

Joseph R. Capriotti

COMPUTATIONAL GEOPHYSICIST · SCIENTIFIC SOFTWARE DEVELOPER

Arvada, Colorado

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Professional Summary

Computational geophysicist and scientific software developer with 13+ years of experience in geophysical inversion, multi-physics simulation, and production software development across Python, C++, Rust, and FORTRAN. Core architect and former lead developer of SimPEG, a widely adopted open-source platform for geophysical simulation and inversion. Current research focuses on coupled fluid-flow and geophysical time-lapse modeling, Bayesian inversion via normalizing flows, and compressive sensing for survey design. Maintains a strong first-hand connection to geophysical data through years of field work and teaching applied geophysics courses covering survey design, data acquisition, and interpretation across gravity, electrical, magnetic, and electromagnetic methods. Proven track record of building HPC software, leading technical teams, and translating research into production-grade tools for industry consortia.

Technical Skills

Languages

Python, C++, Rust, FORTRAN, MATLAB, Java

Scientific Computing

SimPEG, NumPy, SciPy, Dask, PyTorch, MPI, OpenMP, Git/GitHub, CI/CD

Numerical Methods

Finite volume PDE solvers, Tikhonov regularization, Joint inversion, Equivalent source processing, Time-lapse inversion, Gauss-Newton & L-BFGS, Fuzzy c-means clustering

Experience

Research Associate

Golden, Colorado

CENTER FOR GEOPHYSICS, ENERGY, AND MINERALS (CGEM), COLORADO SCHOOL OF MINES, DEPT. OF GEOPHYSICS Aug 2023 – Present

- Continued as SimPEG administrator, reviewing pull requests, assisting in release deployment, and guiding a new inversion framework.
- Applied conditional normalizing flows for Bayesian posterior inference in magnetotelluric inversion, enabling full uncertainty quantification without traditional MCMC sampling.
- Extended the Ergodic Sampling compressive sensing methodology to an N-dimensional generalization; significantly accelerated the experimental design algorithm.
- Developed a fast level-set inversion approach using linear time distance transforms and the Adam minimizer.
- Applied 3D borehole EM simulation (energized casing source) to image stimulated fracture zones at the Utah Frontier Observatory for Research in Geothermal Energy (FORGE).
- Developed a multi-physics time-lapse simulation framework for monitoring geologic hydrogen production coupling fluid and energy flow equations to changes in physical state (density, magnetic susceptibility, electrical conductivity) and the resulting gravity, magnetic, and electrical geophysical responses.
- Maintained and modernized the consortium's distributed FORTRAN HPC code base: refactoring legacy routines, integrating optimized BLAS/LAPACK calls, and managing software distribution across member institutions.
- Developed production-grade geophysical modeling codes in C++ and Rust for consortium-wide deployment.

Adjunct Professor

Golden, Colorado

COLORADO SCHOOL OF MINES, DEPT. OF GEOPHYSICS

Aug 2023 – Present

- *GPGN 318/319: Applied Geophysics 1 & 2* — Taught survey design, data acquisition, processing, and interpretation across positioning, gravity, electrical, magnetic, and electromagnetic methods using field instrumentation including surveying equipment, gravimeters, magnetometers, resistivity systems, time-domain EM systems, and frequency domain EM systems.
- *GPGN 329: Physics of the Earth 2* — Taught foundational physics of time-varying fields: electromagnetic theory and elastic wave propagation and their interactions with earth materials.
- *Summer Field Camp (invited instructor)* — Guided students in field collection of electrical and electromagnetic data.

Postdoctoral Research Fellow

Vancouver, British Columbia, Canada

UBC GEOPHYSICAL INVERSION FACILITY

Jan 2020 – Aug 2023

SimPEG Director of Operations

- Led architecture, development, and maintenance of the open-source SimPEG Python framework for simulating and inverting geophysical data across potential field, resistivity, IP, and electromagnetic methods.
- Designed scalable parallel inversion infrastructure using Dask and MPI, enabling SimPEG workflows to run on large HPC clusters.
- Implemented tetrahedral mesh support and improved quadtree/octree generation in the *discretize* finite volume library; added full boundary-condition capabilities for geophysical PDE systems.
- Integrated multiple joint inversion methodologies (cooperative, petrophysically constrained, joint total-variation).
- Managed CI/CD pipelines, contributor pull-request reviews, release cycles, and community engagement.

Research Projects

- Developed and applied joint inversion workflows to delineate ultramafic rocks with CO₂ mineralization potential; co-wrote Mitacs industry-partnership proposal securing project funding.
- Developed open-source DC resistivity inversion tools for groundwater applications (Geoscientists Without Borders, Mon State, Myanmar).
- Taught EOSC 350 (Environmental, Geotechnical, and Exploration Geophysics) as sole instructor to 45 students.

Research Assistant

Golden, Colorado

CENTER FOR GRAVITY, ELECTRICAL, AND MAGNETIC STUDIES (CGEM), CSM

May 2012 – Dec 2019

Doctoral Research — Fluid-flow Coupled Inversion (Advisor: Dr. Yaoguo Li)

- Developed a novel coupled inversion framework to recover reservoir permeability and porosity from time-lapse gravity data using multi-phase fluid flow modeling.
- Extended the framework to anisotropic permeability; incorporated fuzzy c-means clustering to constrain inversions with borehole physical property measurements.

Software & Algorithm Development

- Modernized the CGEMaestro FORTRAN codebase with object-oriented refactoring and shared-memory parallelism (OpenMP).
- Developed joint equivalent-source processing algorithms for combined gravity and gravity-gradient surveys.
- Built a Python package for CGEM research, accelerating development of potential field algorithms.
- Created a procedural geological model generation tool using Minecraft as an interactive subsurface benchmark.

Field Data Acquisition

- Collected time-lapse gravity data at Leyden Mine Artificial Aquifer Storage site (CO) and the Navy Geothermal Project (Coso, CA).
- Acquired time-lapse active-source EM data for reservoir characterization (Bell Creek, MT).

Teaching Assistant

Golden, Colorado

COLORADO SCHOOL OF MINES, DEPT. OF GEOPHYSICS

May 2012 – Dec 2019

Geophysics Field Camp, Geophysical Inversion, Introduction to Gravity, Magnetism & Electrical Methods. Designed and graded assignments, supervised multi-method field data acquisition, and taught inversion theory (Tikhonov regularization, SVD, conjugate gradient, Gauss-Newton).

Associate Editor — Geophysics Journal

SOCIETY OF EXPLORATION GEOPHYSICISTS

2020 – Present

Manages peer review for potential field and electromagnetic sections; assigns reviewers and adjudicates manuscript decisions.

Education

Ph.D. in Geophysics

Golden, Colorado

COLORADO SCHOOL OF MINES

Aug 2012 – Dec 2019

Minor in Applied Mathematics · CGEM research group · Advisor: Dr. Yaoguo Li

B.S. in Geophysical Engineering

Golden, Colorado

COLORADO SCHOOL OF MINES

Aug 2007 – May 2012

Graduated *Magna Cum Laude*

Publications & Presentations

Peer Reviewed

Um, E., D. Alumbaugh, **J. Capriotti**, J. Weis, E. Nichols, and K. Osato, 2024, 3D modeling of deep borehole electromagnetic measurements with energized casing source for fracture mapping at the Utah FORGE geothermal site. *Geophysical Prospecting*, 72, 2779–2797. DOI

Heagy, L.J., S. Kang, **J. Capriotti**, D. Cowan, D. Fournier, and D.W. Oldenburg, 2024, Opportunities for open-source software to accelerate research in applied geophysics. *The Leading Edge*, 43(2), 84–94. DOI

Capriotti, J., and Y. Li, 2022, Joint inversion of gravity and gravity gradient data: A systematic evaluation. *Geophysics*, 87(2), G29–G44. DOI

Capriotti, J., and Y. Li, 2015, Inversion for permeability distribution from time-lapse gravity data. *Geophysics*, 80, WA69–WA83. — *Honorable Mention, Best Paper in Geophysics, 2015* DOI

In Preparation

Capriotti, J., and Y. Li, Fluid-flow coupled time-lapse gravity inversion for permeability and porosity distributions. *In preparation*

Capriotti, J., and Y. Li, Clustering inversion of electrical potential due to an arbitrarily anisotropic layered half-space. *In preparation*

Selected Conference Papers & Expanded Abstracts

Capriotti, J., N. Perkovich, M. Zhang, and Y. Li, 2025, Geophysical responses of stimulated hydrogen production in ultramafic rocks. *SEG/AAPG International Meeting for Applied Geoscience & Energy*. SEG-2025-4316820 DOI

Soler, S., **J. Capriotti**, D. Oldenburg, and L. Heagy, 2025, 3D geophysical inversions to characterize carbon sequestration potential of ultramafic rocks. *EGU General Assembly*. EGU25-13551 DOI

Capriotti, J., L.J. Heagy, and S.R. Soler, 2023, Joint inversions with the SimPEG framework. *SEG/AAPG International Meeting for Applied Geoscience & Energy*, pp. 1678-1682. DOI

Capriotti, J., L.J. Heagy, D. Cowan, J. Kuttai, S. Kang, D. Fournier, T. Astic, R. Cockett, and D.W. Oldenburg, 2023, 10 years of SimPEG: Recent developments and the next steps forward. *KEGS 2023*.

Capriotti, J., J. Kuttai, D. Fournier, and L.J. Heagy, 2022, Linking open-source tools for geophysical simulation and inversion in rugged topographies. *AGU Fall Meeting 2022*.

Heagy, L.J., T. Astic, **J. Capriotti**, and D.W. Oldenburg, 2021, Carbon sequestration in ultramafic rocks and the role of geophysical inversions. *AGU Fall Meeting 2021*.

Capriotti, J., T. Astic, L.J. Heagy, and D.W. Oldenburg, 2021, Implementing an open-source framework for joint inversion. *AGU Fall Meeting 2021*.

Capriotti, J., L.J. Heagy, and J. Kuttai, 2021, Geophysical simulations and inversions with SimPEG. *Engineering and Mining Geophysics 2021*, pp. 1–2.

Kang, S., **J. Capriotti**, D.W. Oldenburg, L.J. Heagy, and D. Cowan, 2020, Open-source geophysical software development for ground-water applications. *SEG Technical Program Expanded Abstracts 2020*, pp. 1989–1993. DOI

Capriotti, J., and Y. Li, 2019, Equivalent source processing of vector gravity data. *SEG Technical Program Expanded Abstracts 2019*. DOI

Capriotti, J., and Y. Li, 2019, Joint equivalent source processing of gravity and gravity gradient data. *International Workshop on GEM Methods, Xi'an, China*, pp. 324–327. DOI

Capriotti, J., and Y. Li, 2018, Guided fuzzy c-means clustering inversion of electrical potential due to an anisotropic-layered half-space. *SEG Technical Program Expanded Abstracts 2018*, pp. 914–918. DOI

Capriotti, J., and Y. Li, 2017, Geomodelling with Minecraft: Geophysics meets video games. *Exploration 17: 6th Decennial International Conference on Mineral Exploration*, pp. 729–733.

Capriotti, J., and Y. Li, 2017, Time-lapse gravity inversion for multiple reservoir parameters using fuzzy c-means clustering. *SEG Technical Program Expanded Abstracts 2017*, pp. 5865–5869. DOI

Capriotti, J., and Y. Li, 2015, Integrating gravity and gravity gradiometry data for joint inversion: A case study at the Kauring Test Site. *SEG Technical Program Expanded Abstracts 2015*, pp. 1505–1509. DOI

Capriotti, J., and Y. Li, 2014, Gravity and gravity gradient data: Understanding their information content through joint inversions. *SEG Technical Program Expanded Abstracts 2014*, pp. 1329–1333. DOI

Capriotti, J., and Y. Li, 2013, Aquifer storage monitoring at Leyden Mine using time-lapse gravity: A revisit seven years later. *SEG Technical Program Expanded Abstracts 2013*, pp. 1146–1150.

Invited Presentations

Heiland Lecture

CSM DEPT. OF GEOPHYSICS

Fluid-flow coupled inversion of time-lapse gravity data for reservoir properties.

Golden, Colorado

2018

Special Lecture

CHINESE ACADEMY OF GEOSCIENCES

The joint inversion of gravity and gravity gradient data.

Beijing, China

2016

Best of D&P Forum

SEG 84TH ANNUAL MEETING

Inversion for permeability distribution from time-lapse gravity data.

Denver, Colorado

2014

Honors & Awards

Mendenhall Prize for Outstanding Graduate Students

CSM DEPT. OF GEOPHYSICS

2020

Chevron Scholarship

SOCIETY OF EXPLORATION GEOPHYSICISTS

2016

Dr. S. Norman Domenico Scholarship

SOCIETY OF EXPLORATION GEOPHYSICISTS

2016

Honorable Mention, Best Paper in Geophysics

SEG

2015

Lucien LaCoste Scholarship

SOCIETY OF EXPLORATION GEOPHYSICISTS

2015

Poate Fellowship

CSM DEPT. OF GEOPHYSICS

2015

Outstanding Graduating Senior (Highest GPA)

GEOPHYSICAL ENGINEERING, CSM

2012