A comparative study of the integer wavelet transform applied to seismic data lossless compression

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Abstract

The use of massive amounts of seismic data is becoming more frequent and required in seismic processing and analysis. In this context, data compression becomes an essential strategy to minimize the resources to store and transmit these datasets.

Wavelet transforms are commonly used at the decorrelation stage of compression schemes, as presented in Stigant et al. (1995) and Khkne et al. (2000). For lossless compression of integer samples, the integer wavelet transform (IWT) is a suitable approach as described in Giurcaneanu et al. (1999) and Wang et al (2004). In this work, a study was performed on seismic data compression evaluating the improvement of the compression ratio when the same encoding strategy is applied on integer wavelet coefficients instead of the original samples.

Results

In order to evaluate the gains in compression ratio (CR) by compressing integer wavelet coefficients, three different seismic volumes of data were selected. For each set of data, several libraries and codecs (e.g. C-Blosc2, TurboPFor, FastPFor, LZ4, zstd, and SIMDComp) processed original samples and wavelet coefficients to verify if results were consistent through different compression schemes.

For each seismic volume, it was analyzed how often the compression of integer wavelet coefficients produced a higher CR than that of the original samples. It was also verified what the best CR was in each case.

The table below shows the percentage of libraries that obtained better CRs for the original samples, and for the coefficients. In the case of the F3Block volume, for example, 14.29% of the libraries produced higher CRs for the original samples, while 85.71% were more efficient in compressing the coefficients. The best CR obtained for the samples of this volume was 2.37:1 while the best ratio for the coefficients was 2.53:1. These results were obtained using the compressor blosc2-zstd, which combines the meta-compressor blosc2 with the compression library zstd.

Seismic data lossless compression with IWT approach

Volume of seismic data	Original samples		Wavelet coefficients	
	% of better CR	Best CR	% of better CR	Best CR
F3Block (*)	14.29	2.37:1	85.71	2.53:1
Waka3D (**)	21.21	1.72:1	78.79	1.85:1
Nornefield (***)	3.85	1.67:1	96.15	1.81:1

(*) F3Block: Open Repository, Netherlands Offshore
(**) Waka3D: Open Data, New Zealand
(***) Nornefield: Open Data, North Sea

Conclusions

This study shows that better CRs were obtained from the compression of wavelet coefficients instead of original samples, for the great majority of compressors (up to 96.15% of them). Among all analyzed compressors, blosc2-zstd has produced the best results in all cases: the best CR was 2.53:1 and the average CR was 2.06:1. As a conclusion, using integer wavelet coefficients can be an interesting approach in the context of compressing massive data.

Acknowledgments

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