

Using deep learning to identify (urban) form and function in satellite imagery

The case of Great Britain

Dani Arribas-Bel

[\[@darribas\]](#)

Martin Fleischmann

[\[@martinfleis\]](#)



The
Alan Turing
Institute



Geographic
Data Science
Lab

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*

BRITISH SIGNATURES

Countryside (3)



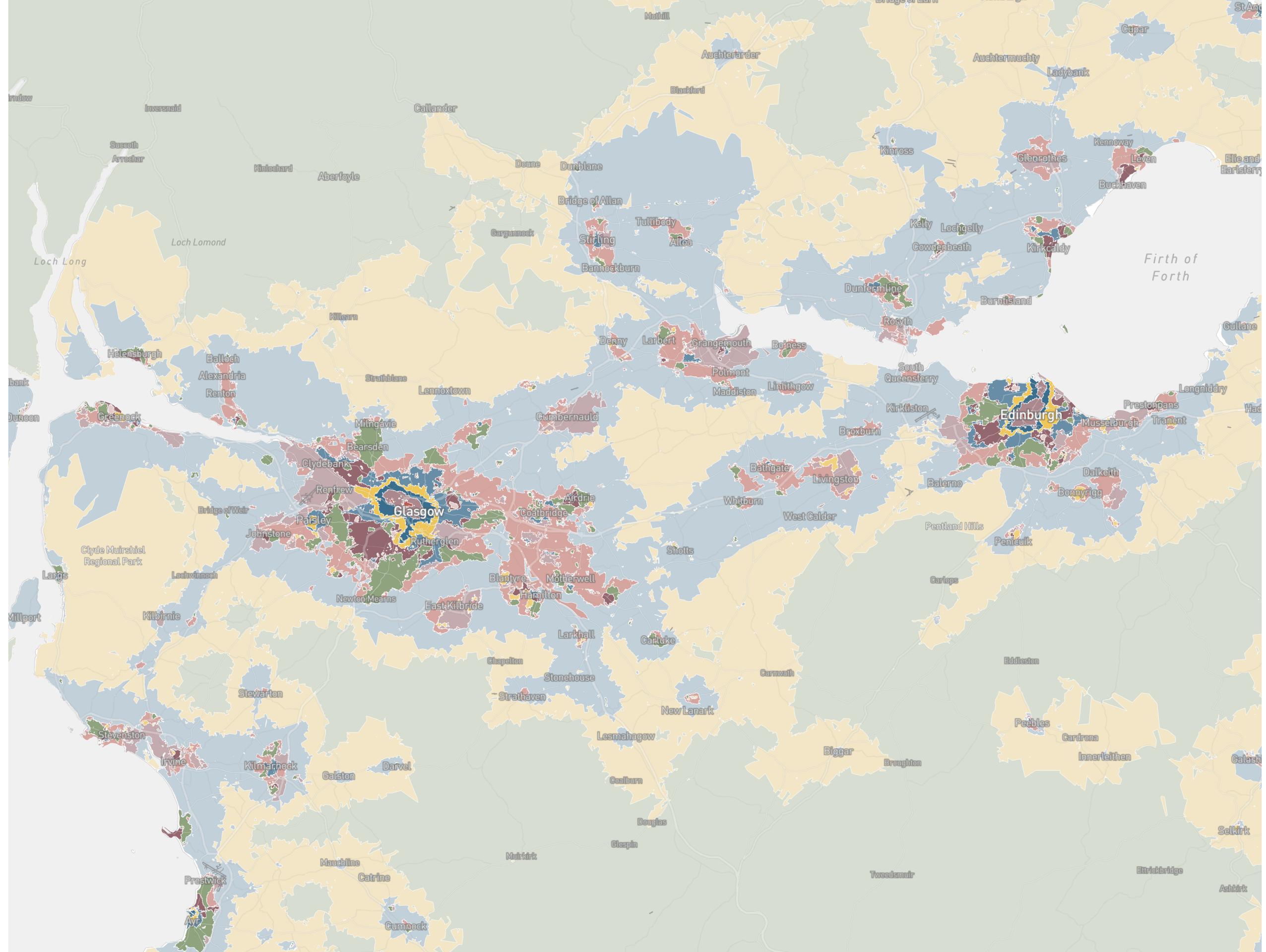
Periphery (4)

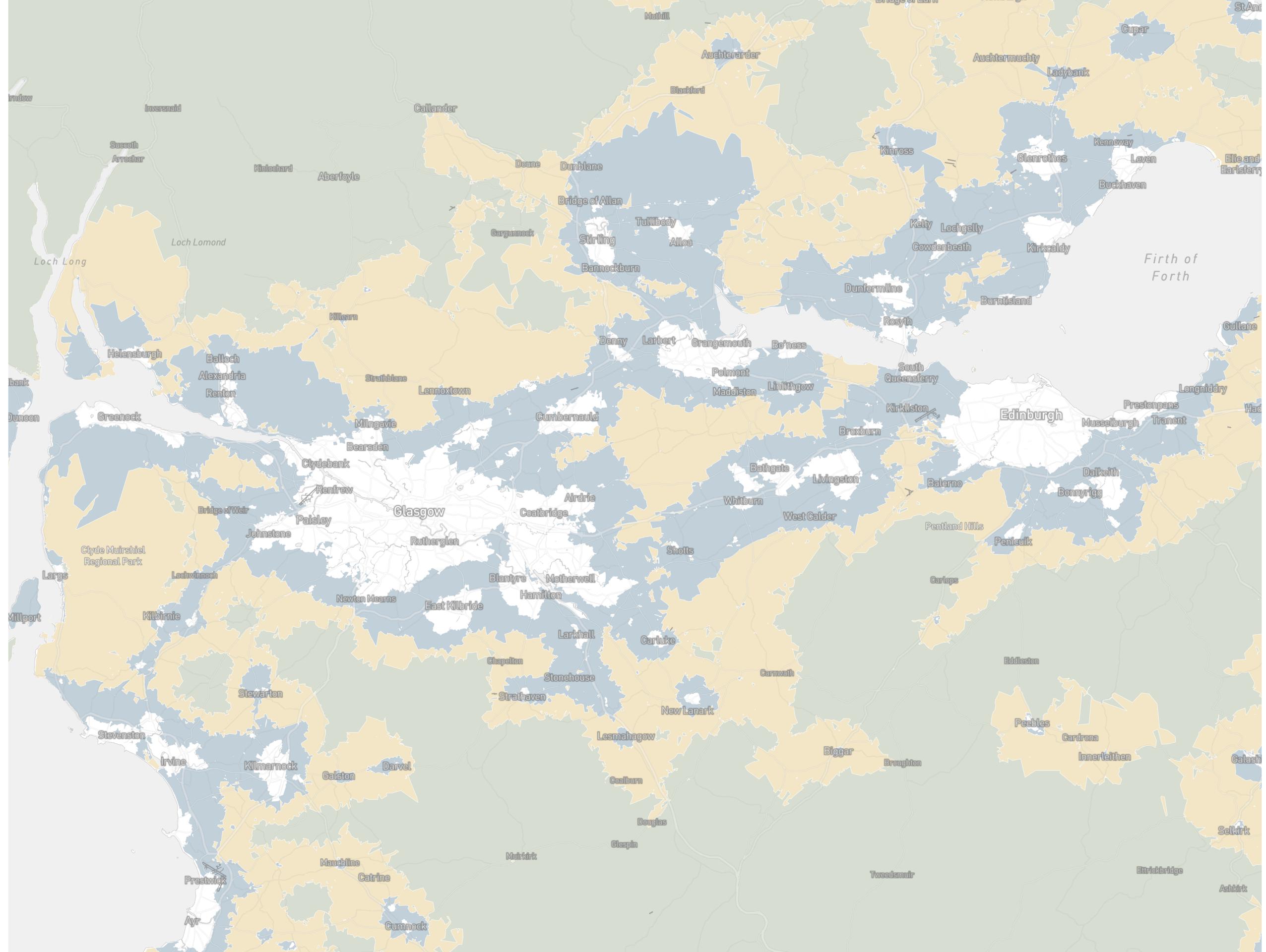


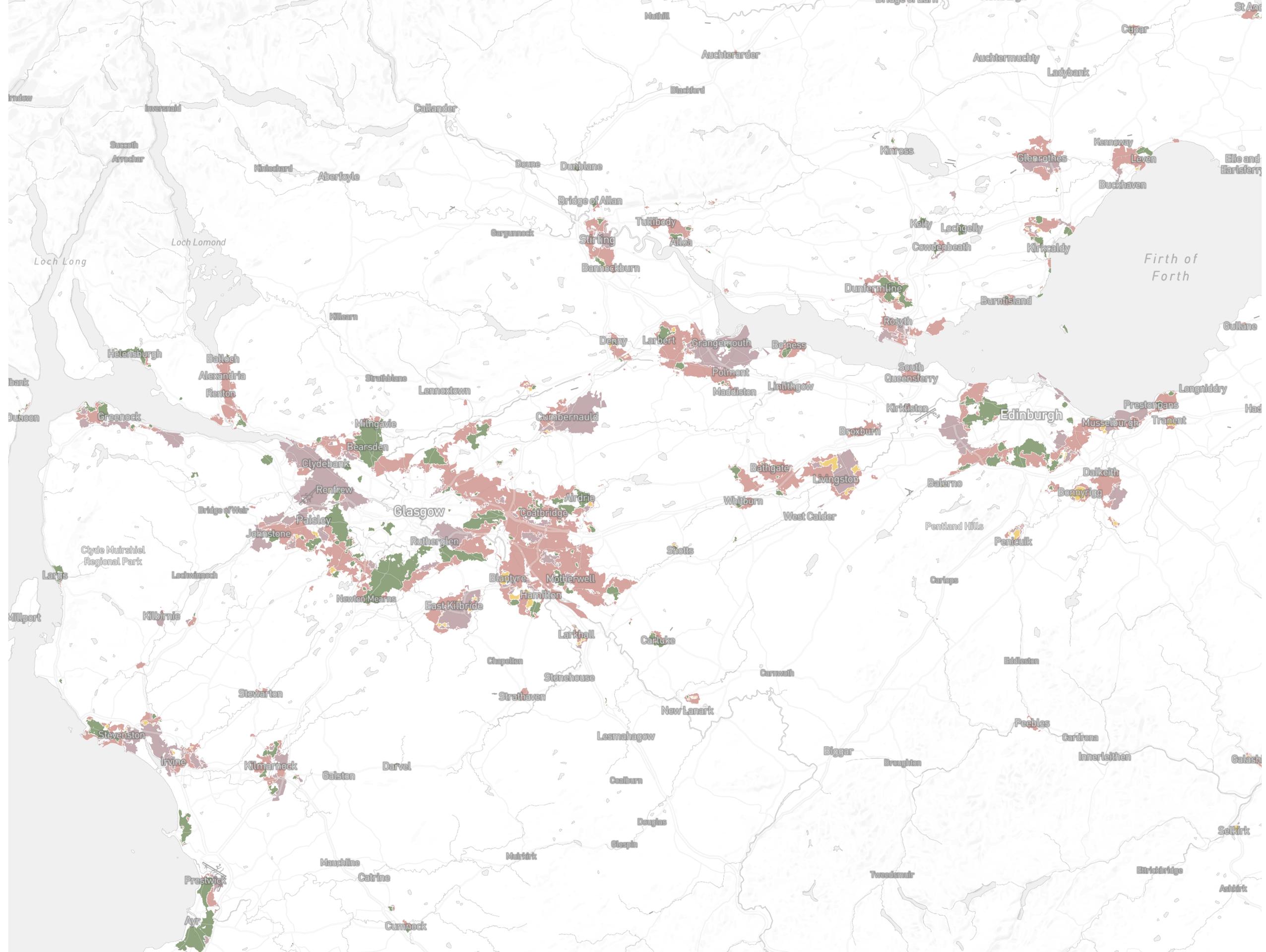
Urban (9)

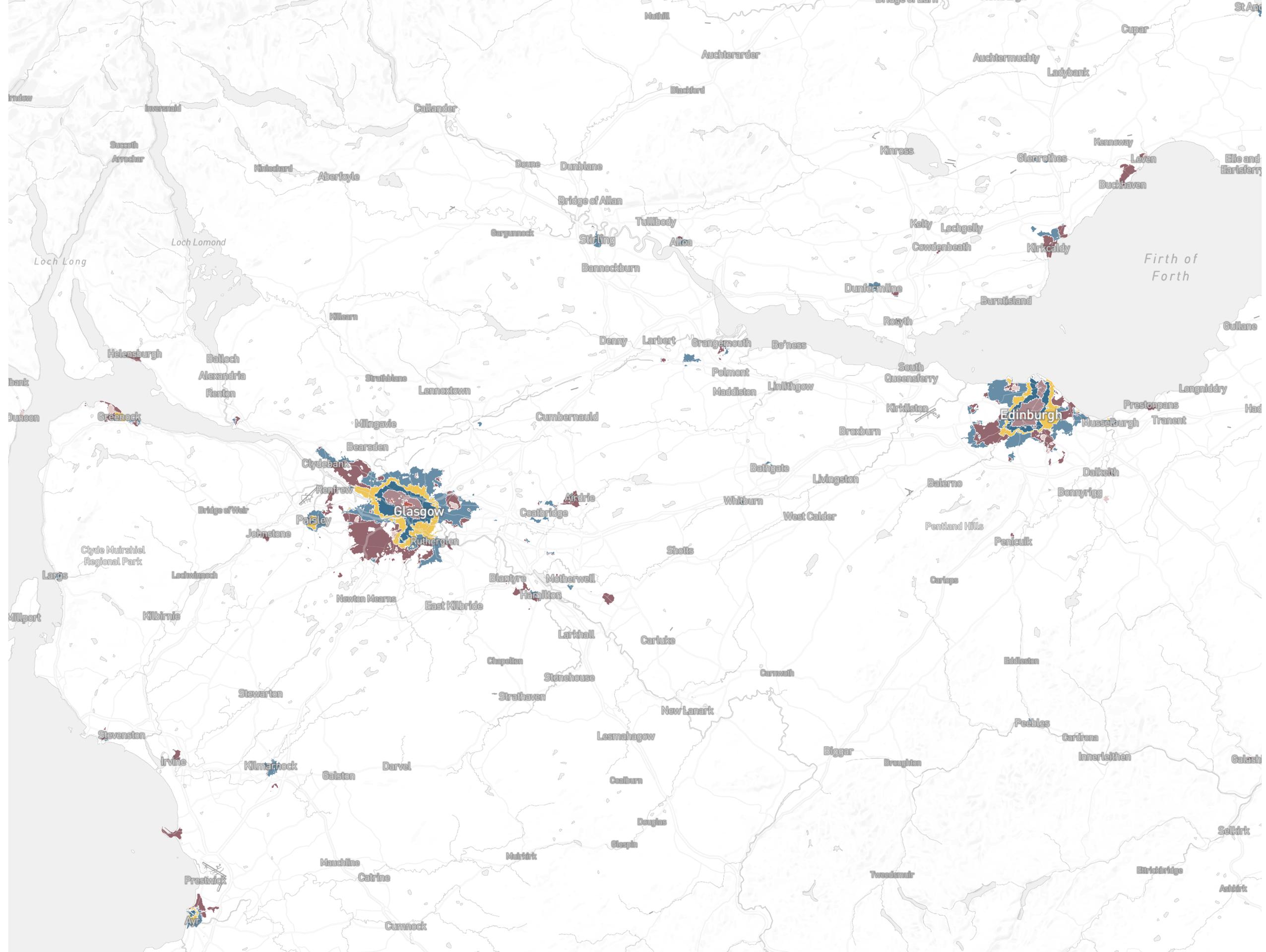


urbangrammarai.xyz/story/





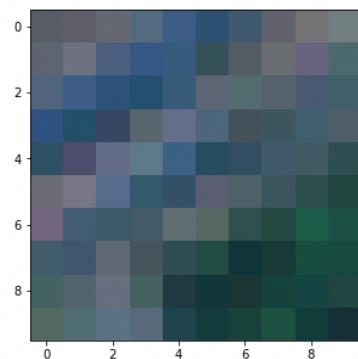




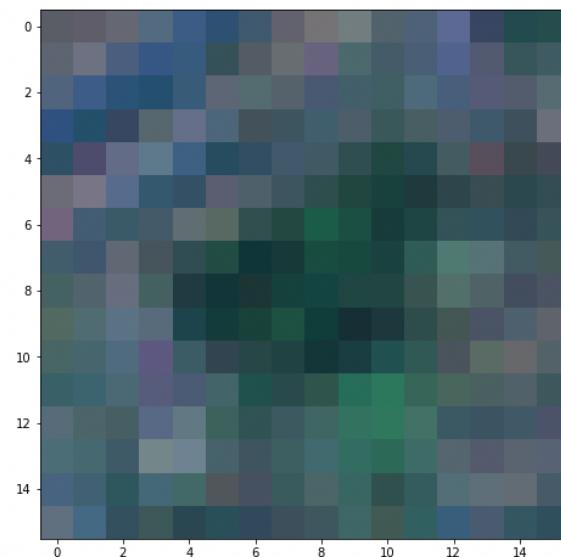


Sentinel 2

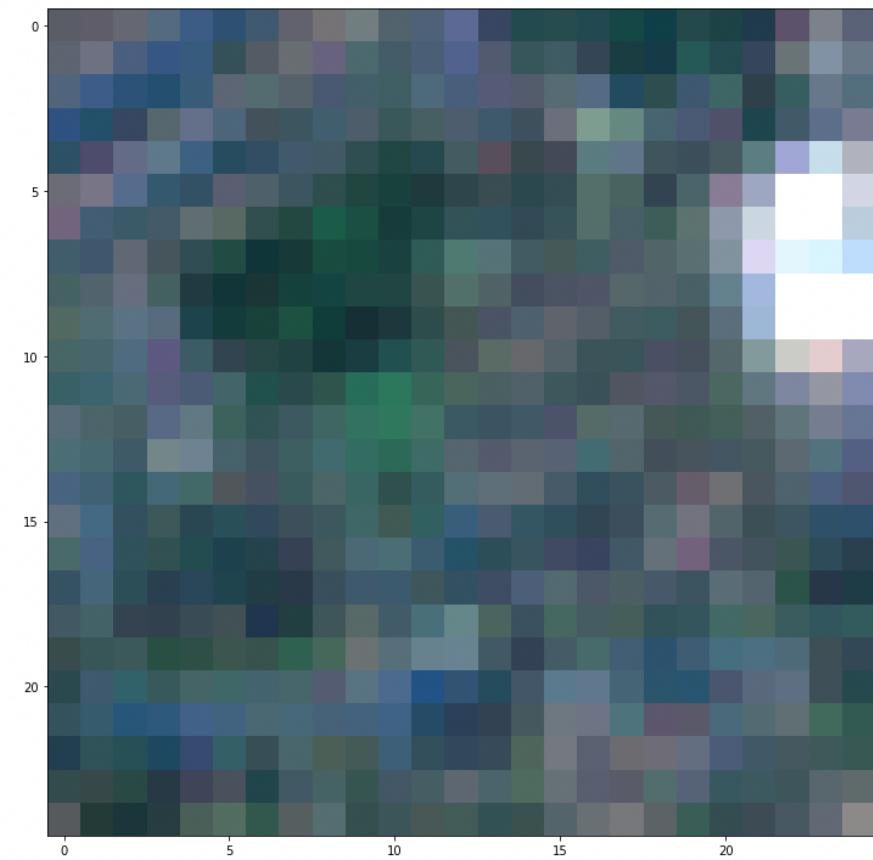
100x100



160x160



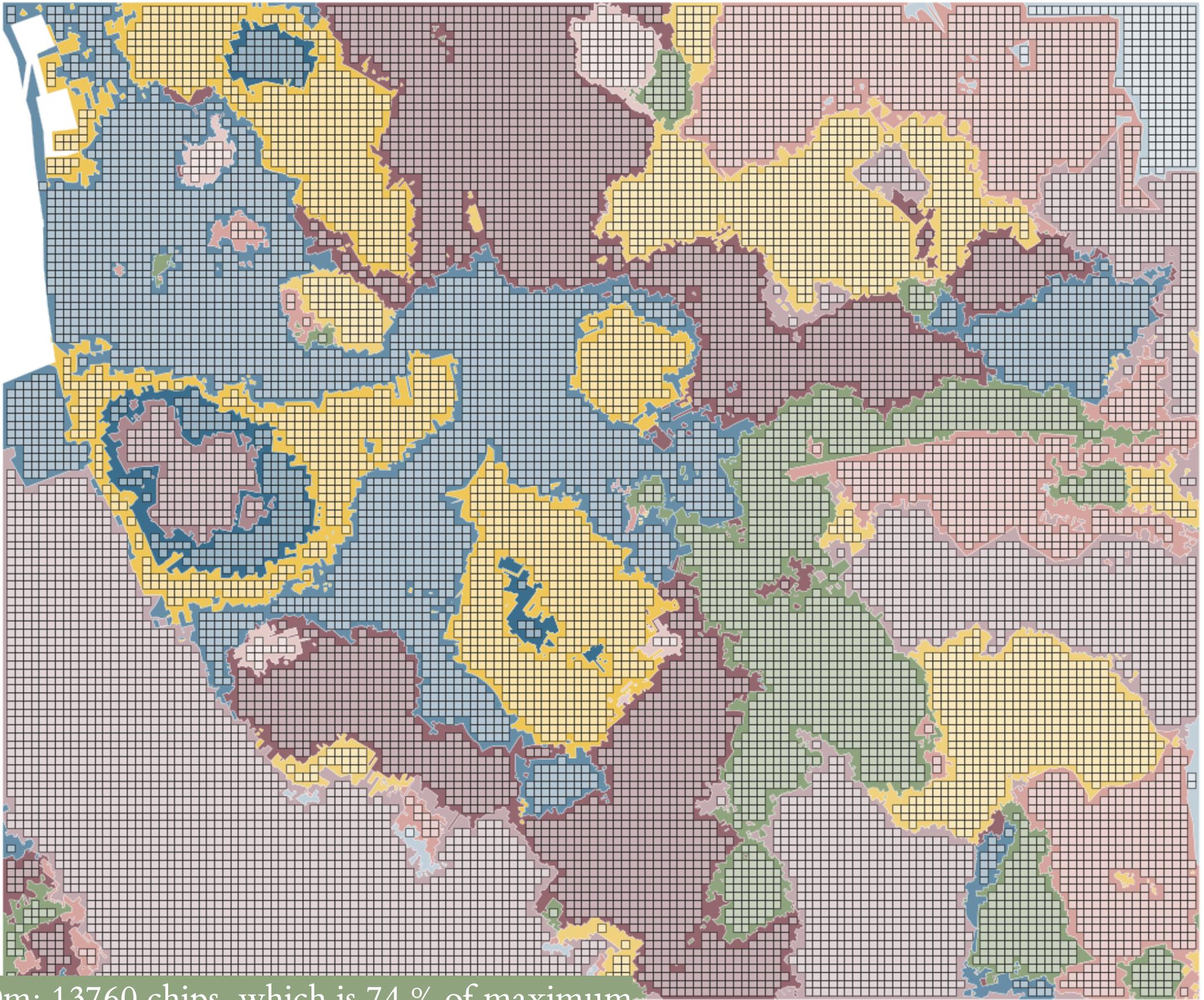
250x250



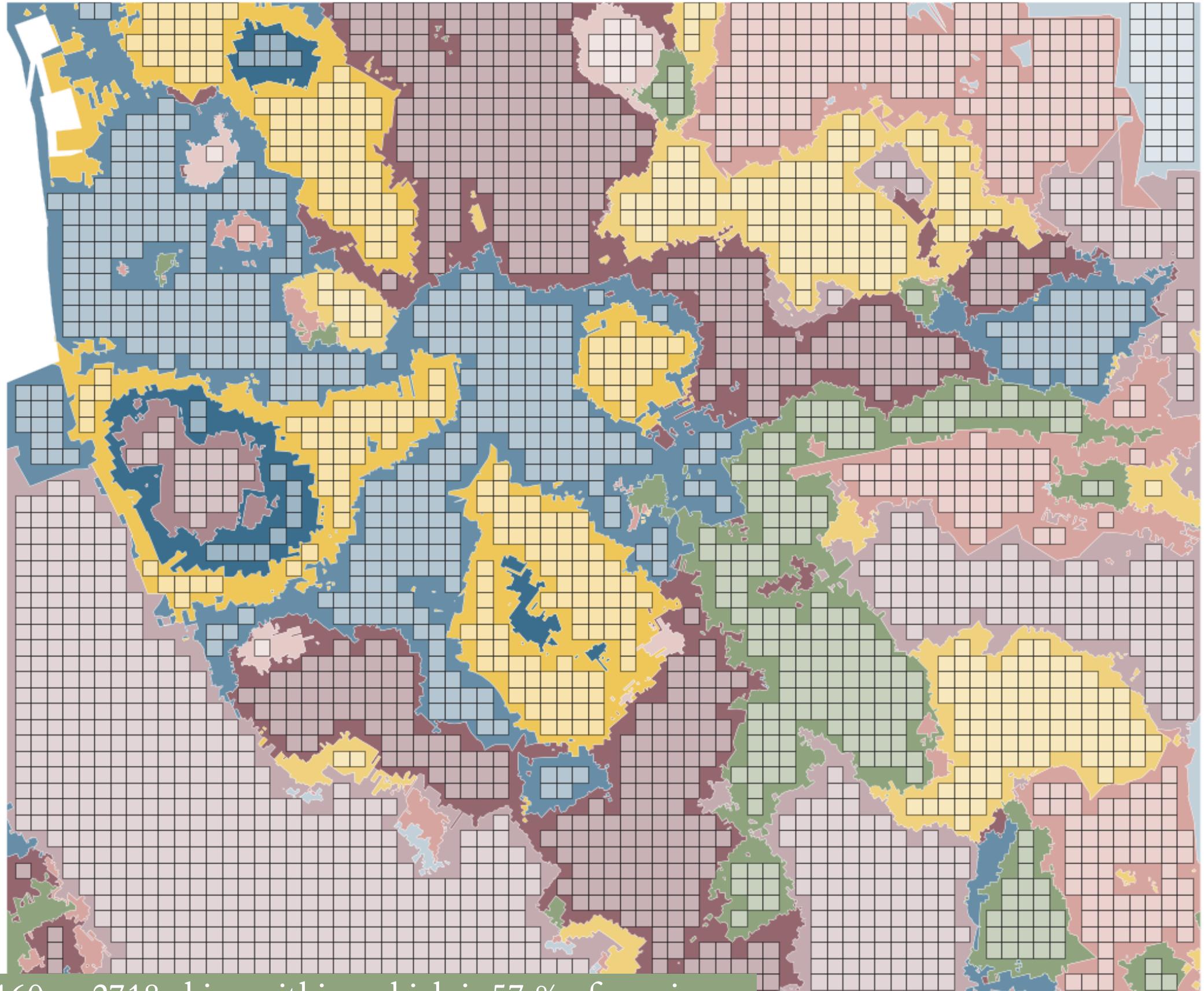
What do we want to do?

train a neural network
understand the role of geography

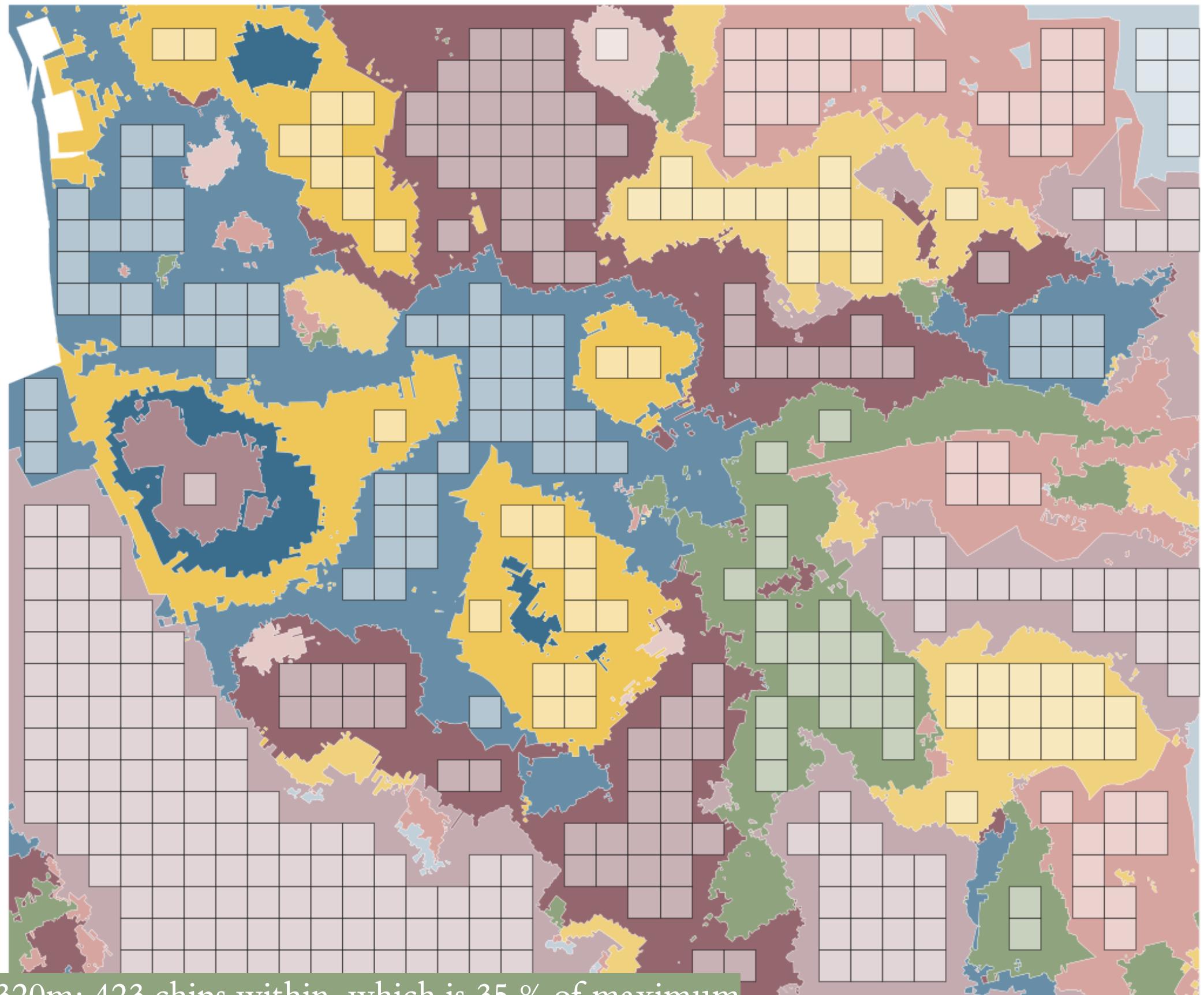
Chip size effect



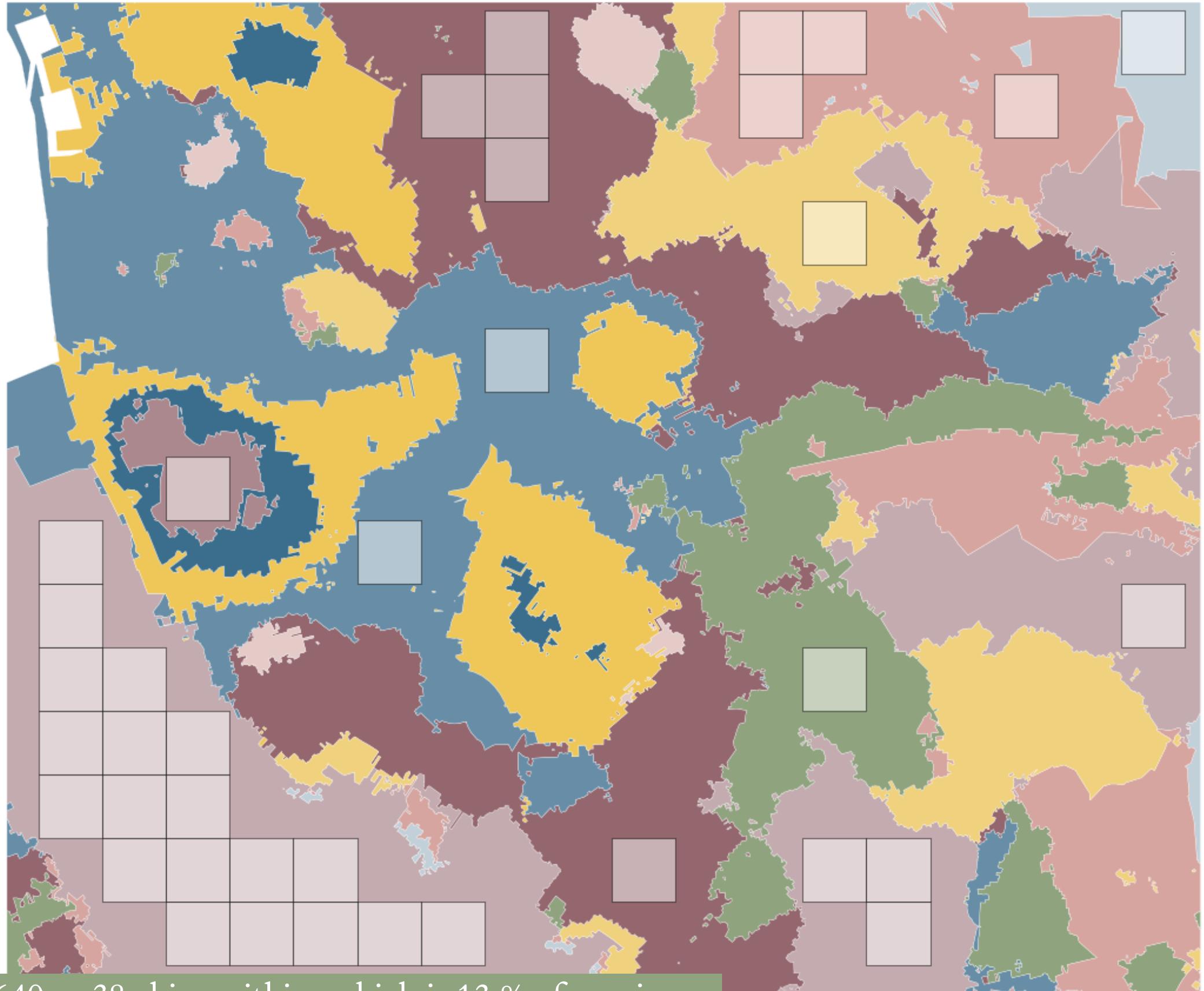
80x80m: 13760 chips, which is 74 % of maximum



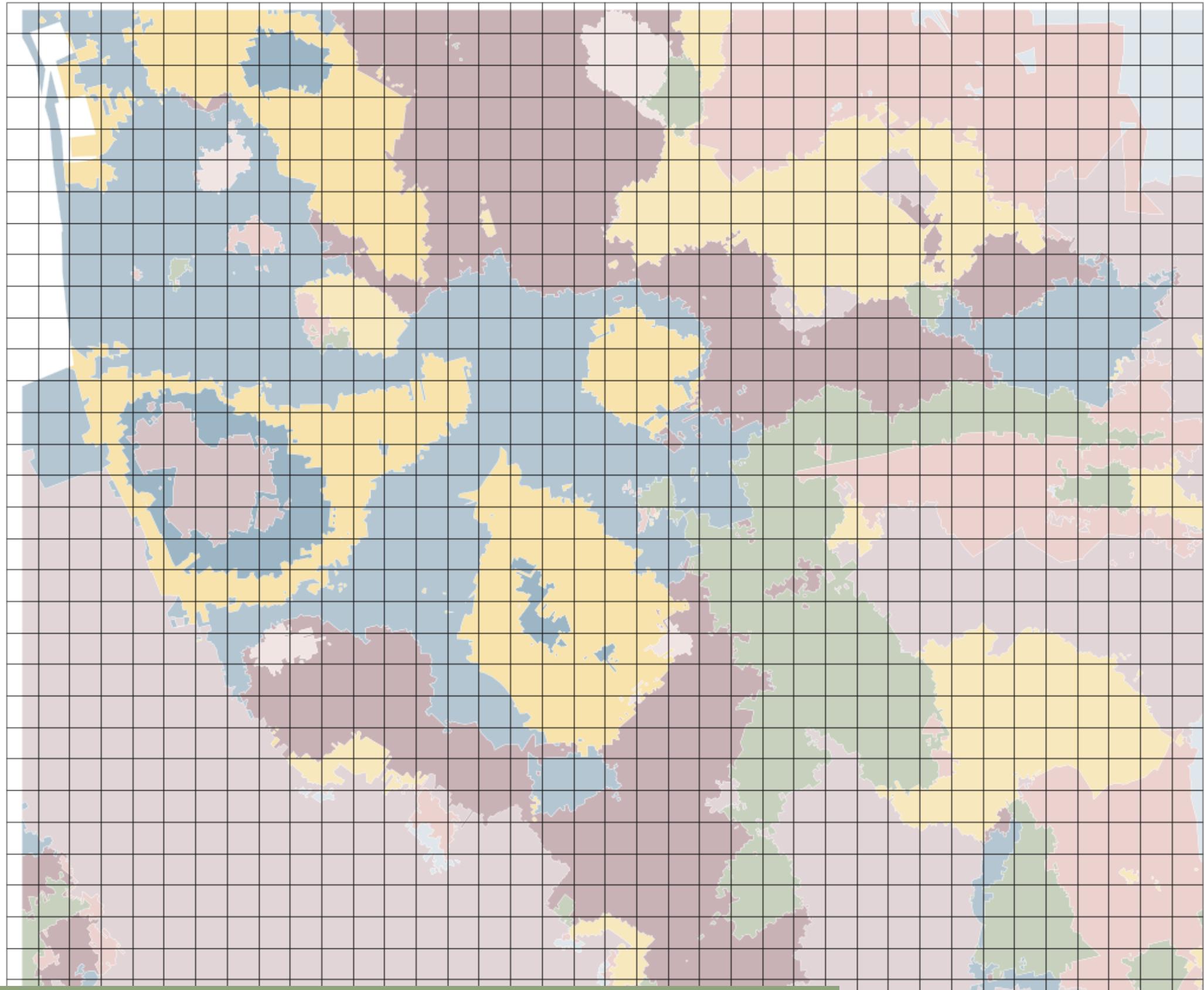
160x160m: 2718 chips within, which is 57 % of maximum



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

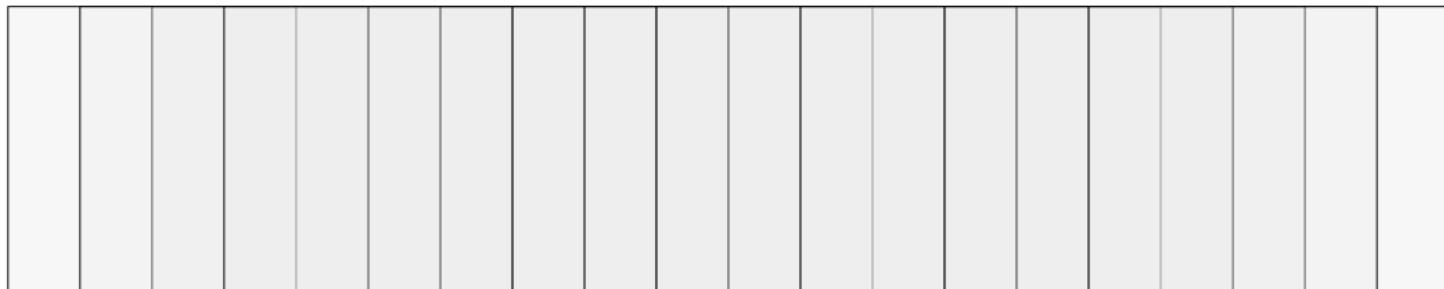


640x640m: 38 chips within, which is 13 % of maximum



320x320m, chips capturing the proportion (100% of maximum)

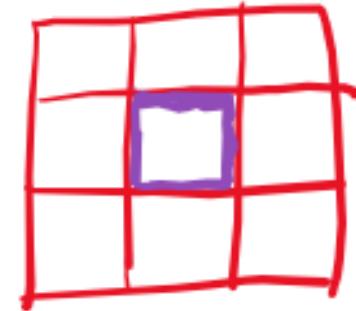
Sliding



Probability modelling

$$S_i = f \left(\sum_k P_k + \sum_k w_k P_k \right)$$

- f {
 - 1. Argmax
 - 2. (MN) Logit
 - 3. Random Forest
 - 4. Grad. Boosted Trees



$$w_{P_i} = \sum_j w_{ij} P_k$$

Preview of results

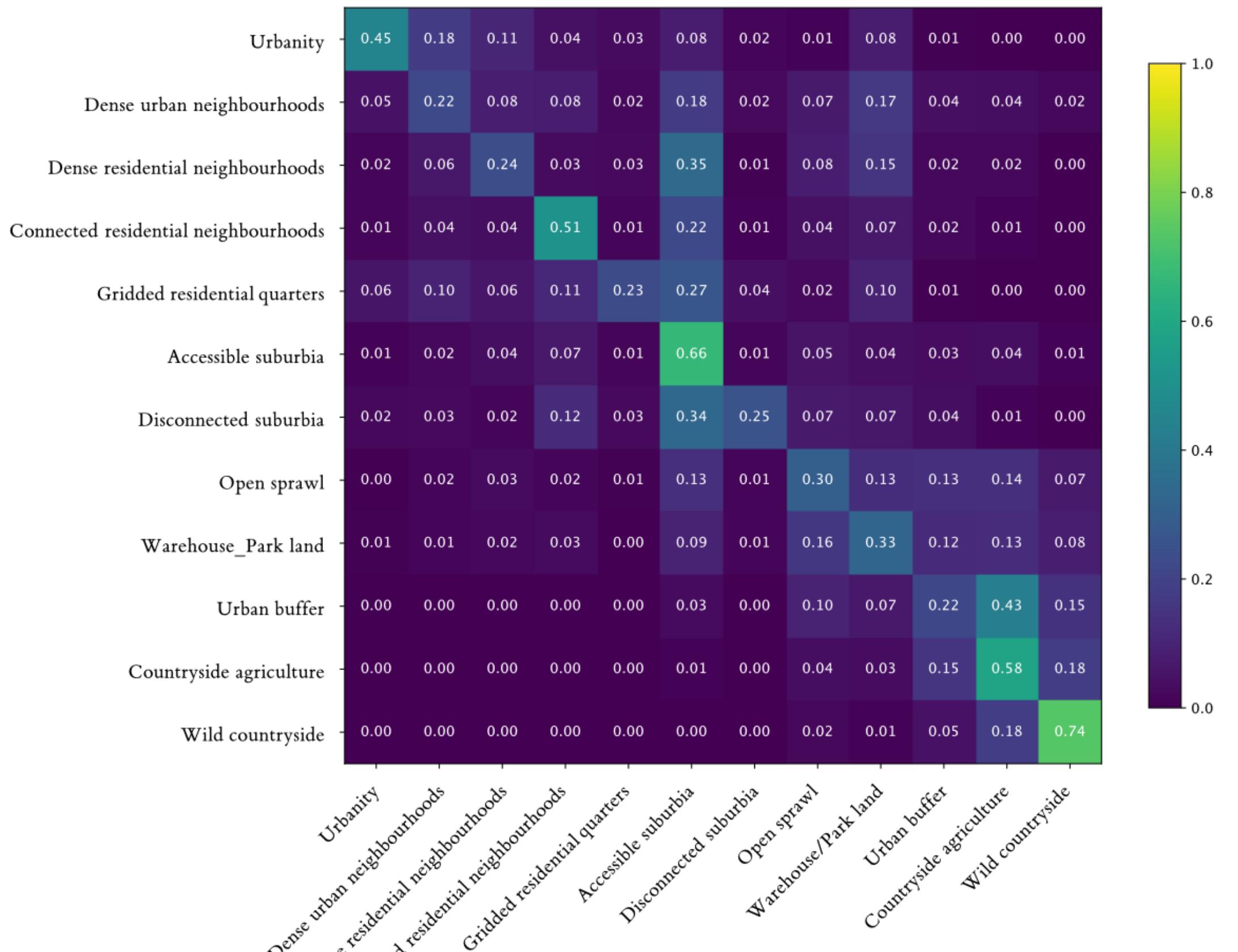
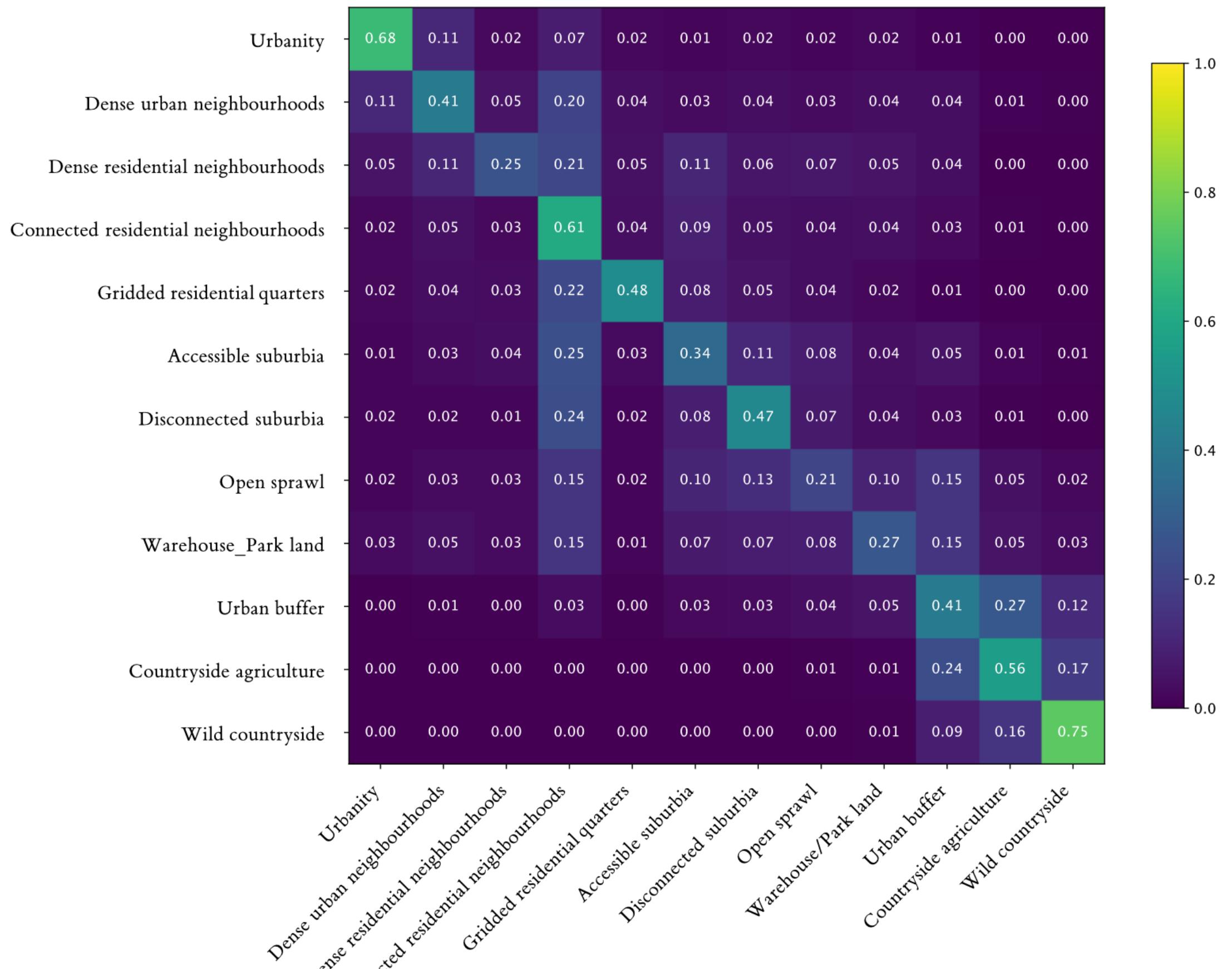


Image classification - Overall accuracy 42.8%



Multi-output regression - Overall accuracy 43.5%

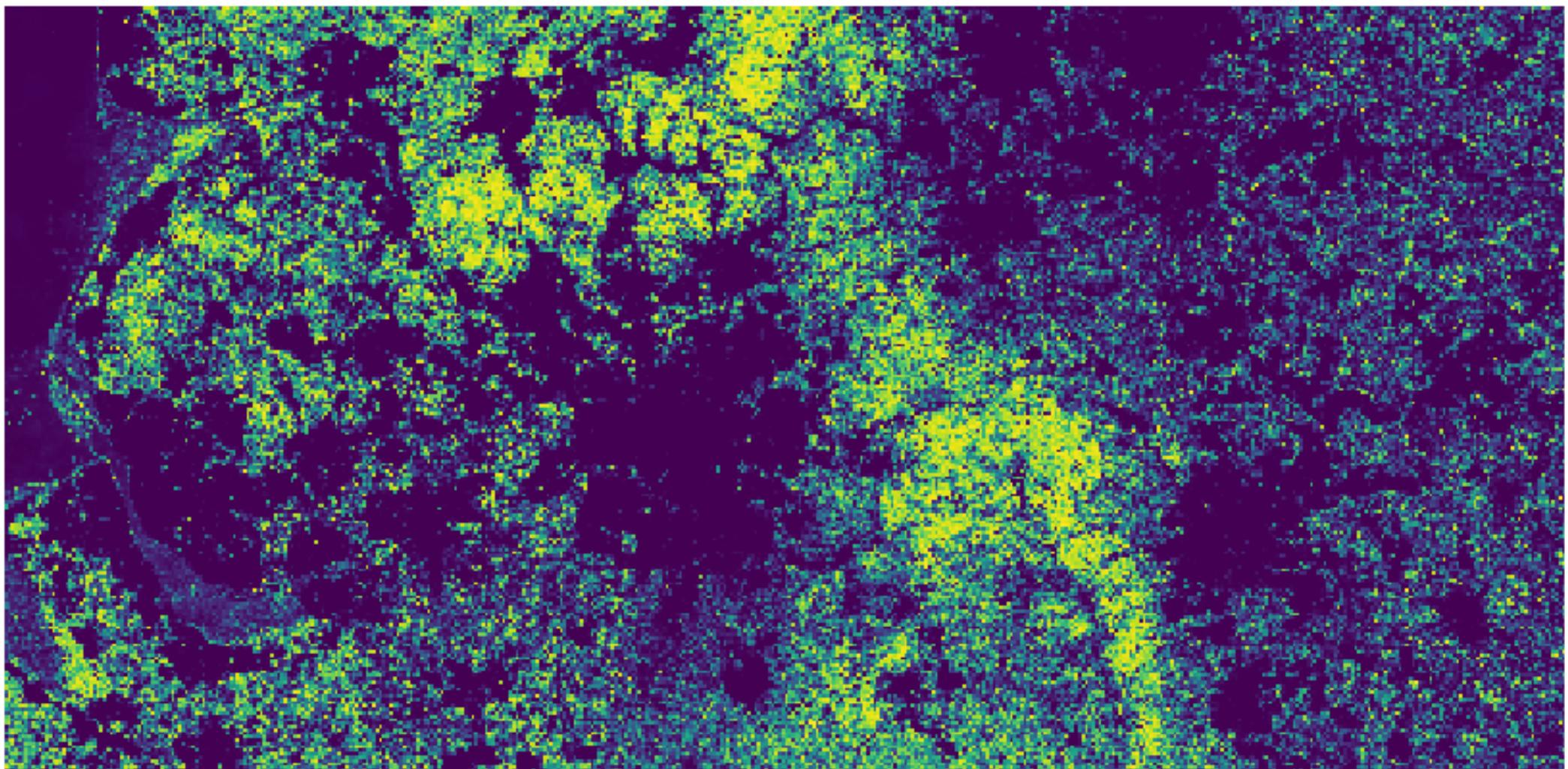
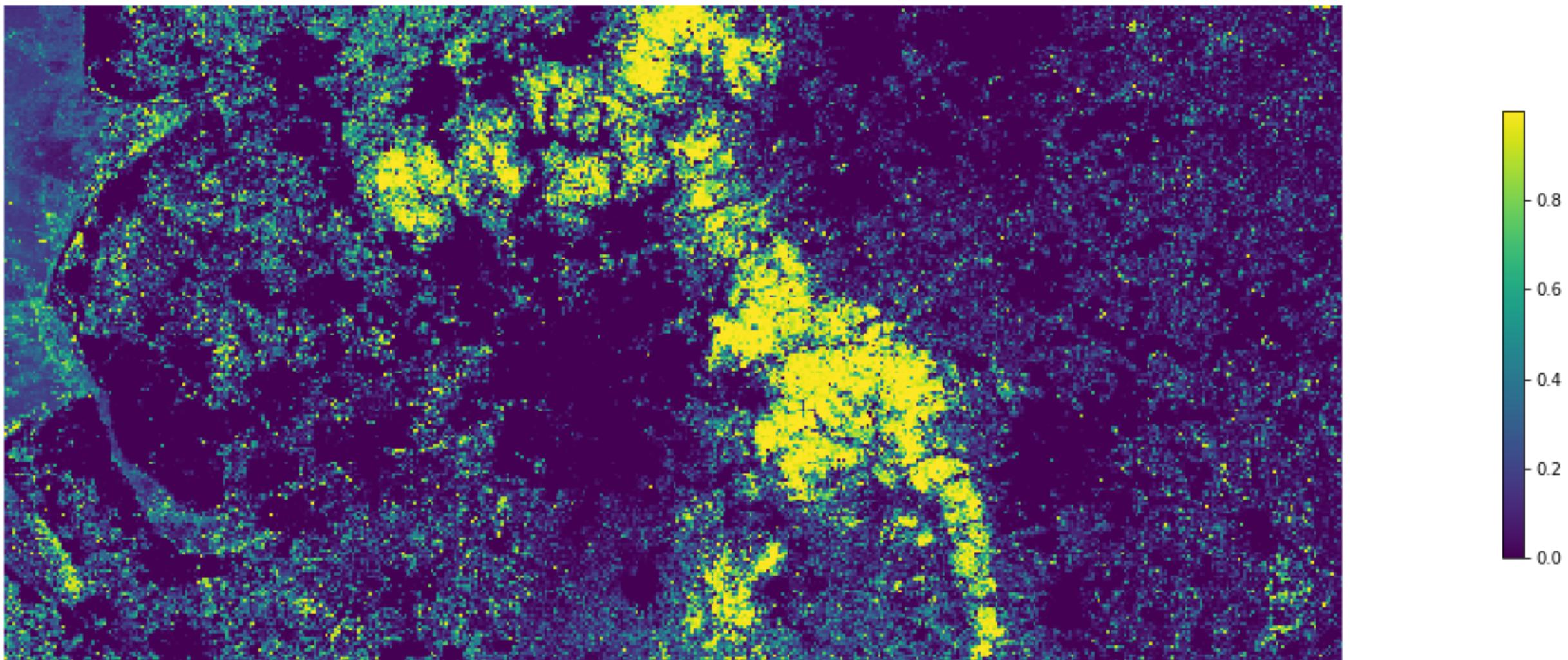


Image classification - Wild countryside



Multi-output regression - Wild countryside

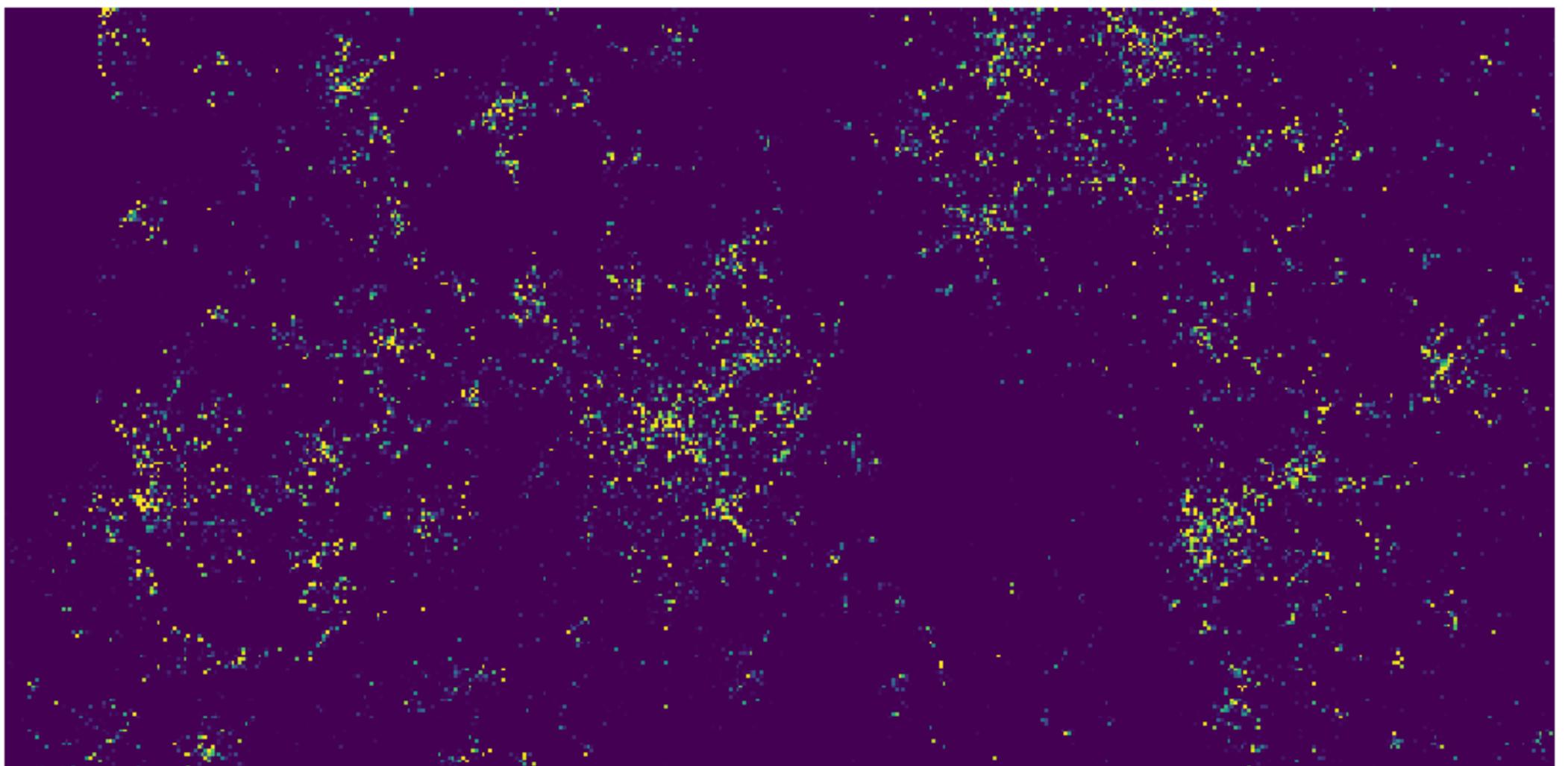
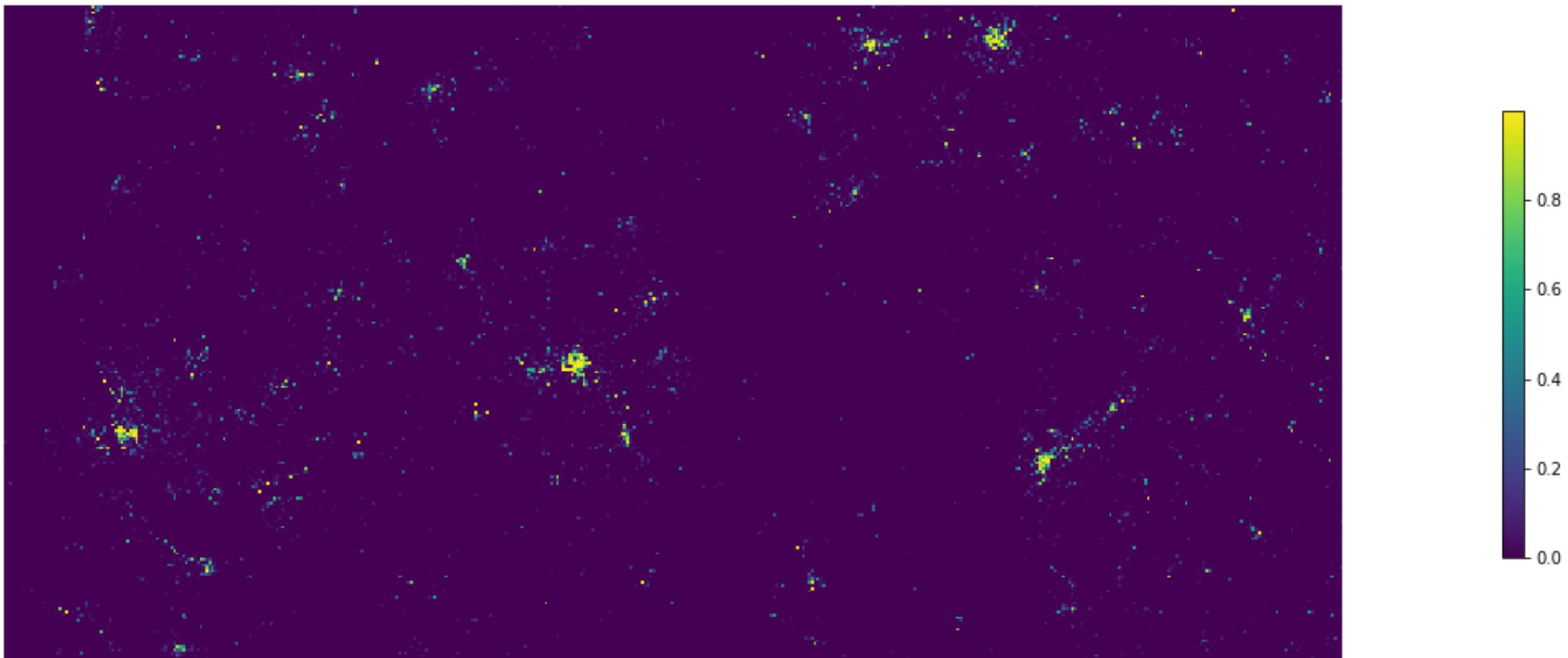
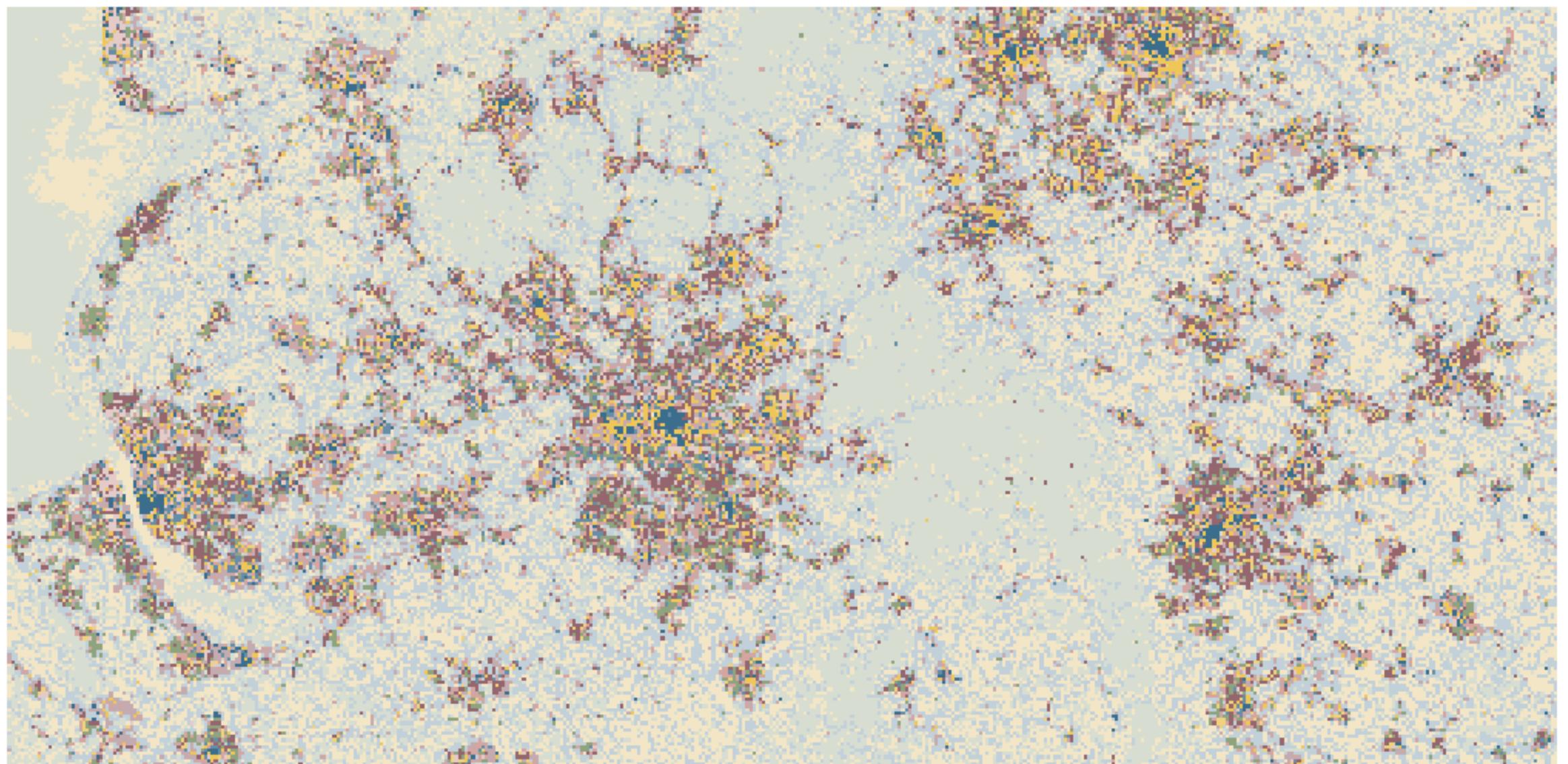


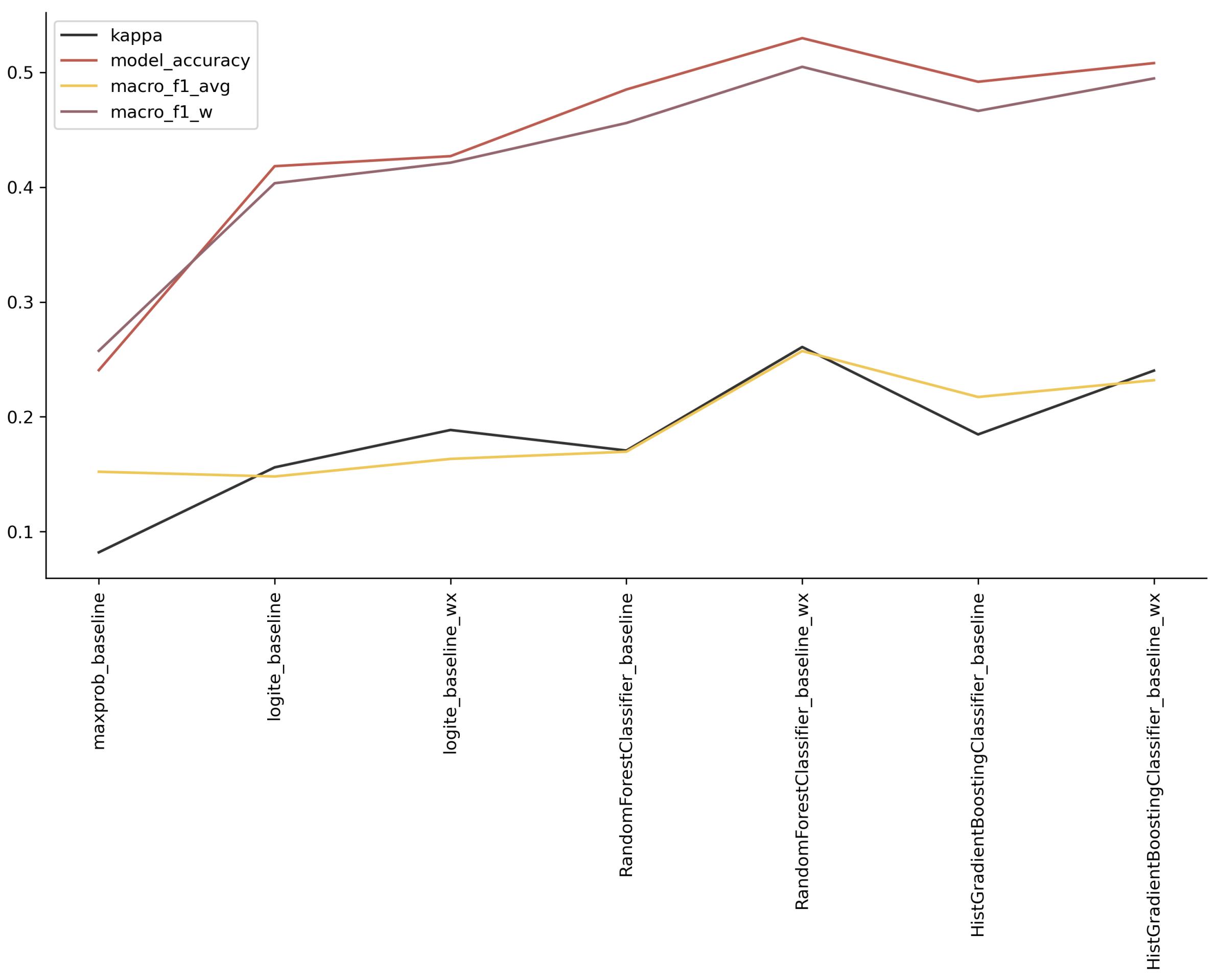
Image classification - Urbanity



Multi-output regression - Urbanity



Multi-output regression - Predicted class (320x320m)



The takeaway

Better (spatial) evaluation of model performance
Probability modeling: *does it make (any) sense?*
Anything else?

Using deep learning to identify (urban) form and function in satellite imagery

The case of Great Britain

Dani Arribas-Bel

[\[@darribas\]](#)

Martin Fleischmann

[\[@martinfleis\]](#)



The
Alan Turing
Institute



Geographic
Data Science
Lab