

Siamese Attention U-Net for Multi-Class Change Detection

1st Place Solution to the DynamicEarthNet Weakly-Supervised
Multi-Class Change Detection Challenge

Sol Cummings

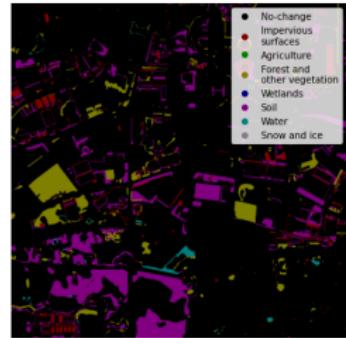
June 2021



2018-11-01



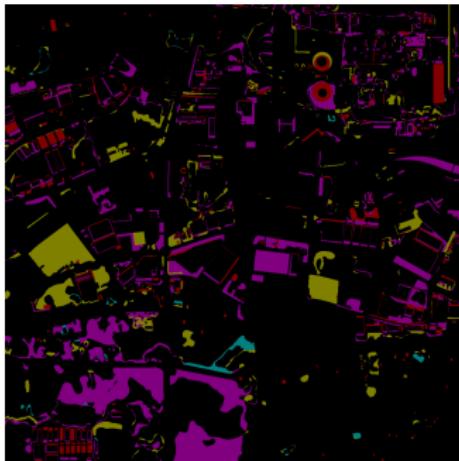
2018-12-01



Label

DynamicEarthNet Dataset

- 10/75 AOIs have labels
- Pixel-wise labels have 8 classes
- No-change is the majority class



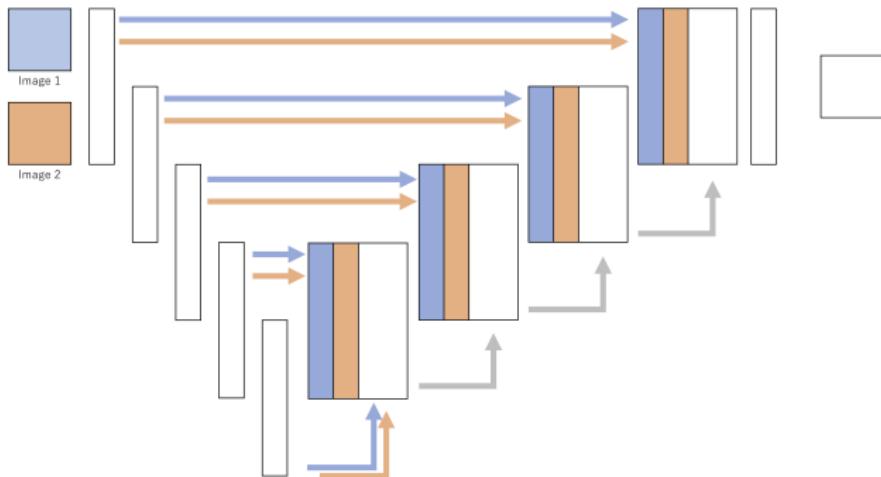
DynamicEarthNet Label



Cityscapes¹ Label

¹Marius Cordts et al. "The Cityscapes Dataset for Semantic Urban Scene Understanding". In: *Proc. of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*. 2016.

Baseline



Structure of the Siamese U-Net²³

²Rodrigo Caye Daudt, Bertrand Le Saux, and Alexandre Boulch. *Fully Convolutional Siamese Networks for Change Detection*. 2018. arXiv: 1810.08462 [cs.CV].

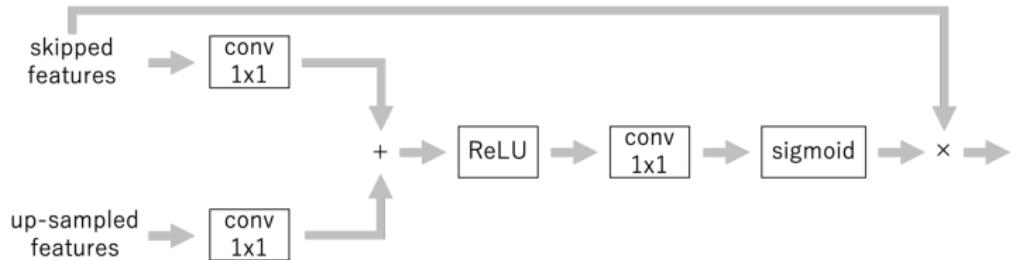
³Vít Růžička et al. *Deep Active Learning in Remote Sensing for Data Efficient Change Detection*. 2020. arXiv: 2008.11201 [cs.CV].

Baseline

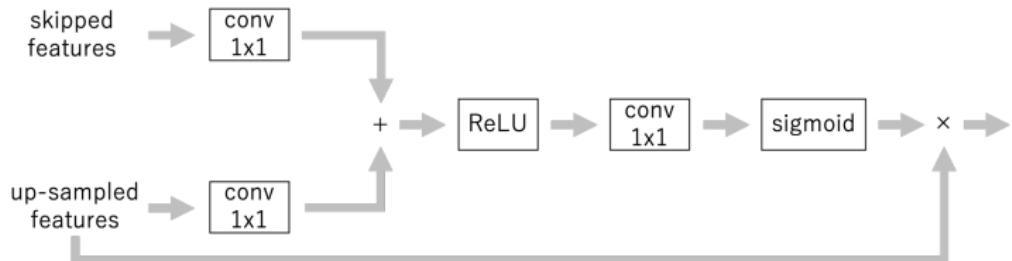
- 128x128 px image chips randomly cropped to 112x112 px
- Undersample such that change:no-change image chips are 1:1
- Random flips and rotations during training
- Flip and rotation TTA
- Cosine annealing learning rate scheduling with warm restarts

Architecture	mean IoU (val)
Siamese U-Net	0.2635

Network Architecture



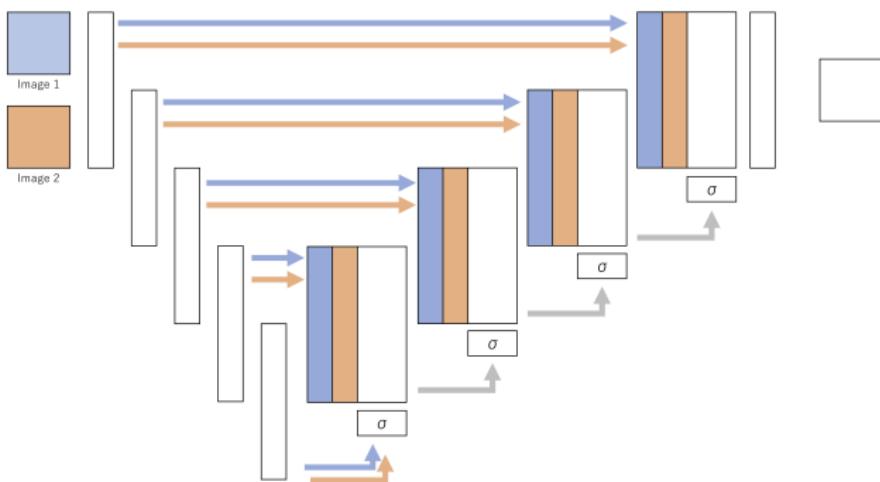
Structure of the Original Attention Block⁴



Structure of the Proposed Attention Block

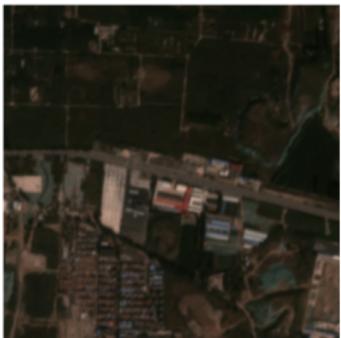
⁴Ozan Oktay et al. *Attention U-Net: Learning Where to Look for the Pancreas*. 2018. arXiv: 1804.03999 [cs.CV].

Network Architecture



Structure of the Siamese Attention U-Net

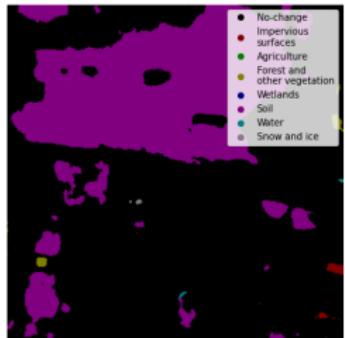
Attention block	mean IoU (val)
None	0.2635
Skip connection	0.2603
Up-sample	0.2658



2018-10-01

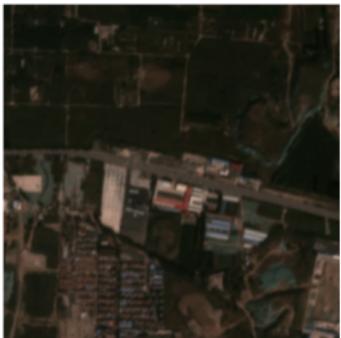


2018-11-01



Prediction

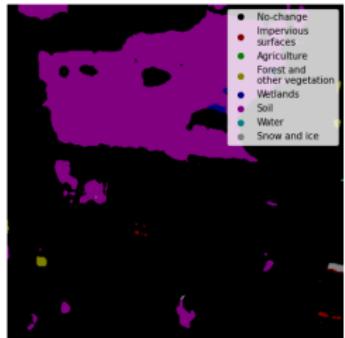
Test Dataset Predictions by the **Siamese U-Net**



2018-10-01



2018-11-01



Prediction

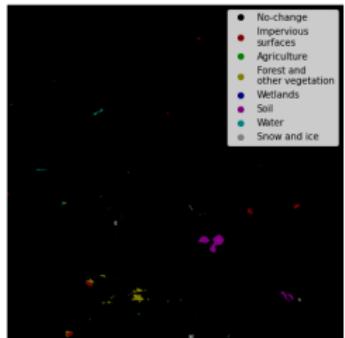
Test Dataset Predictions by the **Siamese Attention U-Net**



2018-09-01



2018-10-01



Prediction

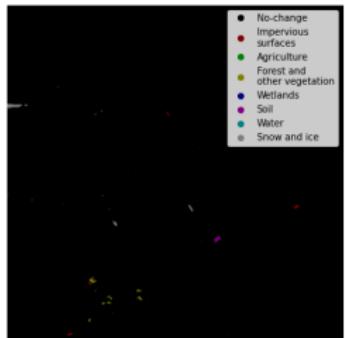
Test Dataset Predictions by the **Siamese U-Net**



2018-09-01



2018-10-01

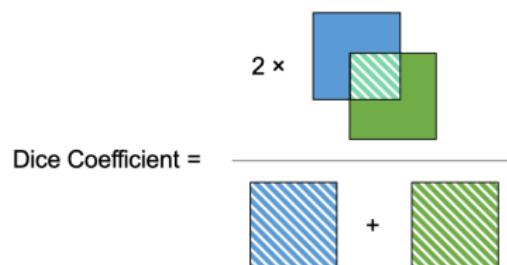
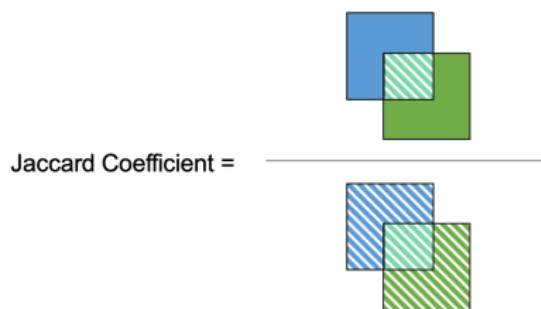


Prediction

Test Dataset Predictions by the **Siamese Attention U-Net**

Loss Function

Loss function	mean IoU (val)
Jaccard	0.2658
Dice	0.2668
Ensemble	0.2676



Label Prediction

Semi-Supervised Learning

- Create pseudo labels on validation and test dataset
- Train on hard pseudo labels

Semi-supervised	Loss function	mean IoU (val)	mean IoU (test)
None val+test	Jaccard	0.2658	-
	Jaccard	0.2669	-
None val+test	Dice	0.2668	-
	Dice	0.2674	-
None val+test	Ensemble	0.2676	-
	Ensemble	0.2684	0.2423

Unsuccessful Approaches

- Label smoothing
- Increasing the amount of training data by creating bi-monthly labels
- Pre-training on binary labels and fine-tuning on multi-class labels

Contribution

Methodology with the highest performance:

- Attention blocks in the up-sample path of the decoder
- An ensemble of models trained on dice loss and jaccard loss
- Semi-supervised learning with hard pseudo labels

Code available at:

<https://github.com/solcummings/earthvision2021-weakly-supervised>