

IP_Seismic

IPLAB LLC

User Manual

**Get started and
Common description**

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Introduction

The IP_Seismic inversion and machine learning software package is designed for deep qualitative and quantitative interpretation of seismic data together with well data.

Modern technologies of seismic inversion and machine learning are used (neural networks, linear and nonlinear regressions, classification and algorithms for projection of multidimensional space into 3-dimensional space with RGB visualization of results).

The software is based on the modern concept of separation of the system core and functional content of the system:

The core of the system is made in the form of a classic graphical interface with a set of panels for the project elements tree, procedure tree and graphical panel, where there are graphical Windows for visualization of seismic sections, slices, maps, well data. The core includes saving and restoring the project. The main elements of the core are a set of standard classes for describing objects-surfaces, cubes, points, wells with the ability to read write them and easy use when writing functional modules in the form of plug-ins.

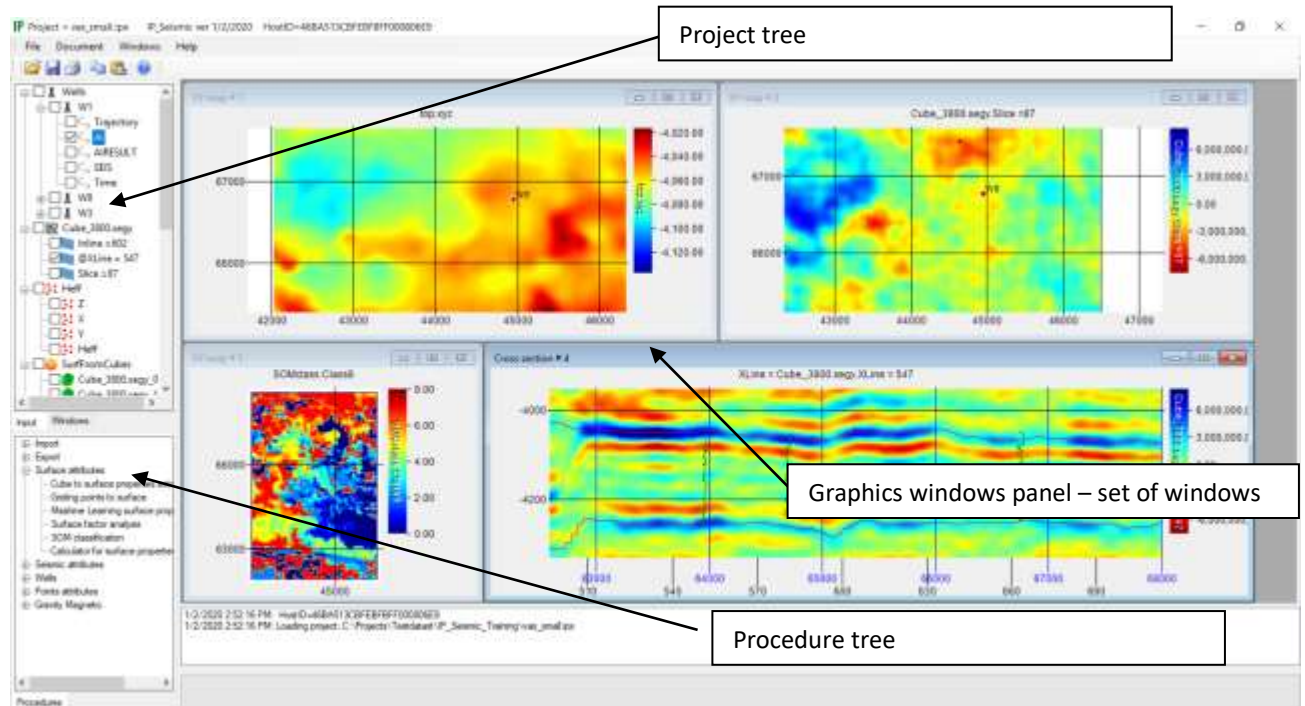
The functional content of the system is made in the form of plug-ins (DLL libraries), including I / o modules with the ability to transfer these functional modules to another system (for example, in Petrel).

The IP_Seismic package is being developed by the company IPLAB LLC -limited liability company "Priezzhev Laboratory" of the official resident of the SKOLKOVO innovation center <http://sk.ru/net/1121541/>

Company website <https://ivanplab.ru/>

1. Graphics Interface

IP_Seismic use three main panels:



IP_Seismic included the following panels:

Project tree – shows a project tree with various types of elements that appear during data import or processing using meaningful procedures.

Procedures tree – shows a list of programs (procedures) that perform meaningful actions.

Graphics panel – allows you to show several graphic Windows of different types.

2. Menu

FILE

File included the following:

Open Project – load the project from files.

Save Project as – save the project to files (one file with **.ipx** extension and folder with files with **.ipxproj** extension).

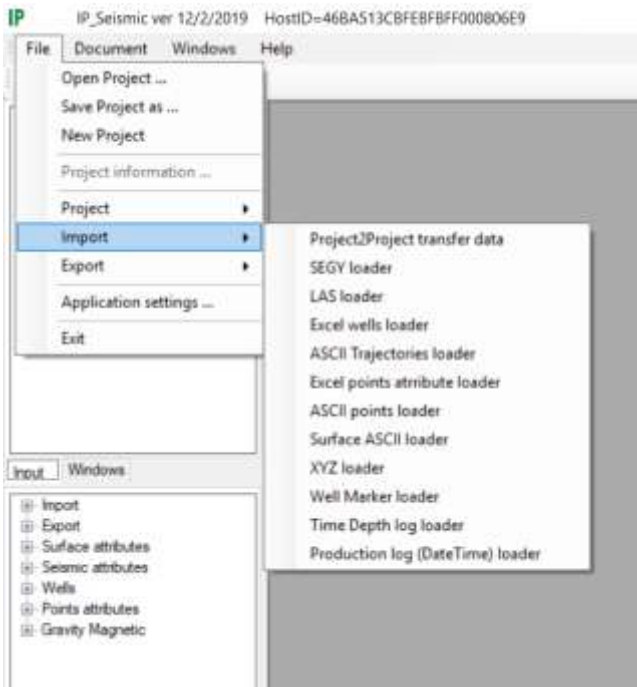
New Project – new empty project creation

Import – import datasets from different files formats: Excel, CPS-3, SEG Y, LAS,...

Export – export SEG Y, surfaces, points, ...

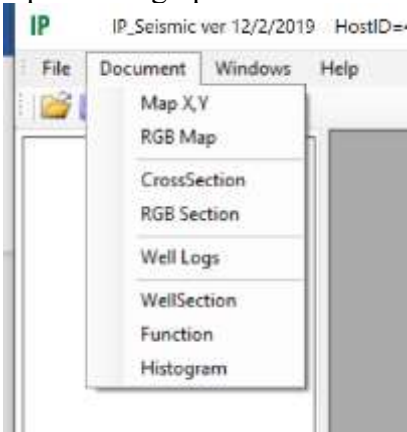
Application setting

Exit



Document

Open new graphics windows.



Map X,Y – will open new map window in *Graphics panel* to visualization several data types: seismic cube slices, surface, surface attributes, points, inline (line position), xline (line position).

RGB Map – allows to output maps with RGB color mixing. The first selected map will be drawn in red, the second in green, and the third in blue. Together, all three cards will be shown in mixed shades according to the values from the three grids.

CrossSection – opens a new window for visualizing seismic sections along inlines or crosslines (2D window) for the following data types: cube inlines, seismic cube slices (position), surfaces(position), surface attributes(position), points and point attributes (position), cube crosslines (position), well logs and well trajectory.

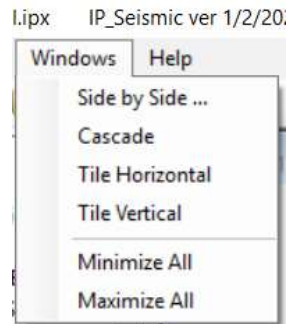
RGB Section – opens a new window for visualization of seismic sections along inlines or crosslines (2D window) with mixing of colors from three cubes.

Well log – opens a new well section window for visualization of log curves along the wellbores.

Function – allows visualization of multiple functions for pairs of selected point attributes.
Histogram – allows visualization of histograms for multiple point attributes.

Windows

Allow to arrange the windows in *Graphics panel*



Side by Side – window to grid

Cascade – window to cascade

Tile Horizontal

Tile Vertical

Help

Allow to get help files:

The screenshot shows a window titled "IP Help" with a standard Windows title bar (minimize, maximize, close buttons). Below the title bar, there is a copyright notice: "Copyright © 2018 IPLAB LLC. All rights reserved." and a language dropdown menu set to "English". The main content area displays a tree view of help topics for "IP_Seismic - Reservoir property prediction and inversion package". The tree structure is as follows:

- Common help
- [-] Import/Export
 - Import points from Excel file
 - Import surfaces
 - Import SEG Y file
 - Import Wells from Excel(header, trajectory...)
 - Import LAS files
- [-] Surface plug-ins
 - Machine Learning Surface Property prediction
 - SOM_Clustering
 - Surface Factor Analysis
 - Surface Calculator
- [-] Seismic plug-ins
 - Machine Learning Seismic Cube prediction
 - ML Fracture detection
 - Seismic Factor analysis
 - Seismic Cubes Kohonen SOM
 - Classic Seismic Inversion
 - AVO Seismic Inversion
 - AVOAZ Seismic Inversion
 - S2L Seismic Inversion
 - Seismic Calculator
- [-] Points plug-ins
 - Points Property prediction
- [-] Gravity Magnetic plug-ins
 - Express interpretation
 - GraviMag ModelingInversion

At the bottom of the window, there is a section for "License information:" with the following details:

HostID=46BA513CBFEBFBFF000806E9
DateStart=2/6/2019
DateEnd=11/2/2021
Feature=All
UserName=lvans ThinkPad x1 Carbon

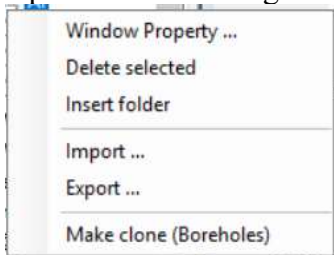
3. *Project tree*

To visualize elements from the project tree for an active graphic window (for example, a map or a section), select these elements in the checked form (setting the " duck " in the selection field).

Another type of selection of project tree elements in the form of "blackening" is used for their removal or for mass movement. Some programs require you to use this selection to define multiple items to process (for example, selecting multiple wells or cubes).

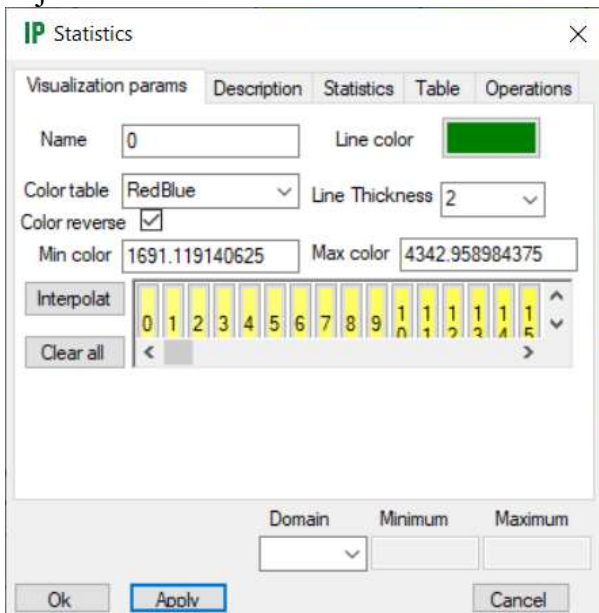
It is possible to move the elements of the project tree with the selection of the element and move it by constantly pressing the right mouse button drag and drop

Open the menu using the right key



Window Property

A property of the objects in the project object tree can be accessed and modified if you press the right button when pointing at the object. The list of bookmarks changes depending on the type of object.



In this window, you can edit the minimum and maximum values of the color table, as well as the thickness and color of the lines for visualization.

Description you can view and edit the Description for an object

Statistics also depends on the type of object and allows you to view the main parameters.

Table shows the values of objects as a table

Operation allows you to perform some operations on objects (the type of operations depends on the type of objects).

Delete Selected

Delete objects from the project tree.

Select (blacken) objects and use Delete Selected from menu

Insert Folder

Create folder – the folder allow to rename and move to any objects from the Project Tree

Import

Export

Will start menu to import or export

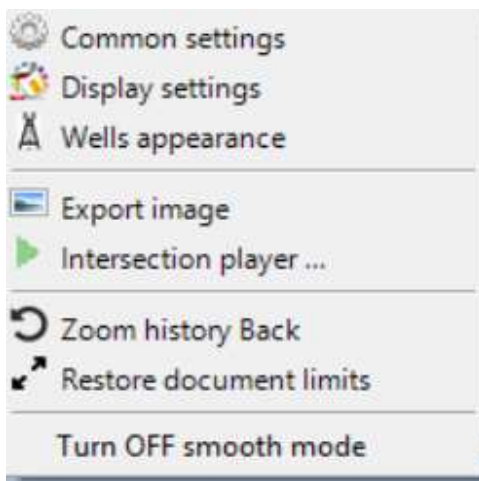
4. *Graphics Panel*

Changing the position of the window (shift in the window sector) can be performed using the mouse with the left button pressed. The graphic window becomes active.

Zoom - you can use the mouse wheel to zoom in and out of graphic Windows. For screens with the "touchpad" function, these functions can be performed using your fingers.

Properties of graphic objects

You can get it and modify it if you click the right button when hovering over an object in the graphics Windows.



Common setting

XY map properties

Common options | Display settings | Wells



Visualization area

MaxY: 67636.671125

MinY: 65391.601820

MinX: 41711.921642 MaxX: 46318.691915

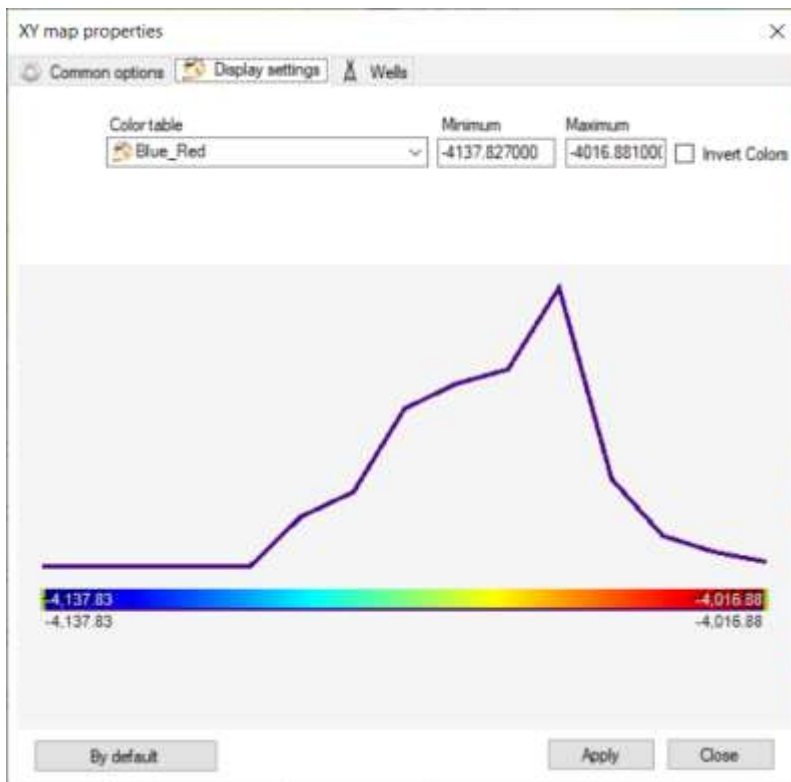
Additional options

Rating surface:  

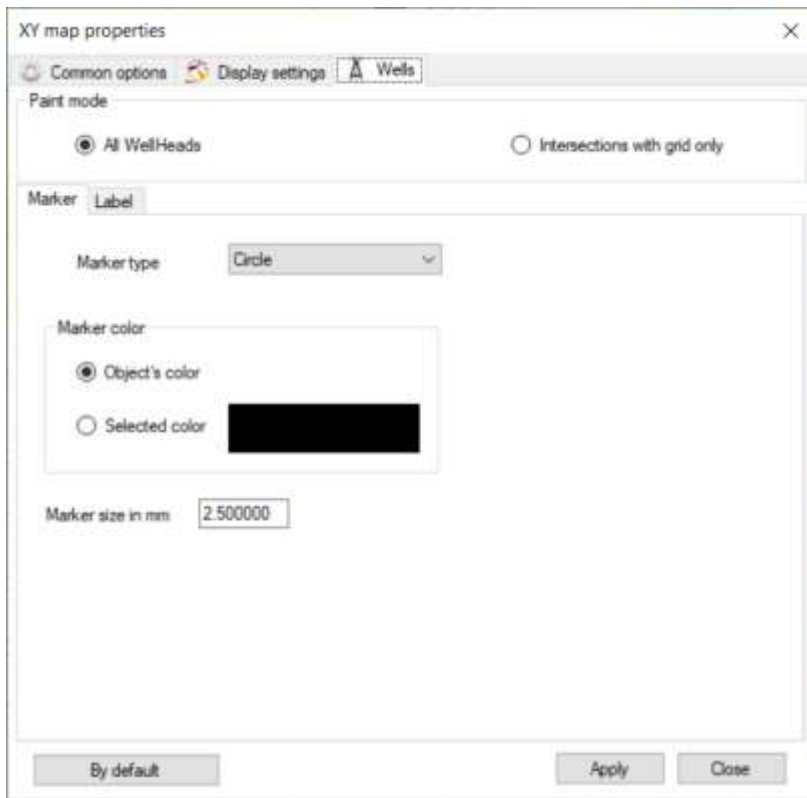
Quick print mode

By default Apply Close

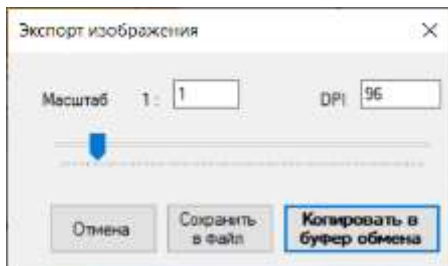
Display setting



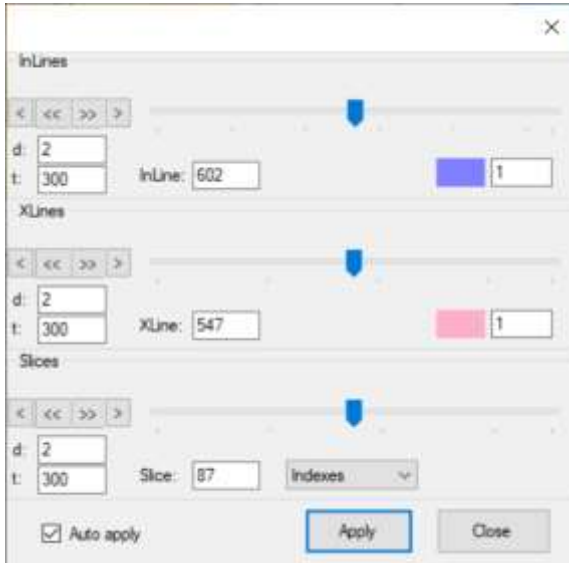
Well appearance



Export image



Intersection player



Zoom history Back

Restore dokument limit

Turn OFF smoth mode

5. Procedure Tree

Will show all procedures

SEGY loader – seismic data input in SEGY format,

LAS loader – input of borehole data in LAS,

Excel wells loader - input of well data in Excel format,

Excel points attribute loader - input of spatial point data with attributes in Excel format,

ASCII points loader - input of spatial point data with attributes in ASCII format,

Surface ASCII loader - input of 2D grid data with attributes in ASCII format,

XYZ loader - input of spatial mesh data with attributes in XYZ format,

Well Marker loader - input of markers data on wells in Petrel ASCII format,

Time Depth log loader - input of data "time-depth" on wells in ASCII format,

SEGY export – output of seismic data in SEGY format,

Surface export – output of 2D grid data with attributes,

Points export – output data points with attributes.

Modules for working with 2D attributes (with a set of maps)

Machine Learning surface property prediction – module for predicting effective parameters by a set of 2D attributes (a set of maps) based on linear regression, regression-based on neural networks, ACE regression, Random Forest regression, Nearest Neighbor regression, regression-based on neural networks with full function activation functions Kolmogorov type.

At the input – there are several maps with seismic attributes (for example, slicing amplitudes in the layer) and a set of intersection points with the predictive parameter (effective thickness, average porosity, cumulative production, ...)

The result – several maps with average forecasts, P10, P50, P90 and the forecast spread (standard deviation).

Surface_Factor_Analysis – a module for calculating independent factors by a set of 2D attributes (a set of maps) based on 1) Autoencoder technology - a "narrow neck"; and 2) PCA (Principal Component Analysis). It can be used to identify fracture zones.

At the input – there are several maps with seismic attributes (slicing amplitudes in the layer)

The result – several cards with independent components (factors).

SOM classification – a module for classifying a set of maps with a sliding window based on the self-organized mapping by Kohonen algorithm using 1D, 2D and 3D configurations of Kohonen neural networks.

At the input – there are several maps with seismic attributes (slicing amplitudes in the layer)

The result – one or more maps with classification results.

Calculator for surface properties – a multi-line calculator based on c # with access to data in a sliding window

At the input – there are several maps with seismic attributes (slicing amplitudes in the layer)

The result – one card with the results of calculations.

Modules for working with seismic cubes

As a result, the modules working with seismic cubes allow you to get **virtual cubes**. Such cubes retain only the computation algorithm and appear instantly. When visualizing on a cut, only those traces that are close to the cut are computed and therefore, it results in a possibility to visualize the result very quickly, without computing the entire cube. It also makes possible to correct “on-the-fly” the calculation parameters with fast visualization, which allows for a quick selection of parameters on a section with visualization of borehole curves.

Machine learning cube prediction – a module for predicting effective parameters by a set of seismic cubes (full, angular amounts) based on linear regression, regression based on neural networks, Random Forest regression, regression based on neural networks with arbitrary activation functions.

At the input - one or several cubes (angular and azimuthal sums, any cubes with attributes) and several wells with predicted curves. It is possible to specify the roof and the bottom of the layer to limit the forecast.

The result – virtual cubes with forecast parameters, average forecasts, P10, P50, P90 and forecast spread (standard deviation).

Poststack seismic inversion – a module of inversion constructions for estimating an acoustic impedance based on classical inversion algorithms using a seismic pulse or on the extraction of a statistical pulse separately for each trace. The module also includes

At the input – there is one seismic cube (full amount). The pulse is automatically extracted from each trace.

The result – a virtual cube with AI, resulting in a quick change of parameters.

AVO seismic inversion – a module of inversion constructions based on the joint application of a set of corner cubes before summation when calculating AI, Vp / Vs, density on the basis of Aki and Richards equations with calculation in the frequency domain.

At the input - a set of corner cubes, the pulse is extracted automatically from each trace. It is possible to specify a low-frequency model.

The result – virtual cubes with AI, Vp / Vs, density with the ability to change parameters quickly.

AVOAZ seismic inversion – a module of inversion based on the joint use of a set of angular and azimuth cubes before summation aiming at calculation of AI, Vp / Vs, density, and the azimuthal heterogeneity indices with calculation in the spectral domain. **Results** – virtual cubes with AI, Vp / Vs, density, and the indices of azimuthal density heterogeneity with the possibility of operative parameter change. (Only for testing - not ready for commercial use)

Seismic Factor Analysis – module for calculating independent factors for a set of 3D attributes (set of cubes) based on technology 1) Autoencoder - "narrow neck"; and 2) the method PCA (Principal Component Analysis). It can be used to identify fracture zones. **The result** – is several virtual cubes with orthogonal components.

Cubes classification – a 3D classification module for a set of seismic cubes based on the self-organized map (SOM) algorithm using 1D, 2D and 3D configurations of Kononen neural networks and RGB visualization of results. **The result** - is virtual cubes with classification results

Seismic facies analysis – a module for seismic facets in the form of a seismic signal in the layer under study, which uses a volumetric signal (sub-cube for several traces) for classification. As an algorithm for classification, the SOM (self-organized map) algorithm using 1D, 2D and 3D configurations of Kononen neural networks and RGB visualization of results is used.

The result – a set of maps with classification results.

Calculator for cubes – a multi-line calculator based on c # with access to data in a sliding window (an example of a procedure for computing a cube of coherence and calculating cubes for spectral decomposition is included). **The result** – virtual cube with the results of the calculation.

Well log data

Calculator for well logs – a multi-line calculator based on c # for calculating new curves on a well with access to data in a sliding window. **The result** – a new curve with the results of the calculation. Modules of work with point data

Machine learning well log prediction and classification – prediction well logs
Well log form classification – well logs form classification

Machine Learning points prediction – a module for predicting effective parameters for a set of attributes based on linear regression, regression based on neural networks, Random Forest regression, regression based on neural networks with arbitrary activation functions. **The result** – a new attribute with predictive parameters.

Modules for working with gravimagnetic data

Layers gravity-mag modeling and inversion – module for modeling and inversion of gravimagnetic data on the basis of 3D layered model. The inversion allows you to adjust the density or position of the boundaries of layers, taking into account the constraint model.

Express gravity-mag modeling and inversion - a module for modeling and inversion of gravimagnetic data based on a 3D model in the form of a cube SEG-Y.

Visualization

Visualization modules include windows with visualization of maps, sections along lines or cross lines. Модули визуализации включают окна с визуализацией карт, разрезов по линиям или по кросс линиям.

