POCS Method for Seismic Data Reconstruction of Irregularly Sampled Data

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We investigate the performance of iterative wavefield reconstution via the POCS method (projection onto convex sets). In particular, we analyze the problem of interpolating irregularly sampled data. POCS reconstruction methods are based on the Gerchberg-Saxton method (Gerchberg and Saxton, 1972), and have well-studied applications in signal and image processing (Papoulis, 1975; Menke, 1991). In addition, POCS has been recently studied as a method for seismic data interpolation by Abma and Kabir (2006).

The basic technique applies the following projections for each iteration

$$x^k = (I - S)F^{-1}T^k BF x^{k-1} + x^{obs}$$

where x^k is the set of traces at k-iteration, S is an operator that identifies known traces (sampling operator), F is the fourier transform operator, T^k is a threshold operator, and B is a band-limiting operator. The threshold operator acts to remove any points below a certain amplitude from the Fourier amplitude spectrum. Early iterations interpolate only the strongest events while later iterations consider weaker ones.

We explore an alternative to a threshold value that is varied linearly with iteration, as well as the effects of including different band-limiting operators (velocity filters). The incorporation of physical projections that are consistent with wave propagation theory leads to an improvement in computational cost and accuracy.

References

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