FindOil
Statistics for oil and gas exploration

Innovation area: Petroleum

Key Innovator: Petter Abrahamsen

Partners: Statoil, UiO, NR, NTNU

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Scope:

Improve oil exploration efficiency, both by improved data interpretation for single prospects and using joint models for several prospects

Results in 2012 and plans:

1. Bayesian networks in oil exploration

The main goal for the work here these last years is to run case studies. Statoil intends to get such a case study started in January 2013. We also want to test this on a developed area, to check against what happened, and to get datasets that can be used for publishing, in particular in connection with the recently started PhD. This PhD will be on Bayesian networks and experimental design. Different information measures for optimisations will be investigated, in addition to multi-selection problems, and utilising of the graph to improve computations. Cases will be from oil exploration, but possibly also other areas.

In addition, in order to make the use of the methodology easily available at Statoil, we need to develop and excellent graphical user interface. Our current plan is to handle this with an external software vendor. Precise plans will be made early in 2013.

2. PCube

The activities presented here are both activities that we intend to finish within (sfi)^2 but also activities that will continue in cooperation with Statoil in one form or another in the years to come. Prioritizing will be done in January, so the list is longer than what will be done in 2013 and 2014. The end of (sfi)^2 is not seen as a deadline by us for many of these projects.

a. Use of non-stationary wavelet and noise model in pointwise Lithology and Fluid Prediction (LFP)

The current statistical models can theoretically handle this, but finding a computationally viable approach is a challenge. LFP is done in two stages, first inverting to elastic parameters, and then

linking to lithology and fluid through rock physics models. Since the information content of the inversion will change with the wavelet, it is in particular the second stage that is challenging here.

b. Non-stationary mean for LF-classes in pointwise LFP
This is similar to the problem above, but now we change the rock physics instead of the seismic inversion parameters. This will impact both the seismic inversion and its interpretation.

c. Combining points a and b
Given that these are successful, this is more of a bookkeeping project to make sure the different approaches are handled consistently.

d. Including anisotropy in pointwise LFP
This extends the space of seismic parameters from 3 to 5 in the seismic inversion. Since the data rarely allows identification of more than two parameters, the main idea here is to allow alternative explanations of the data. We intend to apply data reduction techniques to reduce the dimensionality of the seismic parameters back to 3 before linking to the lithology and fluid classes.

e. Integrating Bayes Dix inversion in pointwise LFP
Bayes Dix is an inversion method for travel time data, and combining this with the AVO data should give better results. This will require a more complicated correlation model than what is currently used, where parameter correlation and depth correlation separates. We will investigate the sensitivity of this assumption, and if necessary try to find robust estimation approaches for these correlations. In addition, we must be able to translate the uncertainty model between different transformations of the model variables.

f. Running a case study for publication of the pattern based LFP method
Pattern based LFP uses a more advanced prior, where we rule out illegal fluid sequences. We lack a good case example for publishing this method, and top tier Geophysical journals require a real case. Running such a case should be done in cooperation between NR and Statoil, where Statoil ensures the quality of the geophysical work.

g. Estimation of non-stationary wavelets without well data
The problem here is that wavelet amplitude cannot be separated from reflection coefficient magnitude. Attempts at doing this with rock physics are very sensitive to the large reflections, and the amplitude is decided by what the most likely transition there is. This leads to a circle, where the amplitude estimate only will confirm the prior used. We intend to avoid this by using wells in the vicinity to estimate a model for the reflection coefficients, but allow for a few unknown large reflections on top of this. Thus, we avoid estimating the amplitude from the large contrasts, and should get a more robust amplitude estimate from the small scale variations.

h. Combine use of seismic AVO data with CSEM data
The goal of this research theme, which will be the focus for one of our PhD students, is to combine seismic AVO data with CSEM data for hydrocarbon probabilities. This will be done by first describing the PCube methodology in the variational Bayes framework, and then utilise this for sequential conditioning of AVO and CSEM data.

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