A comparative analysis between different interpolation techniques applied in FWI using DSL Devito

Gustavo Araujo Alvaro Coelho*, SENAI CIMATEC
Vitor Moraes Aranha, SENAI CIMATEC
Peterson Nogueira Santos, SENAI CIMATEC
Reynam da Cruz Pestana, Universidade Federal da Bahia

Abstract

Interpolation methods allow the construction of new data from a discrete set of points. This process is done by using interpolating functions, whose goal is to estimate the value of undefined arbitrary points from a previously known set of points. This method is widely used in many areas of knowledge, from image processing to seismic imaging in geophysics applications. In the context of seismic modeling, interpolation serves the main purpose of estimating the amplitude of the wavefield in arbitrary positions not defined by the computational grid. Given the importance of this process, we implement over the Devito - DSL (Domain Specific Language) framework two alternate interpolation methods: Cubic interpolation and Lanczos interpolation, aiming at improving and comparing the results obtained from linear interpolation, the default method implemented by this tool. The Devito framework is based upon objects that store and operate computational grid data. In this context, elements that aim at recording the amplitude of the wavefield in a given point in space also called "Receivers", are largely used. Measurement of wavefield amplitude can be done in different positions in space, including positions not defined by the granularity of the computational grid. In these cases, it is required that an interpolation technique is used to estimate the desired position from a set of known grid points in the neighborhood. Devito implements natively bilinear and trilinear interpolation for the 2D and 3D cases, respectively. However, more precise and coherent techniques are known to exist in the literature, and for this reason, we decided to implement and evaluate the Cubic and Lanczos methods. Cubic Interpolation is computed from a third-degree polynomial used as an interpolating function between two points. On the other hand, Lanczos interpolation is based on the product of a Sinc Kernel and a window of points obtained from the grid mesh. When compared to the Linear Interpolation approach, both methods require a larger set of neighbor points to obtain the result, consequently, for more complex and robust input data, the results of their interpolation become smoother and more precise. Once implemented, the methods were tested against each other in Full Waveform Inversion (FWI). This way it was possible to evaluate the precision obtained from each interpolation and compare the results to obtain the best option.