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COMPRESSIVE WAVE COMPUTATION

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In this talk, I will show how recent developpements in the field of compressive sensing data acquisition [1,2] also translate into advances in the large-scale simulations of wave propagation phenomena. It is indeed possible to accurately compute a wavefield by decomposing it onto a largely incomplete set of eigenfunctions of the Helmholtz operator, chosen at random. This provides a natural way of parallelizing wave simulations for memory-intensive applications.
The restoration of the wave equation solution from these compressive computation is obtained through ℓ_1 minimization, that promotes the sparsity of the solution. This "compressive sensing in the Helmholtz domain" is effective for wave propagation in 1D domains of bounded varations because the solution remains sparse enough and because the eigenvectors are delocalized enough, as shown in [4].
In practice, the compressive strategy makes sense because the computation of eigenfunctions can be assigned to different nodes of a cluster in an embarrassingly parallel way. Numerical examples are presented in one spatial dimension and show that as few as 10 percents of all eigenfunctions can suffice for accurate results. Finally, we argue that the compressive viewpoint suggests a competitive parallel algorithm for an adjoint-state inversion method in reflection seismology.

References

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[3] L. Demanet and G. Peyré, Compressive wave computation, Preprint 2008.