Weiqiang Zhu

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Education

Ph.D.	Geophysics, Stanford University	*2016 - 2021*
	Thesis: *Applications of Deep Learning in Seismology*	
	Adviser: *Gregory C. Beroza*	
Ph.D. minor	Computer Science, Stanford University	*2016 - 2021*
M.S.	Geophysics, Peking University	*2013 - 2016*
B.S.	Geophysics, Economics (Double Degree), Peking University	*2009 - 2013*

Research Experience

Director's Postdoctoral Fellow	California Institute of Technology	*2021 -*
Graduate Researcher	Stanford University	*2016 - 2021*

Awards and Honors

Director's Postdoctoral Fellowship, Caltech Seismological Laboratory	*2021*
Exceptional Thesis, Geophysics, Stanford University	*2021*
Outstanding Student Presentation Award (OSPA), AGU	*2021*
National Scholarship, Peking University	*2015*
Outstanding Student Paper Award, Chinese Geophysical Society	*2014*
National Scholarship, Peking University	*2012*

Research Interests

My research focuses on understanding earthquake physics and statistics by applying cutting-edge artificial intelligence and scientific computing methods to gain new insights from large seismic datasets.

1. **Machine Learning/Deep Learning** for Geophysical Signal Discovery
   - Applying deep learning to detecting hidden earthquake signals from large seismic datasets to understand complex earthquake sequences and fault zone structures.
   - Applying cloud computing to large-scale data mining to build high resolution earthquake catalogs for studying earthquake ricks, volcanic activities, glacier evolution, etc.
2. **Earthquake Simulation and Seismic Inversion** for Understanding Earthquake Physics
   - Applying earthquake simulation to analyze multiphysics couplings within fault zones such as fluid, permeability, friction, and other mechanical properties.
   - Applying automatic differentiation to improve geophysical inversion and constrain key physical parameters such as earthquake source parameters and the Earth's interior structures.

Publications

Earthquake Simulation and Seismic Inversion:

Zhu, W., Allison, K. L., Dunham, E. M., & Yang, Y. (2020). Fault Valving and Pore Pressure Evolution in Simulations of Earthquake Sequences and Aseismic Slip. *Nature Communications*. (pdf, code)

Zhu, W., Xu, K., Darve, E., & Beroza, G. C. (2021). A General Approach to Seismic Inversion with Automatic Differentiation. *Computers & Geosciences*. (pdf, code)

Zhu, W., Xu, K., Darve, E., Biondi, B., & Beroza, G. C. (2021). Integrating deep neural networks with full-waveform inversion: Reparametrization, regularization, and uncertainty quantification. *Geophysics*. (pdf, code)

Zhu, W., & Huang, Q.-H. (2016). Attenuation compensated reverse time migration method of ground penetrating radar signals. *Chinese Journal of Geophysics*.

Xu, K., **Zhu, W.**, & Darve, E. (2022). Learning generative neural networks with physics knowledge. *Research in the Mathematical Sciences*. (pdf)

Xu, K., **Zhu, W.**, & Darve, E. (2020). Distributed machine learning for computational engineering using mpi. *arXiv preprint arXiv:2011.01349*.

Machine Learning/Deep Learning:

Zhu, W., & Beroza, G. C. (2018). PhaseNet: a deep-neural-network-based seismic arrival-time picking method. *Geophysical Journal International*. (pdf, code)

Zhu, W., Mousavi, S. M., & Beroza, G. C. (2019b). Seismic Signal Denoising and Decomposition using Deep Neural Networks. *IEEE Transactions on Geoscience and Remote Sensing*. (pdf, code)

Zhu, W., Mousavi, S. M., & Beroza, G. C. (2020). Seismic Signal Augmentation to Improve Generalization of Deep Neural Networks. *Advances in Geophysics*. (pdf)

Zhu, W., McBrearty, I. W., Mousavi, S. M., Ellsworth, W. L., & Beroza, G. C. (2022). Earthquake phase association using a bayesian gaussian mixture model. *Journal of Geophysical Research: Solid Earth*. (pdf, code)

Zhu, W., Tai, K. S., Mousavi, S. M., Bailis, P., & Beroza, G. C. (2022). An end-to-end earthquake detection method for joint phase picking and association using deep learning. *Journal of Geophysical Research: Solid Earth*. (pdf)

Yang, L., Liu, X., Zhu, W., Zhao, L., & Beroza, G. C. (2022). Toward improved urban earthquake monitoring through deep-learning-based noise suppression. *Science advances*.

Retailleau, L., Saurel, J.-M., **Zhu, W.**, Satriano, C., Beroza, G. C., Issartel, S., … Team, O. (2021). PhaseWorm: A real-time machine-learning-based algorithm for volcano-tectonic earthquake monitoring. *Seismological Research Letters (under review)*.

Datta, A., Wu, D. J., Zhu, W., Cai, M., & Ellsworth, W. L. (2022). Deepshake: Shaking intensity prediction using deep spatiotemporal rnns for earthquake early warning. *Seismological Society of America*.

Tan, Y. J., Waldhauser, F., Ellsworth, W. L., Zhang, M., **Zhu, W.**, Michele, M., … Segou, M. (2021). Machine-learning-based high-resolution earthquake catalog reveals how complex fault structures were activated during the 2016–2017 central italy sequence. *The Seismic Record*. (pdf)

Mousavi, S. M., Ellsworth, W. L., **Zhu, W.**, Chuang, L. Y., & Beroza, G. C. (2020). Earthquake transformer—an attentive deep-learning model for simultaneous earthquake detection and phase picking. *Nature Communications*. (pdf, code)

Chai, C., Maceira, M., Santos-Villalobos, H. J., Venkatakrishnan, S. V., Schoenball, M., **Zhu, W.**, … Team, E. C. (2020). Using a deep neural network and transfer learning to bridge scales for seismic phase picking. *Geophysical Research Letters*. (pdf)

Liu, M., Zhang, M., **Zhu, W.**, Ellsworth, W. L., & Li, H. (2020). Rapid characterization of the july 2019 ridgecrest, california, earthquake sequence from raw seismic data using machine-learning phase picker. *Geophysical Research Letters*. (pdf)

Park, Y., Mousavi, S. M., **Zhu, W.**, Ellsworth, W. L., & Beroza, G. C. (2020). Machine-learning-based analysis of the guy-greenbrier, arkansas earthquakes: A tale of two sequences. *Geophysical Research Letters*. (pdf)

Mousavi, S. M., Sheng, Y., **Zhu, W.**, & Beroza, G. C. (2019). STanford EArthquake Dataset (STEAD): A global data set of seismic signals for AI. *IEEE Access*. (pdf)

Mousavi, S. M., **Zhu, W.**, Ellsworth, W., & Beroza, G. (2019). Unsupervised clustering of seismic signals using deep convolutional autoencoders. *IEEE Geoscience and Remote Sensing Letters*. (pdf)

Mousavi, S. M., **Zhu, W.**, Sheng, Y., & Beroza, G. C. (2019). CRED: A deep residual network of convolutional and recurrent units for earthquake signal detection. *Scientific Reports*. (pdf)

Abstracts and Reports (selected)

Zhu, W., Xu, K., Darve, E., Biondi, B., & Beroza, G. C. (2022). Automatic differentiation for seismic inversion. In *SSA 2022 Annual Meeting.*

Zhu, W., Zhu, W., Biondi, E., Ross, Z. E., & Zhan, Z. (2022). Phase picking on distributed acoustic sensing data using semi-supervised learning. In *SSA 2022 Annual Meeting.*

Zhu, W., Hou, A., Yang, R., Datta, A., Mousavi, S. M., Zhang, M., … Beroza, G. C. (2021). QuakeFlow: A Scalable Deep-learning-based Earthquake Monitoring Workflow with Cloud Computing. In *2021 AGU Fall Meeting.*

Zhu, W., Mousavi, S. M., & Beroza, G. C. (2019a). Real-Time Earthquake Detection and Phase Picking Using WaveNet. In *SSA 2019 Annual Meeting.*

Zhu, W., Sheng, Y., & Sun, Y. (2017). Wave-dynamics Simulation using Deep Neural Networks. In *Stanford Report, Stanford Vision and Learning Lab.*

Wang, K., **Zhu, W.**, Ellsworth, W. L., & Beroza, G. C. (2019). Earthquake detection in develocorder films: An image-based detection neural network for analog seismograms. In *2019 AGU Fall Meeting.*

Li, Z., **Zhu, W.**, Hauksson, E., & Beroza, G. C. (2019). Realistic synthetic broadband ground motions by machine learning. In *SSA 2019 Annual Meeting.*

Invited Talks

Automatic Differentiation for Geophysical Inversion, *Department Seminar of Geophysics, Peking University* *Oct 2021*

Deep Learning for Phase Picking and Earthquake Monitoring, *European Seismological Commission (ESC)* *Sep 2021*

Earthquake Monitoring and Modeling with Deep Learning and Numerical Simulation, *Earth System Science (ESSC), CUHK* *Aug 2021*

Deep Learning for Seismic Denoising and Phase Picking, *Seismological Methods and Programs Online Course, USTC* *Aug 2021*

Internship Experience

Google Research Intern *Jun-Sep 2019*

Project: Earthquake Early Warning System based on Mobile Phone Sensors (link)

- Built deep learning models and collected a training dataset to remove false-positive triggering, e.g, phone vibrations, from true earthquake shaking
- Developed methods to estimate shaking intensity and determine warning area by predicting the earthquake magnitude, location, and time from detected phone accelerations

Teaching Experience

Teaching Assistant Crustal Deformation, *Stanford University* *Winter 2019*

Teaching Assistant Earthquakes and Volcanoes, *Stanford University* *Spring 2020*

Workshop Lecturer Deep Learning for Seismology, *National Geophysical Observation and Research Center (Shanghai Sheshan)* *Aug 2021*

Professional Service

Guest editor for :

- Special issue of "Artificial Intelligence in Seismology", *Earthquake Science*, 2021

Reviewer for:

Applied Geophysics;
Bulletin of the Seismological Society of America;
Computers & Geosciences;
Earthquake Science;
Earth Science Review;
Earth, Planets and Space;
Frontiers;
Geochemistry, Geophysics, Geosystems;
Geophysical Journal International;
Geophysical Prospecting;
Geophysical Research Letters;
Geophysics;
Geoscience Letters;
IET Signal Processing;
IEEE Computational Intelligence Society;
IEEE Internet of Things Journal;
IEEE Geoscience and Remote Sensing Society Letters;
IEEE Transactions on Geoscience and Remote Sensing;
Journal of Geophysical Research: Solid Earth;
Neural Information Processing Systems - AI4Science;
Scientific Reports;
Seismological Research Letters;