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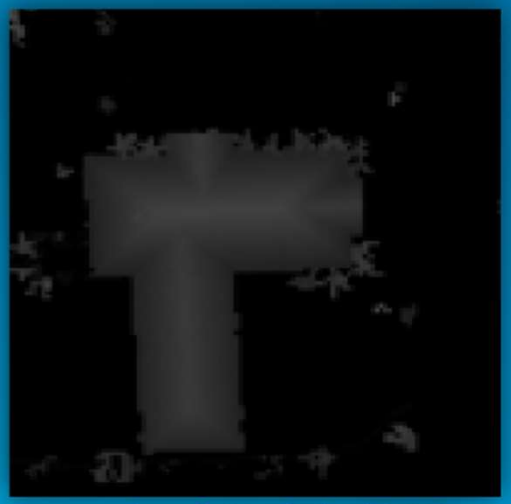
Exploring the latest developments in point cloud applications in ArcGIS

Willem Jan Vierbergen

Contents

- Working with Point Clouds in ArcGIS
  - Rasterize Point Clouds for 3D construction
  - 3D construction from Point Clouds
    - Traditional
    - Using Deep Learning to Classify Point Clouds
- Using Point Clouds in ArcGIS Reality

3D Building model reconstruction from aerial LiDAR



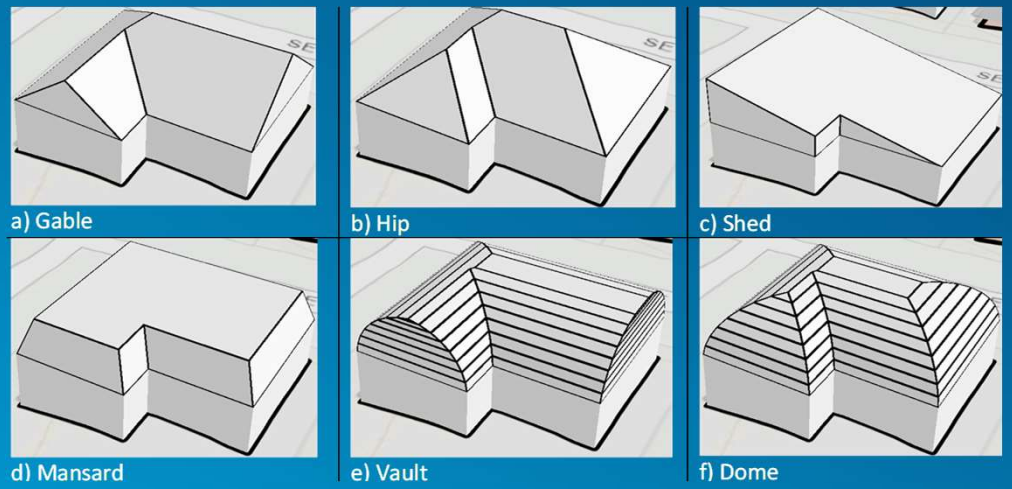
Rasterized Aerial LiDAR

Manually digitized Hip (purple) and Gable (orange) segments

3D reconstruction of building using manually digitized segments

3D Building model reconstruction from aerial LiDAR

- Manually digitizing roof segments:
  - Over 3000 man hours were spent on digitizing about 213000 polygons covering the area of 200 square kilometers.
  - ~71 polygons / man hour.



3D Building model reconstruction from aerial LiDAR

- Using Mask R-CNN to digitize roof segments
- Not as accurate as humans,
  but much faster: 60,000 polygons / hour.
- Regularize Building Footprints helps with accuracy.

Manually digitized “ground truth” data from the Test set

Prediction produced by the neural network

But can we work in true 3D (without rasterization)?

There is a traditional workflow with deterministic GP tools:

1. **ClassifyLASGround**
2. **ClassifyLASBuilding**

To get building footprints:

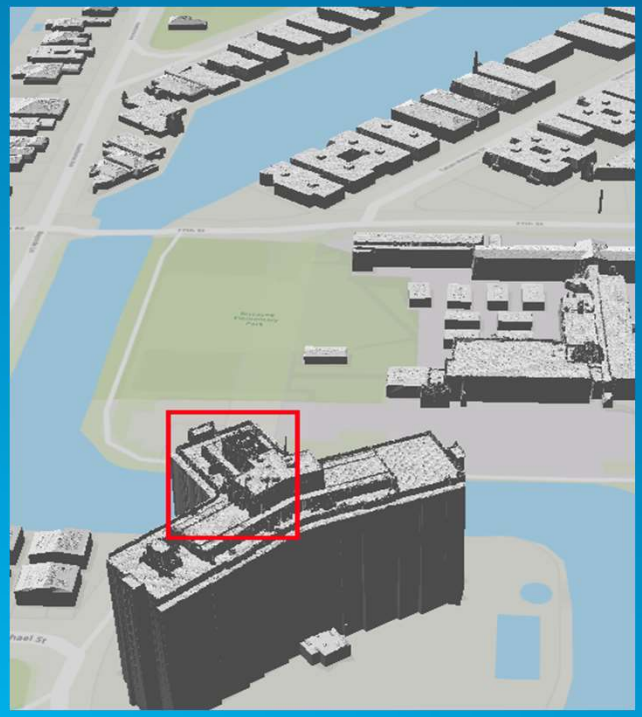
3. **LASPointStatisticsAsRaster**
   - with LAS layer filtered on class 6 (building)
   - using the 'Most Frequent Class Code' option
4. **RasterToPolygon**
   - Turn off the Simplify polygons option
5. **EliminatePolygonPart** to remove small holes (could alternately have performed some manipulation on the raster side for this)
6. **RegularizeBuildingFootprint** to straighten things out.

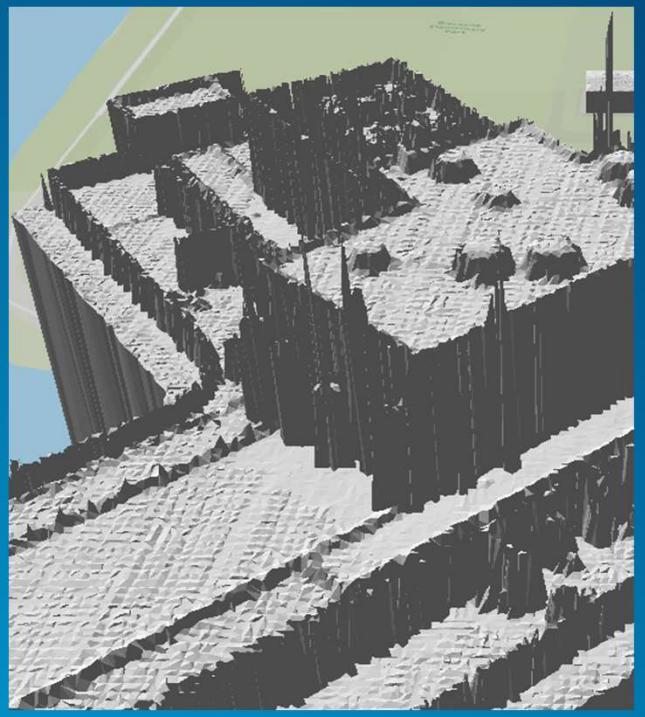
To extract shells:

7. **LASDatasetToRaster** with input LAS layer filtered on class 2 points to make DEM
8. **LASBuildingMultipatch**

Working in true 3D point cloud

- Resulting models are not suitable for manual editing because of large number of vertices
- Important to keep the noise level down



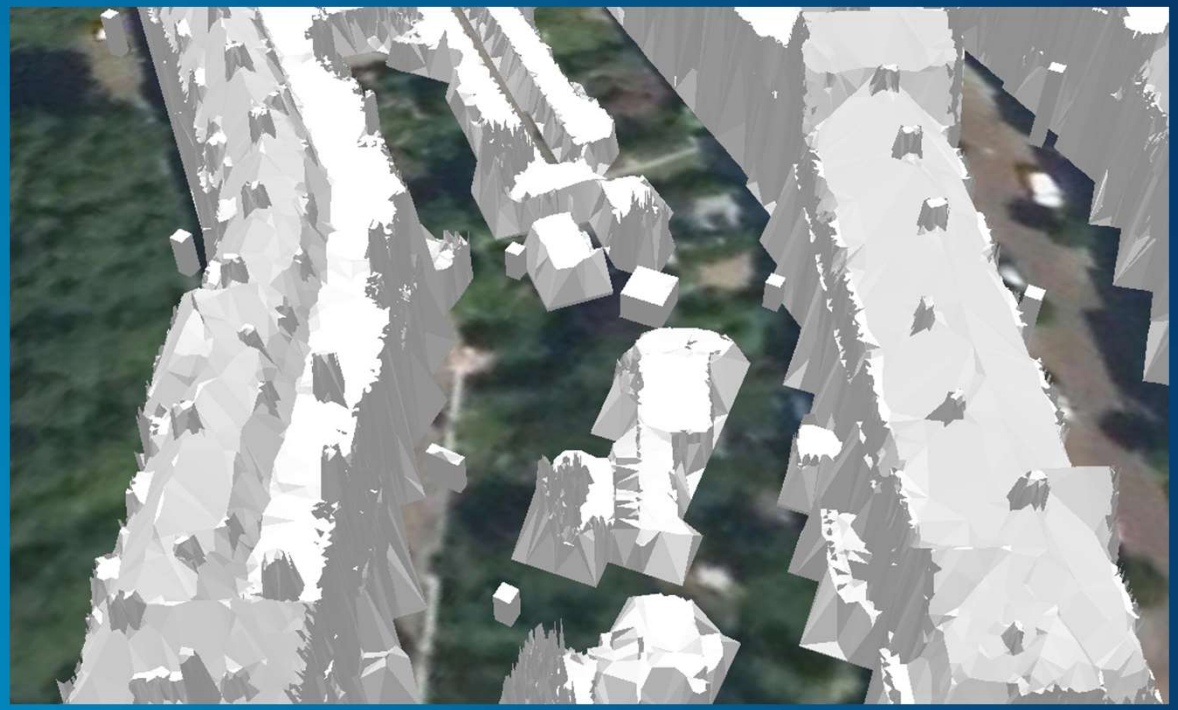


Working in true 3D point cloud

Main sources of noise in resulting models come from misclassification of

- Ground
- Buildings

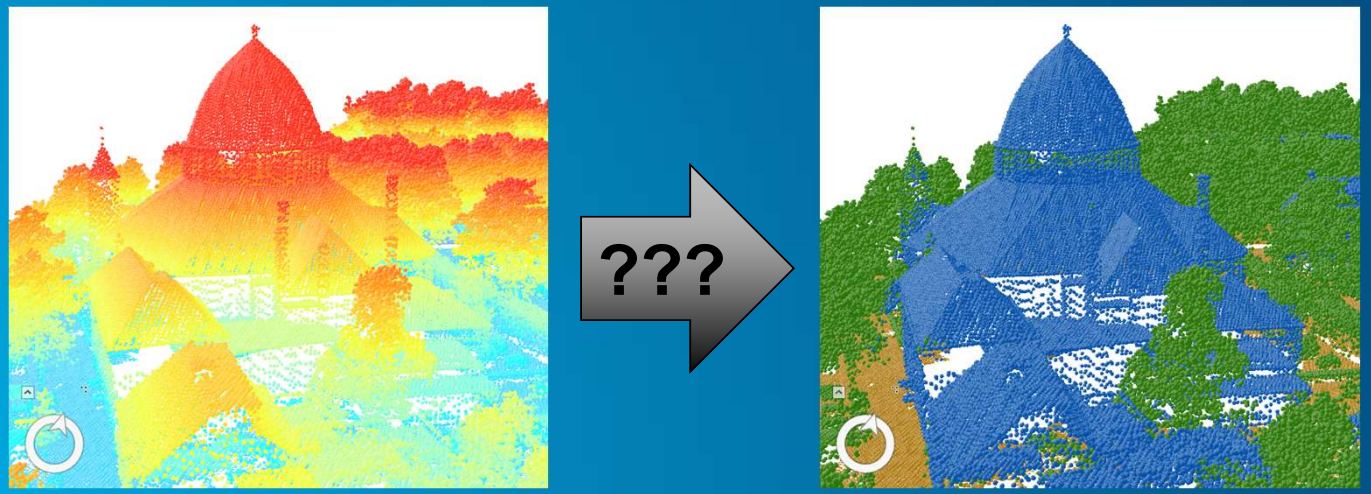
- **ClassifyLASBuilding**
  does not produce reliable results when there is a vegetation in direct proximity to the building



Can we use Deep Learning to classify Point Clouds?

- Point clouds are unordered, sparce data collections where direct application of convolutional kernels does not work efficiently.

- Good news in recent years: PointNet, PointNet++, Graph Convolutional networks, Deep Sets, PointCNN, etc.



PointCNN

- Trained on 1.8B X-Y-Z-intensity points of airborne point cloud collected over Amsterdam, Netherlands.
- 0.97 accuracy just after 6.5h of training on Nvidia QUADRO V100.
- Testing on city of Utrecht, Netherlands

- Classify Building Points

- PointCNN

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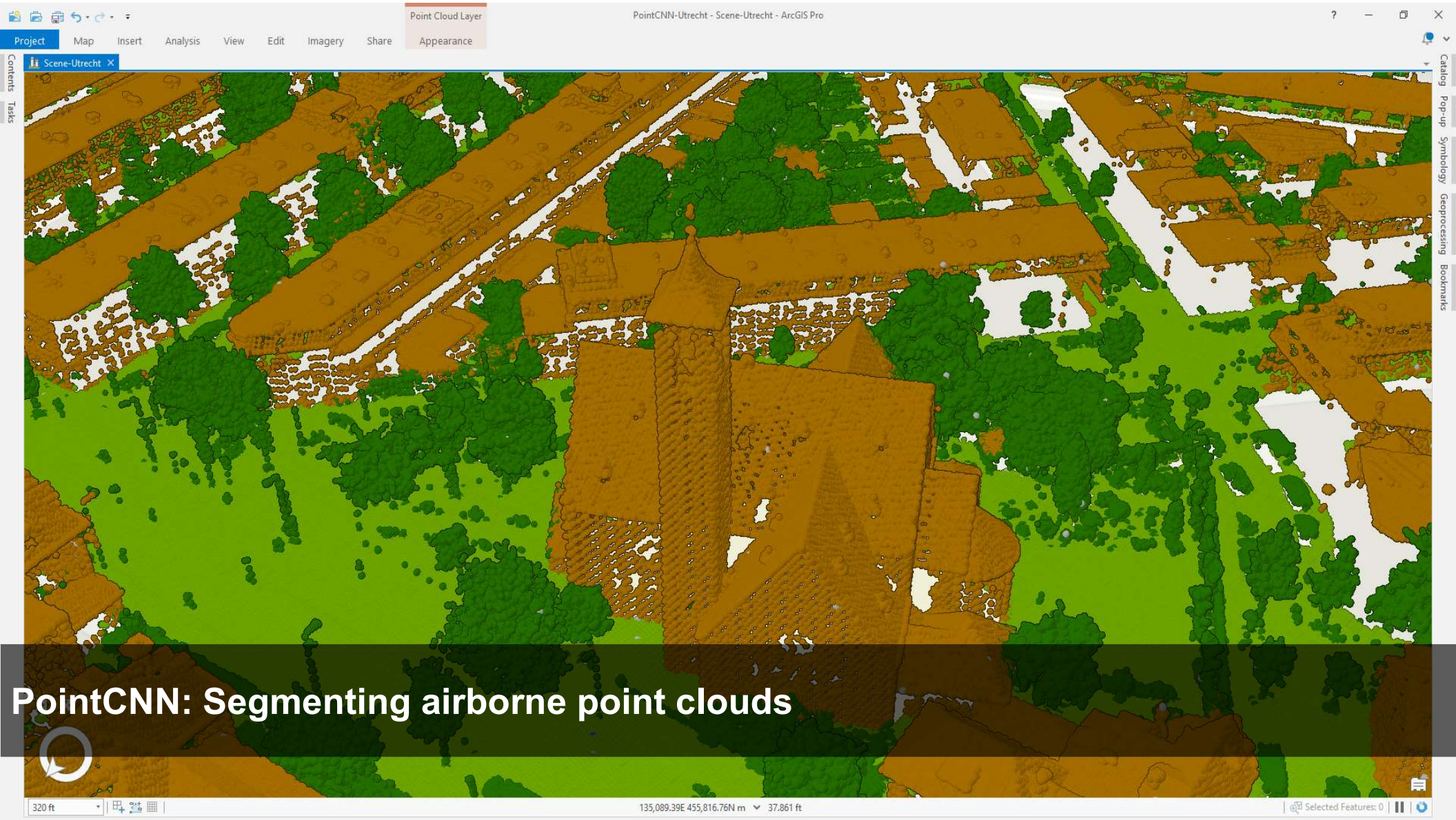
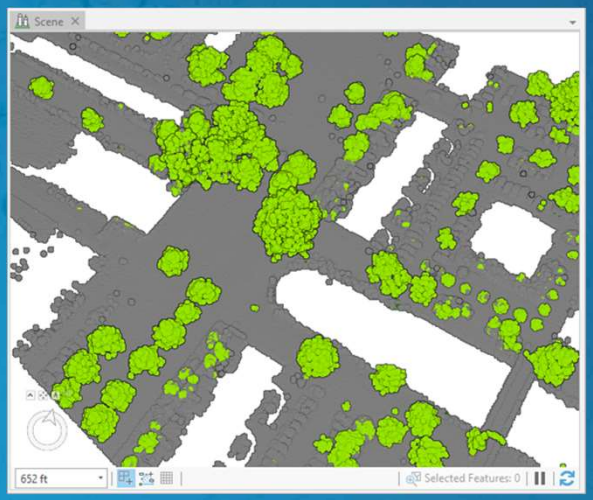
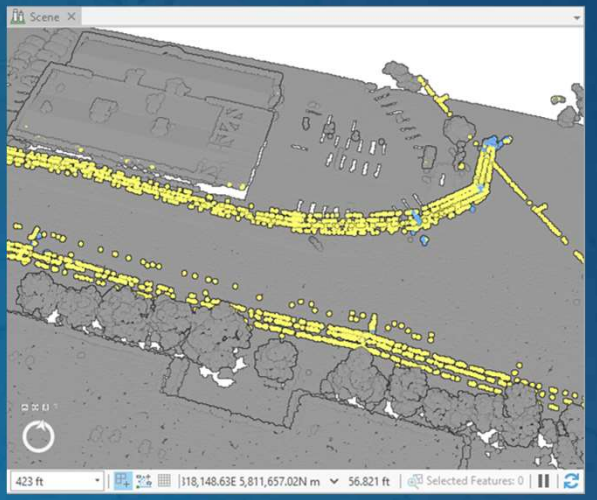
PointCNN
vs
ClassifyBuildingPoints

- Significantly lower noise level in the models reconstructed from point cloud classified by a PointCNN model.

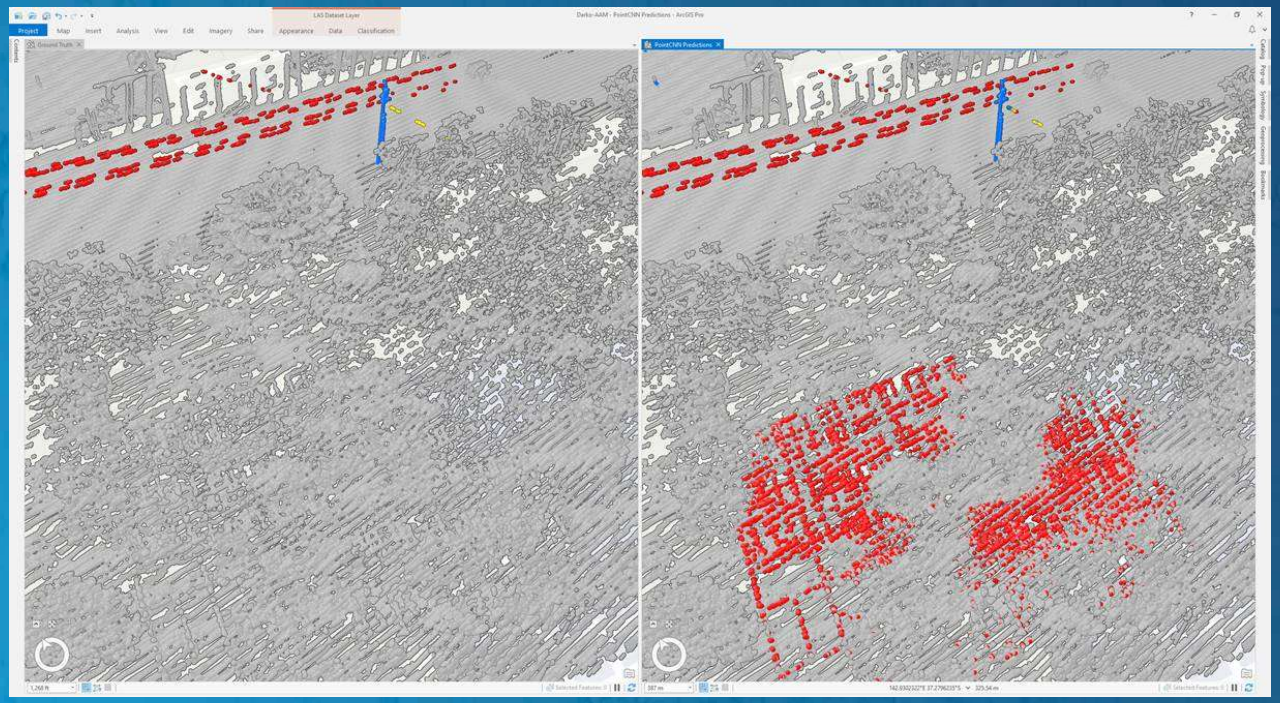

Point Cloud Layer
PointCNN-Utrecht - Scene-Utrecht - ArcGIS Pro
Project
Map
Insert
Analysis
View
Edit
Imagery
Share
Appearance
Scene-Utrecht
Contents
Tasks
Catalog
Pop-up
Symbology
Geoprocessing
Bookmarks
PointCNN: Segmenting airborne point clouds
320 ft
135,089.39E 455,816.76N m
37.861 ft
Selected Features: 0

Pretrained deep learning models available in ArcGIS Online

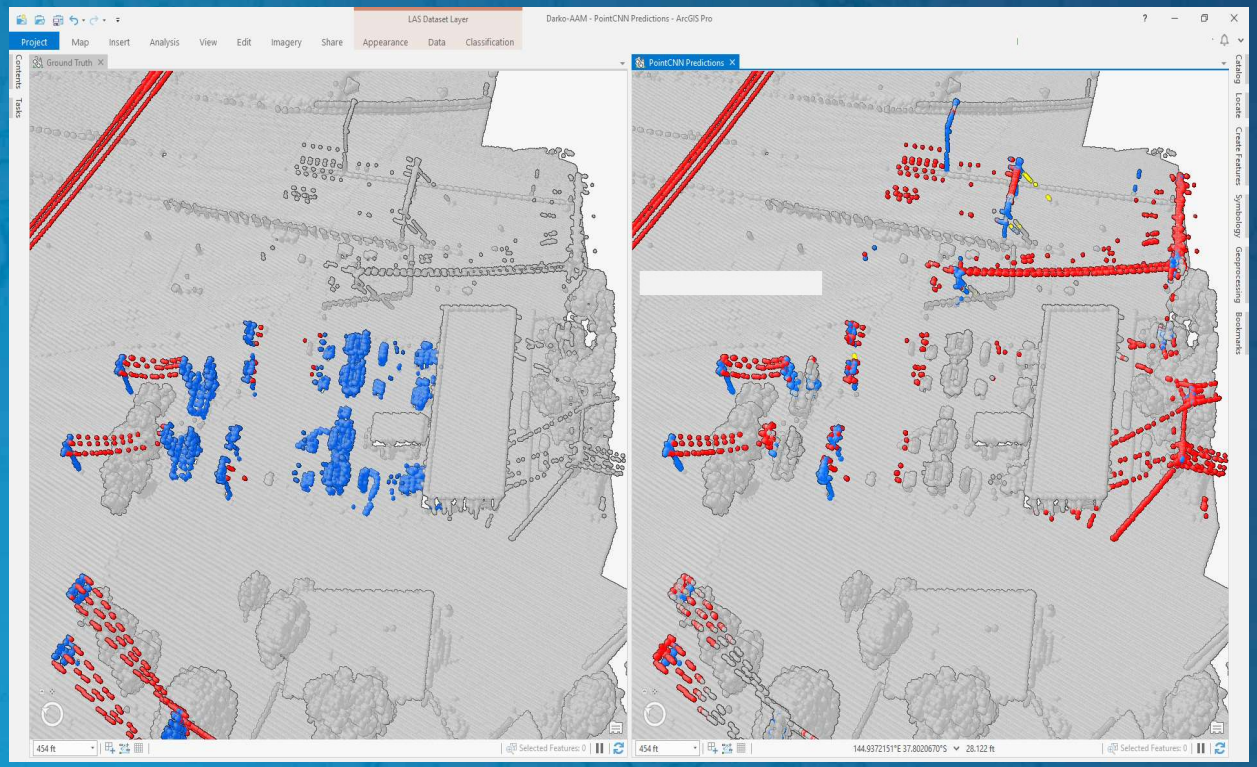




Power lines



Power lines


Darko-AAM - PointCNN Predictions - ArcGIS Pro
LAS Dataset Layer
Project
Map
Insert
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Share
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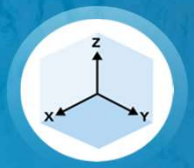
Data
Classification
Ground Truth
PointCNN Predictions
Contents
Tasks
Catalog
Locate
Create Features
Symbology
Geoprocessing
Bookmarks
454 ft
Selected Features: 0
454 ft
144.9372151°E 37.8020670°S
28.122 ft
Selected Features: 0

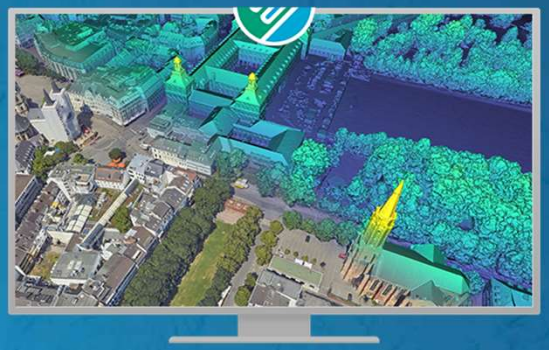
Coming in this year: ArcGIS Reality

Input

Images



Orientations



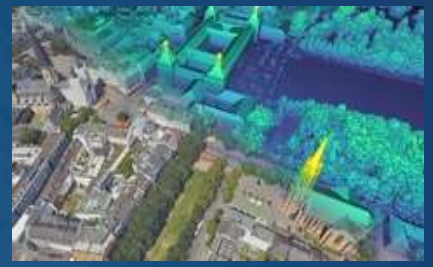
ArcGIS Reality

ArcGIS Reality Studio
ArcGIS Reality for ArcGIS Pro
ArcGIS Drone2Map
SiteScan for ArcGIS

Output Data

Digital Surface Models

Textured Meshes



True Ortho

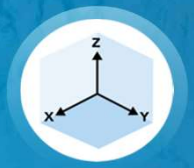
3D Pointclouds


Catharijne
FS NL Poortgebouw Opco 16
TivoliVredenburg
Vredenburgplein
Hoog Catharijne
Westerkerk
Dilatec Holland
Vinkenband
Spaghetteria
Veelder
Piatto
Kloek
WAKU WAKU
30ml Vredenburg Coffee & Food
EHM Hotel Utrecht

Coming in this year: ArcGIS Reality

Input

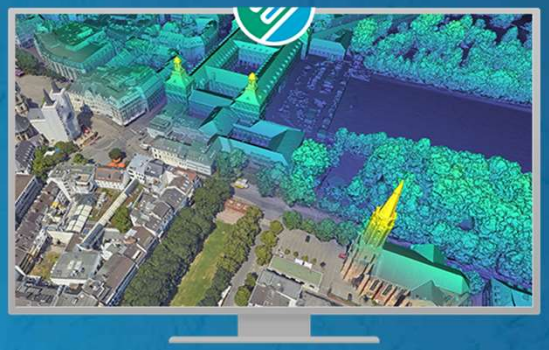
Images



Orientations

Optional:
LiDAR

Less compute
More accuracy



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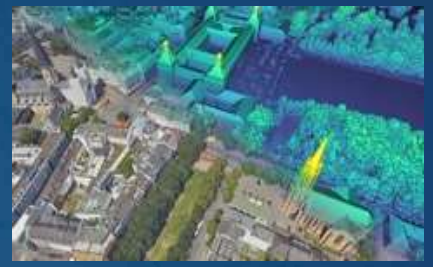

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