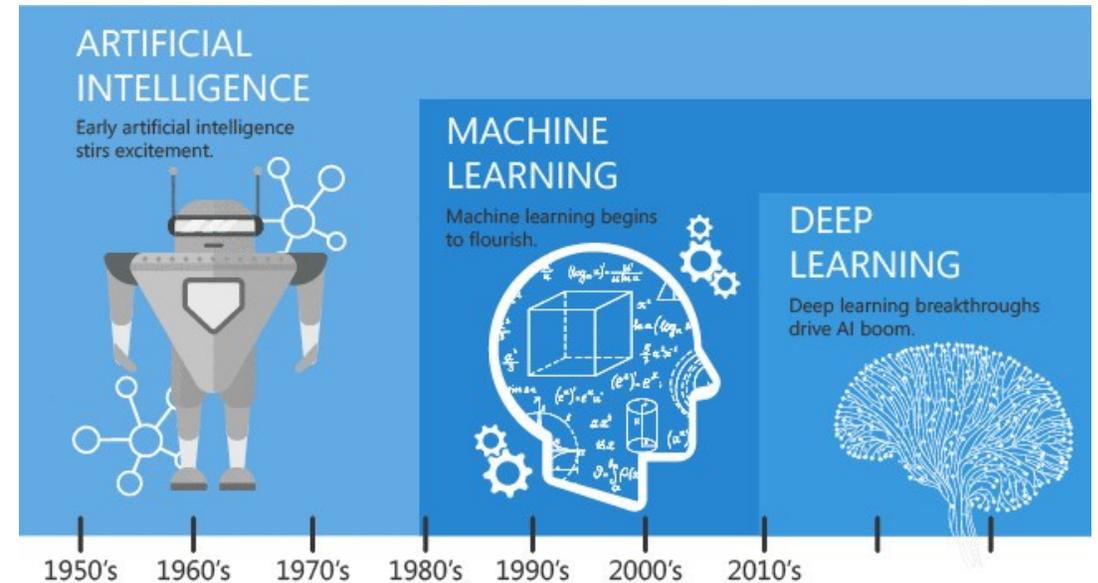
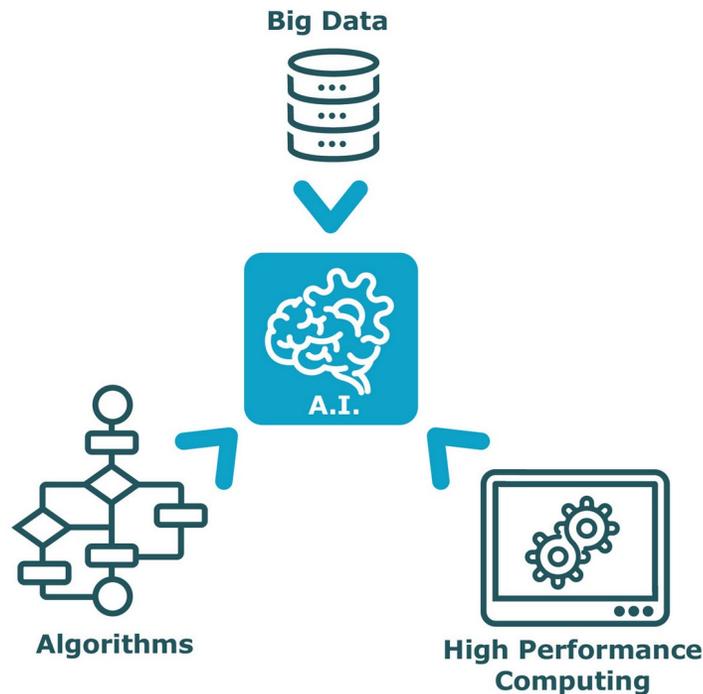


# FOSS powering Scalable GeoAI



# 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.

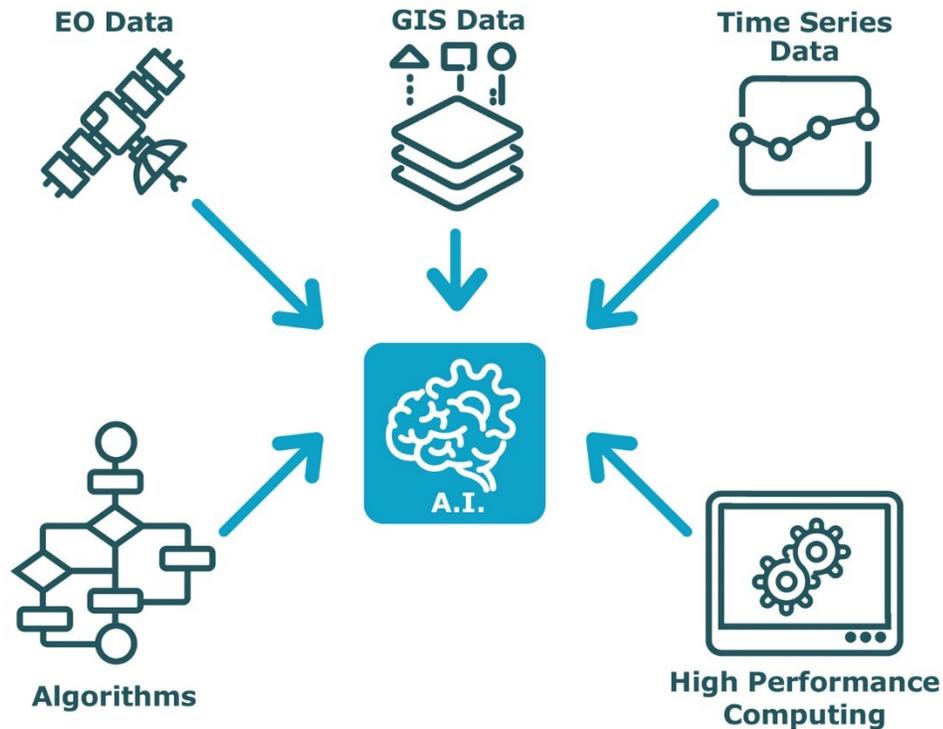


Since an early flush of optimism in the 1950's, smaller subsets of artificial intelligence - first machine learning, then deep learning, a subset of machine learning - have created ever larger disruptions. Source: <https://mindmajix.com/>

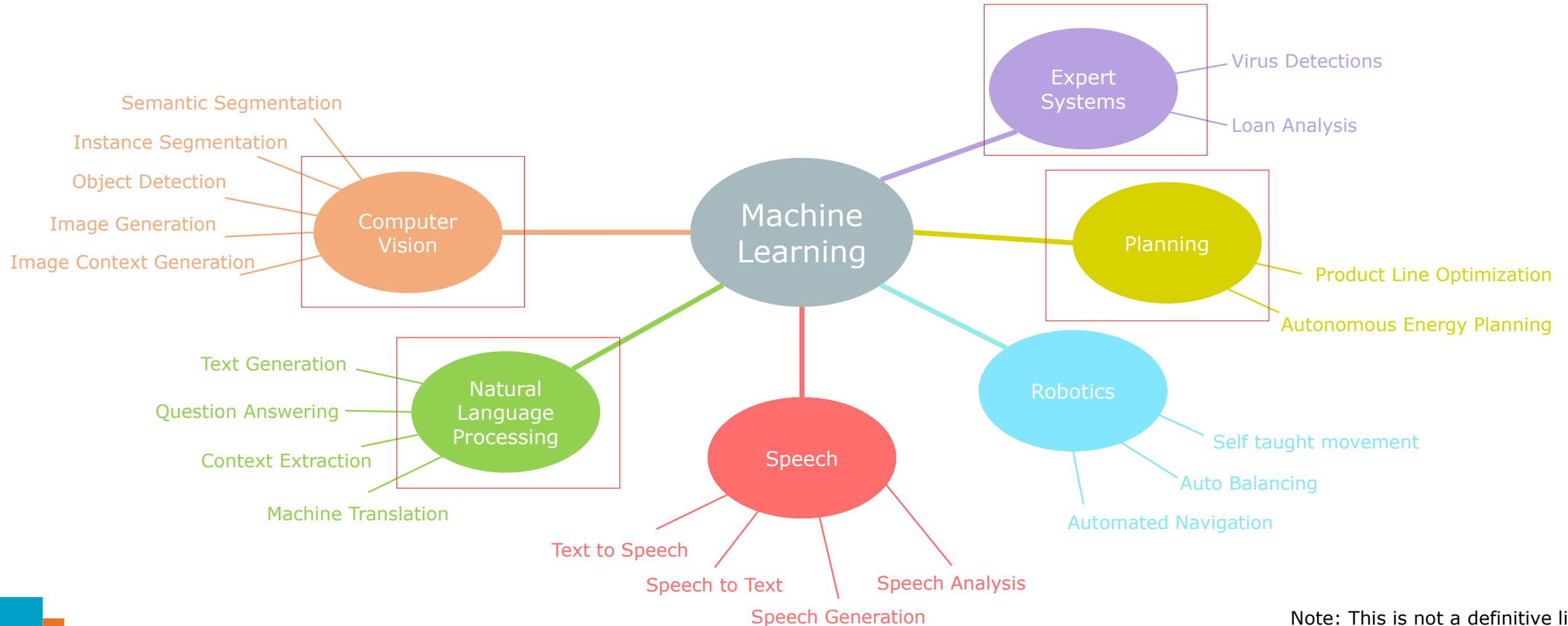
Almost all applications today fall in the scope of **Machine Learning**

# 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

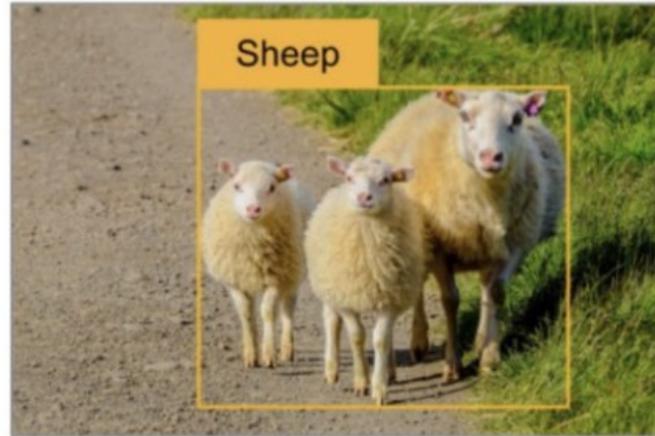


# Different fields of machine learning

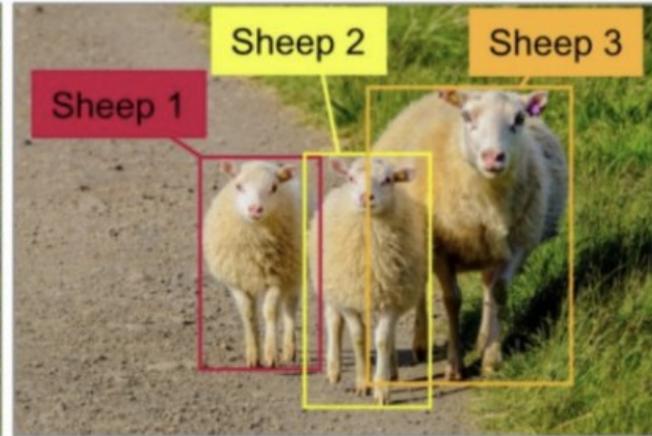


Note: This is not a definitive list

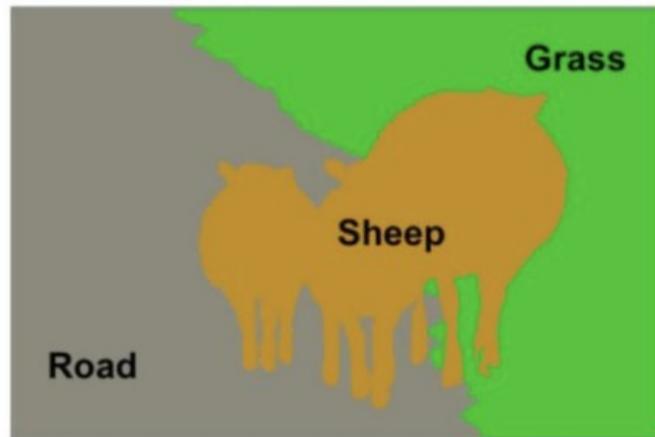
# Computer Vision – application types



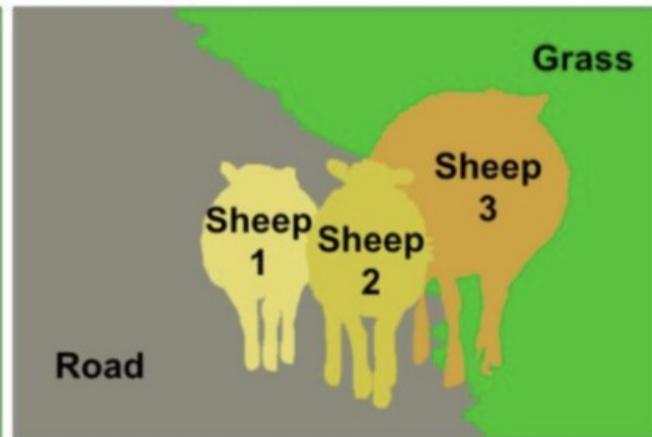
**Classification + Localization**



**Object Detection**



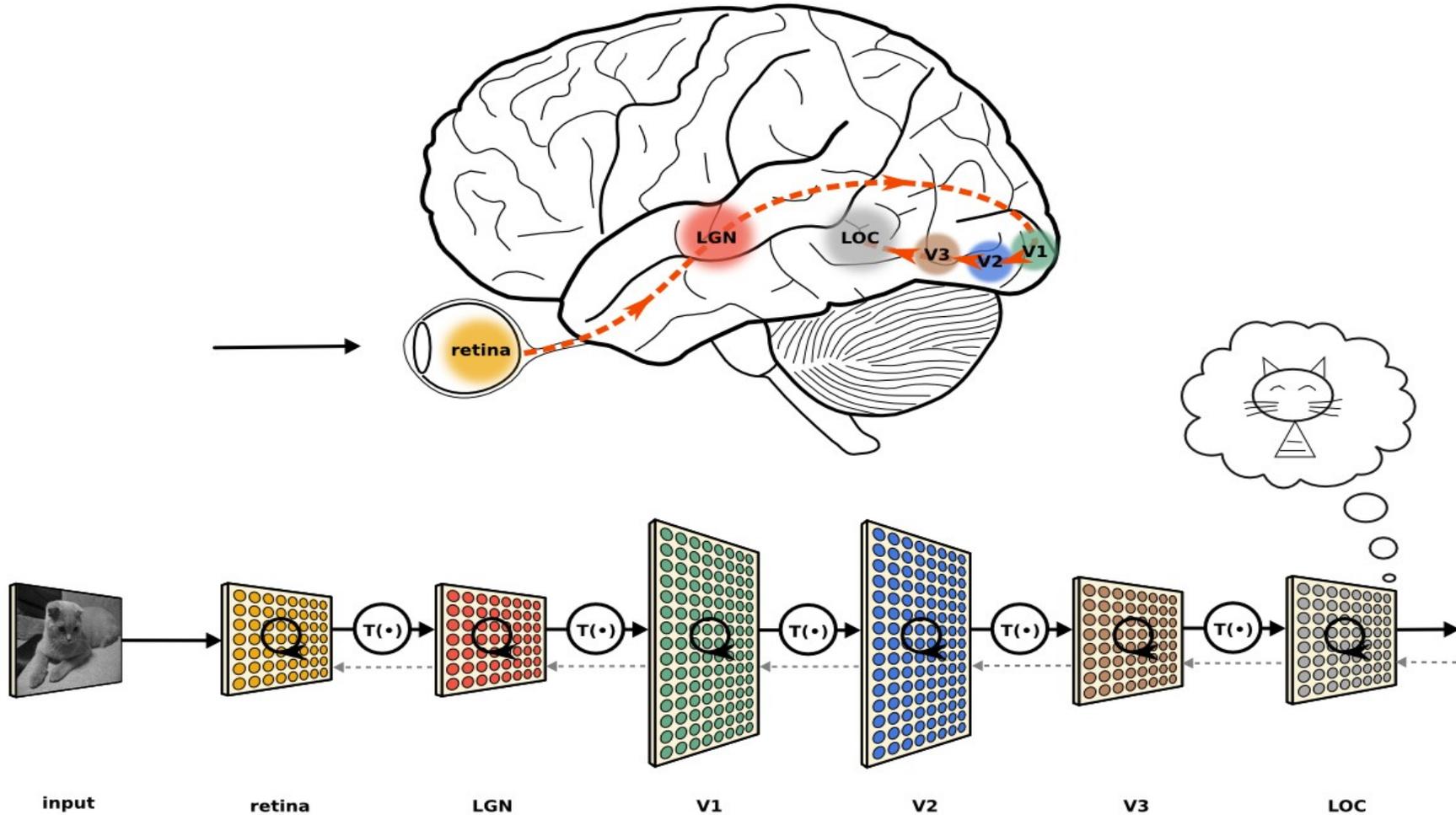
**Semantic Segmentation**



**Instance Segmentation**

Source: [https://www.oreilly.com/content/introducing-capsule-networks/?cmp=tw-data-na-article-ainy18\\_thea](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](https://neuwritesd.files.wordpress.com/2015/10/visual_stream_small.png)

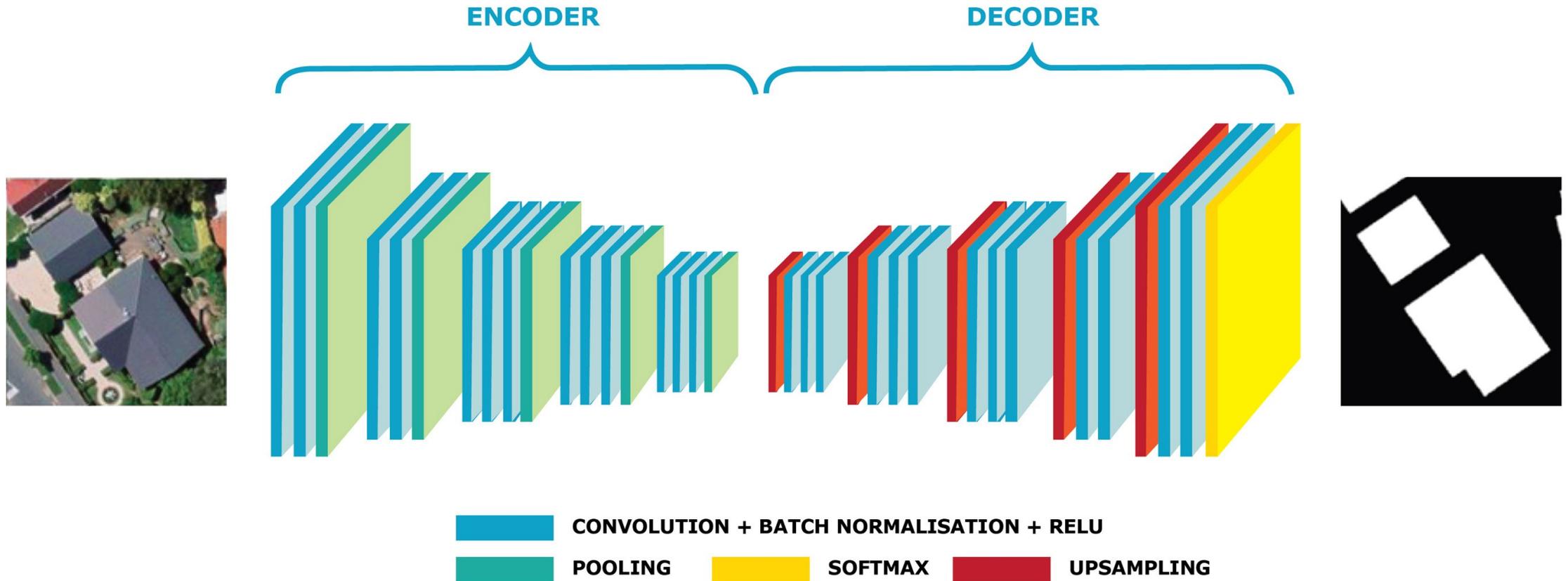
# The basics – convolution filters



Input

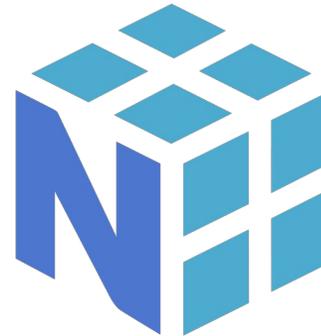
Source: [https://cs.nyu.edu/~fergus/tutorials/deep\\_learning\\_cvpr12/](https://cs.nyu.edu/~fergus/tutorials/deep_learning_cvpr12/)

# Convolutional neural networks for semantic segmentation

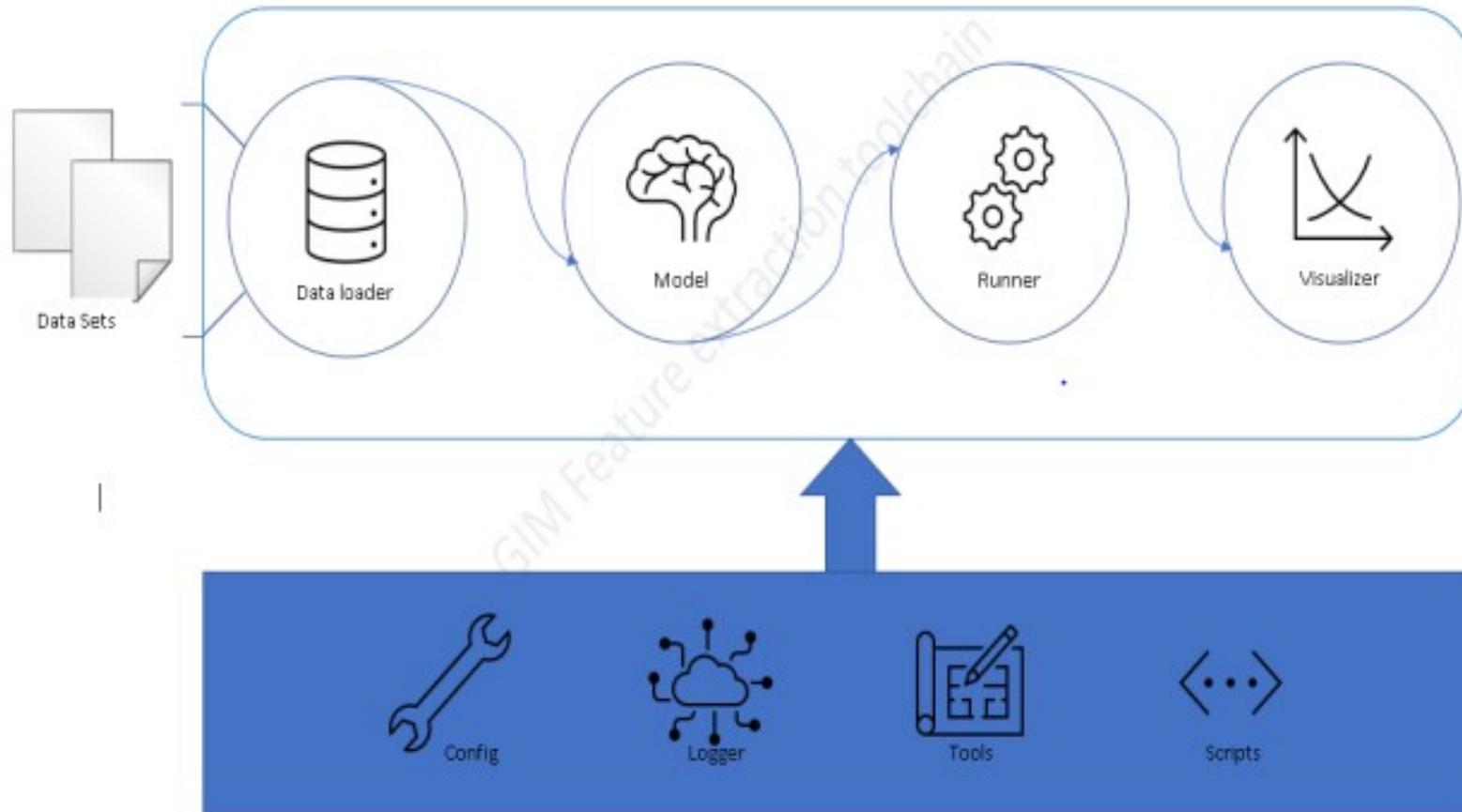


# Tools

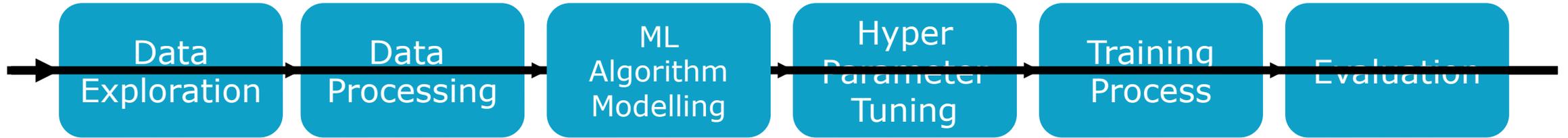
## The Machine Learning ecosystem



# GIM Deep Learning pipeline



# Development Process



# Use Cases for Belmap The GeoDigital Twin of the Benelux



# Gardens: Swimming pools

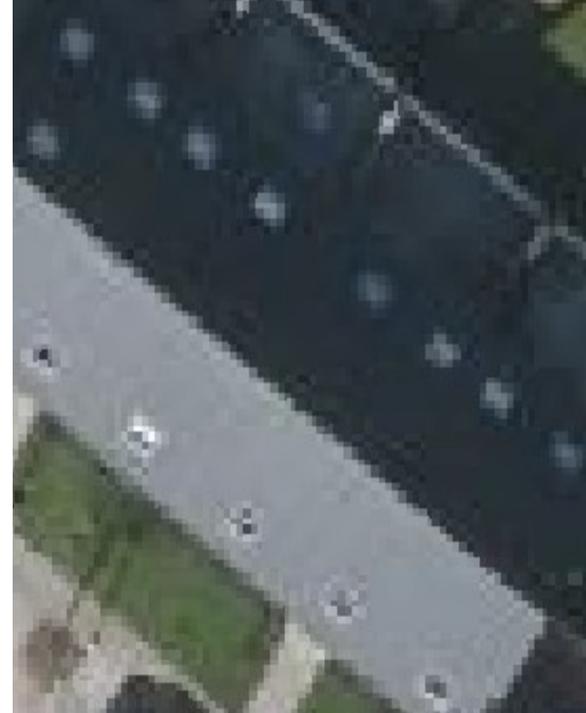


Swimming pools

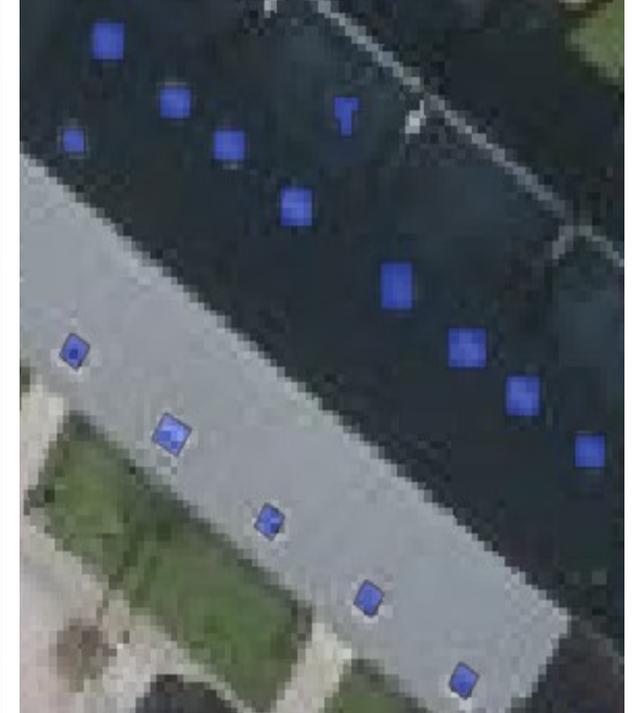
# Belmap Roofs: solar panels & roof windows



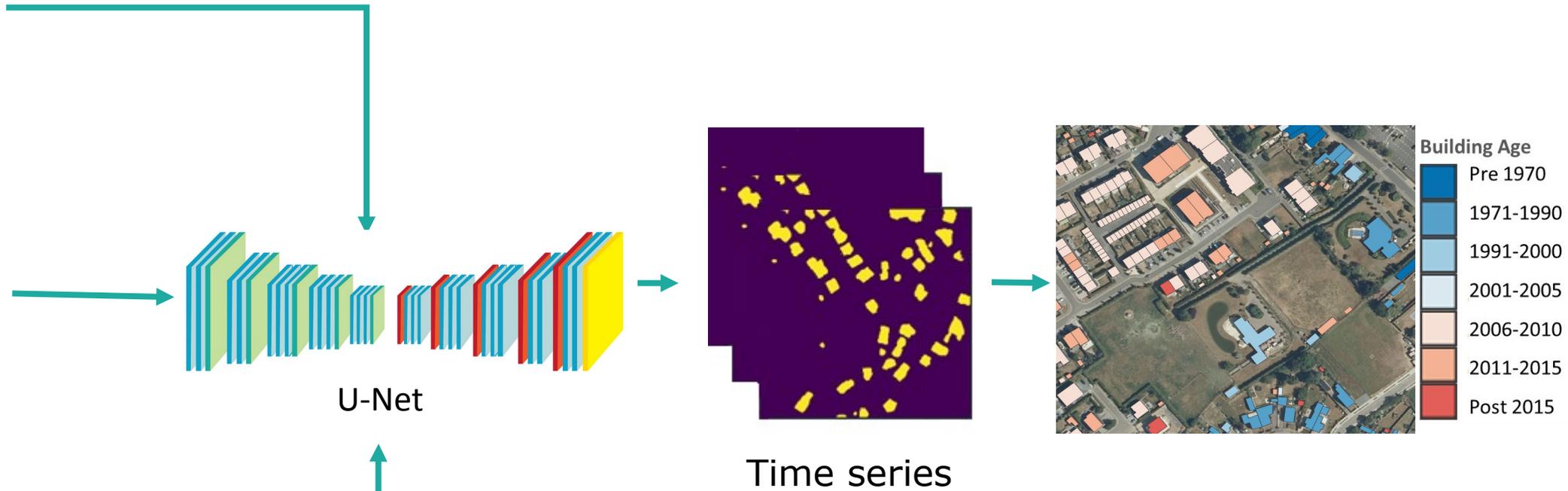
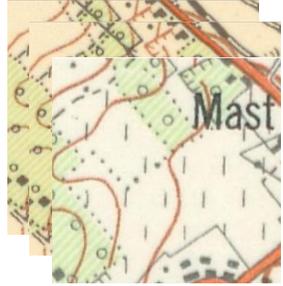
Solar panels



Roof windows



# Determining the age of all Belgian buildings



# Gardens: Landcover



**RGB Image**



**GIMs Land Cover Prediction**

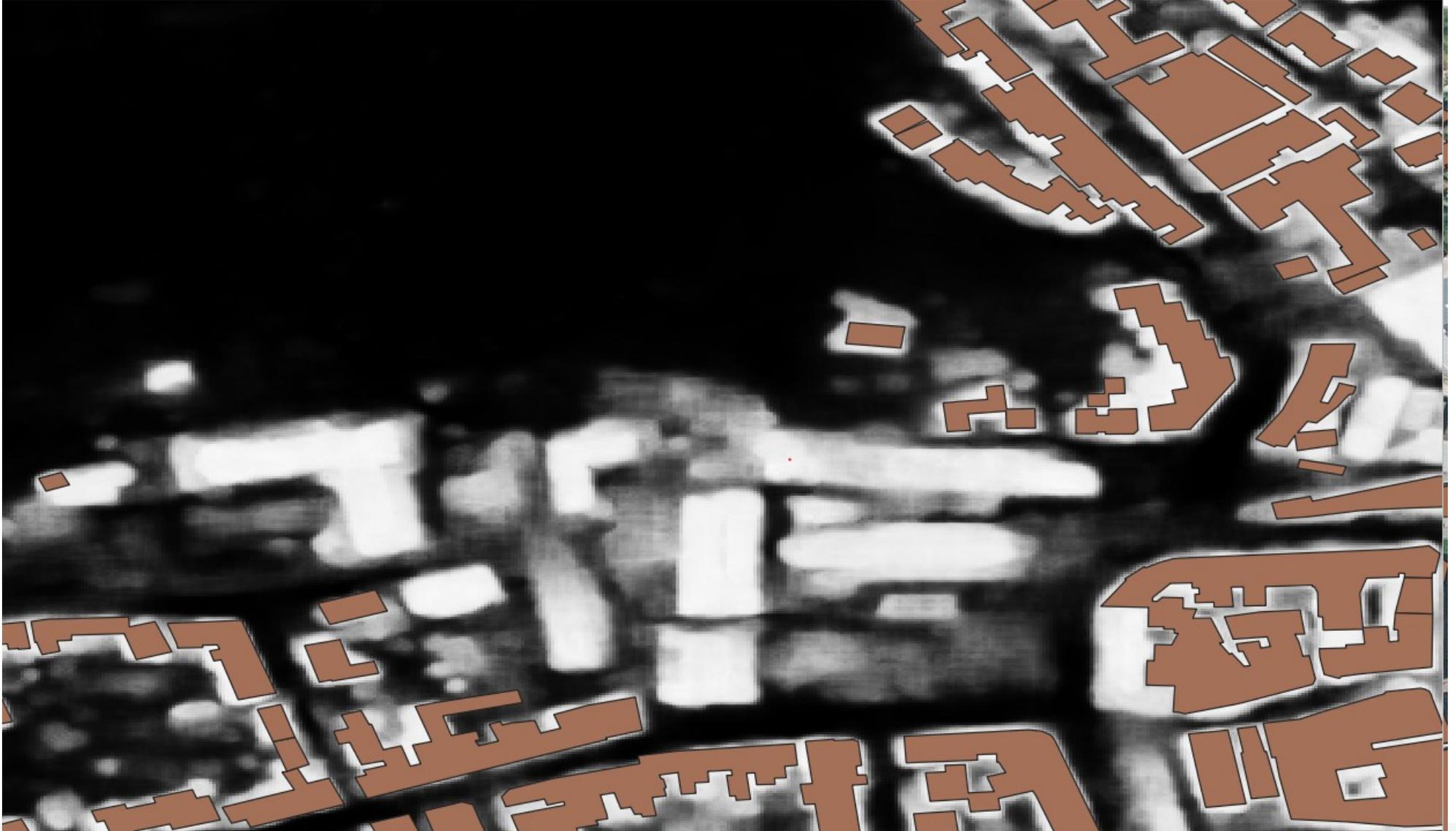
- Detection of **9 distinct land cover classes**
- Training on 2018 summer imagery 40cm with 1m landcover map
- Combination of supervised and unsupervised models to allow sharper delineation of road edges
- AI Deep learning model applied on 2020 winter imagery 25cm

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



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

# Detecting building changes



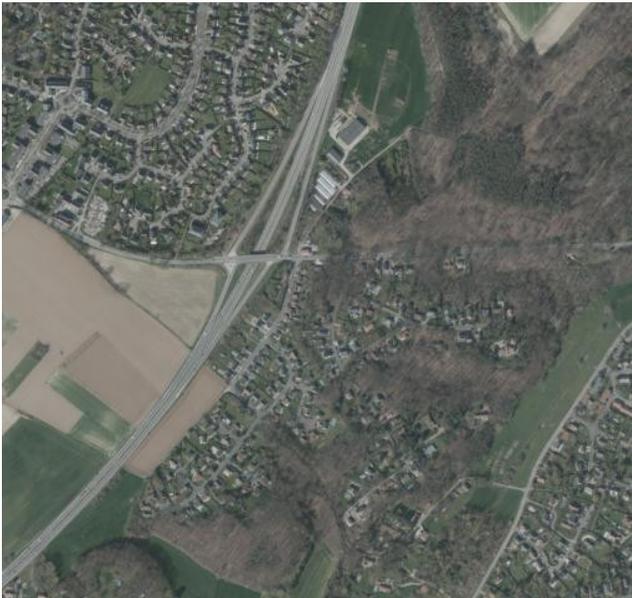
# Mapping informal settlements



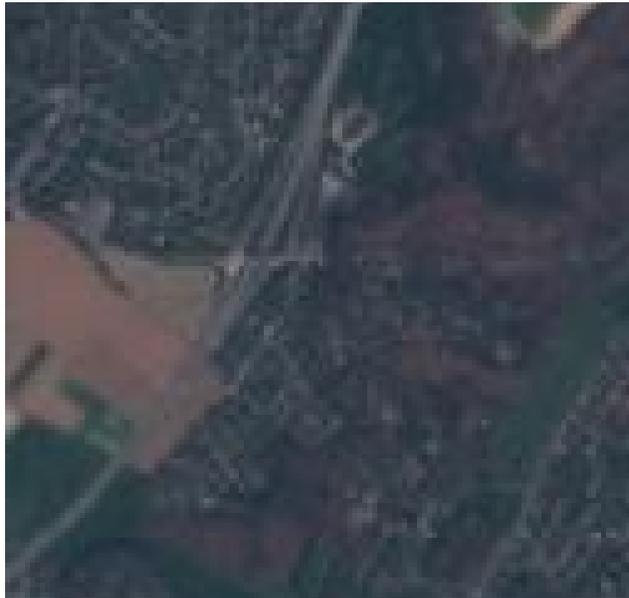
United Nations Development Program & Inter-American development bank

# 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



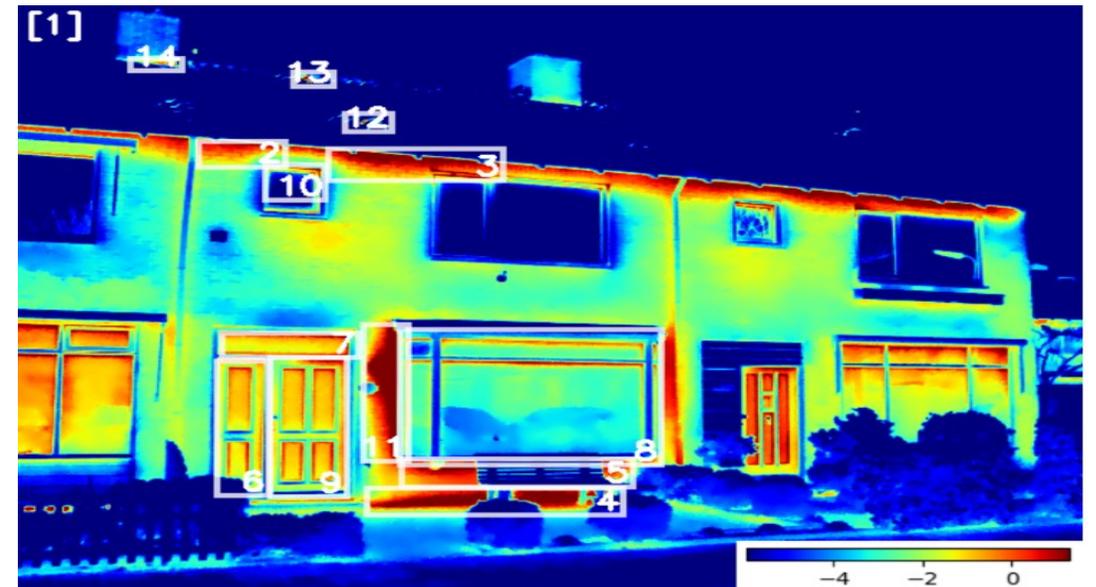
Super Resolved Image

# Also applicable to mobile mapping and other imagery



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

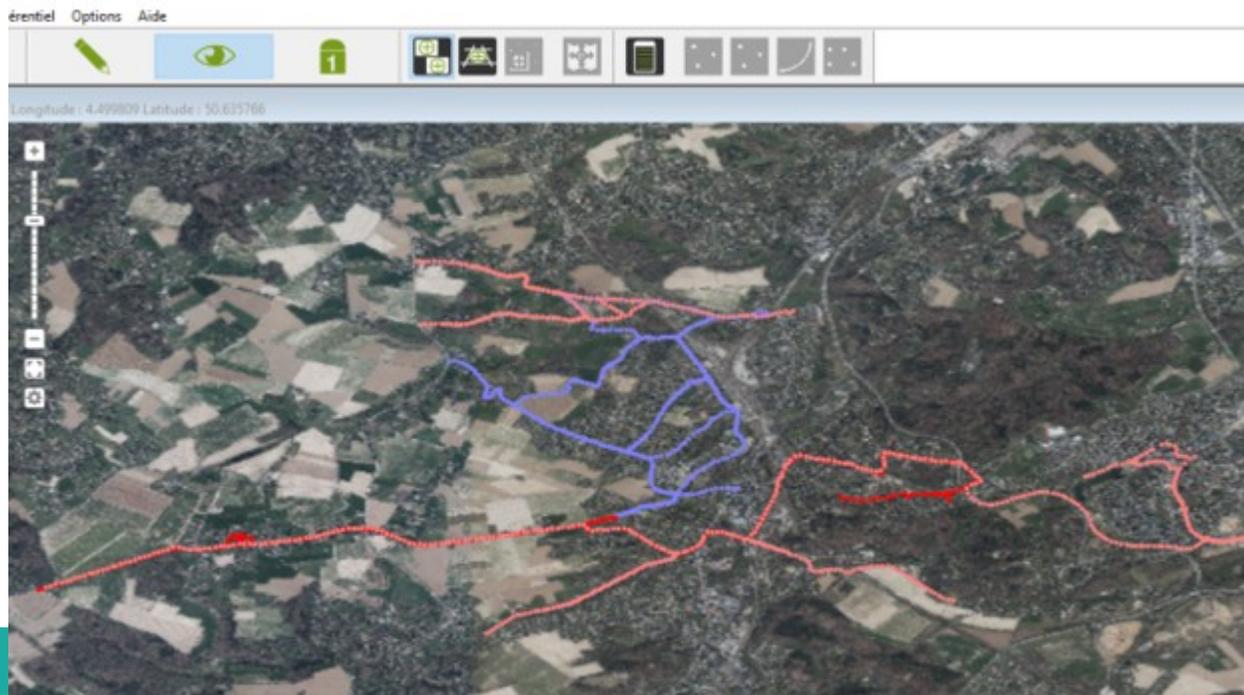
Optical



source:sobolt.ai

Hyperspectral - thermal

- **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

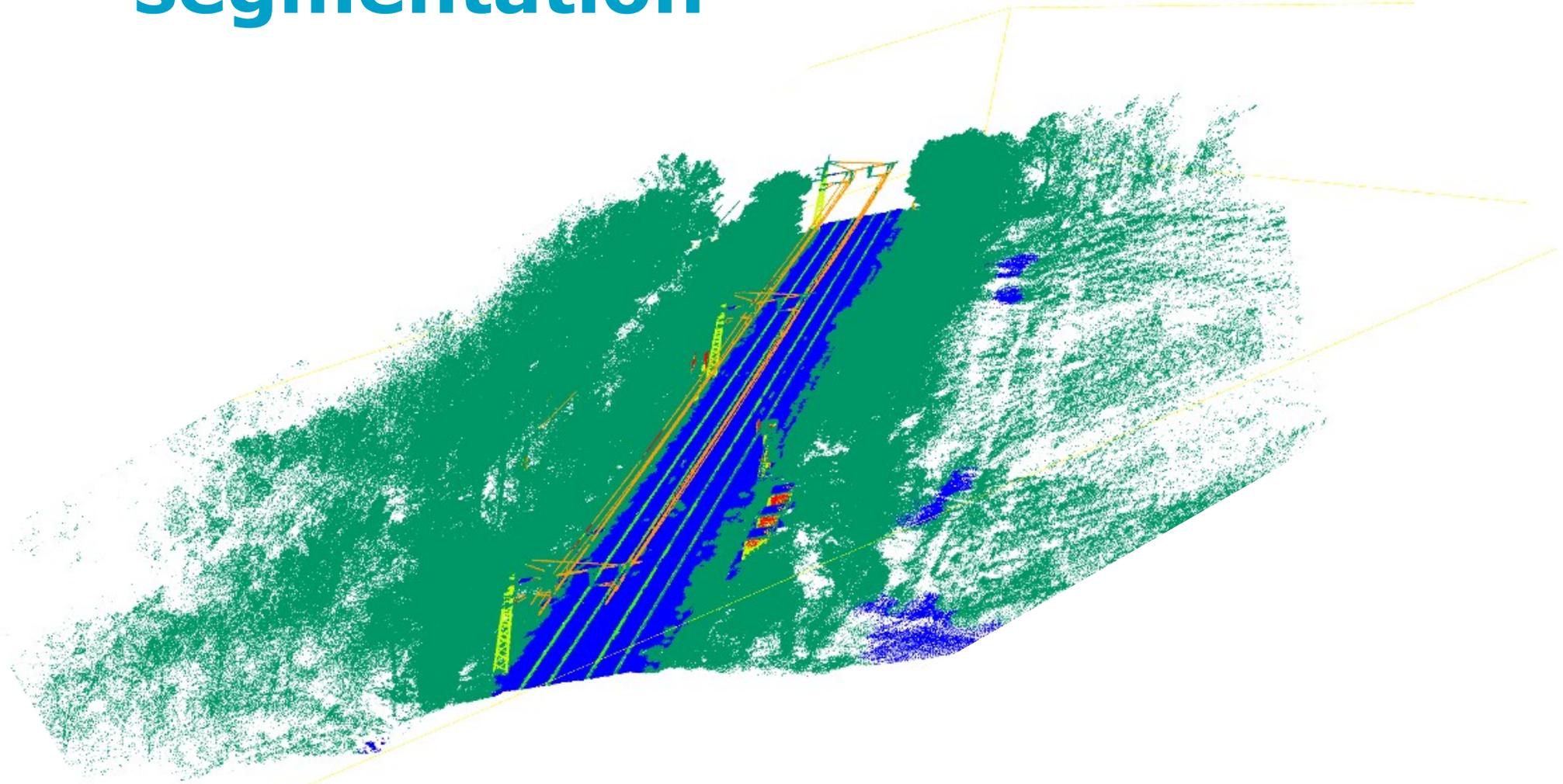




# Utility Poles detection

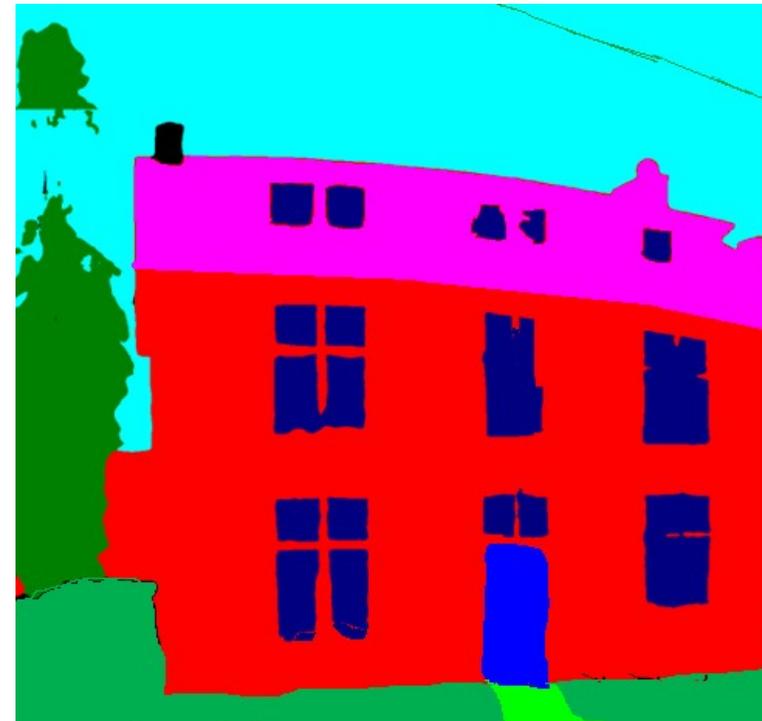


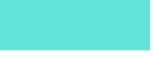
# Mobile mapping LIDAR point cloud segmentation



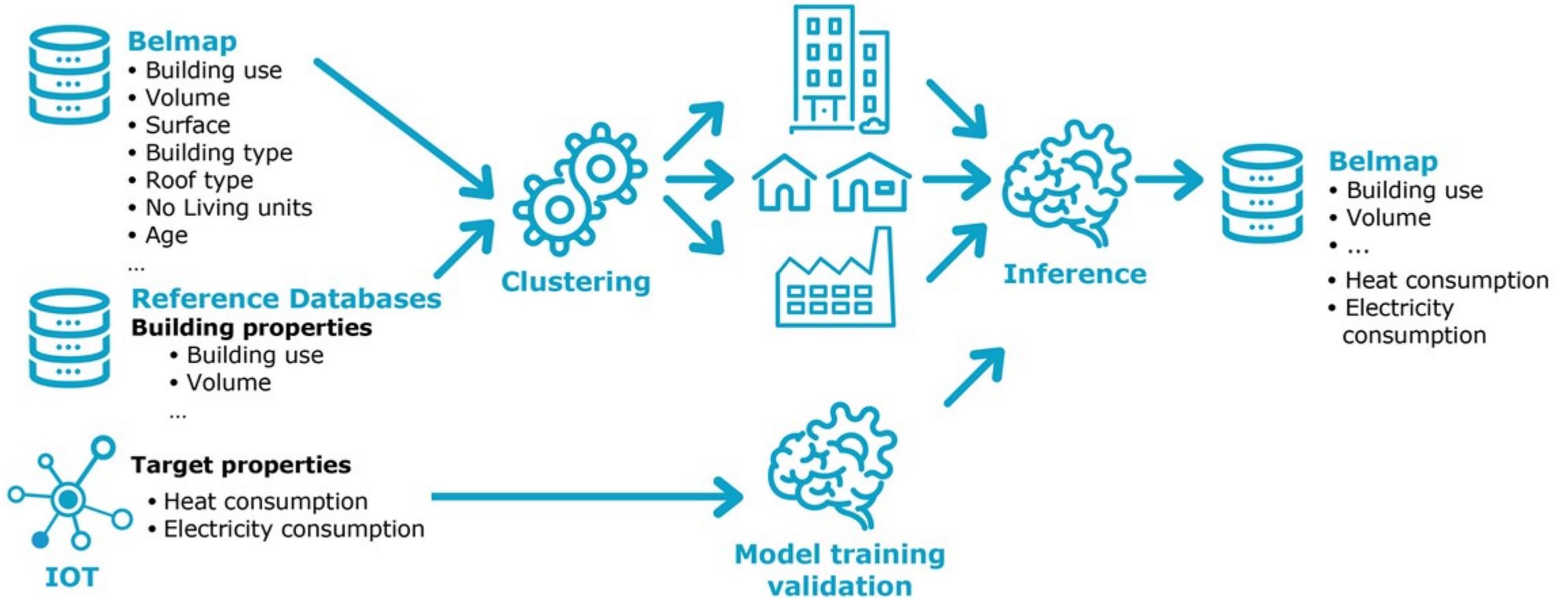
# Mobile mapping façade schematisation

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

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

# Questions?

Contact: [steven.smolders\[at\]gim.be](mailto:steven.smolders@gim.be)

