Compressed sensing in 4-D marine – recovery of dense time-lapse data from subsampled data without repetition

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Time-lapse seismic

Current acquisition paradigm:
- Repeat expensive dense acquisitions & independent processing
- Compute differences between baseline & monitor surveys
- Hampered by practical challenges to ensure repetition

Compressive sampling paradigm:
- Cheaper subsampled acquisition, e.g., via time-jittered marine subsampling
- May offer possibility to relax insistence on repetitiveness
- Exploits insights from distributed compressed sensing

Aim: recovery of both vintages & time-lapse signal from incomplete data

Distributed compressed sensing

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\begin{align*}
A_1 &\, \cdot\, z_1 = b_1 & \text{(baseline)} \\
A_2 &\, \cdot\, z_2 = b_2 & \text{(monitor)}
\end{align*}
\]

Randomized sampling in (4-D) marine

Time-jittered marine acquisition:

4-D recovery (Joint recovery method)

As the calibration error increases, the 4-D signal recovery decreases significantly (b,c). Moreover, the recovery becomes competitive to the recovery with 0% overlap between the surveys, i.e., random recovery without repetition (d).

Monitor recovery (Joint recovery method)

Increasing error increasing SNR

Conclusions

Processing time-lapse data jointly leads to improved recovery of both vintages and time-lapse signal

Given the context of randomized subsampling, calibration errors:
- Deteriorate recovery of the time-lapse signal
- Improve recovery of the vintages

Since calibration errors are inevitable in the real world, the insistence on repetition in time-lapse surveys can be relaxed

Possible to recover dense time-lapse data from randomized subsampling and joint processing

References