
# Automatic And Robust Chain For Urban Reconstruction From Satellite Imagery

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# About LuxCarta

LuxCarta focuses on the creation and delivery of geodata for the global telecom, navigation and other vertical markets.

**EXPERTISE**

Remote Sensing

Photogrammetry

Elevation Models

3D Models

**R&D PRODUCTION**

Data production automation

Automatic correlation

Machine learning

**PRODUCT INNOVATION**

Population maps

2.5D clutter height

3D building\tree model

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# Goal

Automatically produce 3D databases from stereo imagery

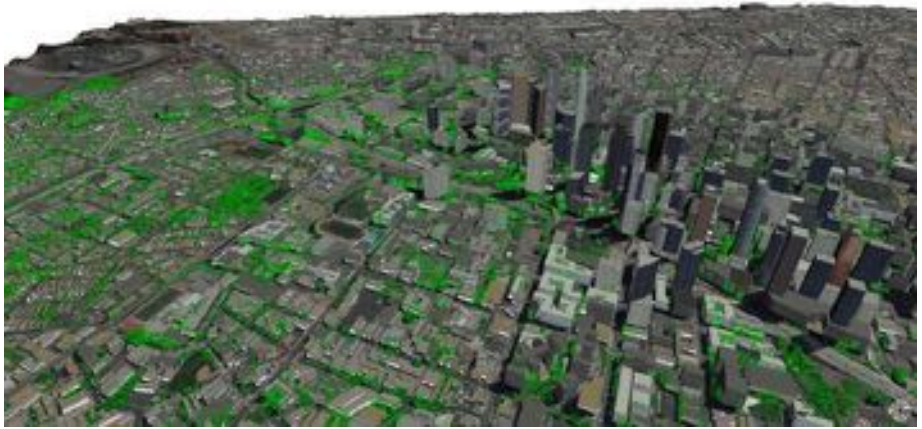
Stereo-pairs
Geodata
Parameters

Input Data

Automatic Chain

3D Database

DTM
DSM
Ortho-image
3D Building\tree



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# Plan

- Overview of the Automatic Chain
- Height Computation
- Building/tree extraction
- Conclusion

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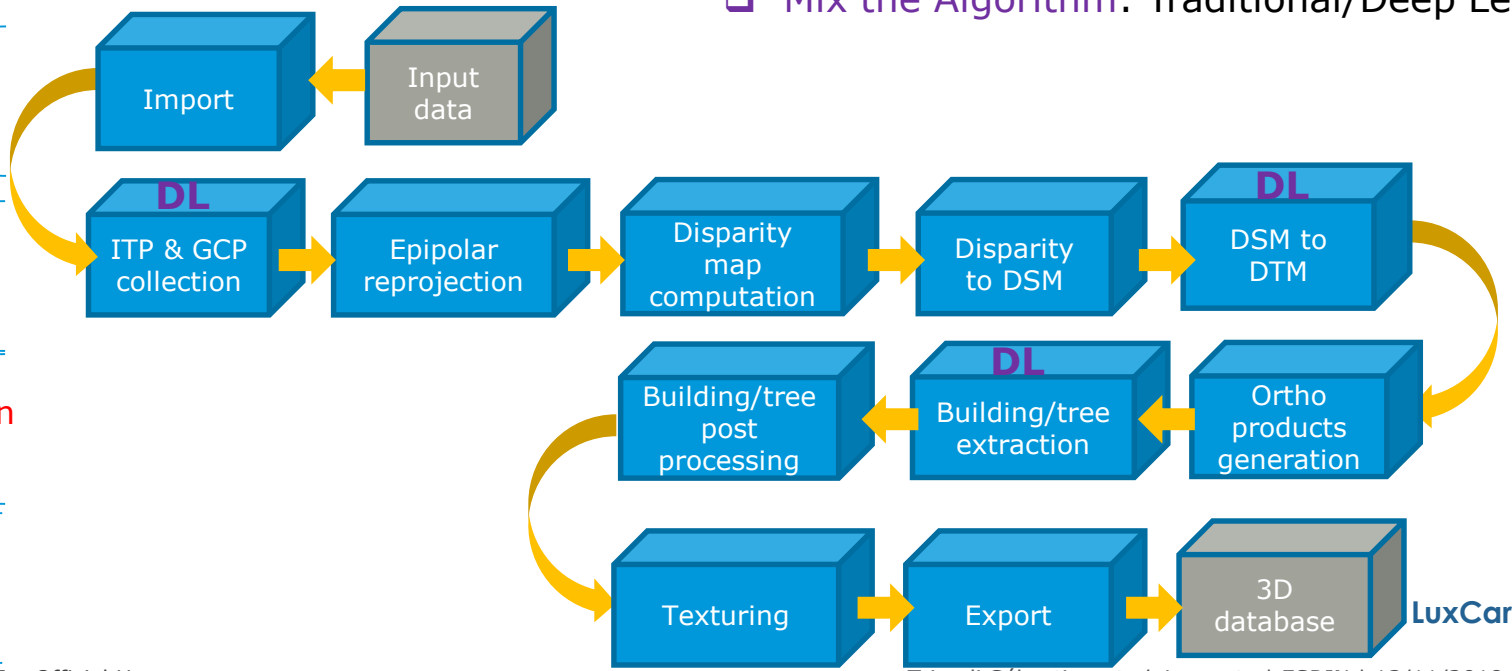
# Automatic and Robust Chain

3D building/tree extraction consists of:

Robust :

- Multiple Data : PairS stereo imagery
- Mix the Algorithm: Traditional/Deep Learning

- Input
- Height Computation
- Classification Polygonization
- Output

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# ITP & GCP Collection

Automatic Detection of Ground Control Point based on feature detection and matching

➡ DL Classification of buildings and trees allows to valid in most cases the GCP detection.

# Computation DSMs

## Semi Global Machine:

- An algorithm to compute a disparity map from epipolar images

## SGM improved by us with:

- Possible use of an input disparity map, to reduce the search range
- Adaptive penalty coefficients for a better deal with pixelwise ambiguity
- Filter to align the edge in the disparity map and the source image
- Filter by information cross to reduce the bad matches: mirror effect, right-left inversion
- CPU Multi-Thread/GPU

## DSM Fusion :

- Fill all the non informed values
- Remove the artefacts
- Increase the elevation accuracy

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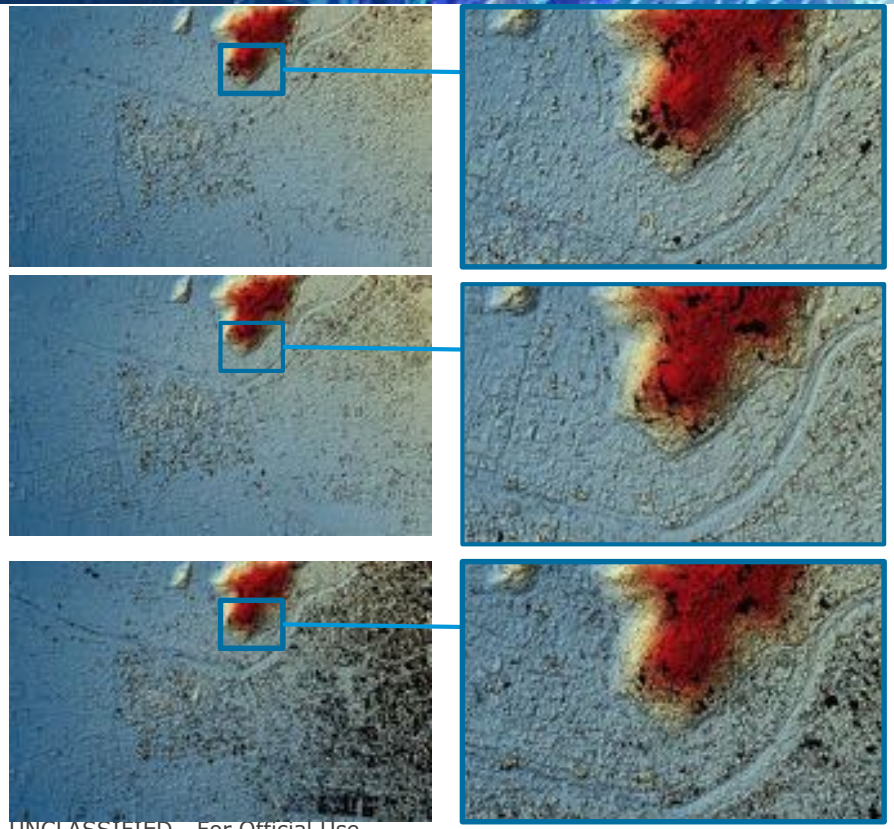
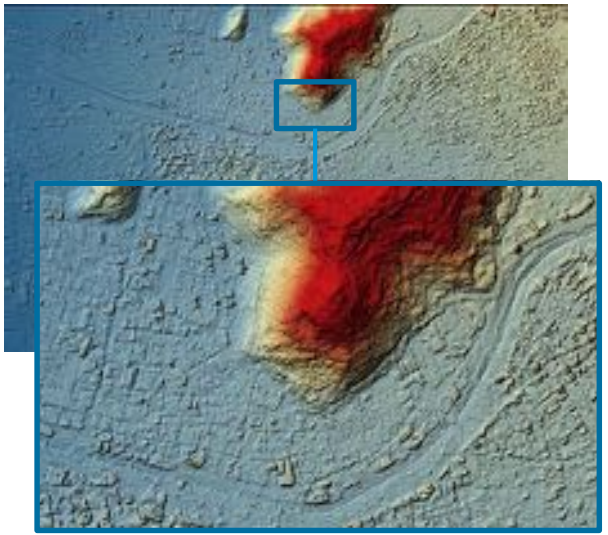
# Fusion DSMs



FUSION



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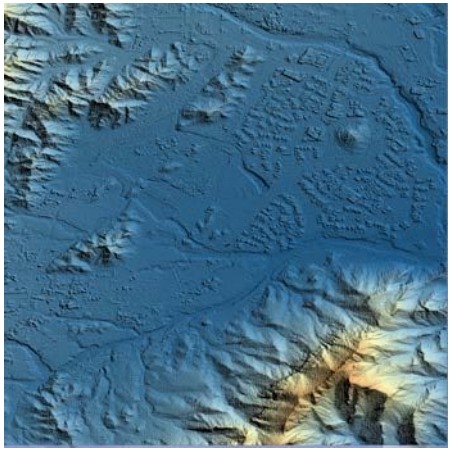
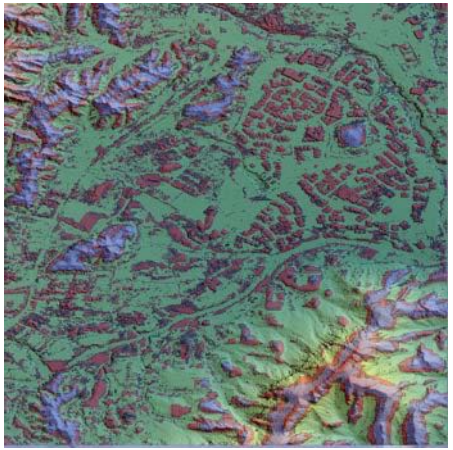
# Computation DTM

Original approach based on the study the profile of the DSM

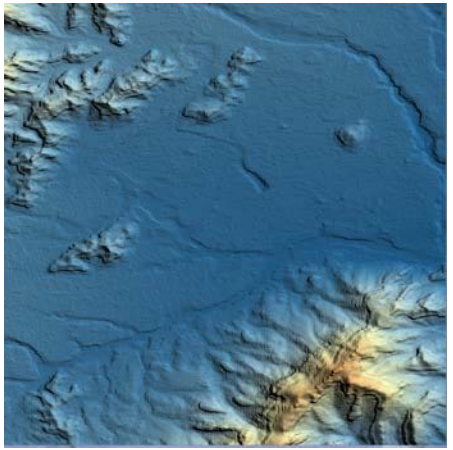
DSM



Classification



Surface Reconstruction



➡ DL Classification of buildings and trees allows to valid Classification done using DSM

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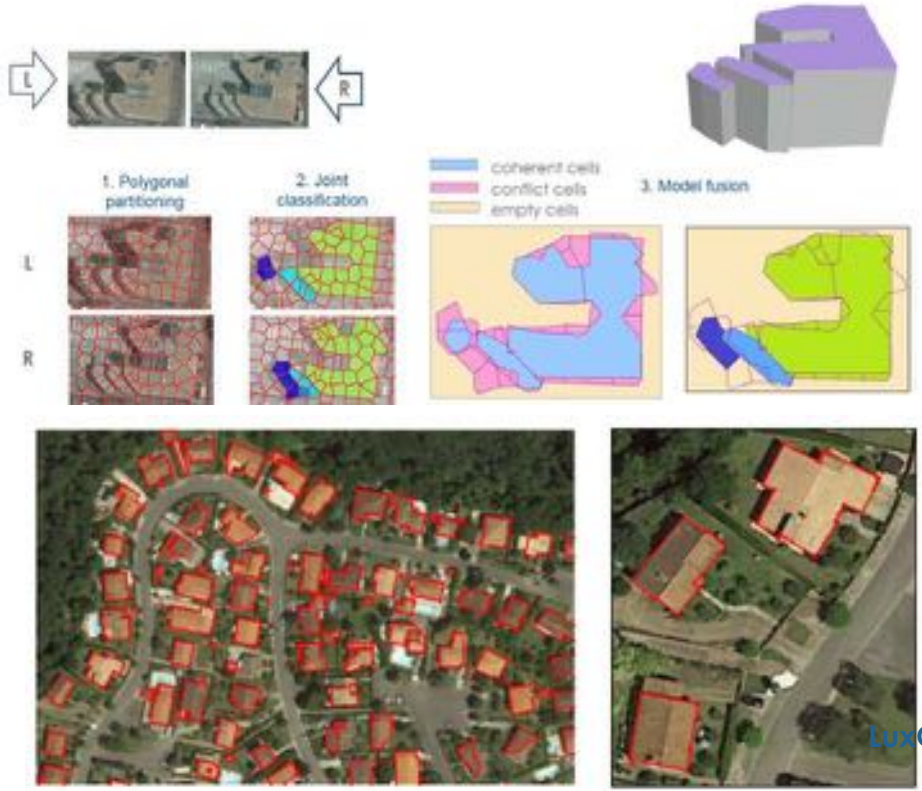
# Building\Tree Reconstruction

Our Work in the last years:

- **Towards large-scale city reconstruction from satellites**
  *Duan Liuyun and Lafarge Florent*
  Proc. of the European Conference on Computer Vision, 2016

- **KIPPI: KInetic Polygonal Partitioning of Images**
  *Bauchet Jean-Philippe and Lafarge Florent*
  IEEE Conference on Computer Vision and Pattern Recognition, 2018



# Building\Tree Reconstruction Using DL

## Classification:

- based on UNET model:

***Large-scale semantic classification: outcome of the first year of Inria aerial image labeling benchmark.***
*Bohao Huang, Kangkang Lu, Nicolas Audebert, Andrew Khalel, Yuliya Tarabalka, et al..*
IEEE International Geoscience and Remote Sensing Symposium – IGARSS 2018, Jul 2018, Valencia, Spain.

## Polygonization:

- based on constraints:
  - angles
  - shapes

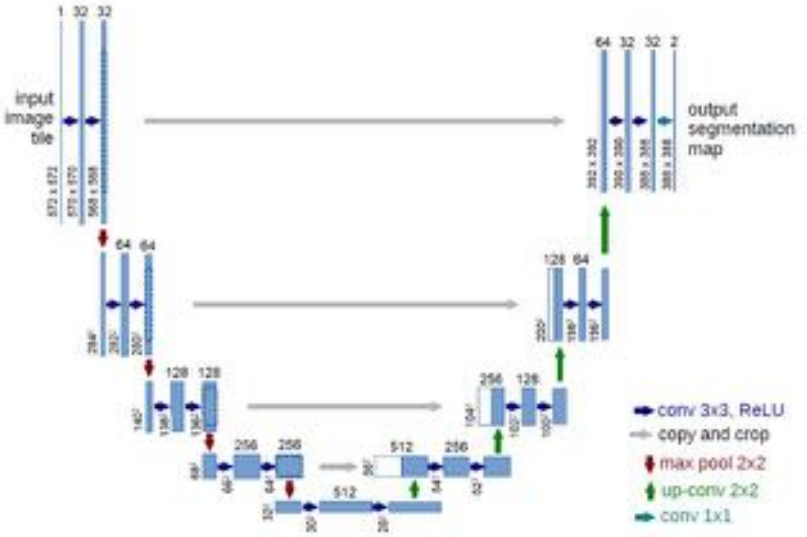



**Fig. 1**: U-net architecture designed by AMML.

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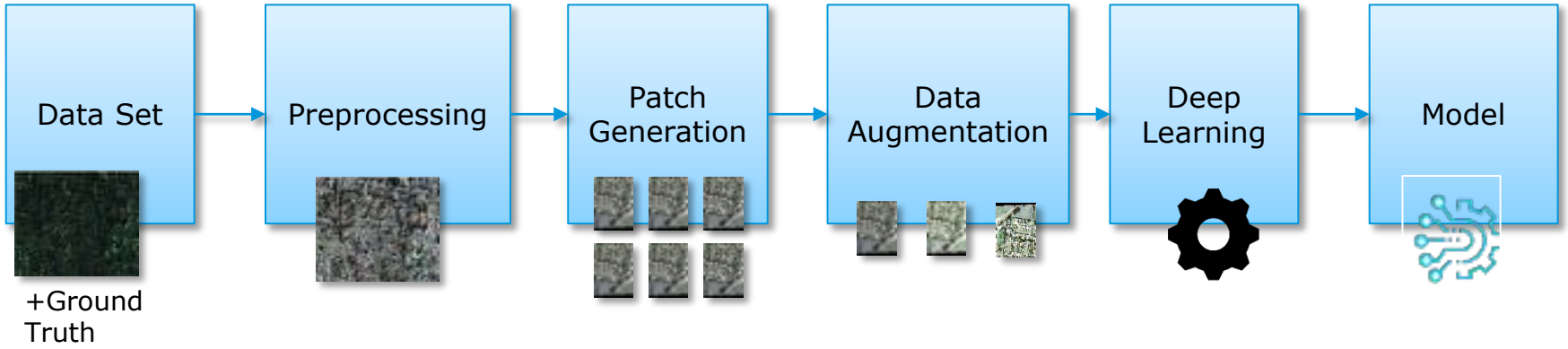
# Our Methodology: Build a Generic Model

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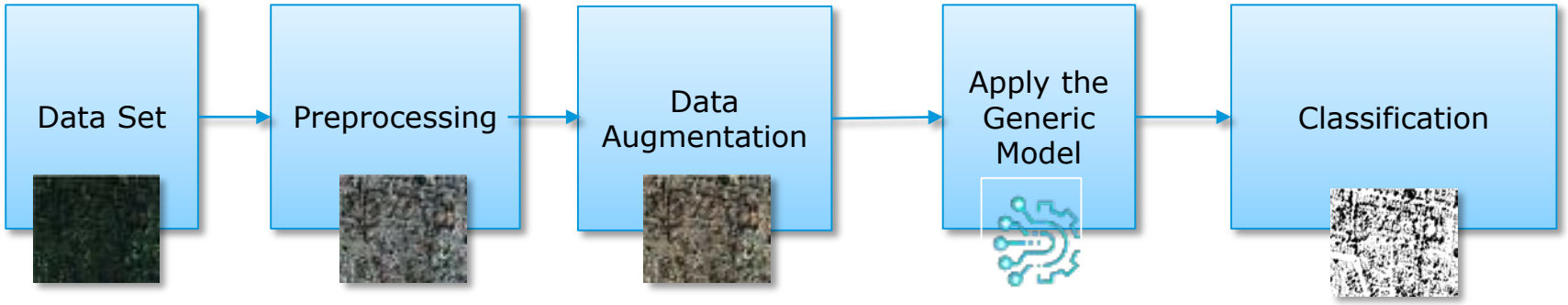
# Our Methodology: Test Model

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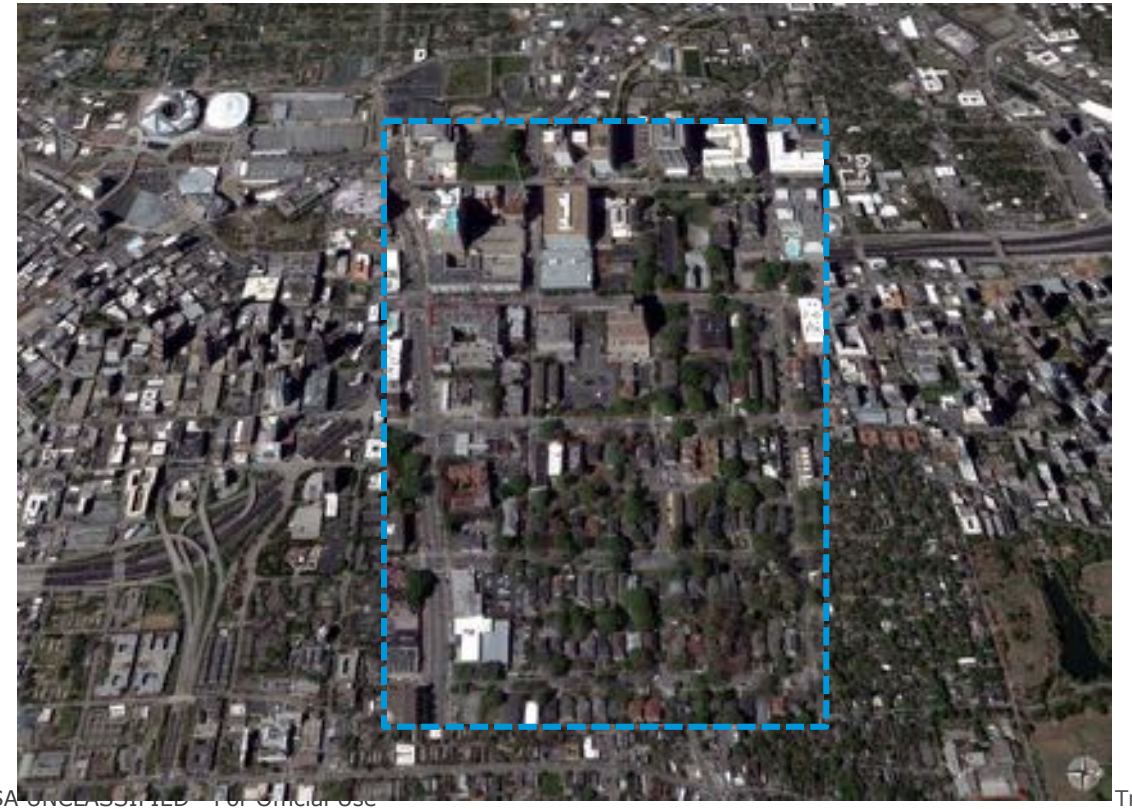
# Fine Tune the Generic Model if the Test Failed



Area of “fine tuning”

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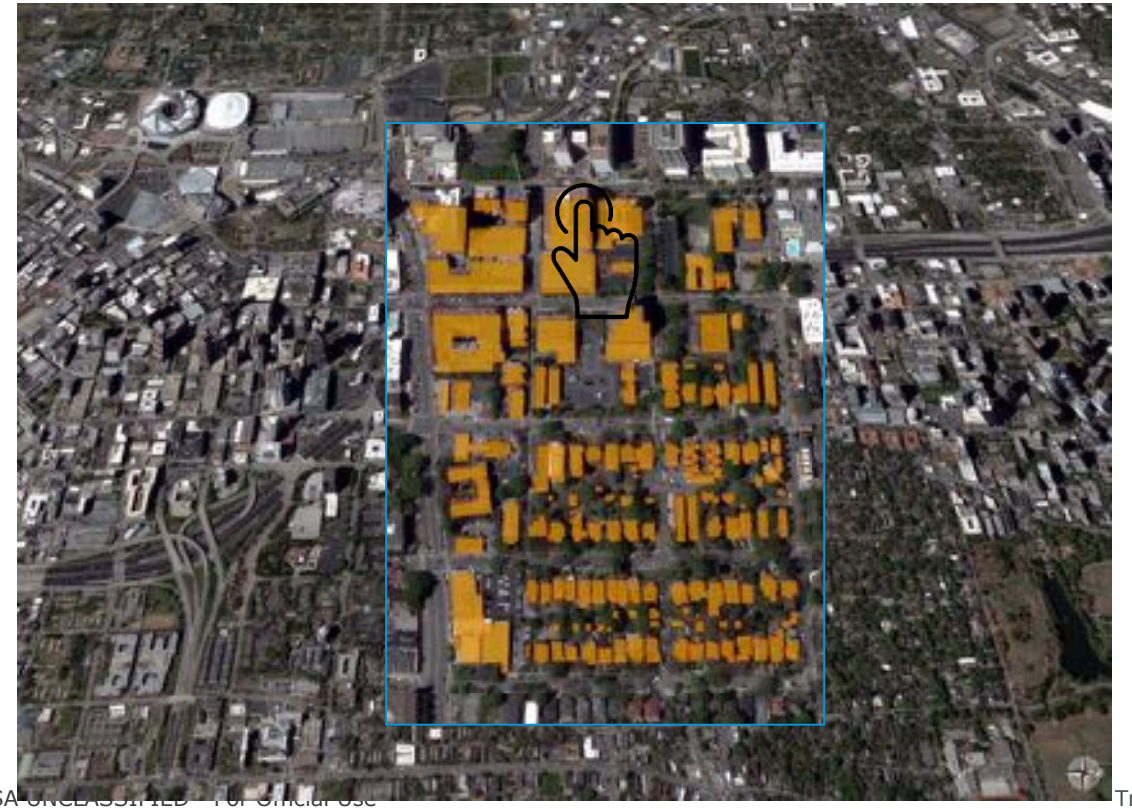

Area of “fine tuning”

Manual digitalization of 3D features (buildings for example)

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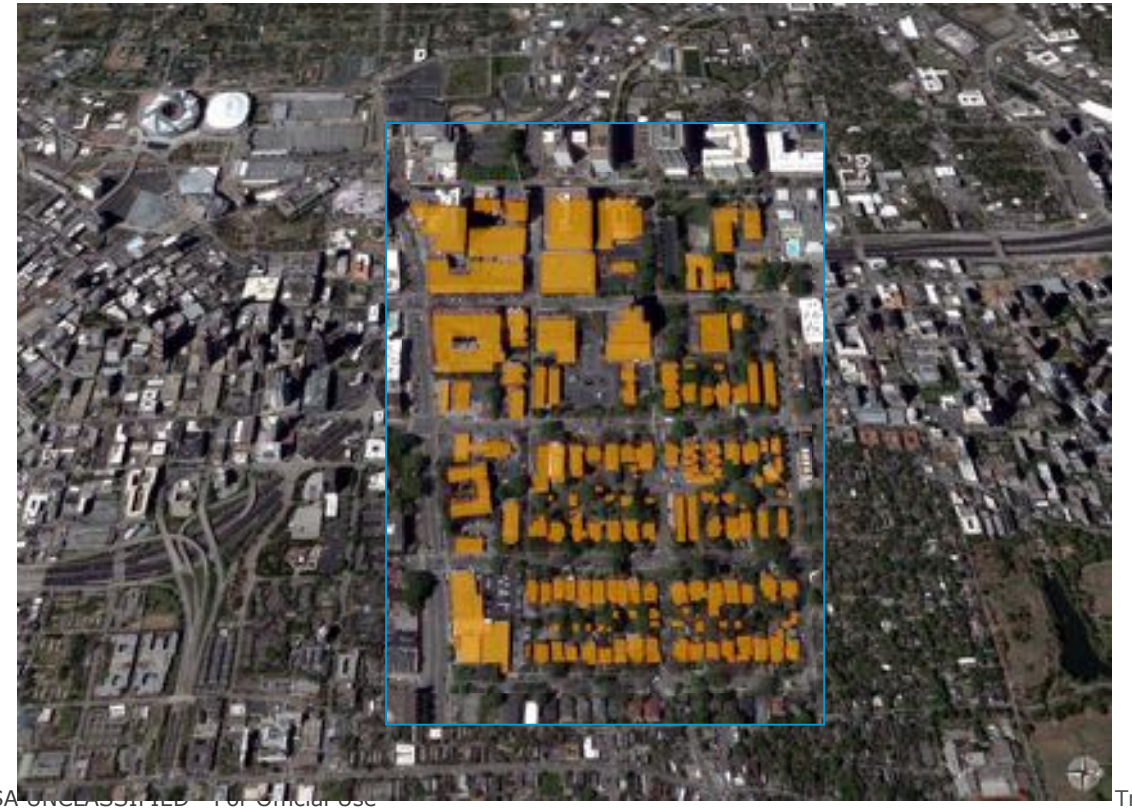

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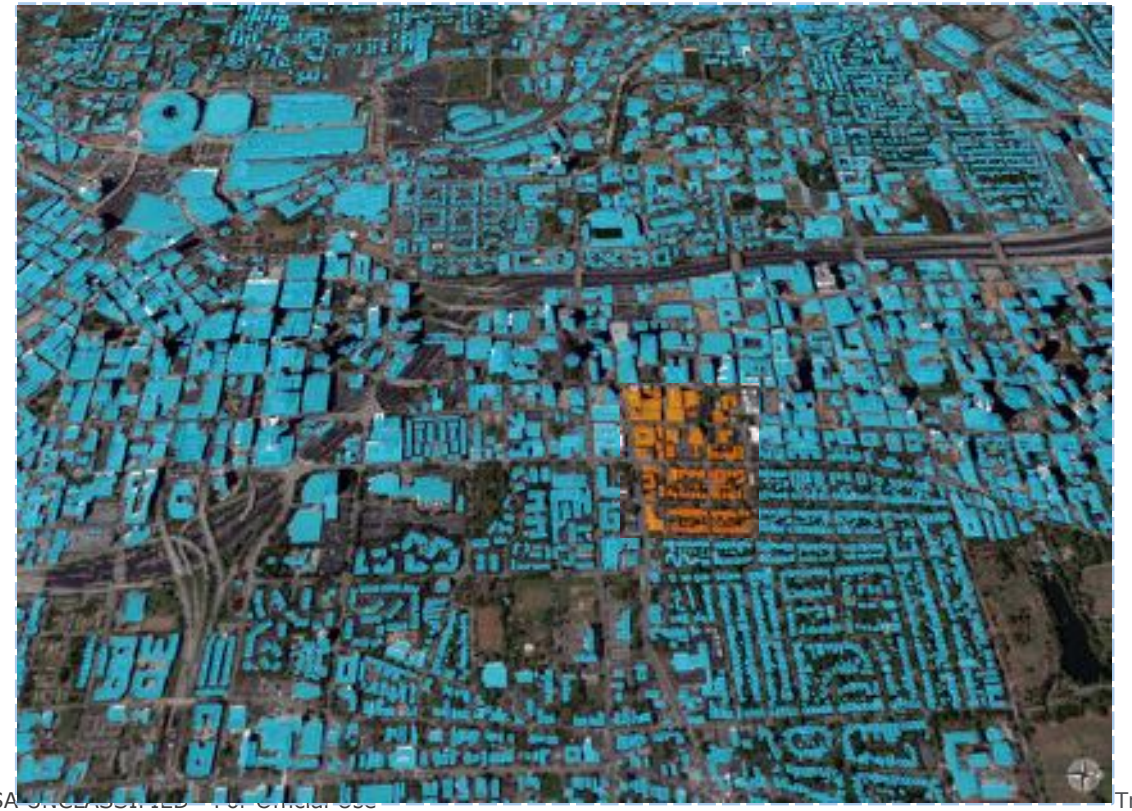

Area of “fine tuning”

Manual digitalization of 3D features (buildings for example)

Machine Learning

Learning from the Generic Model and Test

Polygonization

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# Fine Tune the Generic Model if the Test Failed

Area of “fine tuning”

Manual digitalization of 3D features (buildings for example)

Machine Learning

Vectorization

Automatic height assignment from DSM

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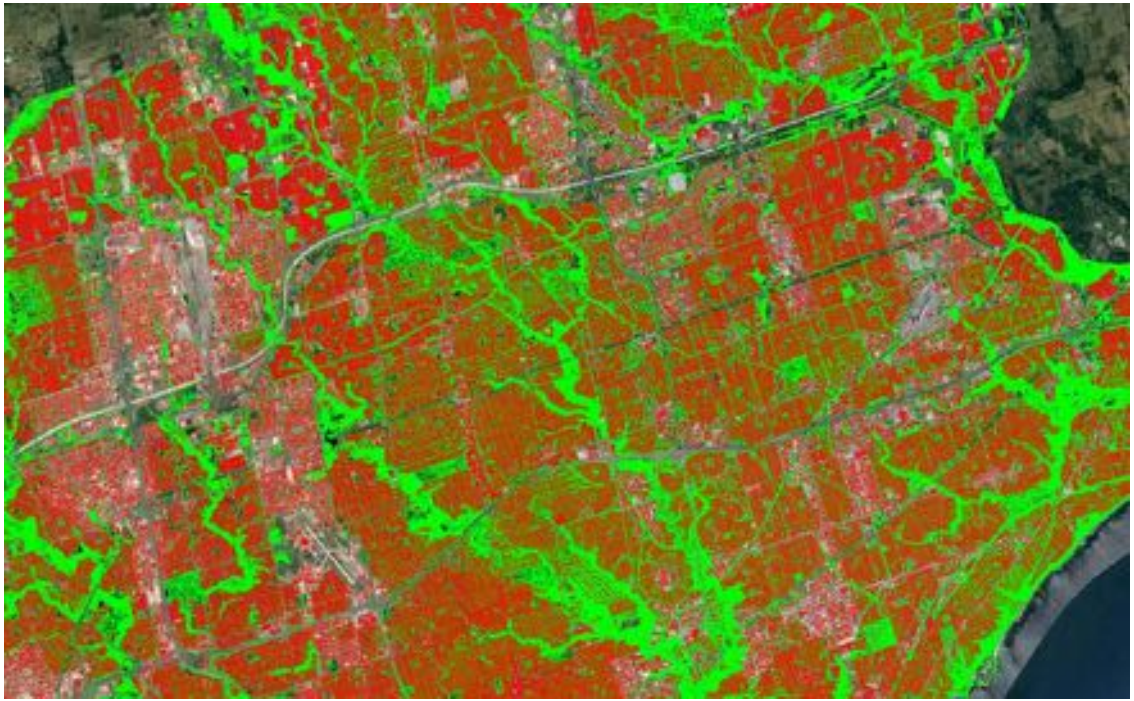
# Classification Results



# 3D Results

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# Statistics on the Results

- Using **only 1-3 km²** for the fine tuning that takes around **2 minutes of learning** to **classify an area 2000 km²**
- We have tested ten of thousands km² on different areas: USA, Canada, Australia, …
- In Average, 80% Polygons no need of manual correction according to the quality asked by our customer

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# Conclusions & Perspectives

## Conclusions :

- Automatic And Robust Chain For 3D Urban Reconstruction
- Deep Learning has allowed to surpass the bottleneck of extracting the buildings\trees in an **automatic way**
- Our chain is **robust** by applying multiple data sources and combining non-learning and learning algorithms
- Our automatic chain has reduced drastically the delivery time for huge areas

## Perspectives:

- Aim at replacing all the manual interactions:
  - Remove the fine tuning operation, etc...
- Add other classification as: roads, rivers, lakes, …
- Deep Learning based dense matching

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# Questions ?

Thank you for your attention !!!
Any questions ?

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