ParJoInv: high-performance scientific computing for multidimensional joint inversion

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This talk deals with the study of a Tikhonov-like approach to the joint inversion of multidimensional data, based on an edge-preserving regularizer (M.D. Zhdanov *et al.*, 2004; E. Haber *et al.*, 1997), and its parallel implementation in an HPC software package. The package is built on top of the well known and widely used high-performance parallel libraries PETSc and TAO. The starting point is a joint work with G. Vignoli. Effective methods and efficient codes for a truly joint inversion have recently received increasing interest, because multiple types of observations of the same object can be used at once in a single procedure to recover an estimate of the object itself via non-invasive inspection (M.D. Jegen *et al.*, 2009; M. Meceira *et al.*, 2008; N. Linde *et al.*, 2008; L.A. Gallardo *et al.*, 2007, 2005; Dell'Aversana, 2007; D. Colombo *et al.*, 2007; G. Vignoli *et al.*, 2005). Indeed, jointly inverting different kind of data could allow to reduce both the ill-posedness of the data reconstruction problem and the total number of data to be collected, while still preserving the accuracy of the results. This is relevant to a large number of research and industrial fields such as Biology, Geophysics, Medicine and many others. Unfortunately, the study and the coding are more difficult than in the classical inversion. We discuss the current development of the software, which can use both first- and second-order methods to solve the underlying optimization problem. Finally, we report the preliminary results of a numerical experimentation that shows its potential for large-scale real-world applications.