A Supervised Pre-Stack Seismic Inversion Algorithm for Extraction of Earth Parameters

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For more than a decade VFSA (Very Fast Simulated Annealing) has been used to estimate elastic parameters of earth material by inverting seismic data. This global optimization technique can handle both linear and non-linear seismic inversion. Any linearized form of Zoeppritz equations, e.g., Aki and Richards, full Zoeppritz equations, and even full elastic reflectivity can be used as forward modeling engines. The uncertainty of elastic parameters can be quantified via several VFSA runs initiated from random points in model space. However, computational cost can be much more compared to that of a single solution.

To speed up VFSA inversion, we focus on developing an algorithm to incorporate a priori knowledge of elastic parameters which can be extracted from well logs, core data, etc. We apply various methods to incorporate prior data by defining different mathematical weighting functions. It is demonstrated that a faster computational convergence can be reached by moving from pure VFSA, to polynomial, linear, exponential, and constant weighting functions. The broader the probability distribution function of prior data, the longer VFSA's convergence time. VFSA can easily deal with broadly erroneous distributed priors, but it hardly converges when combined with sharply erroneous distributed priors. In summary, the proposed algorithm is flexible enough to be adjusted with any inverse problem by tuning the appropriate weighting function for including prior information.