EGU21-13905
https://doi.org/10.5194/egusphere-egu21-13905
EGU General Assembly 2021

Rx TimeMachine: A global pseudoprospective earthquake forecast database for training and ranking predictive algorithms

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Recent advances in machine learning and pattern recognition methods have propagated into various applications in seismology. Phase picking, earthquake location, anomaly detection and classification applications have benefited also from the increased availability of cloud computing and open-source software libraries. However, applications of these new techniques to the problems of earthquake forecasting and prediction have remained relatively stagnant.

The main challenges in this regard have been the testing and validation of the proposed methods. While there are established metrics to quantify the performance of algorithms in common pattern recognition and classification problems, the earthquake prediction problem requires a properly defined reference (null) model to establish the information gain of a proposed algorithm. This complicates the development of new methods, as researchers are required to develop not only a novel algorithm but also a sufficiently robust null model to test it against.

We propose a solution to this problem. We have recently introduced a global real-time earthquake forecasting model that can provide occurrence probabilities for a user defined time-space-magnitude window anywhere on the globe (Nandan et al. 2020). In addition, we have proposed the Information Ratio (IR) metric that can rank algorithms producing alarm based deterministic predictions as well as those producing probabilistic forecasts (Kamer et al. 2020). To provide the community with a retrospective benchmark, we have run our model in a pseudoprospective fashion for the last 30 years (1990-2020). We have calculated and stored the earthquake occurrence probabilities for each day, for the whole globe (at ~40km resolution) for various time-space windows (7 to 30 days, 75 to 300 km). These can be queried programmatically via an Application Programmable Interface (API) allowing model developers to train and test their algorithms retrospectively. Here we shall present how the Rx TimeMachine API is used for the training of a simple pattern recognition algorithm and show the algorithm's prospective predictive performance.

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