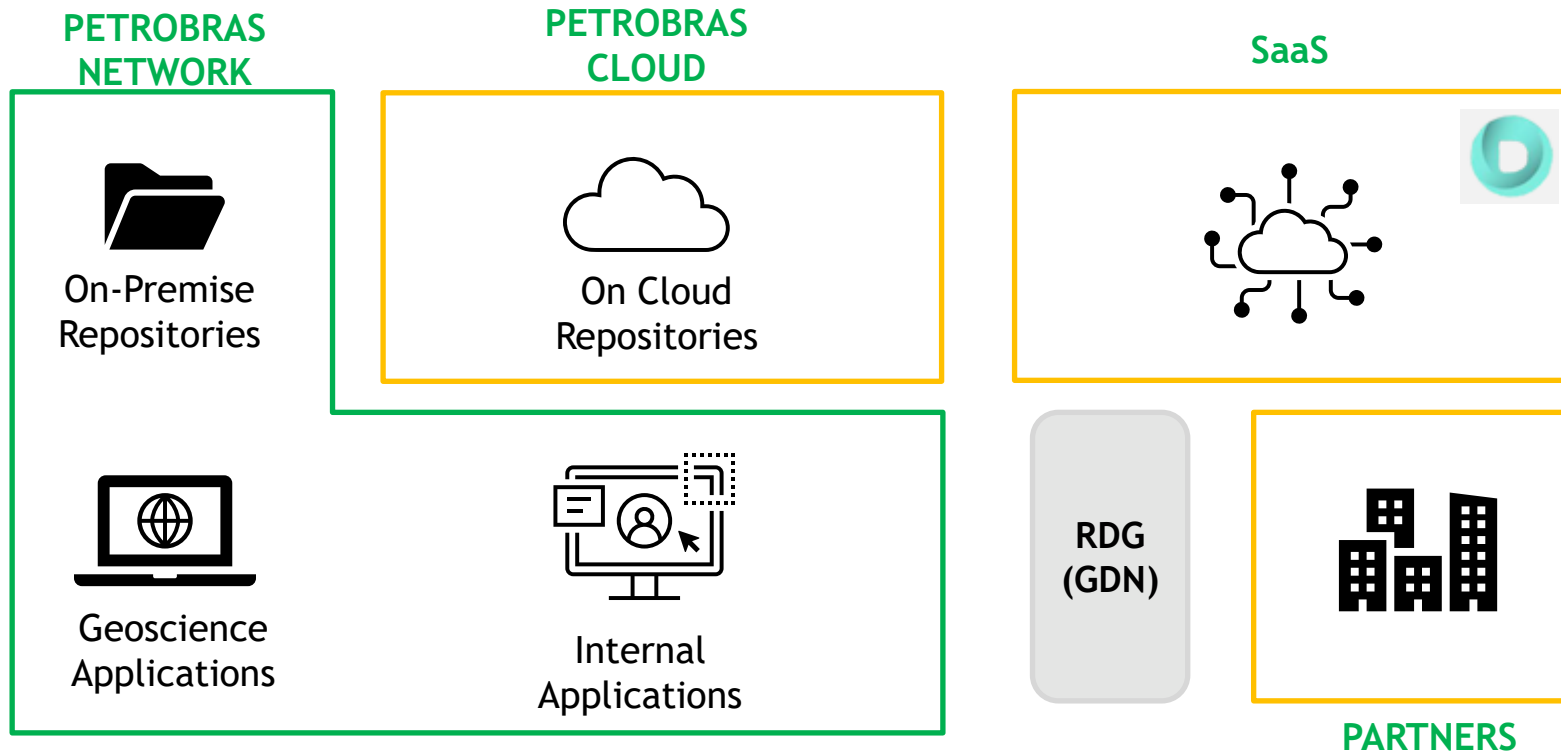


Petrobras Reservoir Digital Journey: from on-premise solutions to working on the cloud

Rodrigo Link Federizzi
September 2022

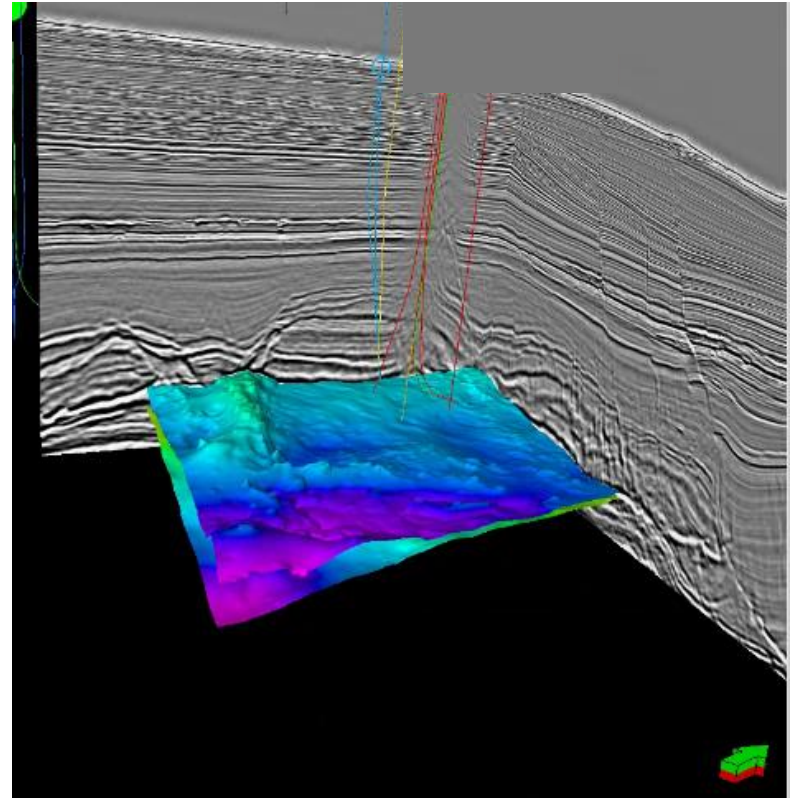
On-premise solutions and the move to the cloud



Two fields were selected as targets

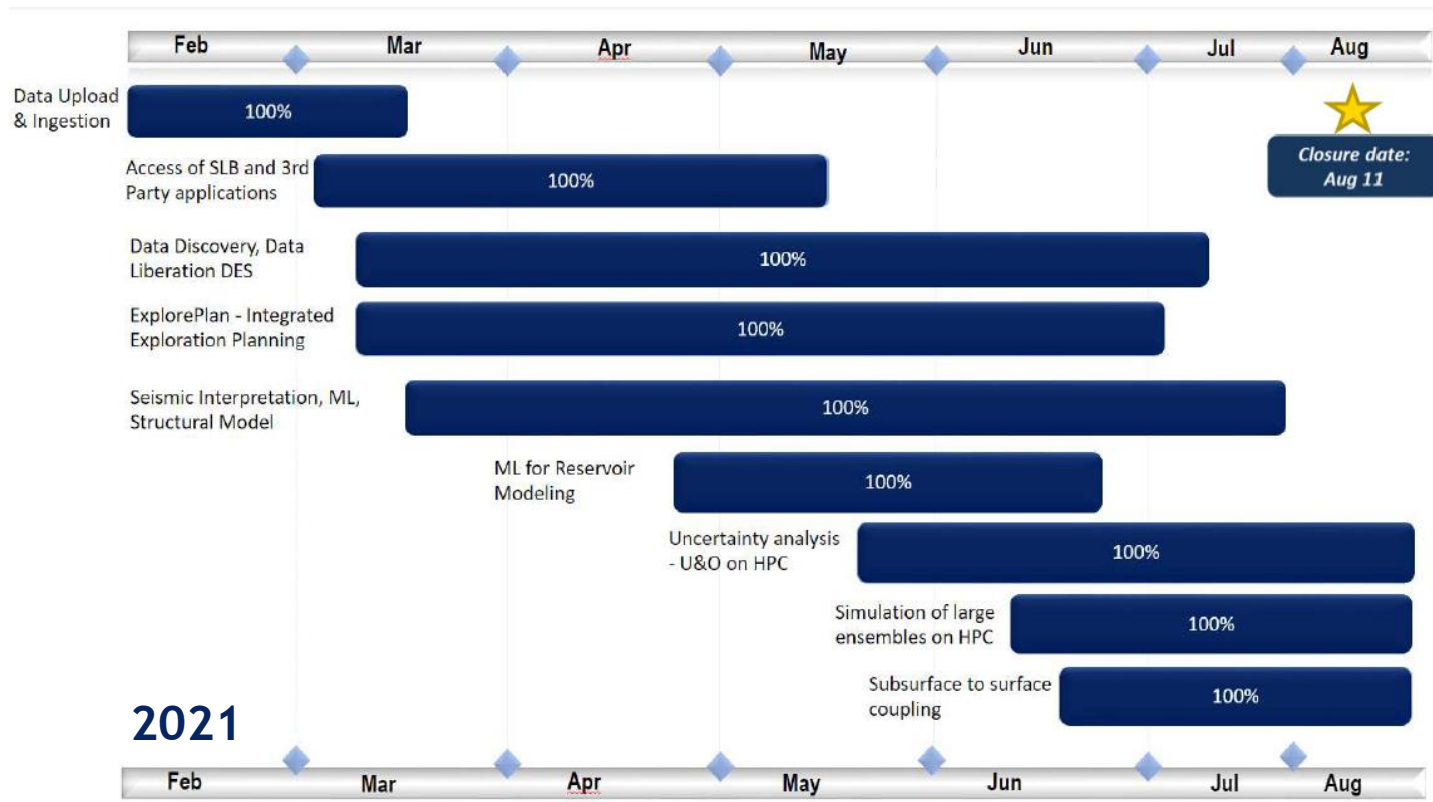
Four terabytes of data
(Exploration + Reservoir)

- Seismic data
- Interpreted horizons
- Well data
- Full projects (Seis+Horiz+Well)



Salt top and base

Validation of DELFI and its use on the targets



Data Management Interface



File Management - Shared Storage

Storage Usage: 100% / 100GB

Upload

Download

Cancel

71% of 1.0 MB

Please Note: MS/EXE Files Blocked. Potentially unsafe upload

Name	Size	Owner
..	-	-
..	-	-
..	-	-
PETROSTEP.zip	2.1 GB	Outp Ve...
PETROSTEP.zip	2.1 GB	Outp Ve...
PETROSTEP.zip	2.1 GB	Outp Ve...
PETROSTEP.zip	2.1 GB	Outp Ve...
PETROSTEP.zip	2.1 GB	Outp Ve...
PETROSTEP.zip	2.1 GB	Outp Ve...

Schlumberger OCLF

API Reference

Home / Data Ecosystem Services / API Reference

- Analytics Service (Internal)**
Analytics service to broadcast record for Data Ecosystem and domains to Analytics database.
- Compliance Service**
Compliance Service for Data Ecosystem Services.
- CRS Catalog Service**
Data Ecosystem - CRS Catalog Service
- CRS Converter Service**
CRS Converter service for Data Ecosystem Services.
- Data Catalog Service**
Data Catalog Service for Data Ecosystem.
- DDM Rules Engine Service (Internal)**
DDM Rules Engine Service for Data Ecosystem Services.
- Enrichment Attribute Catalog Service (Internal US)**
Enrichment Attribute Catalog Service for Data Ecosystem Services.
- Enrichment Attribute Catalog Service (Internal)**
Enrichment Attribute Catalog Service for Data Ecosystem Services.
- Enrichment Fetch Service (Internal)**
Enrichment Fetch Service (Internal) for Data Ecosystem.
- Enrichments Service (Internal)**
Enrichments Service (Internal) for Data Ecosystem.

enrichment

Implementation Notes
Returns a list containing all wells. The list supports paging

Response Class (Status 200)
A list of wells

Model: **Example Value**

```
{
  "application": "application",
  "well": "well",
  "wellName": "wellName"
}
```

Response Content Type: application/json

Curl

```
curl -X GET --header 'Accept: application/json' 'http://localhost:8080/enrichment/wells'
```

Request URL

```
http://localhost:8080/enrichment/wells
```

Response Body

```
{
  "application": "app_1",
  "well": "well_1",
  "wellName": "well_1"
},
{
  "application": "app_2",
  "well": "well_2",
  "wellName": "well_2"
}
```

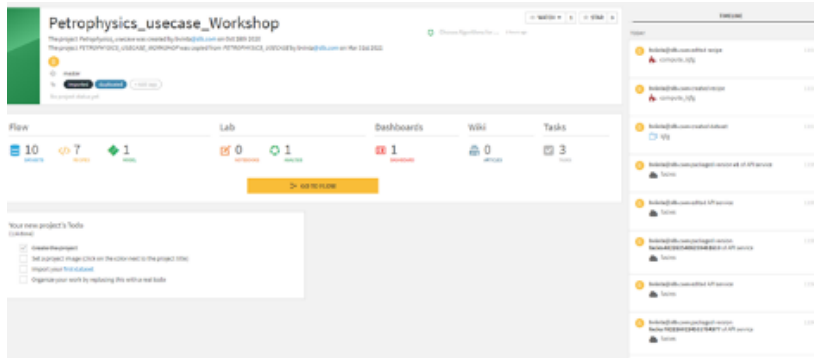
Response Code

Response Headers

```
Content-Type: application/json
Date: Tue, 20 Dec 2016 06:06:00 GMT
Server: Tomcat/9.0.31.2 Python/3.5.0*
```



Analytics Workspace + AI Workspace



Project history and analysis



Data transformation flow

Create prediction model on [Description](#)

AutoML Let Dataiku create your models.

- Quick Prototypes** Get some models, generic and quick.
- Interpretable Models for Business Analysts** Produce decision tree and simple linear models.
- High Performance Models** Be patient and get even more accurate models.

Expert Have full control over the creation of your models.

- Deep Learning** Create the architecture of your deep learning models and train them. *Keras / TensorFlow*
- Choose Algorithms** Select the algorithms and the hyper parameters to use in cross-validation.
- Write Your Own Estimator** Train your own Python or Scala models. *scikit-learn / H2O*

Machine Learning Algorithms

Algorithms CHANGE ALGORITHM PRESETS COPY TO... COPY FROM...

BASIC

- Target
- Train / Test Set
- Metrics

FEATURES

- Features handling
- Feature generation
- Feature reduction

MODELING

- Algorithms
- Hyperparameters

ADVANCED

- RunTime environment
- Weighting strategy
- Probability calibration

Random Forest

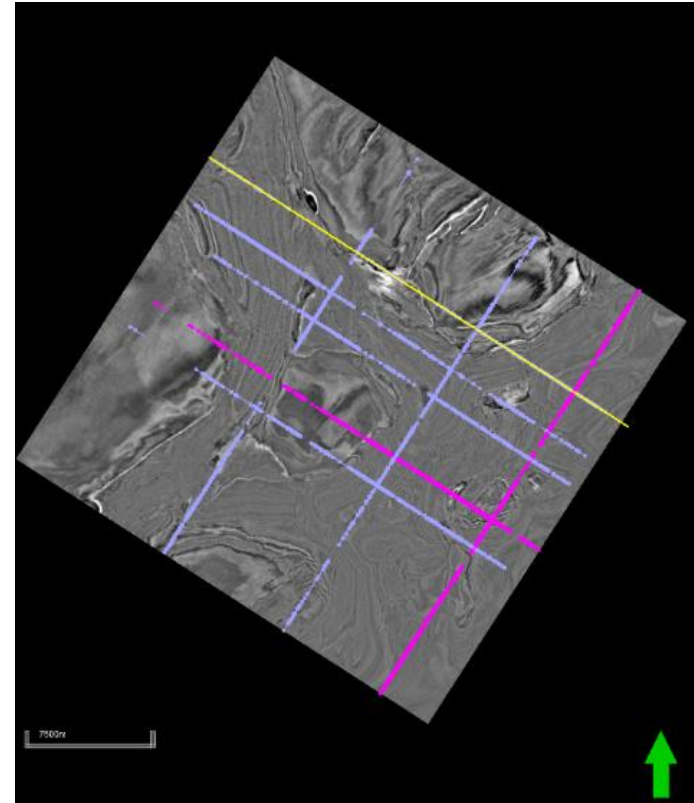
- Number of trees: 100
- Feature sampling strategy: Default
- Maximum depth of tree: 6-16
- Minimum samples per leaf: 1-5
- Parallelism: 4

Easy setup

Automated Fault Extraction

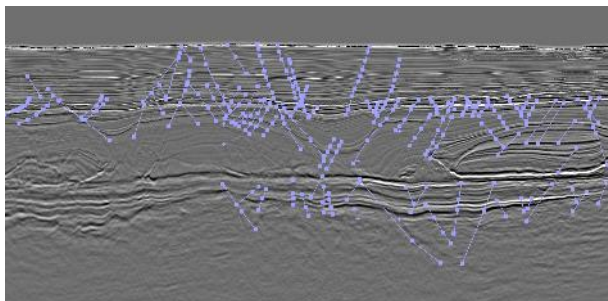
Machine Learning Applied to Seismic Interpretation

- Pre-trained neural network for fault identification
- Few lines manually interpreted
- Expansion to full seismic volume

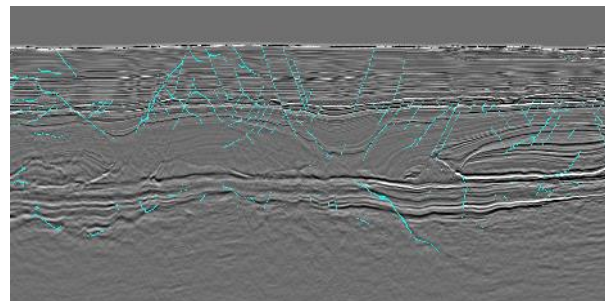


Initial input from user

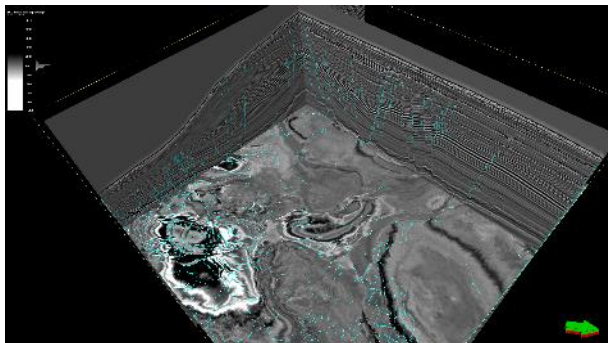
Interpreter's time is spent validating, in quality control and model construction



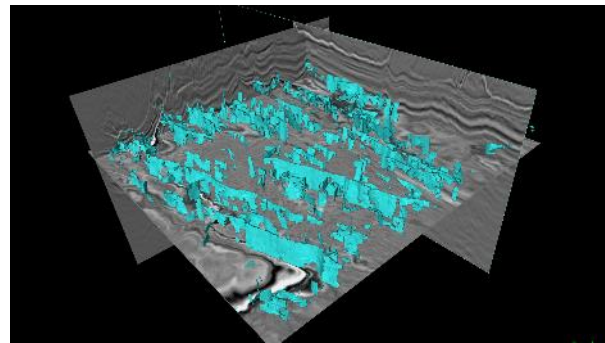
Initial interpretation



After the neural network



Mapping the full volume

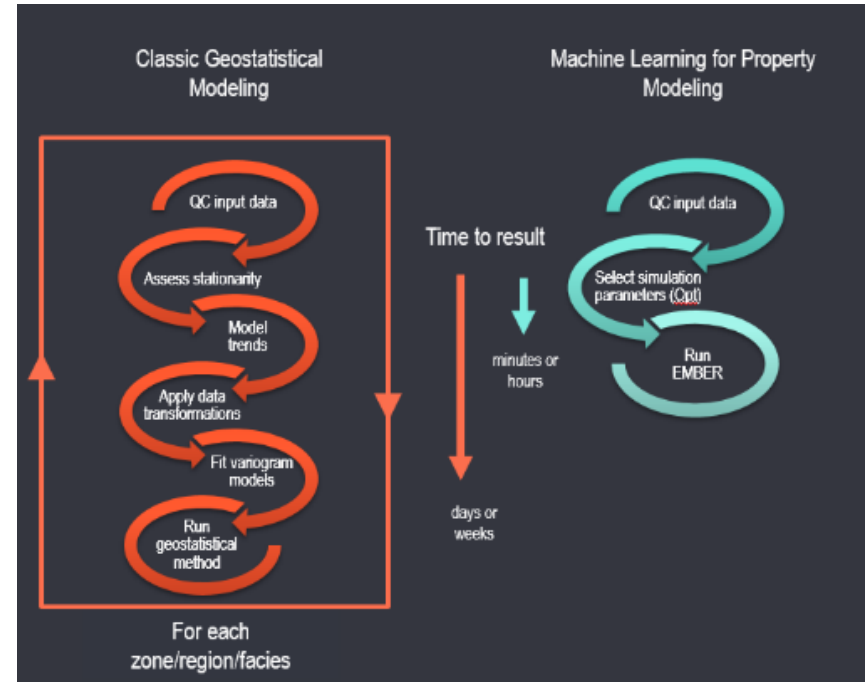


Large number of faults, big and small

Using more data to model properties

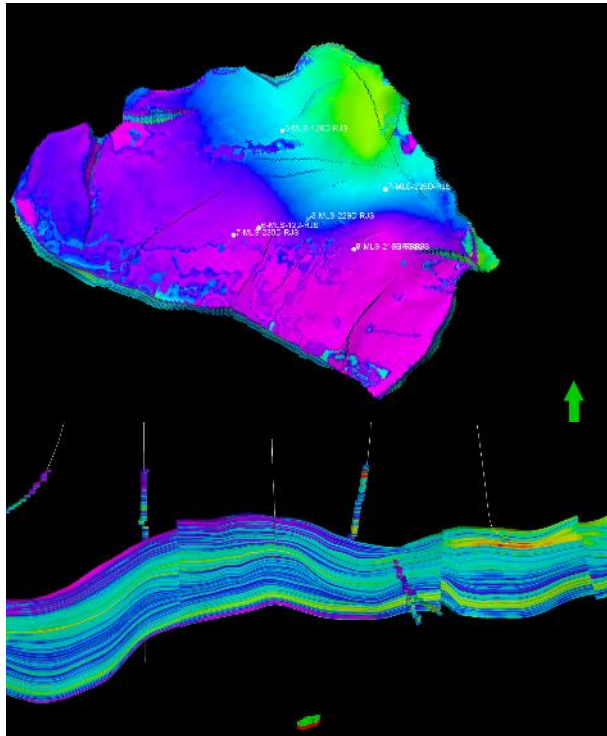
Machine Learning for modeling

- Choosing data input
- Selecting parameter model
- Generating model

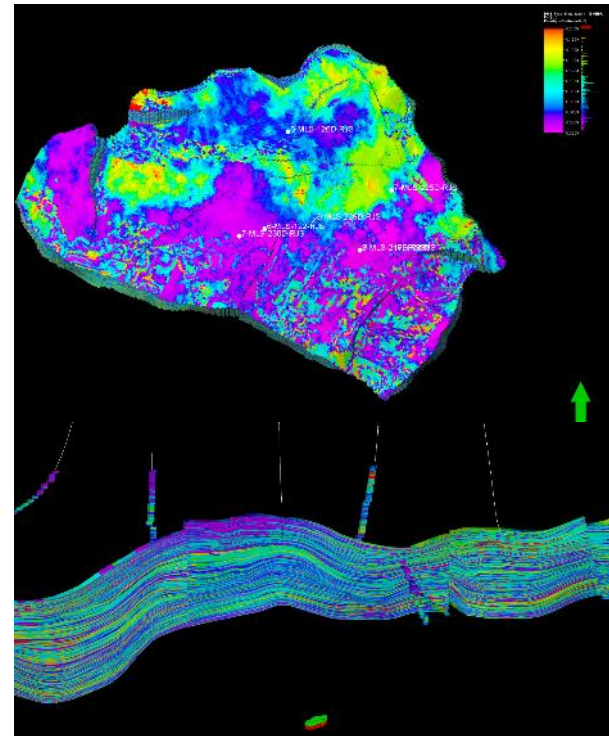


Data driven modeling

Machine Learning assisted geostatistical modeling



Porosity model with kriging



Porosity model with kriging+AI

Schlumberger-Private

Simulation of scenarios

Simulations on the Cloud

- Parallel processes
- Quick results
- Cost per simulation

```
CA:\Program Files\Schlumberger\Petrel 2020\regfiles>
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1683_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1682_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1681_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1680_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1679_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1678_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1677_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1676_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1675_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1674_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1673_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1672_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1671_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1670_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1669_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1668_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1667_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1666_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1665_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1664_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1663_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1662_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1661_000\experiment.log
D:\Petrel\HPC\7adb80e8-2b66-4dcd-8969-cfabd22f93d8\experiment_001_1660_000\experiment.log
Download: 2880 files, 49.90s, Size: 2.68 MB, Speed: 0.85 MB/s

easy.exe sessions delete propnod-us2-ndrlj --baseURL https://api.delfi.slb.com/engines --appkey XCPocYj47TbAn@wSDEDeb2v4
qntNAEBP --subscriptionID 979e38846bc3e4143fc7c1931e518a1f

Easy session finished. Total time (seconds) : 634
```

Two thousand simulations in 634s

Flow simulation

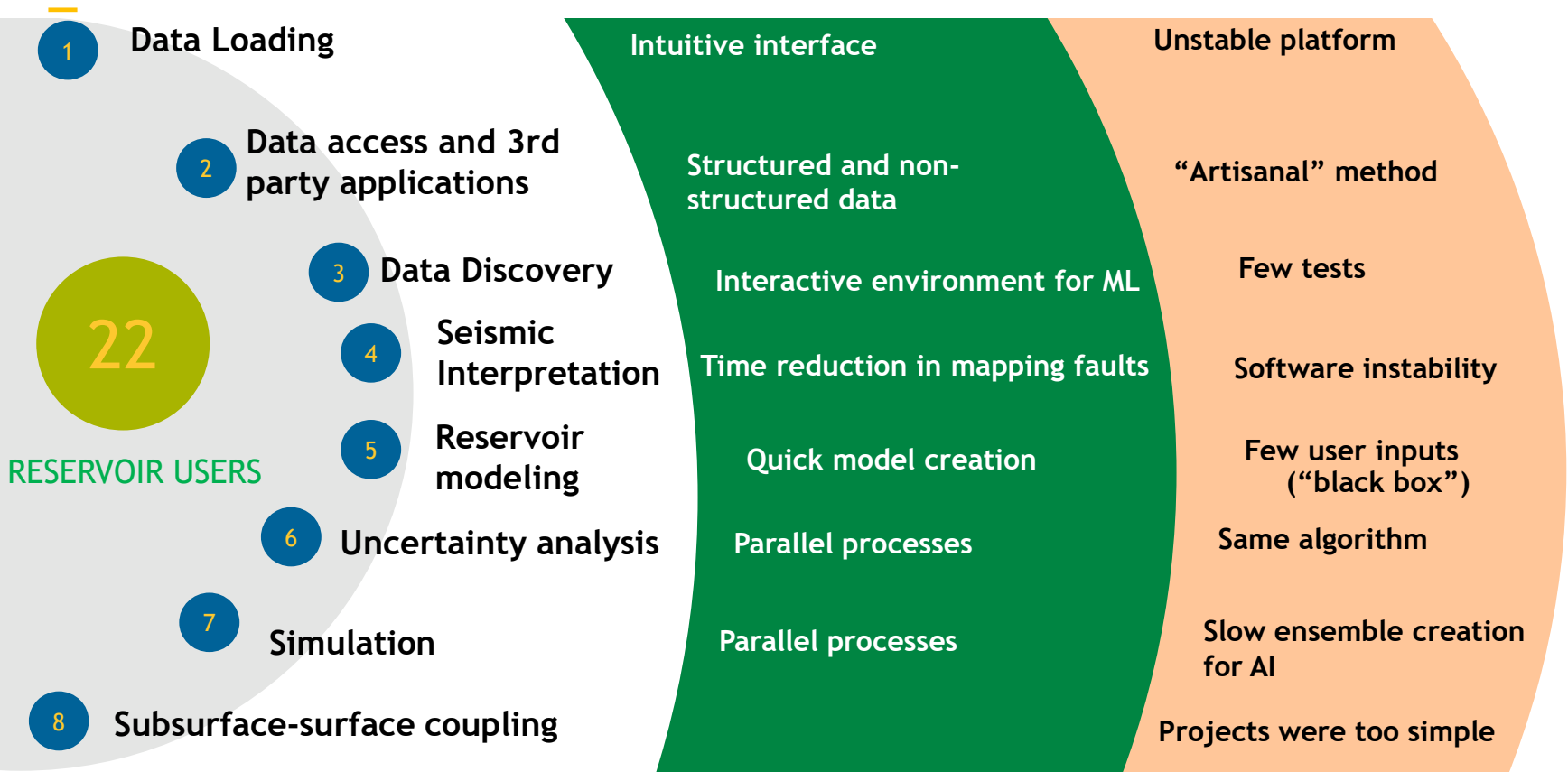
Pros

- Parallel processes
- Results readily available for post-processing
- Quick post-processing of results

Cons

- Jobs take some time to start running
- Slow ensemble creation for AI
- Integration with other solutions were outside the scope

DELFI was shown to be an useful tool, specially for geoscientists



Conclusion

- DELFI offers what is available on-premise and more (“**quick wins**”).
- DELFI is still in **development**, but it already **brought benefits** to some of Reservoir’s processes.
- **Onboarding process** is well planned for scaling up.

Thank you

Rodrigo Link Federizzi
rodrigolink@petrobras.com.br