Fully Convolutional Neural Network for Impervious Surface Segmentation in Mixed Urban Environment

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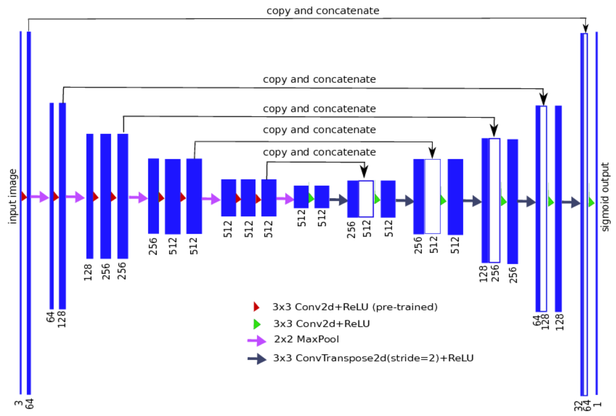
ABSTRACT

Impervious surfaces are traditionally mapped from remotely sensed imagery using image classification algorithms. The surface type is complex; it consists of many distinct materials, for which image classification and aggregation approaches are used to map it. This work explores the use of fully convolutional neural networks (FCNN), specifically, UNet, in mapping these complex features at the pixel level from DigitalGlobe WorldView-2 high resolution multispectral satellite imagery. Surface reflectance (SR) products were used. Initial results are promising in both qualitative and quantitative assessment when compared to automated products, using ROC Area-Under-Curve (AUC), F1-score, and mean average precision (mAP) as performance metrics.

METHODS



TernausNet: UNet with VGG11 Encoder Pre-Trained on ImageNet for Image Segmentation, V. Iglovikov and A. Shvets, 2018

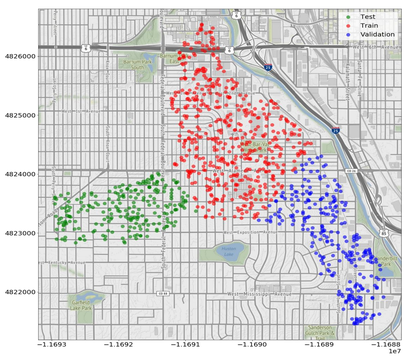
FINDINGS & FUTURE WORK

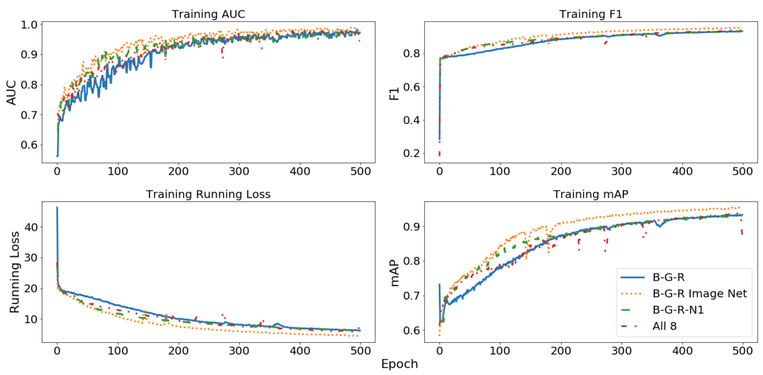
UNet with a Resnet-152 encoder showed satisfactory performance in classifying impervious pixels. Test set performance metrics were highest, on average, for Blue-Green-Red-NIR1 channels. Future work will focus on utilizing different encoders to take advantage of all spectral bands of WorldView data, as well as evaluate generalizability to other satellite SR products.

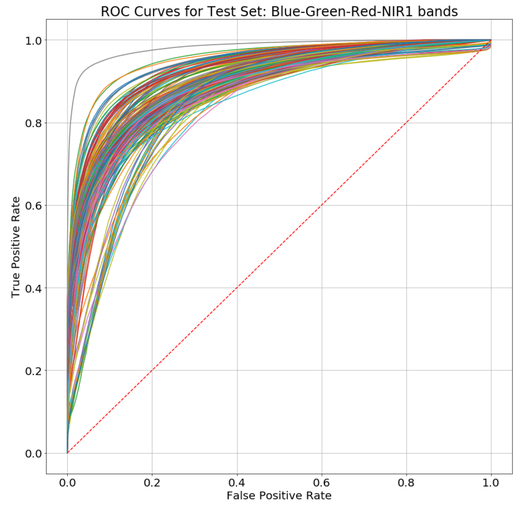
Bands	Test F1			Test AP			Test AUC			
	min	*mean*	*max*	*min*	*mean (mAP)*	*max*	*min*	*mean*	*max*	**total avg.**
B-G-R	0.497	0.666	0.917	0.559	0.715	0.887	0.646	0.723	0.825	0.701
B-G-R*	0.593	0.714	0.886	0.646	0.746	0.901	0.706	0.768	0.835	0.743
B-G-R-N1	0.556	0.709	0.906	0.736	0.82	0.915	0.736	0.807	0.855	**0.779**
All-8	0.483	0.629	0.788	0.767	0.845	0.933	0.734	0.795	0.856	0.756
LULC	0.733	0.793	0.878	0.684	0.767	0.864	0.733	0.765	0.820	0.775
BUE	0.644	0.719	0.846	0.481	0.574	0.744	0.530	0.560	0.630	0.647

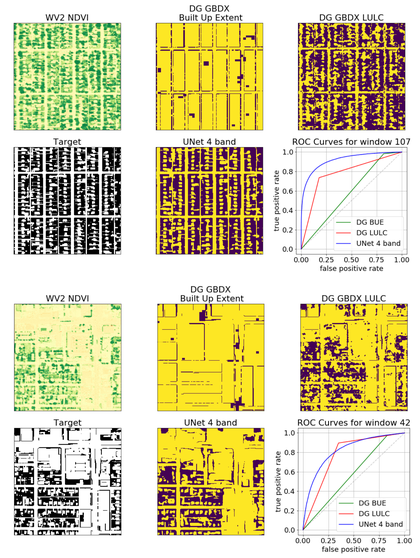
TRAINING & MODEL PERFORMANCE

K-MEANS BLOCKING (K=3)

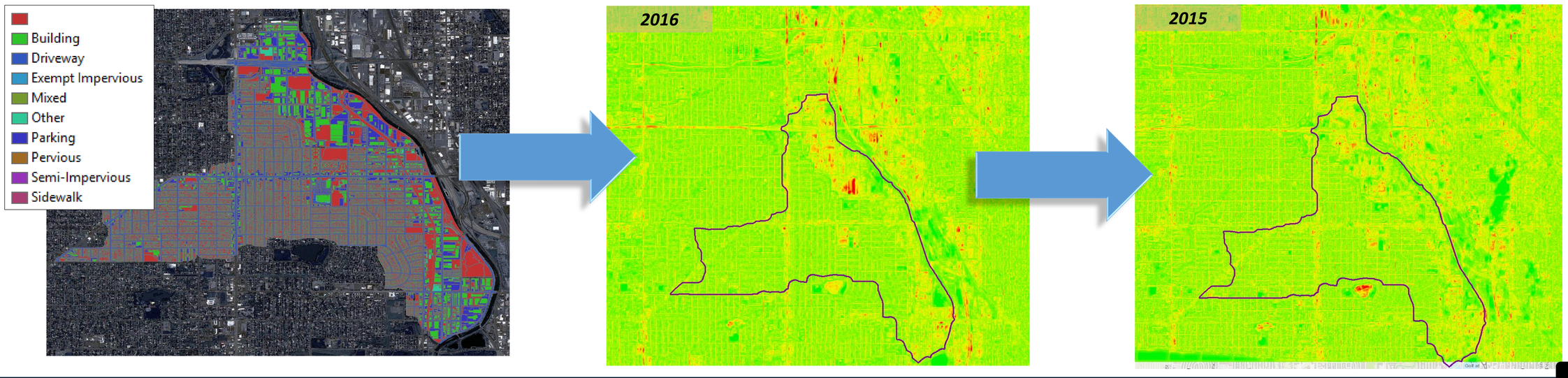








GROUND TRUTH, SOURCE DATA, AND SAMPLE RESULTS – GIS and DIGITALGLOBE WORLDVIEW-2



SCAN ME