

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

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How we arrange “stuff” in cities matters...



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

... it matters *a lot*



A screenshot of the American Economic Review website, specifically the article "Cities in Bad Shape: Urban Geometry in India" by Mariaflavia Harari. The article is in Volume 110, Number 8, August 2020, pp. 2377-2421. The American Economic Association logo is at the top.

A screenshot of the Environmental Science & Technology website, showing the article "Effects of Income and Urban Form on Urban NO₂: Global Evidence from Satellites" by Matthew J. Bechle,[†] Dylan B. Millet,^{†,‡} and Julian D. Marshall^{*,†}. The article is an "ARTICLE" published in 2020. The ACS logo is at the top.

A screenshot of the "Living with beauty" report page from the UK government. The report is titled "Living with beauty: report of the Building Better, Building Beautiful Commission". It's an independent report from the Ministry of Housing, Communities & Local Government, published on 30 January 2020. The report aims to promote high-quality design for new build homes and neighbourhoods.

The cover of the "Rethinking Urban Sprawl: MOVING TOWARDS SUSTAINABLE CITIES" report by the OECD. It features a circular image of a dense, green urban area. The OECD logo is at the bottom.



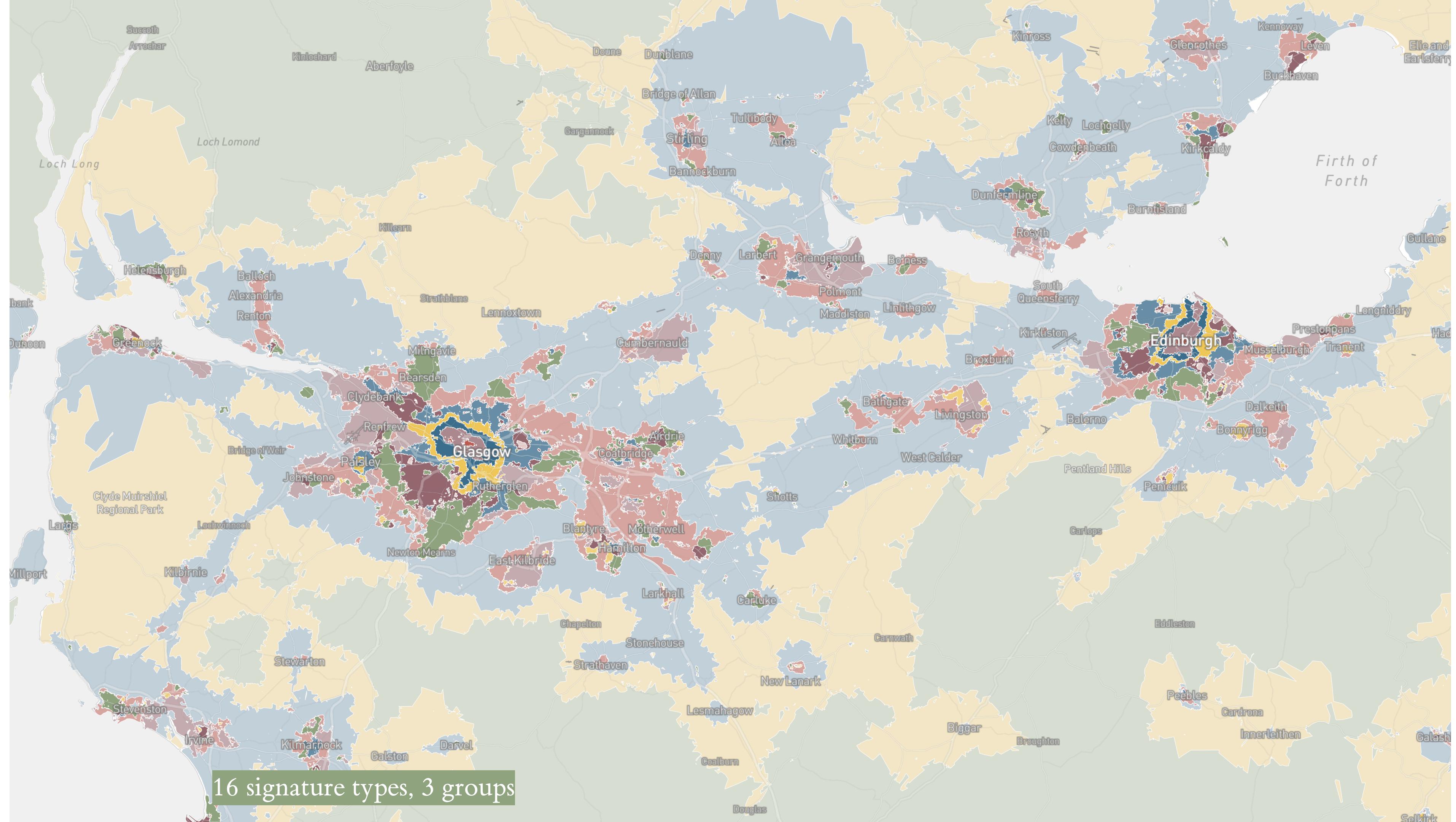
Spatial Signatures

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

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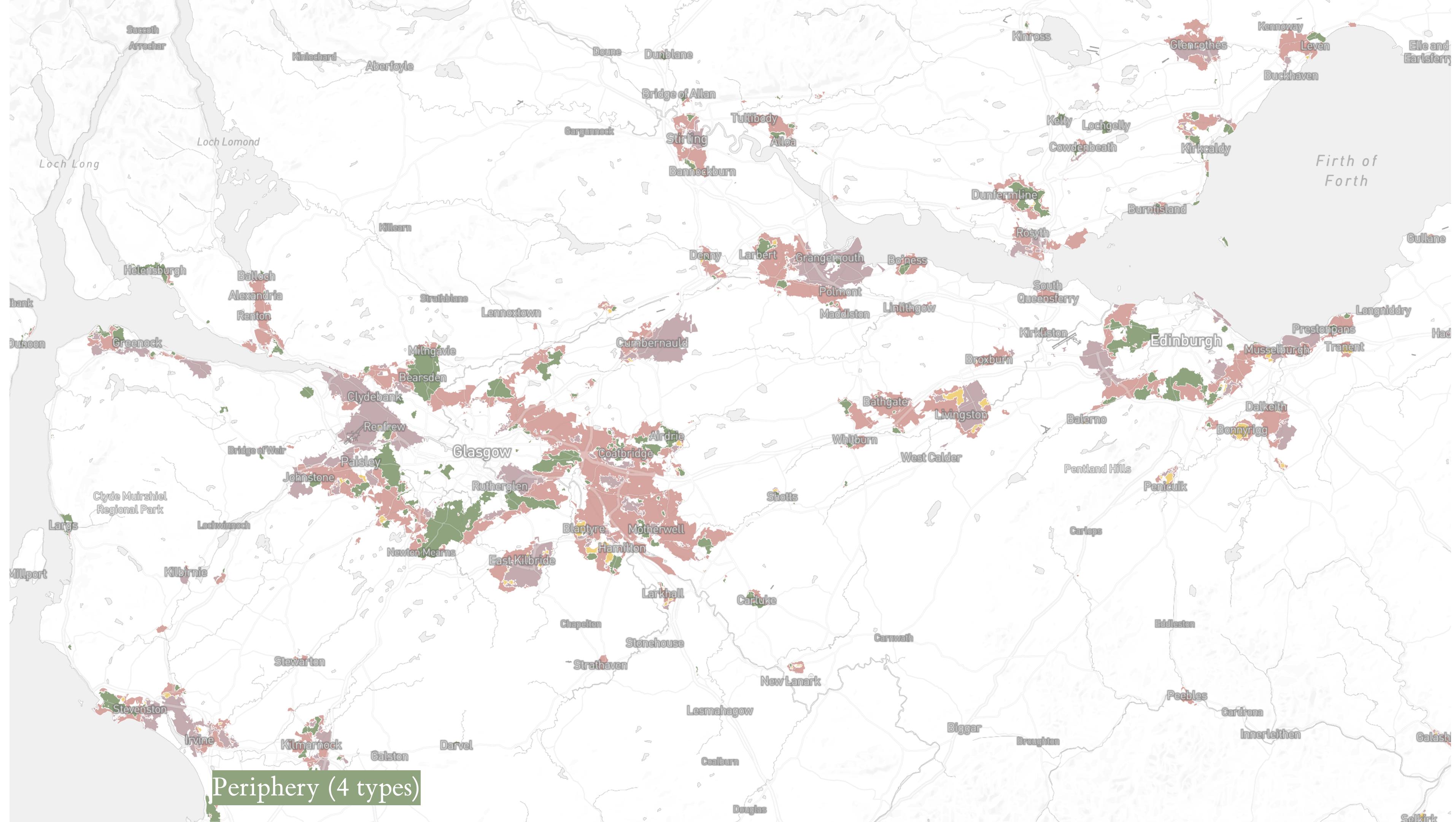
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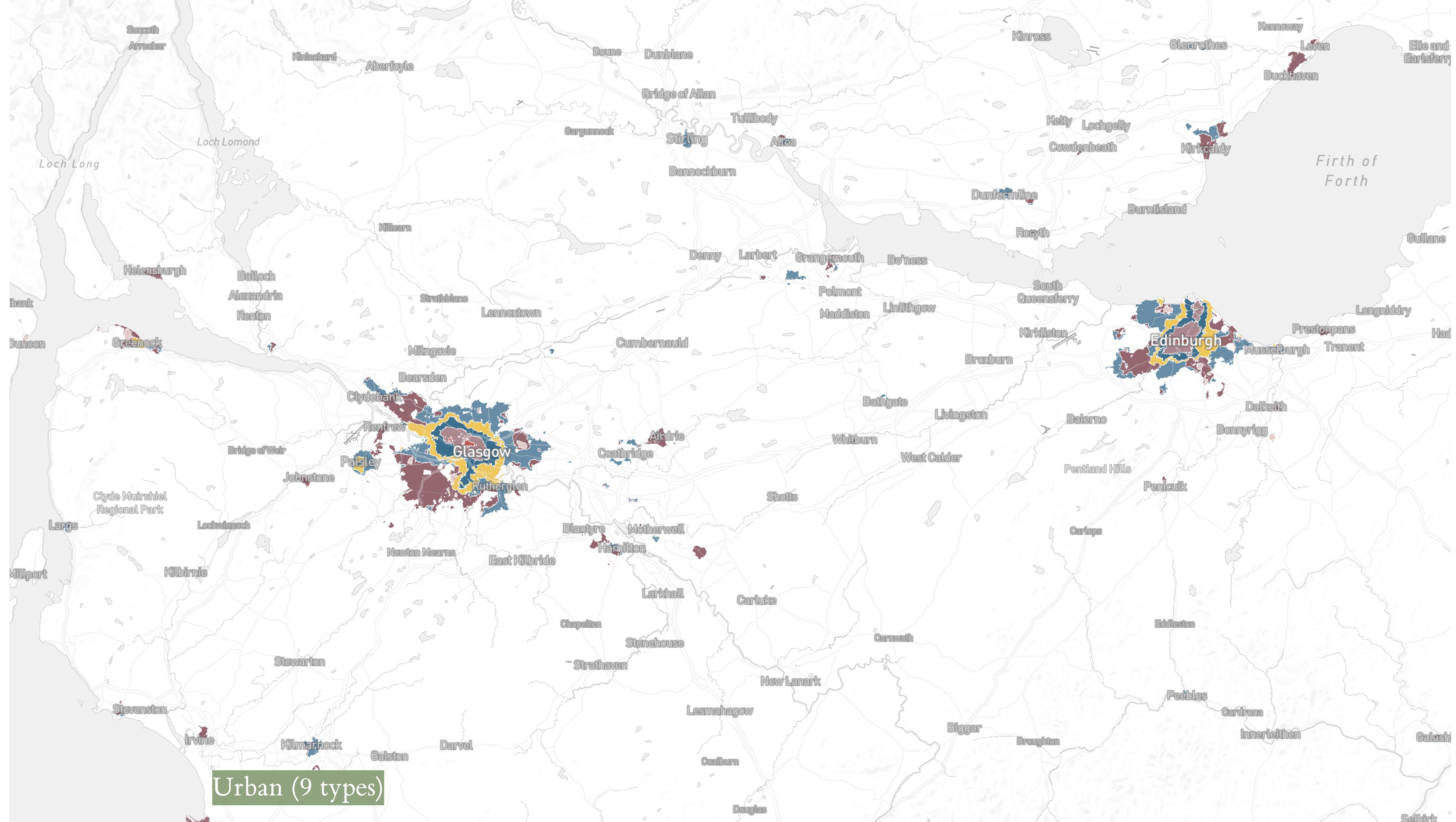


16 signature types, 3 groups





Periphery (4 types)



Urban (9 types)

The issue

Data

Form

- OS OpenMap
- OS OpenRoads

Function

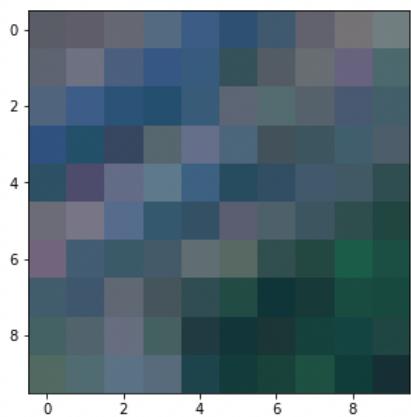
- (Business) Census
- OpenStreetMap
- Geolytix
- Listed buildings
- CDRC
- CORINE /
Sentinel 2
- VIIRS

Possible solution?

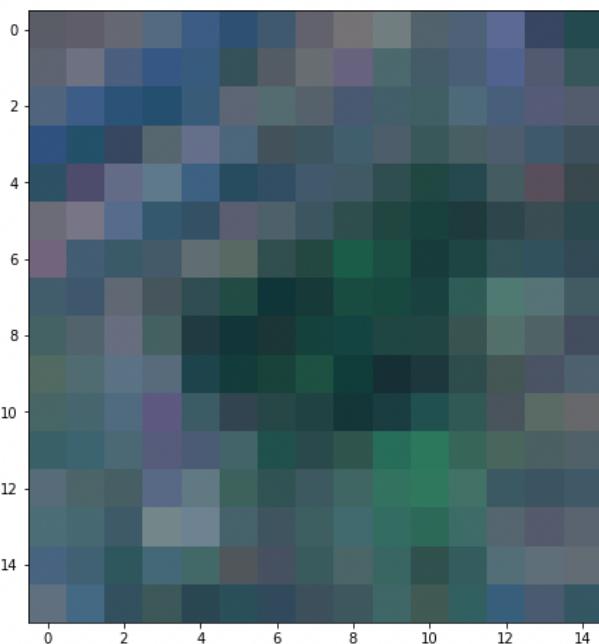


Sentinel 2

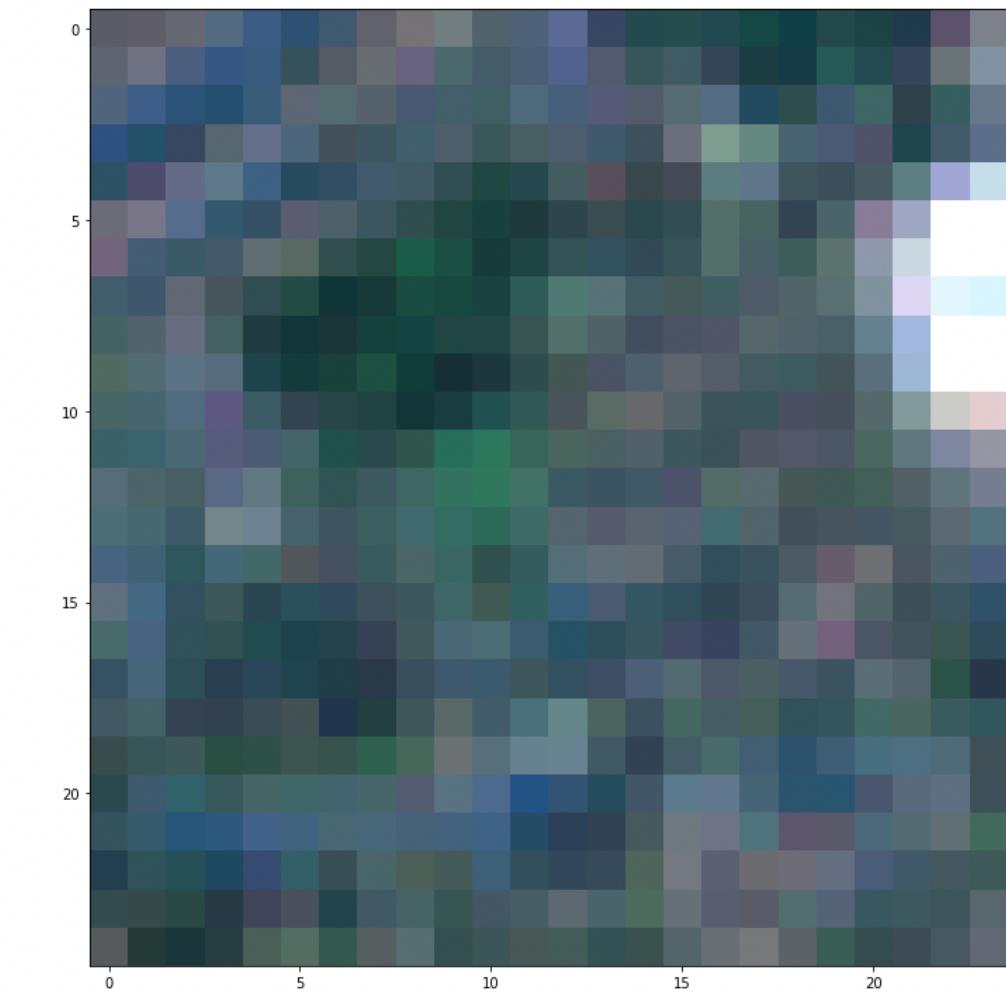
100x100



160x160



250x250



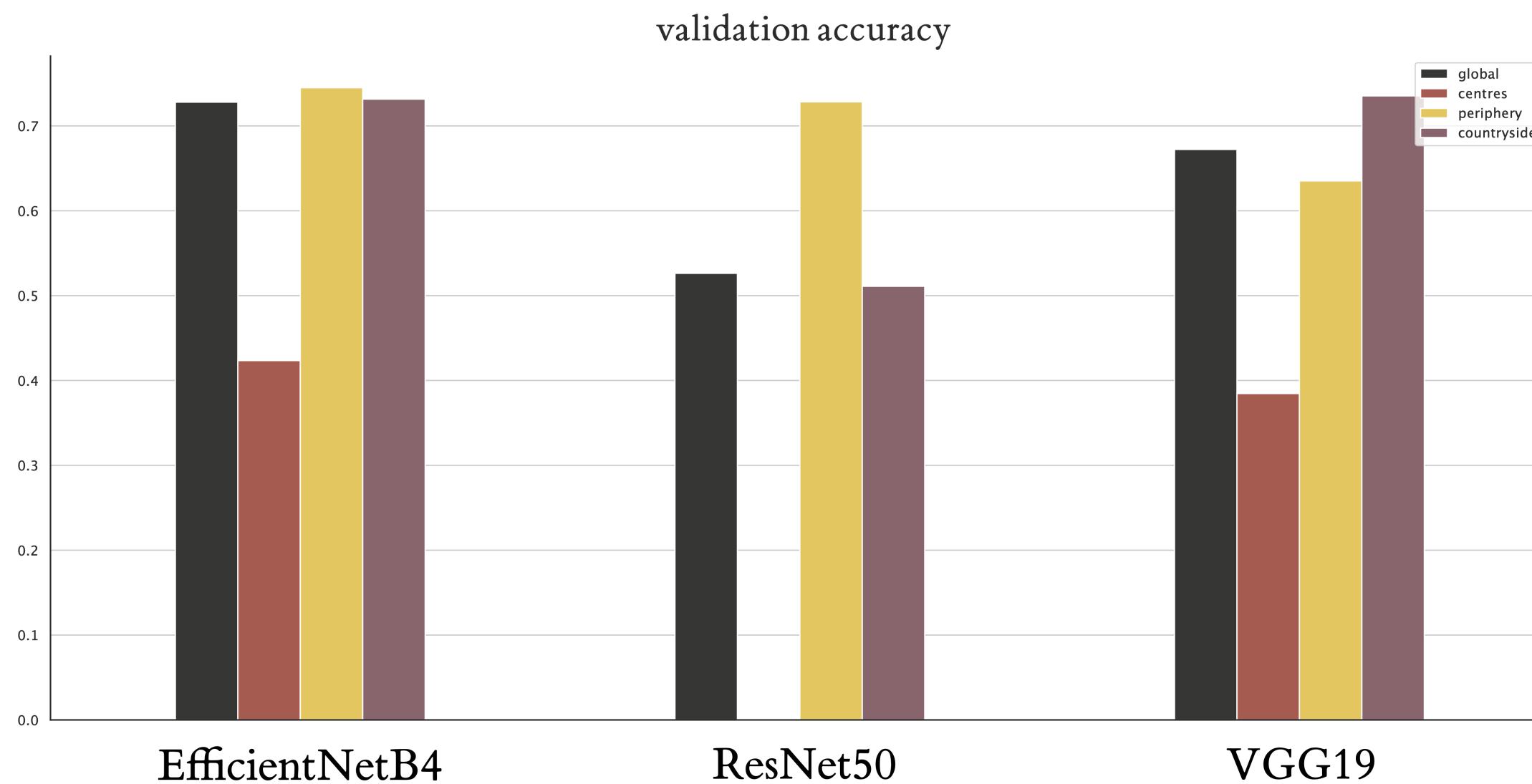
What do we want to do?

train a neural network
understand the role of geography

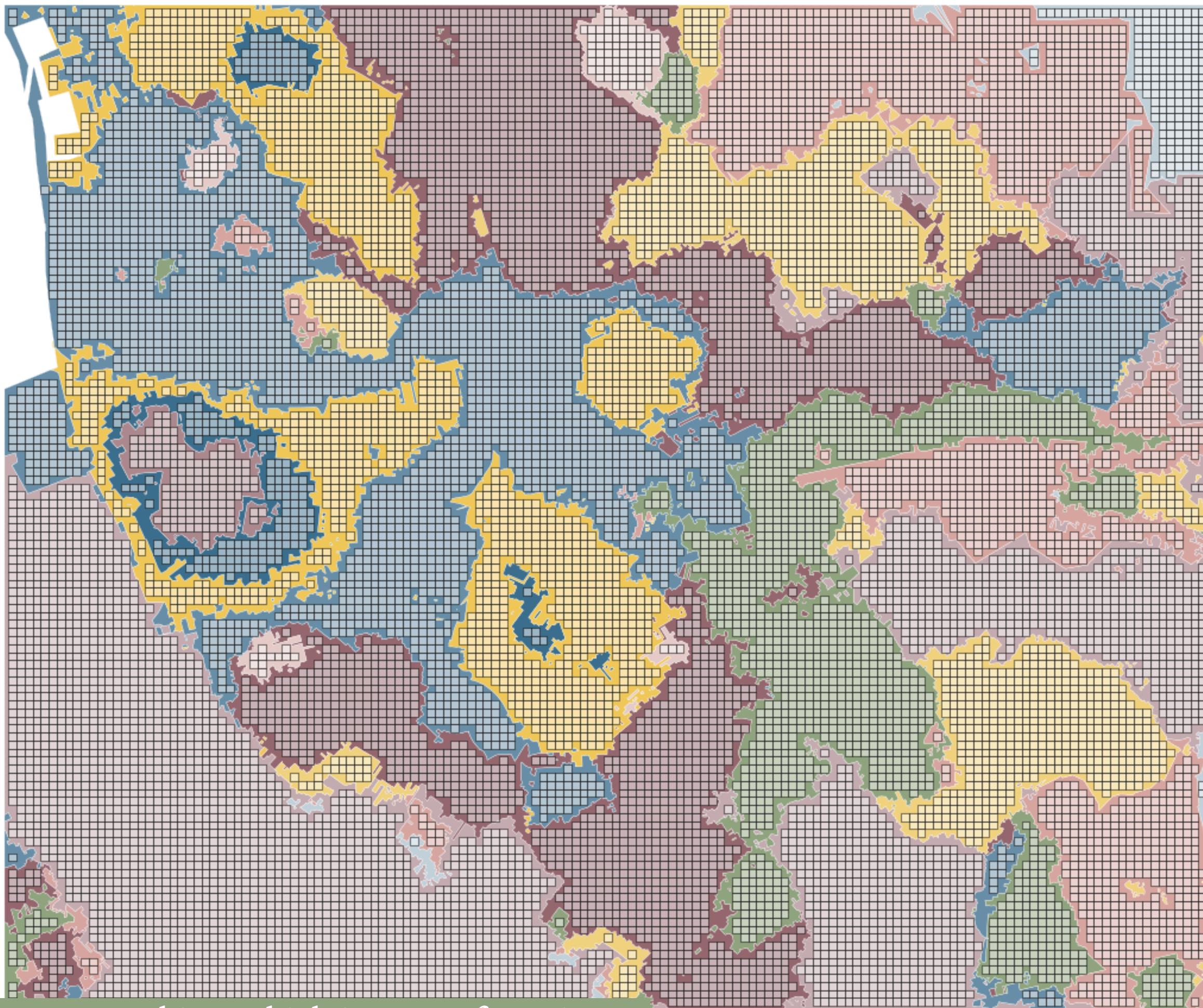
Exploration

Image classification

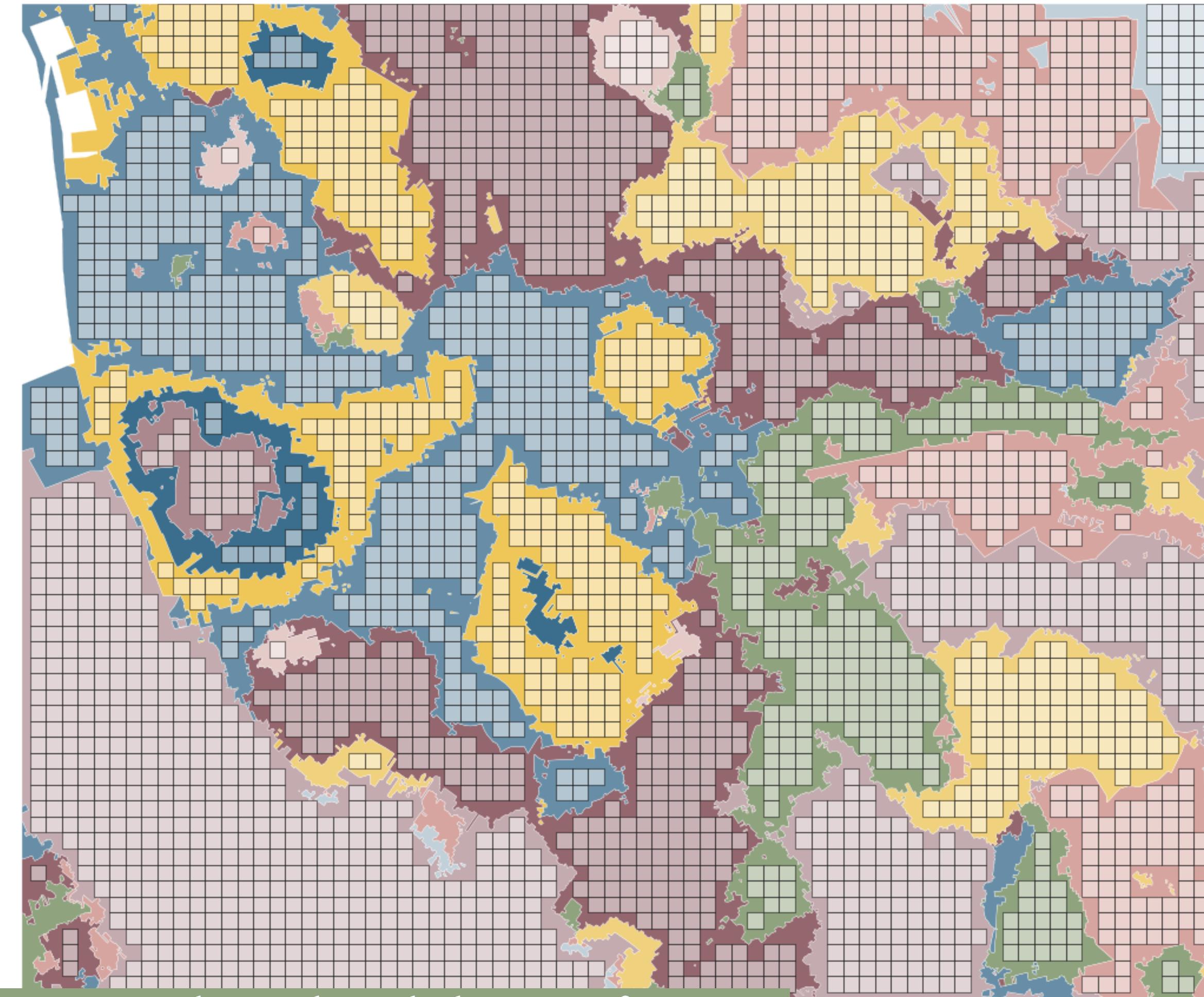
Neural network architecture



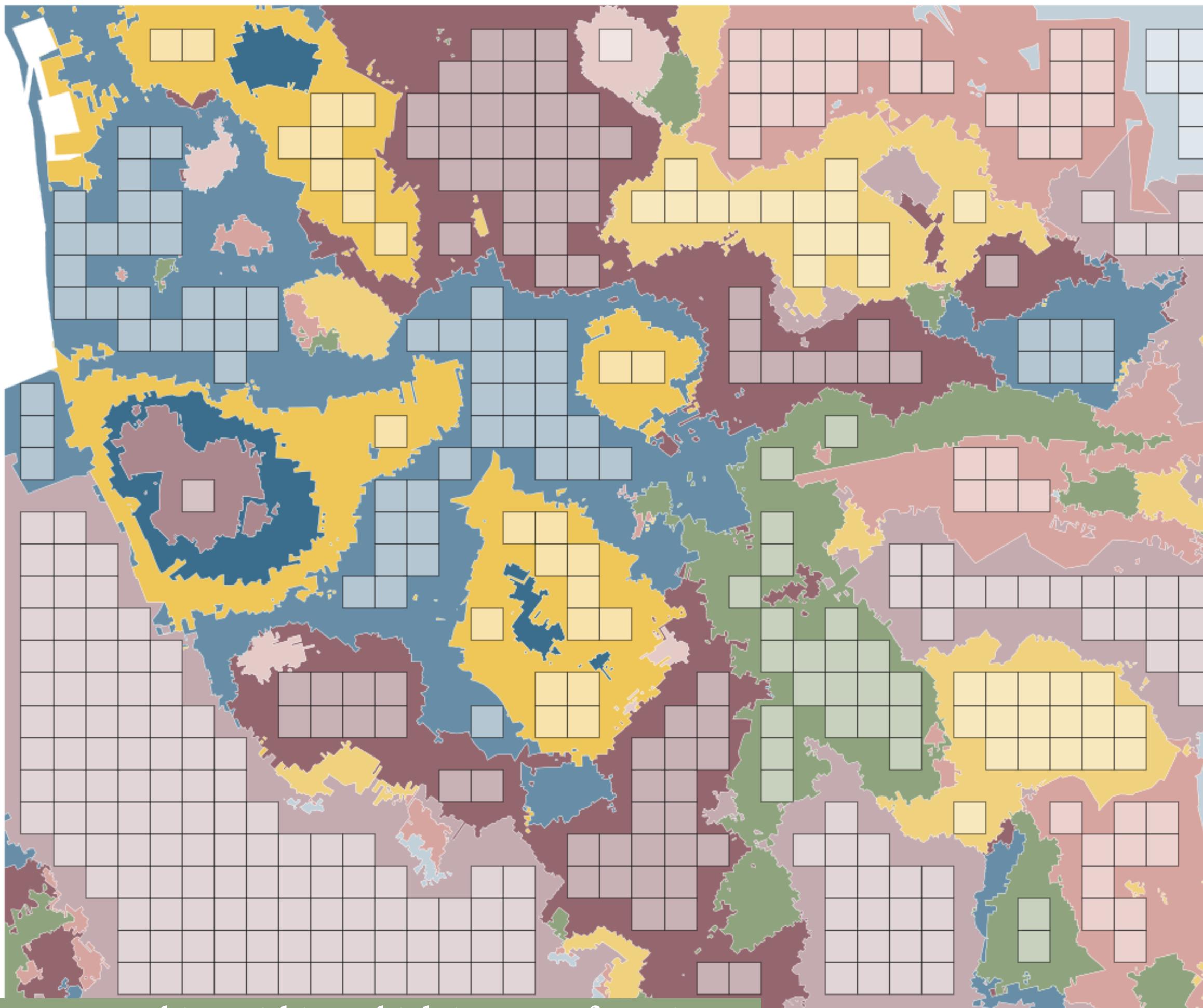
Chip size effect



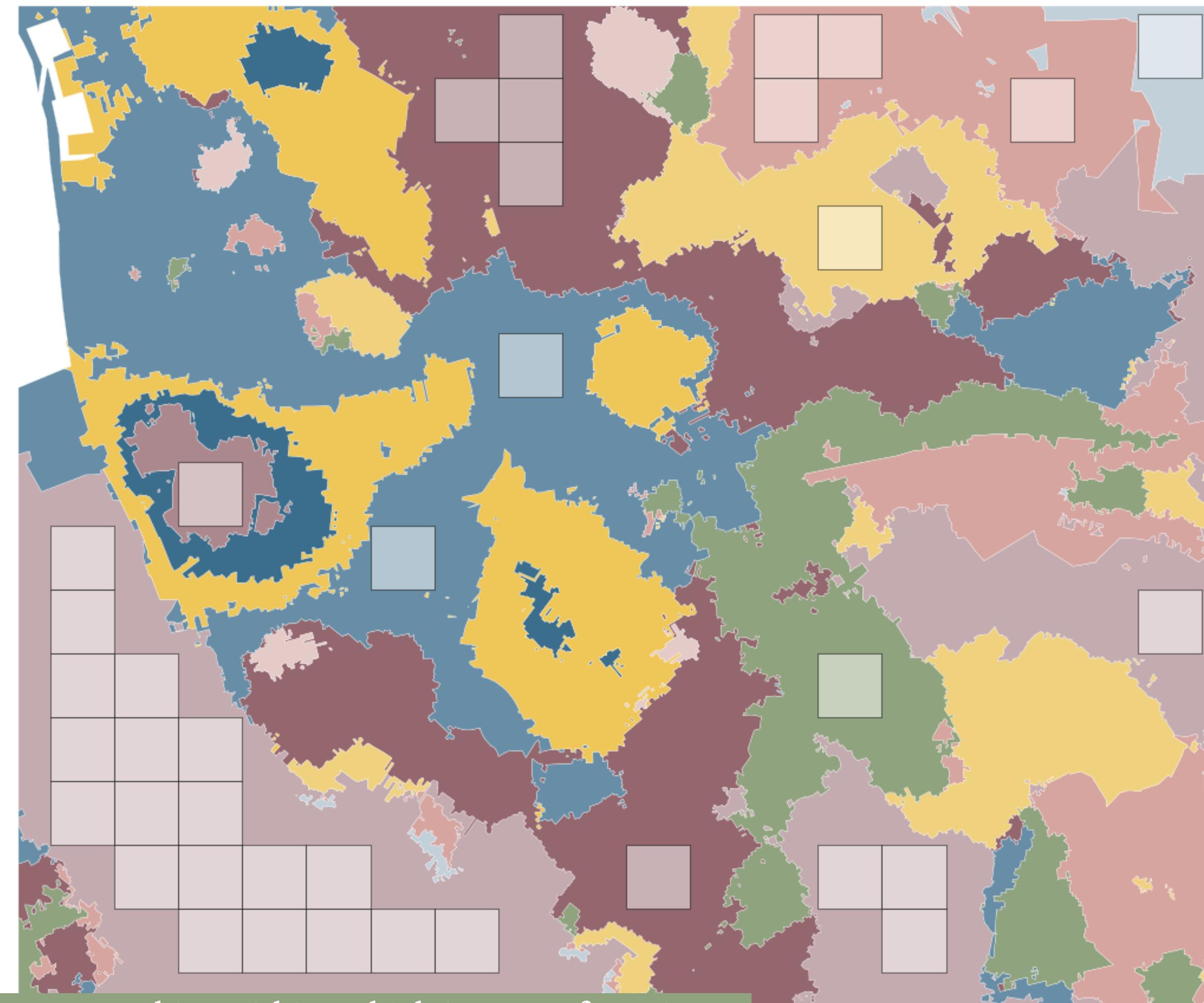
80x80m: 13760 chips, which is 74 % of maximum



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

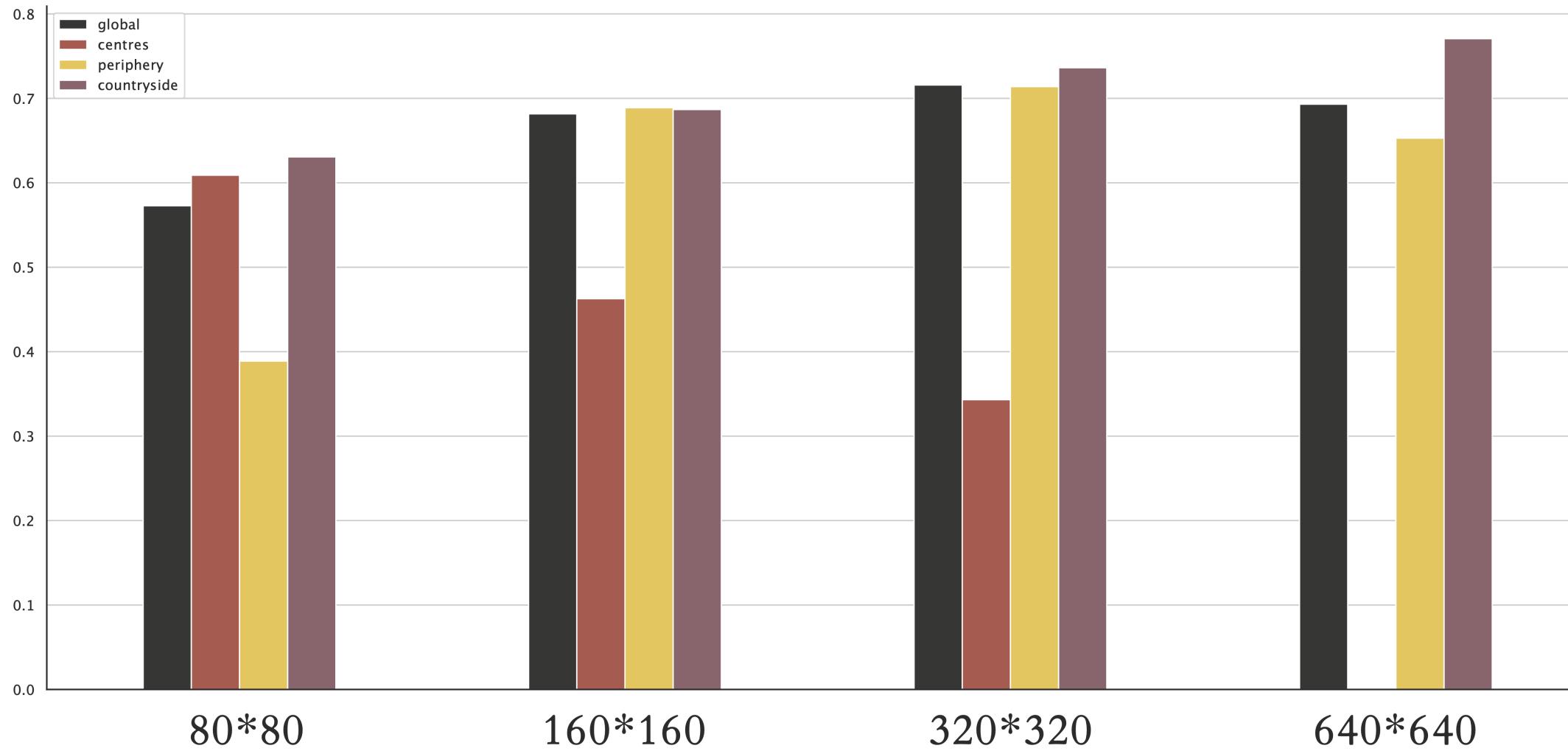


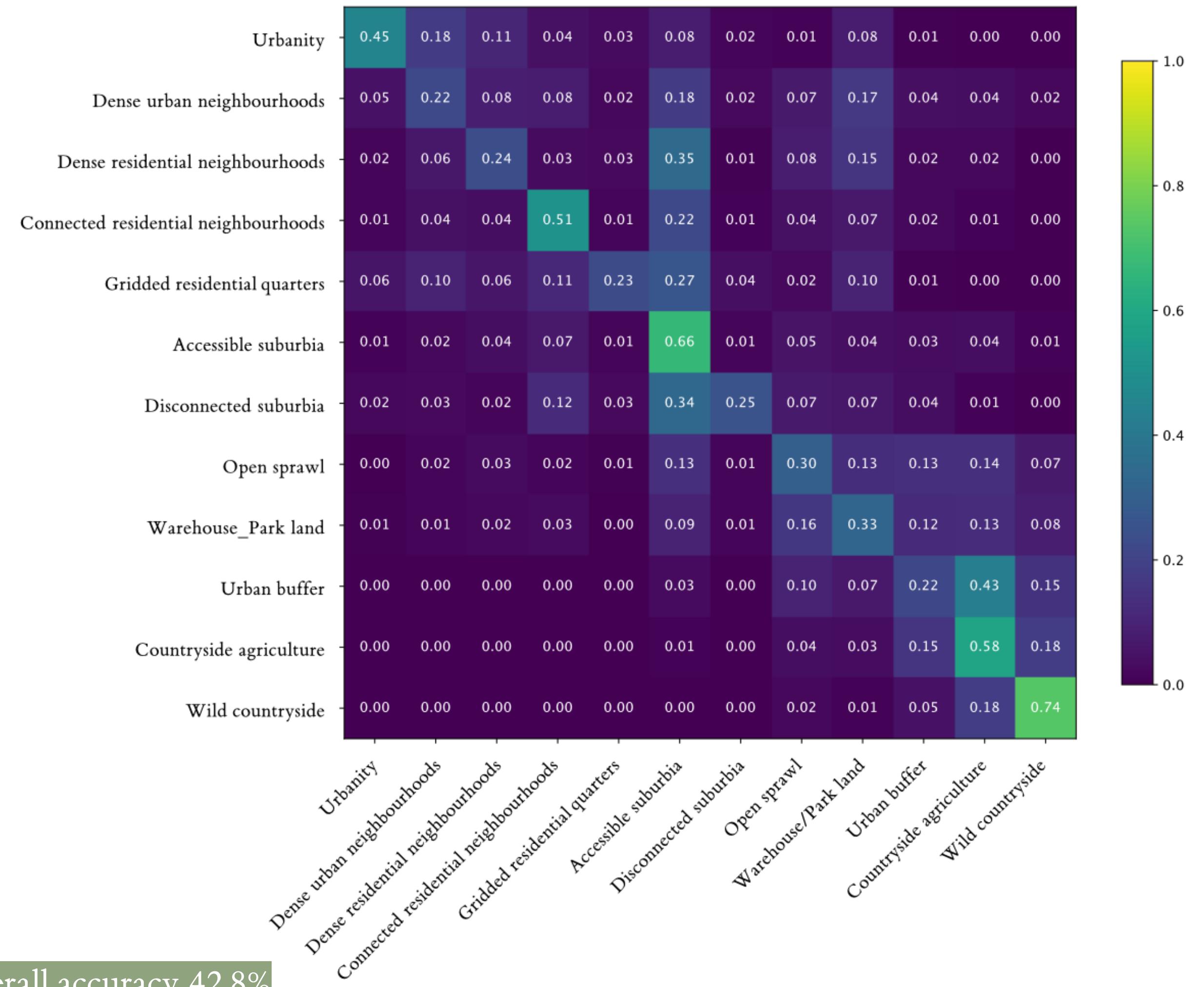
320x320m: 423 chips within, which is 35 % of maximum

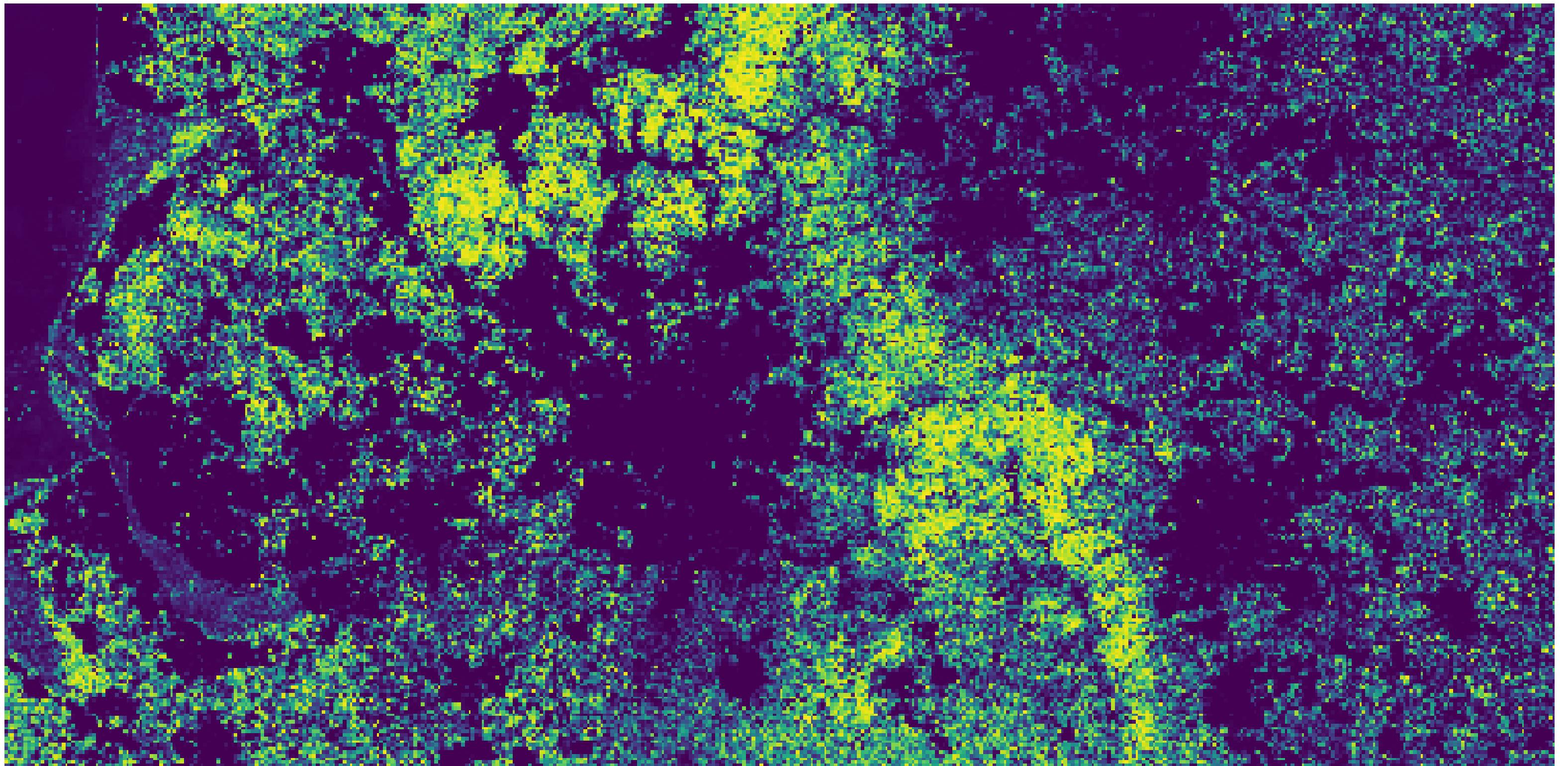


640x640m: 38 chips within, which is 13 % of maximum

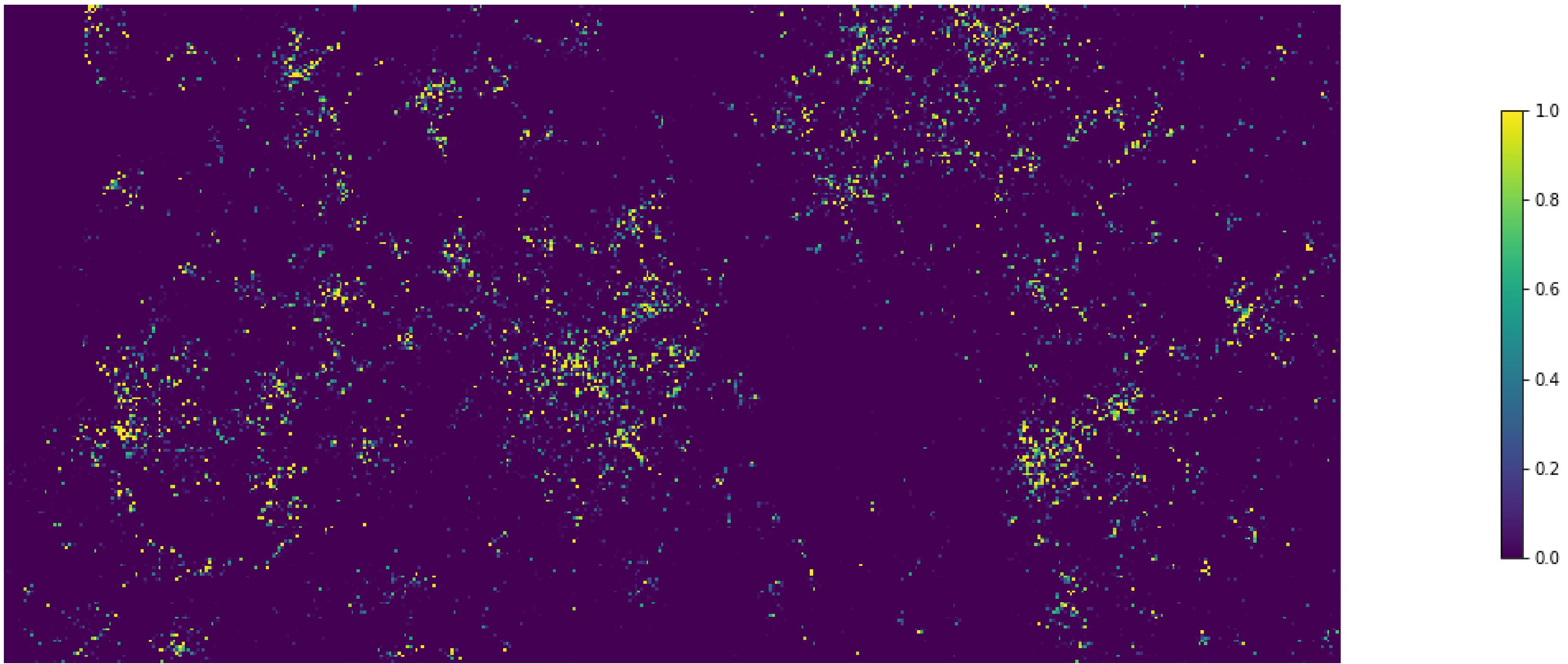
validation accuracy







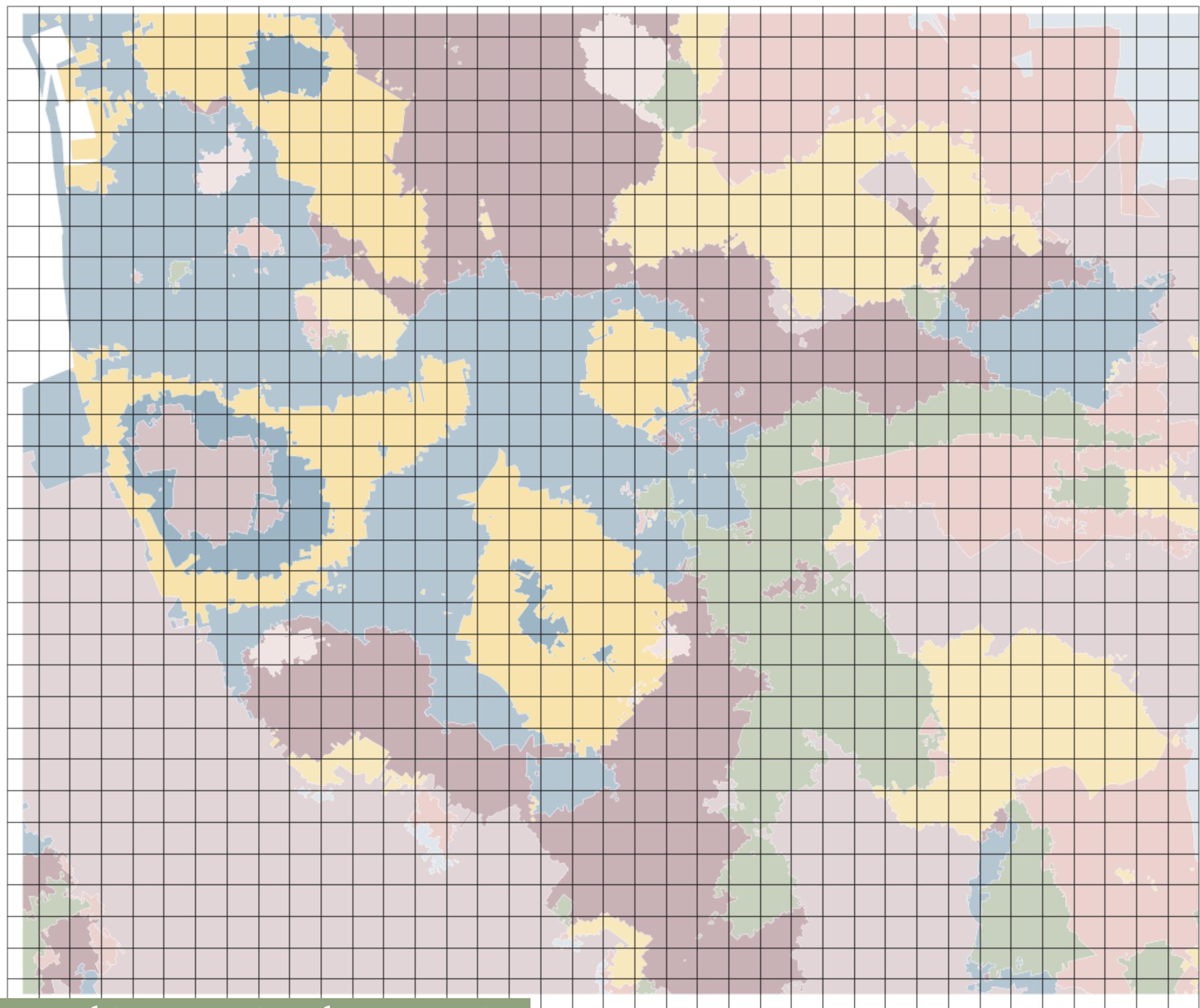
Wild countryside



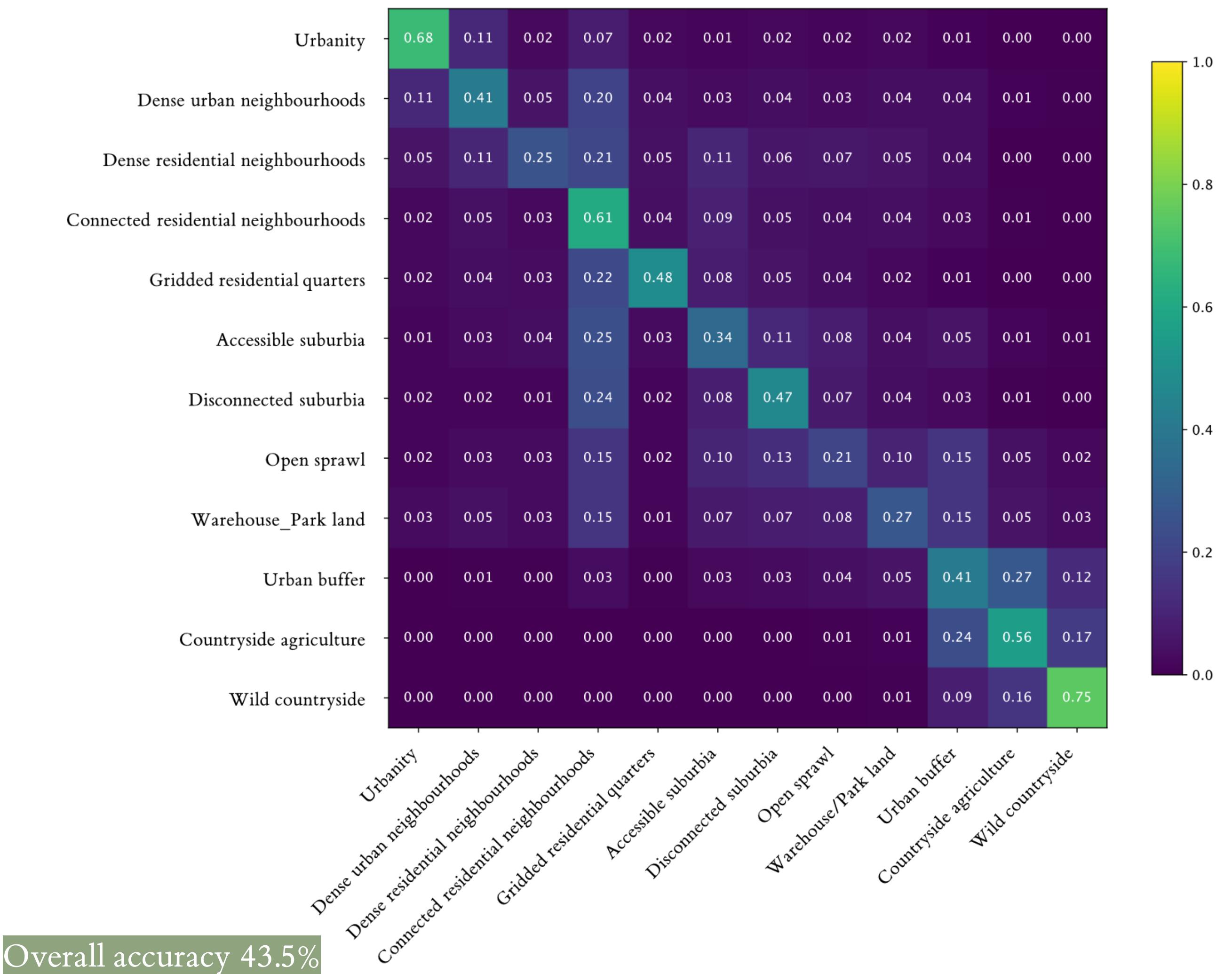
Urbanity

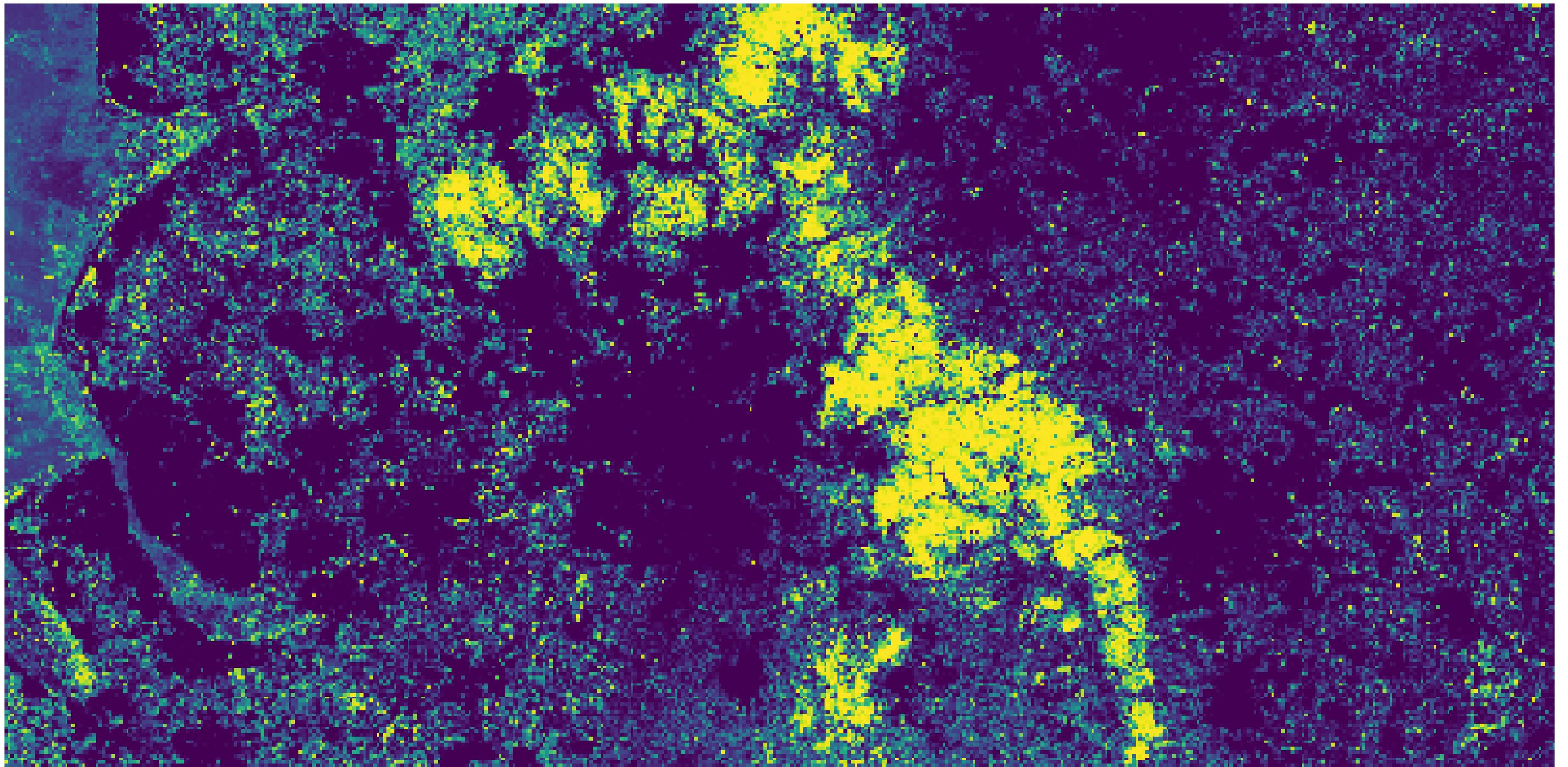
Co-location

Multi-output regression



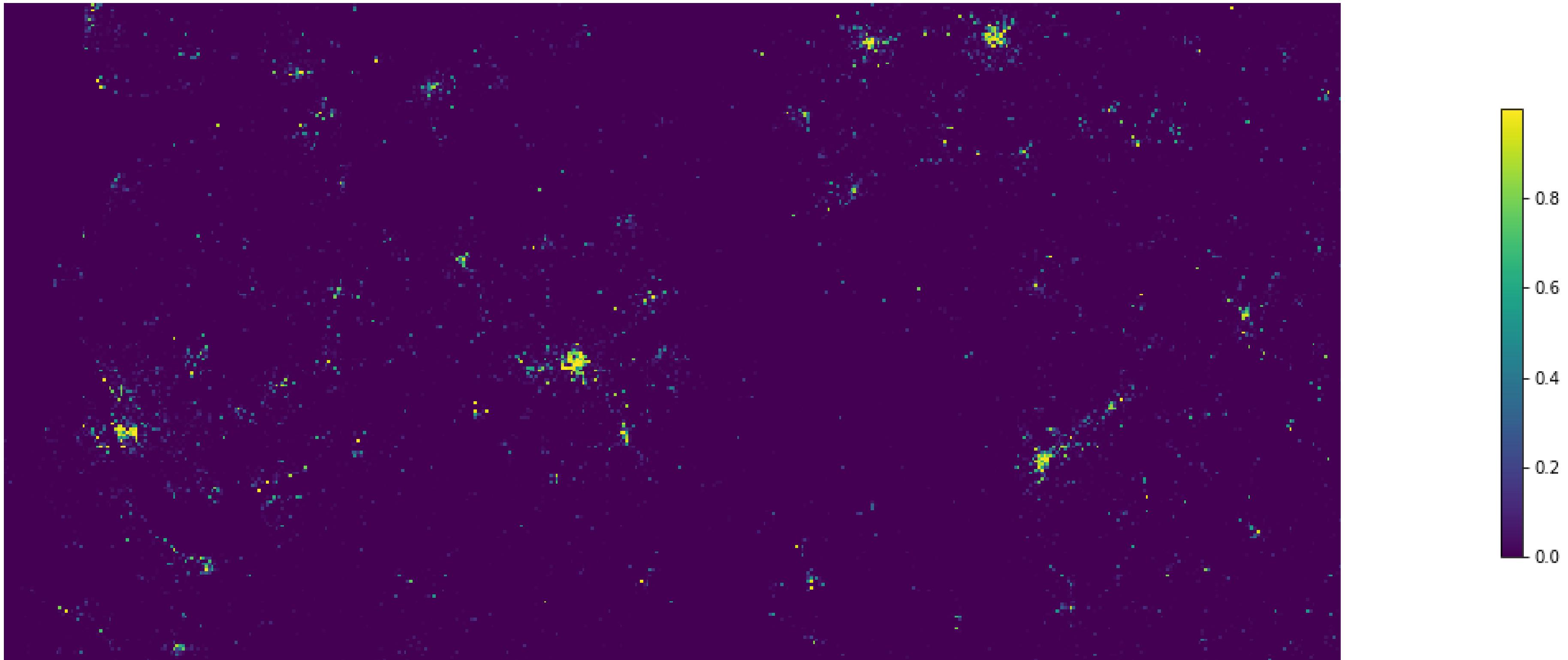
320x320m, chips capturing the proportion





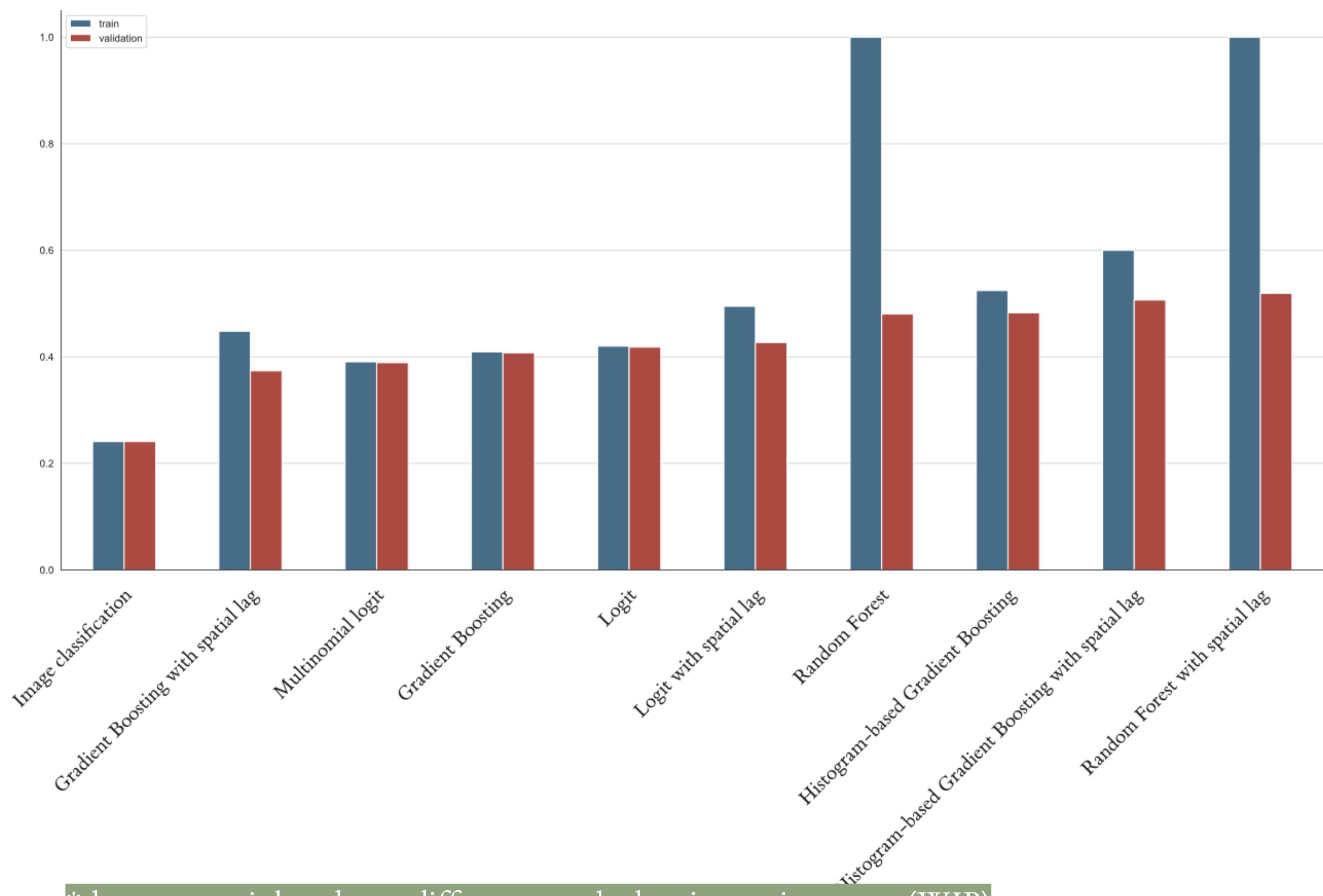
Wild countryside





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

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