SLIM

Seismic Laboratory for Imaging and Modeling

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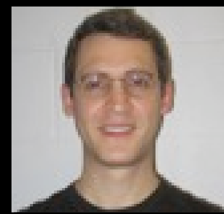

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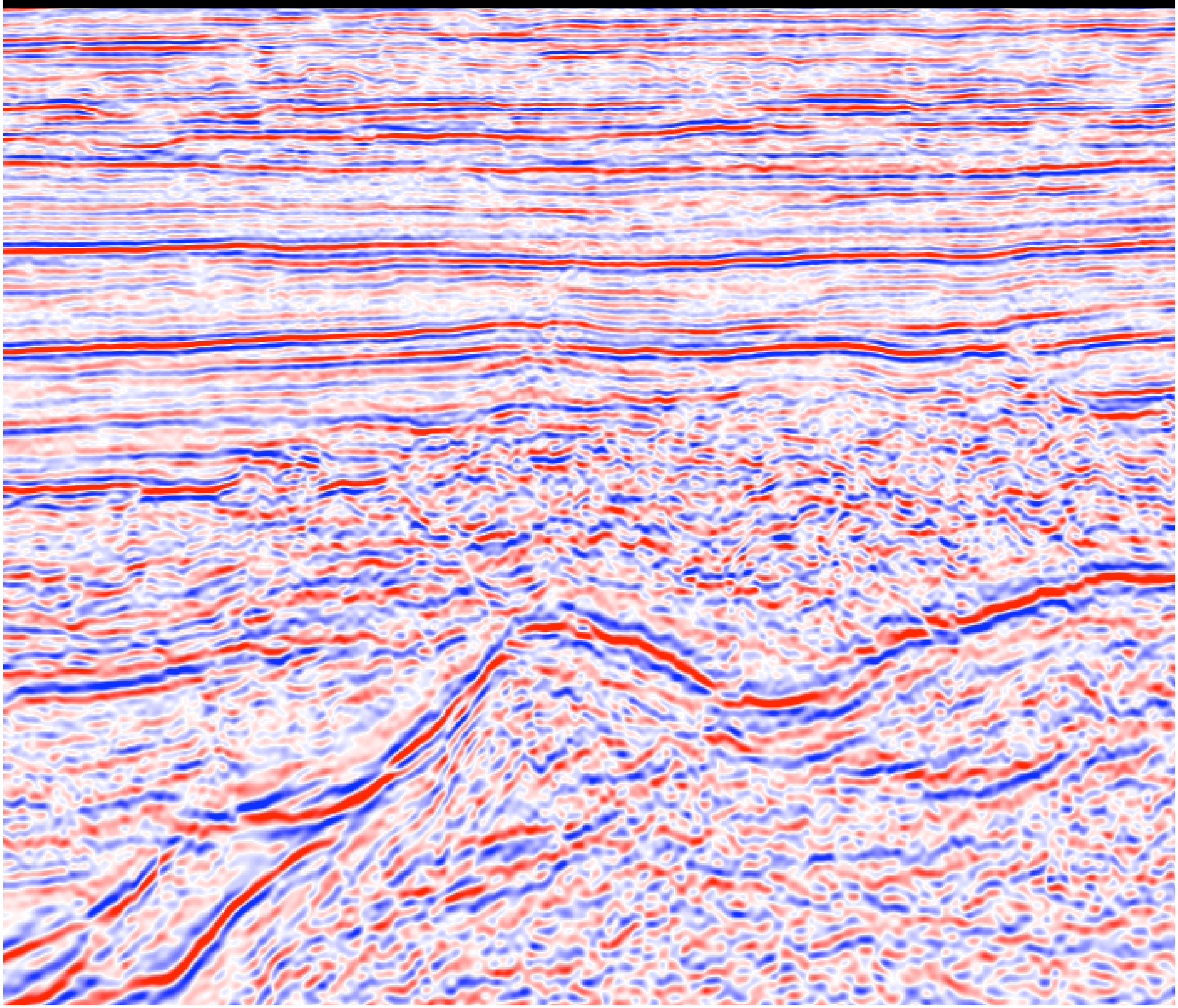
DNOISE

Dynamic Nonlinear Optimization for Imaging in Seismic Exploration



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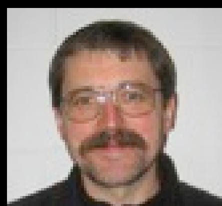

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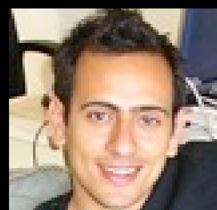
Scientific programmer



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SINBAD (Seismic Imaging by Next-Generation Basis Functions Decomposition)

This proposal describes a systematic five-year research project to apply recent techniques in modern computational and applied harmonic analysis to problems in seismic imaging, inversion, and processing. The application of these new techniques requires a seismic shift that moves away from traditional operator design towards the construction of multi-scale frame decompositions. These decompositions must consist of multi-dimensional prototype waveforms or atoms that are localized and mimic the directional and multi-scale character of seismic and subsurface reflectors. With the project DNOISE, we seek funding to complement and expand current industrial research projects operating in the Seismic Laboratory for Imaging and Modeling (SLIM).

One of the main challenges will be the development of recovery techniques that are not only stable for incomplete and noisy data -- they must also preserve frequency content during imaging. We plan to address this challenge by leveraging the recently proposed uniform uncertainty principles in the field of information theory to the seismic-imaging problem. Uncertainty principles provide machinery to predict the accuracy of signal recovery by techniques in nonlinear optimization that promote signal sparsity.

We hope to answer the basic question: "What accuracy is attainable given certain acquisition geometries?" To answer this and other questions, we propose to extend the current theory, and to develop (i) directional frames adapted to the seismic-imaging context that can deal with images sampled on irregular grids; (ii) uniform uncertainty principles that apply to frames, including those that arise from seismic-imaging operators; (iii) specialized nonlinear optimization algorithms suitable for very large seismic data sets. By replacing inversion techniques based on linear least-squares with those based on a more accurate nonlinear model that promote sparse frame expansions, the outcome of DNOISE will be a substantial improvement in the quality and resolution of seismic images.

Industrial partners: BG, BP, Chevron, ExxonMobil, Shell.

CHARM (Characterization of Reflectors and Modeling)

In this project we decompose imaged reflectors in pre-/post-stack data and well, core and outcrop data into dictionaries consisting of parameterized basis functions. By selecting the best fitting basis functions, information is obtained on the location, sharpness, characteristic scale and instantaneous phase of the transitions from seismic images as well as from direct (outcrop), in situ(well/core) and controlled experimental sedimentary data. This information is used (i) to constrain geological models for the depositional system (permeability) and diagenic processes (porositiy); (ii) as input for rock-physical mixture models that predict sharp (phase) transitions in the elastic modulias a function of a slowly (on the length-scale of the seismic wavelength) varying composition/sorting.

Industrial partners: Chevron.