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LETTER TO THE EDITOR

Letter to the Editor in reference to the article entitled '4D-GWR: geographically, altitudinal, and temporally weighted regression'

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To the Editor:

We write concerning the recently published study by Tasyurek and Celik [1]. The authors extended the geographically weighted regression model (GWR) [2] to incorporate spatial (i.e., latitude and longitude), altitudinal, and temporal nonstationarities (4D-GWR). The core of the study was a model competition including GWR, geographically and altitudinal weighted regression (GAWR), geographically and temporally weighted regression (GTWR), 4D-GWR, and geographically weighted artificial neural network (GWANN) [3]. The authors reported that 4D-GWR is superior in achieving the lowest prediction error and the highest coefficient of determination. While we agree with the authors that 4D-GWR offers promise in predicting outcomes accurately and has some strengths, including the fast calculation of parameters and the consideration of different kinds of nonstationarities, we would like to call the model comparison into question. Our concerns revolve around whether the model comparisons were not always carried out in a methodologically reliable manner and lacked rigor.

First and foremost, the hyperparameters for GWANN were inappropriately chosen, which likely resulted in its lower predictive performance. For instance, the authors used the same bandwidth determined for GWR to fit a GWANN. Since, in contrast to GWR, GWANN can model nonlinear relationships [3] and interactions between variables, the optimal bandwidth for both methods likely differs. Also, the choice of the number of neurons per hidden layer and the learning rate is critical for GWANN. These parameters must be chosen with care. Second, the authors criticized that GWANN can only be fitted with small data sets. This claim is wrong. Given that the computer's memory is sufficiently large, GWANN can deal with large data sets. However, depending on the number of hidden neurons and layers, the number of parameters of GWANN is typically larger than that of GWR; hence, it also requires more memory. Third, in their basic form, both GWR and GWANN were not developed to explore higher-order spaces or temporal nonstationarity. It is thus no surprise that their performance is inferior to 4D-GWR when dealing with higher-order spaces.

Taken together, while there is no silver bullet to model selection, we would like to stress how important it is to carefully tune the models' hyperparameters rather than using some arbitrarily selected off-the-shelf parameters. Given our concerns, we urge caution against the conclusion that 4D-GWR is superior to the competing models.

Declarations

Competing interest The authors declare no competing interests.

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