**Network Applications in Earthquake Prediction (1994–2019): Meta-Analytic and Statistical Insights on Their Limitations**

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Abstract

In the last few years, deep learning has solved seemingly intractable problems, boosting the hope to find approximate solutions to problems that now are considered unsolvable.

近幾年，深度學習已經解決表面上棘手的問題，提振希望找到解決現在被認為無法解決的問題的近似解決方案

Earthquake prediction, the Grail of Seismology, is, in this context of continuous exciting discoveries, an obvious choice for deep learning exploration.

地震預測，地震學的聖杯，是在連續興奮發現的景況，對深度學習探勘是一個明顯的選擇

We reviewed the literature of artificial neural network (ANN) applications for earthquake prediction (77 articles, 1994–2019 period) and found two emerging trends: an increasing interest in this domain over time and a complexification of ANN models toward deep learning.

我們複習有關地震預測的人工神經網路應用的文章(77篇，在1944~2019間)然後找到2種新興趨勢:隨著時間推移，在這個領域有逐漸增加的利益和人工神經網路的複雜性朝向深度學習

Despite the relatively positive results claimed in those studies, we verified that far simpler (and traditional) models seem to offer similar predictive powers, if not better ones.

儘管相關正面的結果在這些文章已公布，我們以驗證較簡單的模型似乎提供相似的預測力量，如果不是較好的一個

Those include an exponential law for magnitude prediction and a power law (approximated by a logistic regression or one artificial neuron) for aftershock prediction in space.

那些包含大小預測的指數分布和空間中餘震預測的冪定律

Because of the structured, tabulated nature of earthquake catalogs, and the limited number of features so far considered, simpler and more transparent machine-learning models than ANNs seem preferable at the present stage of research.

因為地震目錄自然列表的結構和到目前為止考慮的功能數量有限，比ANN更簡單透明的機器學習模型似乎在現階段的研究更受喜愛

Those baseline models follow first physical principles and are consistent with the known empirical laws of statistical seismology (e.g., the Gutenberg–Richter law), which are already known to have minimal abilities to predict large earthquakes.

那些基準模型遵守第一原理和統計地震學的已知經驗定律(例如 GR Law)一致，已經知道有最小能力預測大地震

Introduction

Deep learning is rapidly rising as one of the most powerful go to techniques not only in data science(Jordan and Mitchell,2015；Lecun et al,2015) but also for solving hard and intractable problems of physics(Carleo and Troyer,2017；Hen et al, 2018；Pathak et al,2018)

深度學習快速成為一種強力的科技，不只是資料科學還有解決困難棘手的物理問題

This is explained by the greater performance of such techniques to discover hidden patterns in very large data sets. One of the main advantages of artificial neural networks(ANNS), which encompass both shallow and deep neural networks(DNNs), is that they do not require feature extraction and feature engineering, as relatively unprocessed data can be used directly to train the network with potentially very good results.

被這類科技較好的表現解釋，發現大量數據的隱藏模式最主要的優勢之一為ANNs，包含淺層和深度神經網路，他們不需特徵提取和特徵工程，作為相對未處理的檔案可以直接被用於訓練潛在網絡非常好的結果