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Forecasting the Preparatory Phase of Induced Earthquakes by Recurrent Neural Network

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Earthquakes prediction is considered the holy grail of seismology. After almost a century of efforts without convincing results, the recent raise of machine learning (ML) methods in conjunction with the deployment of dense seismic networks has boosted new hope in this field. Even if large earthquakes still occur unanticipated, recent laboratory, field and theoretical studies support the existence of a preparatory phase preceding earthquakes, where small and stable ruptures progressively develop into an unstable and confined zone around the future hypocenter. The problem of recognizing the preparatory phase of earthquakes is of critical importance for mitigating seismic risk for both natural and induced events. Here, we focus on the induced seismicity at The Geysers geothermal field in California. We address the preparatory phase of M~4 earthquakes identification problem by developing a ML approach based on features computed from catalogues, which are used to train a Recurrent Neural Network (RNN). We show that RNN successfully reveal the preparation of M~4 earthquakes. These results confirm the potential of monitoring induced microseismicity and should encourage new research also in predictability of natural earthquakes.