Performance assessment between deterministic and geostatistical seismic inversion methodologies.

The CERENA-IV synthetic dataset
1. Overview & Objectives

2. Methods

**Deterministic approaches:** Model Based Inversion; Sparse Spike Inversion

**Stochastic approaches:** Global Stochastic Inversion; Global Elastic Inversion; Geostatistical Inversion of Seismic AVO data directly to facies models

3. Work in Progress & Preliminary results

4. To do next…
Overview & Objectives

• Geophysical inverse problems infer subsurface properties from a set of indirect measurements:

\[ d = F(m) + e \]

• Deterministic

• Bayesian inference frameworks are natural ways to tackle geophysical inverse problems.
  – Stochastic or geostatistical
Overview & Objectives

- Synthetic dimensions:
  - Grid size: 121x200x250
  - 6 050 000 cells
- 3 normal faults
- 4 facies groups
- Constrained dataset:
  - 14 wells placed randomly
  - Seismic (post and pre stack)
Deterministic approaches

Sparse Spike Inversion
(Linear Programming)

- Puts events only where the seismic demands
-Attempts to produce the simplest model consistent with the seismic data
- It often produces fewer events that are known to be true

(Adapted from Russel, 1988)
Deterministic approaches

Model Based Inversion

- Produces a broadband, high frequency result
- The results can be highly dependent on the initial guess model: filtering the model may lessen its effect
- The effective resolution of the seismic is enhanced
- There is a non uniqueness problem, as with all inversion

(Adapted from Russel, 1988)
Global stochastic approaches

- Iterative methodologies
- Model perturbation recurs to sequential simulation and co-simulation
- Global optimizer: genetic algorithm

(Adapted from Azevedo, 2013)
Global Stochastic Inversion

Adapted from Azevedo, 2013
Global Elastic Inversion

(Adapted from Azevedo, 2013)
Geostatistical Inversion of seismic AVO data directly to facies models

(Adapted from Azevedo, 2013)

(28/May/2014) Instituto Superior Técnico
Work in Progress & Preliminary Results

Parameters used in the applied methodologies

- **Global Stochastic Inversion**
  - Well data, variograms
  - 32 cubes
  - 6 iterations

- **LP Sparse Spike**
  - 10% sparseness
  - 8Hz constraint
  - Window length: 128 samples

- **Model Based**
  - Low frequency model w/ low pass filter 5-12Hz
  - 10 iterations

- **Available data:**
  - Well logs (AI, Vp, Vs, Rho, Facies)
  - Seismic data (pre and post-stack)
  - wavelet

- **Control data**
  - Original model
Work in Progress & Preliminary Results – seismic assessment

Global Stochastic Inversion

Sparse Spike
Model Based
Original Model

AI_DSS_6_4
AI_DSS_6_14
Arithmetic mean

GSI (AI_DSS_6_4)
Original Model
## Synthetic Seismic vs. Real Model Seismic

<table>
<thead>
<tr>
<th>Inversion Method</th>
<th>Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>LP Sparse Spike</td>
<td>0.9691</td>
</tr>
<tr>
<td>Model Based</td>
<td>0.9854</td>
</tr>
<tr>
<td>GSI</td>
<td>0.9120</td>
</tr>
</tbody>
</table>

### Work in Progress & Preliminary Results – seismic assessment
Work in Progress & Preliminary Results – AI assessment

**Sparse Spike**
- **Original Model**
- **Model Based**

**GSI**
- GSI\_AI\_DSS\_6\_4
- GSI\_Arithmetic mean
- GSI\_Variance

**Model Based**
- Sparse Spike
- Histograms
- GSI\_AI\_DSS\_6\_4

28/May/2014
Instituto Superior Técnico
To do next…

1. Apply the remaining methods to the case study
2. Fine tune the models to reach the intended correlations that will permit assess the performance of the applied methodologies

Thank you.


