

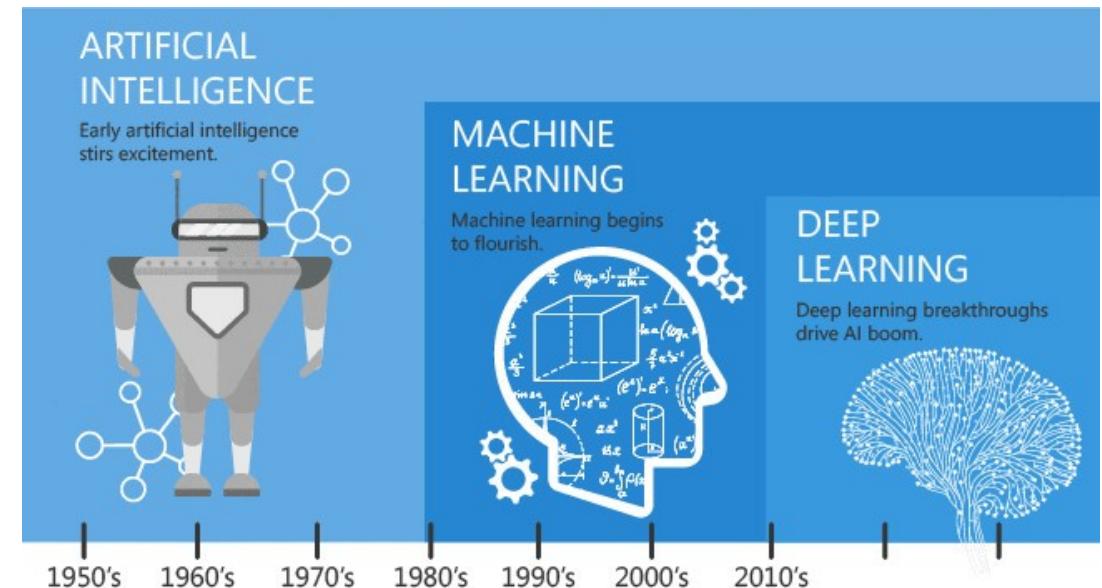
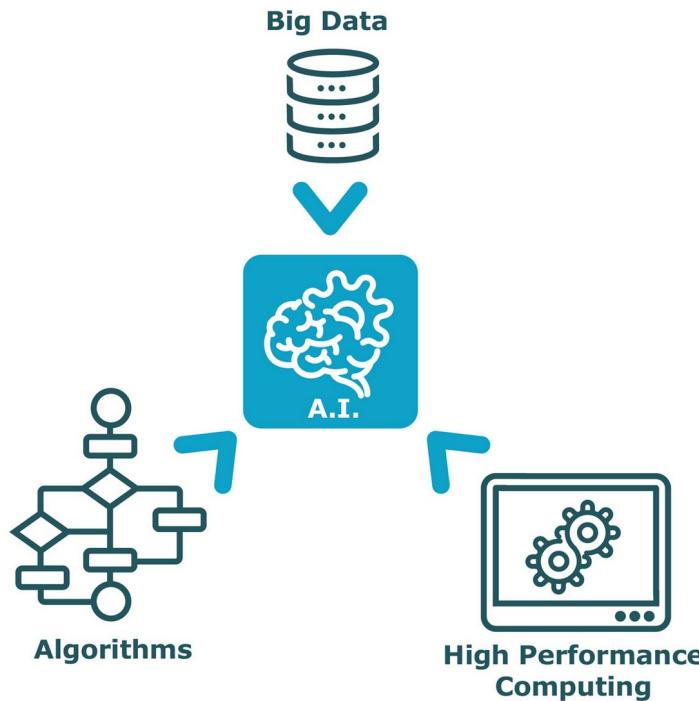


FOSS powering Scalable GeoAI



What is Artificial Intelligence?

Artificial intelligence (AI) refers to a wide range of computer science techniques in which applications are trained to make intelligent decisions.

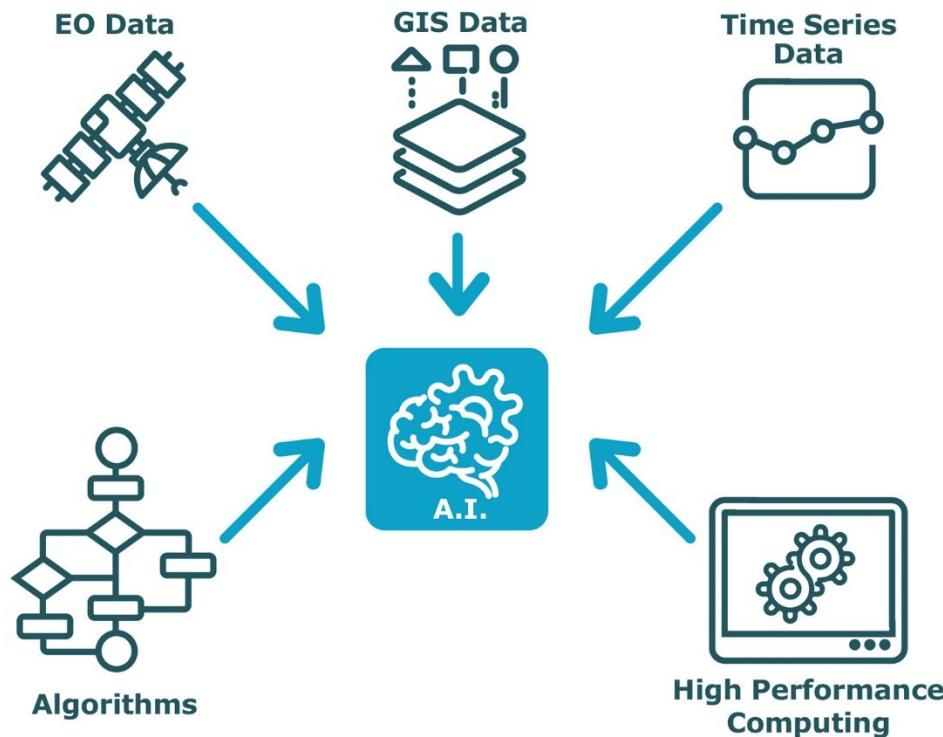


Since an early flush of optimism in the 1950's, smaller subsets of artificial intelligence - first machine learning, then deep learning, a subset of machine learning - have created ever larger disruptions. Source: <https://mindmajix.com/>

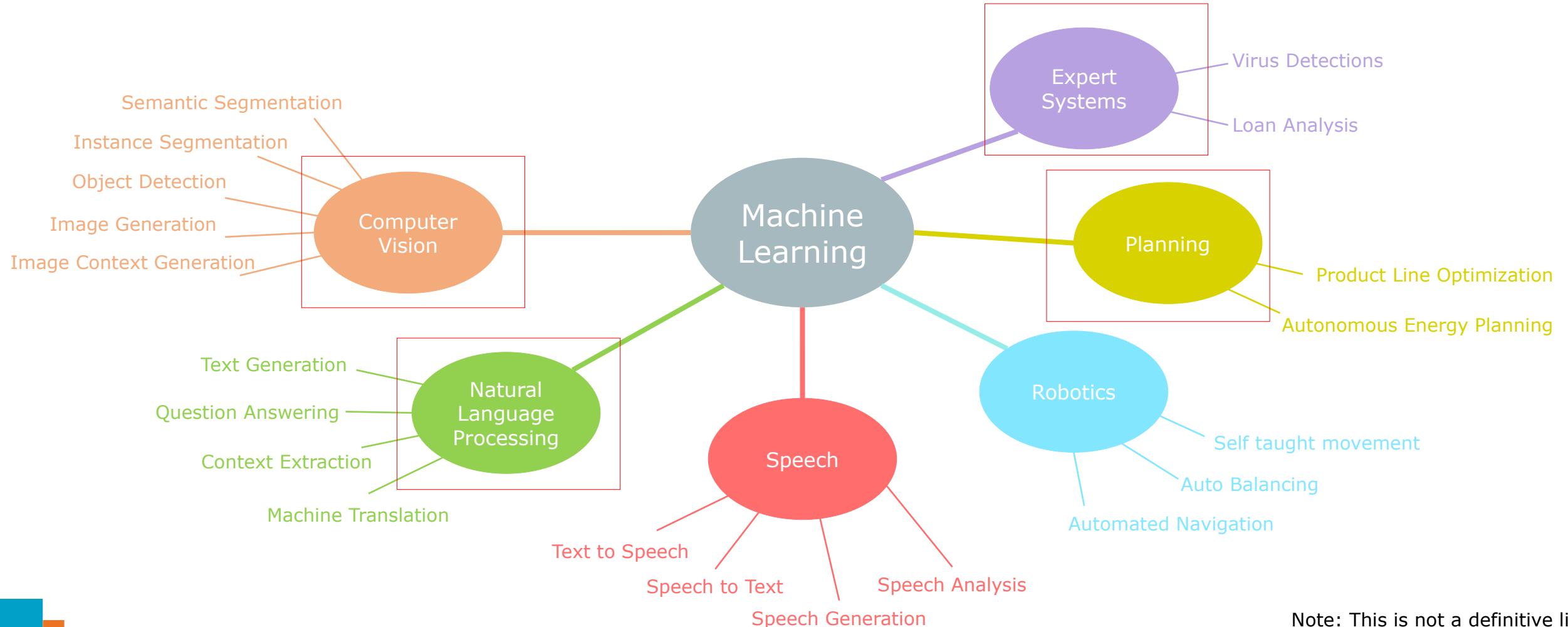
Almost all applications today fall in the scope of **Machine Learning**

What is Geo-AI?

A subset of AI that deals with geospatial datasets, where data possess spatial and/or temporal characteristics (typical: rasters, vectors, pointclouds,...) and helps solving spatial problems

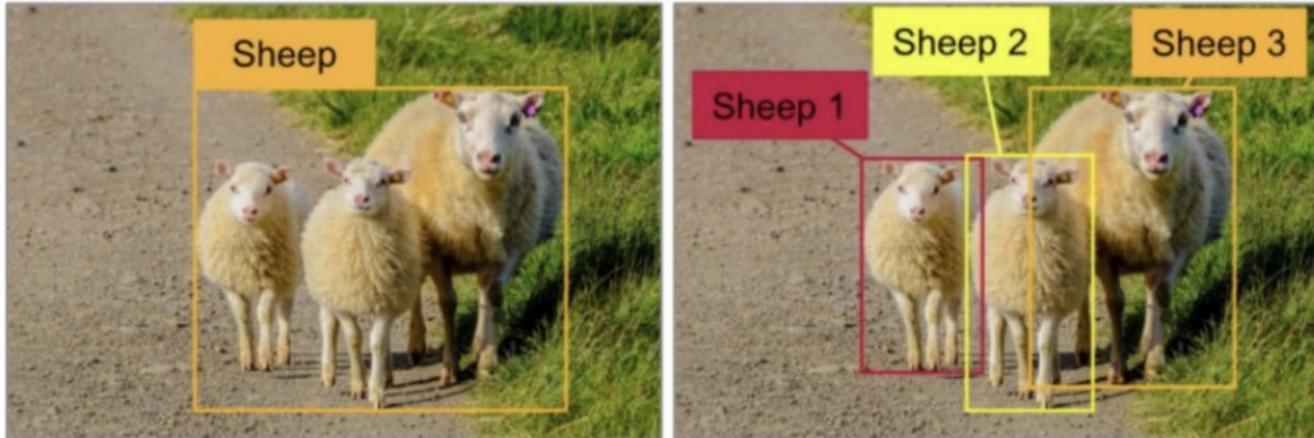


Different fields of machine learning



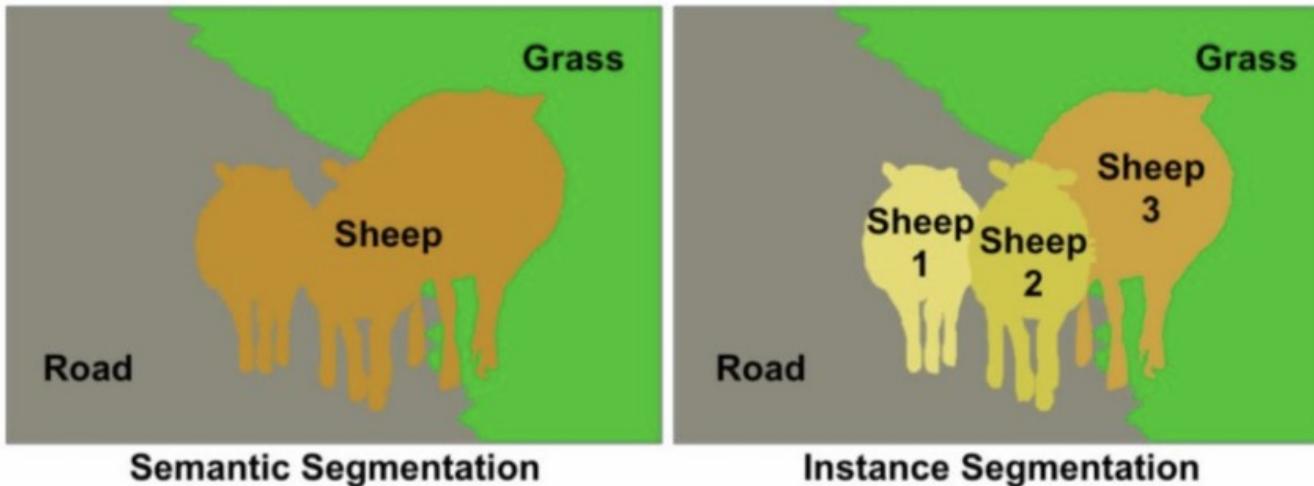
Note: This is not a definitive list

Computer Vision – application types



Classification + Localization

Object Detection

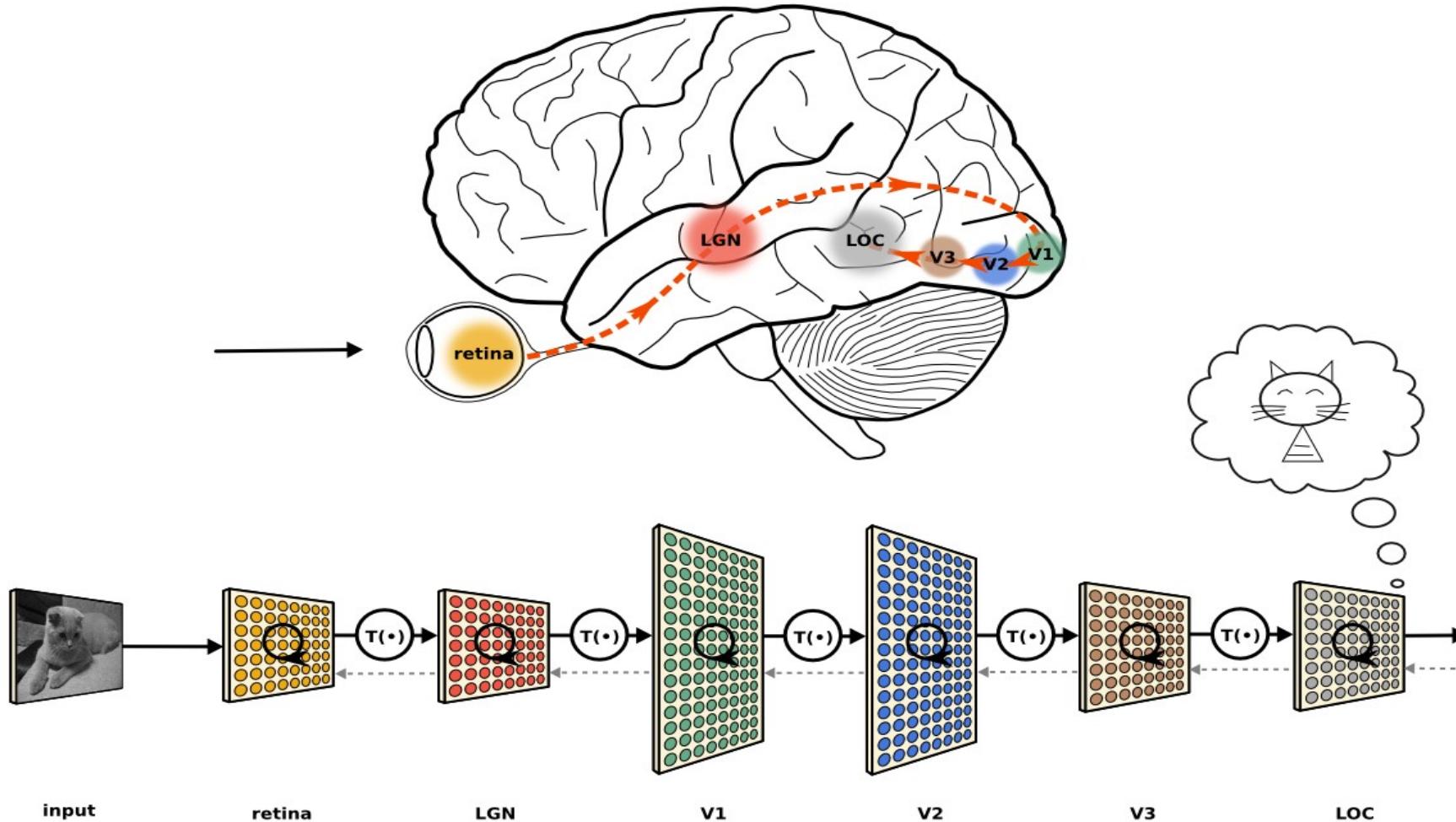


Semantic Segmentation

Instance Segmentation

Source: https://www.oreilly.com/content/introducing-capsule-networks/?cmp=tw-data-na-article-ainy18_thea

Deep Convolutional Neural Networks



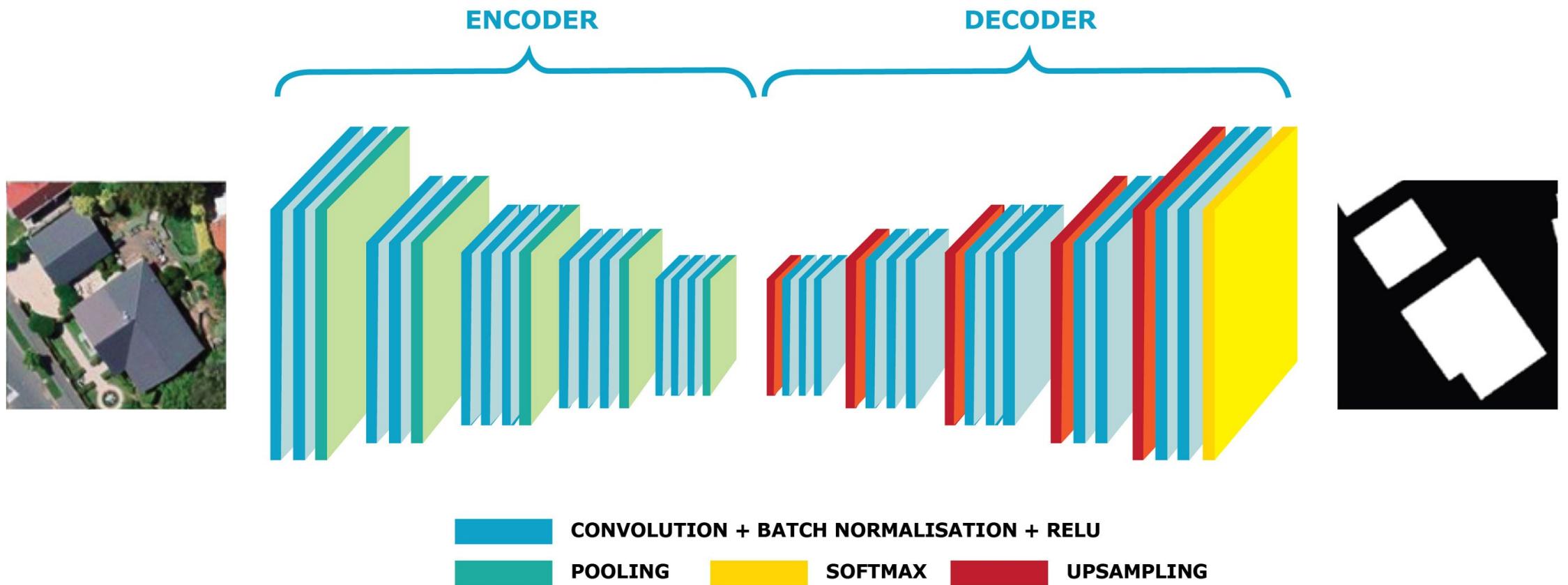
Source: Jonas Kubilius https://neuwritesd.files.wordpress.com/2015/10/visual_stream_small.png

The basics – convolution filters

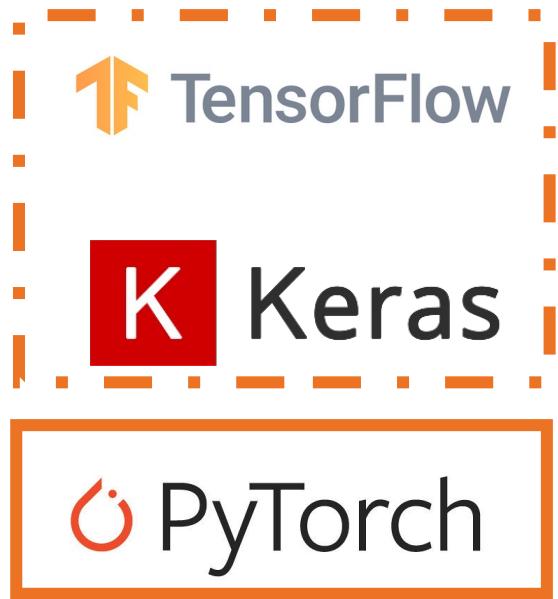


Source: https://cs.nyu.edu/~fergus/tutorials/deep_learning_cvpr12/

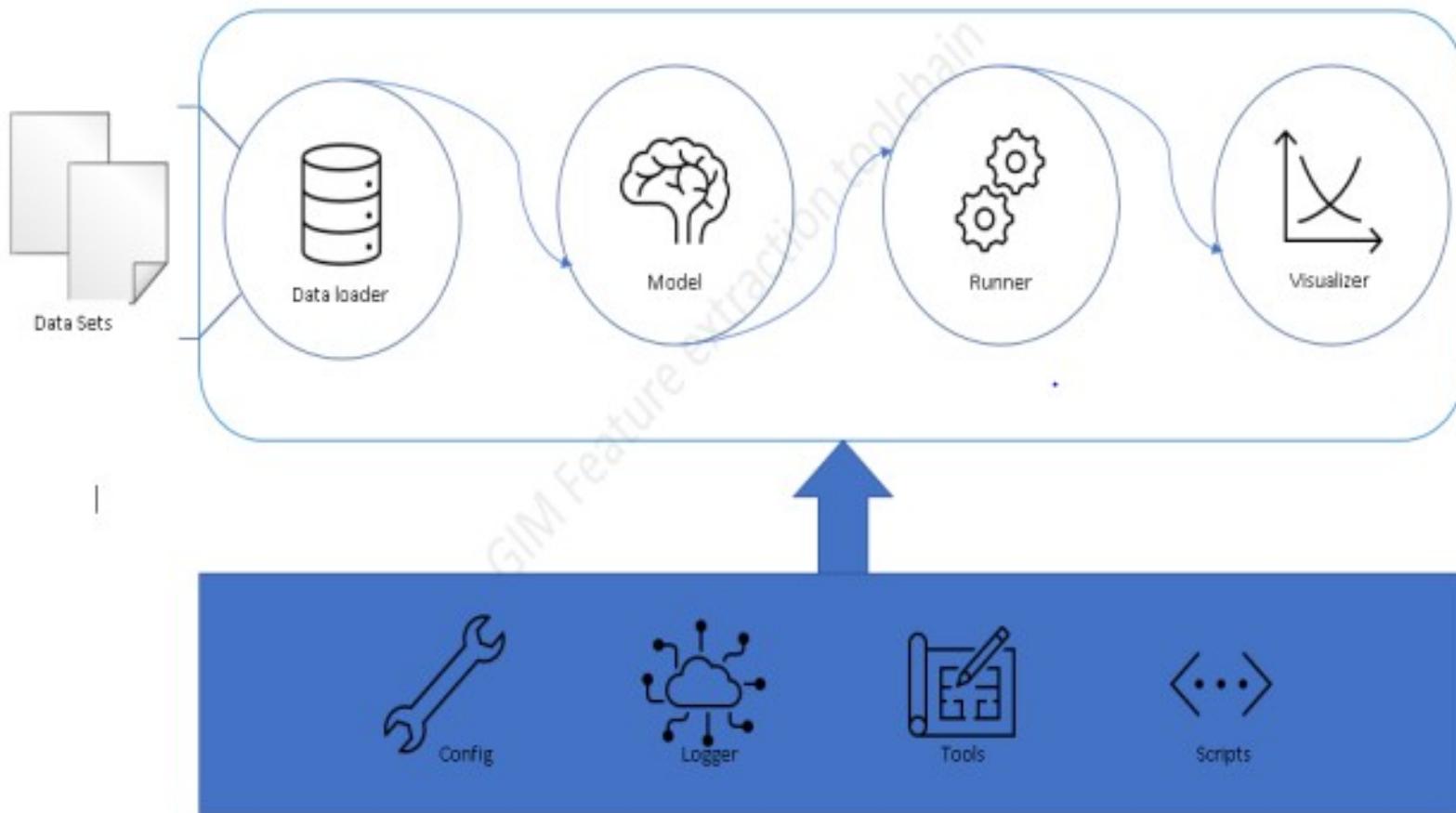
Convolutional neural networks for semantic segmentation



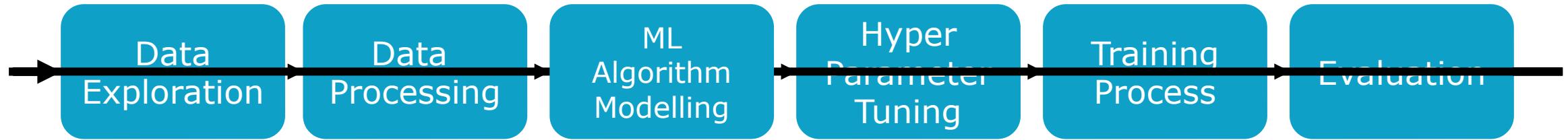
Tools The Machine Learning ecosystem



GIM Deep Learning pipeline



Development Process



Use Cases for Belmap

The GeoDigital Twin of the Benelux



Gardens: Swimming pools

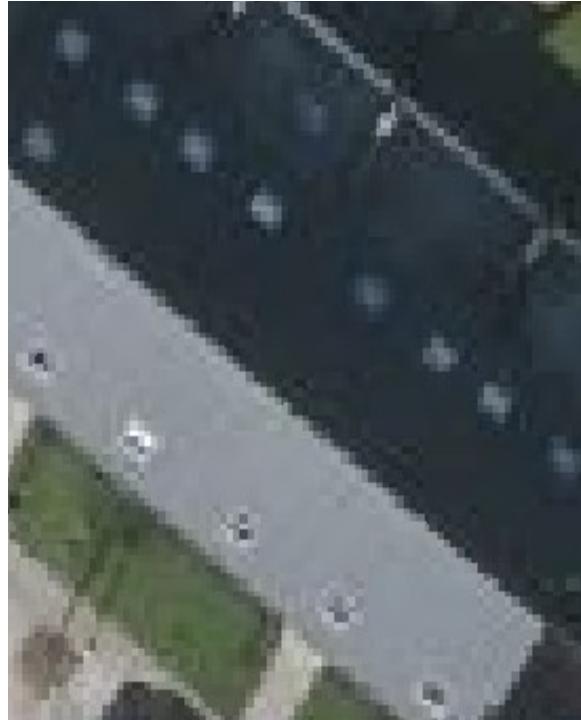


Swimming pools

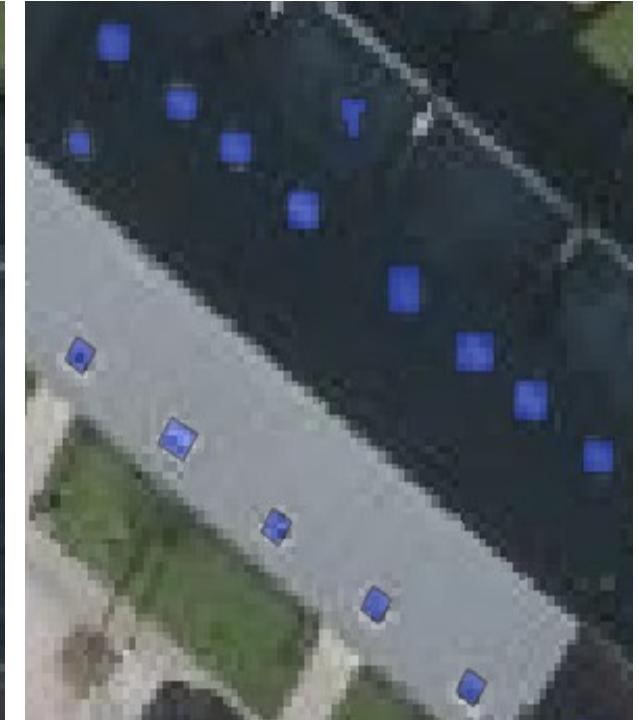
Belmap Roofs: solar panels & roof windows



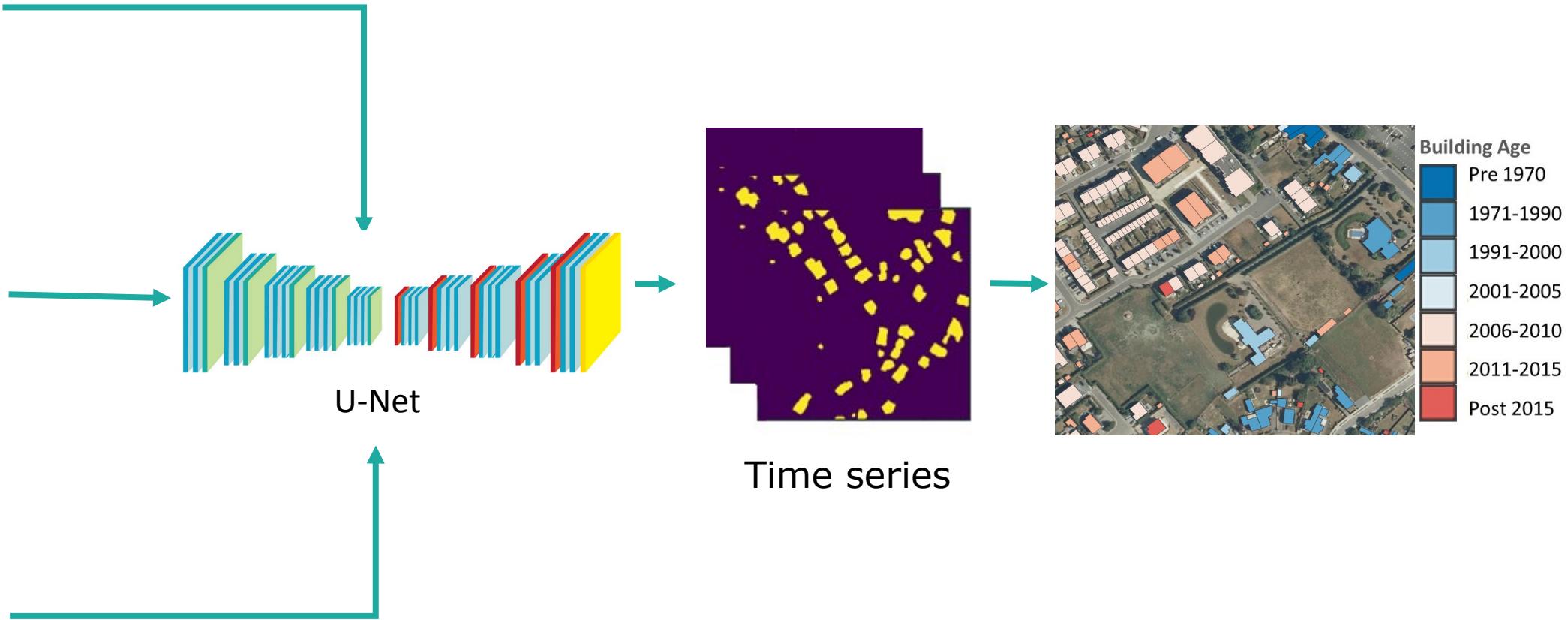
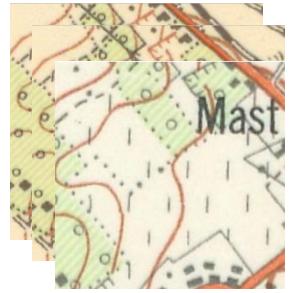
Solar panels



Roof windows



Determining the age of all Belgian buildings



Gardens: Landcover



RGB Image



GIMs Land Cover Prediction

- Detection of **9 distinct land cover classes**
- Training on 2018 summer imagery 40cm with 1m landcover map
- Combination of supervised and unsupervised models to allow sharper delineation of road edges
- AI Deep learning model applied on 2020 winter imagery 25cm

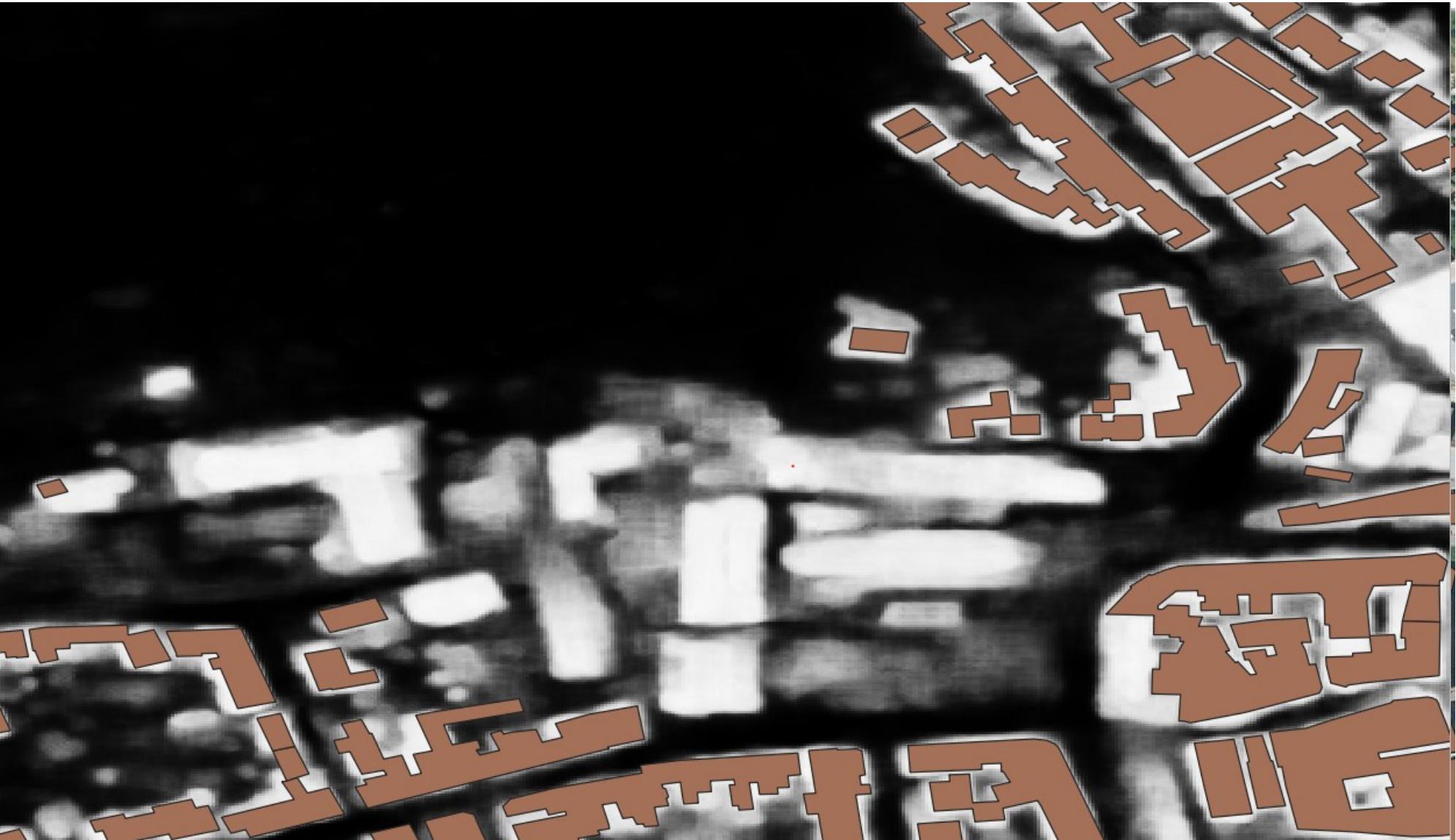
| | |
|---|------------------|
| 1 | Buildings |
| 2 | Roads |
| 3 | Other Covered |
| 4 | Railroads |
| 5 | Water |
| 6 | Other Uncovered |
| 7 | Fields |
| 8 | Grass and bushes |
| 9 | Trees |

Roadsides



Capturing **pervious roadsides** and **covered driveways**

Detecting building changes



Mapping informal settlements



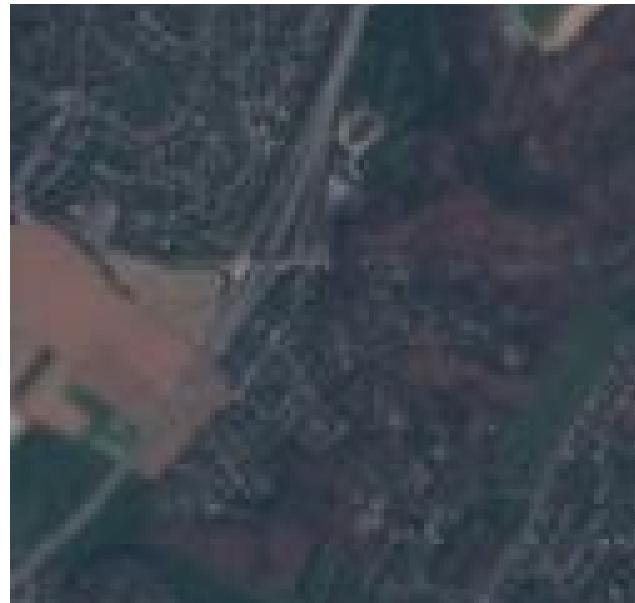
United Nations Development Program & Inter-American development bank

Super-resolution

Artificially enhance the resolution of imagery using a smart combination of generative adversarial networks and U-nets



High Resolution Image



Low Resolution Image



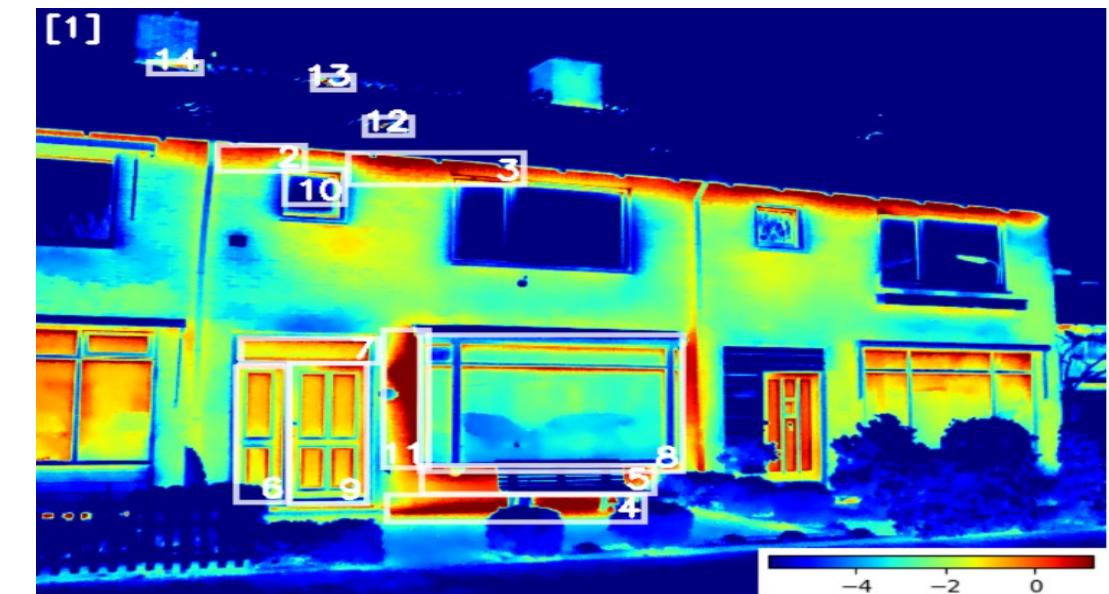
Super Resolved Image

Also applicable to mobile mapping and other imagery



Source: Image segmentation using U-net (Olaf Ronneberger et. al 2015)

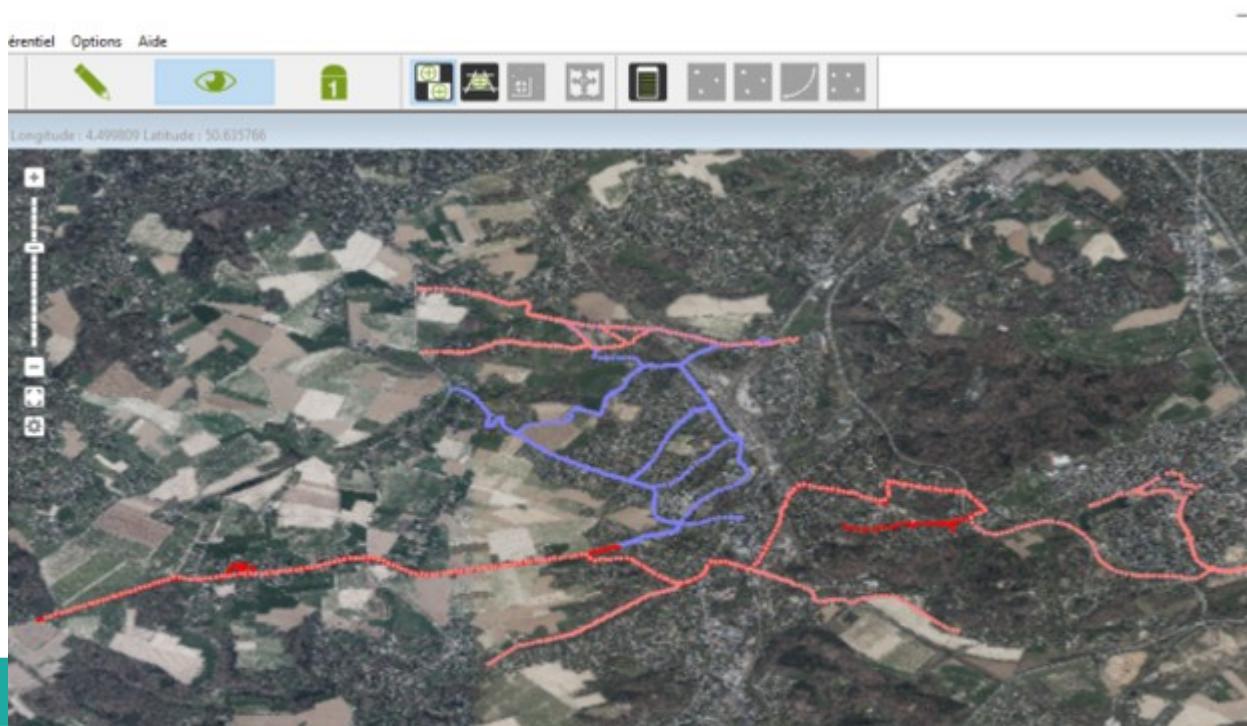
Optical



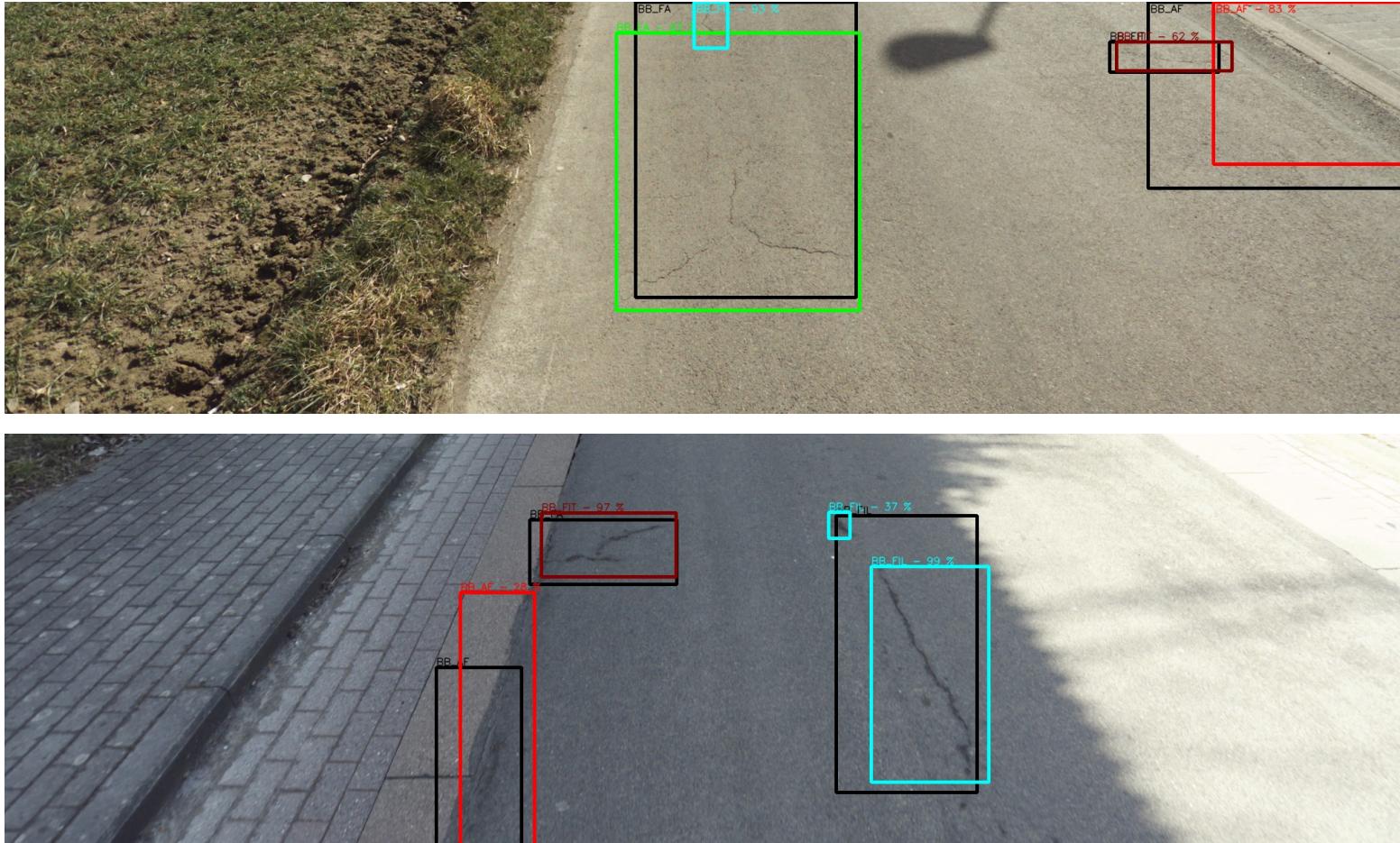
Hyperspectral - thermal

Road defect detection

- **Municipalities & regional government** need to optimize their road work spending's :
 - **Save money** by picking the right road repairs at the right time
 - Methodology of Belgian Road Research Centre – classification of defects



Results

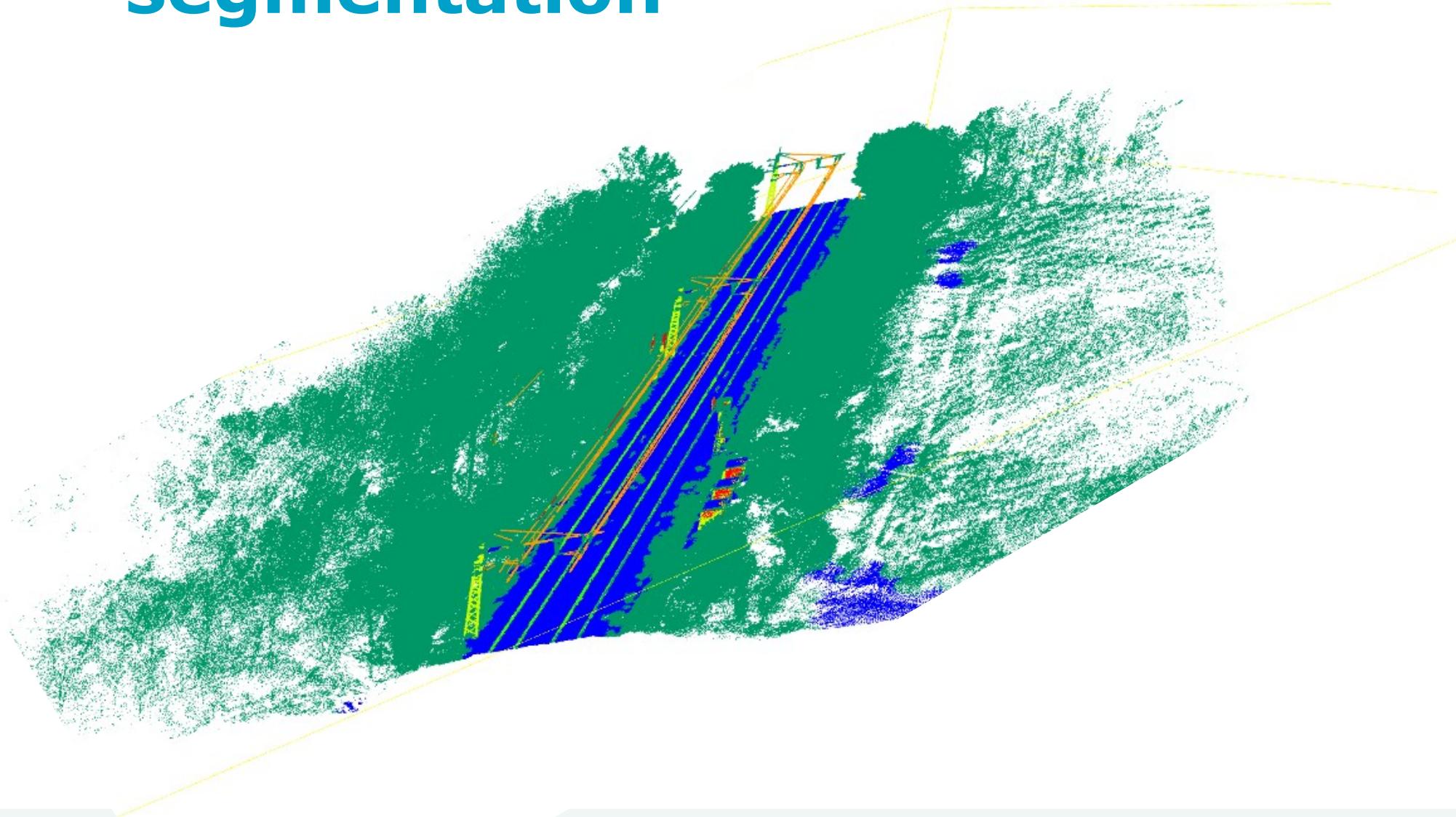


— Ground-Truth
— Detected Defect of a Specific Class

Utility Poles detection

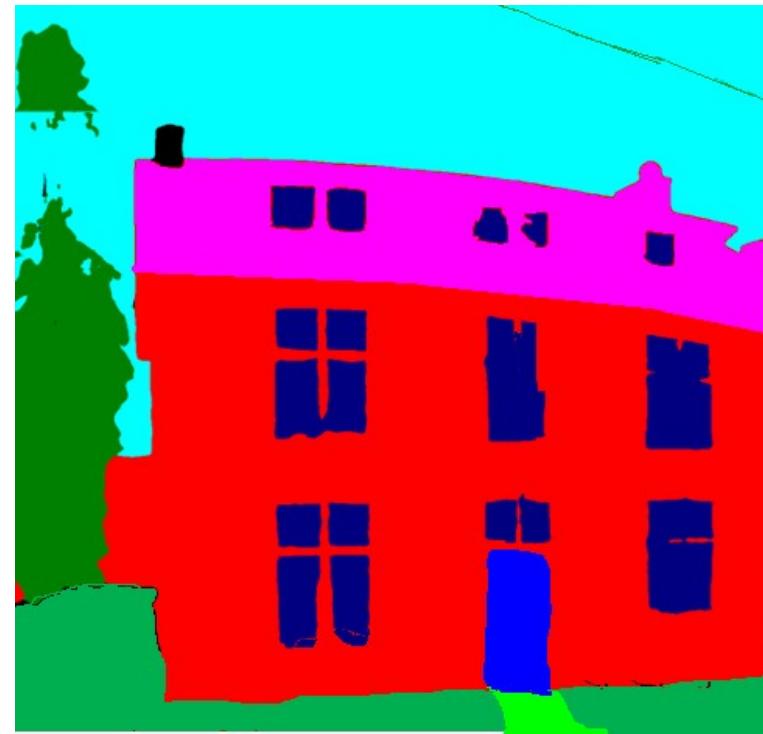


Mobile mapping LIDAR point cloud segmentation



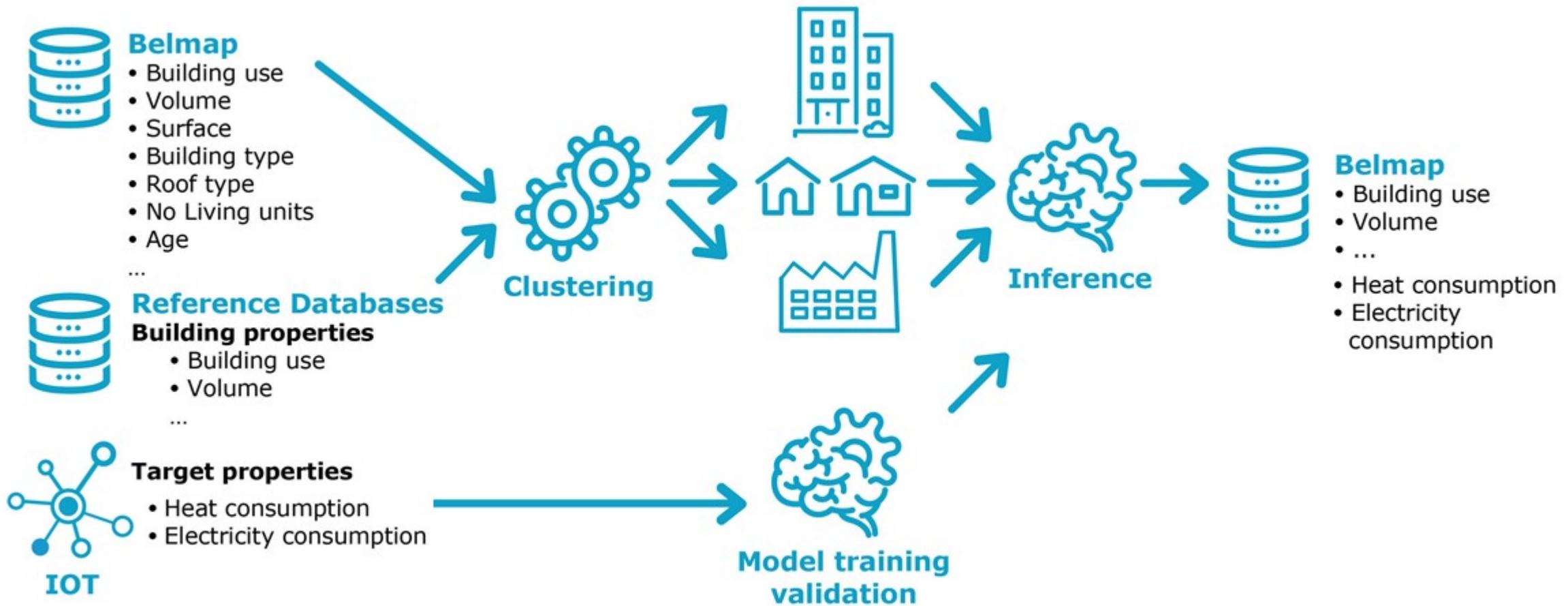
Mobile mapping façade schematisation

Apply supervised DCNNs on façade imagery to determine the number of floors, windows, doors, sills, panels, road cover, ...



| | |
|------------|---|
| Facade |  |
| Sky |  |
| Window |  |
| Door |  |
| Roof |  |
| Road |  |
| Pavement |  |
| Vegetation |  |
| Other |  |

Estimating building properties using unsupervised and supervised machine learning



More use case: Utilities



DIGITISATION OF OLD MAPS

Classification complexity
Semantic segmentation



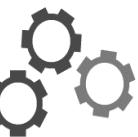
DATA QUALITY CONTROL AND CLEANING

Anomaly detection/flagging



PREDICTIVE MAINTENANCE

Predicting chance of failure based on past failures and spatial context:
underground, type and age of equipment, ...



AUTOMATING REPETITIVE TASKS

Accept/Reject data modifications
Validate excavation/construction permits



ASSET INVENTORY

Classification of equipment types on photographs

More Use Cases – Local Government



PARKING MANAGEMENT

Parking occupancy prediction based on historic parking occupancy/event data

Computer vision on scanning cars or fixed cameras



WASTE MANAGEMENT

Computer vision on photographs that report dumping sites



PUBLIC DOMAIN INFRASTRUCTURE

Computer vision on photographs that report infrastructure issues or report on reparation works



RECREATION

Determination of ideal walking, cycling routes and safe routes based on crowd sourced data



TRAFFIC MANAGEMENT

Predicting and optimizing traffic flows

THE MACHINE LEARNING CANVAS (V1.0)

Designed for:

Designed by:

Date:

Iteration:

| PREDICTION TASK | DECISIONS | VALUE PROPOSITION | DATA COLLECTION | DATA SOURCES |
|--|---|--|--|--|
| Type of task? Input object? Output: definition, parameters (e.g. prediction horizon), possible values? | Process for turning predictions into proposed value for the end-user? Mention decision-making parameters. | Who is the end-user? What are their objectives? How will they benefit from the ML system? Mention workflow/interfaces. | Strategy for initial train set, and continuous update. Collection rate? Holdout on prod inputs? Output acquisition cost? | Which raw data sources can we use (internal, external)? Mention databases and tables, or APIs and methods of interest. |
| OFFLINE EVALUATION | MAKING PREDICTIONS | BUILDING MODELS | FEATURES | LIVE MONITORING |
| Simulation of the impact of decisions/predictions? Which test data? Cost/gain values? Deployment criteria (min performance value, fairness)? | When do we make real-time / batch pred.? Time available for this + featurization + post-processing? Compute target? | How many prod models are needed? When would we update? Time available for this (including featurization and analysis)? | Input representations available at prediction time, extracted from raw data sources. | Metrics to quantify value creation and measure the ML system's impact in production (on end-users and business)? |

Questions?

Contact: steven.smolders[at]gim.be

