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Geospatial Data Science Lab
UW-Madison

Towards Cartographic Knowledge Encoding with Deep Learning: A Case Study of Building Generalization

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Map Generalization

1:8,000

No map generalization

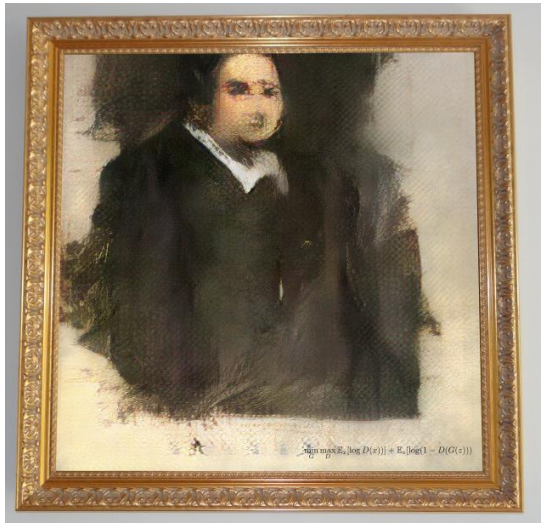
1:15,000

1:50,000

With map generalization

Map Generalization: the process of deriving smaller-scale maps from detailed maps that reduce the contents and complexity but retain the major semantic and structural characteristics for proper use.

Artificial Intelligence and Deep Learning



Painting created by AI.

Mona Lisa created by AI.

Drawing images by AI.

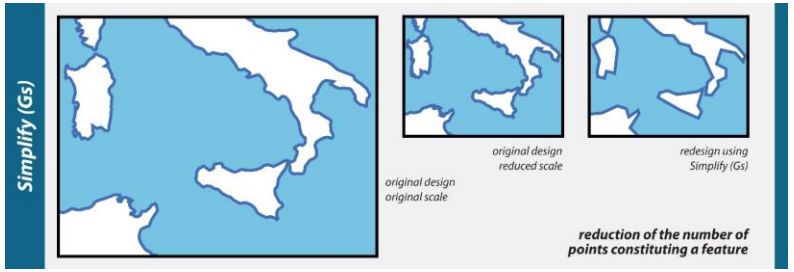
Motivations

Is it possible to introduce advanced deep learning methods into the understanding map generalization?

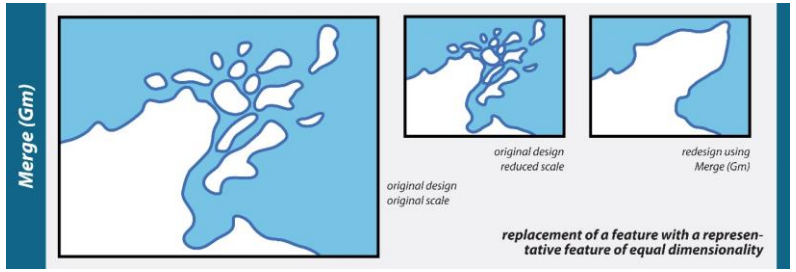
If so, how to encode cartographic knowledge into deep learning models?

Encoding Cartographic Knowledge

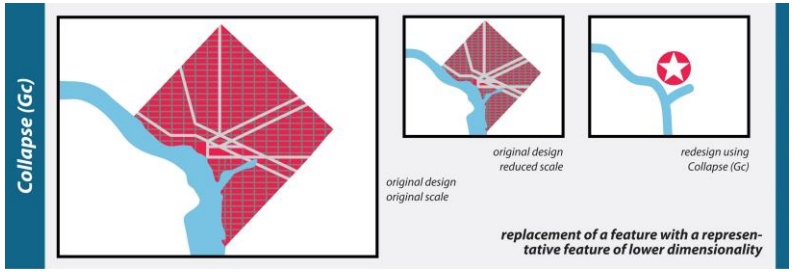
Simplification



Aggregation



Delineation



- Cartographers have designed a set of rules for different map generalization operators relying on cartographic knowledge and principles, such as distance, minimum area, direction, convex hull.
- How to encode these cartographic knowledge into the deep learning models?

Research Questions

A research framework is first proposed for:
(1) map data collection, (2) map data processing and handling,
(3) deep learning model training and testing.

Research Question

Can deep learning help automate the process of **map generalization**?
If so, what generalization operations can be learned and what cartographic knowledge can be encoded?

Data Collection

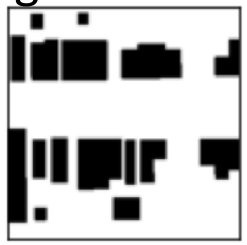
TOP10NL Dataset

ArcGIS

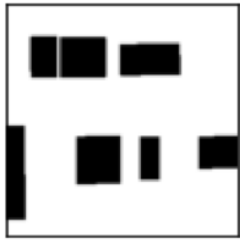
Cartography Toolbox

Building Simplification

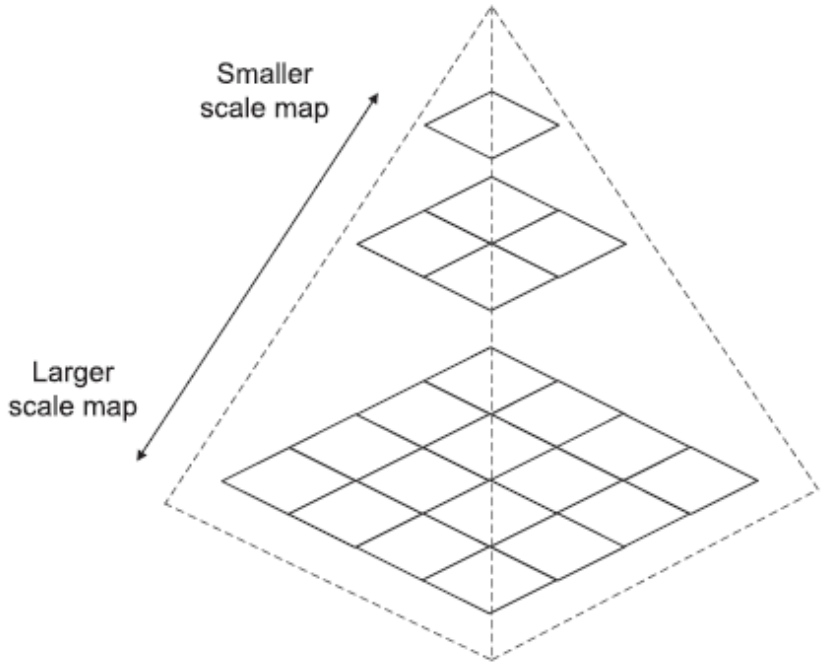
Original Dataset



Generalized Dataset



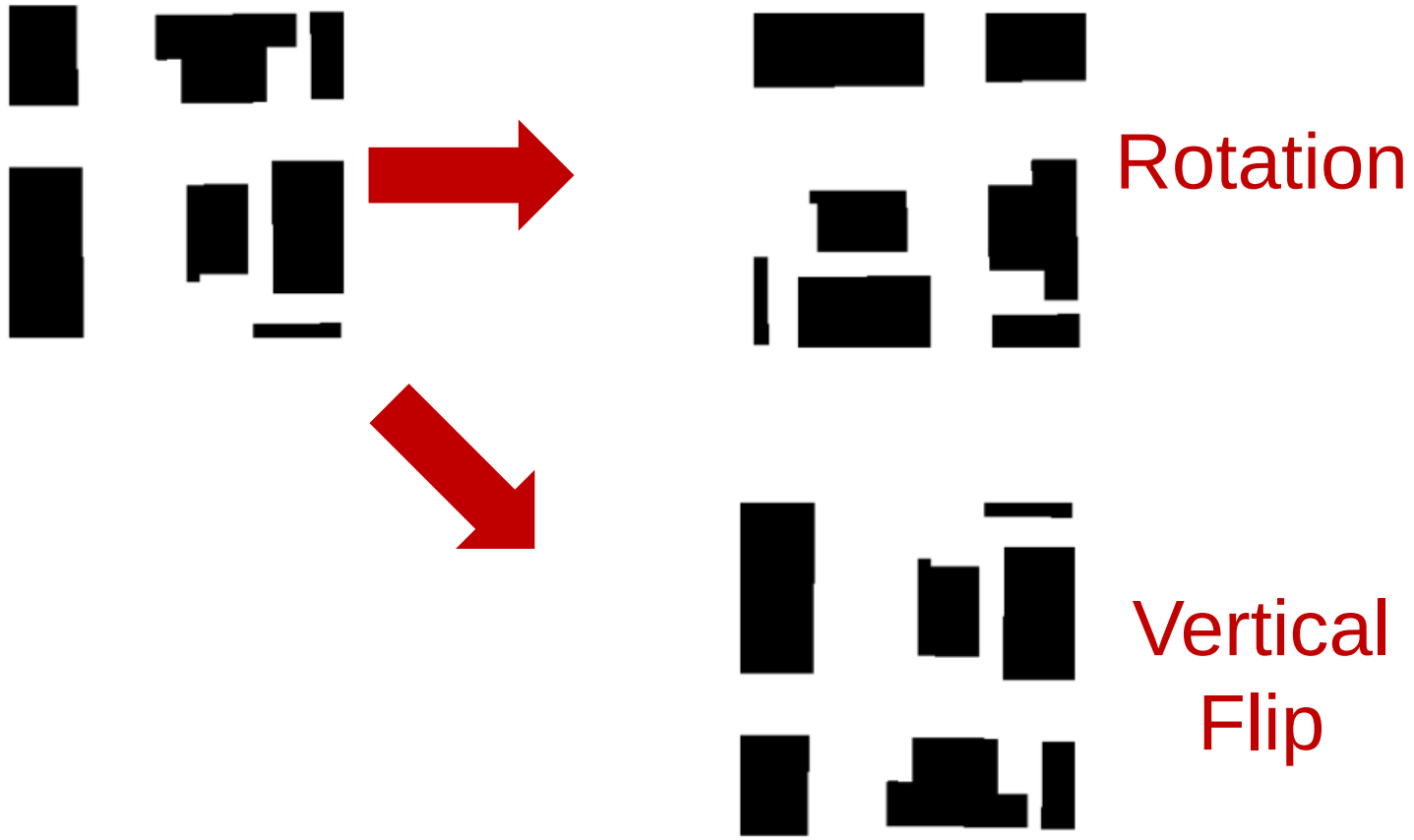
Data Processing



Tiled map services

Vector → **Raster**

Binary Image



Rotation

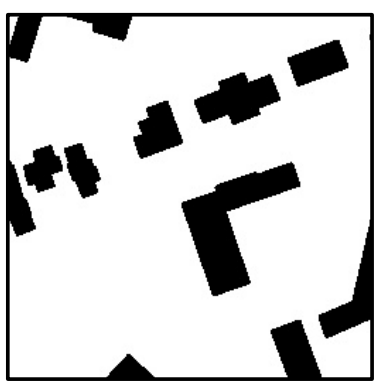
Vertical Flip

Image Processing

Model Training: Generative Adversarial Networks (GANs)

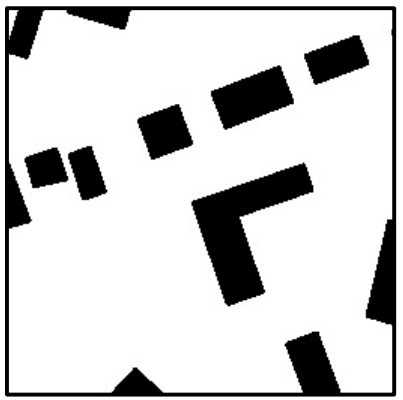
Dataset → **Generator** → **Discriminator**

Input dataset. → Generate fake images → Judge whether the image is real or fake



Original Dataset

Transfer styled maps

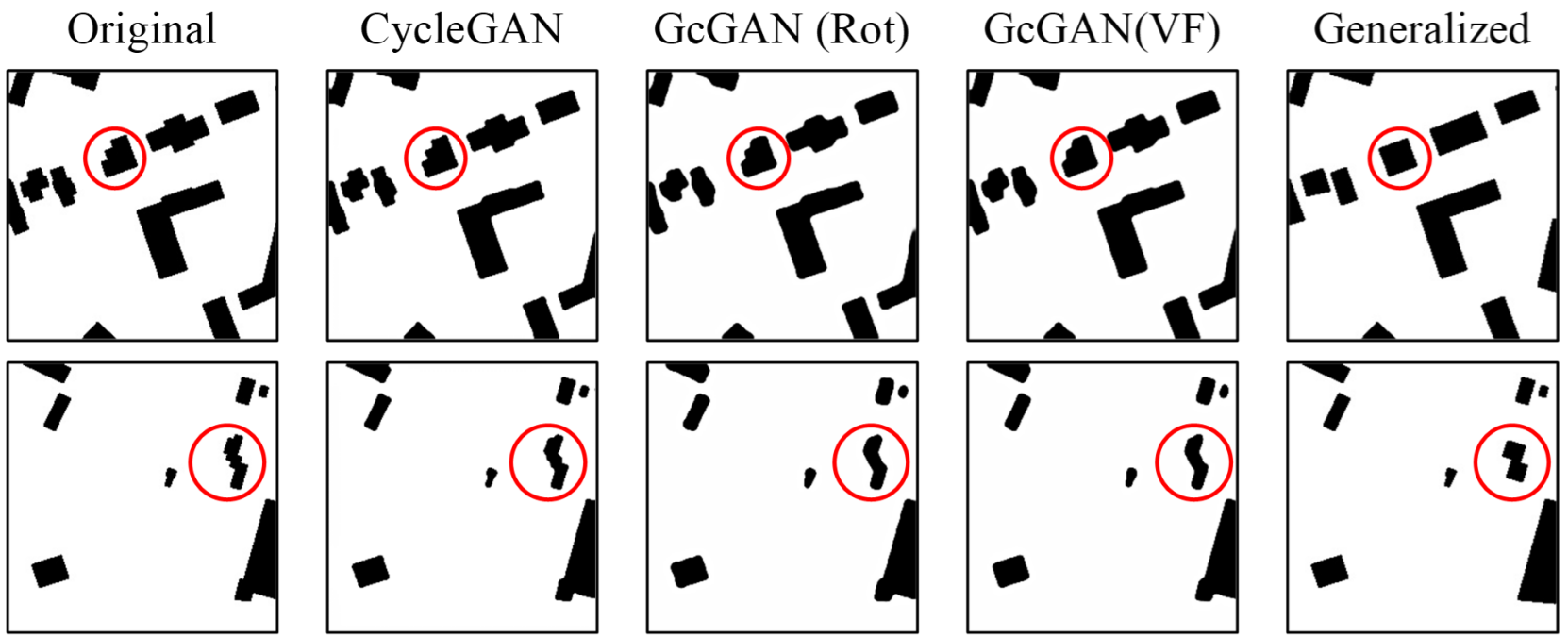


Generalized Dataset

GCGAN

Geometry-Consistent Generative Adversarial Networks

Building Simplification



GcGANs with cartographic knowledge encoded tried to smooth the boundaries and fill in corners of buildings which performs better than CycleGAN without cartographic knowledge encoded.

Conclusion

1 This work proposes a framework integrating artificial intelligence in map generalization.

2 This work illustrates how artificial intelligence can be used for building simplification.

3 This work presents how cartographic knowledge can be encoded for **map generalization**.

Limitation and Future Work

01

- Only **raster-based data** is taken into consideration.
- **Vector data** will be tested in future.

02

- Only **limited** and **shallow** cartographic knowledge is encoded in this work.
- **More** cartographic principles might be encoded in future.

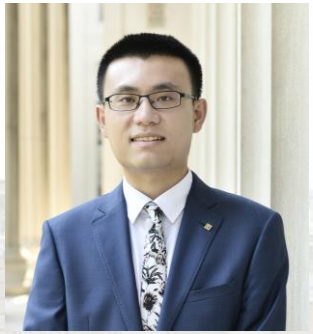
03

- Only building simplification is explored.
- More operators of map generalization can be explored in future.

Acknowledgement

Support for this research was provided by the University of Wisconsin-Madison Office of the Vice Chancellor for Research and Graduate Education with funding from the Wisconsin Alumni Research Foundation. This research was also supported by the Trewartha Graduate Research Awards.

The end



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