MIGUEL ANGEL CORRALES

Geophysics — Petroleum Engineering — Machine Learning

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CAREER SUMMARY

Throughout my professional journey, I have consistently showcased exemplary collaboration with diverse teams and cross-functional units, driving transformative outcomes for the energy sector. My academic foundation in Petroleum Engineering, Geophysics, and hands-on experience in reservoir characterization, uncertainty quantification, and data analytics uniquely position me to seamlessly combine geological, geophysical, and engineering data. This interdisciplinary background allows me to provide transformative solutions to the oil, gas, and broader energy markets. Moreover, my recent foray into machine learning and deep learning has empowered me with data-centric methodologies that amplify predictive precision and bolster rapid decision-making.

EXPERIENCE

Deepwave Consortium Researcher   Jan 2022 - Current
King Abdullah University of Science and Technology (KAUST)   *Saudi Arabia*

An industry-funded research consortium at King Abdullah University of Science and Technology (KAUST), which focuses on the application of machine (deep) learning numerical algorithms for subsurface reservoir characterization.

- Applied machine learning and deep learning algorithms to enhance wave-equation-based processing, imaging, monitoring, and inversion, improving computational efficiency and accuracy in subsurface characterization.
- Extensive hands-on experience with advanced geophysical techniques, including full-waveform inversion, post-stack and pre-stack seismic inversion, petrophysical inversion, rock-physics modeling, and uncertainty quantification, enabling high-resolution subsurface imaging and reservoir characterization.
- Implemented and benchmarked transfer learning techniques to accelerate convergence in seismic imaging applications.
- Designed and deployed explainable AI methods for interpretability of seismic models, incorporating attention mechanisms.
- Expertise in fluid flow modeling at the Darcy scale, covering black oil simulation, compositional simulation, thermal simulation, history matching, pressure transient analysis, pore-scale analysis, CO_2 storage assessment, surrogate modeling, and uncertainty quantification, to optimize reservoir performance and carbon sequestration strategies.
- Developed and implemented Bayesian reservoir history matching using gradient-based optimization techniques, improving model calibration and uncertainty estimation in reservoir simulations.
- Designed and applied advanced pressure transient analysis methods to quantify phase segregation effects in wells with high water cut, improving well performance diagnostics and production forecasting.
- Enhanced reservoir characterization workflows by collaborating in multidisciplinary teams, integrating expertise from geologists, geophysicists, petroleum engineers, computer scientists, and mathematicians, to drive data-driven insights and improve decision-making in subsurface modeling.

Research Intern in Computational Geophysics   Jan 2024 - Apr 2024
TotalEnergies   *France*

Developed advanced Bayesian inverse methods for industrial-scale Full-Waveform Inversion (FWI), leveraging Stein Variational Gradient Descent (SVGD) to improve uncertainty quantification in exploration geophysics.

- Developed gradient-based ensemble methods for efficient and scalable uncertainty analysis in FWI.
- Implemented and optimized SVGD techniques to enhance inversion accuracy while adapting to industrial-scale seismic imaging challenges.
- Led the development and benchmarking of SVGD variants, including annealed SVGD and stochastic SVGD, improving robustness and convergence efficiency.
- Designed adaptive regularization strategies to stabilize highly ill-posed seismic inverse problems, improving parameter recovery in complex geological settings.
- Investigated multimodal posterior distributions in Bayesian seismic inversion, ensuring better characterization of uncertainty in subsurface models.
- Applied high-dimensional Bayesian inference techniques to improve non-uniqueness handling in seismic imaging and parameter estimation.

- Explored scalable sampling methodologies for large-scale geophysical inverse problems, leveraging transport maps and variational approximations.

EDUCATION

Ph.D. in Earth Sciences and Engineering – Machine Learning Track (GPA: 3.89) 2022 – 2025
King Abdullah University of Science and Technology (KAUST) *Saudi Arabia*
Dissertation: ML-Assisted Bayesian Reservoir Characterization

- Advancing data-driven methodologies and machine learning techniques for reservoir characterization and subsurface modeling.

- Designed and deployed adaptive regularization strategies to stabilize ill-posed seismic inverse problems.

- Developing novel algorithms for petrophysical inversion, post-stack and pre-stack seismic inversion, seismic segmentation, and geophysical parameter estimation.

- Implementing Bayesian history matching using static and dynamic data for subsurface characterization, CO_2 storage assessment, and predictive modeling.

Msc. Energy Resources and Petroleum Engineering (GPA 3.85), 2019-2021
King Abdullah University of Science and Technology (KAUST) *Saudi Arabia*
Dissertation: Assessment of CO2 storage in saline aquifers in the Unayzah Reservoir, Central Arabia, KSA

- Engaged in advanced research with the Advanced Reservoir and Simulation Group (ARMS), focusing on sustainable energy solutions and environmental preservation.

SELECTED PUBLICATIONS

- Corrales, M., Berti, S., Denel, B., Williamson, P., Aleardi, M., & Ravasi, M. (2024). Annealed Stein Variational Gradient Descent for Improved Uncertainty Estimation in Full-Waveform Inversion. arXiv preprint arXiv:2410.13249.

- Corrales, M., Hoteit, H., & Ravasi, M. (2024). Seis2rock: A data-driven approach to direct petrophysical inversion of pre-stack seismic data. Earth and Space Science, 11(2), e2023EA003301.

- Izzatullah, M., Alkhalifah, T., Romero, J., Corrales, M., Luiken, N., & Ravasi, M. (2024). Posterior sampling with convolutional neural network-based plug-and-play regularization with applications to poststack seismic inversion. Geophysics, 89(2), R137-R153.

- Luiken, N., Romero, J., Corrales, M., & Ravasi, M. (2024). Plug-and-Play regularized 3D seismic inversion with 2D pre-trained denoisers. arXiv preprint arXiv:2401.00753.

- Ravasi, M., Romero, J., Corrales, M., Luiken, N., & Birnie, C. (2024). Striking a balance: Seismic inversion with model-and data-driven priors. In Developments in structural geology and tectonics (Vol. 6, pp. 153-200). Elsevier.

- Izzatullah, M., Alkhalifah, T., Romero, J., Corrales, M., Luiken, N., & Ravasi, M. (2023, June). Plug-and-Play Stein variational gradient descent for Bayesian post-stack seismic inversion. In 84th EAGE Annual Conference & Exhibition (Vol. 2023, No. 1, pp. 1-5). European Association of Geoscientists & Engineers.

- Ravasi, M., Luiken, N., Romero, J., & Corrales, M. (2023, June). Deep Learning to replace or augment model-based seismic inversion?. In 84th EAGE Annual Conference & Exhibition (Vol. 2023, No. 1, pp. 1-5). European Association of Geoscientists & Engineers.

- Corrales, M., Izzatullah, M., Ravasi, M., & Hoteit, H. (2022, November). Bayesian RockAVO: Direct petrophysical inversion with hierarchical conditional GANs. In SEG International Exposition and Annual Meeting (p. D011S117R003). SEG.

- Corrales, M., Izzatullah, M., Hoteit, H., & Ravasi, M. (2022, October). A Wasserstein GAN with Gradient Penalty for 3D Porous Media Generation. In Second EAGE Subsurface Intelligence Workshop (Vol. 2022, No. 1, pp. 1-5). European Association of Geoscientists & Engineers.

- Romero, J., Corrales, M., Luiken, N., & Ravasi, M. (2022, October). Plug and play post-stack seismic inversion with CNN-based denoisers. In Second EAGE Subsurface Intelligence Workshop (Vol. 2022, No. 1, pp. 1-5). European Association of Geoscientists & Engineers.

CORE COMPETENCIES

• Strategic Communication – Planning & Execution • Team Building & Leadership • Python • Matlab • Pytorch • GPU Programming • Machine Learning • Deep Learning • Petrel E&P • Eclipse • Linux • English • Spanish

HONORS AND AWARDS

- Student Poster Paper Award of Merit presented at IMAGE 2022 Bayesian RockAVO: Direct petrophysical inversion with hierarchical conditional GANs. M. Corrales, M. Izzatullah, H. Hoteit, M. Ravasi

- Second Place at ADL Case Competition: Future of Mobility Organized by Arthur D. Little Consulting Company with more than 80 teams in the Kingdom of Saudi Arabia (April 2023). M. Corrales & M. Izzatullah

- Hackathon KAUST NVIDIA 2022 Winner, Accelerating Scientific applications using GPU's (October 2022).

- Petrobowl Team (KAUST) - Top 3 MENA Qualifiers (August 2022).

- BEST IN SHOW, Hackathon - Explainable A.I., EAGE ANNUAL 2022, Madrid-Spain (June 2022)

- Third Place e-Poster competition. KAUST Research Conference - Enabling CO2 Geological Storage Within a Low-Carbon Economy, (February 2021).

- Petrobowl Team (KAUST) - Top 16 Worldwide Competition (January 2021).

REFERENCES

Dr. Matteo Ravasi
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