Doctoral School of Information and Biomedical Technologies Polish Academy of Sciences

Spatial correlations in computational intelligence methods for the air pollution modeling

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Description:
Air pollution is receiving an increasing public attention in recent years as one of the major health risks [1]. Exposure to outdoor fine particulate matter (PM) may affect neurodevelopmental outcomes in humans. However, the mechanisms underlying these relationships are not yet understood and to determine the impact of PM and other air pollutants on the human brains, apart from medical research, it is also necessary to model the exposure levels as accurately as possible throughout life, e.g., using advanced statistical models.
Numerous works on physical models of pollutant distribution (dispersion models) have been published in the literature. However, lack of the necessary historical data and computational requirements make such calculations almost impossible with the required spatial resolution. As part of this doctoral project, other methods will be developed to model concentrations at points in space (across Poland). The main goal of the research will be to develop advanced statistical and fuzzy methods that take into account the spatial correlations of pollutants. The three major health-relevant pollutant (PM2.5, PM10 and NO2) will be considered. Research problems include: (1) selection of explanatory variables and buffers from land-use data, estimates from the dispersion models, emission data; (2) assessments of the spatial correlation of the residuals from the prediction models; (3) development of the fuzzy predictive models to allow for the uncertainty of spatial data to be taken into account and incorporate fuzzy logic to improve models. Fuzzy logic allows to describe the uncertainty associated with measurements and aggregation methods [2].
The research will be carried out on real-life, heterogeneous datasets of high importance for the environment, in particular including data from available dispersion models, data on emissions (related to air quality), data on land-use and metrological data.

Bibliography
1. Kees de Hoogh et al. (2018) “Spatial PM2.5, NO2, O3 and BC models for Western Europe – Evaluation of spatiotemporal stability”, Environment International, Volume 120, pp. 81-92, ISSN 0160-4120,
2. J. Verstraete, "The Spatial Disaggregation Problem: Simulating Reasoning Using a Fuzzy Inference System," in IEEE Transactions on Fuzzy Systems, vol. 25, no. 3, pp. 627-641, June 2017, doi: 10.1109/TFUZZ.2016.2567452

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