A GIS Pipeline to produce GeoAI Datasets from Drone Overhead Imagery

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MockUp Lesson

Agenda

- GeoAI
- Machine Learning and Deep Learning
- GeoAI Datasets
- Applications
- A GIS Pipeline for GeoAI datasets
- A road, vehicle and buildings datasets examples for semantic segmentation
- Learning Test

GeoAI

A set of techniques at the intersection of AI and Geospatial Analysis for geographic knowledge discovery.

(Janowicz et al., 2019)

Machine Learning

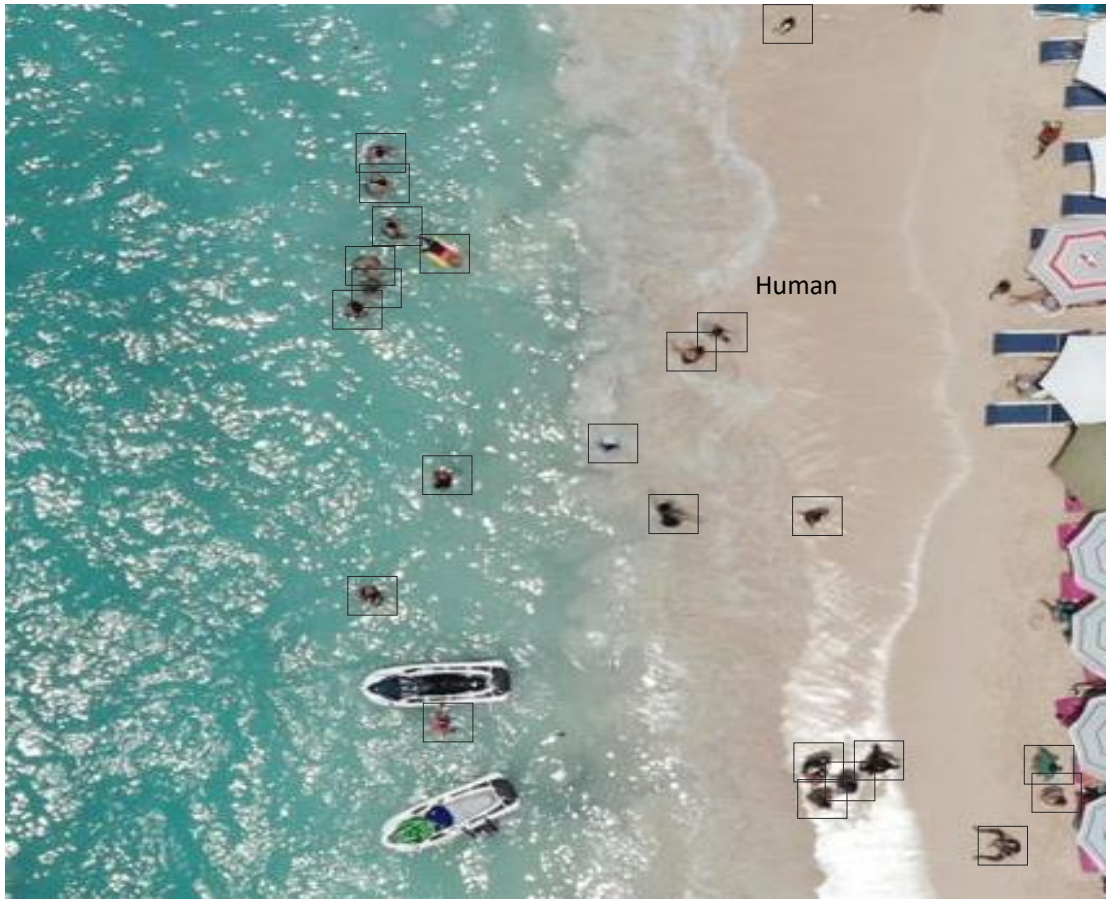
Algorithms that learn directly from data instead of being explicitly programmed.

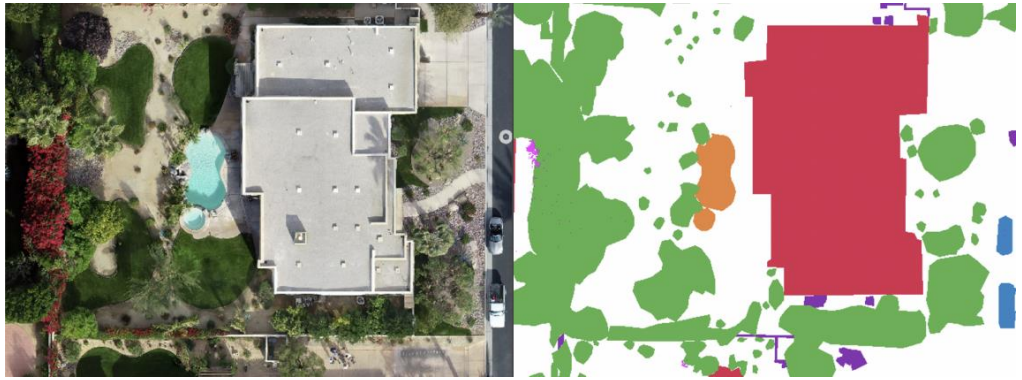
Deep Learning

Flexible mapping functions created by layers of neurons emulating how the brain Works.

GeoAI Datasets

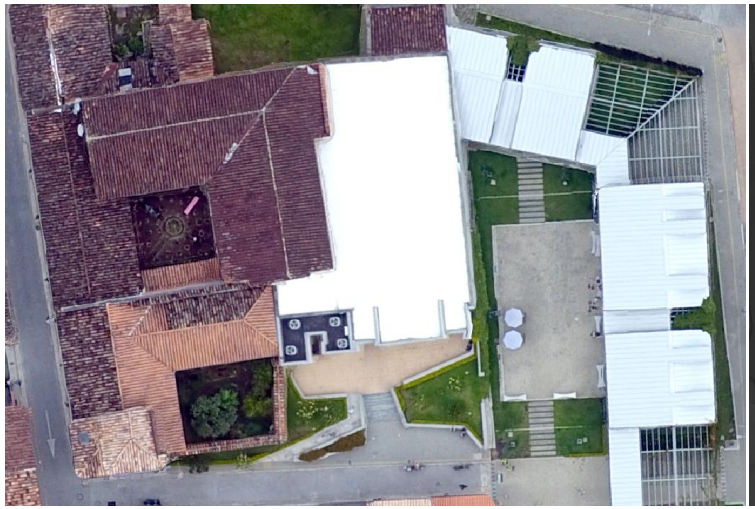
Unbiased and enhanced data features



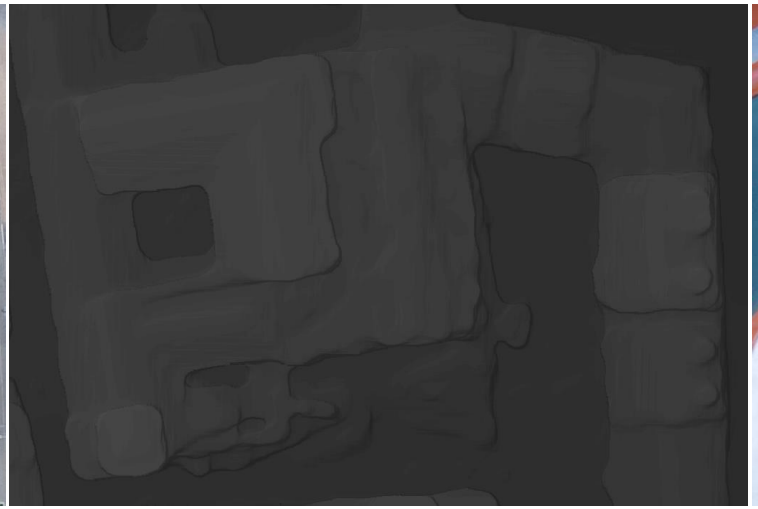


(Blaga and Nedevschi., 2020)

RGB

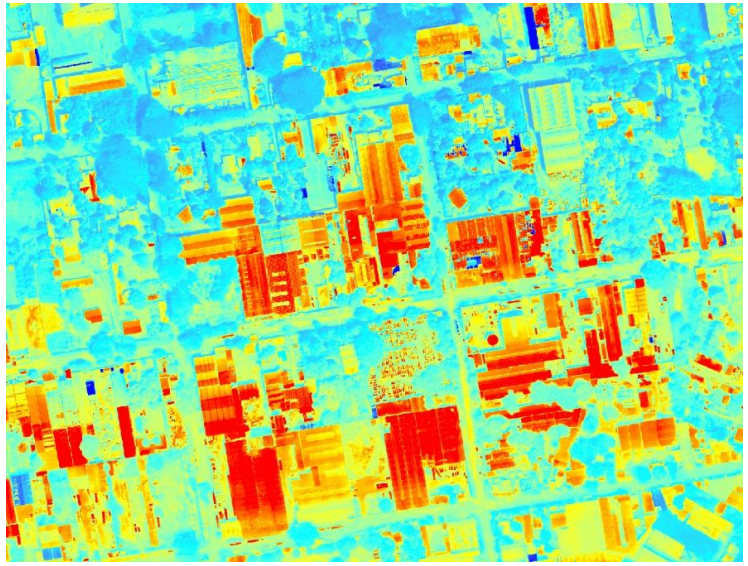


LIDAR



NIR

SAR



THERMAL

RG-DSM

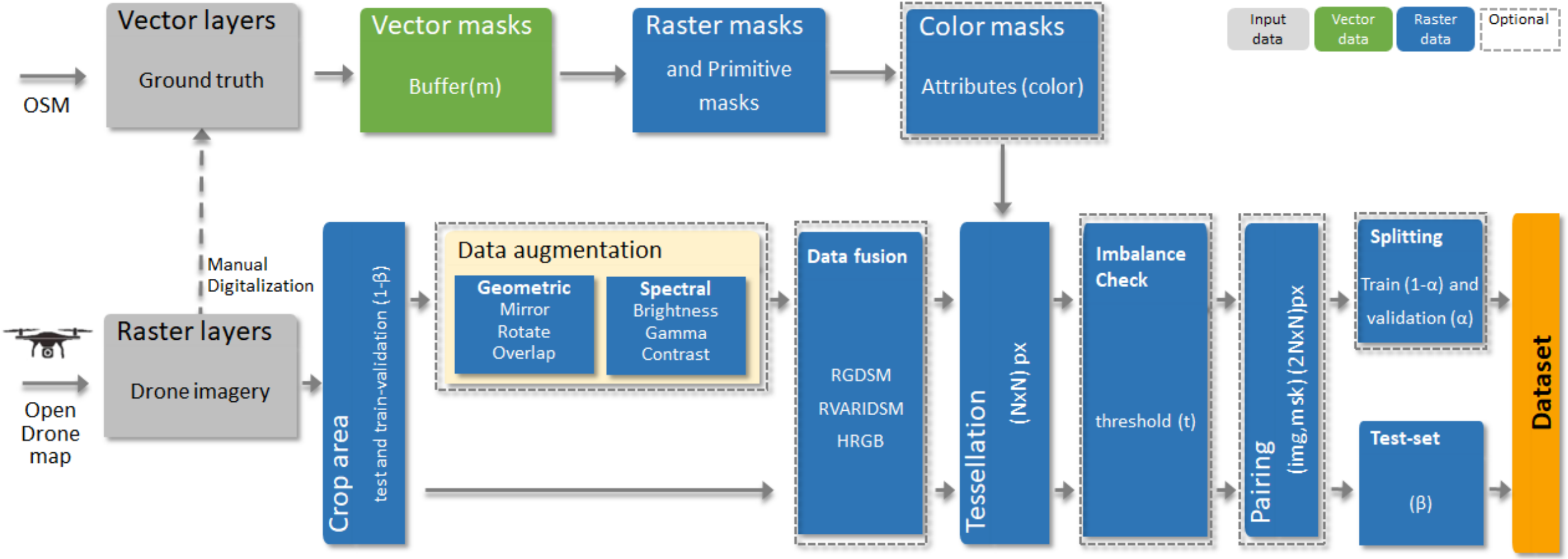
(Abdollahi et al., 2020)

Applications

Encompassing the fast and increasing acquisition of aerial-drone-satellite imagery with the spatial analysis and map production for :

- ***Mapping & cartography*** (in minutes nor months).
- ***Cadaster***
- ***Logistics and Routing***
- ***Disaster management*** (quick production of maps is needed)
- ***Oil and Gas***
- ***Solar Energy***
- ***Urban Planning***
- ***Current environmental problems: Heat Islands***

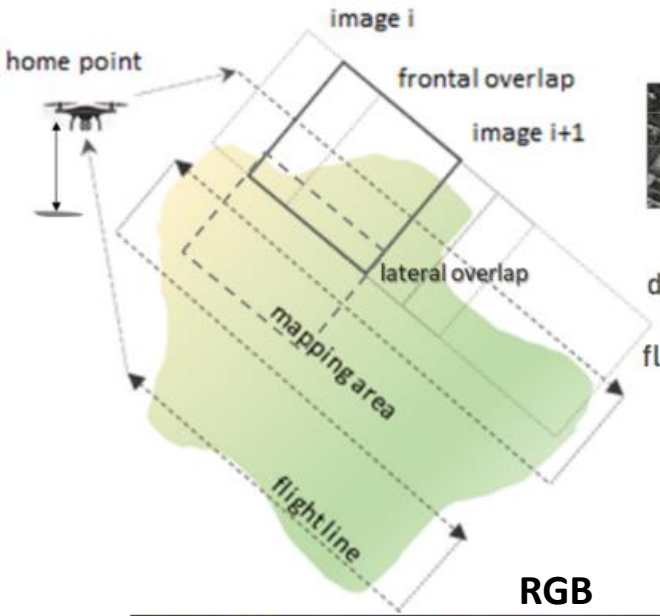
Proposed GIS Pipeline to Produce GeoAI Datasets from Drone Overhead Imagery

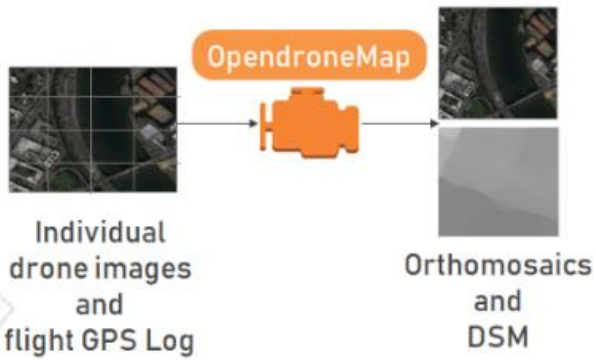


Ballesteros, John R., German Sanchez-Torres, and John W. Branch-Bedoya. 2022. "A GIS Pipeline to Produce GeoAI Datasets from Drone Overhead Imagery" *ISPRS International Journal of Geo-Information* 11, no. 10: 508. https://doi.org/10.3390/ijgi11100508

Drone Imagery Acquisition & Orthomosaic Production

Automatic flight

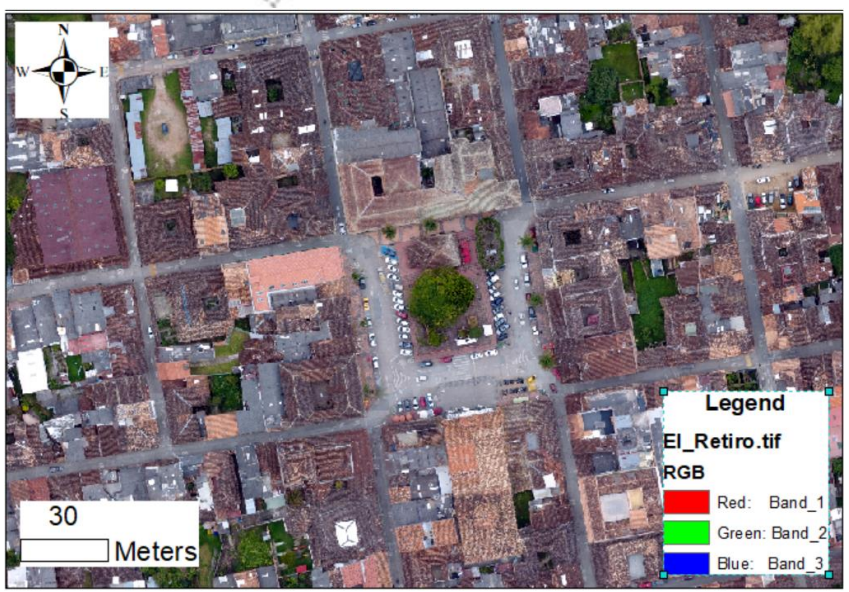




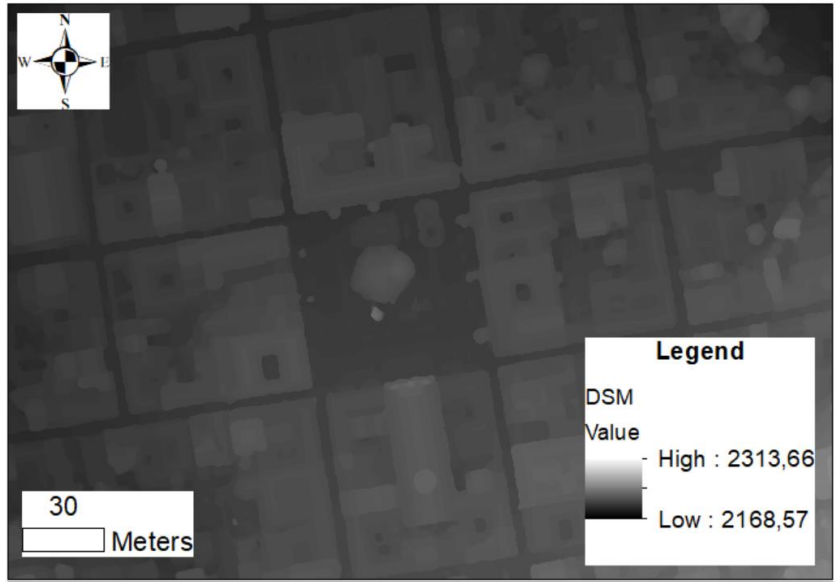
See
For an example of the result

(Crommelinck et al., 2017) employed opendronemap for UAV imagery acquisition for cadaster.

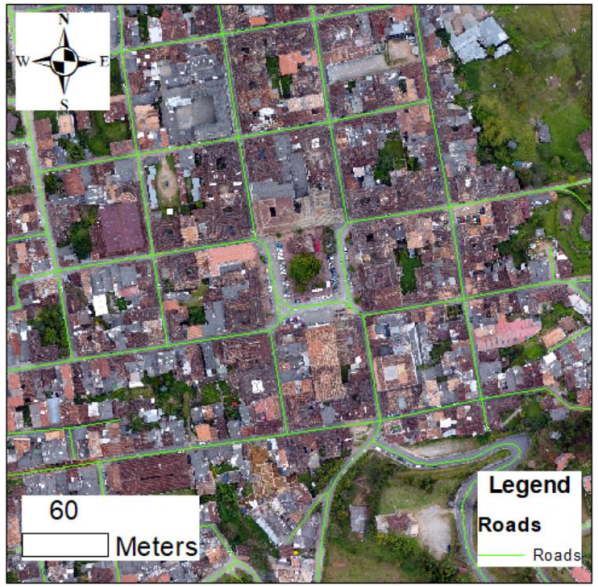
RGB



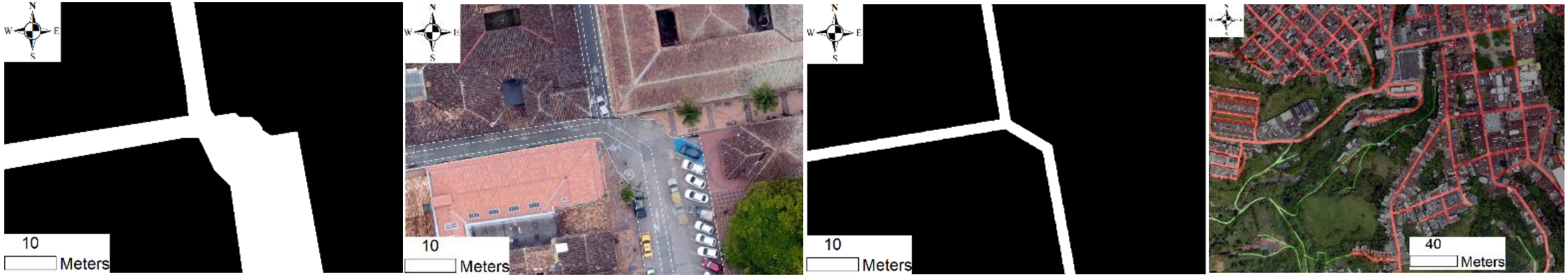
DSM



Vector roads from OSM



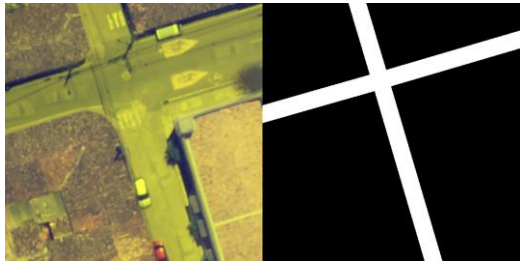
Type of Masks



Full-size mask **Equal-size mask** **Color mask**

Primitive-mask the simplest raster representation of objects present in input images that allow models to learn objects' structure and simplify their vectorization

(Image, Point primitive-mask), ex. Vehicles



(Image, Line primitive-mask), ex. Roads

(Image, Polygon primitive-mask), ex. Buildings

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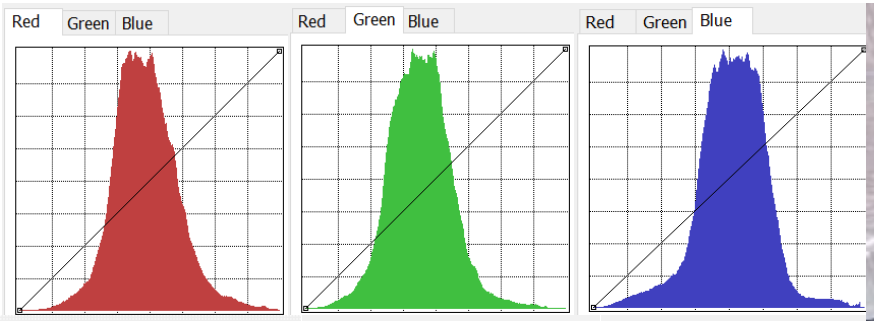
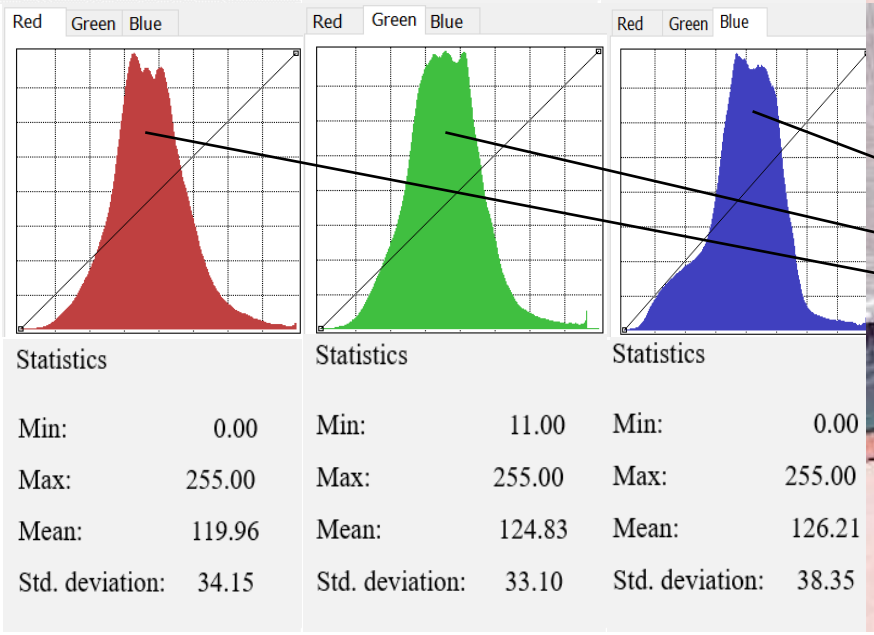
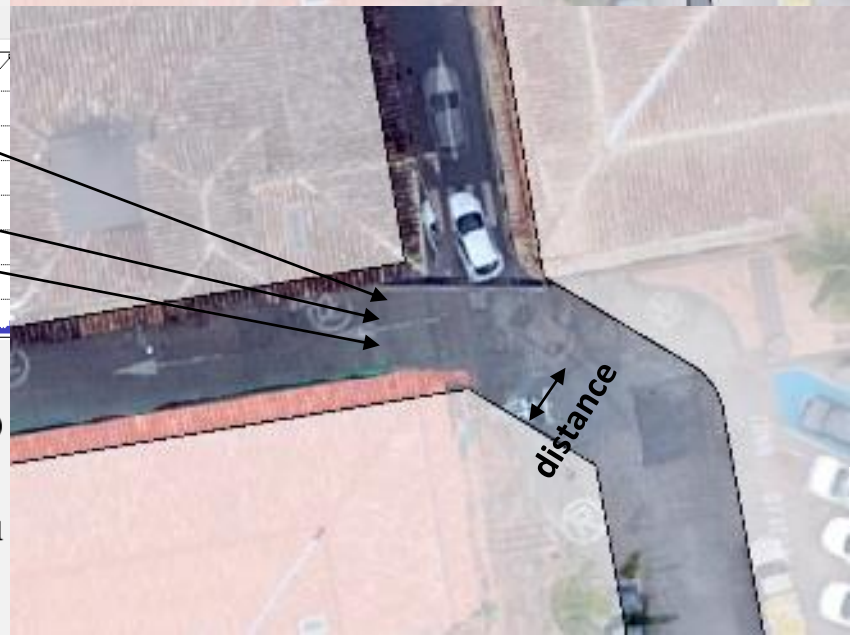
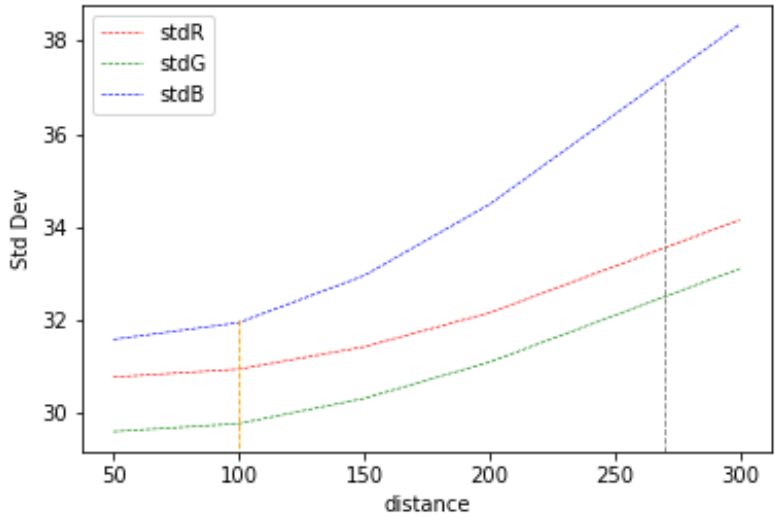
Producing Primitive Linear Masks







RGB pixel values distribution, f(d)



Buffer distance of masks and RGB pixel distribution

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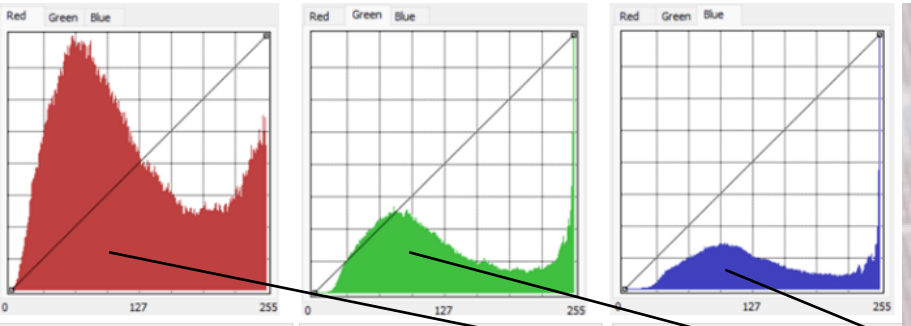
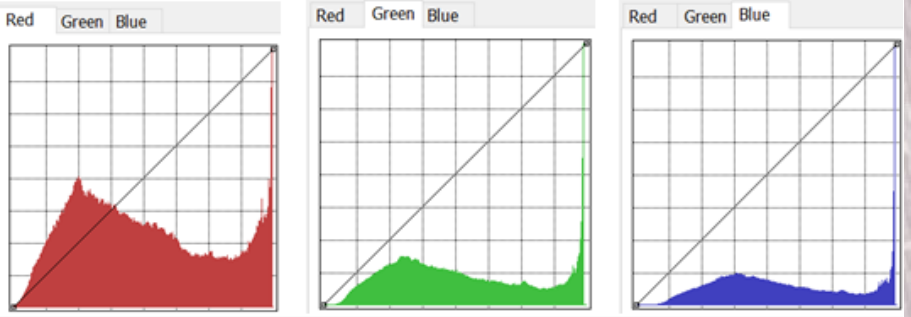
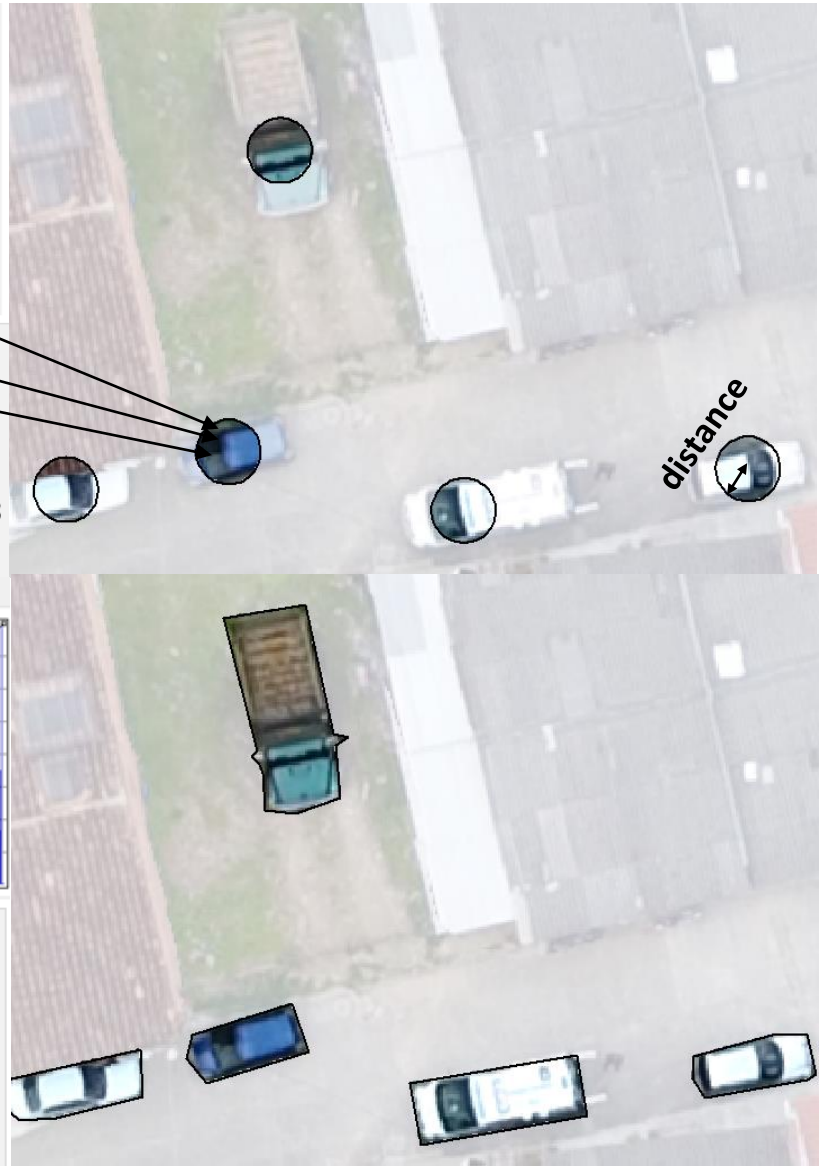
Producing Primitive Point Masks



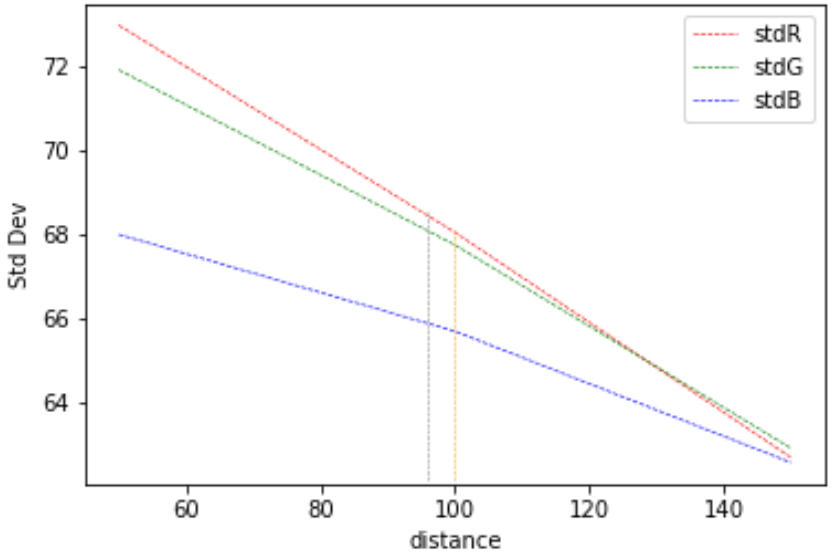
Statistics					
Min:	0.00	Min:	5.00	Min:	2.00
Max:	255.00	Max:	255.00	Max:	255.00
Mean:	117.26	Mean:	127.67	Mean:	139.78
Std. deviation:	68.03	Std. deviation:	67.73	Std. deviation:	65.68



Statistics					
Min:	0.00	Min:	3.00	Min:	2.00
Max:	255.00	Max:	255.00	Max:	255.00
Mean:	129.59	Mean:	139.28	Mean:	149.42
Std. deviation:	69.41	Std. deviation:	68.90	Std. deviation:	66.39



RGB pixel values distribution, f(d)



Buffer distance of masks and RGB pixel distribution

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Producing Primitive Polygon Masks

Massachussets Building Dataset

Mnih et al, 2013

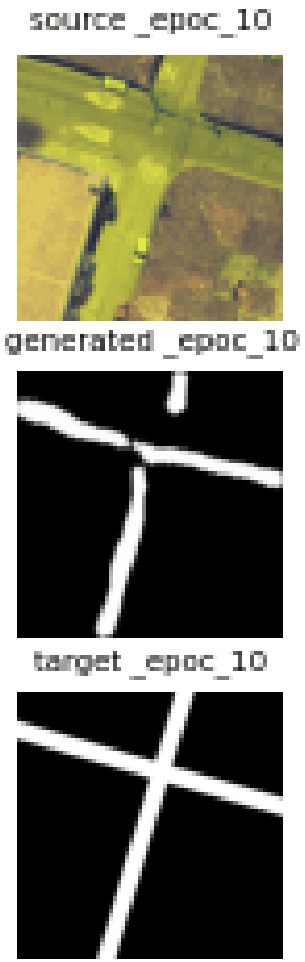
RID Dataset (A boundary mask dataset)

Ballesteros, Sanchez-Torres, Branch-Bedoya, 2022 in progress

- High resolution
- Describes roof structure (runoff, material and area)
- High density building areas (developing countries)

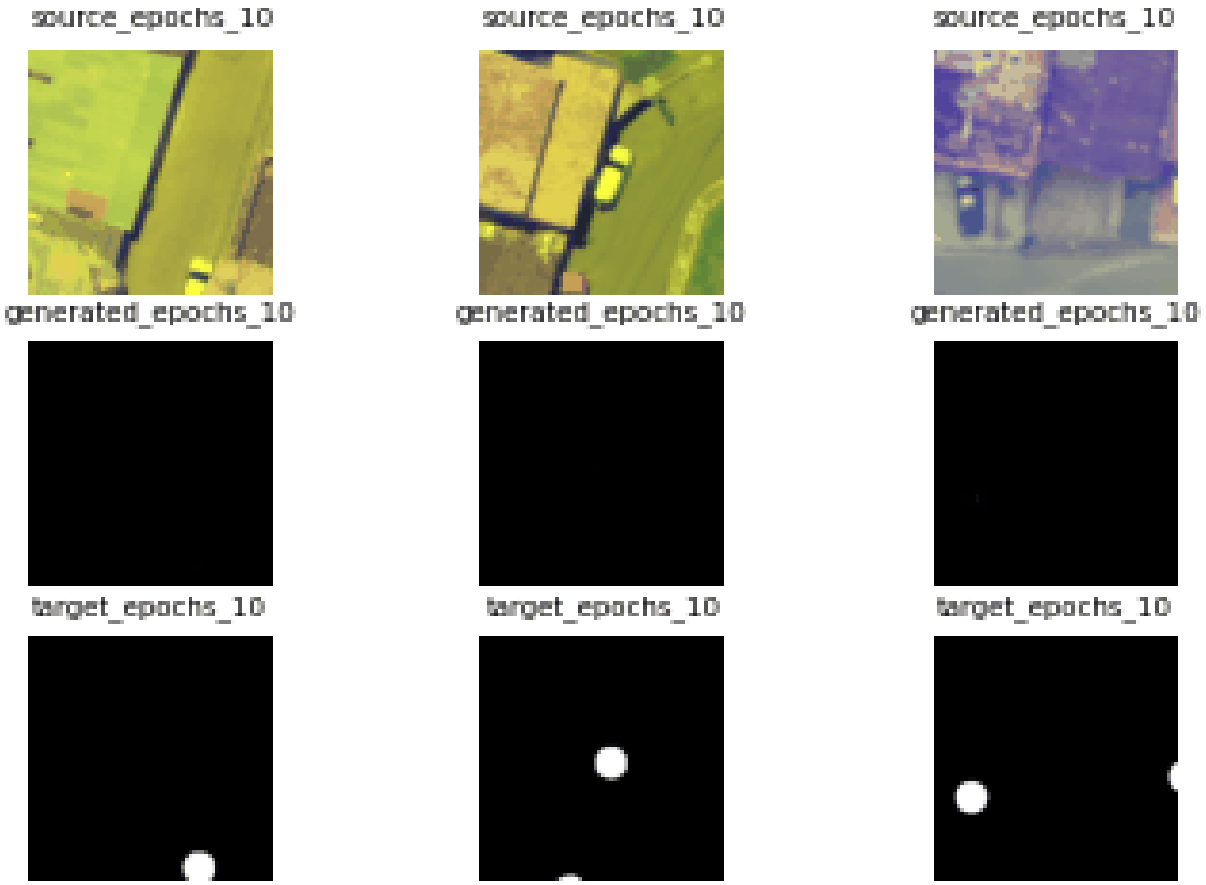
Road Centerline Segmentation using a road dataset

Line masks, 1098 ex., 1m



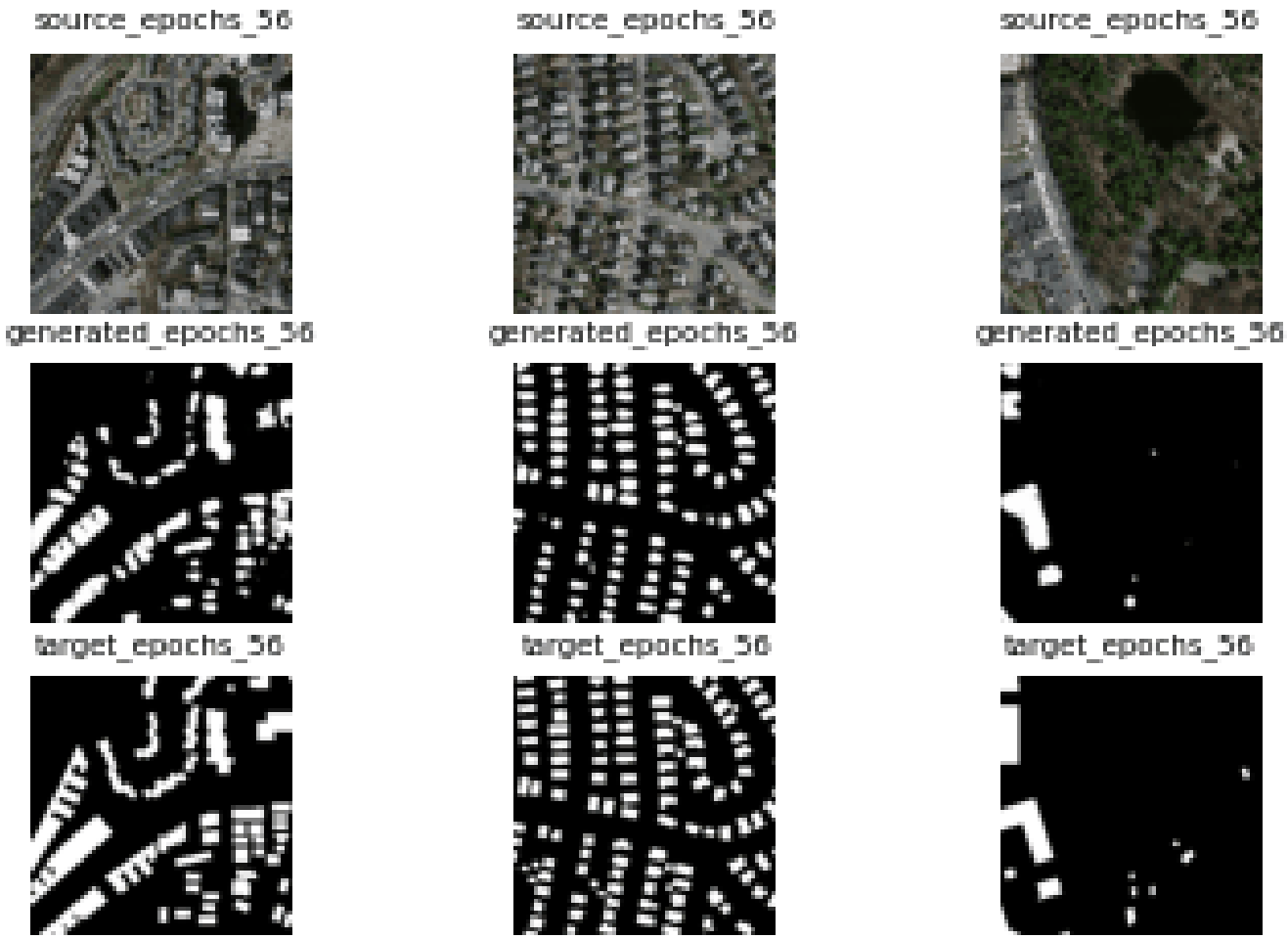
Vehicle Detection

Point masks, 1000 ex, 1m



Building Footprint Segmentation

Polygon masks, 500 ex.



Results on RID: Roof Boundary Mask Dataset

512x512px
mIoU=0.941

256x256px
mIoU=0.950

Mask to mask vectorization

Vectorization of a full size mask of a U-Net

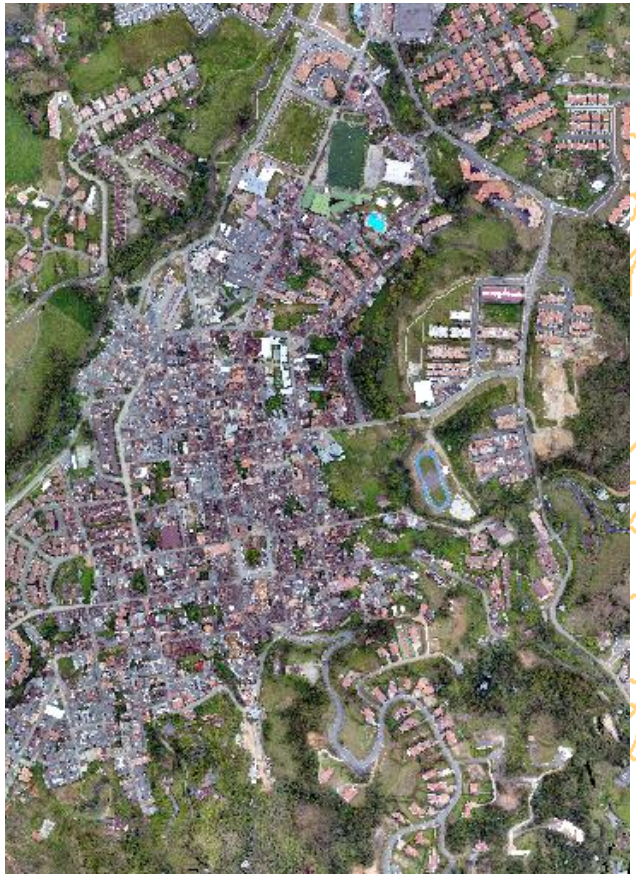
Vectorization of a primitive mask 1m after msk2msk translation

Centerline vector layer

Road vectorization Results

Orthomosaic	Application of AGS Metric - Roads	AGS_Lines Collab GPU
El Retiro, (Ant.)	Image to mask translation model and vectorization without primitive masks	0.801 at 12.87 m/s
	Image to mask translation model with primitive masks and vectorization	0.903 at 12.39 m/s
	Model including double image to mask translation and vectorization	0.940 at 12.03 m/s

Ballesteros et al, 2021



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Contribution - Conferences

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- Ballesteros John, Branch-Bedoya John W., Sánchez-Torres Germán. Semantic Segmentation of Urban objects in Satellite and Drone Imagery using Deep Learning. International Conference on Civil Engineering, Concivil 2022.
- Ballesteros John, Sánchez Germán, Branch John. Modelo de generación automática de capas SIG a partir de aprendizaje profundo. Congreso Colombiano de Geología. Medellín, Agosto 2021.
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- Ballesteros John R., Sánchez-Torres Germán, Branch John W., Segmentación Semántica de Ríos y Erosión Mediante GANs. XV Semana de la geología, Barranquilla, Col., Septiembre 2022.

Contribution - Papers

- Ballesteros, J.R.; Sanchez-Torres, G.; Branch-Bedoya, J.W. A GIS Pipeline to Produce GeoAI Datasets from Drone Overhead Imagery. *ISPRS Int. J. Geo-Inf.* 2022, *11*, 508. https://doi.org/10.3390/ijgi11100508

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