

Clara E. Yoon

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EDUCATION

- 2012 – present **Stanford University, Stanford, CA**
Ph.D. Candidate, Geophysics (Expected December 2017)
Research Focus: Observational Earthquake Seismology
Advisor: Gregory Beroza
- 2012 – 2015 **Stanford University, Stanford, CA**
M.S. Geophysics
- 2002 – 2006 **University of California Los Angeles, Los Angeles, CA**
B.S. Physics, with minor in Mathematics

RESEARCH INTERESTS

- Earthquake detection algorithm development based on waveform similarity
- Data mining, high performance computing, and software development, applied to observational seismology
- Regional earthquake monitoring and data processing
- Seismicity studies: Foreshocks and aftershocks, earthquake triggering, earthquake swarms, induced seismicity, statistical seismology
- Characterization of crustal deformation associated with fluid injection and extraction using interferometric synthetic aperture radar (InSAR) time series analysis

PROFESSIONAL EXPERIENCE

- 2013 – present **Graduate Student Researcher with Dr. Gregory Beroza**
Observational Earthquake Seismology and Seismicity
Department of Geophysics, Stanford University, CA
 - Developed an efficient, correlation-based, over-network earthquake detection algorithm for large continuous waveform data sets using audio fingerprinting technology: feature extraction, hashing, and efficient database search (U.S. Patent Pending #14/704387, filed 2015-05-05)
 - Detected low-magnitude, uncataloged earthquakes on the Calaveras Fault in central California within one week of continuous data, 140 times faster than a reference autocorrelation algorithm

- Identified thousands of $M < 2$ earthquakes in the first 3 months of the potentially induced Guy-Greenbrier, Arkansas, earthquake swarm; analyzed relationship between locations of these earthquakes and wastewater injection / hydraulic fracturing wells
- 2013 – present **Graduate Student Researcher with Dr. Howard Zebker**
Radar Interferometry Applied to Induced Seismicity
Department of Geophysics, Stanford University, CA
 - Performed comprehensive search for crustal deformation signals in InSAR data associated with potentially induced seismicity in the United States and Canada
 - Conducted multi-year InSAR time series analysis on deformation signals near oil and gas production sites in Arkansas, Oklahoma, and Alberta, and presented results at affiliates meeting
- 2006 – 2012 **Staff Scientist**
Areté Associates, Northridge, CA
 - Lead scientific programmer on research and development projects for remote sensing systems; performed simulation and modeling, data analysis, algorithm development, and software implementation in C++ and Fortran 90
 - Implemented, tested, and delivered a C++ computational geometry optimization software package
 - Extensively debugged deliverable software; developed unit and regression tests
 - Generated algorithm documents with conceptual and mathematical descriptions
 - Wrote three technical papers summarizing data analysis procedures and results
 - Presented technical briefings to customers at review meetings
 - Designed, developed and implemented an interpolation algorithm to map high-resolution synthetic aperture radar data, which improved image resolution, added processing flexibility, and reduced computational cost
 - Debugged, refined, and analyzed physics-based algorithms used to process optical image data: enhanced feature detection performance, reduced run-time
 - Developed and implemented noise reduction algorithms, then analyzed their performance on large data sets
 - Experienced with image processing, signal processing, digital filtering, numerical analysis and iterative algorithms, probability and statistics

TEACHING EXPERIENCE

- 2016 **Teaching Assistant: Imaging Radar and Applications**
Department of Electrical Engineering/Geophysics, Stanford University
 - Presented lectures on advanced synthetic aperture radar imaging methods
 - Prepared solutions for and graded homework and exams
 - Maintained course website and online message board for student questions
 - Held office hours and exam review session
- 2014 **Teaching Assistant: Introduction to Seismology**
Department of Geophysics, Stanford University
 - Presented lecture on signal processing techniques in seismology
 - Held office hours, graded homework, and responded to student questions

PUBLICATIONS

- **Yoon, C. E.**, O. O'Reilly, K. J. Bergen, and G. C. Beroza (2015). Earthquake detection through computationally efficient similarity search, *Science Advances*, **1**, e1501057, <http://dx.doi.org/10.1126/sciadv.1501057>.

INVITED TALKS

- Earthquake Detection Through Computationally Efficient Similarity Search (with K. Bergen), U.S. Geological Survey Earthquake Science Center Seminar, Menlo Park, CA, August 2015, <http://earthquake.usgs.gov/regional/nca/seminars/2015-08-05/>.

ORAL PRESENTATIONS

- **Yoon, C.**, and H. Zebker, InSAR Observations of Injection-Related Deformation, Stanford Center for Induced and Triggered Seismicity Affiliates Meeting, February 2015.
- **Yoon, C. E.**, O. J. O'Reilly, K. Bergen, and G. C. Beroza, Computationally Efficient Search for Similar Seismic Signals in Continuous Waveform Data over a Seismic Network, 2014 AGU Fall Meeting, Abstract S52A-04.
- **Yoon, C.**, and H. Zebker, InSAR Observations of Deformation at Oil and Gas Production Sites, Stanford Center for Induced and Triggered Seismicity Affiliates Meeting, October 2014.
- **Yoon, C. E.**, O. J. O'Reilly, and G. C. Beroza, Waveform Fingerprinting for Efficient Seismic Signal Detection, 2013 AGU Fall Meeting, Abstract S21D-02.

POSTER PRESENTATIONS

- **Yoon, C. E.**, O. O'Reilly, K. Bergen, Y. Huang, and G. C. Beroza, Searching for Unknown Earthquakes in the Guy-Greenbrier, Arkansas, Earthquake Sequence using Efficient Waveform Similarity Search, 2015 AGU Fall Meeting, Abstract S13B-2850.
- Bergen, K., **C. E. Yoon**, O. J. O'Reilly, and G. C. Beroza, Unsupervised Approaches for Post-Processing in Computationally Efficient Waveform-Similarity-Based Earthquake Detection, 2015 AGU Fall Meeting, Abstract S53A-2777.
- Bergen, K., **C. Yoon**, O. O'Reilly, Y. Huang, and G. Beroza, Fingerprint and Similarity Thresholding (FAST) for Computationally Efficient Earthquake Detection, 2015 SCEC Fall Meeting, Abstract 132.
- **Yoon, C.**, O. O'Reilly, K. Bergen, and G. Beroza, Computationally Efficient Earthquake Detection with Continuous Seismic Waveform Data, Stanford-USTC-MIT (SUM) Geoscience Summer Camp, Hefei, China, September 2015.
- **Yoon, C.**, O. O'Reilly, K. Bergen, and G. Beroza, Computationally Efficient Earthquake Detection with Continuous Seismic Waveform Data, 9th International Workshop on Statistical Seismology (Statsei9), Potsdam, Germany, June 2015.
- **Yoon, C.**, O. O'Reilly, K. Bergen, and G. Beroza, Computationally Efficient Search for Similar Seismic Signals in Continuous Waveform Data over the Northern California Seismic Network, 2014 SCEC Fall Meeting, Abstract 162.

- O'Reilly, O. J., **C. E. Yoon**, and G. C. Beroza, Similarity Search for Continuous Seismic Data, 2013 AGU Fall Meeting, Abstract S11B-2319.
- O'Reilly, O. J., **C. E. Yoon**, and G. C. Beroza, Similarity Search for Continuous Seismic Data, 2013 SCEC Fall Meeting, Abstract 107.

COMPUTER SKILLS

- **Data Analysis:** MATLAB, IDL, Microsoft Excel
- **Programming Languages:** C++, C, Fortran 90/77, Python
- **Geophysics/Seismology:** SAC, ObsPy, GMT, Google Earth
- **Compilers:** Microsoft Visual Studio, gcc, g++, Xcode
- **Operating Systems:** Windows, DOS, Linux, Mac OS X
- **Miscellaneous:** Microsoft Word/Power Point, Adobe Illustrator, LaTeX, doxygen, vim, make, Subversion, git

PROFESSIONAL AFFILIATIONS

- American Geophysical Union (AGU), 2008 – present
- Seismological Society of America (SSA), 2012 – present
- Institute of Electrical and Electronics Engineers (IEEE), 2008 – 2012

AWARDS AND HONORS

- 3rd place Oral Presentation, Stanford School of Earth, Energy, and Environmental Sciences Research Review, 2015
- Joshua L. Soske Memorial Fellowship, Stanford School of Earth Sciences, 2015
- Best Oral Presentation, Stanford School of Earth Sciences Research Review, 2014
- Chevron Fellow, Stanford Graduate Fellowship, 2013 – present
- E. Lee Kinsey Scholarship, UCLA Physics and Astronomy, 2006
- Rudnick-Abelmann Scholarship, UCLA Physics and Astronomy, 2005
- Regents Scholarship, UCLA, 2002-2006