Scientific Area	Multiscale Systems		
Project Title	Improving the efficiency and quality of 3D seismic imaging addressing physical and machine learning aspects		
Delft University of Technology	Delft University of Technology		
PhD awarding Institution	Delft University of Technology	**PhD Duration**	48 Months
Supervisor/Institution	Delft University of Technology		
Co-Supervisor/Institution	The Cyprus Institute		
Secondment(s)	Training on ML and deep learning approaches – The Cyprus Institute		

Project Description

3D high-resolution seismic imaging – including the background propagation velocity model update – via the so-called Joint Migration Inversion (JMI) method is a computation- and data-intensive process. Terabytes of acoustic measurement at the Earth's surface are transformed to 3D subsurface images, making use of an optimized background speed-of-sound map. The current JMI method needs to be extended to the case of 3D anisotropic subsurface speed-of-sound distribution and attenuation (or "Q") effects. Because the use of anisotropy and Q-related parameters will over-parametrize the inverse problem, constrains are required – obtained via machine learning (ML) – in order to guide parameter updates from physical and geological prior knowledge. In addition, the process of wavefield propagation, which is the bottleneck in the JMI process, may be sped up by using ML approaches to wavefield simulation via so-called physics-informed neural networks (PINNs).

Project Objectives

The basis of the method will be the currently developed JMI parallel C-code. This code will be extended and optimized according to the above described directions via (i) including 3D anisotropy in wave propagation, (ii) include attenuation/Q effects in wave propagation, (iii) constrain these extensions via physical and geologic prior knowledge, using statistical or ML approaches and (iv) investigate the use of PINNs for speeding up the wavefield propagation process.
The final objective is to make the available JMI method physically more realistic and still affordable in order to make the method available for a broader range of acoustic imaging applications, such as seismic imaging for subsurface storage (e.g. CO_2 or H_2) and near-surface analysis.

Required Candidate Qualifications

We are looking for candidates that meet the following requirements:

- M.Sc. in one of the following relevant fields is required: Applied mathematics, Physics, Computational Science or Engineering, Geophysics.
- Knowledge and experience in the field of signal processing and wave-related problems, preferable experience with geophysical problems
- Proficiency in a programming language such as Python, C, C++, Fortran, etc.
- Experience with HPC codes and workflows from simulation science that deal with inverse problems.
- Knowledge in AI/ML methods.
- Strong academic record in the relevant fields, including presentations at international meetings and at least two peer-reviewed journal publications.
- High-level communication and writing skills
- Proficiency in oral and written English
- Excellent interpersonal skills and ability to work as part of an interdisciplinary team