The Promise of Machine Learning in Solid Earth Geoscience: Examples from Seismology

*Gregory C Beroza[1], Mostafa Mousavi[1], Weiqiang Zhu[1], Karianne J Bergen[2], Paul A Johnson[3], Maarten V De Hoop[4]

1. Stanford University, 2. Harvard University, 3. Los Alamos National Laboratory, 4. Rice University

Physical, chemical, and biological processes all have substantial influence on the solid Earth. They range over tremendous spatial and temporal scales and can interact in complex ways. Increasingly, humans interact with the shallow reaches of the Earth in ways that are increasingly consequential. The solid Earth presents a variety of natural hazards that are poorly understood, yet increasingly impactful as exposure grows through increasing urbanization in hazard-prone areas. We need to improve our understanding of how the Earth works; however, attempts to understand the solid Earth are challenging because nearly all of the Earth’ s interior is inaccessible to direct observation. Knowledge of the Earth's interior must be based on inference, through interpretation of measurements taken at or near the surface, through controlled laboratory experiments, and through numerical simulations. For this reason solid Earth geoscience is both a data-driven and a model-driven field. Unanticipated discoveries increasingly will come from the analysis of large data sets, novel developments in inverse theory, and procedures enabled by computationally intensive simulations. Increasingly affordable and capable sensors are dramatically increasing the data available to drive this understanding. Moreover, the increasingly realistic character of computer simulations are better able to represent the behavior of the Earth. We are faced with the challenge of gaining new insights from these data and simulations, and techniques from the rapidly evolving field of machine learning (ML) are likely to play a key role in this effort. In this talk we illustrate the promise of machine learning using recent examples from seismology.

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