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## APPLYING ENSEMBLE LEARNING TO PREDICT OUTDOOR RADON LEVEL: A CASE STUDY

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### ABSTRACT

Radon (the isotope Rn-222) is a radioactive noble gas widely distributed in nature. It is emitted from the Earth's interior and has a short decay half-life of 3.82 days. Due to the properties of radon, fluctuations in its levels are considered an indicator of pre-seismic phenomena, and radon - as a precursor to earthquakes. In this work, the application of ensemble tree learning methods for studying time series with radon emissions data is presented. The Random Forests, and Adaptively resampling and combine (Arcing, Arc-x4) methods were applied. Predictors in the modeling process are rapidly changing meteorological variables such as air temperature, humidity and atmospheric pressure. To construct the models data from two measuring stations located near an earthquake fault in Bulgaria are used. Highly efficient machine learning models for predicting radon concentrations have been built and statistically tested. The influence of predictors in the models has been established. With the help of the obtained models, anomalies in the behavior of radon have been identified, which can be associated with earthquakes that have occurred in the studied geographical area.

**Keywords** Time series · Radon precursor · Ensemble tree learning · Earthquake · Random Forests

### References

- [1] Elío, J., Petermann, E., Bossew, P., and Janik, M., Machine learning in environmental radon science, *Applied Radiation and Isotopes* 194, 110684, 2023.
- [2] Yotov, K., Hadzhikolev, E., and Hadzhikoleva, S., Modeling the relationship between radon anomalies and seismic activity using artificial neural networks and statistical methods, *Mathematics* 13(7), 1075, 2025.
- [3] Breiman L., Random forests, *Machine Learning* 45(1), 5–12, 2001.
- [4] Breiman L., Arcing classifiers, *Annals of Statistics* 26, 801–849, 1998.

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