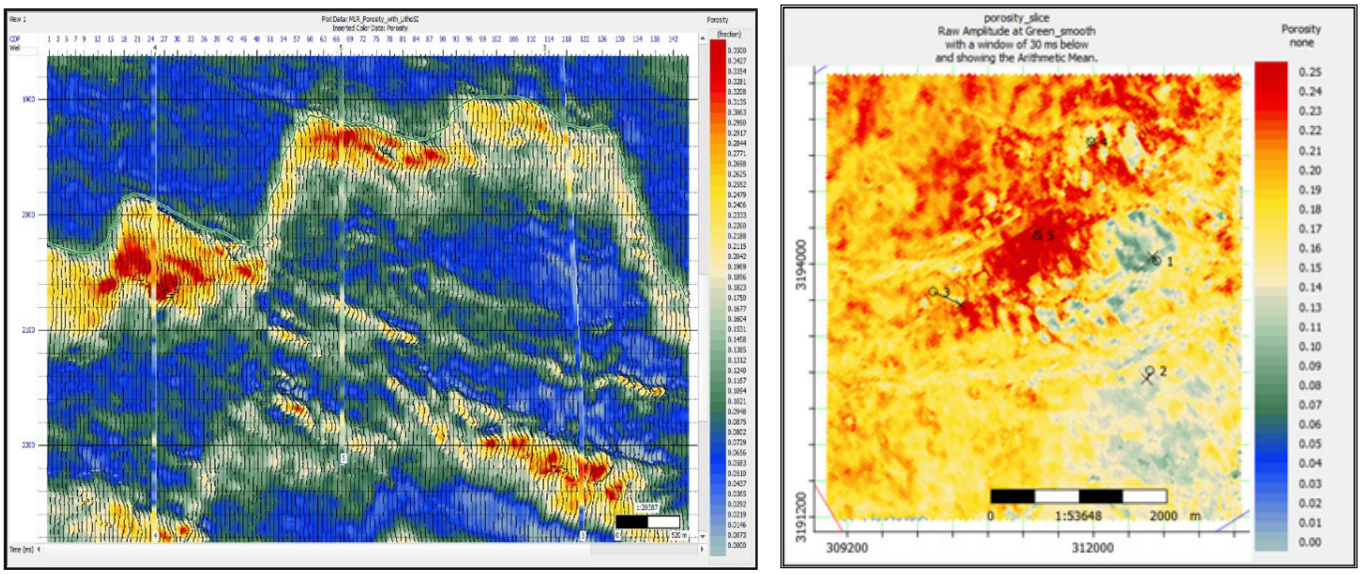
HampsonRussell
Emerge

Multi-Attribute Analysis Module

Emerge leverages machine learning and geostatistical algorithms to predict and classify property volumes using well logs, seismic data and attribute volumes. It can predict a wide-range of property volumes, including porosity, lithology, velocity, density, Vclay, gamma-ray, and water saturation. **Emerge** can also be used to predict missing logs or parts of logs by creating models trained by existing logs that are common to the available wells.



Predicted Porosity Volume and Porosity slice cut from predicted porosity volume with a 30 ms window below the Green Horizon.

Emerge Attribute Prediction

The **Emerge** module predicts rock and elastic property volumes through the application of machine learning techniques. It establishes a relationship between log data and user supplied volumes along with dynamically generated seismic attributes as input. **Emerge** can perform both classification and regression tasks using traditional multi-linear regression aided by non-linear transforms as well as advanced techniques using deep neural networks.

Recognizing the importance of well-conditioned and scaled data for machine learning processes, **Emerge** equips users with tools for optimizing input data. These tools provide functionalities for filtering, editing, and shifting to maximize correlation and elevate data quality. Additionally, **Emerge** offers enhanced Quality Control (QC) measures aimed at refining parameter and attribute selection. Users can access a comprehensive set of metrics, including confusion matrix analysis for classification tasks, correlation and validation metrics, providing reliable estimates for the modeled outcomes.

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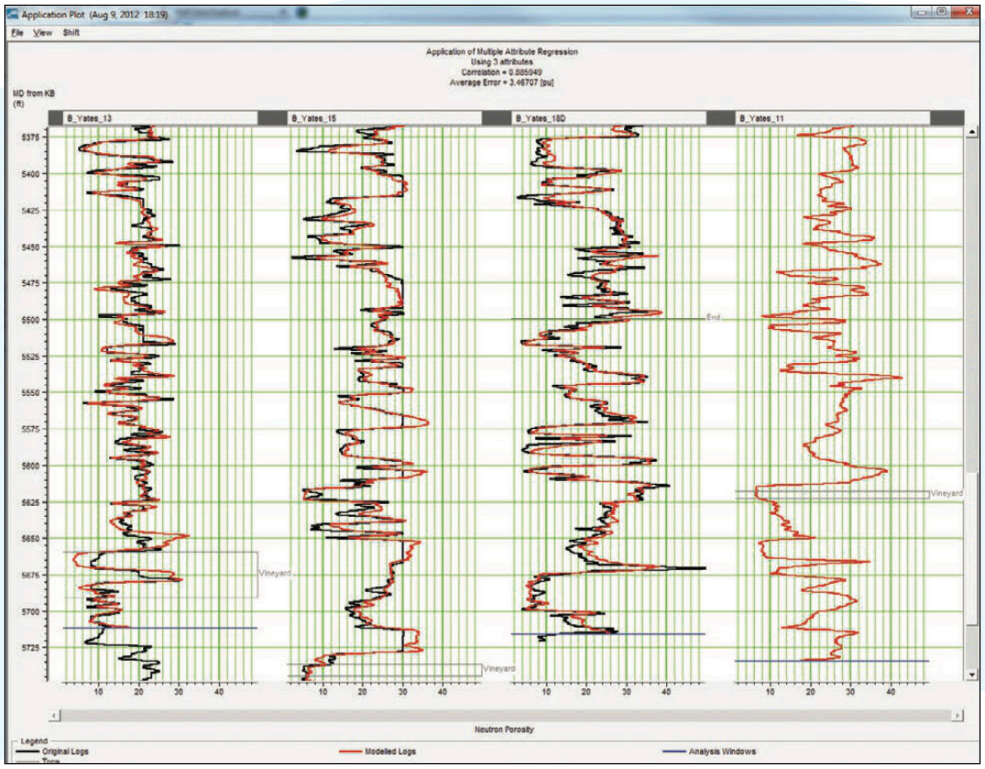
Features

- Predict volumes of any log type (recorded or computed).
- Perform classification and support discrete volume types.
- Utilize stepwise multi-linear regression for the rapid selection of best attributes.
- Apply optional convolutional operator for extended regression capabilities.
- Validate predictions to avoid over-training.
- Customize blind well testing.
- Optimize well-tie by attribute correlations.
- Improve training data with filters, normalization, or outlier removal.
- Crossplot logs, seismic and attribute data.
- Apply non-linear transforms on training data.
- Compute a variety of seismic attributes.
- Calculate Principal Components.
- Utilize an unlimited number of seismic volumes in time or depth domain.

Emerge Log Predict uses similar multi-attribute methodology to seismic attribute prediction. This powerful capability enables the prediction of missing logs or portions of logs, even in the absence of seismic data.

Emerge Log Predict achieves this by using existing logs shared among wells as the training dataset. The trained model is then applied to predict missing logs.



The application of the log prediction is shown above. Note that the black curves are logs that exist within their wells and the red curves are the predicted curves from Emerge. The track on the far right shows a predicted porosity curve where the well has none

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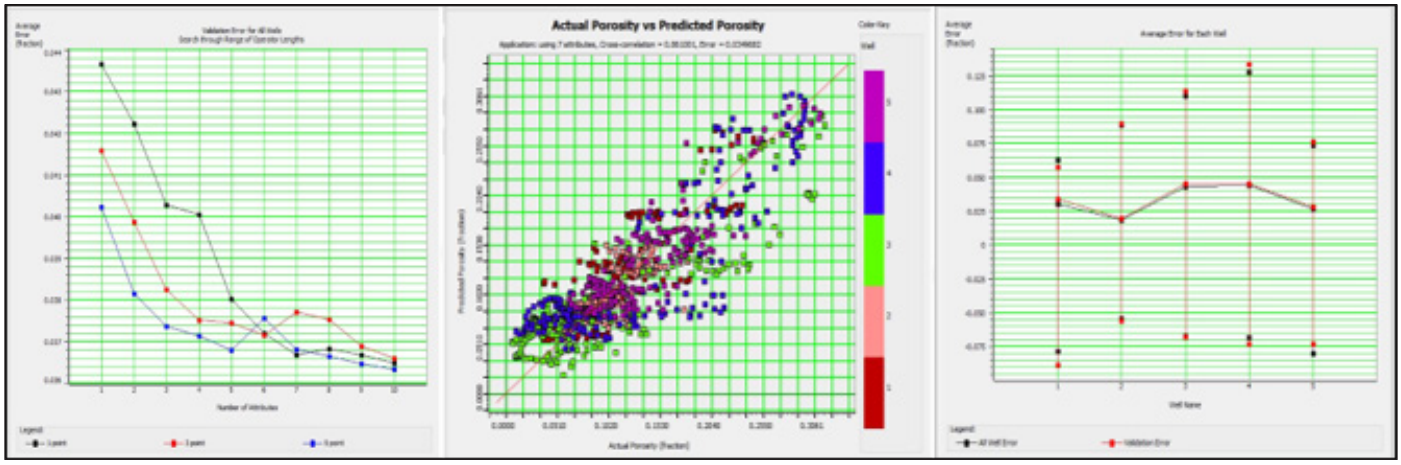
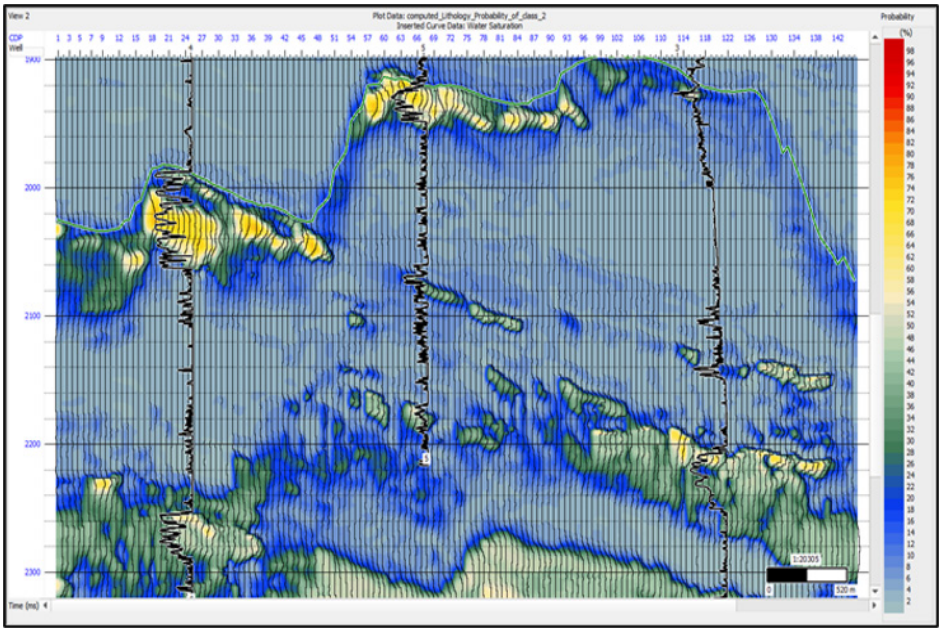


Attribute number vs Validation Error per Convolutional Operator Length QC (left), Actual Porosity vs Predicted Porosity Crossplot Colored by Well QC (middle), and Average Validation Error (Red) and Training Error (Black) per Well with Error Bars QC (right).

Emerge determines the optimum order, number and weighting of attributes as components in the model by performing internal cross-validation. The model is then applied to the seismic attributes creating a volume of the target property.



Water saturation logs overlain volume of probability of pay facies as determined by classification using the Deep Feed Forward Neural Network. High probability of pay facies is shown in yellow colors.

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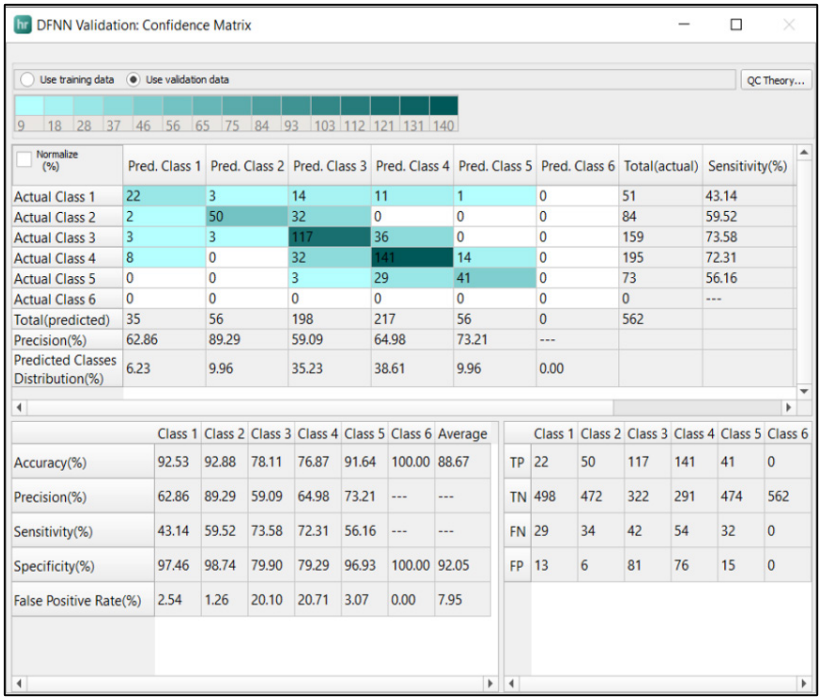
Emerge Prediction Options

- Single and Multi-Attribute Regression Analysis
- Probabilistic Neural Network
- Multi-Layer Feed Forward Neural Network
- Radial Basis Function Neural Network
- Deep Feed Forward Network



Normalize (%)	Pred. Class 1	Pred. Class 2	Pred. Class 3	Pred. Class 4	Pred. Class 5	Pred. Class 6	Total(actual)	Sensitivity(%)
Actual Class 1	22	3	14	11	1	0	51	43.14
Actual Class 2	2	50	32	0	0	0	84	59.52
Actual Class 3	3	3	117	36	0	0	159	73.58
Actual Class 4	8	0	32	141	14	0	195	72.31
Actual Class 5	0	0	3	29	41	0	73	56.16
Actual Class 6	0	0	0	0	0	0	0	---
Total(predicted)	35	56	198	217	56	0	562	
Precision(%)	62.86	89.29	59.09	64.98	73.21	---		
Predicted Classes Distribution(%)	6.23	9.96	35.23	38.61	9.96	0.00		

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Average
Accuracy(%)	92.53	92.88	78.11	76.87	91.64	100.00	88.67
Precision(%)	62.86	89.29	59.09	64.98	73.21	---	---
Sensitivity(%)	43.14	59.52	73.58	72.31	56.16	---	---
Specificity(%)	97.46	98.74	79.90	79.29	96.93	100.00	92.05
False Positive Rate(%)	2.54	1.26	20.10	20.71	3.07	0.00	7.95

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
TP	22	50	117	141	41	0
TN	498	472	322	291	474	562
FN	29	34	42	54	32	0
FP	13	6	81	76	15	0

Confidence matrix showing predictions vs actual classes along with accuracy, precision, sensitivity, specificity, and False Positive metrics for classification prediction of lithology log using Deep Feed Forward Neural Networks

Multi-attribute prediction Benefits With **Emerge**

- Predict volumes of any data type
- Classify volumes with associated probability estimates
- Conduct cross-validation analysis
- Use various QCs to asses correlation and error per well
- Analyze confidence matrix and statistical metrics of classification
- Predict missing log data
- Leverage neural networks for non-linear, high-resolution predictions

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