Karianne J. Bergen, Ph.D.

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PROFESSIONAL EXPERIENCE

2021 – **Assistant Professor**, Brown University, Providence, RI
Data Science Initiative and Department of Earth, Environmental & Planetary Sciences
Department of Computer Science, by courtesy

2020 **Visiting Assistant Professor**, Brown University, Providence, RI
Department of Earth, Environmental and Planetary Sciences

2018–20 **Data Science Initiative Postdoctoral Fellow**, Harvard University, Cambridge, MA
Department of Computer Science, School of Engineering and Applied Sciences

2009–11 **Assistant Technical Staff (Data Scientist)**, MIT–Lincoln Laboratory, Lexington, MA
Biological and Chemical Defense Systems Group

EDUCATION

2018 **Ph.D. in Computational and Mathematical Engineering,** Stanford University, Stanford, CA
Thesis: Big Data for Small Earthquakes: Detecting Earthquakes over a Seismic Network with Waveform Similarity Search

2015 **M.Sc. in Computational and Mathematical Engineering,** Stanford University, Stanford, CA

2009 **B.Sc. in Applied Mathematics**, Brown University, Providence, RI
Study abroad: University of Edinburgh, UK, Spring 2008

PUBLICATIONS

1. H. Wang, …, P. Van Katwyk[##], **K. Bergen**, et al. Enabling Scientific Discovery with Artificial Intelligence [*submitted*].
2. S. J. Arrowsmith, D. T. Trugman, **K. Bergen**, and B. Magnani (2022). The Big Data Revolution Unlocks New Opportunities for Seismology. *Eos*, 103. DOI: 10.1029/2022EO225016. Published on 9 June 2022.
3. S. J. Arrowsmith, J. MacCarthy, D. Trugman, **K. J. Bergen**, D. Lumley & B. Magnani (2022). Big Data Seismology. *Reviews of Geophysics*. DOI: 10.1029/2021RG000769.
4. D. Reiter, V. Napoli, S. Arrowsmith*, **K. Bergen***, G. Beroza*, C. DeGroot-Hedlin*, M. Hedlin*, K. Koper*, A. Mueen*, N. Nakata*, K. Pankow*, Z. Peng*, S. Ravela*, W. Rodi*, B. Stump*, J. Williams* & S.-H. Yoo* (2021). Machine Intelligence for Nuclear Explosion Monitoring: A Strategic Plan to Guide Research and Development Through 2025. White Paper.

5. **K. J. Bergen**, P. A. Johnson, M. V. de Hoop & G. C. Beroza (2019). Machine learning for data-driven discovery in solid Earth geoscience. *Science*, 363. DOI: 10.1126/science.aau0323. †
6. C. E. Yoon, **K. J. Bergen**, K. Rong, H. Elezabi, W. L. Ellsworth, G. C. Beroza, P. Bailis & P. Levis (2019). Unsupervised large-scale search for similar earthquake signals. *Bulletin of the Seismological Society of America* 109(4): 1451-1468. DOI: 10.1785/0120190006.
7. **K. J. Bergen***, T. Chen* & Z. Li* (2019). Preface to SRL Special Focus Section on Machine Learning in Seismology. *Seismological Research Letters* 90(2A): 466-480. DOI: 10.1785/0220190018.
8. **K. J. Bergen** & G. C. Beroza (2018). Detecting Earthquakes over a Seismic Network using Single-Station Similarity Measures. *Geophysical Journal International*, Vol. 213, Issue 3, pp.1984–1998. DOI: 10.1093/gji/ggy100. Winner: Geophysical Journal International 2018 Student Author Award.
9. **K. J. Bergen** & G. C. Beroza (2018). Earthquake fingerprints: Extracting waveform features for similarity-based earthquake detection. *Pure and Applied Geophysics* 176(3): 1037-1059. DOI: 10.1007/s00024-018-1995-6
10. K. Rong, C. E. Yoon, **K. J. Bergen**, H. Elezabi, P. Bailis, P. Levis & G. C. Beroza (2018). Locality-Sensitive Hashing for Earthquake Detection: A Case Study of Scaling Data-Driven Science. *Proceedings of the Conference on Very Large Data Bases (VLDB)*, 11(11): 1674–1687. DOI: 10.14778/3236187.3236214
11. **K. Bergen**, C. Yoon, & G. Beroza (2016). Scalable Similarity Search: A New Approach for Large-Scale Earthquake Detection. Proceedings of the International Conference on Similarity Search and Applications (SISAP), *Lecture Notes in Computer Science*, Vol. 9939. DOI: 10.1007/978-3-319-46759-7_23
12. C. E. Yoon, O. O'Reilly, **K. J. Bergen**, & G. C. Beroza (2015). Earthquake Detection Through Computationally Efficient Similarity Search. *Science Advances* 1, No. 11. DOI: 10.1126/sciadv.1501057. ‡
13. F. El-Masri*, **K. Bergen***, O. Addai*, P. Liu*, S. Chowdhury*, X. Huang*, M. Wolff, & K. Lopiano (2014). Analysis of Self-Reported Health Outcomes from Web Based Media Sources. CRSC Technical Report TR14-11, *Twentieth Mathematical and Statistical Modeling Workshop for Graduate Students*, P. Gremaud, I.C.F. Ipsen, & R. Smith.
14. J. J. Braun, **K. Bergen**, & T. J. Dasey (2011). Inner Rehearsal Modeling for Cognitive Robotics. *Proceedings of SPIE*, Vol. 8064, 80640A. DOI: 10.1117/12.888000
15. J. J. Braun, A. Hess, Y. Glina, E. C. Wack, **K. Bergen**, T. J. Dasey, R. M. Mays, & J. Strawbridge (2010). Information fusion of standoff and other information for biodefense decision support. *Proceedings of SPIE*, Vol. 7665, 76650C. DOI: 10.1117/12.852817
16. J. J. Braun, A. Hess, Y. Glina, E. C. Wack, **K. Bergen**, T. J. Dasey, R. M. Mays, & J. Strawbridge (2010). Approaches to information fusion with spatiotemporal aspects for standoff and other biodefense information sources. *Proceedings of SPIE*, Vol. 7710, 771003. DOI: 10.1117/12.852862

* denotes equal contribution
indicates authorship by graduate student trainee
† Reprinted (in Chinese) in *Translated World Seismology*, 1, 1-21, 2020
‡ Reprinted (in Chinese) in *Translated World Seismology*, 6, 496-516, 2017

Code Repositories

FAST: End-to-end earthquake detection pipeline via efficient time series similarity search
https://github.com/stanford-futuredata/FAST

Media Coverage

Stanford Scientists develop "Shazam for Earthquakes" (Dec 4, 2015). Featured in *Stanford News*, *IEEE Spectrum*, *Smithsonian Magazine*, NBC News

What can machine learning tell us about the solid Earth? (Mar 21, 2019) Featured in *Stanford News*

Algorithms spot millions of California's tiniest quakes in historical data (Apr 18, 2019). *Nature*

Shazam for Seismologists? How a new data mining technique is shaking up earthquake science (May 12, 2019). *Yale Scientific Magazine*

PRESENTATIONS

Invited Talks (since 2018)

Big Data Analysis in Geoscience
International Symposium on the Frontier of Understanding Earth's Interior and Dynamics, Tohoku University, Sendai, Japan (2022) [virtual].

Big data for small earthquakes: Data mining, deep learning and explainable AI
Njord Center, University of Oslo (2022) [virtual]; Geoscience Seminar, University of Montana, Missoula, MT (2022) [virtual]; Scientific Computing and Numerics Seminar, Cornell University, Ithaca, NY (2021) [virtual]; Department of Geology and Geophysics, University of Utah, Salt Lake City, UT (2021) [virtual]; Department of Earth, Atmospheric and Planetary Sciences, MIT, Cambridge, MA (2021).

Explainable AI in Seismology: An interpretable convolutional neural network for earthquake detection
Symposium on Artificial Intelligence and Earthquake Engineering, EERI San Diego Chapter (2022) [virtual]; Brazilian Seismology Symposium, International Congress of the Brazilian Geophysical Society, Rio de Janeiro, Brazil (2021) [virtual].

Machine Learning in Seismology: Where are we now and where are we going?
Plenary Panel, Seismological Society of America Annual Meeting (2021) [virtual].

Advancing solid Earth geoscience with machine learning.
Geological Society of Washington DC (2021) [virtual].

Shaking up Earthquake Science in the age of Big Data
Michigan Institute for Data Science Consortium for Researchers in Training, University of Michigan, Ann Arbor, MI (2020) [virtual].

DAS and big scientific data analysis
Distributed Acoustic Sensing Virtual Workshop and Tutorial, IRIS (2020) [virtual].

Event detection in big sensor data: Applications in earthquake seismology and beyond
Life on Planet Earth: Above and Below workshop, Mathematical Biosciences Institute, Ohio State University, Columbus, OH (2020) [virtual].

Big data for small earthquakes: Computational challenges in large-scale earthquake detection
Department of Computational Mathematics, Science and Engineering, Michigan State University, East Lansing, MI (2020); Oden Institute for Computational Sciences and Engineering and Department of Statistics and Data Science, University of Texas at Austin, TX (2020); Department of Geophysics, Colorado School of Mines, Golden, CO (2020); Data Science Initiative and Department of Earth, Environmental, and Planetary Sciences, Brown University, Providence, RI (2020); Department of Earth, Ocean, and Atmospheric Sciences, University of British Columbia, Vancouver, Canada (2020); Department of Electrical and Computer Engineering, University of California, Santa Barbara, CA (2020); Faculty of Computing and Data Science, Boston University, Boston, MA (2020) [virtual]; Data Science Institute and Department of Computer and Information Sciences, University of Delaware, Newark, DE (2020) [virtual].

Machine learning for data-driven discovery in solid Earth geosciences.
National Academies Committee on Seismology and Geodynamics Fall Meeting, Washington, DC (2019).

Earthquake monitoring in the age of "big data:" Challenges and opportunities.
College of the Holy Cross, Worcester, MA (2020) [cancelled due to COVID]; Marine Geology and Geophysics Seminar, Graduate School of Oceanography, University of Rhode Island, Narragansett, RI

(2020) [canceled due to COVID]; Women in Data Science @ Stanford Earth workshop, Stanford University, CA (2019); Department of Geosciences, Princeton University, Princeton, NJ (2019); Institute for Geophysics, Jackson School of Geosciences, University of Texas at Austin, TX (2019).

Data mining for earthquake detection: Lessons for data-driven geoscience.
Machine Learning in Solid Earth Geoscience Conference, Santa Fe, NM (2019).

Shaking up seismology: Improving earthquake detection capabilities with locality-sensitive hashing.
Microsoft Research New England, Cambridge, MA (2019).

Big data for small earthquakes: a data mining approach to large-scale earthquake detection.
Department of Applied Mathematics, University of Washington, Seattle, WA (2019); Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY (2019); Department of Earth, Environmental and Planetary Sciences, Brown University, Providence, RI (2018); Earth Resources Laboratory, MIT, Cambridge, MA (2018); Data Science and Cyber Analytics Group, Sandia National Laboratory, Livermore, CA (2018).

Machine Learning in Seismology: Using AI to Improve Earthquake Monitoring.
Congressional briefing, hosted by the Seismological Society of America, Washington D.C. (2019).

Towards data-driven earthquake detection: Extracting weak seismic signals with locality-sensitive hashing.
Conference on Neural Information Processing Systems (NeurIPS), Workshop on Machine Learning for Geophysical and Geochemical Signals, Montreal, Canada (2018).

Improving earthquake detection with data mining and machine learning.
IRIS Workshop: Foundations, Frontiers & Future Facilities for Seismology, Albuquerque, NM (2018).

Scalable Similarity Search for Earthquake Detection.
Institute of Mathematical and Computational Engineering, Pontificia Universidad Católica de Chile, Santiago, Chile (2018).

Invited Talks (before 2018)

Society of Exploration Geophysics Annual Meeting, Workshop on Data Analytics for Geoscience, Houston, TX (2017); Department of Earth and Planetary Sciences, University of Tokyo, Japan (2016); Earthquake Science Seminar, US Geological Survey, Menlo Park, CA (2015); Lawrence Livermore National Laboratory, Livermore, CA (2015).

University Talks (selected)

Big data for small earthquakes: data mining, deep learning and explainable AI
Geophysics Lunch Bunch, DEEPS, Brown University (2021).

Big data for small earthquakes: Scalable earthquake detection with locality-sensitive hashing and deep learning
Applied Math Colloquium, Brown University (2021)

How robust is deep learning-based earthquake detection? Insights from adversarial machine learning.
Earthquake Seismology Group, Department of Geophysics, Stanford University, Stanford, CA (2019).

Big data for small earthquakes: Shaking up seismology with data science.
Department of Earth and Planetary Sciences, Harvard University, Cambridge, MA (2018).

Invited Panelist (selected)

Seismic and Nuclear Explosion Monitoring Panel, Dynamic Data Driven Application Systems (DDDAS) Workshop, MIT (2022) [hybrid]

AI for Science: Mind the Gaps, Conference on Neural Information Processing Systems (NeurIPS), Workshop (2021) [virtual]

Trainee Presentations, Posters or Talks

Normalizing flows for density estimation and uncertainty quantification in Earth Data.
Poster presented by P. Van Katwyk, SAGE/GAGE Community Science Workshop, Pittsburgh, PA (2022).

TEACHING EXPERIENCE

Instructor

- Tackling Climate Change with Machine Learning (EEPS 1720 / DATA 1720), Brown University
  Spring 2023 [in-person format];
- Machine Learning for the Earth and Environment (EEPS 1960D), Brown University
  Spring 2021 [virtual format]; total enrollment: 22 students (12 undergrad, 10 graduate, 1 auditor)
  Spring 2022 [in-person format]; total enrollment: 24 students (14 undergrad, 10 graduate)
- Probability, Statistics and Machine Learning (DATA 1010), Brown University
  Fall 2021 [hybrid/remote-accessible format]; total enrollment: 48 students (1 undergrad, 47 graduate)

Teaching Assistant (Instructor of Record)

Developed new 4-week short-course. Responsibilities included designing syllabus, selecting course materials, and co-teaching the material as both a graduate-level course and a week-long workshop for professionals and researchers.

- Introduction to Machine Learning, Stanford University
  Winter 2015, Spring 2015, Fall 2015, Winter 2016 (total enrollment: 301 students)

Workshop Instructor

- Introduction to Machine Learning
  Fundamentals of Data Science Workshop (Jan 2018), Pontificia Universidad Católica, Santiago, Chile
  ICME Summer Short Courses (Aug 2014 and 2015), Stanford University
- Applied Linear Algebra
  ICME Math Refresher Course Series (Sept 2013), Stanford University

Instructor

Developed syllabus and recorded lectures in studio for online course offered by Stanford Foundations in Data Science Affiliates Program by the Stanford Center for Professional Development

- Introduction to Machine Learning, Stanford University

Teaching Assistant (Grader)

- Introduction to Probability and Statistics for Engineers (Summer 2012), Stanford University

Guest Lecturer

Machine Learning across the Earth and Planetary Sciences (Oct 2019), Harvard University
Time Series and Prediction (Nov 2018), Harvard University
Know Your Planet: Big Earth (Jan 2017, Jan 2018), Stanford University

Pedagogical Training

Sheridan Junior Faculty Teaching Fellows Program, Brown University (AY 2022-2023)
Data Science Course Design Institute, Brown University (2020)
Topics in Science and Engineering Education, Stanford University (2013)

FUNDING AND AWARDS

Grants (awarded)

Co-PI, Towards the Smart Interconnected Bay – Artificially intelligent detection of harmful algal blooms in Narragansett Bay, Rhode Island. Rhode Island Science and Technology Advisory Council (STAC). $30,000.

Subcontractor, Machine Intelligence Solutions for Nuclear Explosion Monitoring. Air Force Research Laboratory (2020–21). $23,745.

Collaborator, Rockfalls on Mars – Indicators of Seismicity, Impacts or Thermal Fatigue. Mars Data Analysis, NASA (Announcement NNH21ZDA001N-MDAP).

Fellowships

AAAS Science and Technology Policy Fellowship Finalist (2020, declined).

Harvard Data Science Initiative Postdoctoral Fellowship, Harvard University (2018–20). $268,000.

Stanford Graduate Fellowship in Science and Engineering, Stanford University (2011–15). $213,000.

Teaching Awards

Senior Teaching Fellow, ICME, Stanford University (2016)

Short Course Instructor Award, ICME, Stanford University (2015)

Academic Recognitions

Sleeping Bear Award for good humor at meetings, Geological Society of Washington (2021)

Student Author Award, Geophysical Journal International (2018)

Student Leadership Award, ICME, Stanford University (2018)

Student Presentation Award, Seismological Society of America Annual Meeting (2016, 2017)

Innovative Research Award, ICME Xpo, Stanford University (2016)

Workshop Grant, Broadening Participation in Data Mining Workshop, KDD, San Francisco, CA (2016)

Outstanding Student Paper Award, American Geophysical Union Fall Meeting (2015)

Workshop/Travel Grant, Computing Research Association (CRA-W) Grad Cohort Workshop, Boston, MA (2013), and Santa Clara, CA (2014)

TRAINEES

Ph.D. Student Research

Peter Van Katwyk (EEPS), 2021–

Awards: NSF Graduate Research Fellowship in field of Geosciences – AI (2022–)

Master's Student Research

Qingyan Guo (Data Science), Summer 2021

Yijing Gao (Data Science), Summer 2021

Tianqi Tang (Data Science), DATA 2050 practicum advisee, Summer 2021

Zhirui Li (Data Science), Summer 2022

Graduate Student Committees

Ethan Kyzivat (EEPS), Ph.D. Thesis Advisory Committee, 2020–

Matt Jones (EEPS), Ph.D. Thesis Advisory Committee, 2022–

Carol Hundal (EEPS), Ph.D. Preliminary Examination Committee, 2022
Sarah Esenther (EEPS), Ph.D. Preliminary Examination Committee, 2022

Undergraduate Advising

Benny Smith (Applied Math), DATA 1150 Data Science Fellow, Spring 2021
Nikolai Stambler (History, Data Science fluency), DATA 1150 Data Science Fellow, Fall 2021
Geordie Young (Computer Science-Economics, Political Science), DATA 1150 Data Science Fellow, Fall 2022

OTHER PROFESSIONAL ACTIVITIES

Short-term Research Visits

Department of Earth and Planetary Sciences, University of Tokyo, Japan (October 2016)
Host: Satoshi Ide
Institute for Pure and Applied Mathematics, University of California, Los Angeles, CA (Summer 2008)
Hosts: Research in Industrial Projects for Students program
Department of Marine Meteorology, Ocean University of China, Qingdao, P.R.C. (Summer 2007)
Hosts: Fei Huang (OUC), Hung Tao Shen (Clarkson University, Potsdam, NY)

PROFESSIONAL SERVICE

Editorial

Guest Editor

Seismological Research Letters – Special Focus Section on Machine Learning in Seismology

Reviewer

Advances in Geophysics; Bulletin of the Seismological Society of America; Computers and Geosciences; Geophysical Research Letters; Geophysical Journal International; IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing; IEEE Transactions on Circuits and Systems for Video Technology; Journal of Geophysical Research: Solid Earth; Nature Communications; Science; Science Advances; Scientific Reports

Workshops and Conferences

Session Chair/Co-chair

SAGE/GAGE Community Science Workshop, New Horizons in Observation: Innovative Data Collection and Analysis, Pittsburgh, PA (2022)
Workshop on AI for Earth and Space Sciences (AI4ESS), ICLR (2022) [virtual]

Moderator

Session on Artificial Intelligence in Earthquake Science, SCEC Annual Meeting (2020) [virtual]
Panel on Interpretable Machine Learning for Earth and Space Science, AI4ESS Workshop (2022) [virtual]

Student Travel and Research Grant Reviewer

Seismology Section Student Travel Grant, AGU Fall Meeting (2020)

Student Presentation Judge

Outstanding Student Paper Award (OSPA), AGU Fall Meeting (2020–2021)

Conference Tutorials

Introduction to Machine Learning Workshop and Advanced Machine Learning Workshop, Seismological Society of America (SSA) Annual Meeting, Bellevue, WA (2022)

Machine Learning for Seismology Workshop, SSA Annual Meeting, Seattle, WA (2019)

Unsupervised Learning for Geoscience Applications, Machine Learning in Solid Earth Geoscience Conference, Santa Fe, NM (2019)

Introduction to Machine Learning, SIAM Geosciences Conference, Stanford, CA (2015)

Review Panels

Short Call Proposals, Geological Survey Ireland, Ireland (2020)

University Service

Committee on Honorary Degrees, Brown University (2021–)

Advisory Team for Creation of an Institute for Sustainable Energy at Brown, Brown University School of Engineering (2021)

Panelist, Tales from the Battlefront: Q&A Among Survivors and Casualties of the Academic Job Search, Office of Postdoctoral Affairs, Harvard University (2020)

Departmental Service

Computing Committee, DEEPS, Brown University (AY 22-23)

Postdoctoral Fellow Search Committee, Data Science Initiative, Brown University (2022, 2023)

Lecturer Search Committee, Data Science Initiative, Brown University (2022)

Volunteer, Graduate School Applications Assistance Initiative, SEAS Office of Diversity, Inclusion and Belonging, Harvard University (2020)

Selection Committee, HDSI Public Interest Data Science Summer Fellowship, Harvard University (2019)

ICME Industrial Affiliates Program, Stanford University: Xtrapolate Roundtable Moderator (2017–2018); Foundations in Data Science Course Lecturer (2016); Summer Workshop Instructor (2014–2015)

Student Volunteer, Women in Data Science Conference, Stanford University (2016–2017)

Science Communication and Outreach

Presenter, Data Science for Science Teachers Bootcamp, NIH Office of Data Science Strategy (2020) [virtual]

Presenter, Seismological Society of America briefing on Capitol Hill (2019)

Classroom speaker (K-12), Skype a Scientist Program (2018–2021)

Sam D. Bundy Elementary School, Farmville, NC; Academy of the Sacred Heart, New Orleans, LA; Turtle River Montessori, Jupiter, FL; McIntosh Middle School, McIntosh, SD

Media Interviews

TWIML Podcast, Machine Learning for Earthquake Seismology with Karianne Bergen (Jan 20, 2022)

A Promising Forecast for Predictive Science, *EoS* (Feb 25, 2021)

Interview with KRON4 News – Bay Area. (Dec 11, 2015)

Professional Development

Workshop for Early Career Geoscience Faculty, On The Cutting Edge program, National Association of Geoscience Teachers and National Science Foundation (2021)

Diversity and Inclusion Training

Diversity, Inclusion and Belonging Trainings: Allyship and Calling in vs. Calling out, Harvard School of

Engineering and Applied Sciences (2020)
New England Graduate Women in Science and Engineering Retreat: Empowering Individuals to Foster an Inclusive Campus Climate (2019)

RESEARCH PROFILES

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Google Scholar: https://scholar.google.com/citations?user=nQbmcDUAAAAJ&hl=en

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