Integrating Geology and Geostatistical methods for effective reservoir prediction

A Dissertation

Submitted in partial fulfillment of the

Requirements for the award of the degree

of

Integrated Master of Technology

in

Geological Technology

by

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<u>Candidate's Declaration</u>

I hereby certify that the work which is being presented in the thesis entitled "**Integrating Geology and Geostatistical methods for effective reservoir prediction"** submitted by me in partial fulfilment of requirements for award of the degree '**Integrated Master of Technology**' in **Geological Technology** to the **Department of Earth Sciences, Indian Institute of Technology Roorkee,** is an authentic record of my work carried out during the period from May - 2018 to May-2019, under the supervision of **Dr. Ravi Sharma,** Assistant Professor, Department of Earth Sciences, Indian Institute of Technology, Roorkee.
The matter embodied in this dissertation has not been submitted by me for the award of any other degree at this or any institution.

(**Shubham)**

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

Date: (Dr. Ravi Sharma),

Place: Roorkee Supervisor

Acknowledgment

At the very outset, I would like to express my soulful gratitude, sincere appreciations and a big thanks to my guide Dr. Ravi Sharma, Assistant Professor, Department of Earth Sciences, IIT Roorkee for his invaluable guidance, expert suggestions, immense knowledge, constant engagement and encouragement throughout the entire course of my dissertation work with his personal attention and interest, without which it would have become very difficult and cumbersome for me to complete this dissertation work in an efficient manner.

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I feel short of words to express my sentiments towards my loving family for their unduly love and fondle, for their everlasting moral support, for the sacrifices they have made on my behalf.

Abstract

Geological information is often available at various scales but an integrational perspective is often missing. Apart from that, there is an underutilization of machine learning in geosciences. With the recent developments in machine learning and data sciences, the risks and uncertainty involved in exploration, development and production projects can be greatly reduced.

With the advancement and understanding of the subsurface variation in rock and fluid properties and the availability of high-performance computing, the use of software to solve complex earth problem has become a routine.

There is a need for a free source platform where multi-scale geological information can be integrated, optimized and visualized with minimum uncertainty.

PRIME is an Integrated platform for solving Petrophysical and Rock Physical challenges for today's exploration and development activities. More than the conventional solutions, PRIME aims to integrate machine learning in the most natural way for predicting the hydrocarbon that is; yet to be found.

PRIME is used to analyze the seismic and well data. It determines the value and accordingly applies quantitative methods to predict fluid, rock, and pressure properties. With PRIME, seismic related data can be integrated with pressure and log data. PRIME can be used to identify many other types of geological variations, and porosity, based on the well data and seismic data.

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Chapter 1: Introduction

With the advancement and understanding of the subsurface variation in rock and fluid properties and the availability of high-performance computing, the use of software's to solve complex earth problem has become a routine. In recent years, the focus has shifted more on the optimization of existing routines or creation of smart algorithms using machine learning and Artificial Intelligence for solving problems that had long and redundant workflow at a time.
In this thesis, work is done around the same line of making fit for the job routines for providing both quick and comprehensive petrophysical analysis.

1.1 Motivation

It is a routine job in reservoir exploration and development to have analysis and interpretation of well and seismic data. However, it takes a lot of time because the process is linked and cumbersome. Therefore, the need is to develop tools to make this process run fast and output intelligent/ easily interpretable results.

1.2 Objective

Rigorous and advanced geoscience solutions are needed to analyze wells and seismic data to determine the value and apply quantitative methods to predict different rock, fluid and pressure properties.
With this motivation, PRIME is being developed from the year 2017. During this thesis, work was done to improve the existing tool and add new features. However, after completion of 75% time, it became clear that there are too many drawbacks in the foundations of the tool. Lack of dependency management, deep hardcoding of directories and files, poor UX(user experience) being an example of the drawbacks.
It was decided to rewrite the whole codebase.
Python was chosen as the language to write the tool instead of earlier used Java due to its ease and efficiency of working with complex and big data. More about the technologies used are talked about it.

1.3 Plan of thesis

The entire thesis has been divided into the following chapters:

<u>Chapter 1</u>: This chapter discusses the introduction and describes the motivation, objective and the plan of the thesis.

<u>Chapter 2</u>: This chapter discusses the literature review of Petrophysics, well logging and volume of shale.

Chapter 3: This chapter introduces the PRIME software, what it does, the technologies used by it and how and why the decisions to choose those technologies were taken.

Chapter 4: This chapter discusses the features of PRIME in detail. It describes ranging from plots to interpolation to 3-d plots etc.

Chapter 5: This chapter discusses the improvements the current version makes over the previous version of the tool and the future works planned for the tool.

Chapter 2: Literature review

2.1 Petrophysics

Petrophysics literally means physics of rocks. It is a branch of Geosciences and is closely linked with Geology, Geophysics and Petroleum engineering ("Beginner's guide to Petrophysics," 2000). Petrophysics deals with the study of chemical and physical properties of rocks and their interaction with the contained fluids.

Petrophysics has a major application in studying reservoirs for the Hydrocarbon industry. The properties relating to pore systems, its fluid distribution and the characteristics of the fluid flow are used to evaluate Hydrocarbon reservoirs, sources, and seals(Petrophysics, n.d.). Bed thickness, porosity, saturation, fluid characterization, permeability, fractional flow are some examples of petrophysical reservoir properties. These properties can be identified using various tools:

1. Mud logging
2. Measurement while drilling (MWD) and Logging while drilling (LWD)
3. Wireline logging
4. Core sampling and core analysis
5. Fluid sampling

2.2 Well logging

Well logging is the process of making a record of properties in the formation penetrated by the borehole. Of the types of Well logs, Wireline log and Mudlog are of special interest to us.

2.2.1 Wireline logging

Wireline logging is used to obtain a continuous record of a formation's rock properties. Wireline logging is the acquisition and analysis of geophysical data as a function of the well depth. Wireline logging and mud logging are closely linked through the integration of the data sets. The measurements are made with reference to "TAH" - True Along Hole depth: these can then be used to indicate further properties, such as hydrocarbon formation pressure and saturation, and to make further decisions.

Logging tools measure the electrical, acoustic, natural gamma ray, nuclear magnetic resonance, stimulated radioactive responses, electromagnetic, pressure and other properties of the rocks and their contained fluids.

Real-time data is recorded against well depth whereas memory data is against time, and depth data measured against time.

Wireline logs can be divided into the following categories based on the properties measured:

1. Electrical logs

   a. Resistivity log
   b. Borehole Imaging
2. Porosity logs
   a. Density
   b. Neutron porosity
   c. Sonic
3. Lithology logs
   a. Gamma ray
   b. Self/spontaneous potential
4. Miscellaneous
   a. Caliper
   b. Nuclear magnetic resonance
   c. Spectral noise logging

2.3 Volume of shale

Usually, shale is more radioactive than carbonate or sand. Hence gamma ray log can be used to calculate the volume of shale. The volume of shale expressed as fraction or percentage is called Vshale. Calculation of the gamma-ray index is the first step needed to determine the volume of shale from the gamma-ray log(Asquith, G., & D. Krygowski, 2004).

Equations for Vshale Calculation using gamma-ray log:
Linear response:

$$V_{sh} = I_{GR} = \frac{GR_{\log} - GR_{\min}}{GR_{\max} - GR_{\min}}$$

(Asquith, G., & D. Krygowski, 2004)

a. Non-Linear responses:
   i. Larionov for Tertiary rocks

$$V_{sh} = 0.083(2^{3.7 I_{GR}} - 1)$$

(Asquith, G., & D. Krygowski, 2004)

ii. Steiber

$$V_{sh} = \frac{I_{GR}}{3 - 2 \times I_{GR}}$$

(Asquith, G., & D. Krygowski, 2004)

iii. Clavier

$$V_{sh} = 1.7 - \left[(3.38 - (I_{GR} + 0.7)^2\right]^{\frac{1}{2}}$$

(Asquith, G., & D. Krygowski, 2004)

iv. Larionov for older rock

$$V_{sh} = 0.33 \times (2^{2I_{GR}} - 1)$$

(Asquith, G., & D. Krygowski, 2004)

Chapter 3: Results (PRIME Introduction)

3.1 About

Petrophysics Rockphysics Interpretation Modeling and Evaluation or PRIME is a tool for automated 2d and 3d geological data interpretation platform for easy assimilation and integration of geological data for reservoir property prediction. PRIME is intended to

support both Seismic and Well log data and integrate them. In the current iteration, the work is done for well log data and laying down the software foundations.
There are basic features like saving a project, opening the saved projects, etc. The tool boast of a highly efficient *LAS* file reader.
The tool utilizes machine learning in a natural way. Machine learning is used in various features like 3d-interpolation plot of various properties of a well in the whole area, 3-d interpolation of facies in the area. Other than that, there are features for various plots in the tool. The features include a log-plot, an overlay plot for two properties, a cross-plot two when a single well is selected, and correlation plot, a 3d plot when multiple wells are selected.

3.2 Technologies used(and why)

1. **Language:**
   PRIME is written purely in *Python*.
   Python is not best suited for the GUI part, but there are very few languages/framework which matches the libraries available in python used for machine learning and data visualization.
   Another option which was used in the previous version of the tool was to use Java for building GUI and Python for data analysis and machine learning. However, the overhead created by communication between two languages would not justify the advantages.
   After taking the above points into consideration, Python was decided to be the best fit for the tool.

2. **GUI framework:**
   The tool uses wxWidgets as it's GUI framework.
   There are various toolkits for GUI building available in python like Tkinter, WxPython, PyQt, PySide, Gtk, PyOpenGL.
   It was decided to go with WxPython due to its ability to use system GUI whenever possible, which will give the native feeling in every OS. Its *GPL (General Public Licence)* license, its support for various plotting libraries.

3. **Plotting libraries:**
   All the plots in the tool are implemented using python library: Plotly.
   There are various options available for plotting in python. Few examples are Matplotlib, GgPlot, Seaborn, Plotly, Mayavi, OpenGL, Pygal. Out of these options, Plotly was chosen because of the balance between ease of use from both the developer side, the user side, it's the ability to render 3d plots efficiently and handling the user's interaction with the plot.

4. **Plotting canvas:**
   CefPython is used as the canvas for Plotly library.
   Plotly only works inside a browser, so a skeleton web browser was integrated into the tool. The bonus of doing that is anything which requires a browser(Javascript, HTML, any javascript plotting library) can be seamlessly integrated into the tool with minimal effort.
   The browser is integrated using CefPython. CefPython is a Python binding for the Chromium Embedded Framework(or CEF). This integrated Chromium browser inside Python GUI toolkits. The binding works with every major operating system.

5. **Data analysis and data manipulation libraries:**
   Numpy and Pandas.
   Numpy and Pandas were used for manipulating and processing of large data. Both these libraries provide highly efficient tools for applying mathematics functions to the multidimensional arrays and other data structures. Numpy provides low-level mathematical functions, whereas Pandas is used for high-level processing of the data.

6. **Machine learning algorithms used:**
   PyKriging, Scikit-learning algorithms.
   All major algorithms from PyKriging, Scikit-learning libraries are presented as options to the user, out of which they choose anyone based on the validation scoring of the algorithm.

Chapter 4: Results (PRIME Features)

4.1 Initial Dialogue

Upon starting the PRIME tool, the user is presented with a dialog which asks them to either *Open existing project* or to *Create New Project*. The screenshot of the dialog is in the following figure:

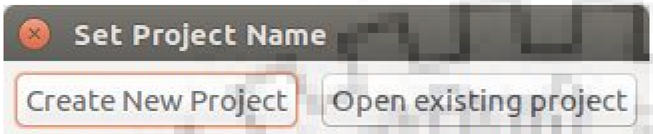

Fig-1 Initial dialogue menu

1. ***Create new project***

   If the user clicks on *Create a new project, they are presented with* another screen shown in the following figure:

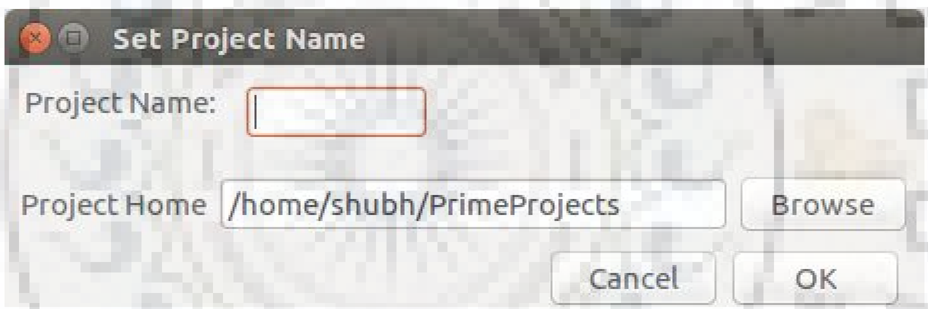

Fig-2 Create new project menu

The user is asked to enter a project name and project home directory. The project name can any alphanumeric string.
By default, the project home directory is *PRIMEProjects* located at the user's home. If the directory doesn't exist, PRIME automatically creates it.
The user can click on the *Browse* button if they wish to use another directory as the project home. Upon clicking the *Browse* button, another screen to select the project home directory as shown in the following figure:

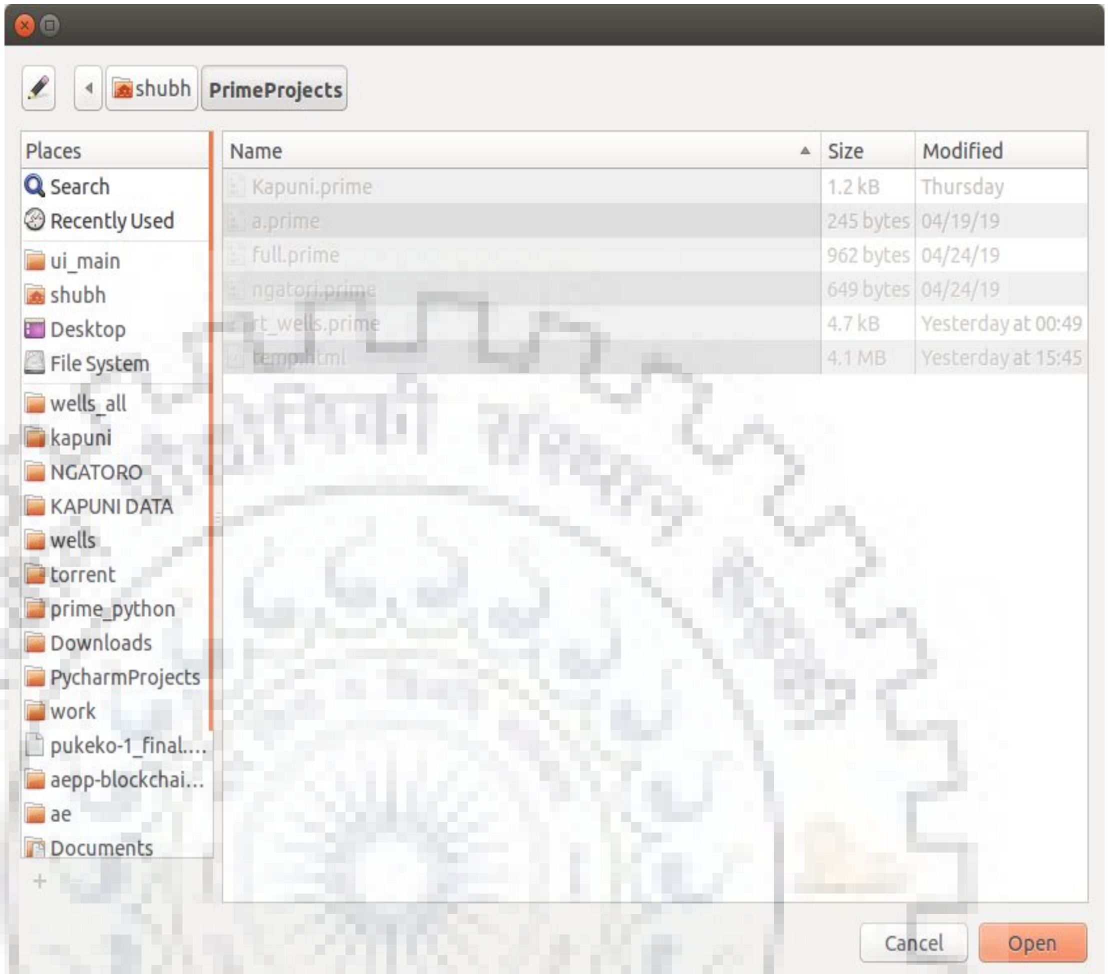

Fig-3 Select prime home

Upon entering both *Project Name* and *Project Home*, and clicking OK, the main screen of PRIME opens as shown in the following figure. The screen is blank here as no data has been yet added.

Fig-4 Main window blank

More will be discussed on the components of the screen in the next sections.

2. ***Open existing project***
   Upon clicking on *Open existing project* from the Initial dialog, the user is presented with a File dialog which asks them to open an existing PRIME project. This dialogue by default opens the *PRIMEProjects* directory of the user.
   Only files with extension *.prime* are acceptable to this file dialogue. These files are generated only when saving a project from inside of PRIME. The screen is shown in the following figure:

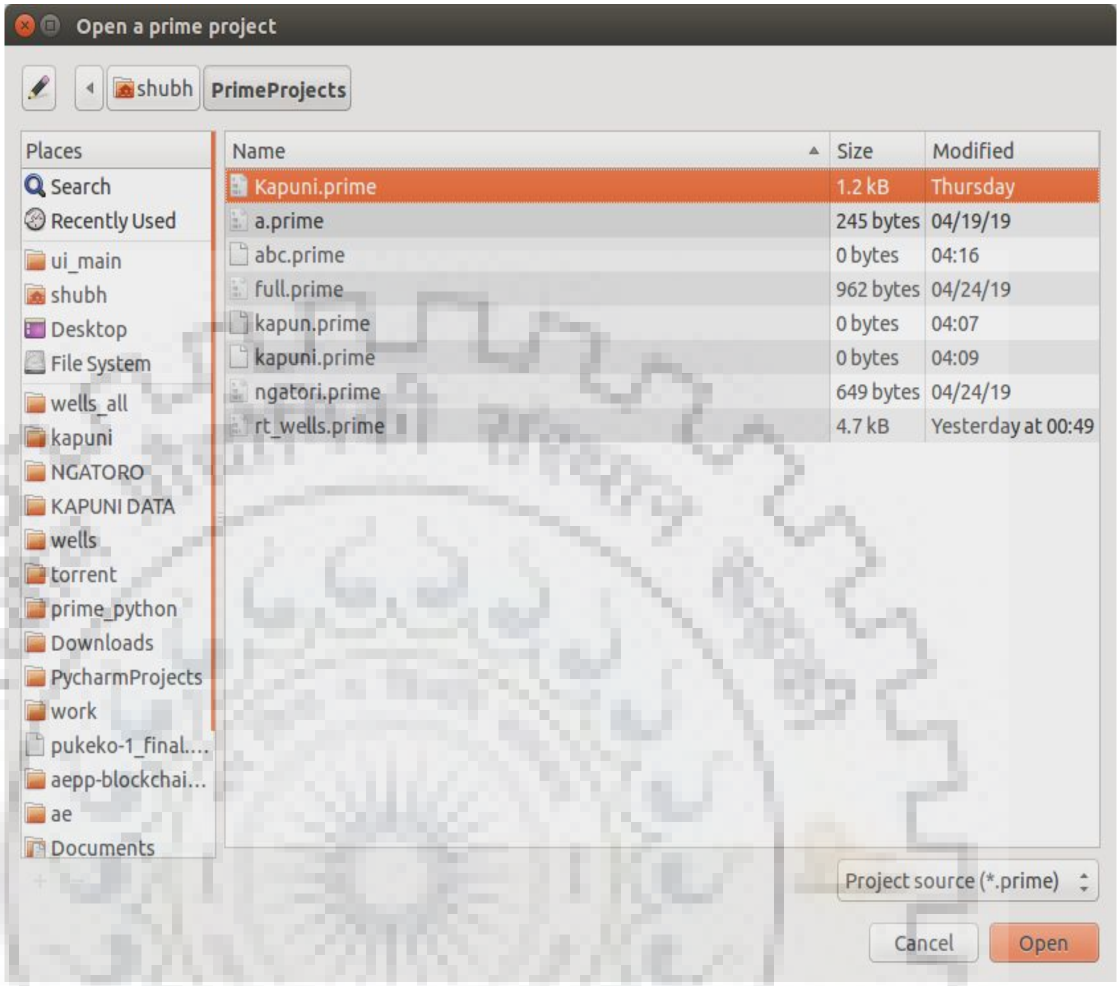

Fig-5 Open prime project

Upon opening a project, the main window of PRIME is displayed as shown in the following figure:

Fig-6 Main window-loaded

4.2 Main Window

The screen shown in fig-6 is called the main screen of PRIME. The user will remain on this screen for the majority of the time. The screen is divided into 4 components:

1. **Menubar**

   The uppermost sections contain the menus for interacting with the tool. This bar is known as menubar and is shown in the following figure:

   

   Fig-7 Menubar

2. **Project viewer**

   The left panel of the window contains the project level data consisting of the project name, well name, well heights. Every well contains a checkbox next to them which selects the given well for any function. The project viewer is shown in the following figure:

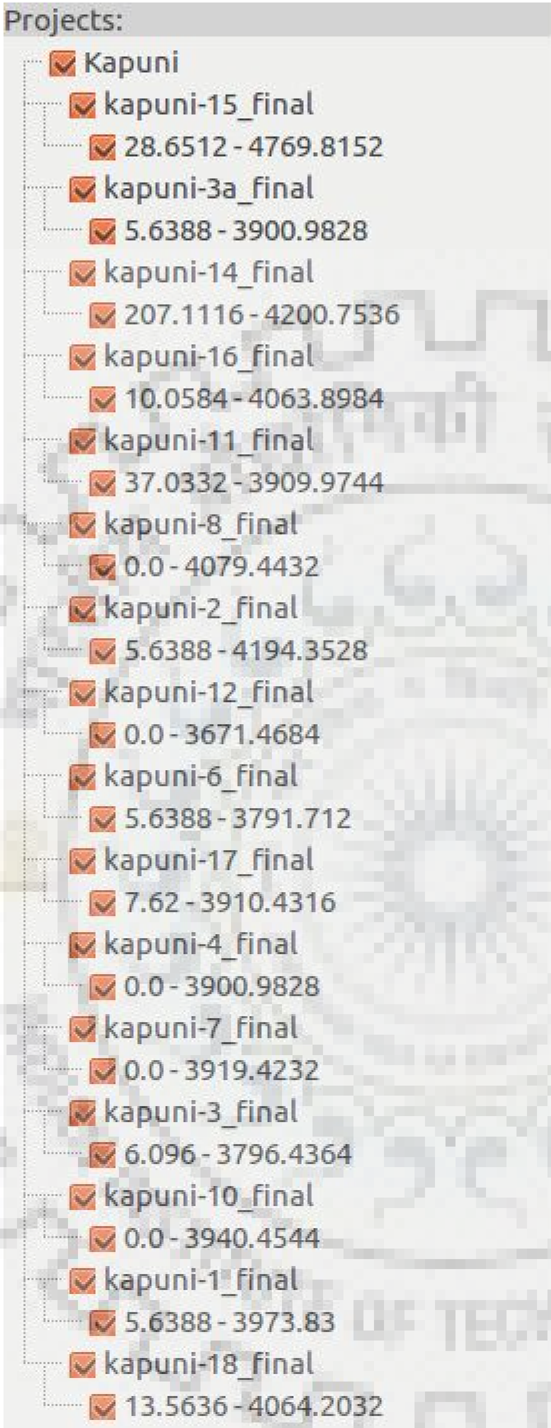

Fig-8 Project viewer

3. **Data viewer**
   The empty space in the right part of fig-6 is called Data Viewer. This space is used for showing various plots in PRIME.
4. **Statusbar**
   The bar in the bottommost part of the screen in fig-6 is called the status bar and is used to show various statuses in the tool. An image of the Statusbar is shown

in the following figure:

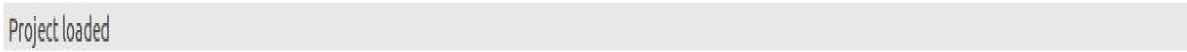

Fig-9 Statusbar

4.3 Features

i. **File menu**

1. **New**
   Creates a new project and opens the same screen as section 1a. Can also be accessed using the keyboard shortcut: *Ctrl + N*
2. **Save**
   Saves the current changes to the project. Can also be accessed by using the keyboard shortcut: *Ctrl + S.*
3. **Open**
   Open an existing project and opens the same screen as section 1b. Can also be accessed by using the keyboard shortcut: Ctrl + O
4. **Quit**
   Exits PRIME. Can also be accessed by using the keyboard shortcut: Ctrl + Q

ii. **LAS menu**

1. **Load LAS**
   Open a file select dialog which accepts files only in *.las* format. More than one file can be selected from the dialog if all files reside in the same folder. All the necessary data including version info, the longitude and the latitude of the well, curve info is read and processed.
   The wells are then added to the project and are shown in the project viewer section. The name of the well is the same as the file name of the *LAS* file.
   If the reading of some well fails, rest are processed normally and after that, a dialogue is shown stating the number of wells failed with their file names.

iii. **Plot menu**

1. **Log plot:**
   This plots all the available properties for one well log vs depth in the data viewer panel. If the plots do not fit inside the screen, they can be scrolled vertically. Following figures show the various section of the log-plot:

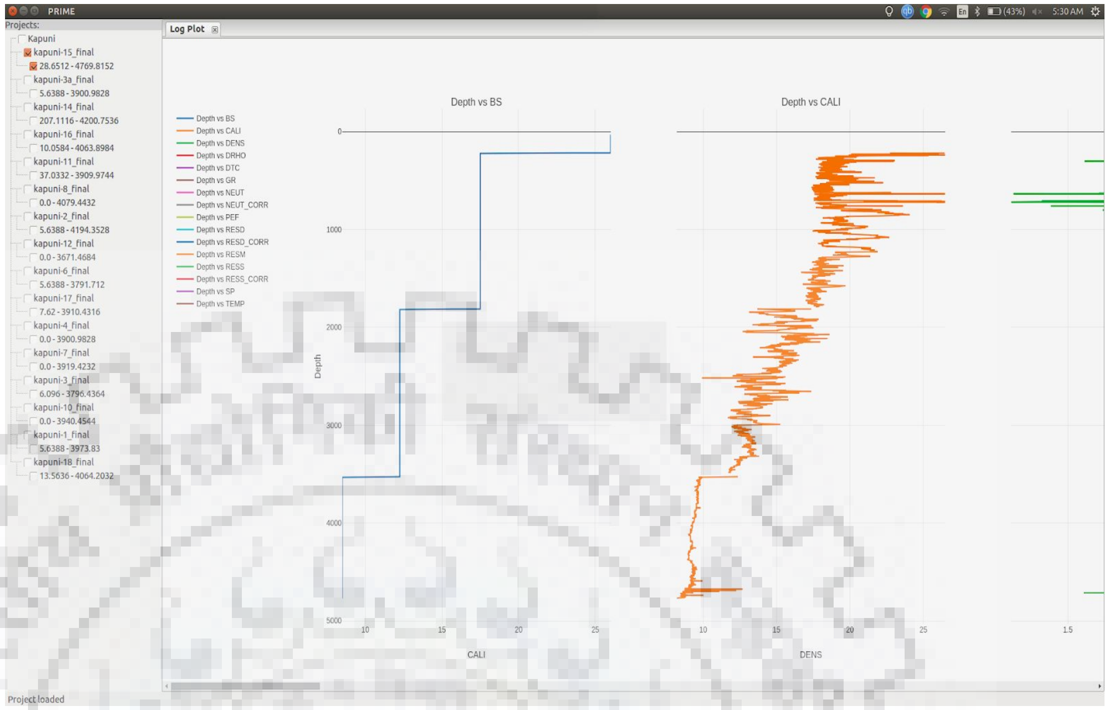

Fig-10 Log plot 1

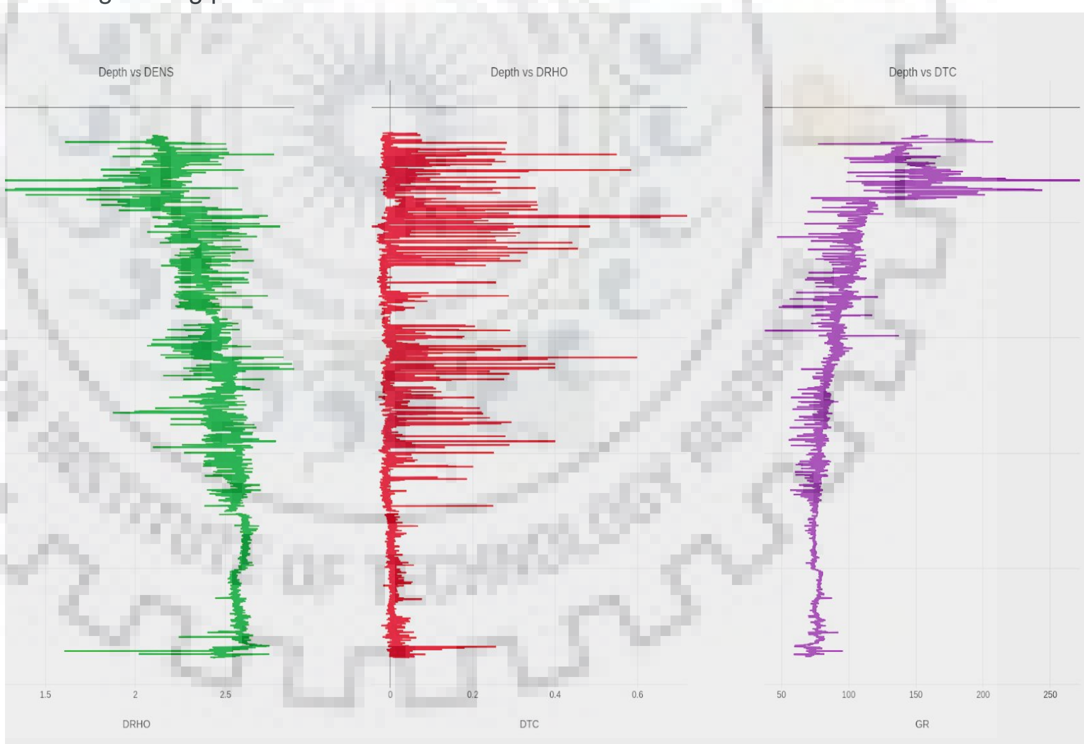

Fig-11 Log plot 2

There are many other features as well like zooming on one graph will zoom every other as well. The plot can be saved in the user's computer as a png document. User can pan through the image etc.

The features are accessed from the toolbox in the top-right of the screen:

Fig-12 Feature box

Please note that only one well needs to be selected for log-plot. If more than one wells are plotted, it throws an error as shown in the following figure:

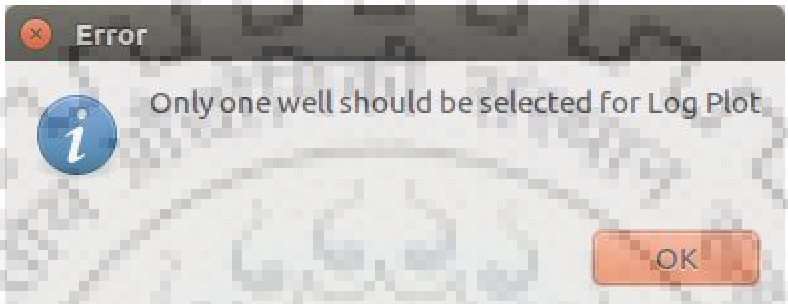

Fig-13 Error box in log plot

2. **Correlation plot:**
This plots any one property vs depth for different wells. Correlation plot is used when comparing more than one well. For this plot, more than one well should be selected.
Upon selecting wells and clicking *Correlation plot*, a dialogue box is opened which contains a drop-down menu containing all the common properties in the selected wells. The dialogue is shown in the following figure:

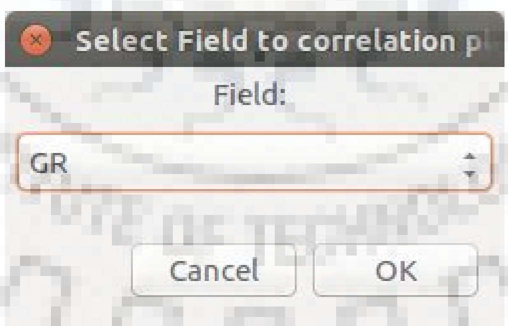

Fig-14 Field select dialogue in the correlation plot

Plots for all the wirelines are drawn with names of the wirelines in the title of the plot. The features of the plot are similar to log-plot in the previous section. An example if the correlation plot is shown in the following figure:

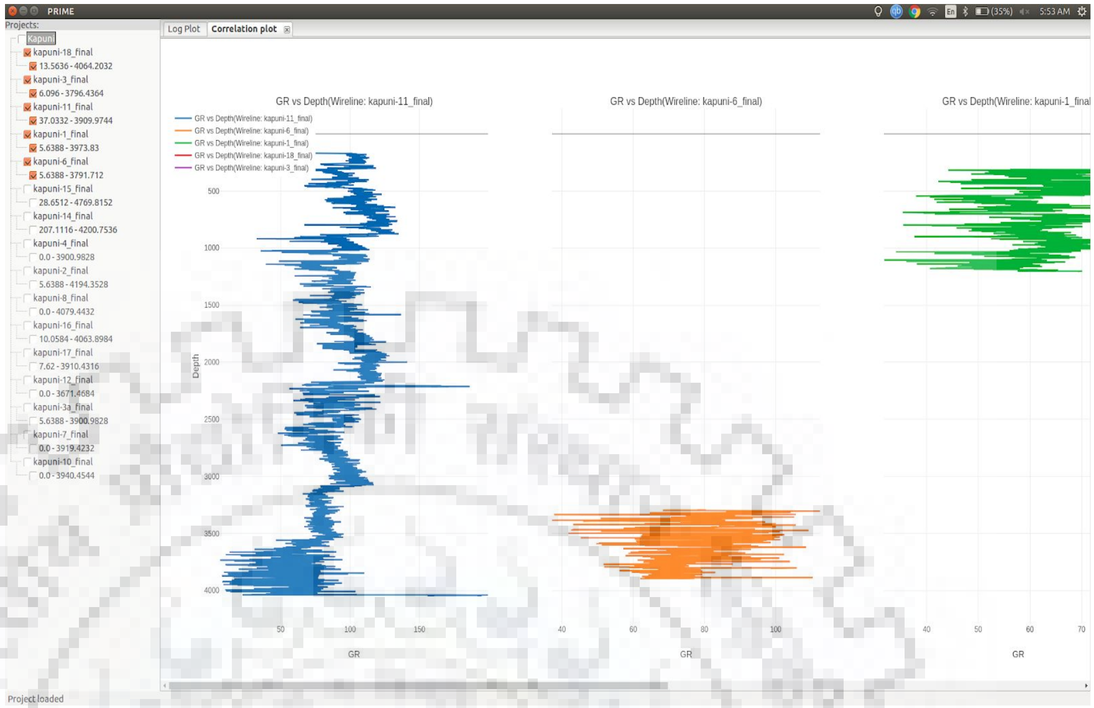

Fig-15 Correlation plot graphs

Also note that the plots are made in the form of tabs with names and can be toggled through, compared and closed by the user.

Atleast two wells should be selected for this function. If it is tried on with less than two wells, an error is thrown as shown below:

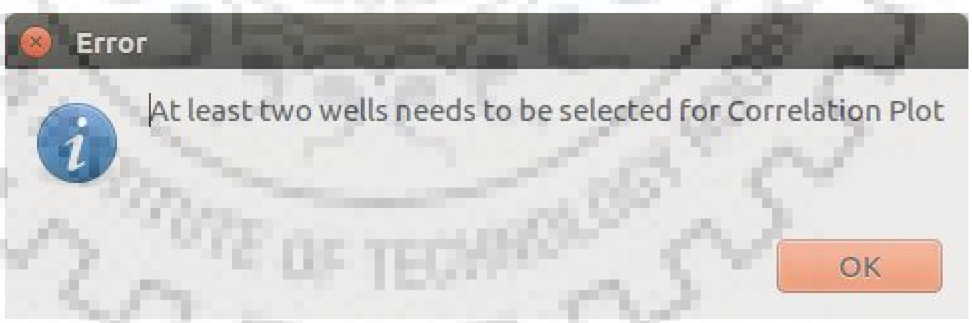

Fig-16 Correlation plot error box

3. **Overlay plot**

   This plots two properties of one well against depth on the same axis. Upon selecting one well, and opening overlay plot, a dialogue with two drop-down menus is presented to the user asking about the properties to plot as shown in the following figure:

Fig-17 Select properties in overlay plot

Upon selecting the properties, a plot is plotted on the data view area with one property as x-axis on top of the plot, and other as x-axis on the bottom, and the y-axis being depth.
This plot has the same user-interaction features as well: zoom, pan, save, reset zoom and pan.
If there are more than one well selected, this plot throws an error as well.
An example of the plot is shown in the following figure.

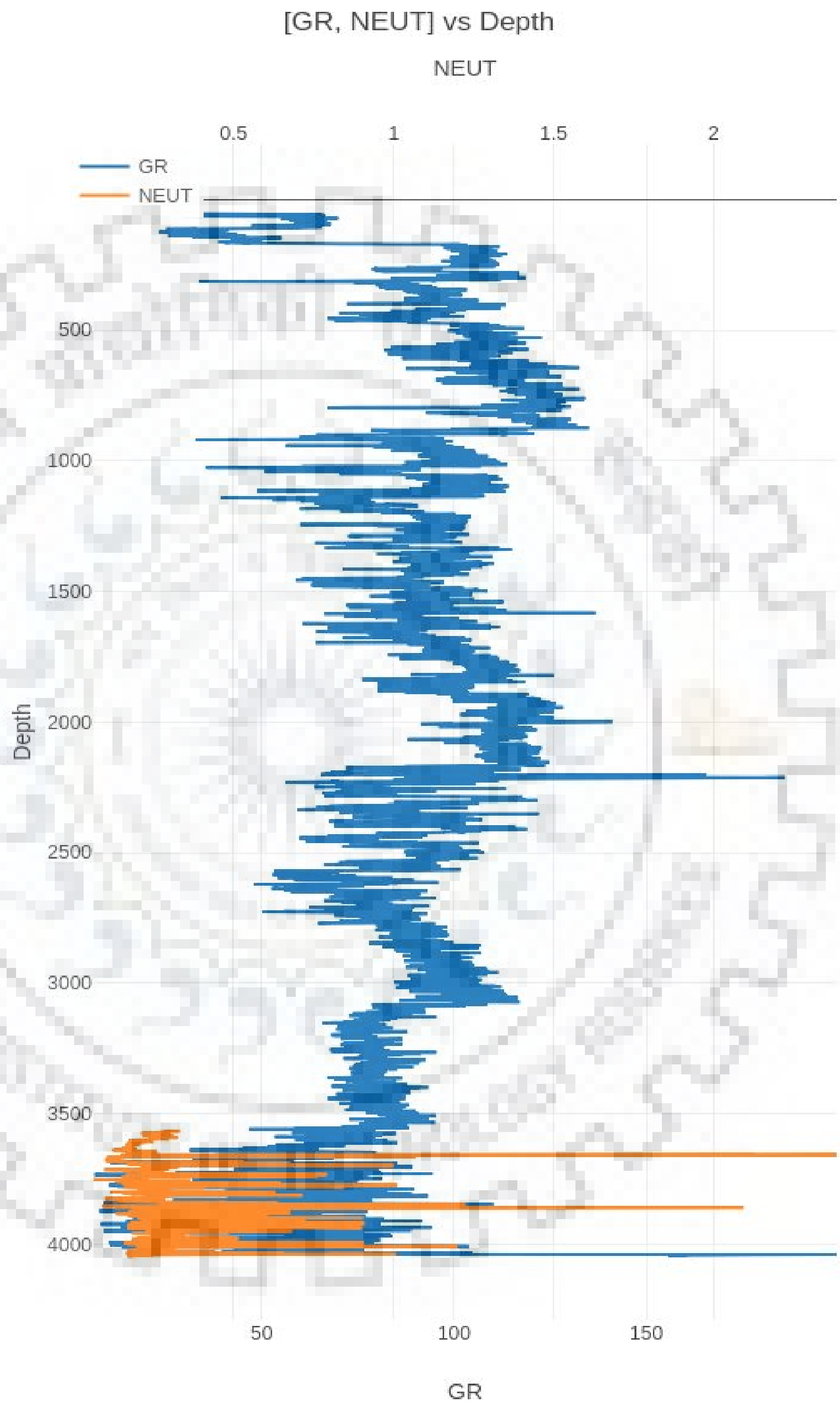

Fig-18 Overlay plot graph

4. **Cross plot:**
This plots any two properties of a well as x and y-axis of the graph. This graph is plotted as a scatter-plot. Upon selecting one well, and opening cross plot, a dialogue with two drop-down menus is presented to the user asking about the properties to plot as shown in the following figure:

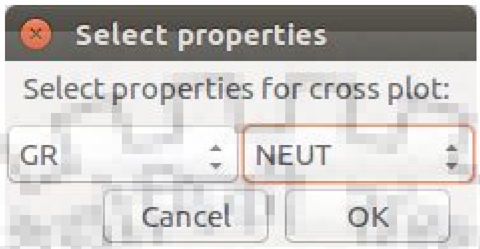

Fig-19 Select properties in the cross plot

Upon selecting the properties, the cross plot is plotted with the first property as the y-axis and the second property as the x-axis.
An example of a cross plot between GR and Neutron density is shown in the figures below:

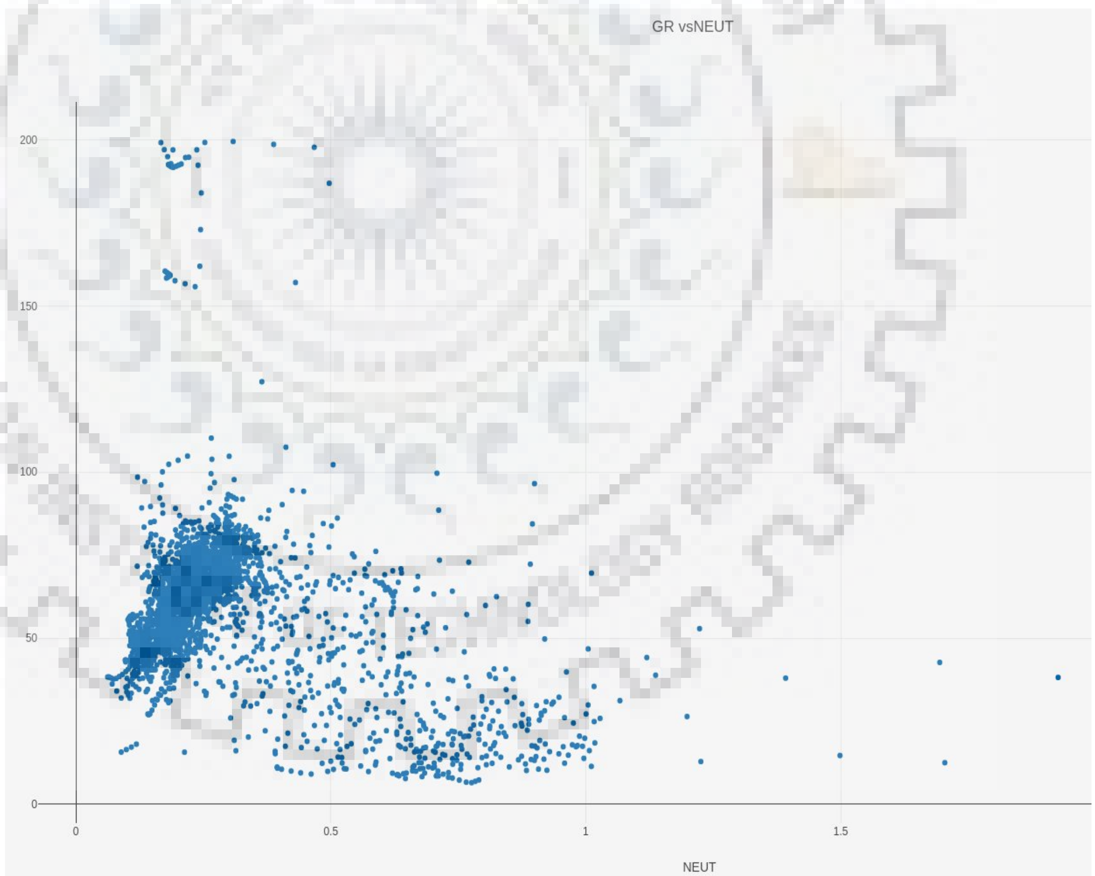

Fig-20 Cross plot graph 1

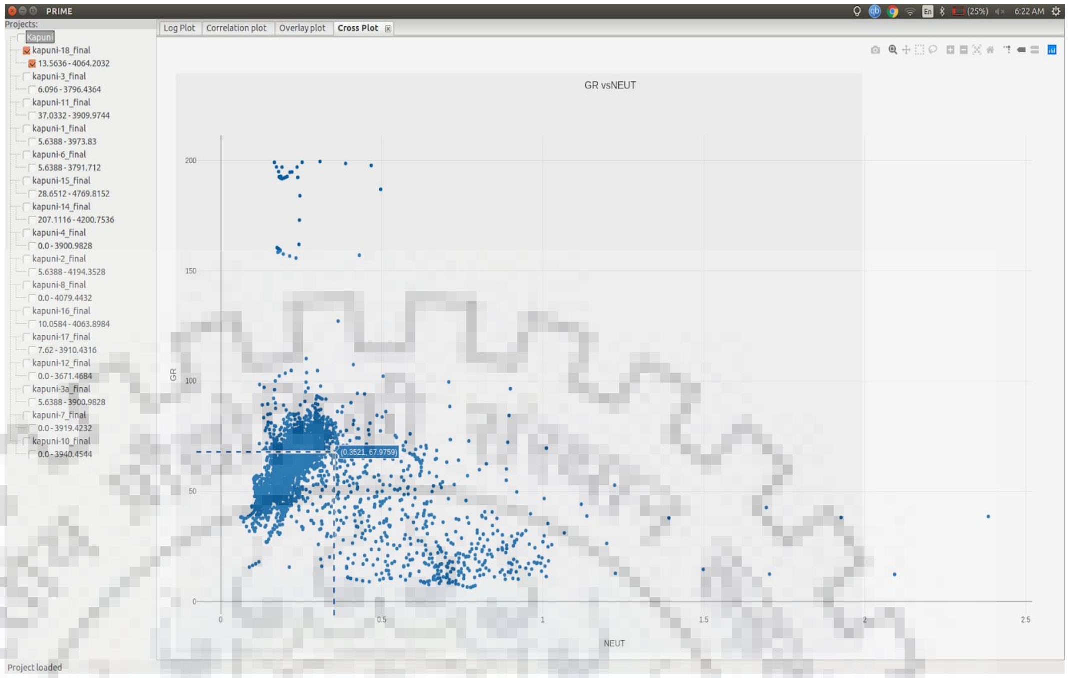

Fig-21 Cross plot graph 2

5. **3d-plot:**
This is a 3d interactive plot of specific properties of any number of wells, showing latitude, longitude, depth as 3-dimensions and given property as color dimension.
Upon clicking the *3-d* plot, a dialogue to select the properties is shown to the user. The properties which are common among all wells selected are shown in a dropdown menu to select from. An example of the dialogue is shown in the following figure:

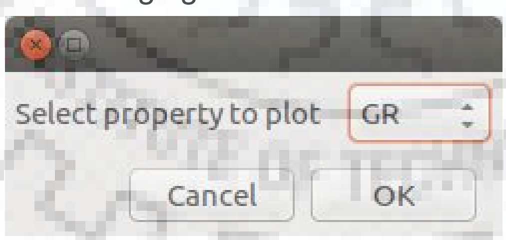

Fig-22 Select 3d plot property

Upon selecting the property, a 3d plot is drawn. The 3d plot tab has the number of wells and the property selected inside its tab name. The plot is fully interactive, can be rotated, zoomed inside, hovered to view information about all four dimensions. It also contains a legend color bar showing color mapping to the selected property value. Following figures show the example of the 3d plot:

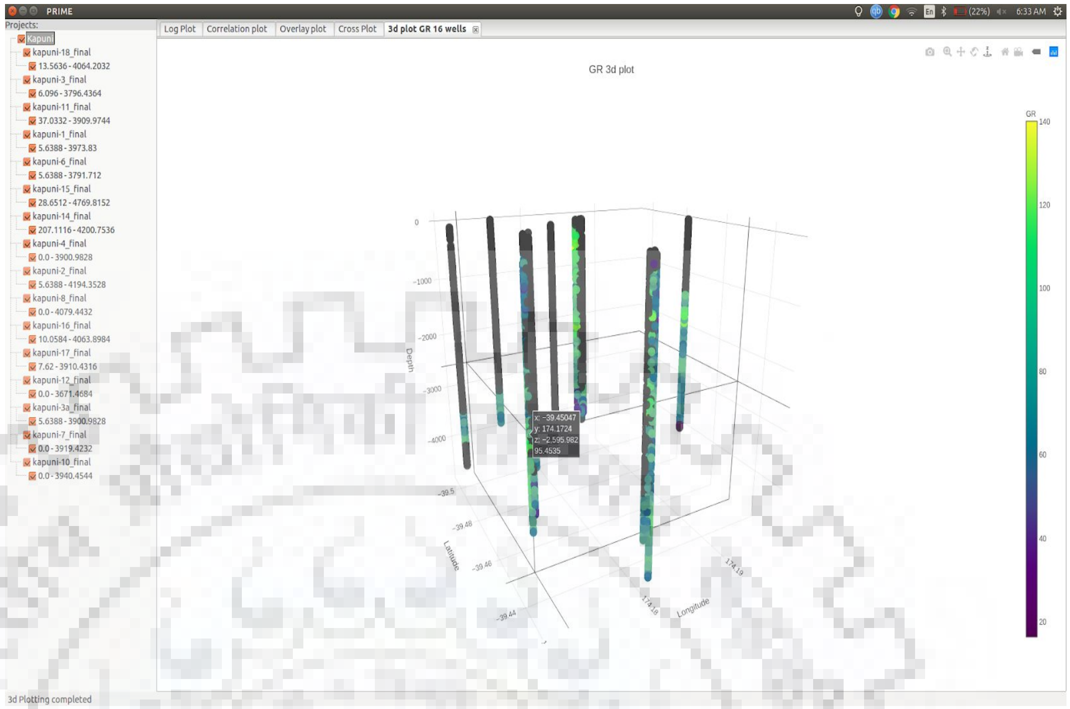

Fig-23 3d plot: with hover

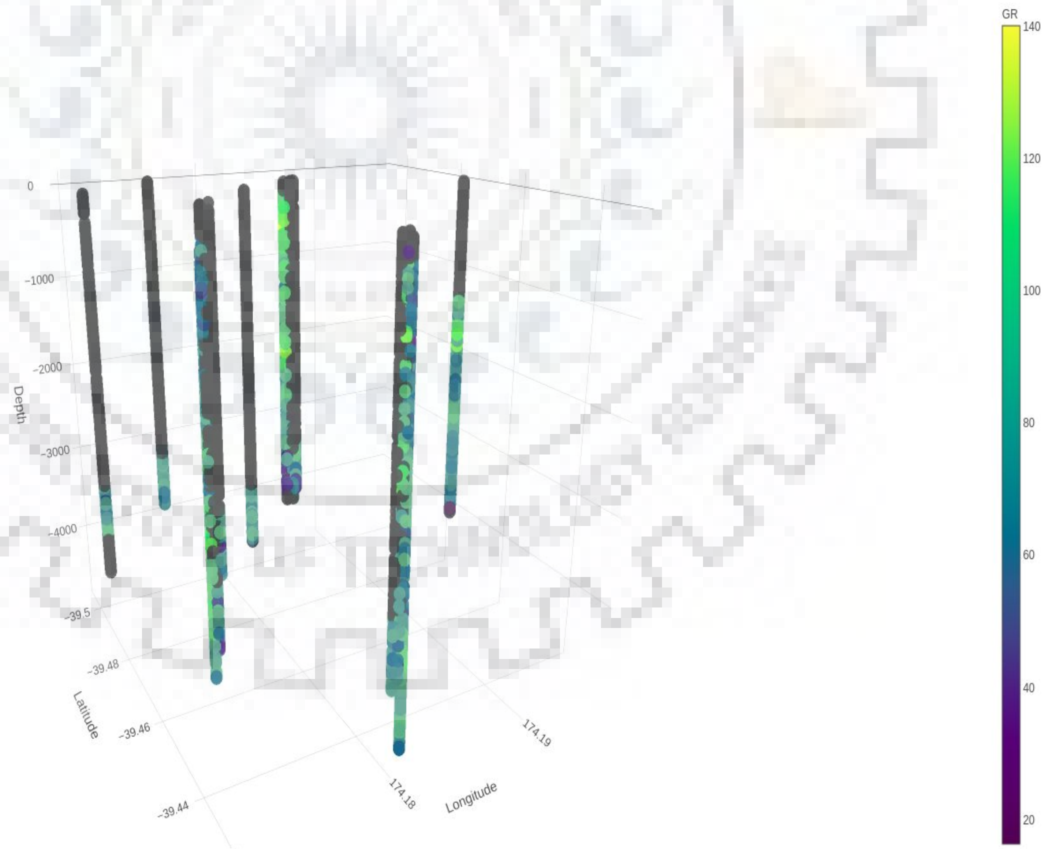

Fig-24 3d plot: zoomed

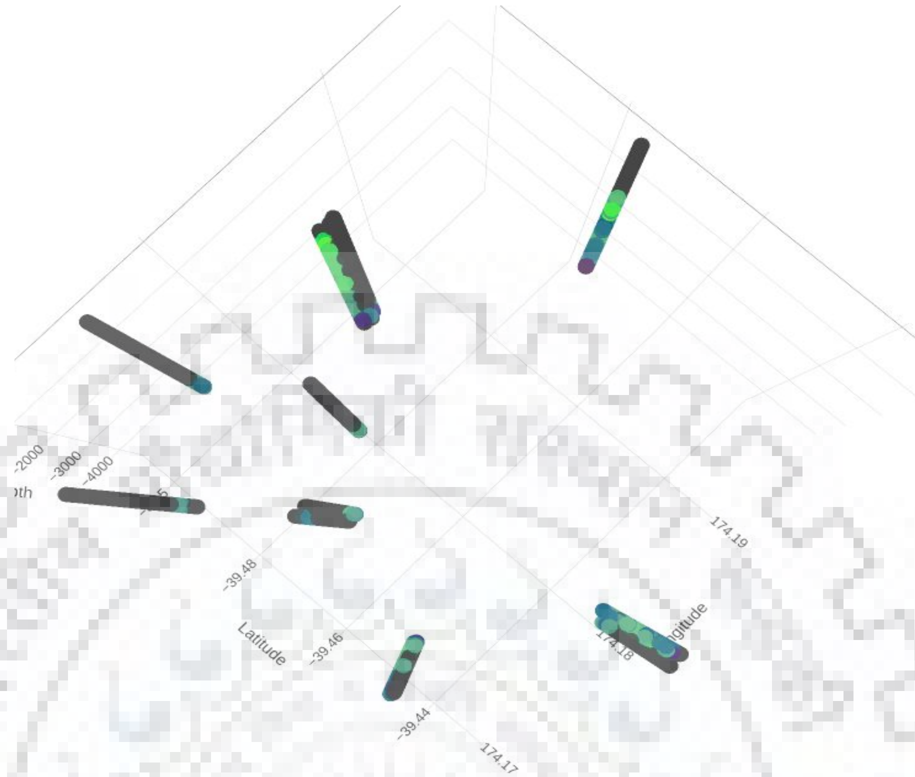

Fig-25 3d plot: top view

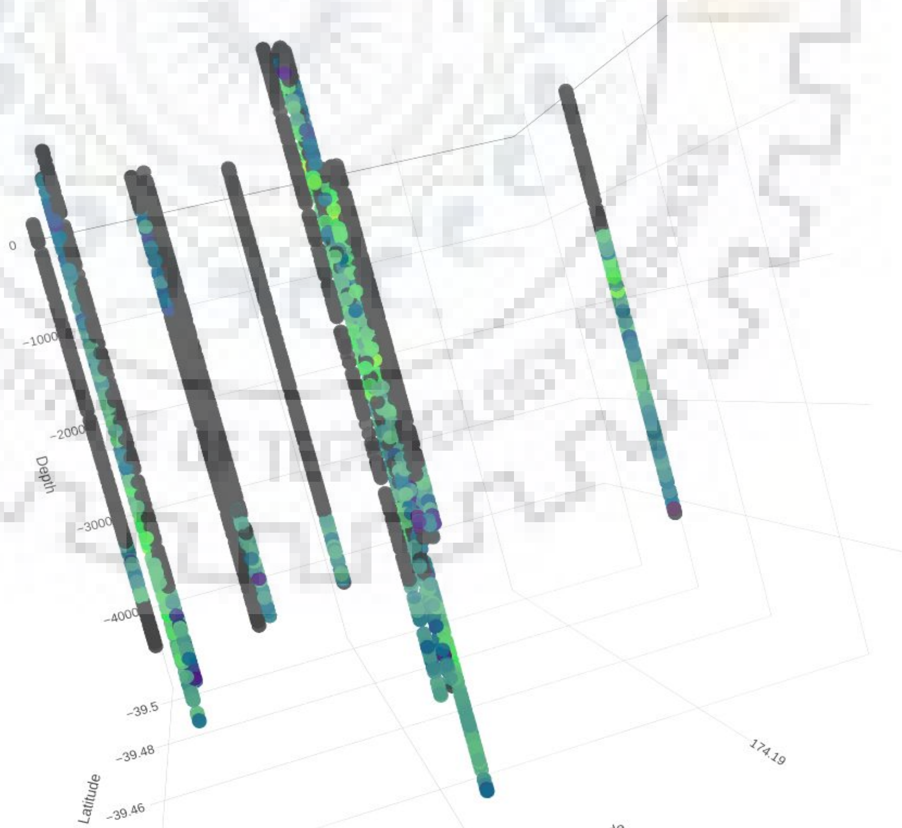

Fig-26 3d plot: zoom, and side rotated.

iv. Interpolate menu

1. Petrophysics

This menu is used for the prediction of well log properties using machine learning algorithms. Few wells are taken as input and based on an algorithm selected by the user, well log properties are plotted for the whole volume.

a. Validation

Validation is used to calculate the accuracy of a machine learning model. It breaks the data(available wells) into training and testing data. Trains the model on training data and check the accuracy on testing data.
At-least 3 wells are required for both validation and prediction or an error will be thrown.
Upon clicking *validation*, a dialogue opens where the user needs to select the interpolation method and the scoring used. The default value of scoring is kept as *r2*(r squared). Only advanced users are expected to change this value. The interpolation methods available are:
Upon selecting the interpolation method and scoring, the box plots of validation scoring are plotted. The name of the tab of the plot contains the name of the method for comparing later.
These plots help to judge which algorithm will give a better result for a property prediction. A mini case study is done with the help of two example box plots as follows:

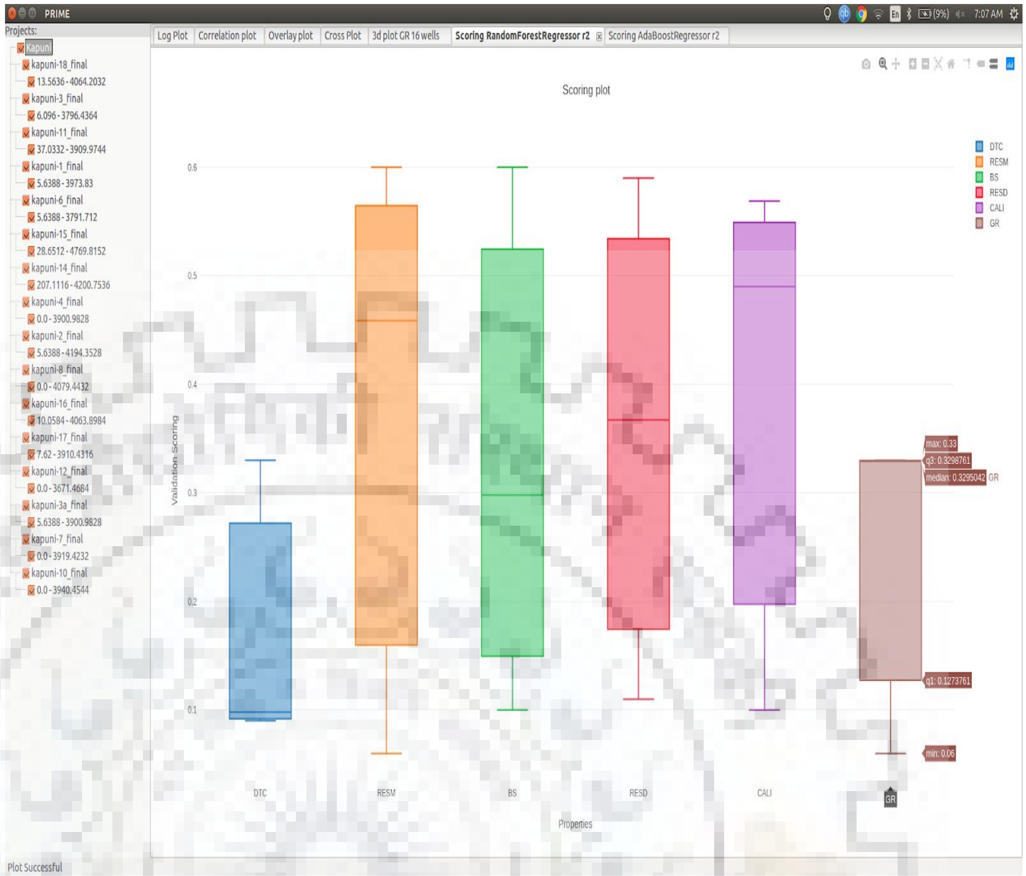

Fig-27 Validation score box plot: GR low, RESM high

The figure shows box plots, which have the median, max, min, etc marked for scoring values of validation. The above figure represents scoring for RandomForestRegressor algorithm. The scoring value for *GR* in this method is low, whereas, for *RESM,* it is high. This signifies that RandomForestRegressor is good for prediction of *RESM,* whereas not good for prediction of *GR,* in this project.

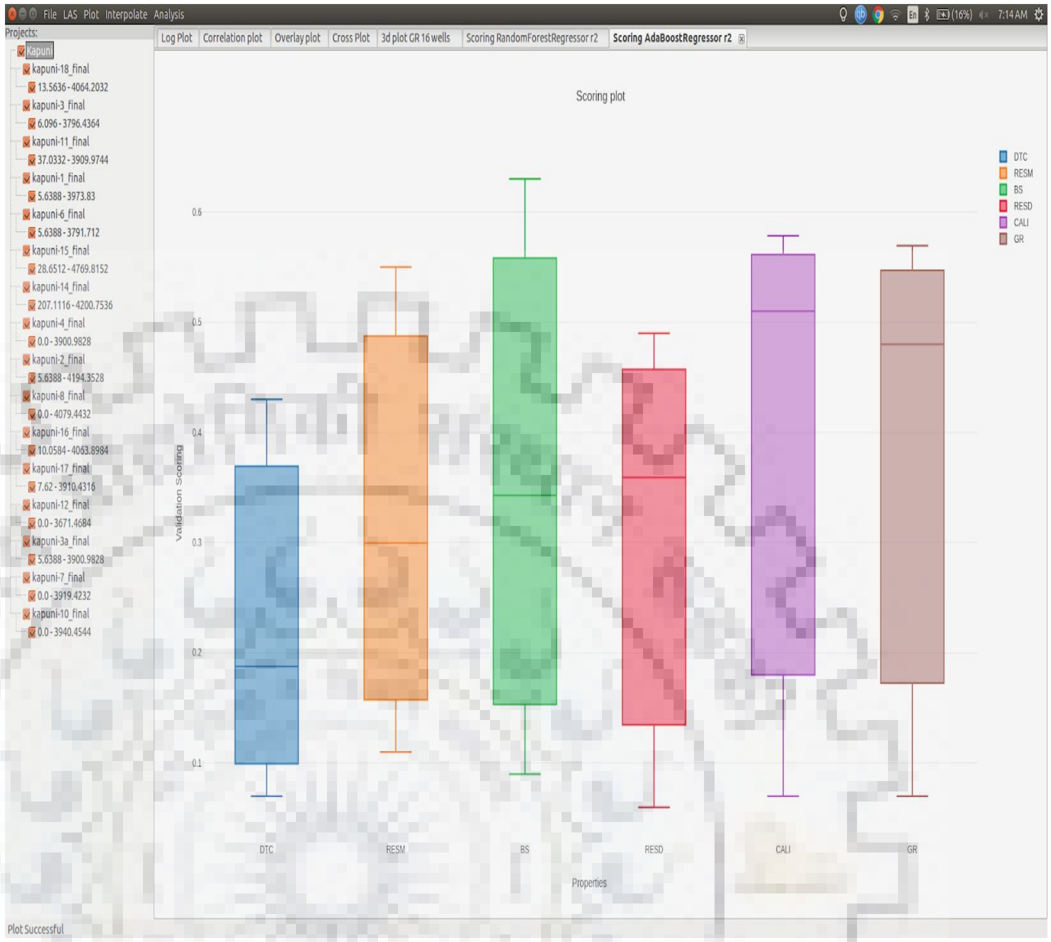

Fig-28 Validation score box plot: GR high, RESM low

Above figure represents scoring for *AdaBoost Regressor* method. It can be observed from this plot that *AdaBoost Regressor* is performing better in this case for GR compared to the previous algorithm whereas it is performing poorly on *RESM* compared to the previous algorithm. Above information can be used in prediction for properties. However, this should be misinterpreted as a generalization that one method is better at predicting one property. Above generalization was correct only for the specific data, and algorithm performance can change depending on data.

b. Prediction

Prediction is used to predict or interpolate well log properties into unknown points. This interpolates specified number inside the area. If the number of wells is high enough, it gives an intuition of continuity and any structure or layer can be easily identified. But, it is also sparse enough so that the user can zoom inside and can have a view of an inner layer. This also requires a minimum of 3 wells selected. Failing to which it will give an error message to the user.

Upon clicking prediction a dialog will open which will have the options for the number of wells to be interpolated and the interpolation method. The interpolation method options are the same as that of the Validation menu.
An example of dialogue is shown in the following figure:

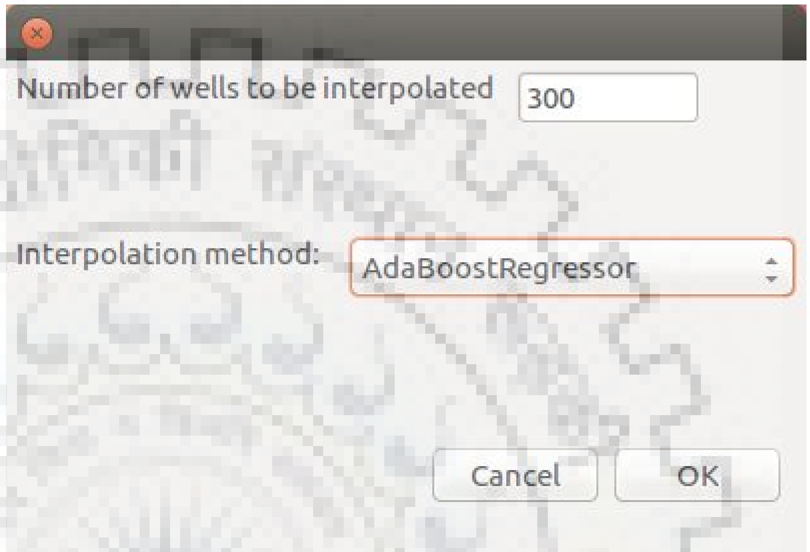

Fig-29 Prediction dialogue: Select method and wells

Upon completion of the prediction, the Statusbar will have the text: *'Prediction completed'.*

c. **3-d plot**

This menu will 3d plot the wells predicted in the previous step. Upon click, it shows a dialogue as follows:

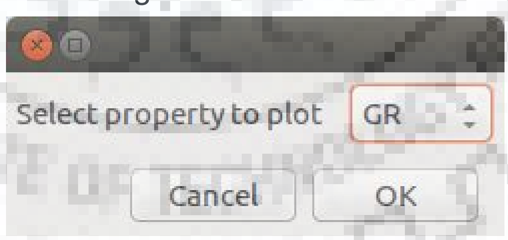

Fig-30 3d plot property select

Upon selecting the property, the wells are plotted in 3d. The features are similar to the 3-d plot in section 2-c-iv.
Example of the plot is shown in the following figures:

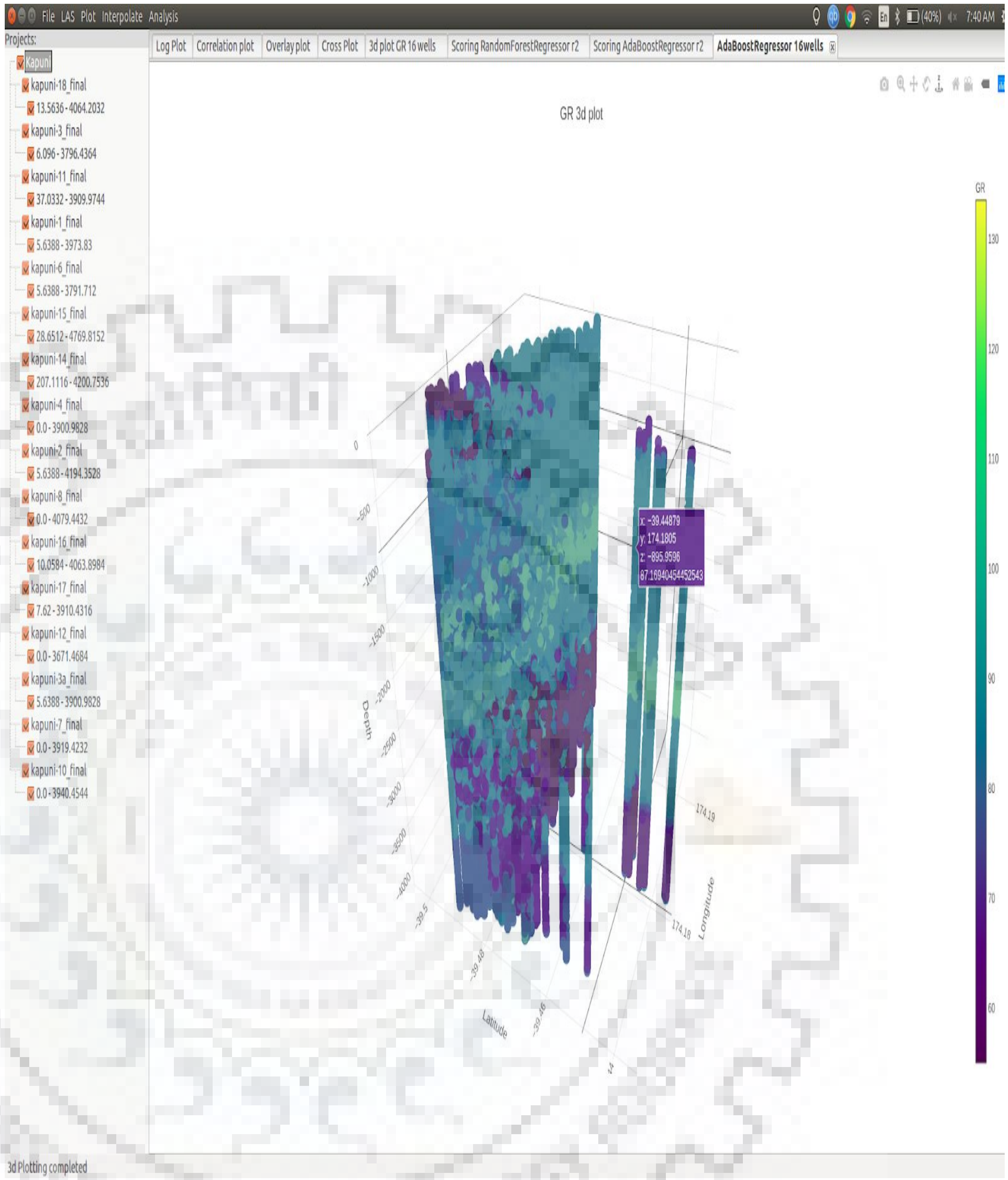

Fig-31 3d plot interpolation

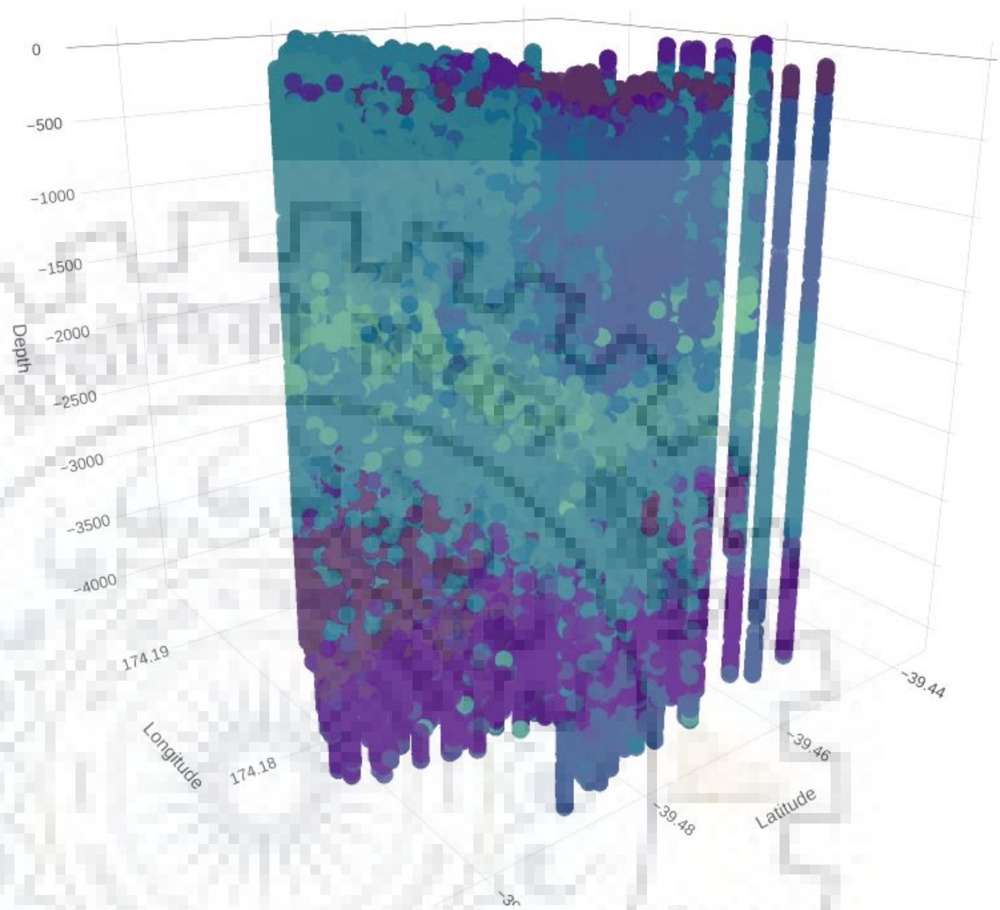

Fig-32 3d plot interpolation zoomed

2. **Facies**
   This function takes a CSV file containing the facies of one well obtained either from a mudlog or done manually. This uses machine learning to learn the correlation between petrophysical properties and the facies. Based on that, facies are predicted for the whole of the 3d area, properties to which were calculated in the previous step.
   Please note that this function can only be run after prediction is run.
   Result of 3d interpolation and plot is shown in the given figure:

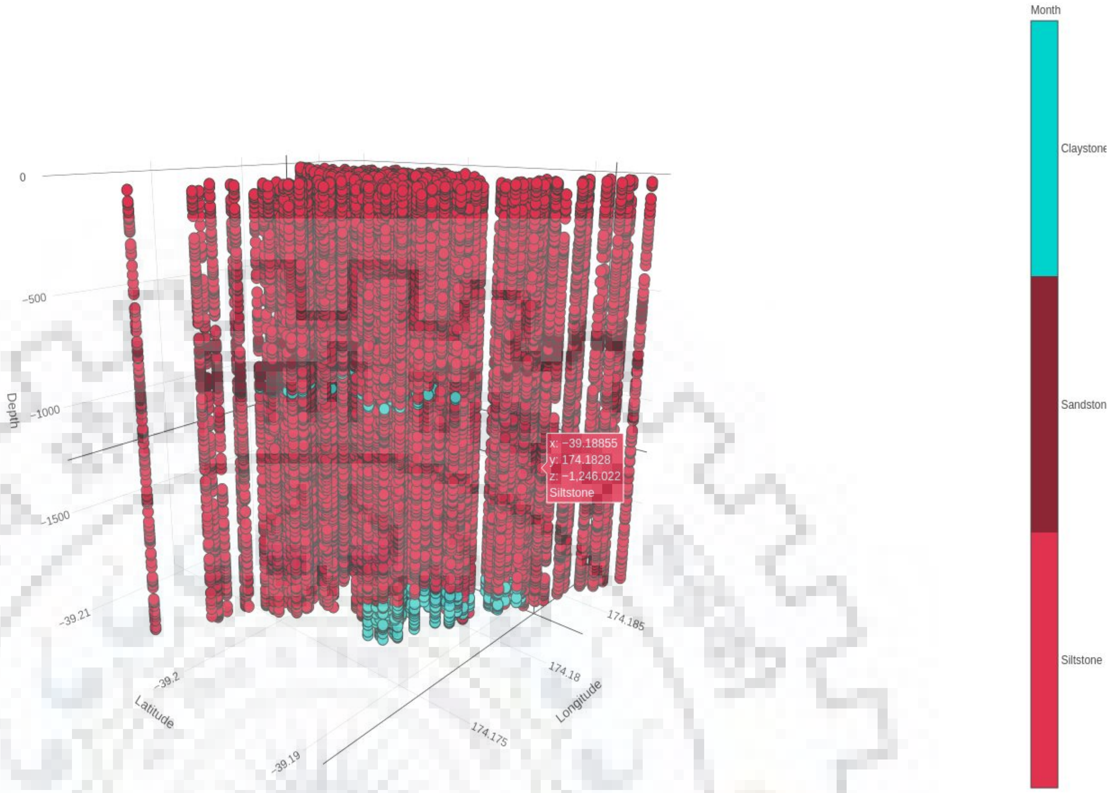

Fig-33 3d plot facies prediction

v. Analysis

1. Vshale

a. GR

This function is used to calculate Vshale based on GR values of the well log. It calculates both linear responses as well as nonlinear responses for the formation. The responses are calculated based on given formulas:

i. Linear response:

$$V_{sh} = I_{GR} = \frac{GR_{\log} - GR_{\min}}{GR_{\max} - GR_{\min}}$$

(Asquith, G., & D. Krygowski, 2004)

ii. Non-Linear responses:

At times many studies (Mavko, 2010) suggested that this linear relation is not accurate for all the formation type and further modifications with more accuracy were proposed as explained below:

1. Larionov for Tertiary rocks

$$V_{sh} = 0.083(2^{3.7 I_{GR}} - 1)$$

(Asquith, G., & D. Krygowski, 2004)

2. Steiber

$$V_{sh} = \frac{I_{GR}}{3 - 2 \times I_{GR}}$$

(Asquith, G., & D. Krygowski, 2004)

3. Clavier

$$V_{sh} = 1.7 - \left[(3.38 - (I_{GR} + 0.7)^2\right]^{\frac{1}{2}}$$

(Asquith, G., & D. Krygowski, 2004)

4. Larionov for older rock

$$V_{sh} = 0.33 \times (2^{2 I_{GR}} - 1)$$

(Asquith, G., & D. Krygowski, 2004)

Using the equations, GR plot, and plots of every response of Vshale are plotted. Upon clicking *GR*, a histogram distribution curve is displayed which has options to manually select GR_{min} and GR_{max}. The default values are set at absolute max and min of GR.
An example of the curve is shown below:

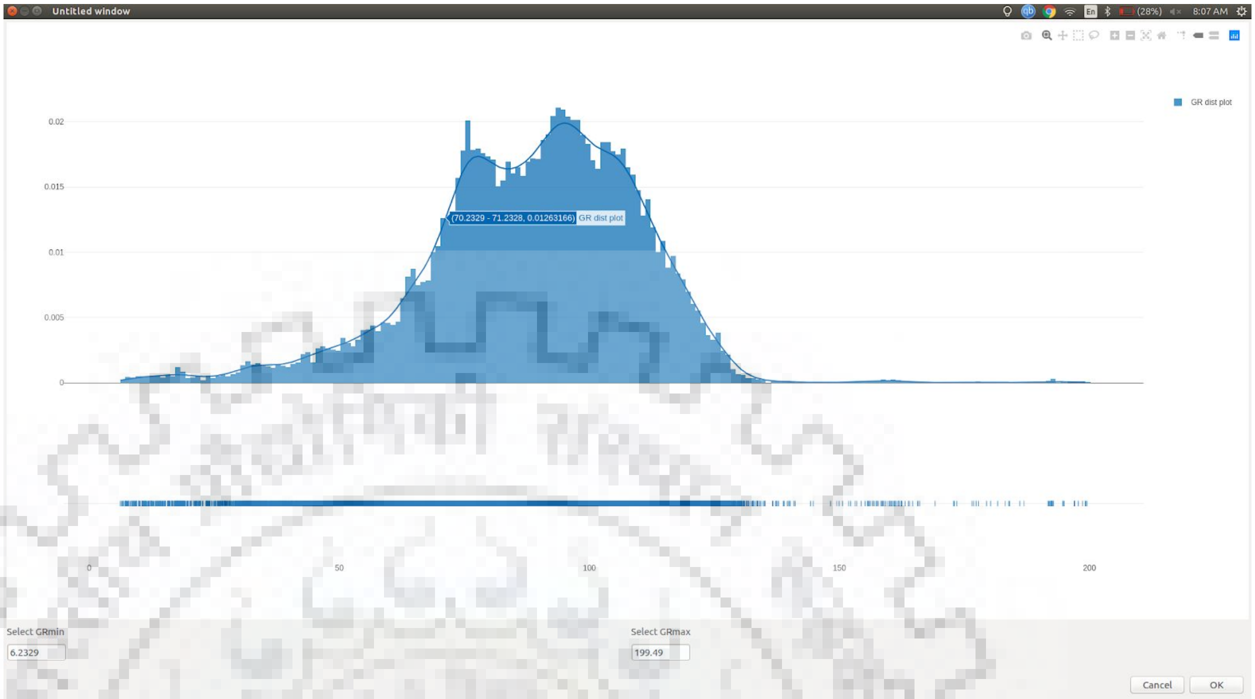

Fig-34 GR distribution curve and GRmin, GRmax select

After selecting GR_{min} and GR_{max}, the GR plot is shown to the user. An example of the same is shown in the figure below:

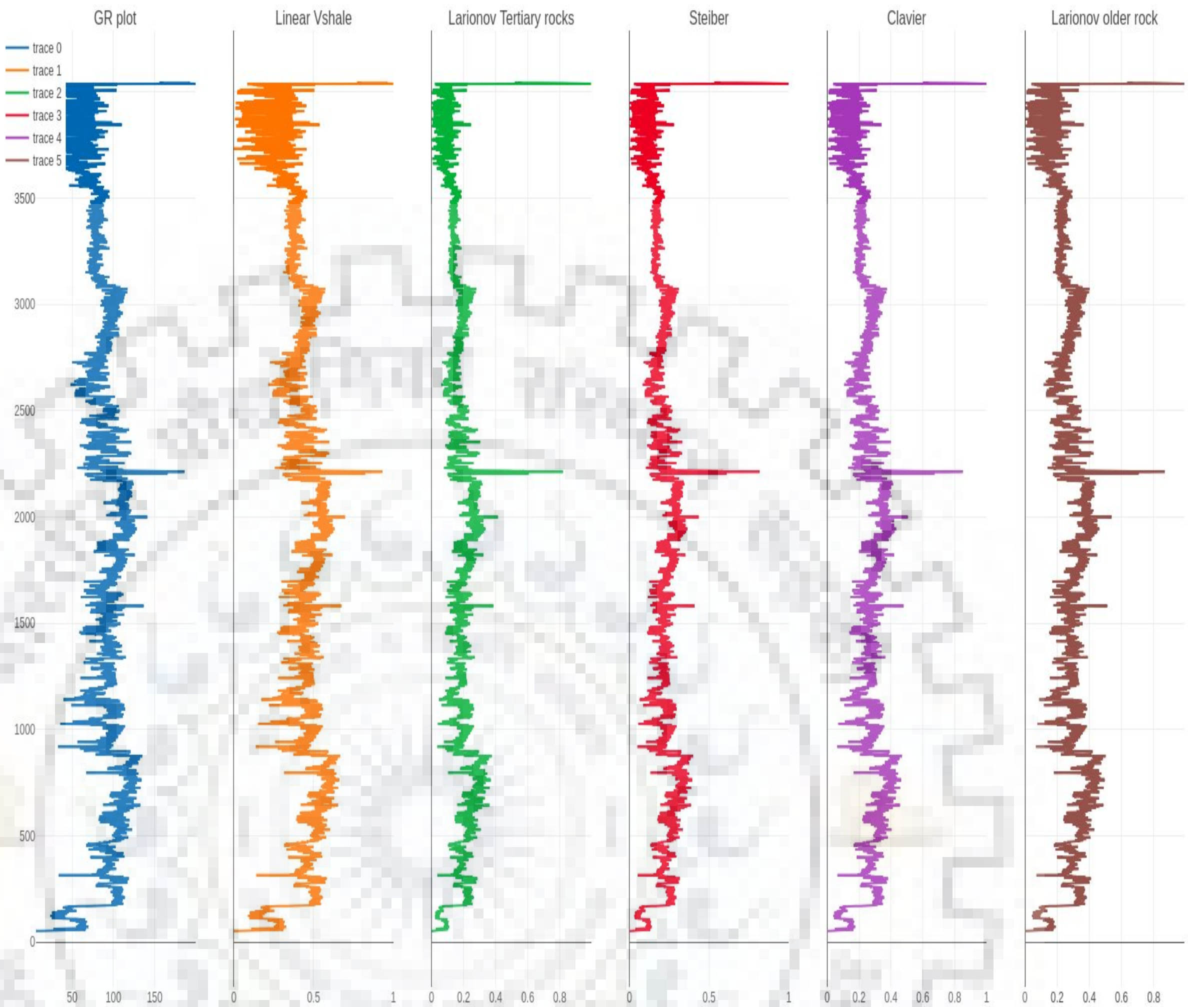

Fig-35: Vshale plots

Chapter 5: Improvements and Future Work

Improvements

- PRIME has been through a long journey with the work first beginning in May 2017. The work before this thesis although had good features, but it was poor on fundamentals of software architecture. There were many shortcomings ranging from hardcoding of filenames and database properties to need to manually add dependencies and manually setting the database.
- The current software has laid all the **necessary foundations**, made the tool easy to work on by future developers.
- The UX(**user experience**) or how easy the tool is to work with has been vastly improved.
- There was no **error handling** in the previous version. In this version, the user gets an error window whenever they do something which should not have been done(for example, plotting a well without selecting it). Along with the error message, they also get instructions about how to resolve the error.
- The LAS reader has been greatly improved as well. The time to read one file in the previous version was about 2.5 minutes, however, in this version, the time is less than 0.25 seconds. An improvement of **600 times**.
- There is an addition of multiple plots like correlation plot for one property, the 3d plot of property and well,
- The tool can interpolate in 3 dimensions any of the properties of the well using various machine learning methods.
- For any other machine learning methods integration, the groundwork is laid, and the modules can be plugged easily.

Future work

- Making a standalone installer of PRIME for every operating system.
- Making the tool multi-threaded. Currently, it stops the processes if a process is running.
- Integrating other Petrophysical modules and making the tool more complete in terms of Petrophysics.
- Integration of Seismic data in the well-seismic tie module.

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