



Machine learning-detected signal predicts time to earthquake

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‘Fingerprint’ of fault displacement also forecasts magnitude of rupture

LOS ALAMOS, N.M., Dec. 17, 2018—Machine-learning research published in two related papers today in *Nature Geosciences* reports the detection of seismic signals accurately predicting the Cascadia fault’s slow slippage, a type of failure observed to precede large earthquakes in other subduction zones.

Los Alamos National Laboratory researchers applied machine learning to analyze Cascadia data and discovered the megathrust broadcasts a constant tremor, a fingerprint of the fault’s displacement. More importantly, they found a direct parallel between the loudness of the fault’s acoustic signal and its physical changes. Cascadia’s groans, previously discounted as meaningless noise, foretold its fragility.

“Cascadia’s behavior was buried in the data. Until machine learning revealed precise patterns, we all discarded the continuous signal as noise, but it was full of rich information. We discovered a highly predictable sound pattern that indicates slippage and fault failure,” said Los Alamos scientist Paul Johnson. “We also found a precise link between the fragility of the fault and the signal’s strength, which can help us more accurately predict a megaquake.”

The new papers were authored by Johnson, Bertrand Rouet-Leduc and Claudia Hulbert from the Laboratory’s Earth and Environmental Sciences Division, Christopher Ren from the Laboratory’s Intelligence and Space Research Division and collaborators at Pennsylvania State University.

Machine learning crunches massive seismic data sets to find distinct patterns by learning from self-adjusting algorithms to create decision trees that select and retest a series of questions and answers. Last year, the team simulated an earthquake in a laboratory, using steel blocks interacting with rocks and pistons, and recorded sounds that they analyzed by machine learning. They discovered that the numerous seismic signals, previously discounted as meaningless noise, pinpointed when the simulated fault would slip, a major advance towards earthquake prediction. Faster, more powerful quakes had louder signals.

The team decided to apply their new paradigm to the real world: Cascadia. Recent research reveals that Cascadia has been active, but noted activity has been seemingly random. This team analyzed 12 years of real data from seismic stations in the region

and found similar signals and results: Cascadia's constant tremors quantify the displacement of the slowly slipping portion of the subduction zone. In the laboratory, the authors identified a similar signal that accurately predicted a broad range of fault failure. Careful monitoring in Cascadia may provide new information on the locked zone to provide an early warning system.

The papers:

- [Similarity of fast and slow earthquakes illuminated by machine learning](#), Nature Geoscience, Dec. 17, 2018
- [Continuous chatter of the Cascadia subduction zone revealed by machine learning](#), Nature Geoscience, Dec. 17, 2018

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