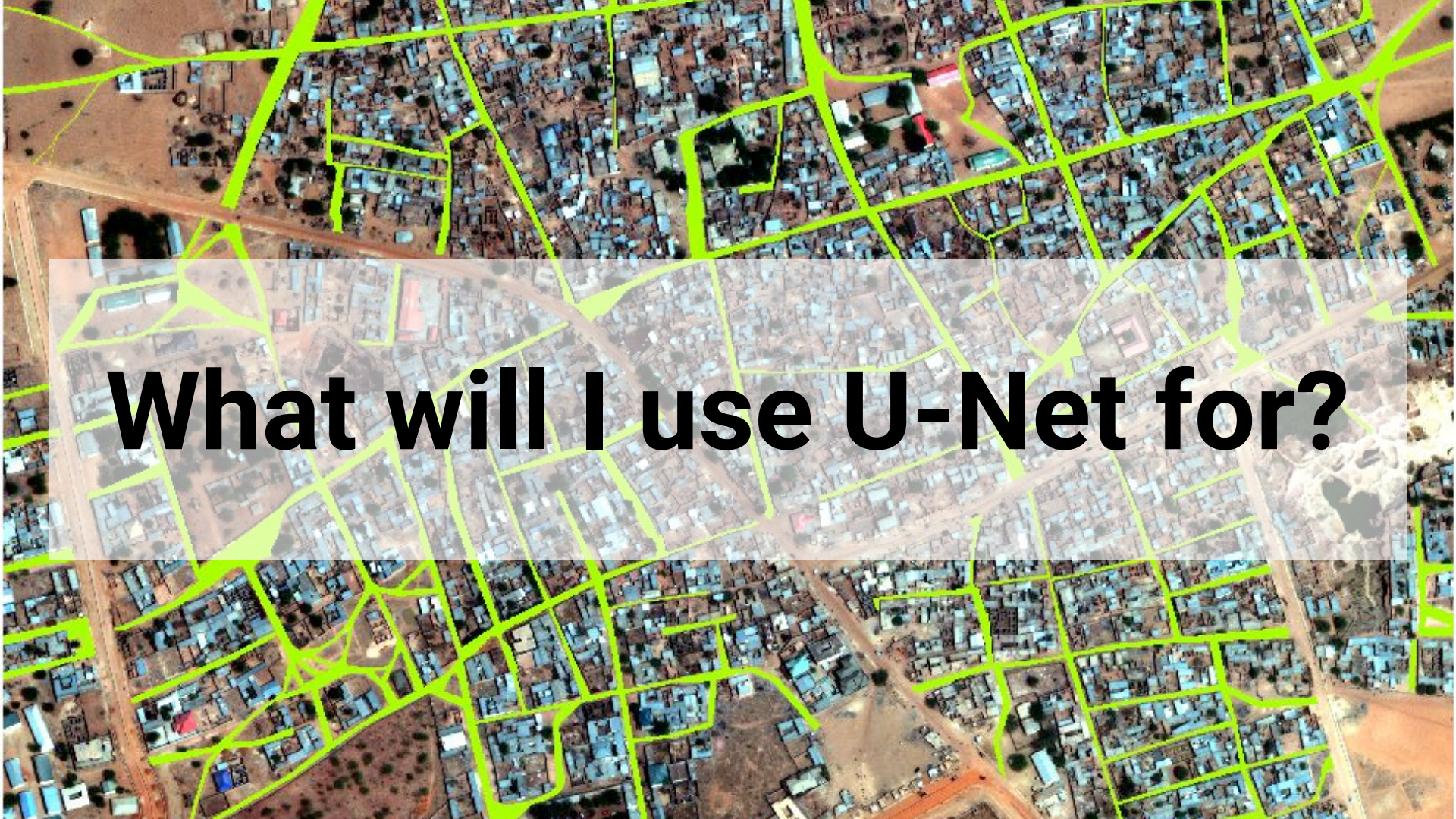
U-Net achieves state-of-the-art results in various competitions

Differential interference contrast microscopy

- DIC-HeLa data set - unstained HeLa cells on glass slides
- >30% advantage over 2nd place

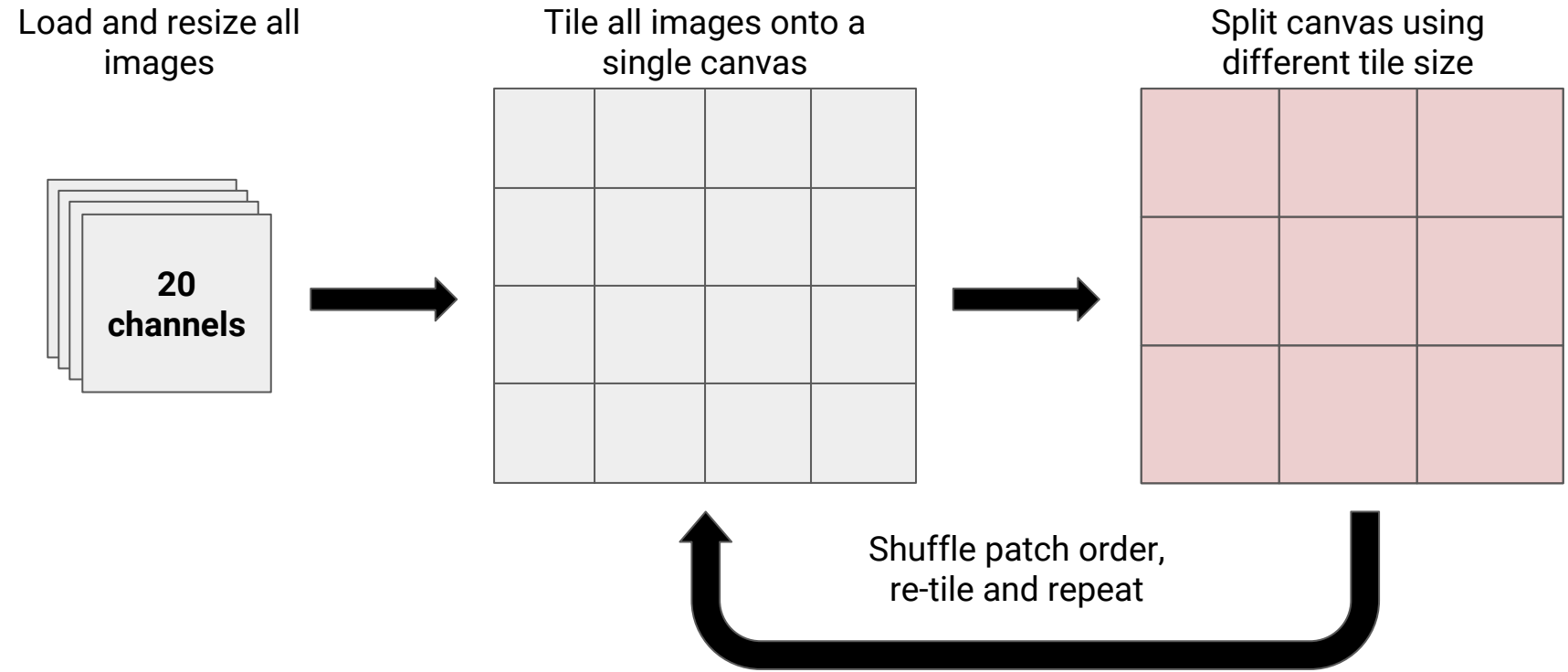
Input image | **Ground-truth segmentation** | **Generated segmentation**

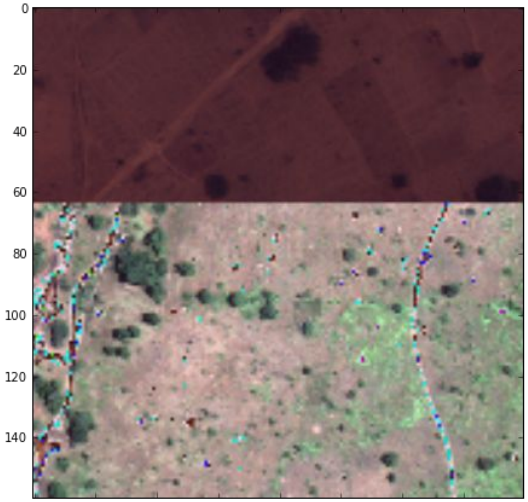
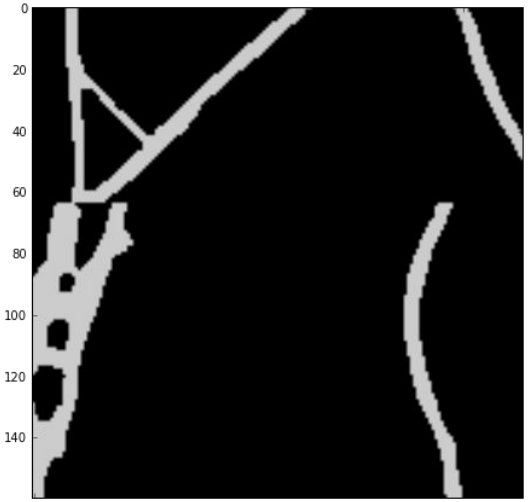
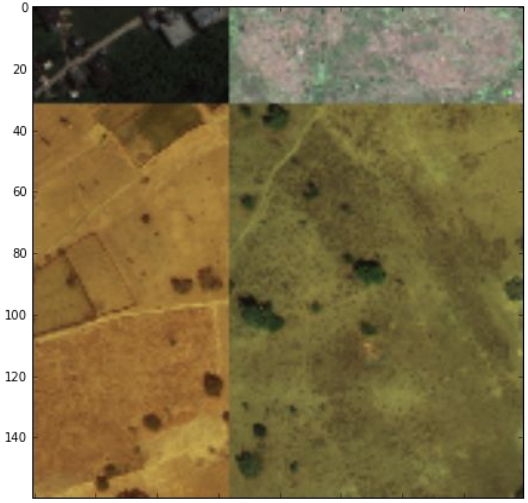
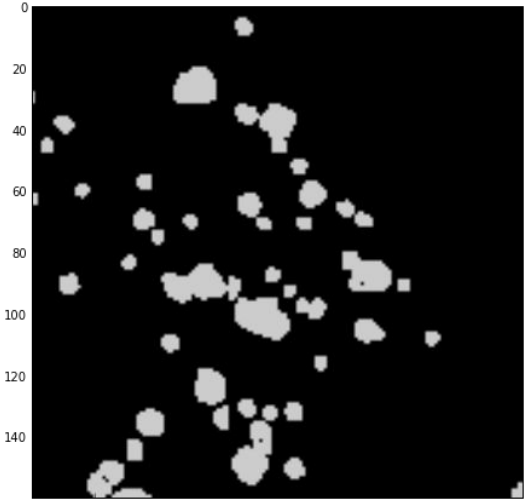


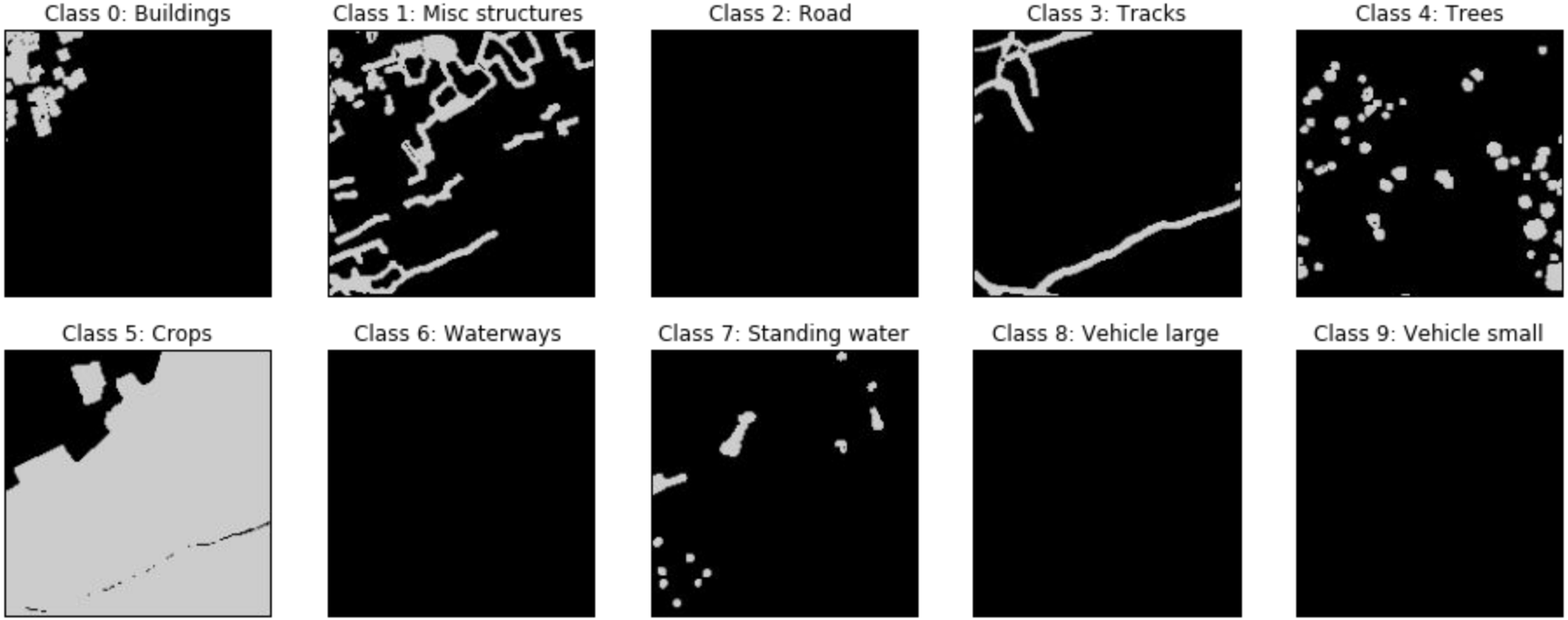

What will I use U-Net for?

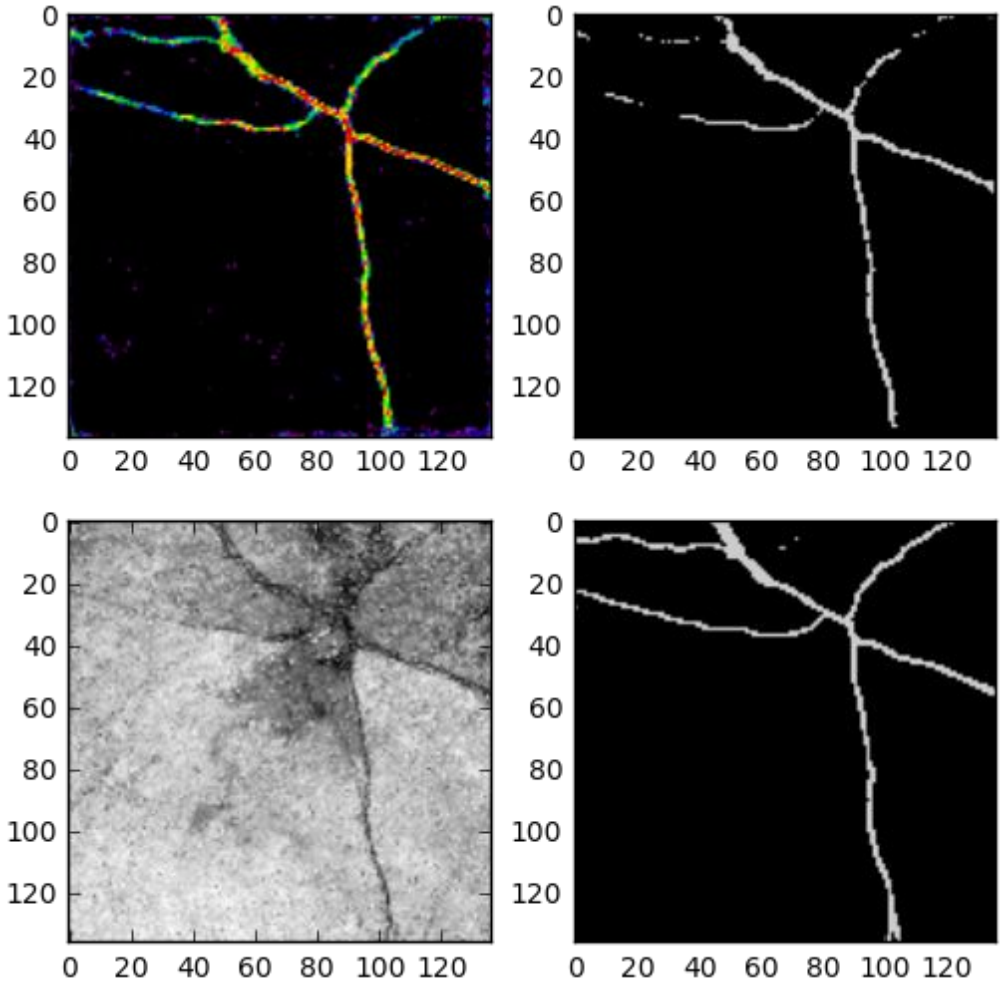

6040_4_4
6060_2_3
6040_1_3
6040_2_2
6010_1_2
6110_3_1
6170_4_1
6140_3_1
6010_4_4
6100_1_3
6120_2_0
6170_2_4
6070_2_3
6110_1_2
6100_2_3
6170_0_4
6150_2_3
6160_2_1
6040_1_0
6010_4_2
6120_2_2
6100_2_2
6090_2_0
6140_1_2
6110_4_0

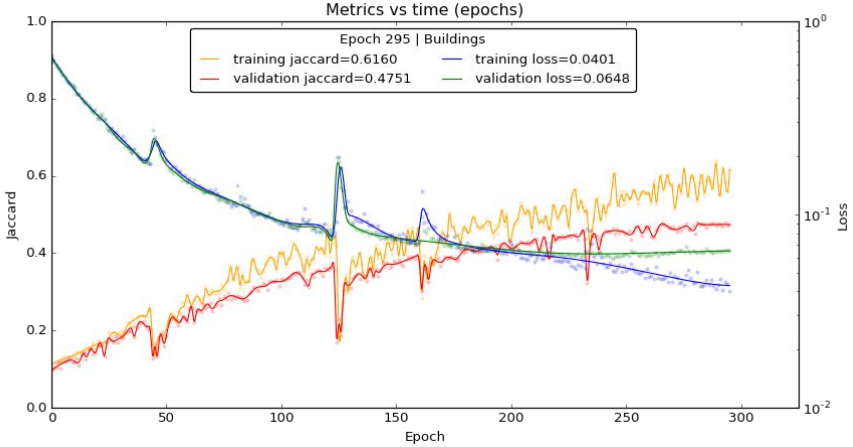
Generating multiple views

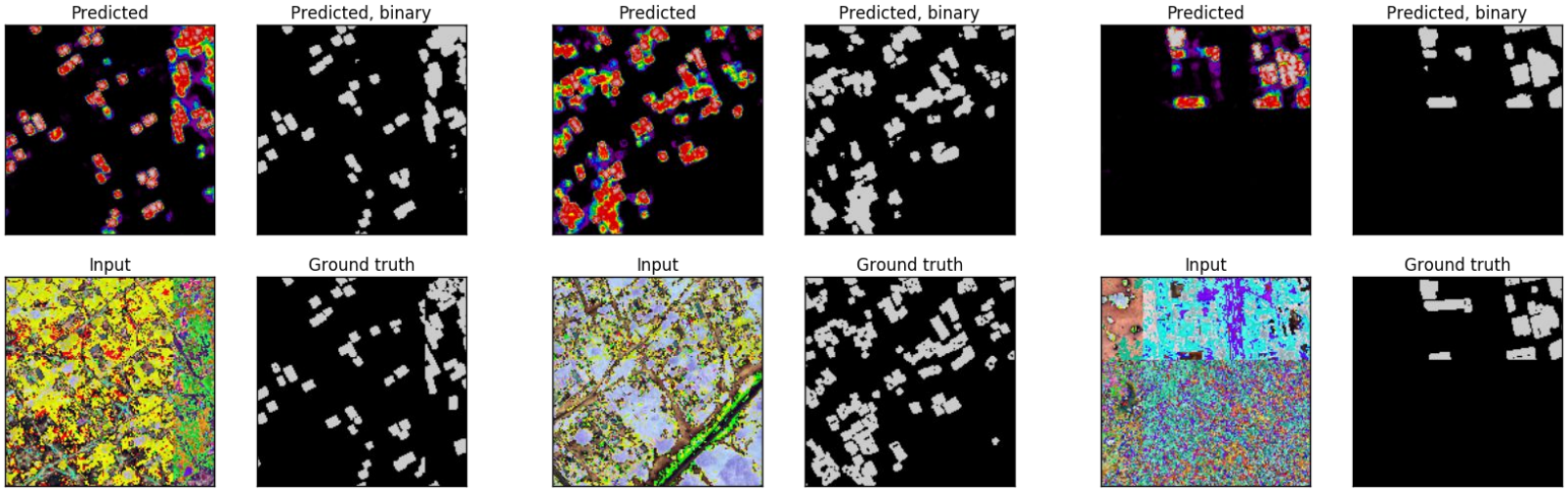


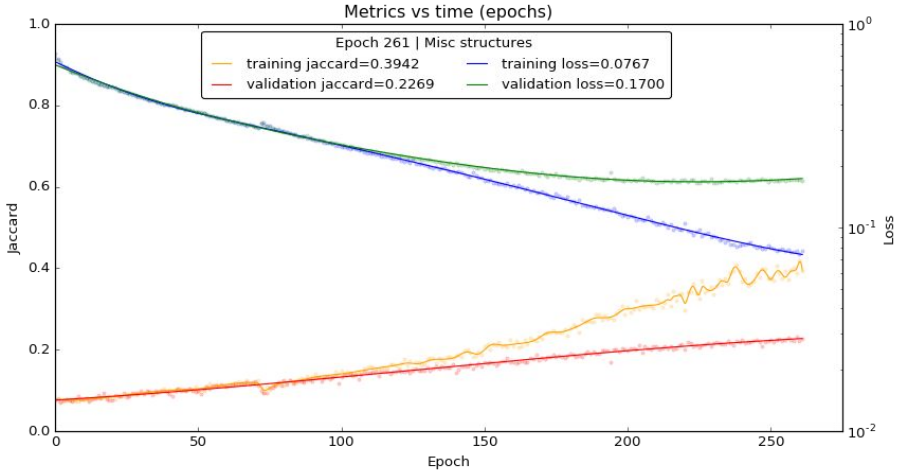





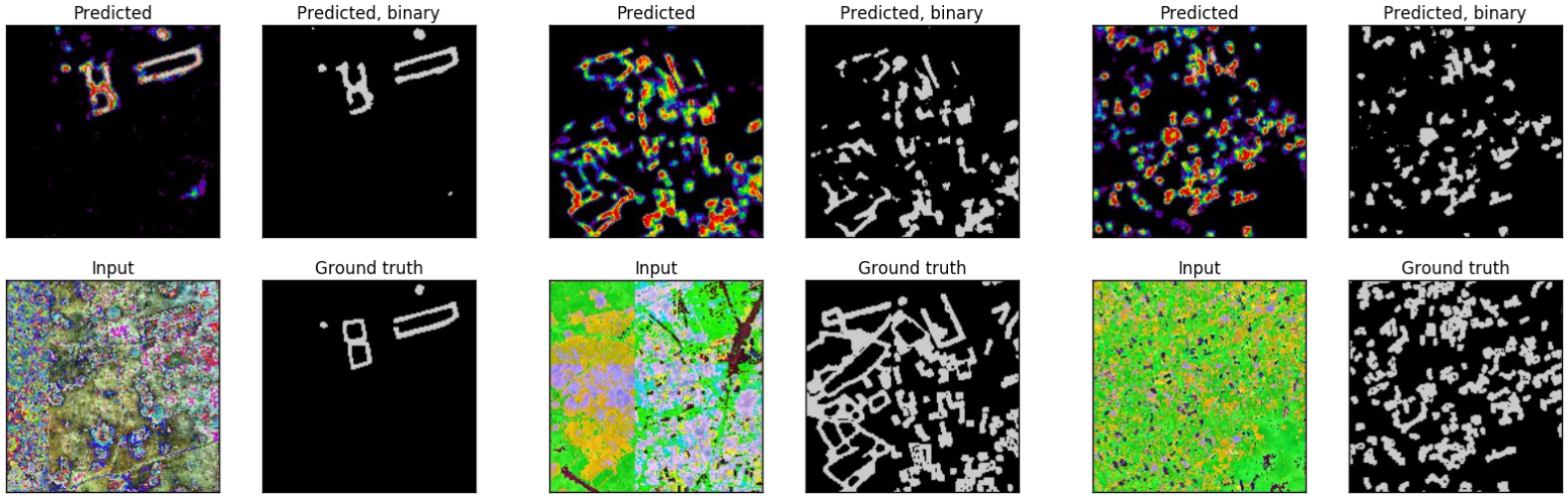

Class 0: Buildings
Class 1: Misc structures
Class 2: Road
Class 3: Tracks
Class 4: Trees
Class 5: Crops
Class 6: Waterways
Class 7: Standing water
Class 8: Vehicle large
Class 9: Vehicle small


0 20 40 60 80 100 120


Metrics vs time (epochs)
Epoch 295 | Buildings
training jaccard=0.6160
validation jaccard=0.4751
training loss=0.0401
validation loss=0.0648
Jaccard
Loss
Epoch
1.0
0.8
0.6
0.4
0.2
0.0
10^0
10^{-1}
10^{-2}
0
50
100
150
200
250
300


Predicted
Predicted, binary
Predicted
Predicted, binary
Predicted
Predicted, binary
Input
Ground truth
Input
Ground truth
Input
Ground truth


Metrics vs time (epochs)
Epoch 261 | Misc structures
training jaccard=0.3942
validation jaccard=0.2269
training loss=0.0767
validation loss=0.1700
Jaccard
Loss
Epoch
1.0
0.8
0.6
0.4
0.2
0.0
10^0
10^{-1}
10^{-2}
0
50
100
150
200
250


Predicted
Predicted, binary
Predicted
Predicted, binary
Predicted
Predicted, binary
Input
Ground truth
Input
Ground truth
Input
Ground truth