Compressive Sensing Challenged

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Abstract

Compressive Sensing Challenged .The move to single sensors and also the arrival of the first surveys with carpet geometry are probably some of the main reasons for the current popularity of Compressive Sensing (CS) in seismic acquisition. Carpet geometries have advantages over cross-spread geometries, but they require either a very large number of RPs or a very large number of SPs. Therefore we hope to get away with under-sampled (if possible seriously under-sampled) carpet geometries. CS promises a significant reduction in SPs or RPs (source points or receiver points) or both without a reduction in the quality of the final seismic images.

It is sometimes said that we have always under-sampled seismic wavefields because applying the Nyquist rule would have been prohibitively expensive. This is not true. In many surveys we indirectly adhered to the Nyquist rule by using arrays. The purpose of arrays was not (so much) to improve signal to (random) noise but to suppress the groundroll by adequately sampling it. We can do much better now with single nodes, but a spacing between nodes the same as what it was between separate arrays is too large for adequate sampling. On the other hand, a spacing as close together as it was between individual geophones in an array is probably more than is needed. We are not replacing an array of (say) 12 geophones with 12 single nodes. We should not sample denser than necessary.

Under-sampling and over-sampling Much in CS theory is about reconstructing signal from under-sampled data, but when it comes to land seismic data it is more about reconstructing coherent noise (on land mostly groundroll) while avoiding destruction of the signal. It is not that we are so interested in noise but we can only remove it successfully if we measure it first. The upside is that if the noise is adequately measured then the signal will be adequately measured as well. If the noise is adequately sampled then everything else is over-sampled. If we want to under-sample (to save time and money) then it is first of all this noise that will be under-sampled. Much of the rest will still be adequately sampled, and often still over-sampled.

Papers about CS often start with the promise that applying CS will allow a fairly significant amount of under-sampling without losing data quality, thereby claiming major cost savings. Unfortunately few papers (if any) end with at least a rough estimate of how much has been or is likely to be saved. Perhaps those savings are more modest than advertised. Many examples shown in the literature, of applying CS to seismic data, use data that is over-sampled to begin with, even after sparsification. Such data does not need CS and can therefore not be used to demonstrate the strength of CS.

Whereas application of CS likely has benefits, this presentation will address issues with CS that should not be ignored, but that do not or hardly feature in existing literature.