Feasibility Study of Machine learning for Lithostratigraphy on Troll field

Yonghai Zhang

yhzhang67@gmail.com

Tel: 95433436

Overview

- Motivation
- Resources used in the study
- Test results
- Remarks

Motivation

- Feasibility study of machine learning (ML) for lithostratigraphy
- Test parameterization of ML modeling

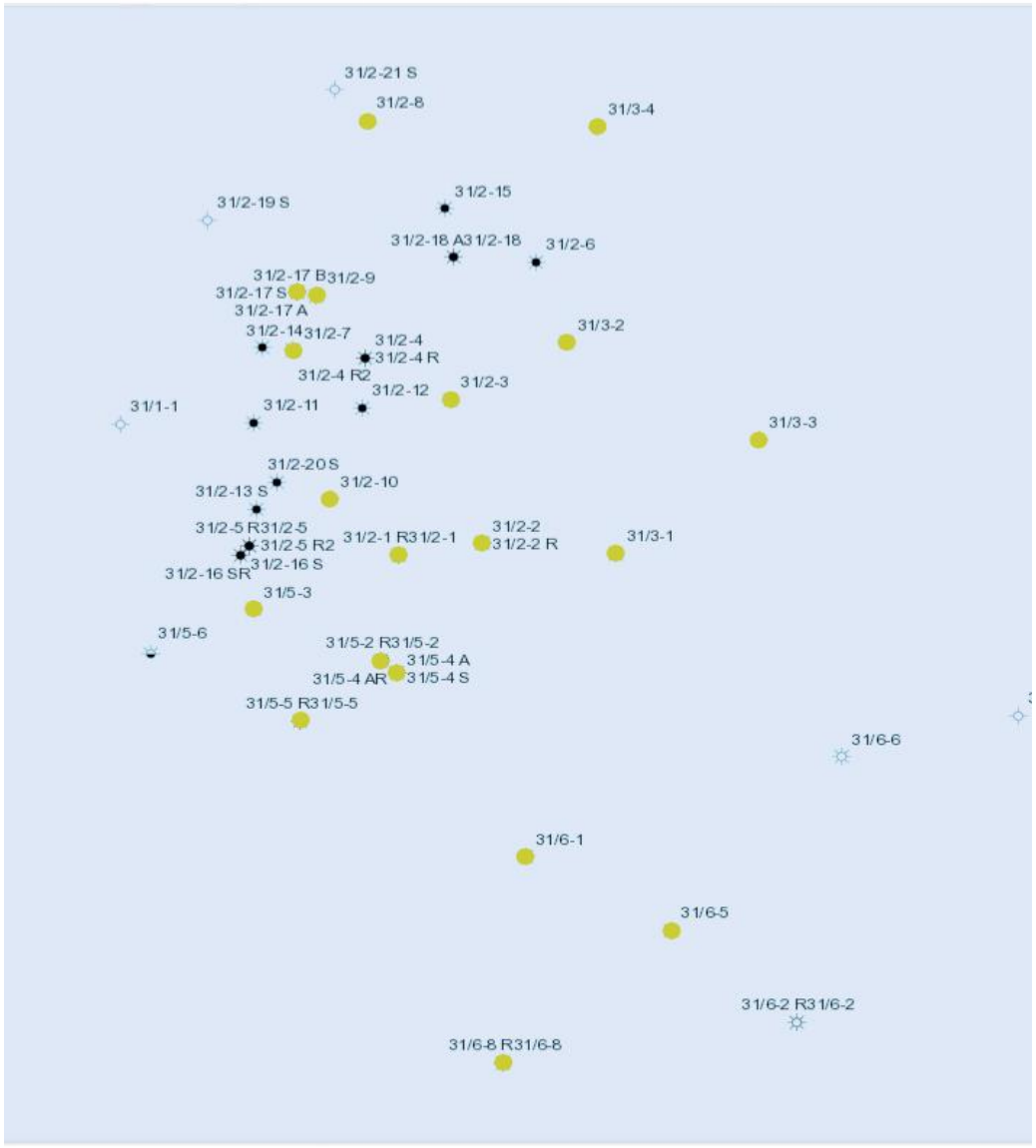
Overview

- Motivation
- Resources used in the study
- Test results
- Remarks

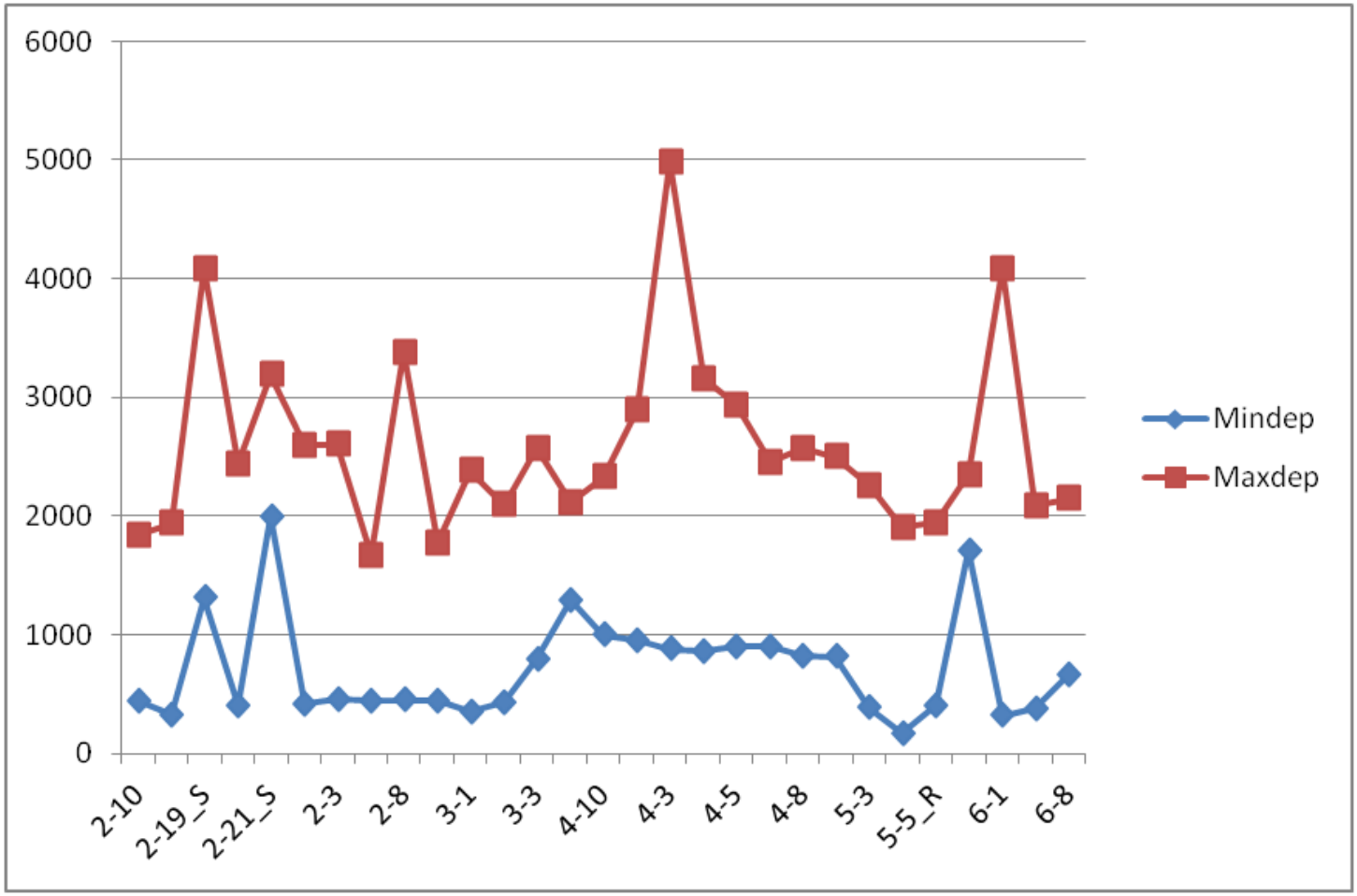
Resources used in the study

- Well-logs with labled lithotype from Troll oil field.
- Original data in LAS format, converted to CSV table, used as input to Python (pandas).
- Easting and northing from NPD website.
- Work environment: Python and Tensorflow workframe

Troll field selected well logs



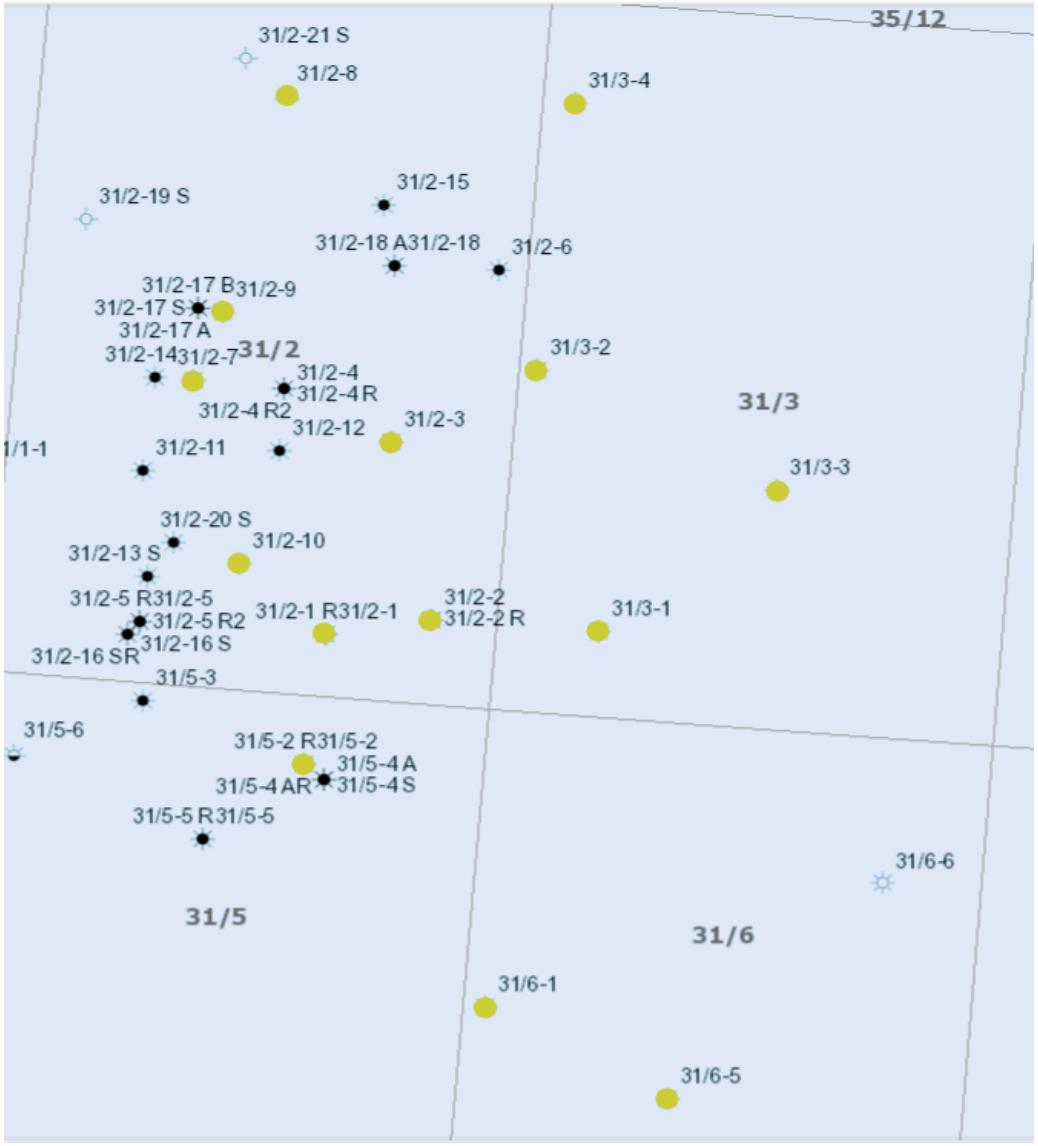
Well depths


6000
5000
4000
3000
2000
1000
0
2-10
2-19_S
2-21_S
2-3
2-8
3-1
3-3
4-10
4-3
4-5
4-8
5-3
5-5_R
6-1
6-8
Mindep
Maxdep

Data selection

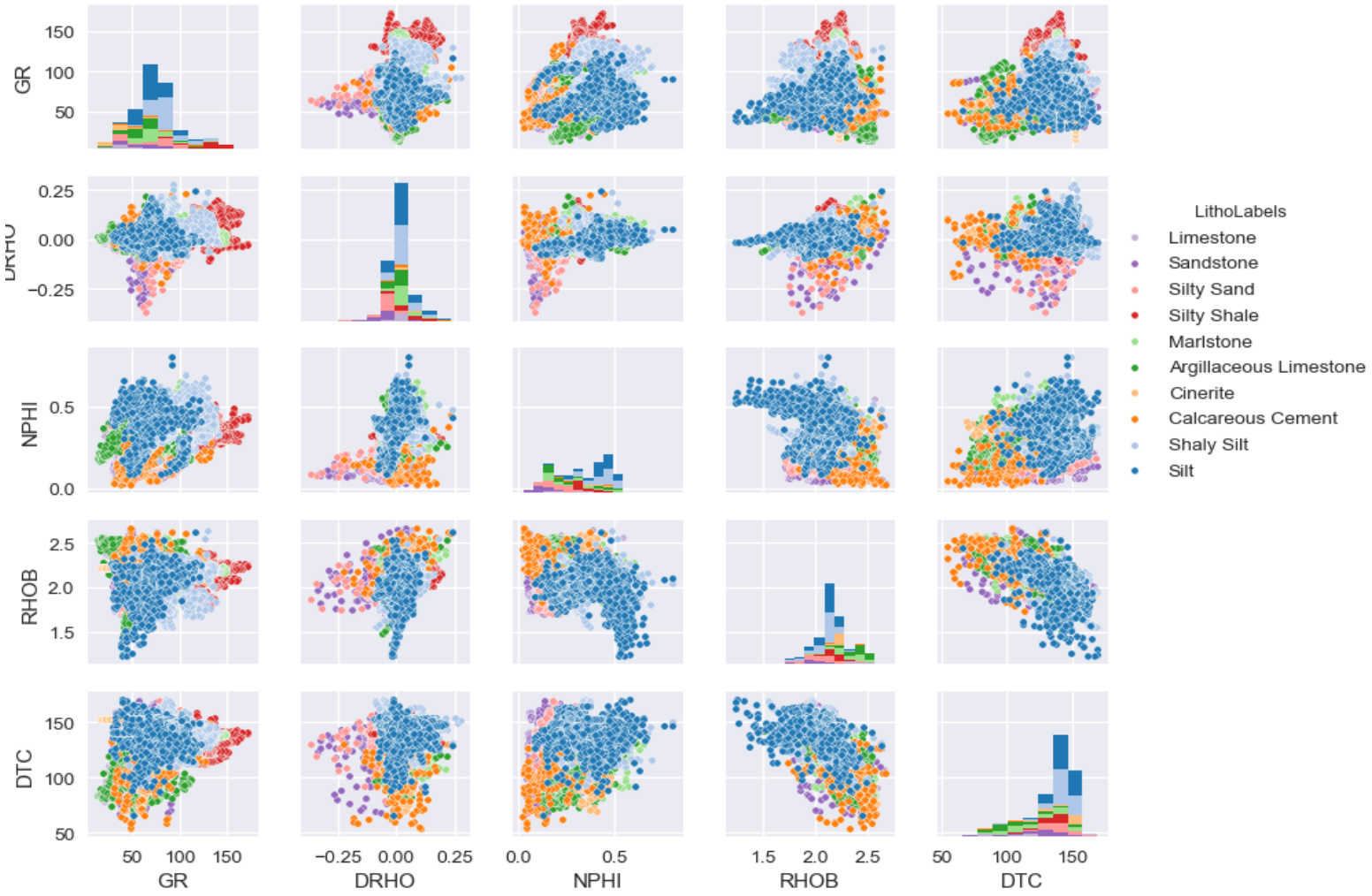
- Selected data in depth range: 1390 -1490 m
  increment: 0.1524m (6 inches)
  sample each well: 656
- Selected wells: 14
- Types of rocks appeared: 10
- Data randomly split into:
  training data 95%, 9781 samples
  test data 5%, 515 samples

Troll field used well logs



Statistics of rock types

Rock feature pairplot



Overview

- Motivation
- Resources used in the study
- Test results
- Remarks

Test results

- Four tests
  1. Use (X,Y,Z) as features, this yields a 3D volume
  2. Use 5 physical features + Z as features
  3. Use five physical features + (X,Y,Z)
  4. Use five physical features only—rock facies classification

Preparation and parameterization

- Data preparation: scaling and outlier removal
- DNN, 8 - 10 layers
- Cross-entropy as cost funtion
- Tensorflow built-in back propagation algorithm

Test 1, 3 spatial features

- Use (X,Y,Z) as input features, this yields a 3D field, can be output to a 3D volume. Independent of physical features.
- Best accuracy: 81%, at iteration 147,000
- Converges very slowly

Test 2, 6 features

- Five physical features: GR, RHOB, NPHI, DRHO,DTC and the depth Z
- Converges very fast, good accuacy
- Best accuracy: 85.2% within 50,000 iteration

Test 3, 8 features

- Five physical features and 3 spatial coordinates (X,Y,Z)
- Converges fast, very good accuacy
- Best accuracy: 90.5% within 120,000 iteration

Test 4, RFC

- Rock facies classification
- Five physical features only, on spatial dependence
- Best accuracy: 81.2%, iteration 140,000

Overview

- Motivation
- Resources used in the study
- Test results
- Remarks

Concluding remarks

- In all the tests, the accuracy reached level > 81%
- The one with (X,Y,Z) is independent of physical properties, can be output to a 3D volume, useful for the area. The program can be used for any 3D fields.
- Combinantion of physical features and spatial ones improve the accuracy.
- The rest 3 tests can be used in logging while drilling (LWD).