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Automating LPIS updates

At the Department of Agriculture and fisheries, Flanders

DEPARTEMENT
LANDBOUW
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Agenda

- **Context**
- Automatic digitization
- Technology used
- Conclusions

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Context

- **2005: adoption of risk based LPIS updates**
  - → CAPI of parcels with (high) risk of ineligle elements
  - → Higher efficiëncy
  - → Better quality
    - × Better concentration of operators!

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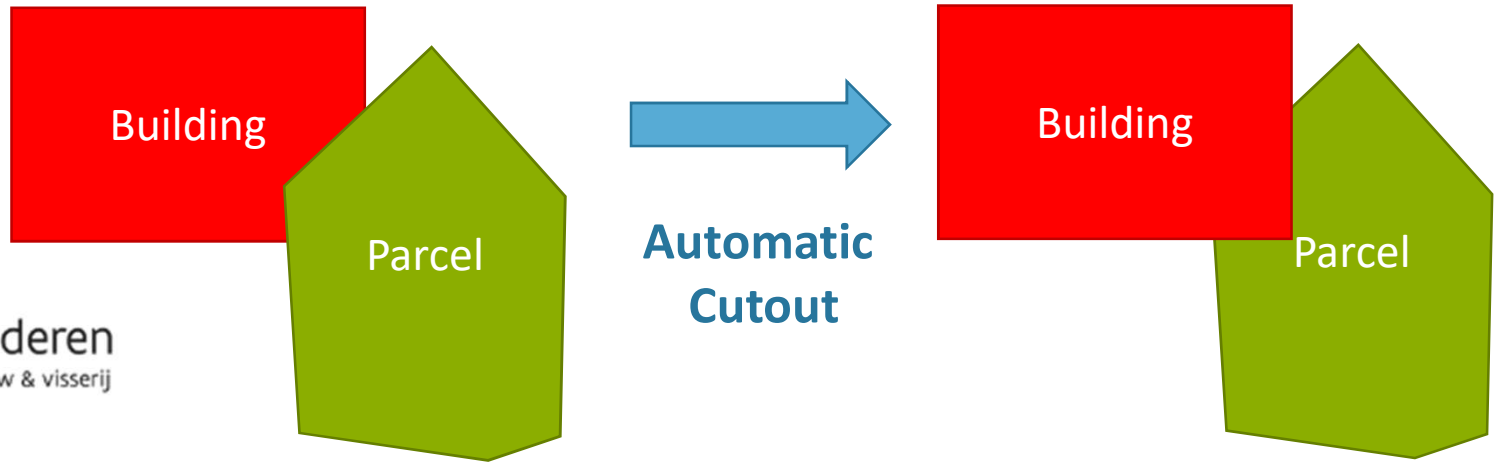
Context

- **2007: (some) automatic LPIS updates**
  - → High-precision GIS layers in Flanders:
    - × Buildings
    - × Roads
    - × Watercourses
  - → In-house creation of 'ineligible layer'
    - × Football fields
    - × …
  - → Automatic, realtime removal of ineligible elements from parcels



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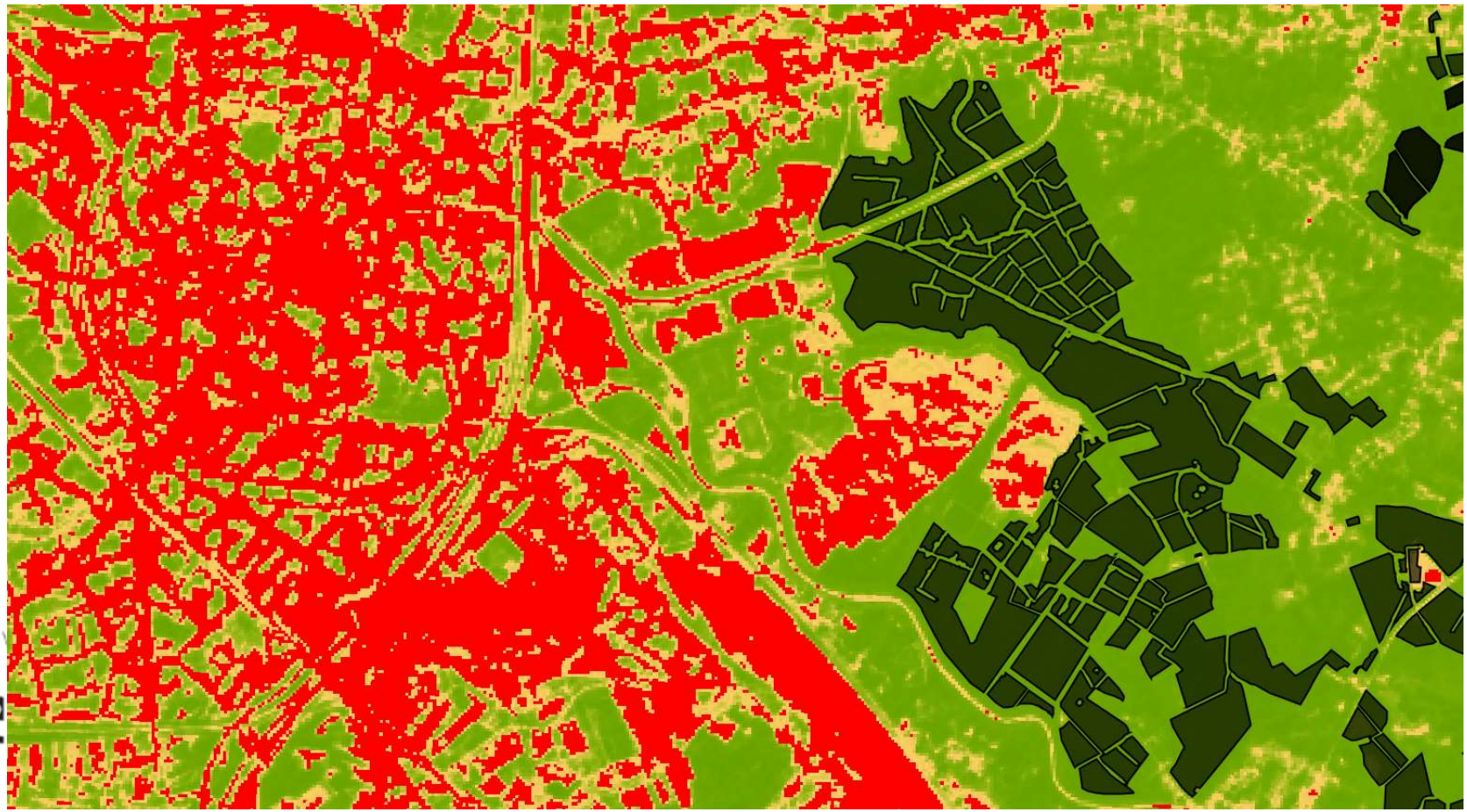
Context

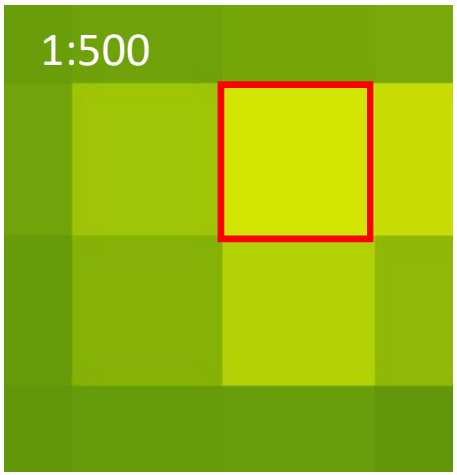
- **2017: development of risk-criterium based on S2**
  - → Pixel has low NDVI (=growth) entire year = ineligible!
    - × Inside parcel -> check parcel!



Context

- **But…**
  - → Resolution of S2 = 10 meter
  - → + mixed pixels (mixels)!

  - → **Result**: problems < 20 meter not always detected ☹.



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- 1/3 house
- 2/3 grass

⇒ "OK" ☹

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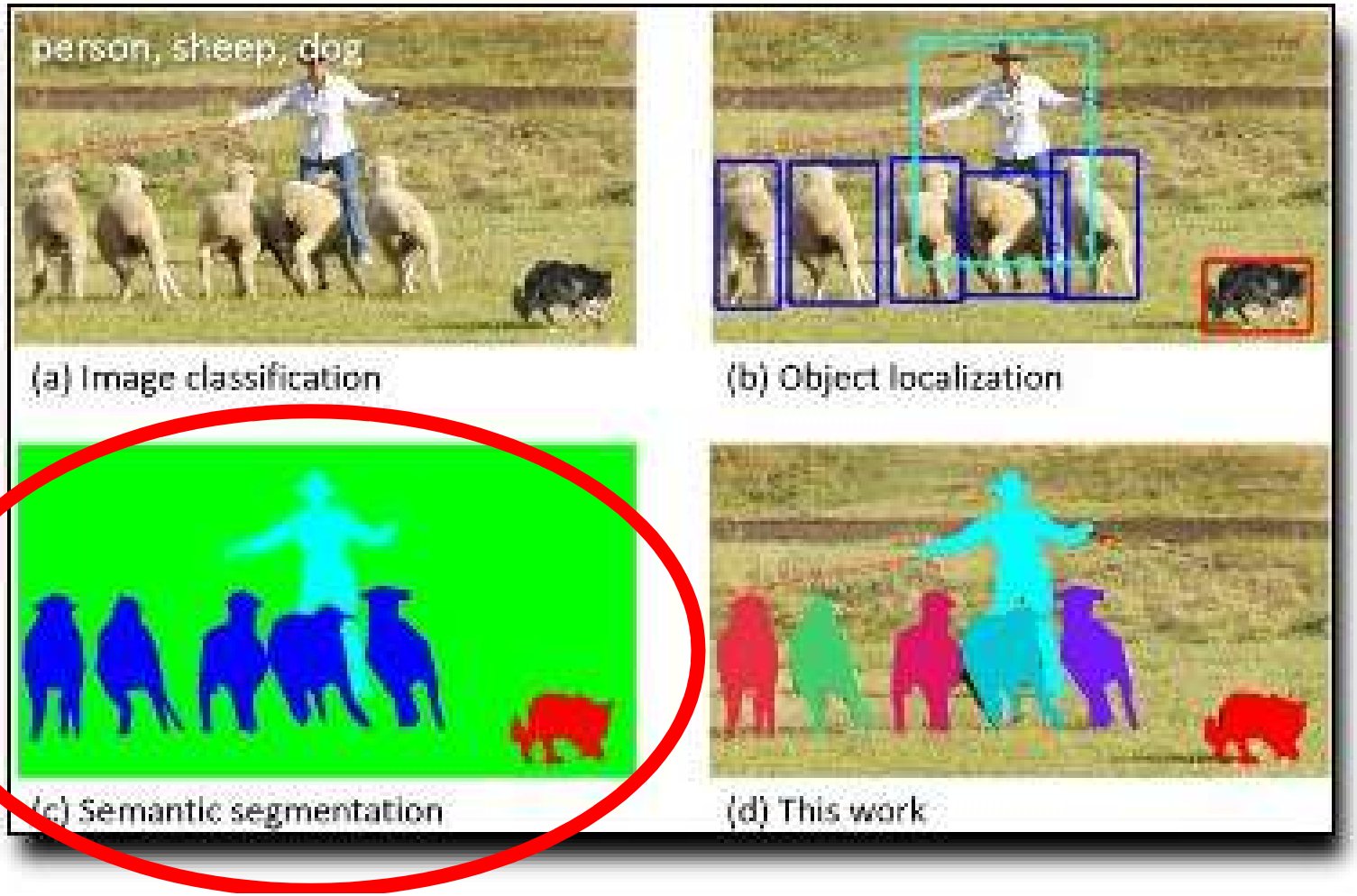
Automatic digitization

- **Wish = can we automate the digitization of polygons?**
  → Technical term: Semantic segmentation



Automatic digitization

- **Aerial photos in Flanders:**
  - → Frequency:
    - × 1/year: winter photo for entire region
    - × 1/3 years: summer photo for entire region
  - → Accuracy: 0,25 meter/pixel
  - → RGB + NIR

Dream?

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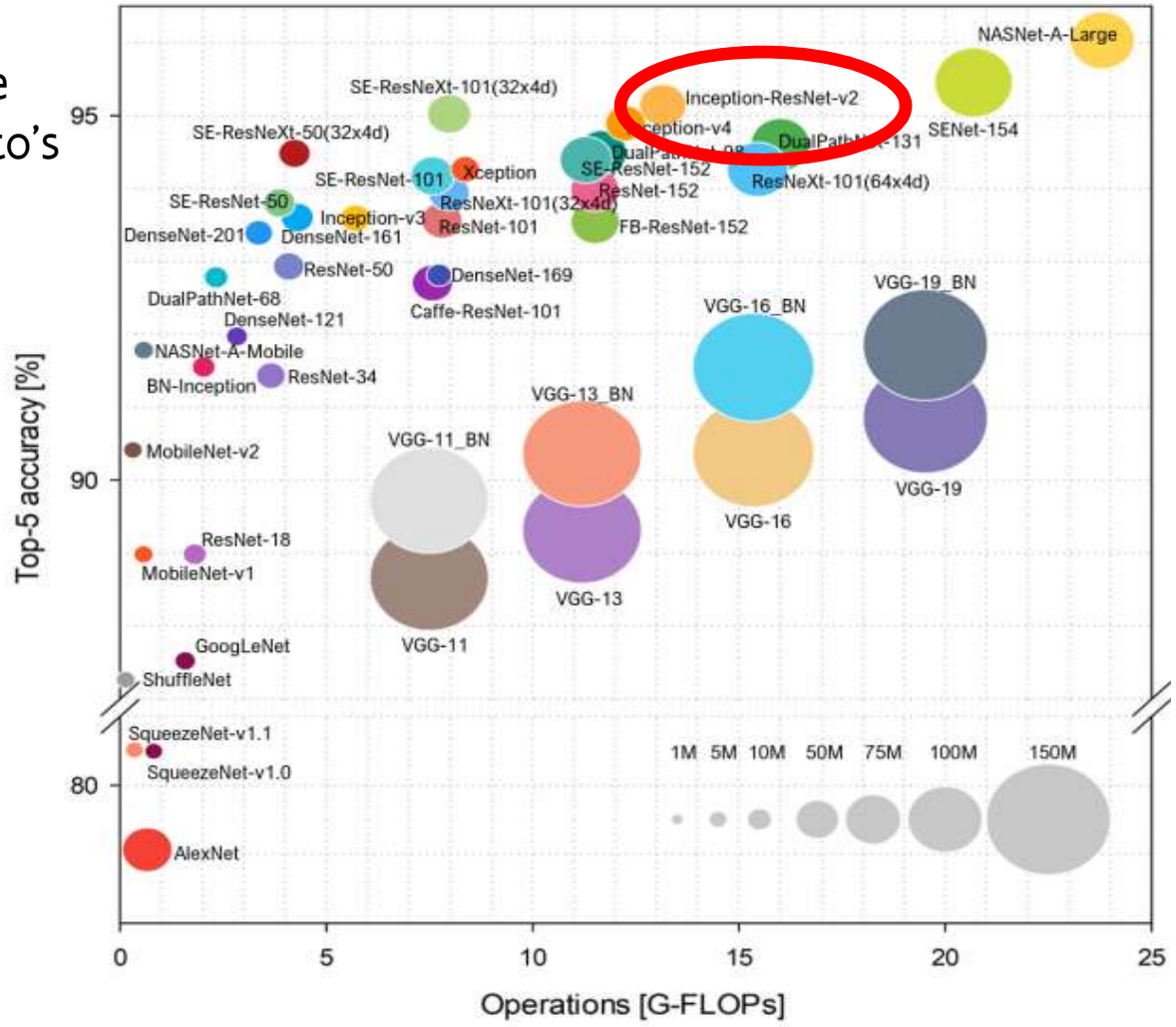
Automatic digitization

- **How? Convolutional Neural Network (CNN)**
  - → Inception-ResNet-v2 + unet
    - × High precision
    - × Pre-trained by google
      - → using > 1 mio photo's
    - × > 400 layers



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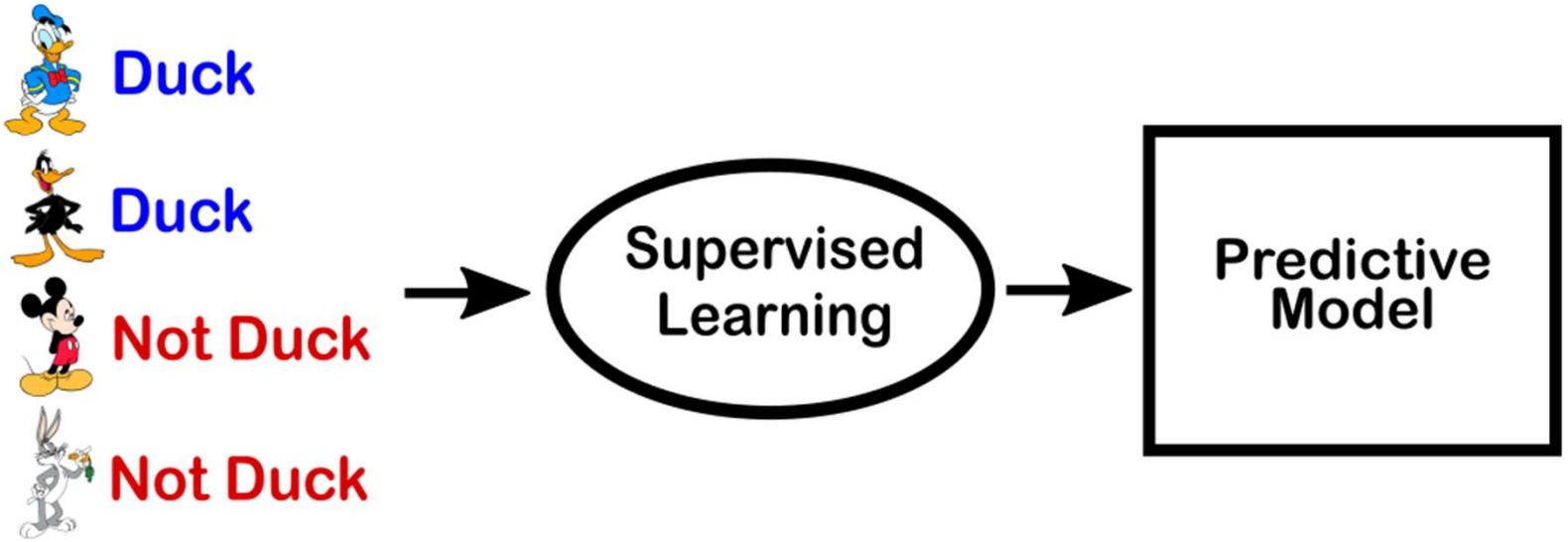
Automatic digitization

- **CNN = machine learning**
  → Training data necessary!



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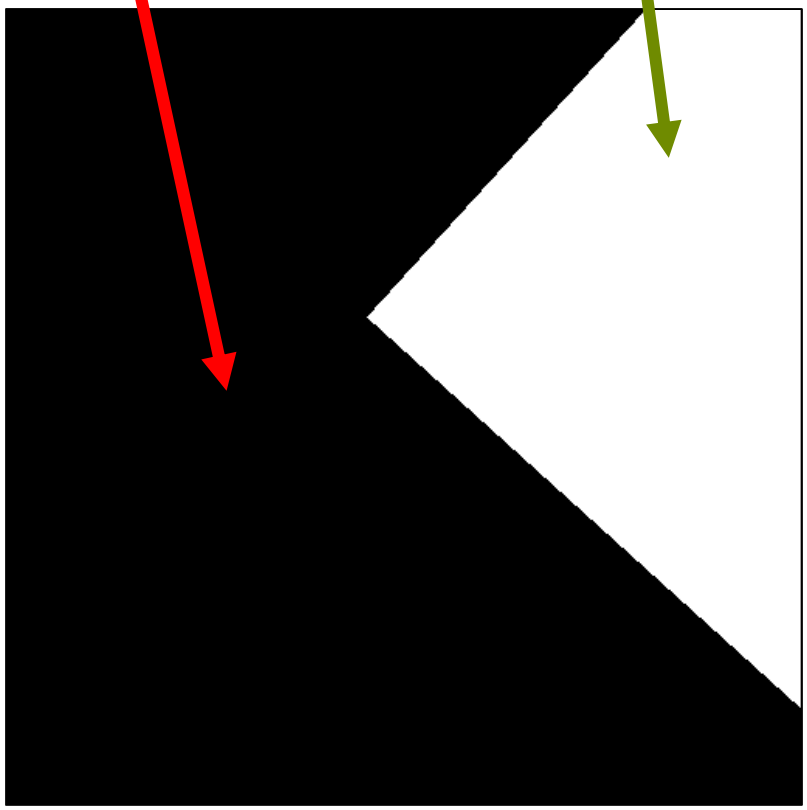
Automatic digitization

- **Training data**
  → iterative improvement!

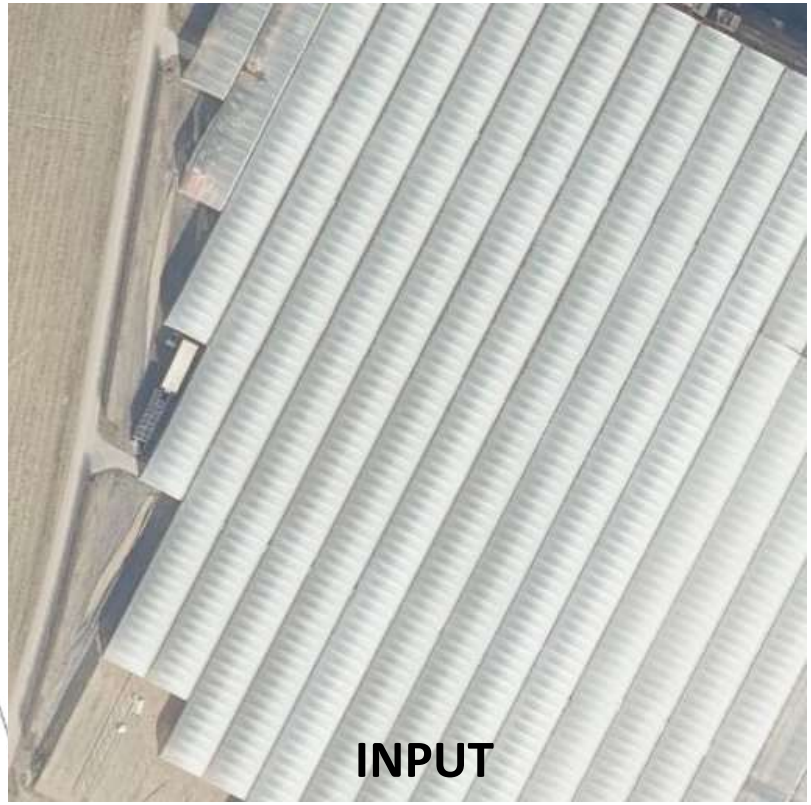
Automatic digitization

- **Add training examples**
  - → Initially: +- 100
    - × Aerial photo
    - × Mask: greenhouse <> no greenhouse

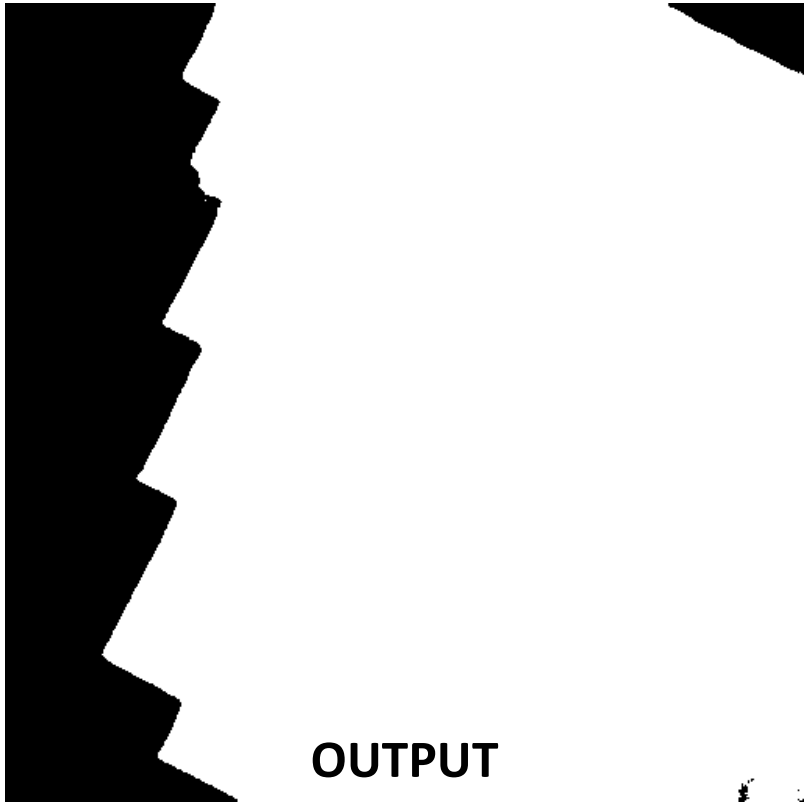


Automatic digitization

- **Predict**
  - → Random test set in first iterations
  - → Flanders (13.500 km^2)
    - × 220.000 tiles of 1152x1152 pixels
    - × 32 meters overlap (edge = less good prediction)



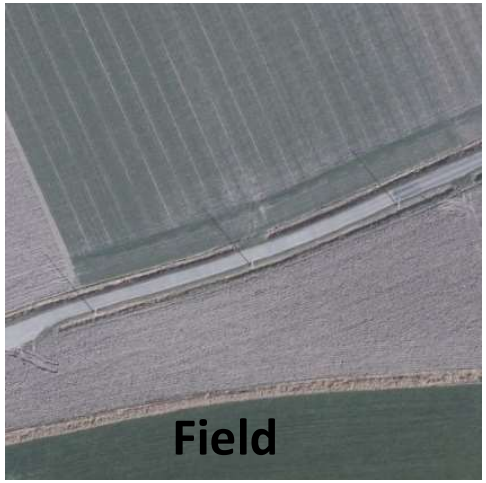
INPUT



OUTPUT

Automatic digitization

- **Find false positives**
  - → = algorithm sees greenhouse incorrectly!
  - → +- 300 added



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Automatic digitization

- **Find false negatives**
  - → = algorithm doesn't detect some greenhouses
  - → +- 100 specific/rare types of greenhouse added

Royal greenhouses

Missing plastic

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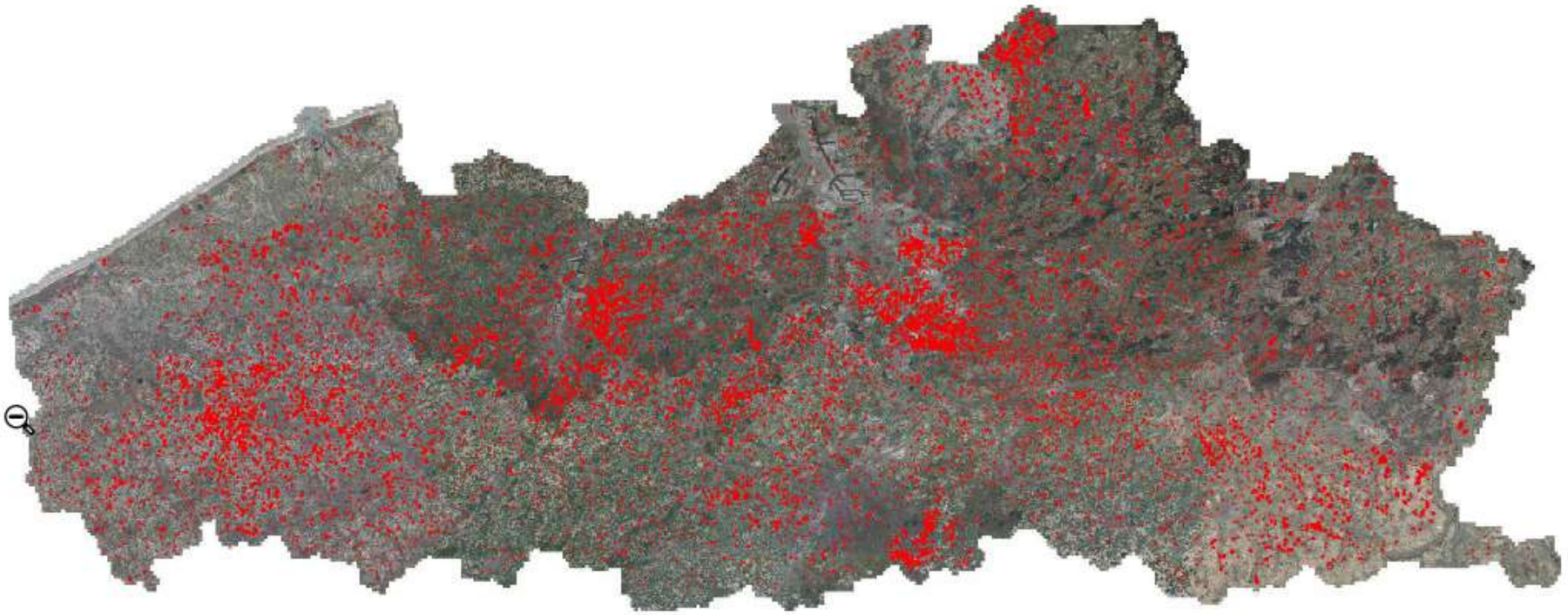
Automatic digitization

- **Greenhouses results**
  - → training dataset: +- 550 images, in 29 iterations
  - → 18.098 found
  - → 99,92% of declared permanent greenhouses detected



Automatic digitization

- **Greenhouses – examples**
  → Permanent greenhouses

Automatic digitization

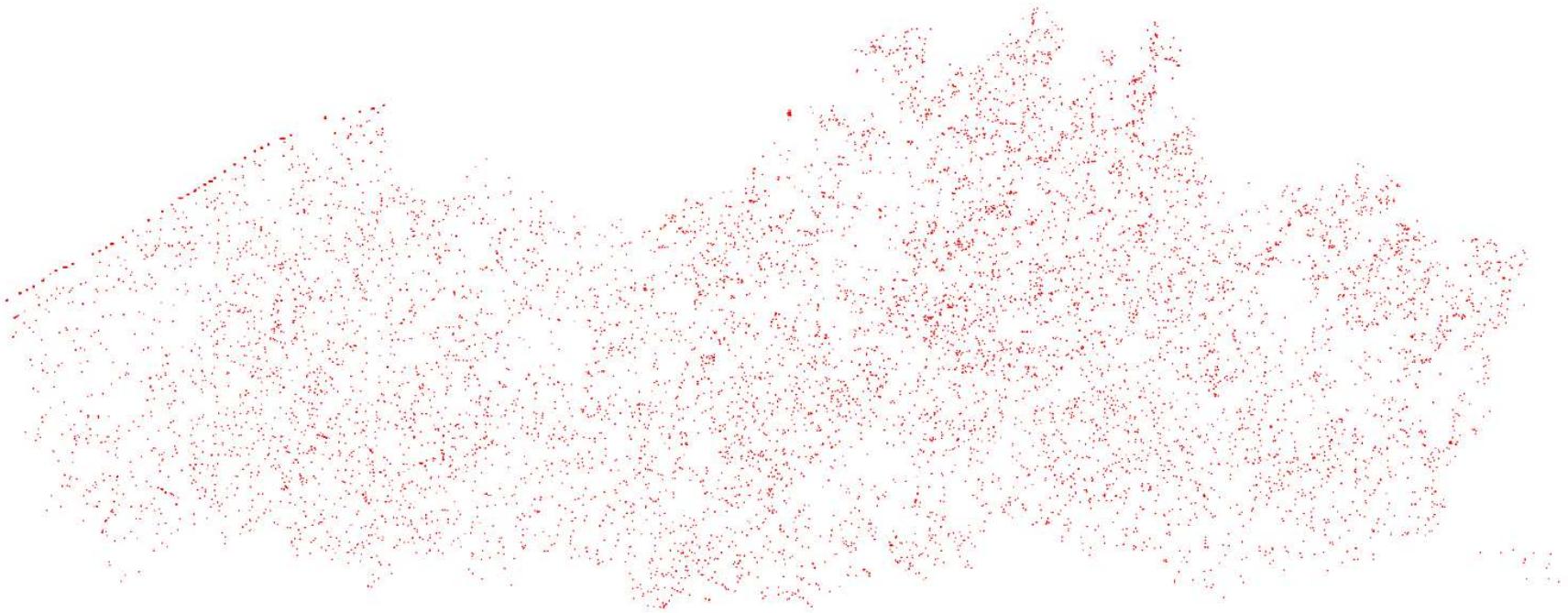
- **Greenhouses – examples**
  → "Temporary" greenhouses

Automatic digitization

- **Greenhouses – examples**
  → Small greenhouses (some still missing)

Automatic digitization

- **Horse tracks**
  - → Training dataset: 350 examples, in 20 iterations
    - × Can still be improved, results not yet as good as greenhouses
  - → 13.002 found
  - → Used in LPIS update 2018
    - × 1336 horse tracks overlapped with LPIS parcels



Automatic digitization

- **Horse tracks - examples**

Automatic digitization

- **Horse tracks - examples**

Automatic digitization

- **Horse tracks - examples**

Automatic digitization

- **Sealed surfaces**
  - → Training dataset: 30 examples, in 3 iterations
    - × Just started on creating training dataset
  - → First results look promising

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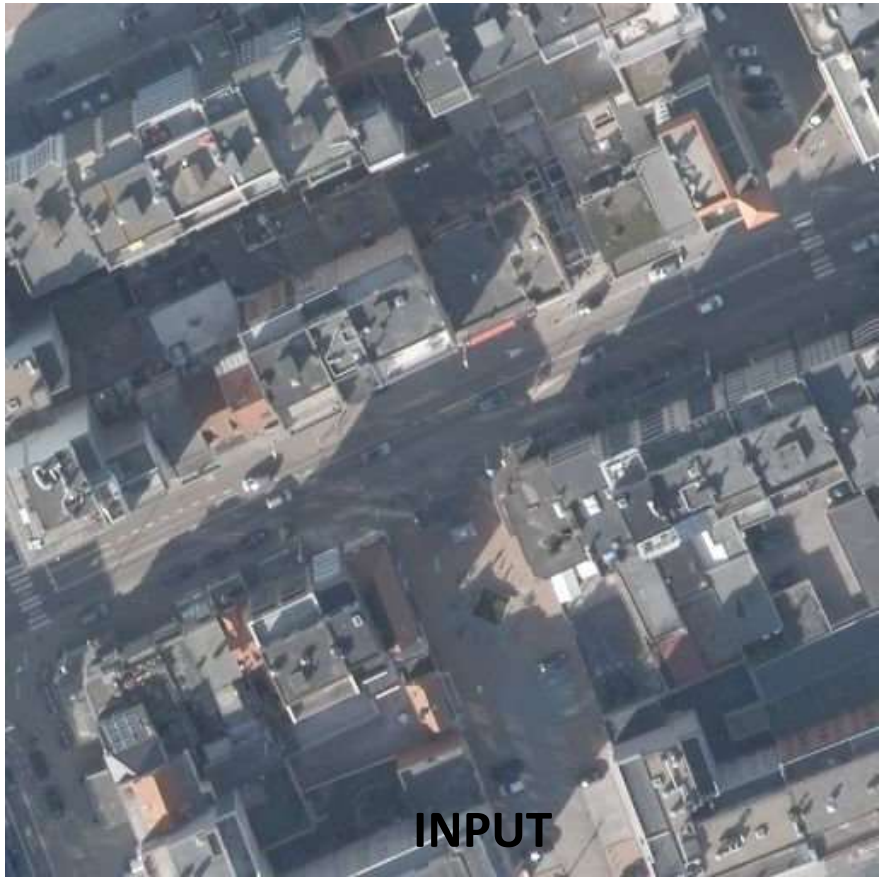
- **Sealed surfaces – examples**
  - → Urban area
    - × 100% sealed surface (= white)

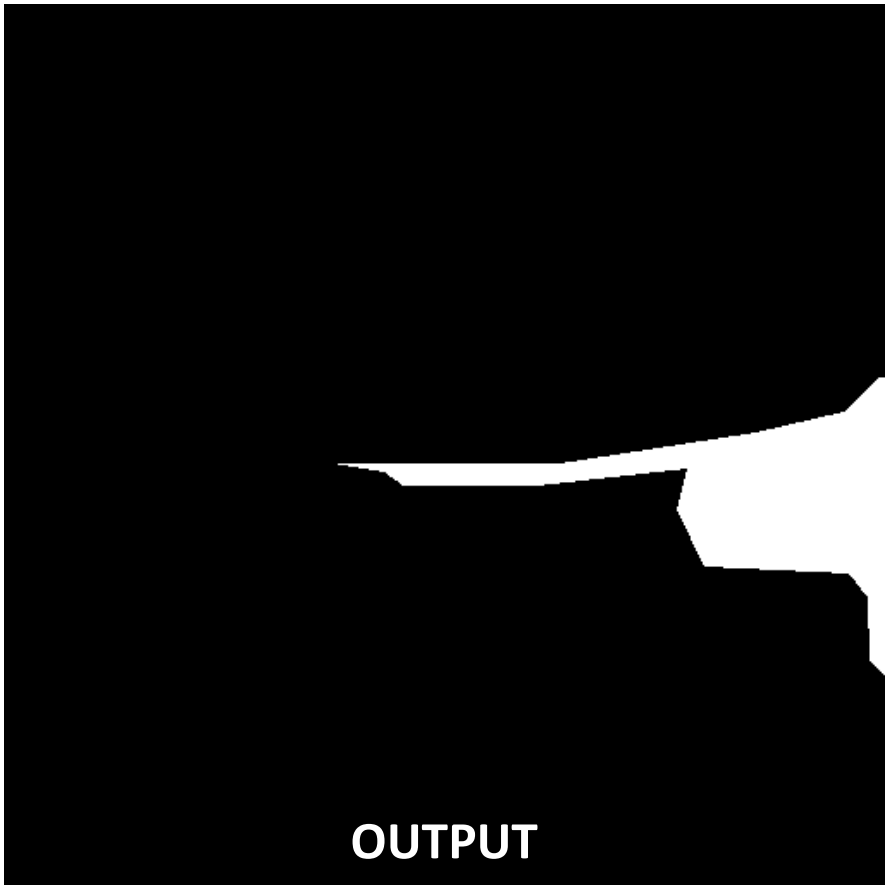


INPUT

OUTPUT

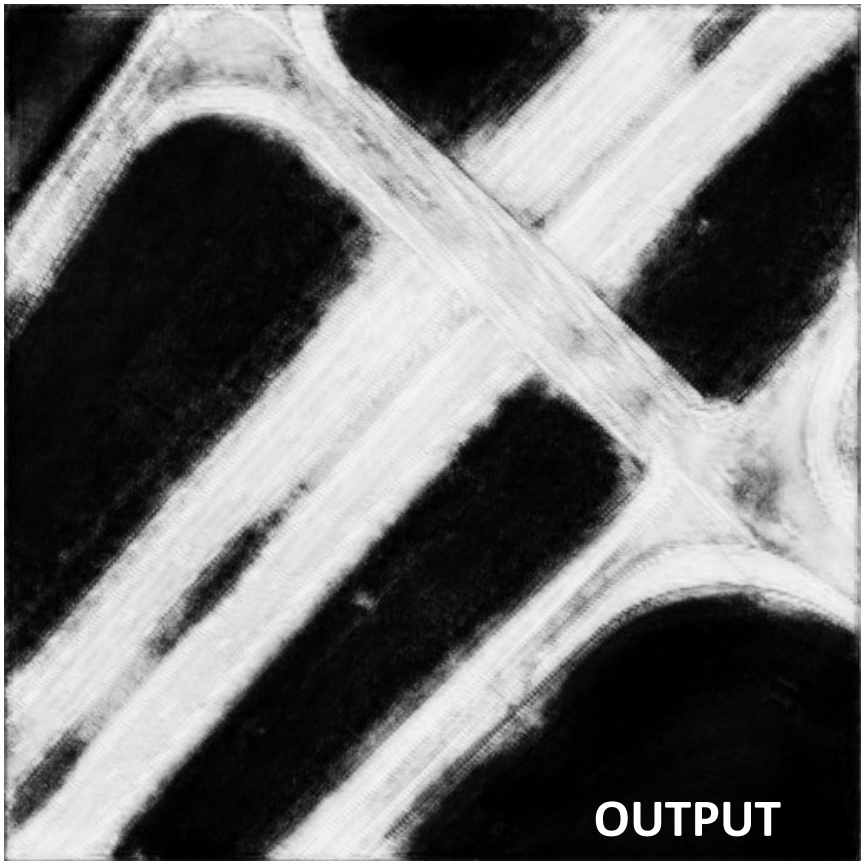
Automatic digitization

- **Sealed surfaces – examples**
  → Road + house + terrace + driveway



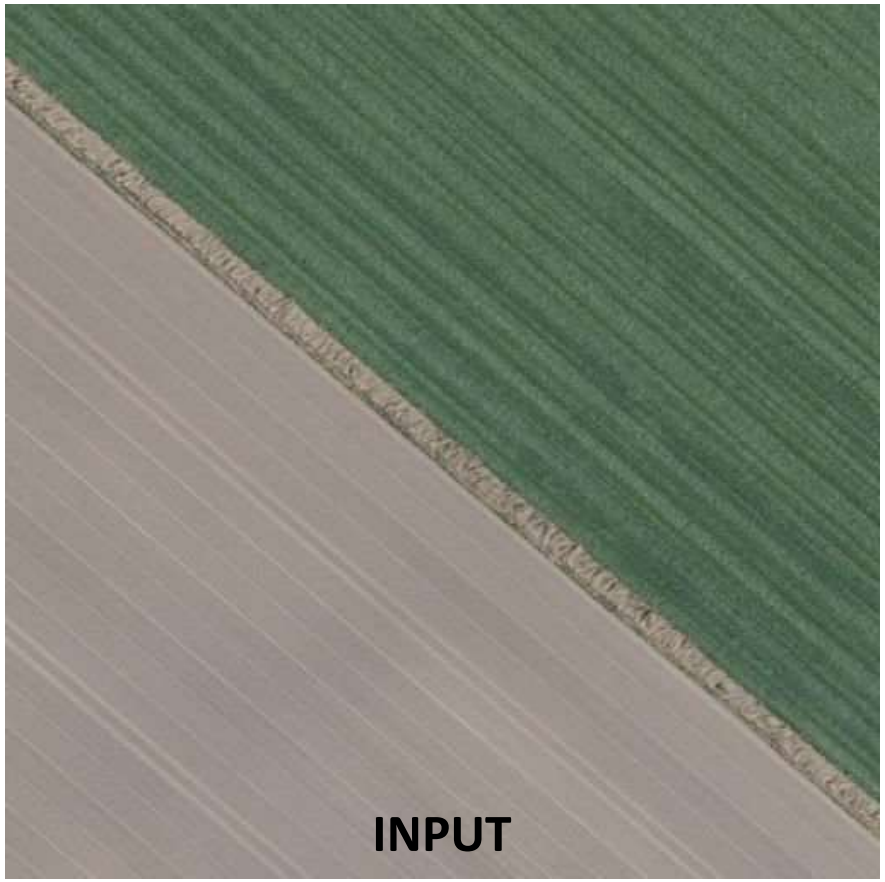
Automatic digitization

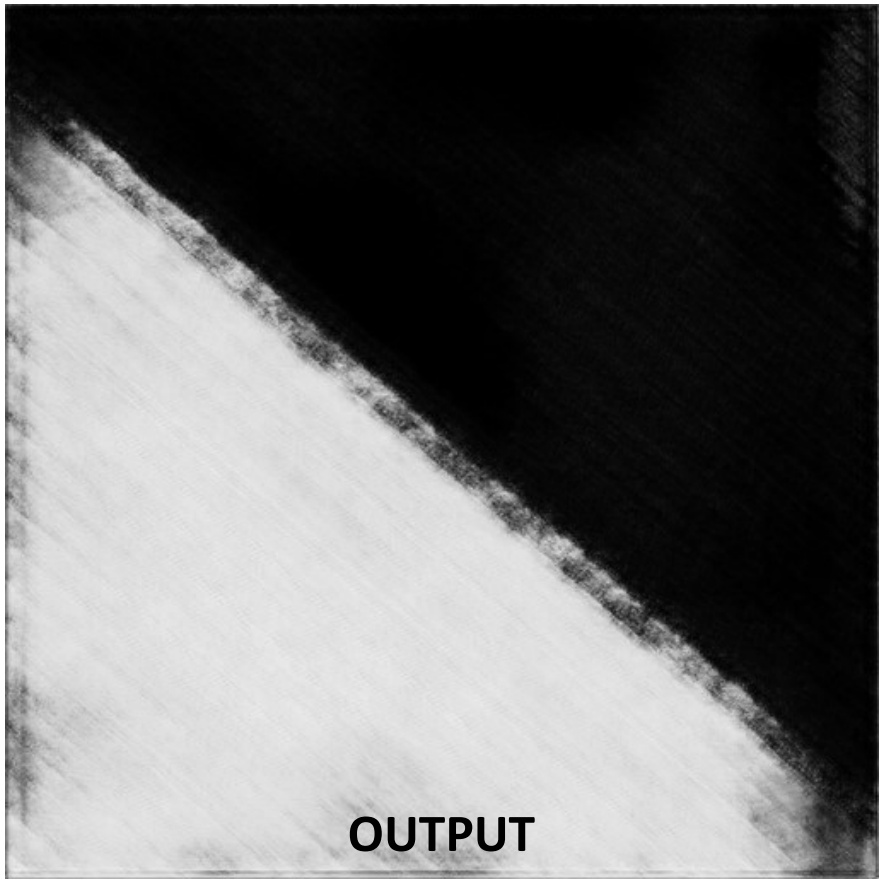
- **Sealed surfaces – examples**
  → Highway



Automatic digitization

- **Sealed surfaces – examples**
  - → Ploughed field ☹... -> false positive!
    - × Add to training dataset





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Technology used

- **Only free/open source software**
  - → Keras/Tensorflow
  - → Python
    - × Rasterio
    - × Geopandas
    - × ….
  - → QGIS (to digitize training data)

- **Hardware**
  - → Standard PC
    - × mid-range GPU (Nvidia Quadro 5000)
    - × 20 hours for Flanders (13.500 km^2)
  - → For larger areas -> cloud?

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Conclusions

- **LPIS update**
  - → Very detailed risk analysis -> automatic cutout?
  - → In future:
    - × Trees/forests
    - × Water surfaces
    - × Recreation (football fields, tennis courts,…)
    - × …
- **Monitoring**
  - → Follow up of permanent land uses
    - × Fruit trees
    - × Grassland: detect encroachment (bushes,…)
    - × Greenhouses
    - × Christmas trees (= ineligible)
    - × …

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Conclusions

- **Swiss knife: many other uses as well!**
  - → Support policy choices
    - × Support cogeneration of electricity + heating for greenhouses
    - × Monitor the “horsification” of Flanders
    - × …
  - → Interest from/for many other agencies…
    - × Sealed surface map
    - × Forest/trees map
    - × …

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Questions?

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