



**Lead institution:** Institute of Mathematics and Statistics (IME), University of São Paulo (USP)
**Department:** Applied Mathematics https://www.ime.usp.br/map
**Work address:** Rua do Matão, 1010 - CEP 05508-090 - São Paulo - SP

**Type and duration:** 1 Postdoc (2 years), 1 PhD (4 years), 1 MSc (2 years)
**Supervisors name:** Saulo R.M. Barros, Antoine Laurain, Pedro S. Peixoto
**Recipient:** https://vagas.ime.usp.br/

**Project title:** Optimization of finite-difference seismic wave solvers and their adjoints.

**Research theme area:** inverse problems, seismic imaging, numerical analysis, partial differential equations, optimization.

**Abstract:** Full waveform inversion (FWI) is a high-resolution seismic imaging technique that is based on using the entire content of seismic traces for extracting physical parameters of the medium sampled by seismic waves. The aim of the project is the theoretical study and implementation of optimization methods to solve the FWI problem, and to develop a range of software technologies required for simulation and data inversion.

**Description:** The successful candidates will collaborate with researchers from the project "Software technologies for simulation and inversion" of the Research Centre for Gas Innovation of POLI-USP at the University of São Paulo. Summary of the program and projects can be found at the RCGI website (http://www.rcgi.poli.usp.br/).

The general objective of the project is to create a library of numerical discretizations for numerical seismic imaging expressed symbolically using Devito, a domain-specific language (DSL) and code generation framework for the design of highly optimized finite difference kernels for use in inversion methods (https://www.devitoproject.org/).

The first specific objective of this workstream is to develop discretization methods for several types of partial differential equations relevant for full waveform inversion: isotropic acoustic system and anisotropic acoustic and elastic systems, with the following properties: (1) stability in the presence of high medium contrasts for long time integrations, (2) accuracy of key solution metrics, e.g. minimized dispersion errors, (3) computational efficiency. The second specific objective is the theoretical study and implementation of both state of the art and novel optimization methods to solve the FWI problem. In particular, we will focus on the development of sharp interface models, which are relevant for geological settings presenting strong discontinuities, such as the case of delineation of salt bodies.

The successful candidates will perform the numerical analysis of the proposed methods, and are expected to use the Devito and/or FEniCS and/or Firedrake package (Python or C++) for the numerical implementation of the finite-difference method and the resolution of the inverse problem.

**Requirements to fill the position:** Programming skills, experience in numerical analysis and proficiency in English are required for all positions.
- The postdoc candidate should hold a PhD in Mathematics, Physics or Engineering. Experience in geophysics or inverse problems is desired.
- The PhD candidate should hold a MSc in Mathematics, Physics or Engineering. Experience in inverse problems and/or partial differential equations is desired.

**Scholarship values (tax-free):**
- Postdoc: 6819 BRL
- PhD: 2784 BRL (first year), 3446 BRL (second year)
- MSc: 1889 BRL (first year), 2005 BRL (second year)

Candidates should apply by sending their CV to Antoine Laurain (e-mail: laurain@ime.usp.br). The positions will remain open until they are filled.

For further informations please contact Antoine Laurain:
e-mail: laurain@ime.usp.br, tel.: +55 (11) 3091-6304.