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Special Session Title:

Hybrid AI Strategies in Seismic Engineering: A Machine Learning Framework for Structural Systems

Organizers

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Abstract

This special session introduces a hybrid artificial intelligence framework that integrates advanced machine learning techniques with conventional seismic engineering practices to predict and analyze dynamic responses of diverse structural systems. By combining data-driven algorithms with numerical-based models, the proposed framework offers enhanced accuracy and reliability in forecasting seismic behavior in steel and reinforced concrete (RC) structures, steel and RC shear wall systems, lateral force-resisting system, and other construction typologies. Considering historical seismic records, laboratory experiment data, and high-fidelity computational simulations, the framework employs machine learning methods, ensemble strategies, and transfer learning to extract critical features from complex datasets. These hybrid AI strategies allow for the identification of nonlinear response patterns, real-time adaptation to evolving seismic conditions, and improved estimation of displacements, interstory drift, residual deformation, stress distributions, and energy dissipation during earthquake events. This special session advances the state-of-the-art in seismic response prediction while contributing to the development of resilient infrastructure. The integration of hybrid AI strategies into seismic engineering represents a transformative step toward smarter, safer, and more adaptive structural systems in earthquake-prone regions. It provides a solid foundation for future studies aimed at design optimization, seismic performance assessment, seismic failure probability, seismic risk assessment, and promoting sustainable practices in civil engineering. Overall, this framework marks a significant advance in using AI for practical seismic engineering and retrofitting structures.

Contents of interest include, but are not limited to, the following topics:

- Overview of hybrid AI strategies in seismic engineering, structural designing, and retrofitting structures
- Integration of machine learning with traditional numerical-based models for monitoring and real-time response assessment
- Applications of machine learning methods for passive, semi-active, and active control of lateral force-resisting systems to improve structural behavior
- Data-driven and ensemble methods for feature extraction, nonlinear response prediction and uncertainty quantification
- Advanced machine learning methods in seismic probabilistic analysis, predictive models, and estimation tool
- Machine learning-based response curve prediction compared with traditional seismic analysis methods
- Improvements in machine learning algorithms and adaptation techniques, including transfer learning across structural types