Rebuilding the cadastral map of the Netherlands:

the Artificial Intelligence solution

FIG 2021 Online Conference

Jeroen Franken (Sioux Technologies),
Wim Florijn, Maarten Hoekstra, Eric Hagemans (Kadaster)

Jeroen.Franken@sioux.eu

May 2021
Approach: from field sketches to updated cadastral map

See also:
Hagemans et al.: Rebuilding the Cadastral Map of the Netherlands, the Overall Concept
Van den Heuvel et al.: Rebuilding the Cadastral Map of the Netherlands, the Geodetic Concept
Field Sketch Breakdown

(a) Line & points

(b) Measurement

(c) Parcel number

(d) Building

(e) Symbol

5 million sketches
VeCToR pipeline

Algorithm

Pre-processing

Detection

Interpretation

Deduction

Positioning and Linking

Human Validation
VeCToR: AI components

Detect (dashed) lines and points

Detect Buildings

Combine two scans

Removing JPG artifacts

Localize measurements

Read handwriting

27.82
VeCToR: Detect lines

1. Variants

- Normal line
- Building line
- New border

2. Solution

- Multi-label segmentation: predict pixels belonging to class
- U-NET based on Efficientnet-B5 architecture
- LSD and RANSAC are used to construct lines out of pixels
- Performance: pixel-wise F-score of 0.85
VeCToR: Detect objects

1. Object Variants
   - Measurement
   - Parcel number
   - Year, point number, etc

2. Solution
   - Instance segmentation: Find and classify objects
   - Mask-RCNN algorithm with multiple classes
   - Performance: object-wise F-score of 0.84
VeCToR: Optical character recognition

1. OCR: Textbox Variants
   - Measurement
   - Parcel
   - Year, point number

2. Solution
   - Neural Net with CNN / RNN layers and CTC loss
   - Performance: word-level F-score of 0.88

Prediction: 20.55↑

Prediction: 121.28↓
Positioning

1. Find the sketch location on map

- Parcel numbers indicate rough location
- Used data sources: historical borders (HPD) and building map (DKK)
- Search translations from rough location to data sources
Positioning

1. Hypothesis: Distance between sketch points ≈ distances between points on target map

- Select line segments from sketch, HPD en DKK
- Find all possible translations \([\Delta x, \Delta y, \phi]\) from location to sources.
- Cluster the possible translations (Nearest Neighbours)
- Biggest cluster of translations = optimal translation
- Performance: Accuracy of 52 – 87%
Conclusion

- AI components are used during vectorization, positioning and linking
- AI components serve to reduce the necessary human labour
- Due to the usage of Machine Learning, performance increases with more data (during production)
- Significant reduction in annotation work makes KKN feasible

Questions?
Rebuilding the Cadastral Map of The Netherlands

the Artificial Intelligence solution

Jeroen FRANKEN

Wim FLORIJN
Maarten HOEKSTRA
Eric HAGEMANS