UNIVERSITÉ LIBRE DE BRUXELLES

Thesis update - 04/03/2024

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March 4, 2024

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Outline

1. Introduction

Where am I

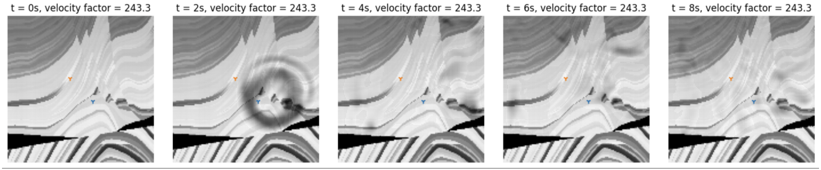
- Problem defined
  - Given the propagation of a wave through a heterogeneous field, retrieve the wave epicenter
- Data defined
  - Scalar and Vector Acoustic Wave Equation: $\frac{d^2u}{dt^2} = f(t,x,y) + c^2(x,y)\nabla^2 u$
  - u is initialized at random to give an idea of background noise: probably not the best idea
  - The *heterogeneous* part appears since c is a (non-linear) spatial function $c(x,y)$.
  - I use the *Marmousi*[1] field, scaled by a random factor between 0 and a random value uniformly drawn between 200 and 400.

[1] Brougois, A. & Bourget, M. & Lailly, P. & Poulet, M. & Ricarte, Patrice & Versteeg, Roelof. (1990). Marmousi, model and data. 10.3997/2214-4609.201411190.

Where am I

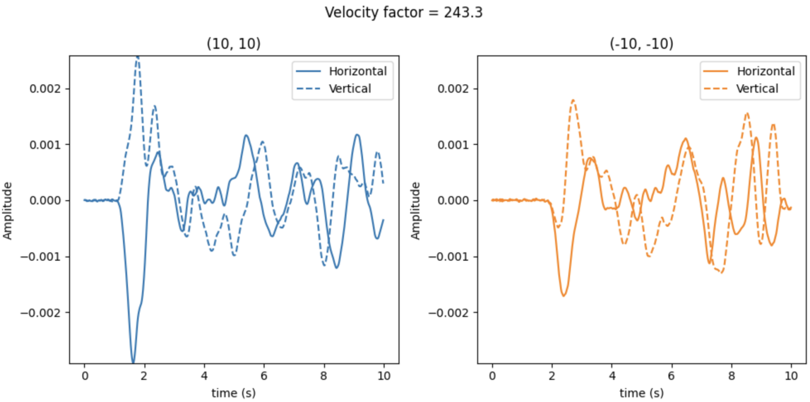
- Data defined
  - Can be interrogated from chosen *Interrogators* (see blue cross on figure 1) that outputs a time series of the amplitude at this spatial point
  - Currently in 2D for the vector equation, with interrogators being vertical and horizontal
  - See Video example

Example in Vector from



Example of propagation

Example in Vector from



Example of interrogators

Where am I

- Data defined
  - Acoustic Wave Equation: $\frac{d^2u}{dt^2} = f(t,x,y) + c^2(x,y)\nabla^2 u$ on the Marmousi velocity field, with multiple interrogators
  - Stored in a PyTorch dataset for ML convenience
  - Hosted on GitHub and PyPI with multiple notebooks for presenting the tool
  - ScalarAcousticWaveDataset and VectorialAcousticWaveDataset available
  - Visualisations are available for both

Where am I

- Data defined
  - Typical questions:
    - Retrieve (hypo/epi) center from the seismograms when they are < 3
    - Retrieve the propagation speed field $c(x, y)$ (inverse problem) from the entire simulation or given a few seismograms
    - Predict the wave propagation given the external force or given a few initial steps
    - Faster than the classical computation used here