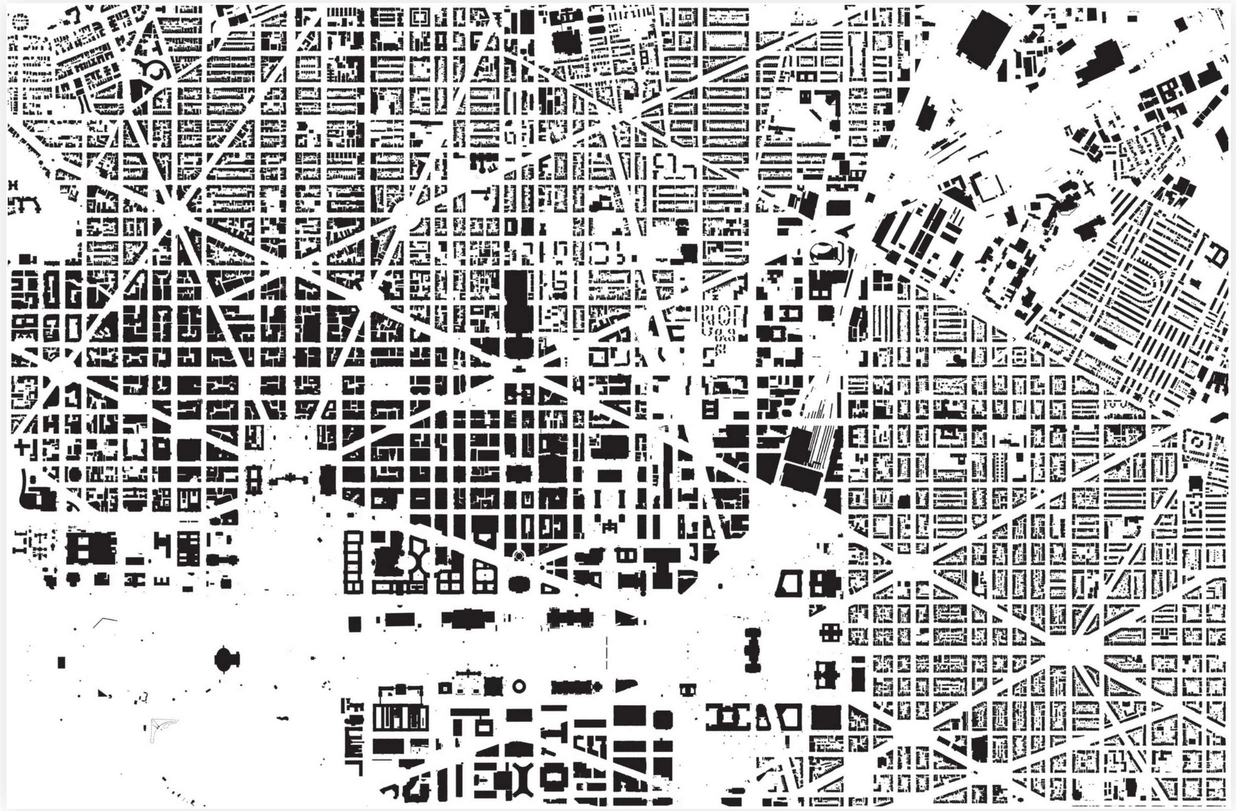
Using deep learning to identify (urban) form and function in satellite imagery - the case of Great Britain

Martin Fleischmann
Dani Arribas-Bel

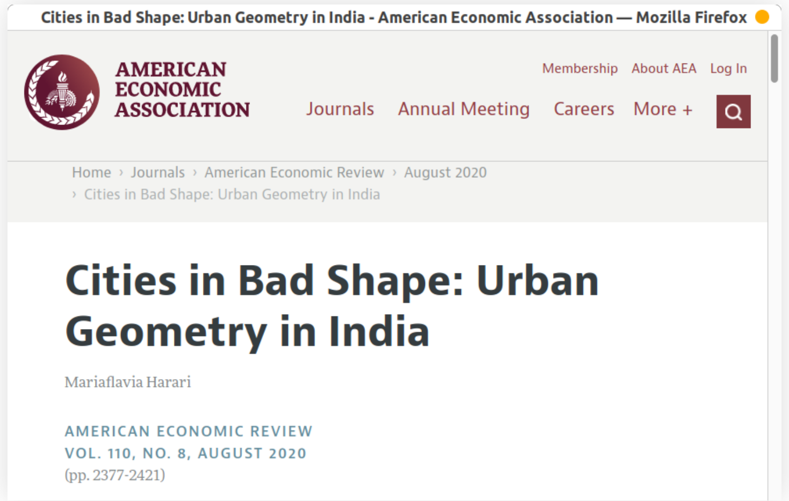
University of Liverpool
The Alan Turing Institute
Geographic Data Science Lab

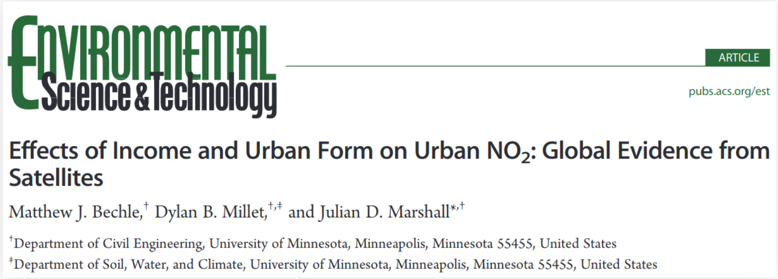
How we arrange "stuff" in cities matters…

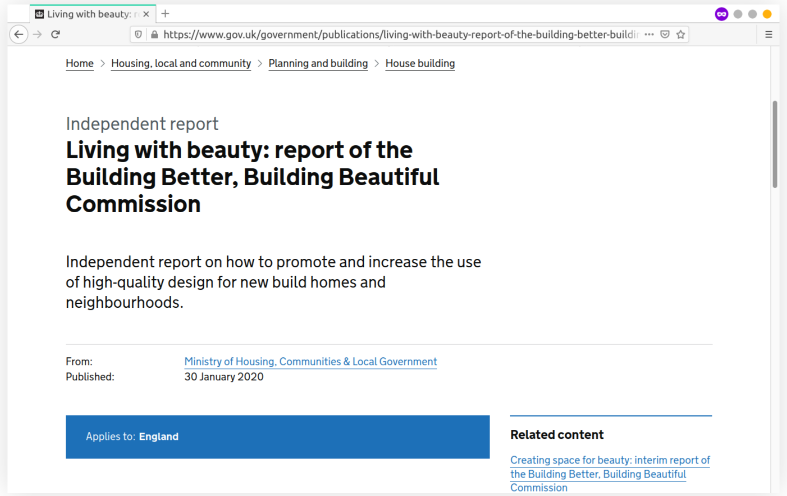


Source: *A map of every building in America* (New York Times)

… it matters *a lot*







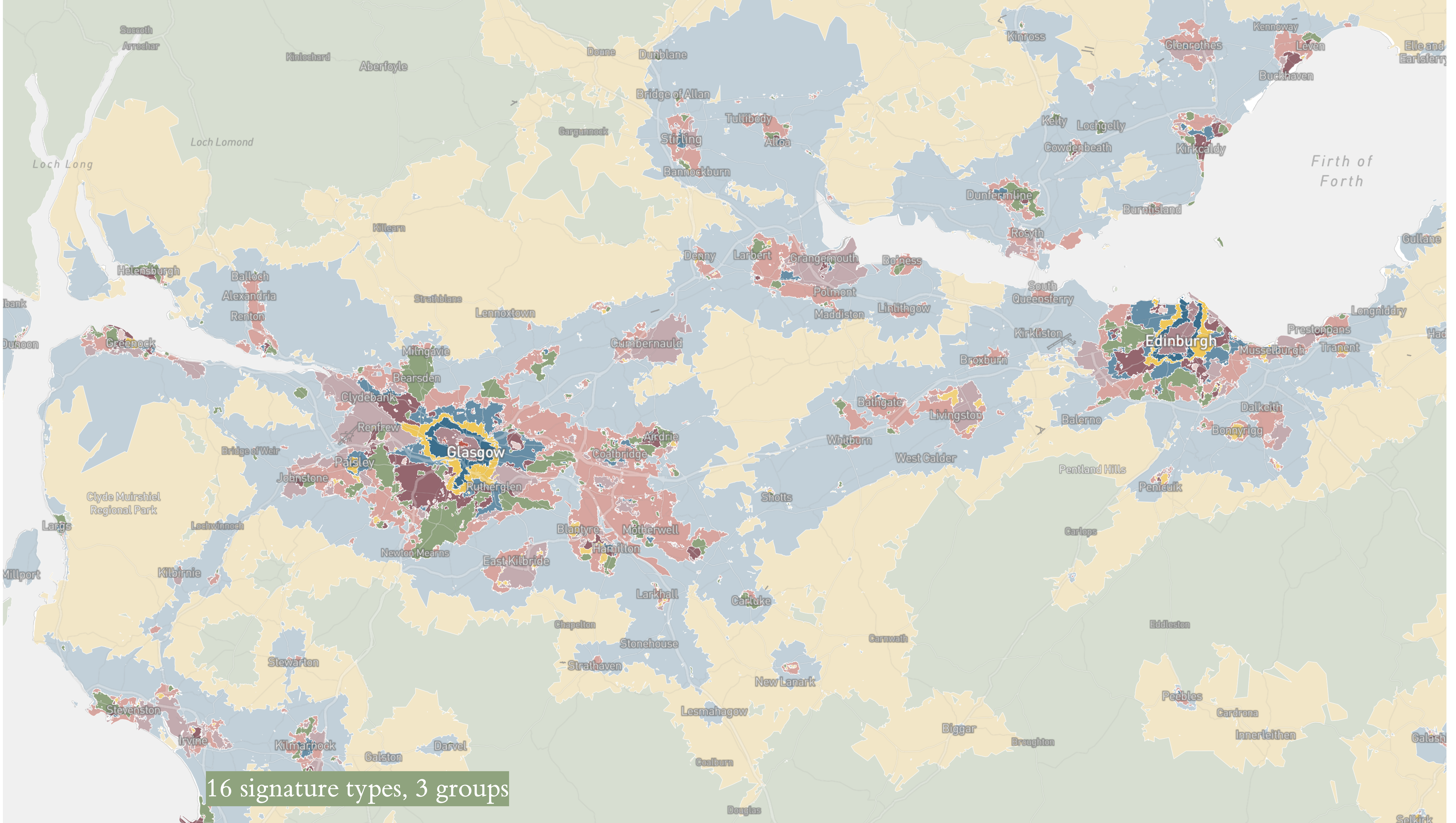
Spatial Signatures

A characterisation of space based on form and function designed to understand urban environments

A characterisation of space based on form and function designed to understand urban environments

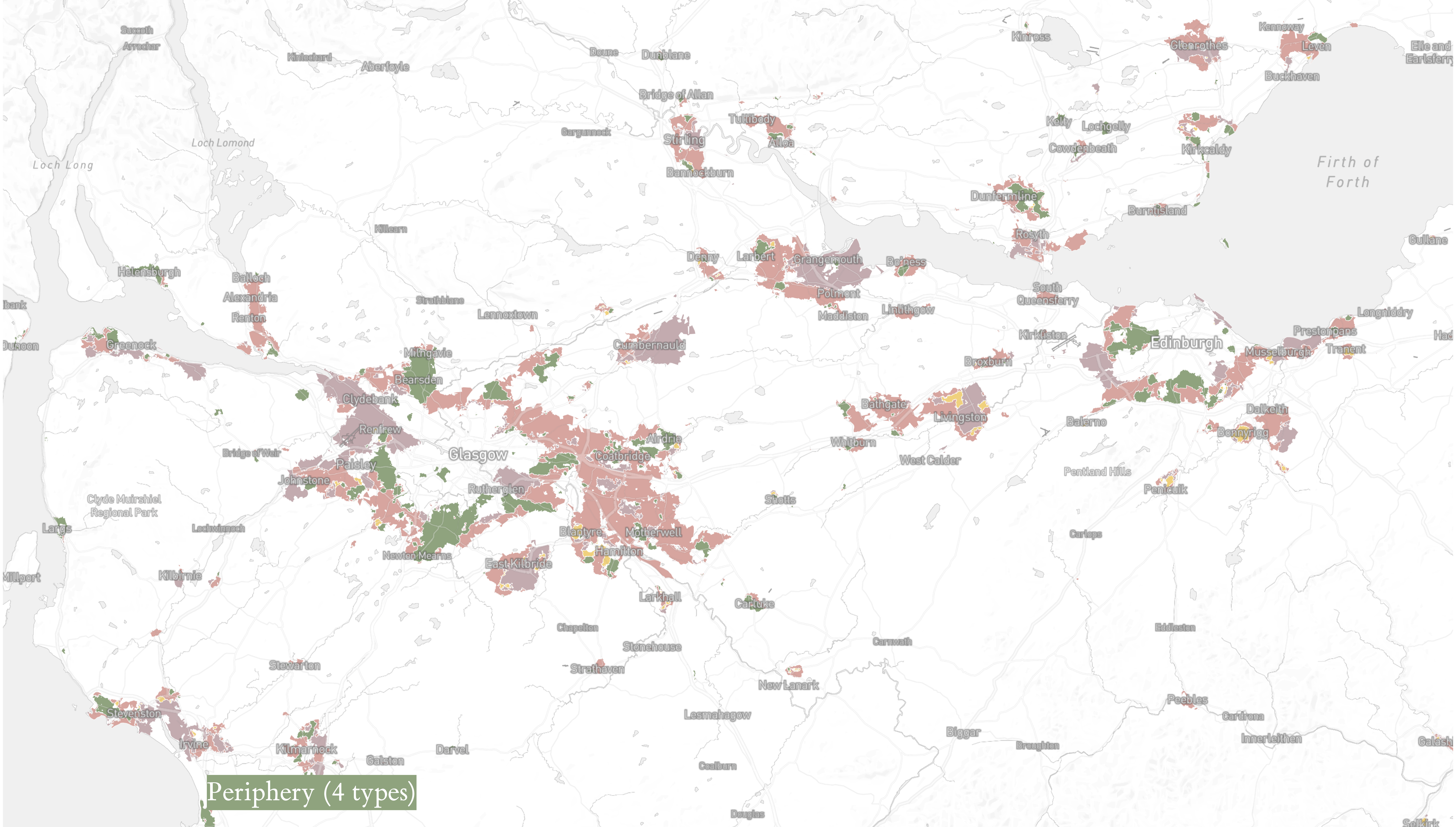
A characterisation of space based on form and function designed to understand urban environments

A characterisation of space based on form and function designed to understand urban environments

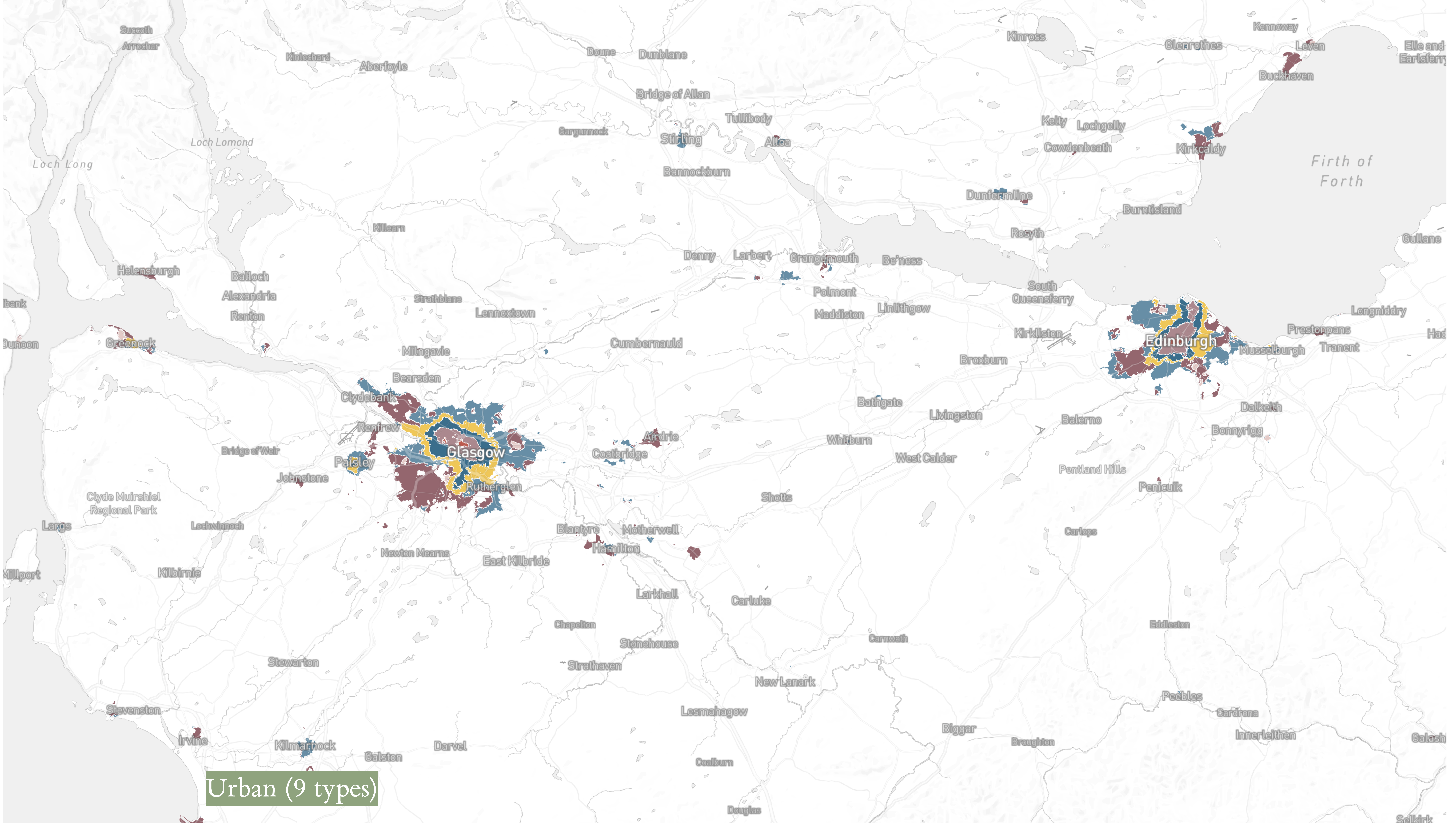


16 signature types, 3 groups

Countryside (3 types)



Periphery (4 types)



Urban (9 types)

The issue

Data

Form

- OS OpenMap
- OS OpenRoads

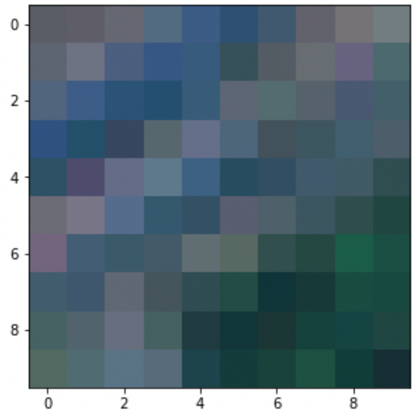
Function

- (Business) Census
- OpenStreetMap
- Geolytix
- Listed buildings
- CDRC
- CORINE / Sentinel 2
- VIIRS

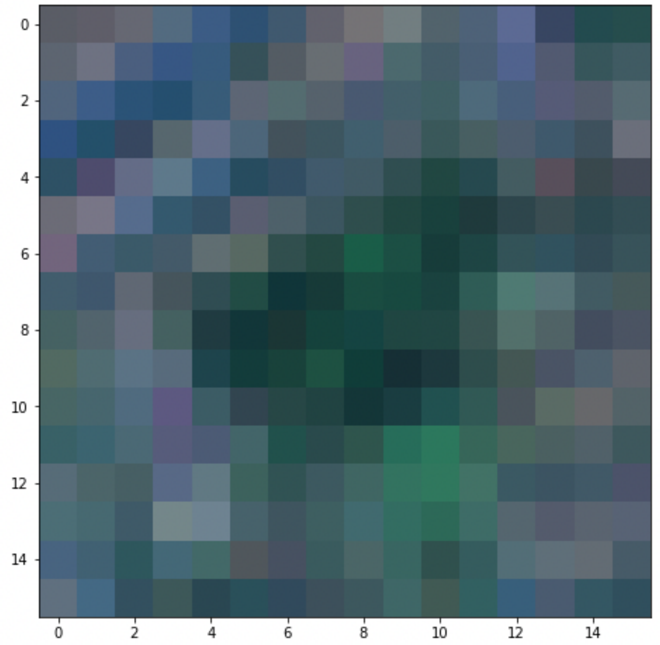
Possible solution?

Sentinel 2

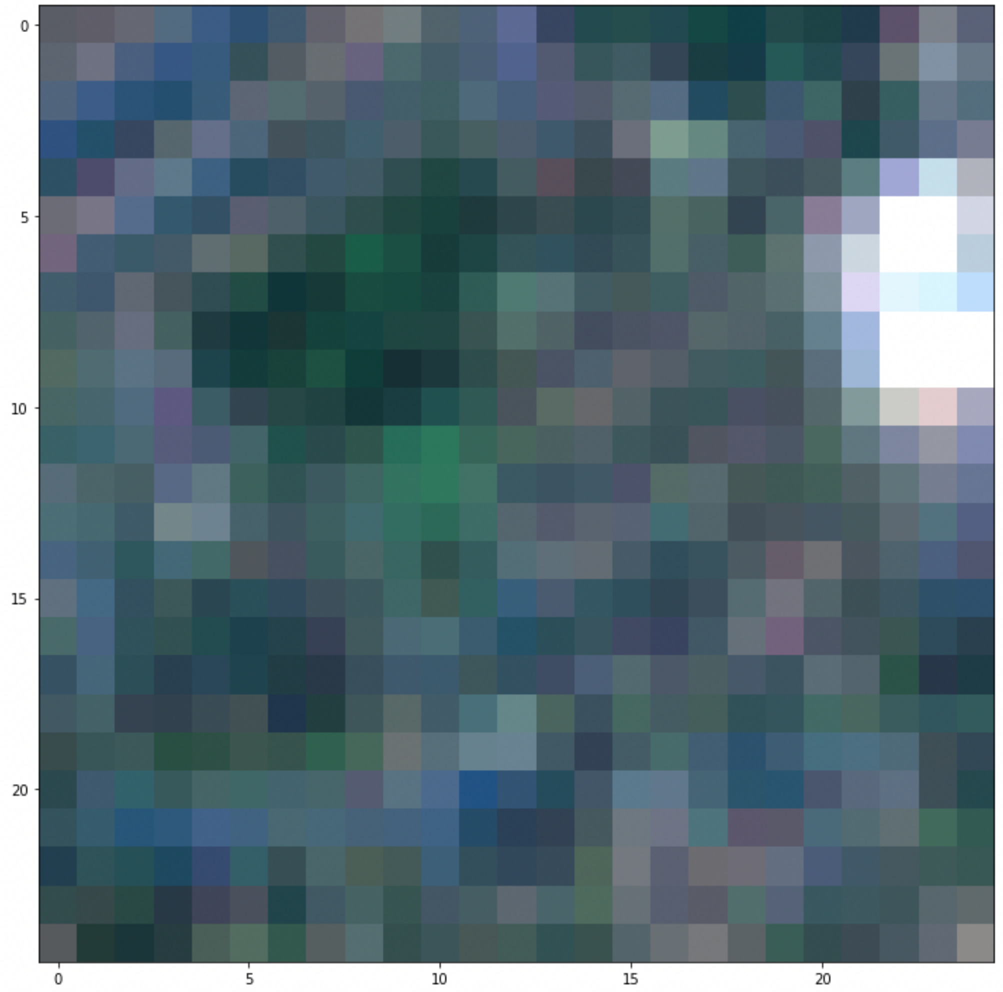
100x100



160x160



250x250



What do we want to do?

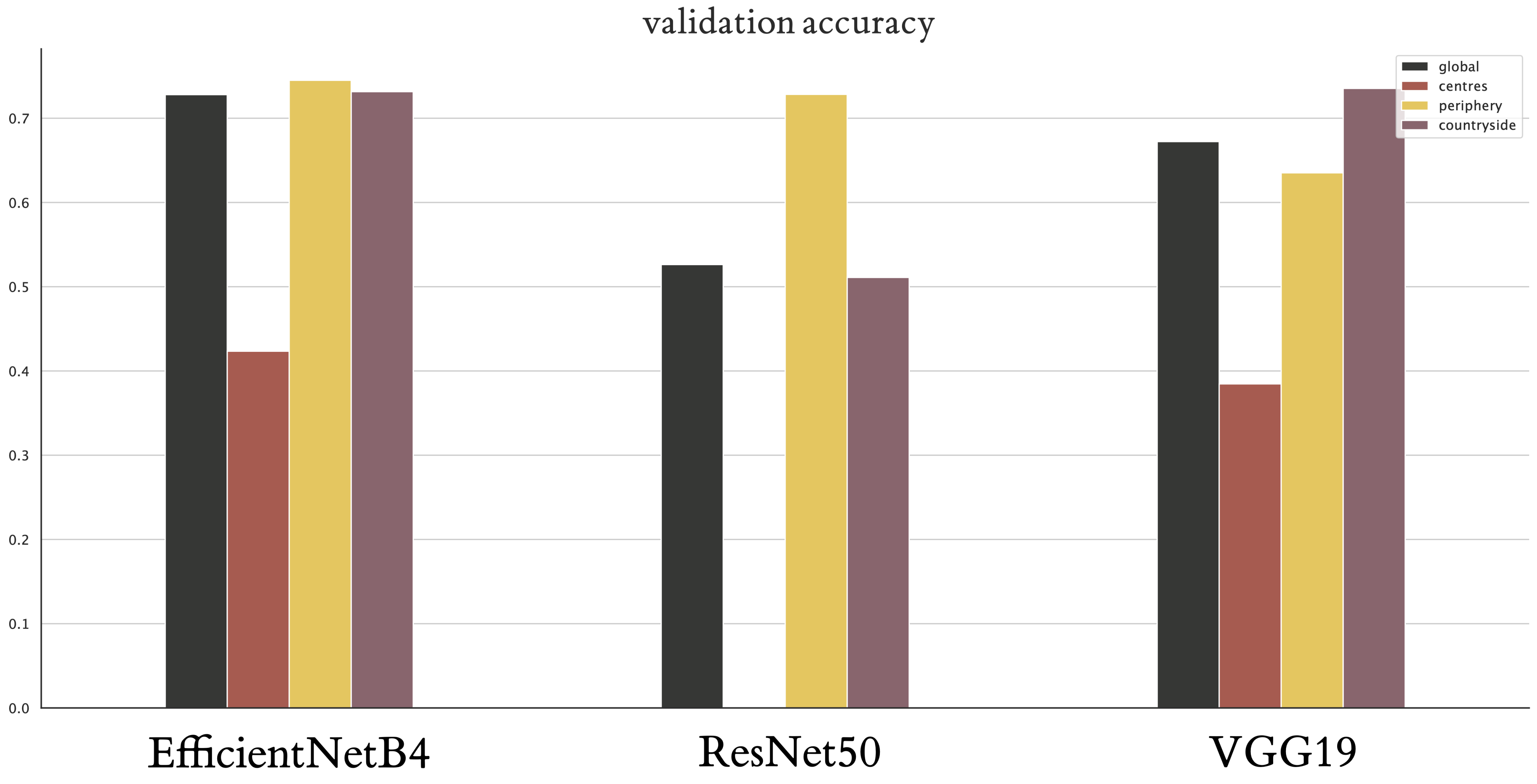
train a neural network

understand the role of geography

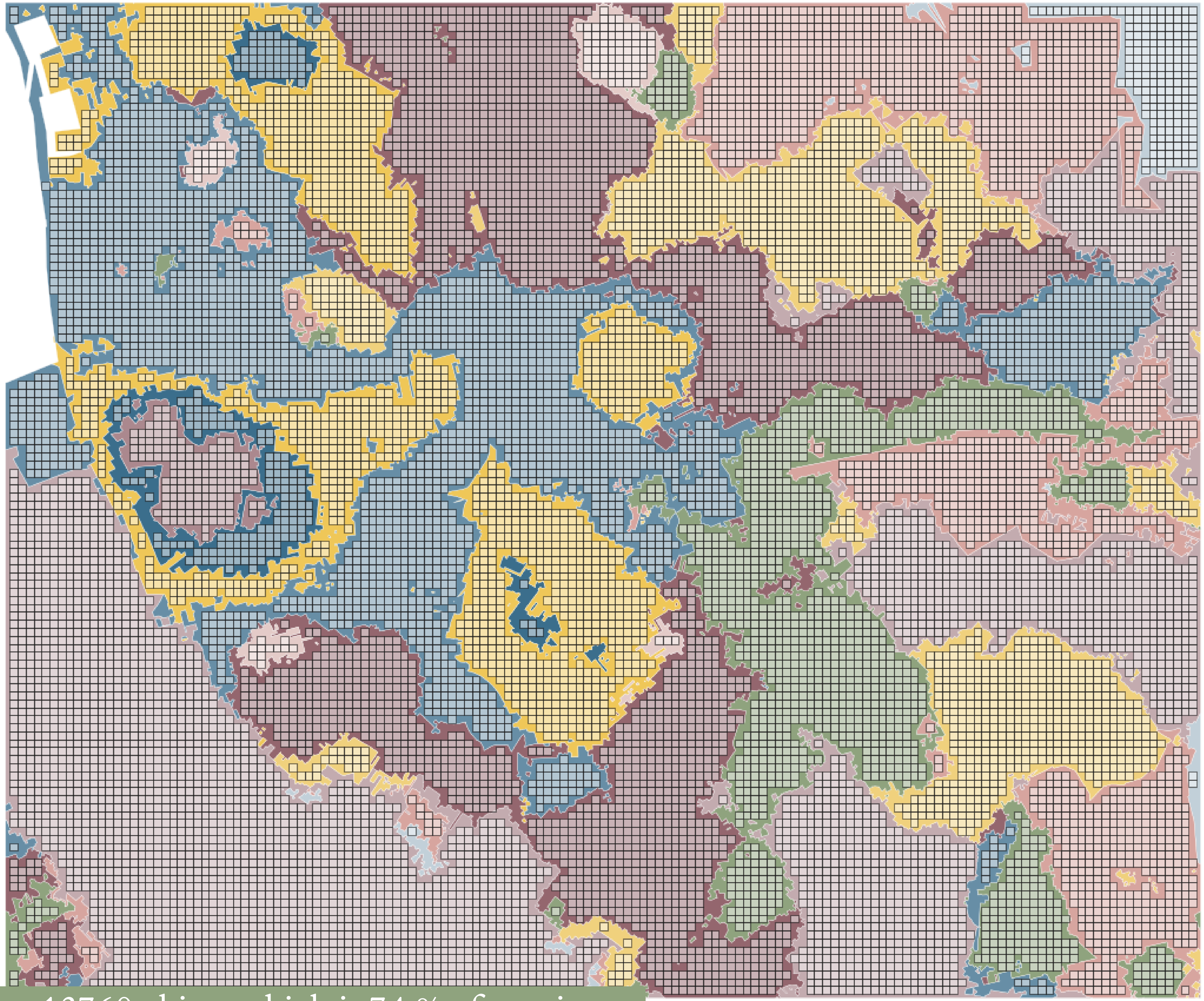
Exploration

Image classification

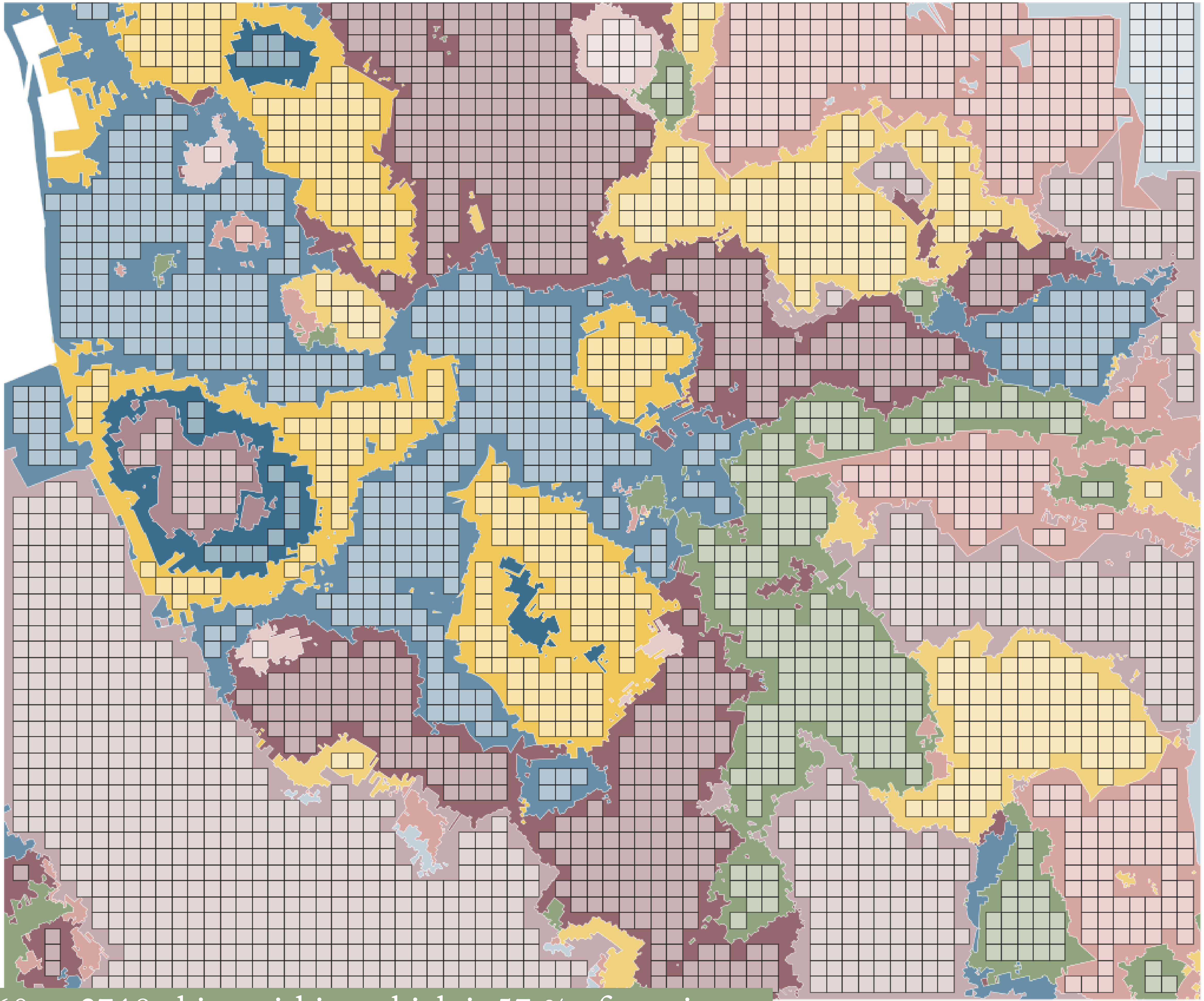
Neural network architecture



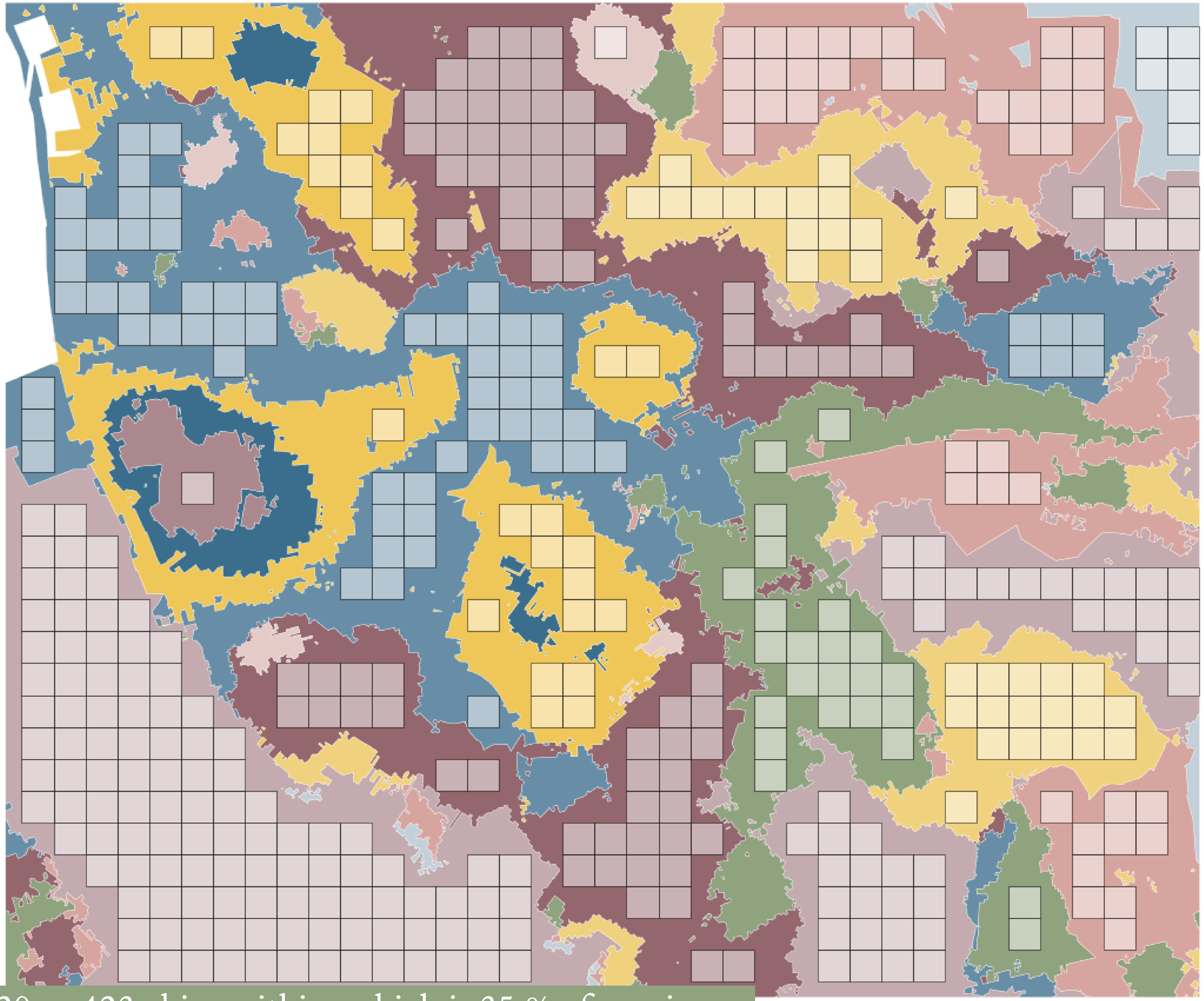
Chip size effect



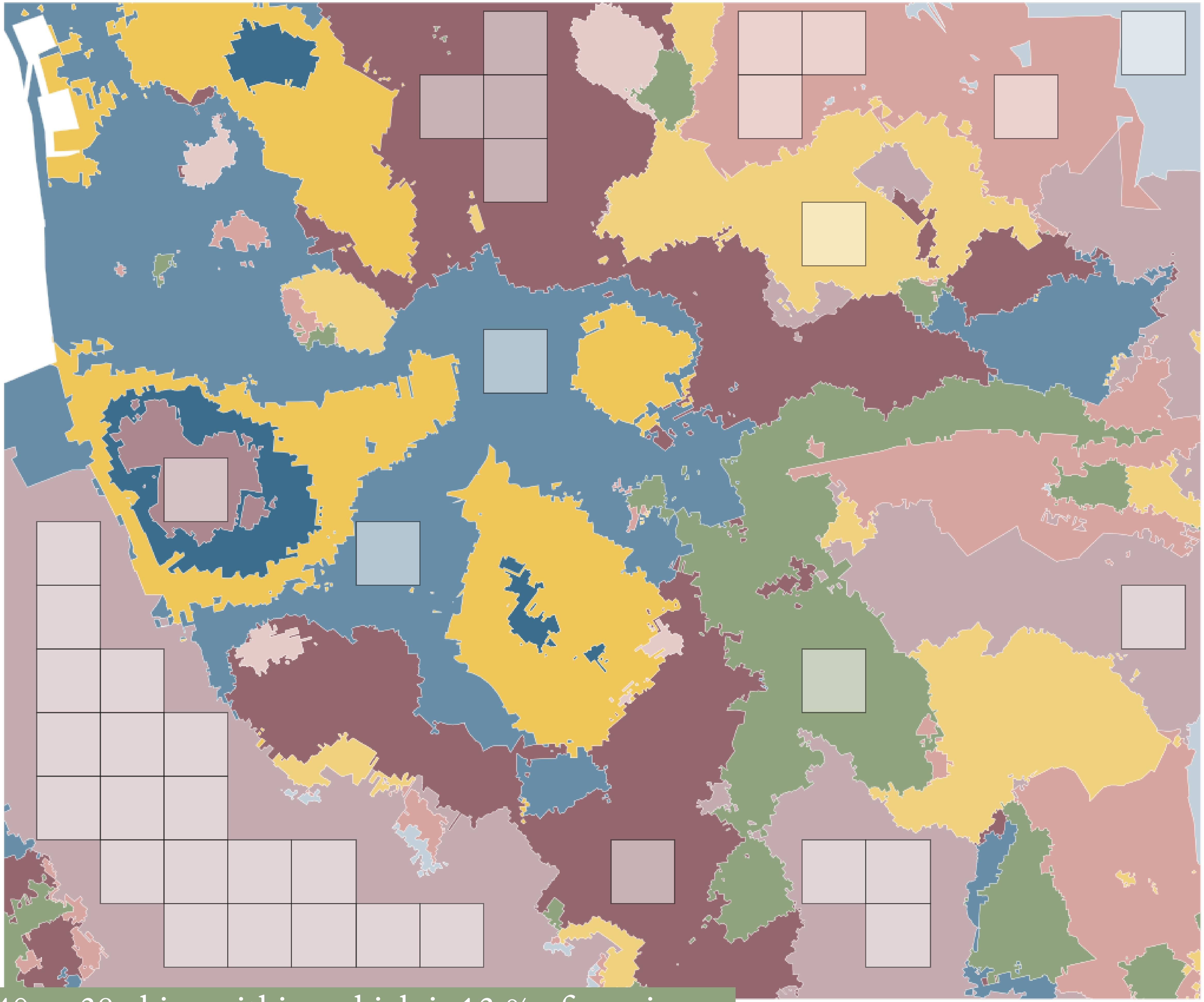
80x80m: 13760 chips, which is 74 % of maximum



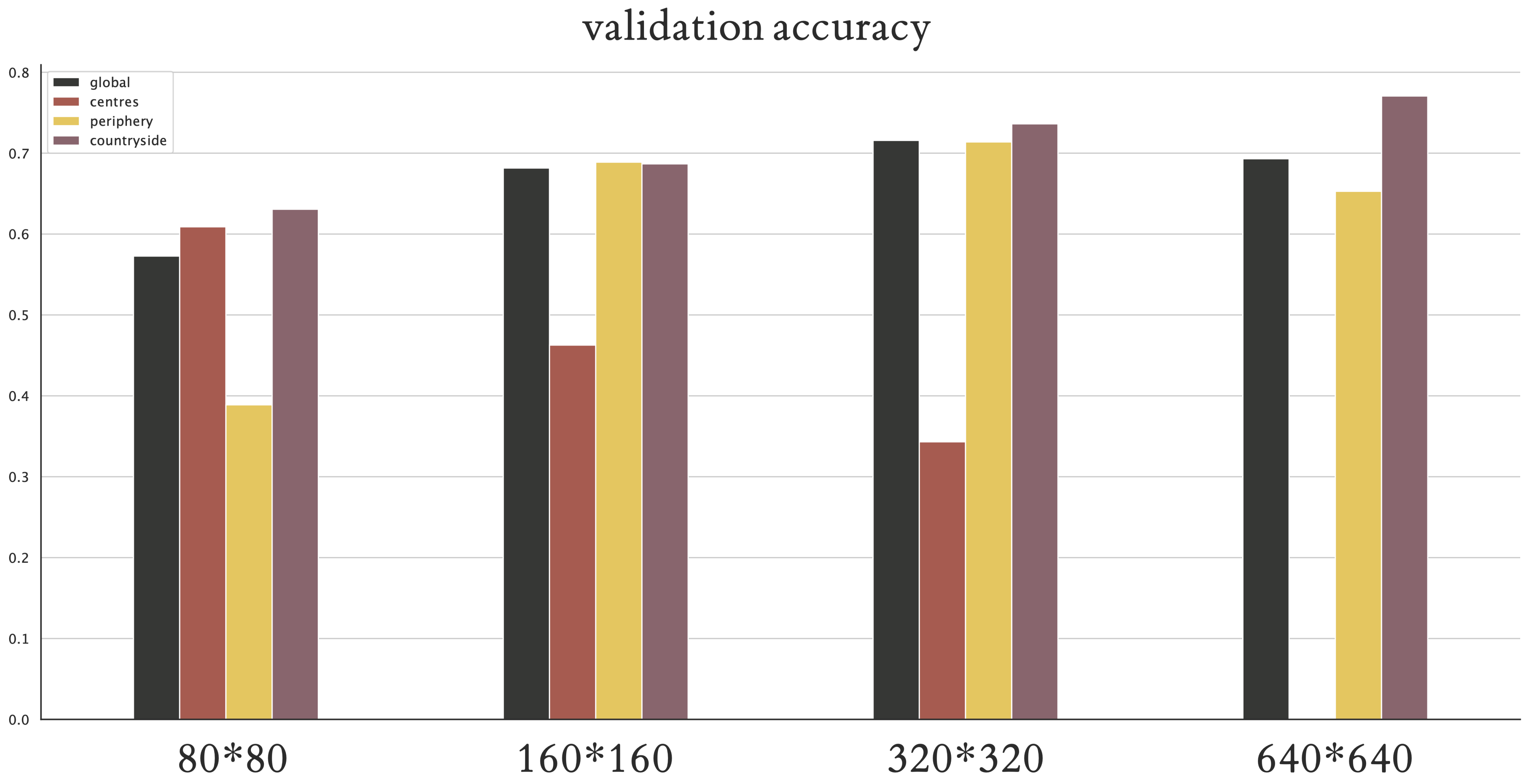
160x160m: 2718 chips within, which is 57 % of maximum



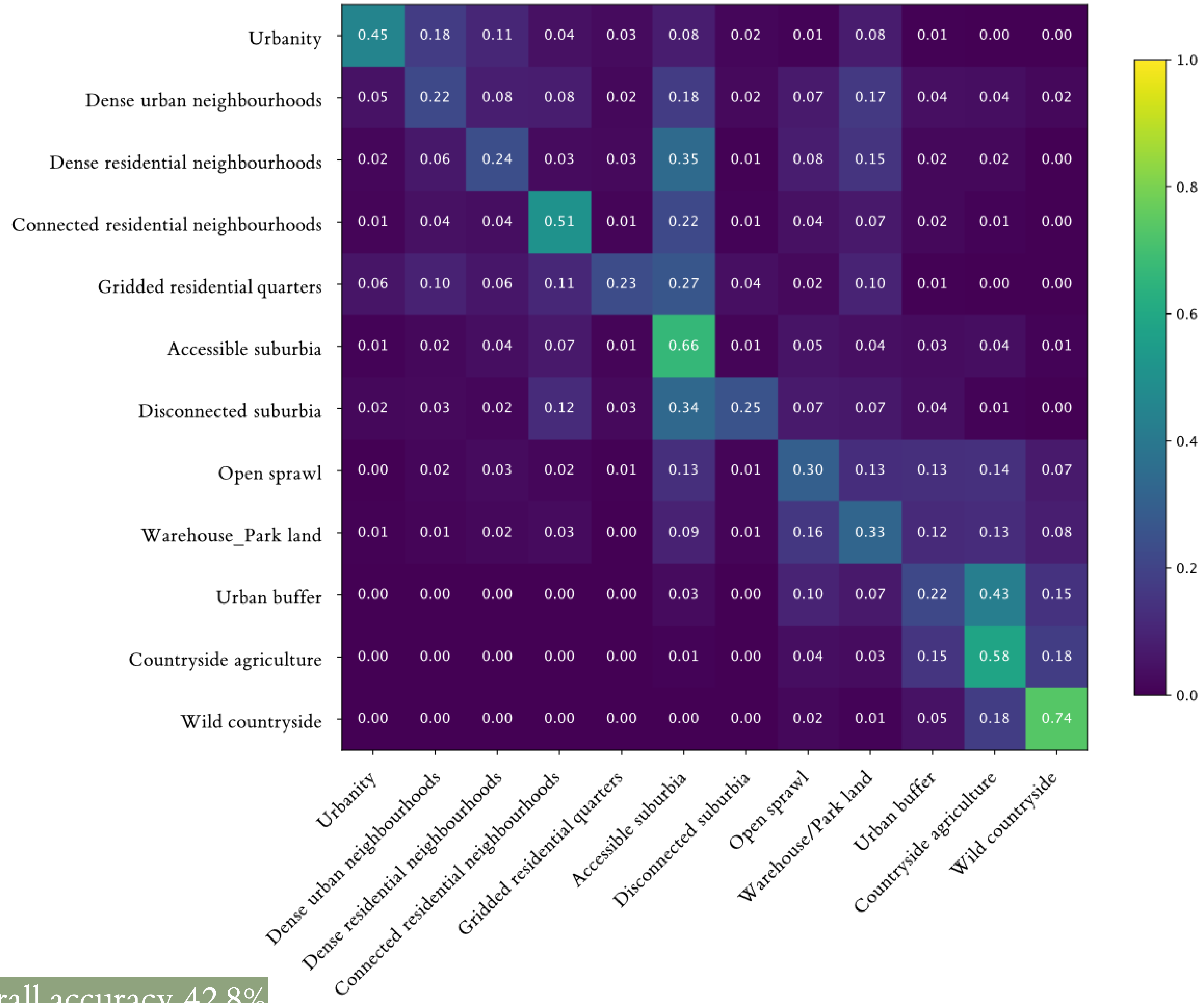
320x320m: 423 chips within, which is 35 % of maximum



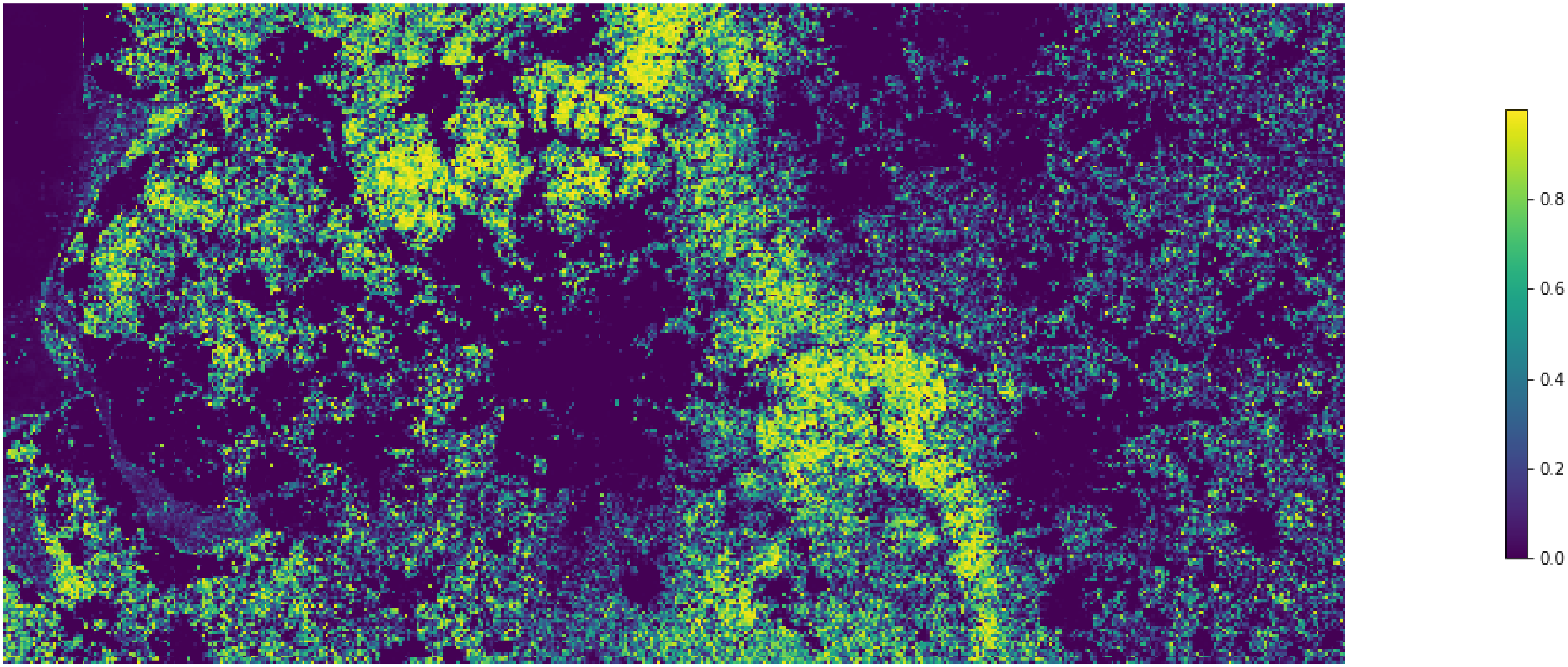
640x640m: 38 chips within, which is 13 % of maximum



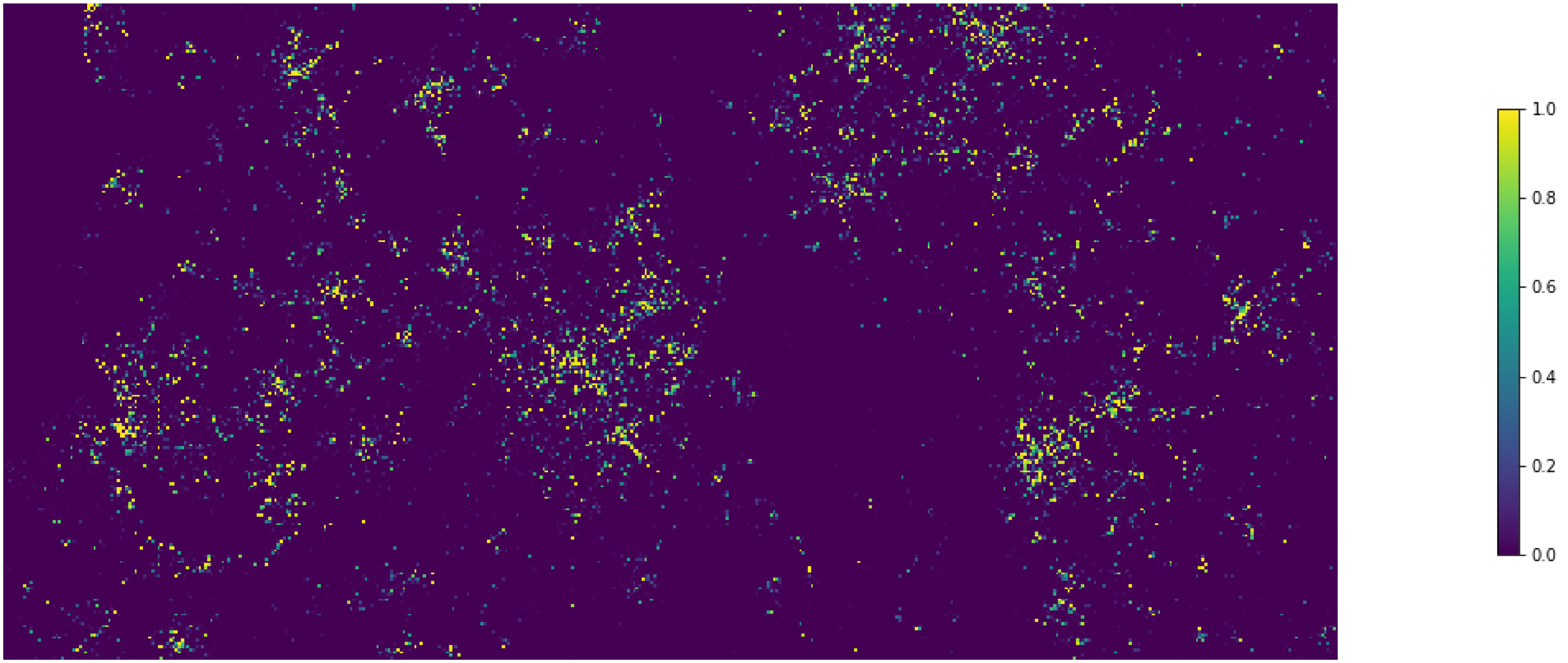
validation accuracy
global
centres
periphery
countryside
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
80*80
160*160
320*320
640*640



Overall accuracy 42.8%



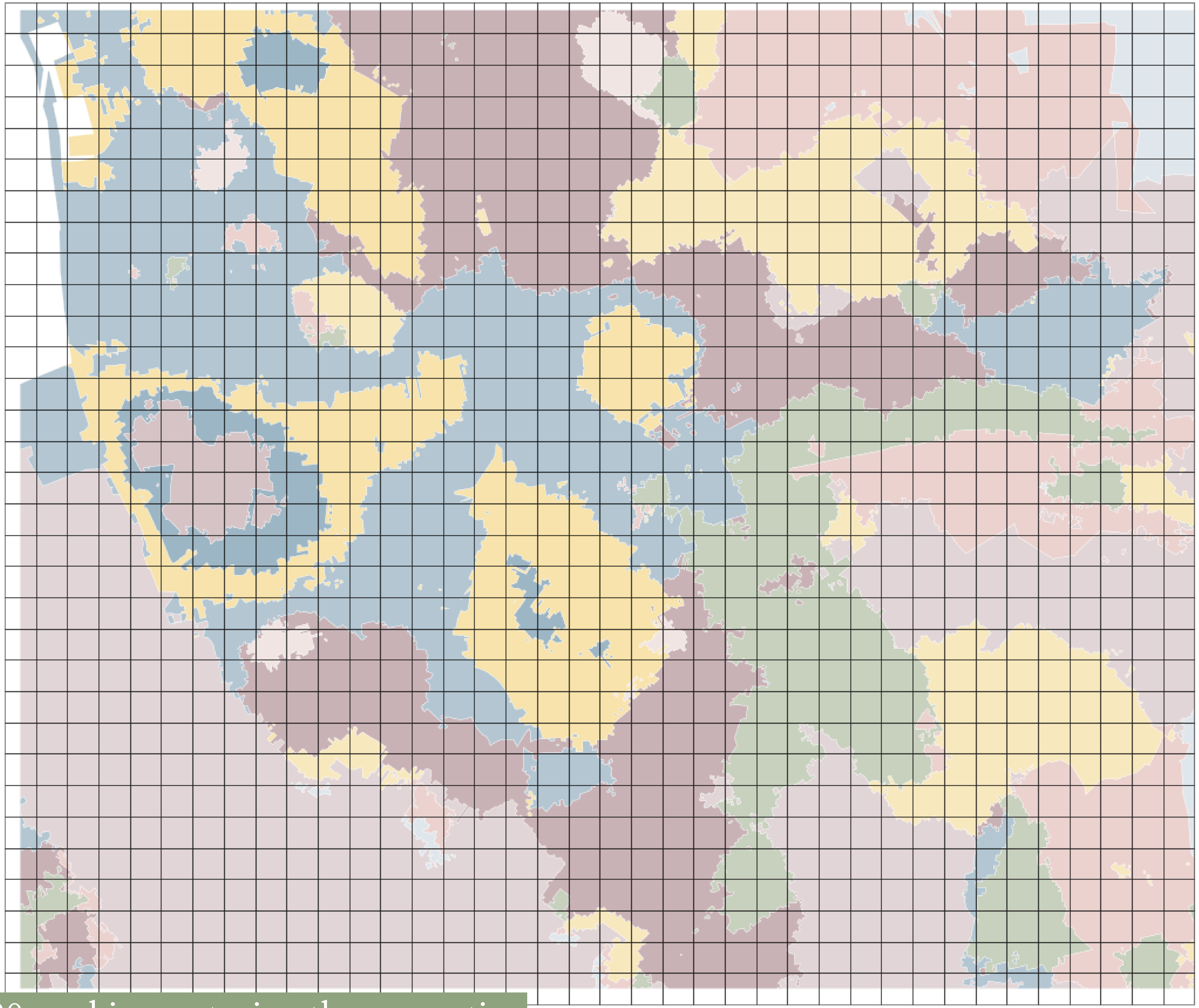
Wild countryside



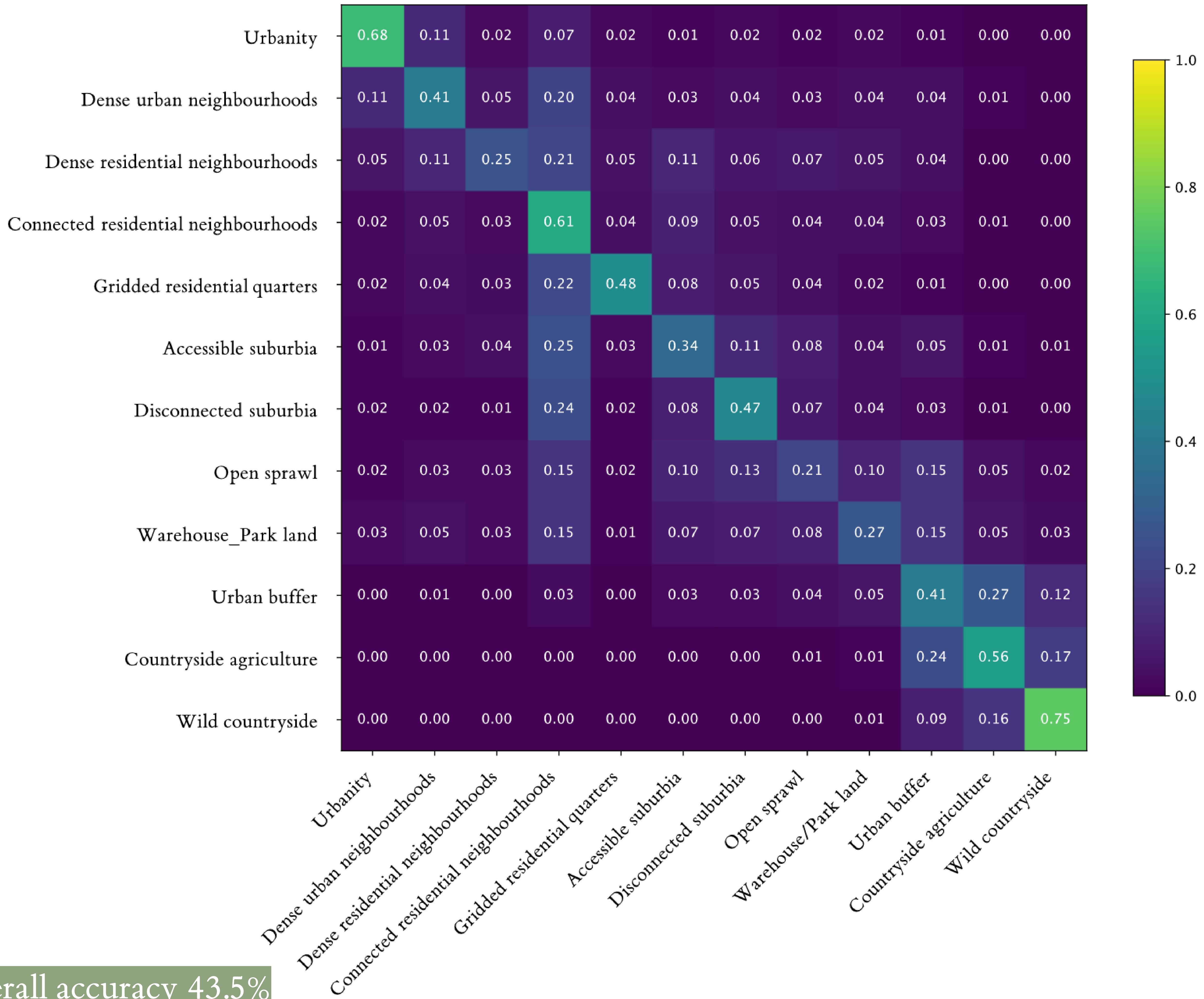
Urbanity

Co-location

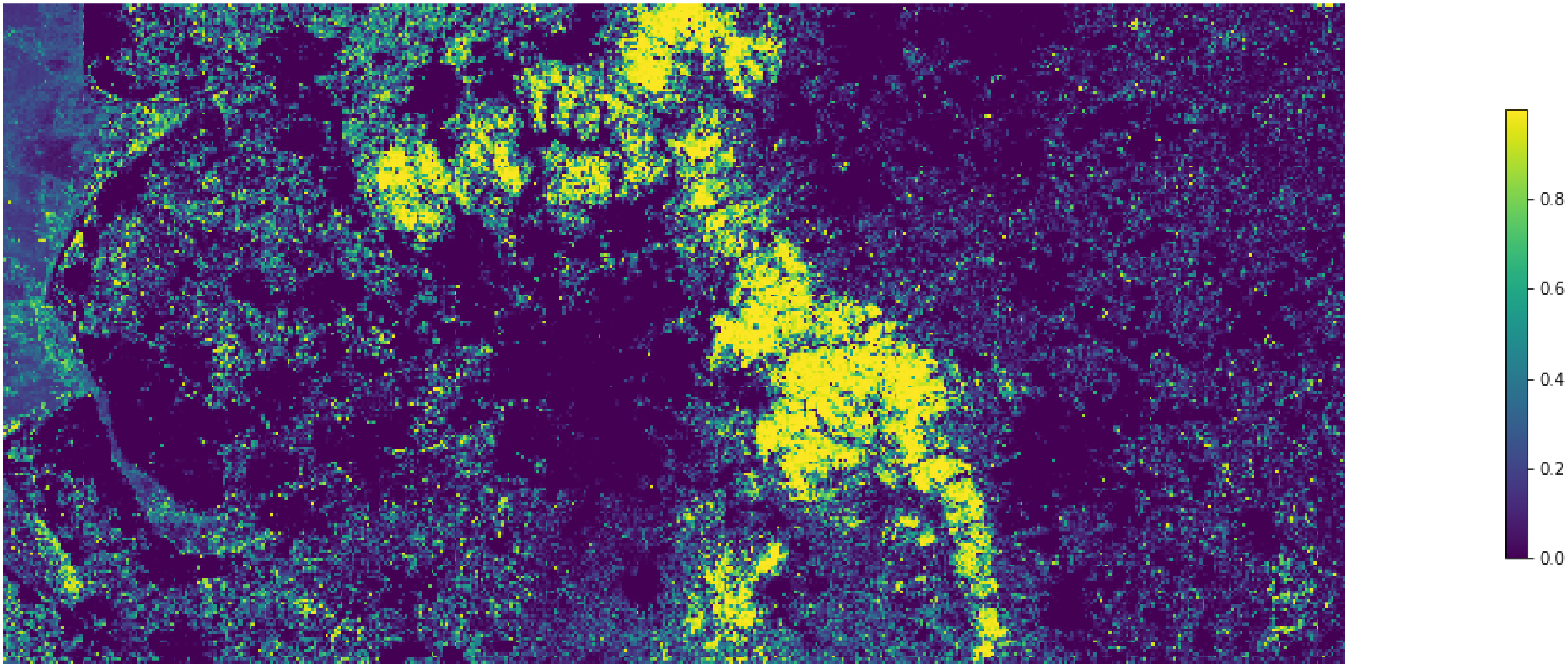
Multi-output regression



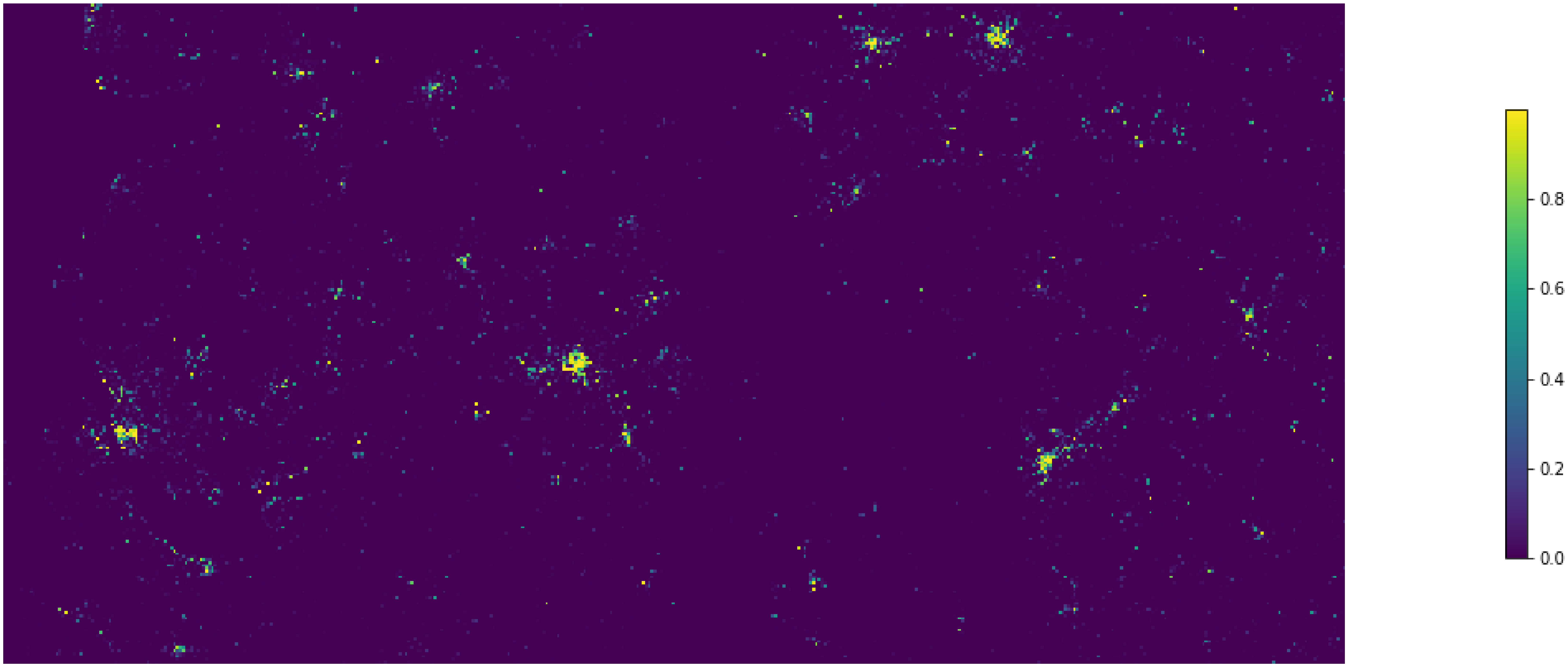
320x320m, chips capturing the proportion



Overall accuracy 43.5%

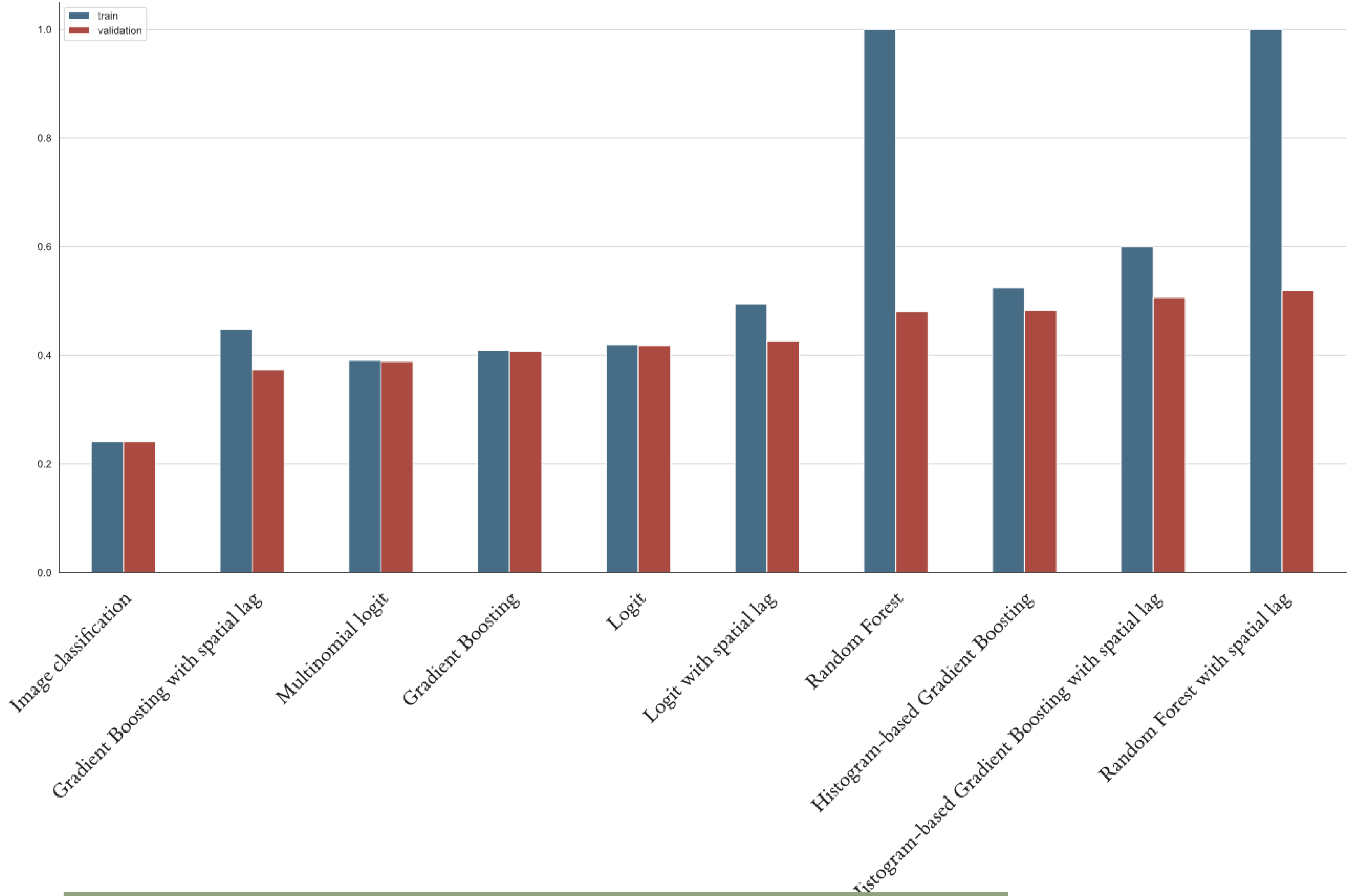


Wild countryside



Urbanity

Probability modelling



*the accuracy is based on a different sample than in previous cases (WIP)

A way forward

1. Deploy probability modelling on GB
2. Image segmentation
3. Alternative NN architecture including additional context in a single model

Conclusions

1. Relationship between signatures and satellite data is fuzzy
2. Chip size needs to balance information and relation to input geometry
3. Co-location information needs to be embedded in the model

Using deep learning to identify (urban) form and function in satellite imagery - the case of Great Britain

Martin Fleischmann

[`@martinfleis`]

m.fleischmann@liverpool.ac.uk

Dani Arribas-Bel

[`@darribas`]

d.arribas-bel@liverpool.ac.uk

UNIVERSITY OF LIVERPOOL

The Alan Turing Institute

Geographic Data Science Lab