

# **Surface Property Prediction**

**Geological potential using Lineal regression,  
ACE regression, Neural Network regression or  
Random Forest regression**

**User Manual**

**IPLAB**

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## 1. Introduction

The **Surface Property Prediction** IP\_Seismic plug-in (version: 2017.1.0.0, release date: July 2017) can be used to predict production possibility attribute of the rock in the layer using set of surface attributes and set of production points in boreholes.

To do the prediction there are two main calculation studies:

1. Training stage – to get prediction operator (coefficients of the operator) according set of pairs – production points with value of production possibility attribute and values of surface attributes around the production points. During this stage, all coefficients in neural network will be estimated to minimize objective function. Prediction operator can be Linear Regression, ACE regression (Alternating Conditional Expectation, LEO BREIMAN and JEROME H. FRIEDMAN, 1985), Neural Network regression or Random Forest regression.
2. Calculation stage – to calculate values of production possibility attribute for every node in the surface based on surface attributes.

## 2. Start

**start:** Surface Attributes->

**Surface Property Prediction**

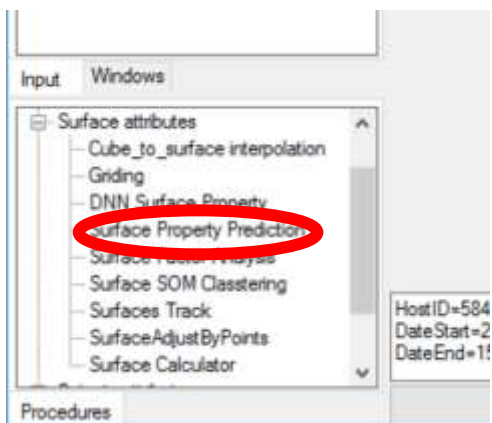


Figure 1: Project tree and programs tree to start **Surface Property Prediction**

### 3. Input parameters

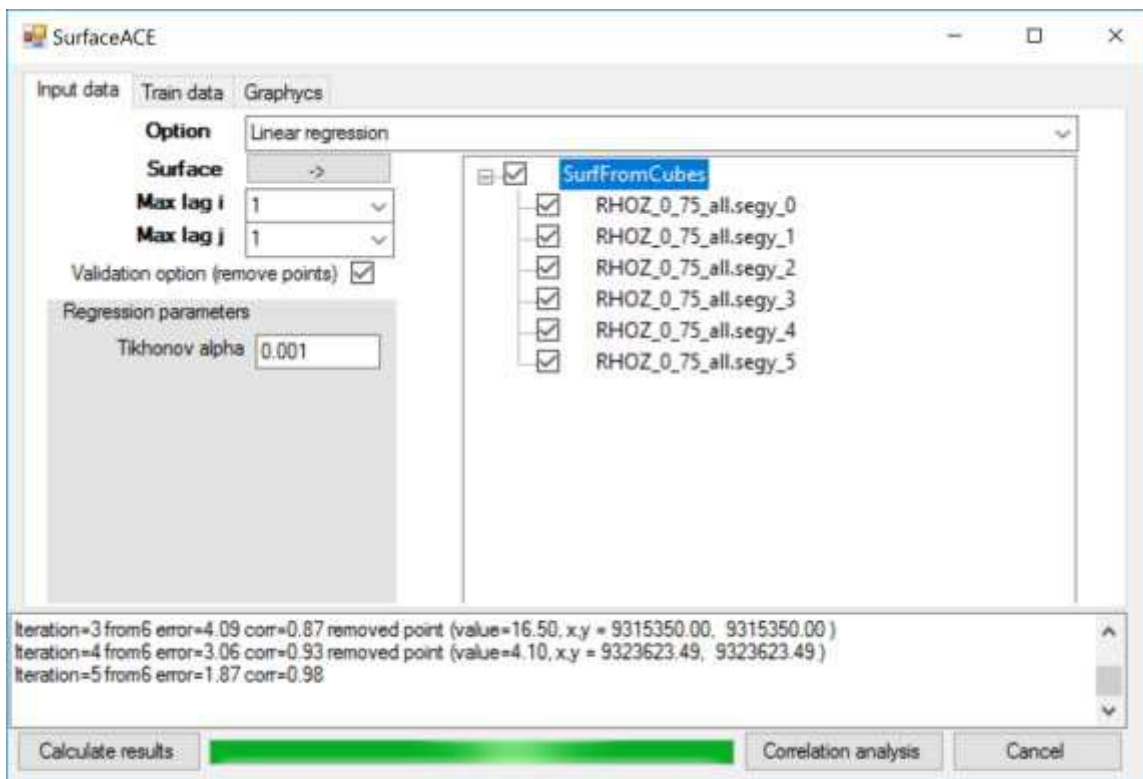


Figure 2: Input surface attributes data tab dialog view **DNN\_SurfaceProperty**

Parameters have to be defined before calculation:

**Surface:** allow select surface with set of surface attributes from the project tree. All marked attributes will be used for calculations.

**Max lag i, Max lag j:** allow define moving window size around production points during training stage and around node for calculation during calculation stage.

**Validation Option (remove points):** if checked, that several calculations will be done. Any calculation will use all wells (points) exclude one current well (point). As result will be several maps:

- Average
- Standard
- Min
- Max
- P10
- P50
- P90

**Option:**

**Linear Regression:** prediction based on Linear Regression.

**ACE Regression:** prediction based on ACE Regression

**Neural Network:** prediction based on Neural Network Regression

**Random Forest:** prediction based on Random Forest Regression.

#### **Parameters for different options:**

**Tikhonov alpha:  $>0$  and  $<1$**  allow avoid overlearning effect or instability for prediction. If  $\alpha=0$  then we can get very good approximation of the training set but the predictability can be very low and results can be very different for every realization. If  $\alpha > 0$  then training quality (correlation coefficient) will be less if use  $\alpha=0$ , but predictability will be much higher (quality control with "blend well" test).

**Iteration:** allow define maximum iteration during training stage to teach the neural network.

**Cross validation (%): ( $\geq 0$  and  $\leq 99$ )** allow define percent of training pairs what will not be used for training and will be used only for quality control.

**Deep learning option: Not used** default, **Kohonen SOM, Restricted Boltzmann machine . Autoencoder.** Option allow to generalized first layers.

**Hidden layer 1 (2, 3, 4, 5) nodes:** allow to define number nodes in 1st (2nd, 3rd, 4th, 5th) hidden layer for neural network definition.

To select production points attributes need to use second tab:

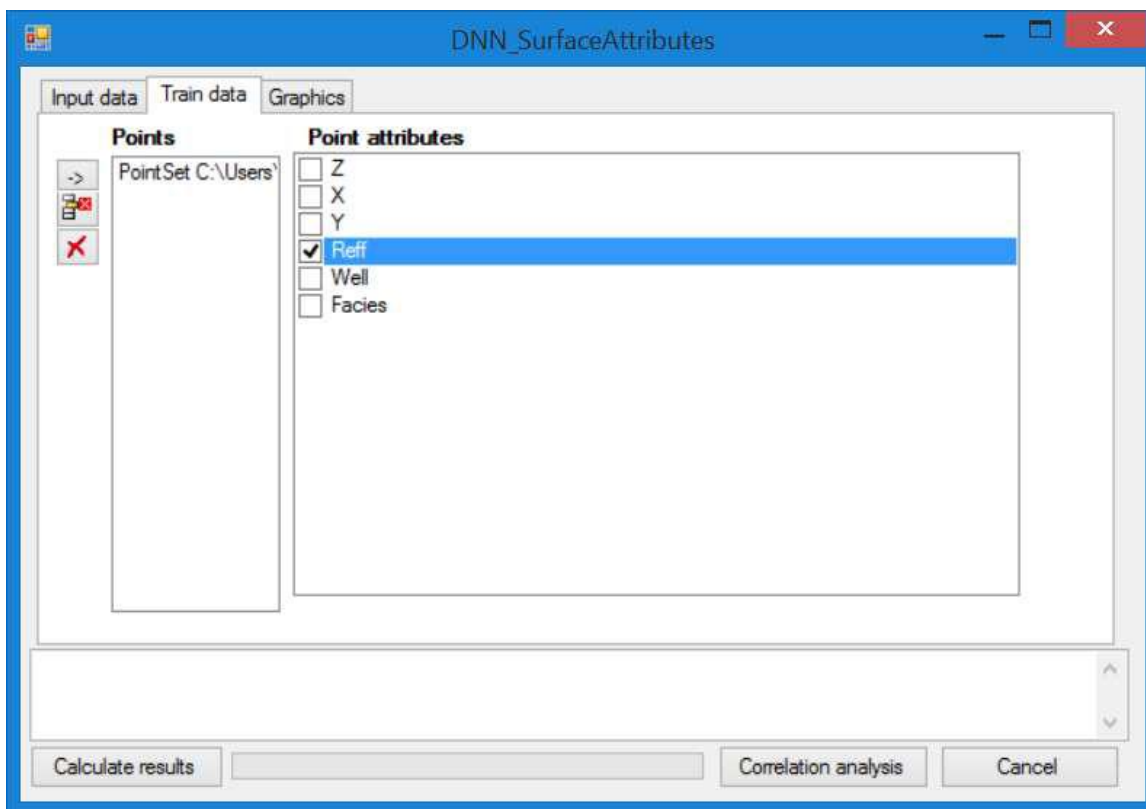


Figure 3: Input production points attributes tab dialog

To do correlation analysis need to push “Correlation Analysis” bottom. After calculation you can see correlation table (see Figure 4) with cross correlation values and with Principal components (shift table to right). Table is sortable for every column (click to column name). Double click – sort from big to small.

CorrelationAnalysis

Restore original sorting

Number points used for calculation: 5

	#	Mean	Std	J3_I	RHOZ	RHOZ_	RHOZ_	RHOZ_	RHOZ_	RHOZ_	Factor1 weight= 53.04% sum= 53.04%	Factor2 weight= 35.05% sum= 88.09%	Factor3 weight= 11.83% sum= 99.92%
▶	J3_I	8.460...	7.070...	1.000	-0.26...	-0.58...	-0.57...	-0.37...	0.063...	0.615...	0.2732	-0.3990	0.6318
	RHOZ_0_7...	2.640...	0.040...	-0.261...	1.00	0.748...	0.449...	0.146...	-0.17...	-0.40...	-0.2341	0.3986	0.7007
	RHOZ_0_7...	2.560...	0.038...	-0.585...	0.74	1.000	0.925...	0.736...	0.378...	-0.13...	-0.4783	0.2153	0.2110
	RHOZ_0_7...	2.550...	0.040...	-0.572...	0.44	0.925...	1.000	0.931...	0.659...	0.127...	-0.5181	0.0251	-0.0441
	RHOZ_0_7...	2.583...	0.041...	-0.371...	0.14	0.736...	0.931...	1.000	0.880...	0.441...	-0.4881	-0.2005	-0.1402
	RHOZ_0_7...	2.639...	0.039...	0.063...	-0.17...	0.378...	0.659...	0.880...	1.000	0.809...	-0.3564	-0.4630	-0.0540
	RHOZ_0_7...	2.687...	0.043...	0.615...	-0.40...	-0.13...	0.127...	0.441...	0.809...	1.000	-0.0899	-0.6168	0.2020
*													

*Figure 4: Correlation table results according Correlation Analysis bottom*



## 1. Calculation

To start the prediction need to push "Calculate result" button (during training stage error and correlation curves will be calculated in Graphics window (see Figure 5))

If **Cross validation** =0 only two curves will be calculated and **Cross validation** >0 four curves additionally with error and correlation according cross validation set of points (see Figure 6). Dispersion of quality controls curves around main curves allow to estimate predictability of the DNN operator.

If use **Number realization** >3 prediction results will be calculated several times according this number.

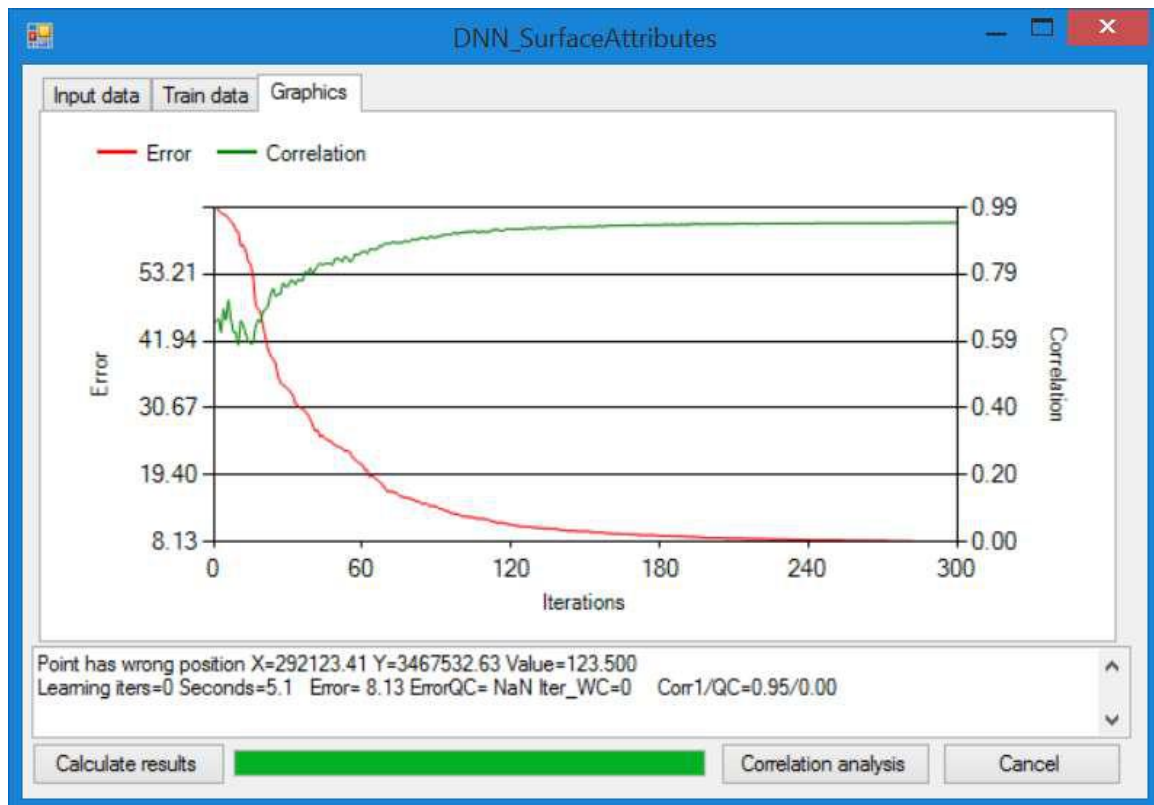


Figure 5: Output graphics window with error and correlation values during learning iterations (for number realization =1 and Cross validation =0)