COMPUTATIONAL FRAMEWORK FOR NUMERICAL PROBABILISTIC SEISMIC HAZARD ANALYSIS (PSHA)

Tech ID: 33597 / UC Case 2024-147-0

PATENT STATUS

Patent Pending

BRIEF DESCRIPTION

Probabilistic Seismic Hazard Analysis (PSHA) has become a foundational method for determining seismic design levels and conducting regional seismic risk analyses for insurance risk analysis, governmental hazard mapping, critical infrastructure planning, and more. PSHA traditionally relies on two computationally intensive approaches: Riemann Sum and conventional Monte Carlo (MC) integration. The former requires fine slices across magnitude, distance, and ground motion, and the latter demands extensive synthetic earthquake catalogs. Both approaches become notably resource intensive for low-probability seismic hazards, where achieving a COV of 1% for a 10^{-4} annual hazard probability may require 10^{8} MC samples.

UC Berkeley researchers have developed an Adaptive Importance Sampling (AIS) PSHA, a novel framework to approximate optimal importance sampling (IS) distributions and dramatically reduce the number of MC samples to estimate hazards. Efficiency and accuracy of the proposed framework have been validated against Pacific Earthquake Engineering Research Center (PEER) PSHA benchmarks covering various seismic sources, including areal, vertical, and dipping faults, as well as combined types. Seismic hazards are calculated up to 3.7×10^{4} and 7.1×10^{3} times faster than Riemann Sum and traditional MC methods, respectively. Coefficients of variation (COVs) are below 1%. Enhanced “smart” AIS PSHA variants are also available that outperform “smart” implementations of Riemann Sum by a factor of up to 130.

SUGGESTED USES

» Insurance risk analysis, seismic hazard maps, critical infrastructure planning, and other PSHA analyses

» PSHA cases requiring extensive logic trees and with epistemic uncertainty

ADVANTAGES

» Fast seismic hazard computation, beating traditional Reimann sum ($3.7x10^{4}$ faster) and Monte Carlo ($7.1x10^{3}$ faster) methods

» Coefficients of variation (COV) below 1%

RELATED MATERIALS

» Soung Eil Houng, Luis Ceferino; Fast Probabilistic Seismic Hazard Analysis Through Adaptive Importance Sampling. Bulletin of the Seismological Society of America 2025. - 02/19/2025

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OTHER INFORMATION

CATEGORIZED AS

» **Agriculture & Animal Science**
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