Machine Learning: Facies Classification & Target Identification

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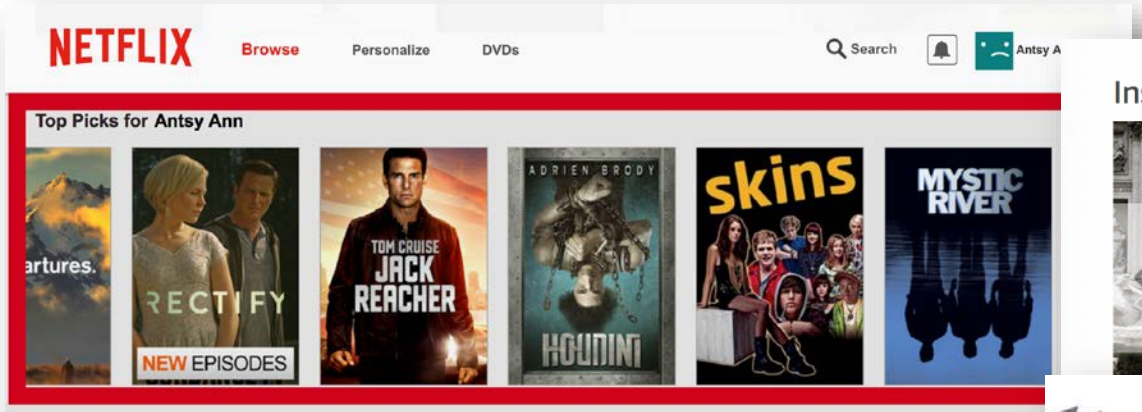
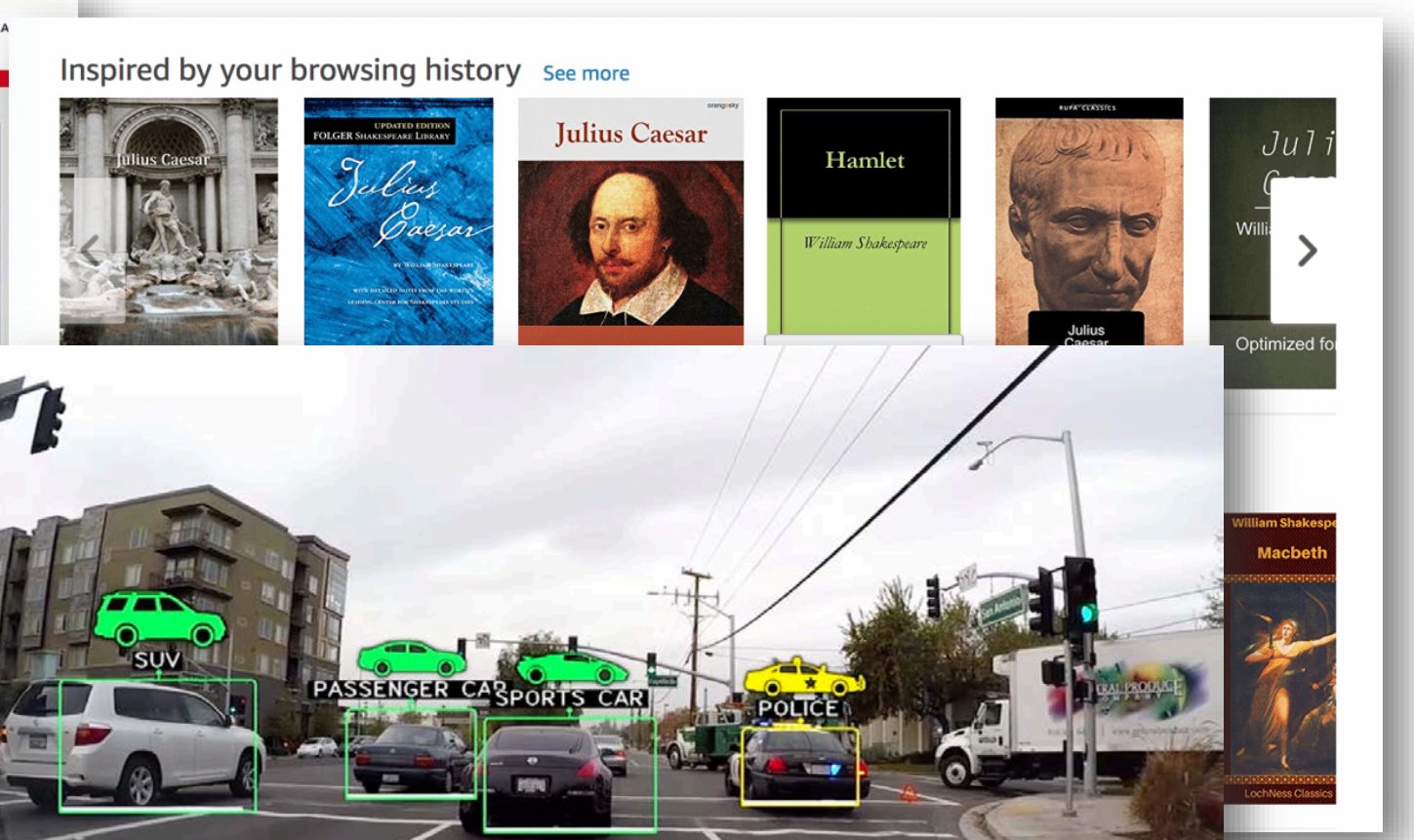
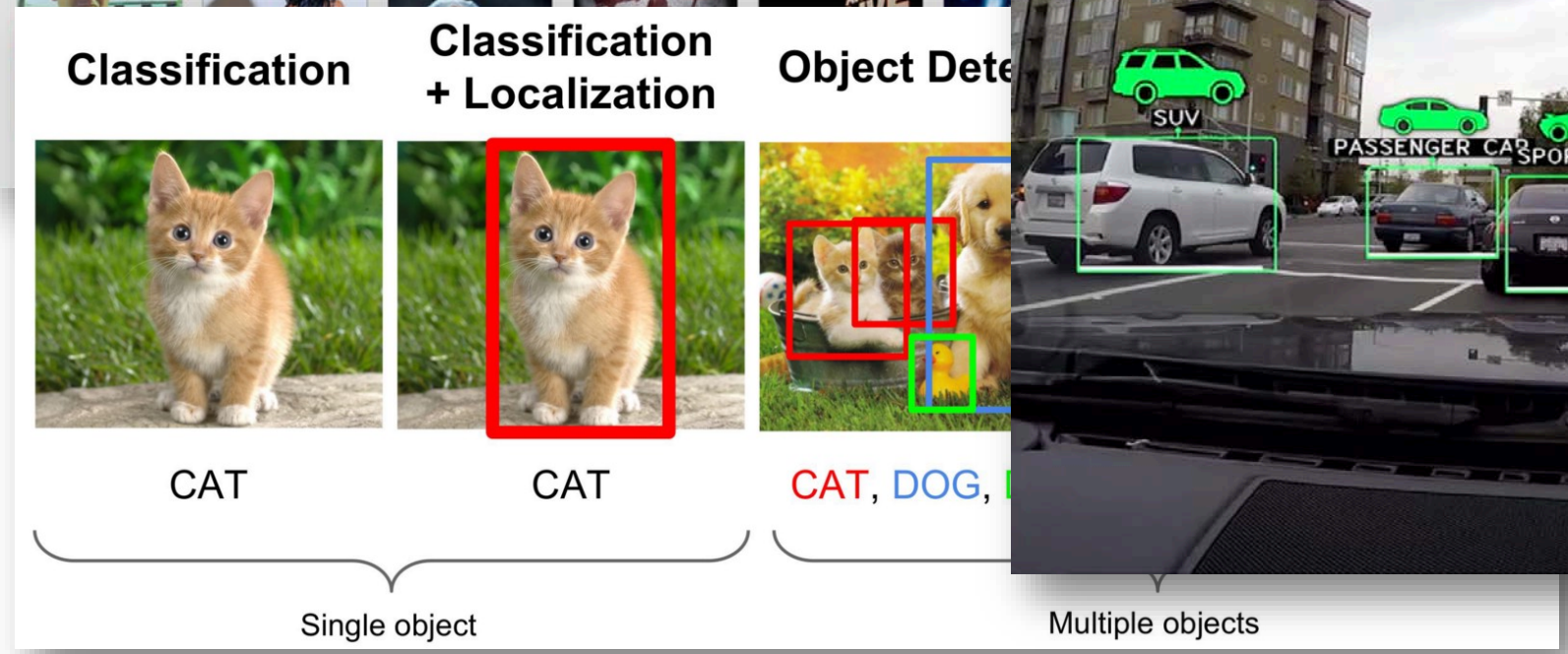
Machine learning *is a field of computer science that gives computer systems the ability to "learn" (i.e. progressively improve performance on a specific task) with data, without being explicitly programmed.*

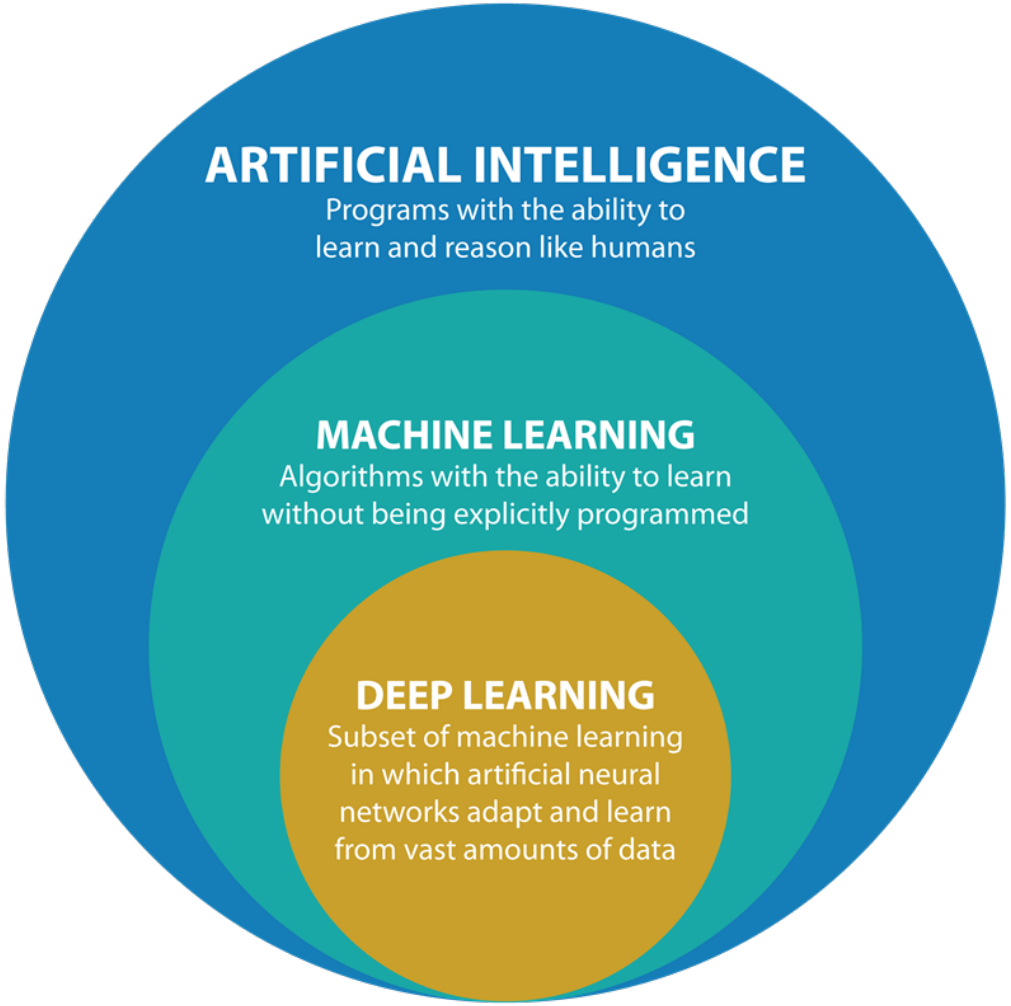
Introduction to Machine Learning

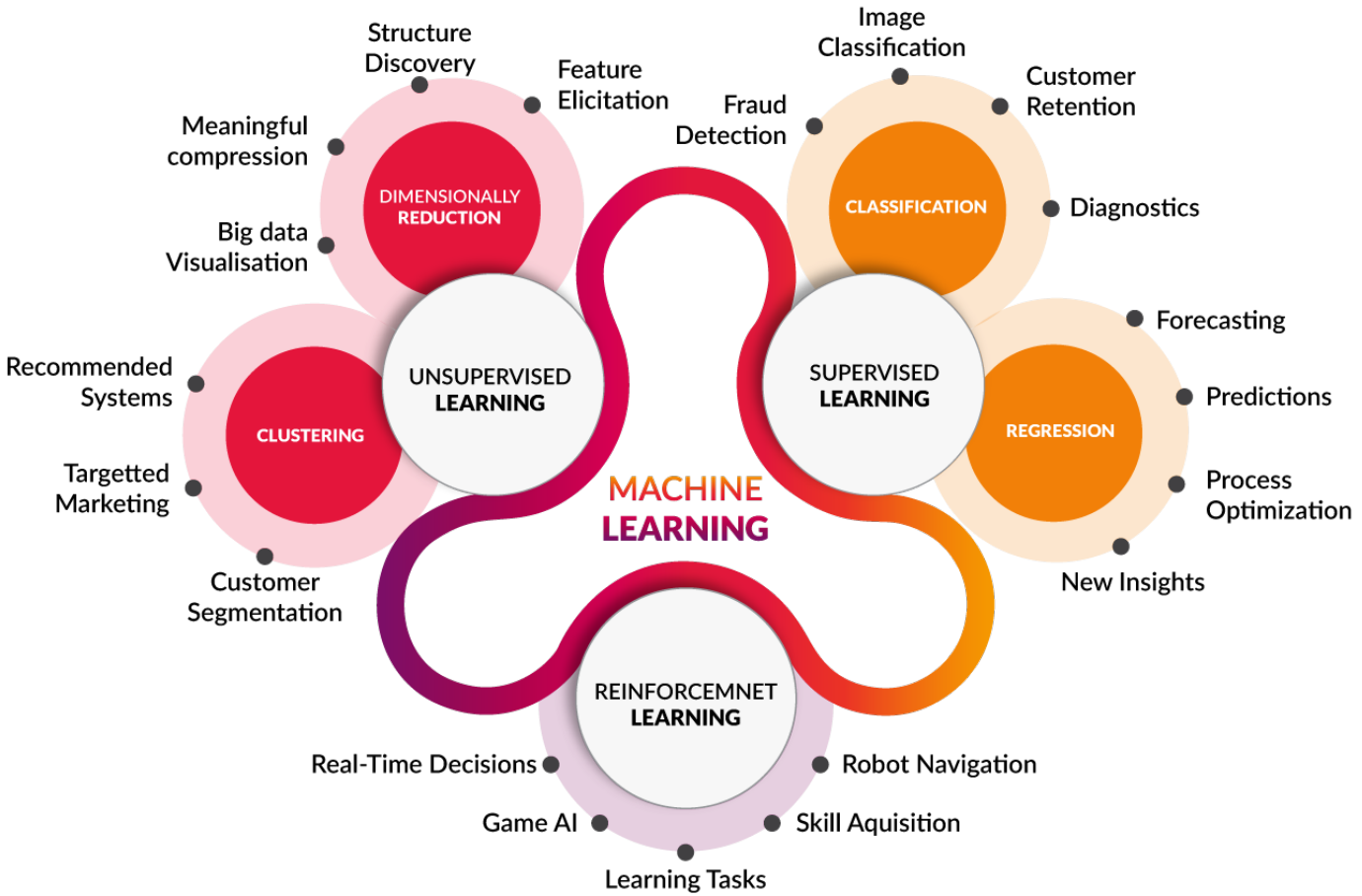






Introduction to Machine Learning





Figures from Argility website

Introduction to Machine Learning

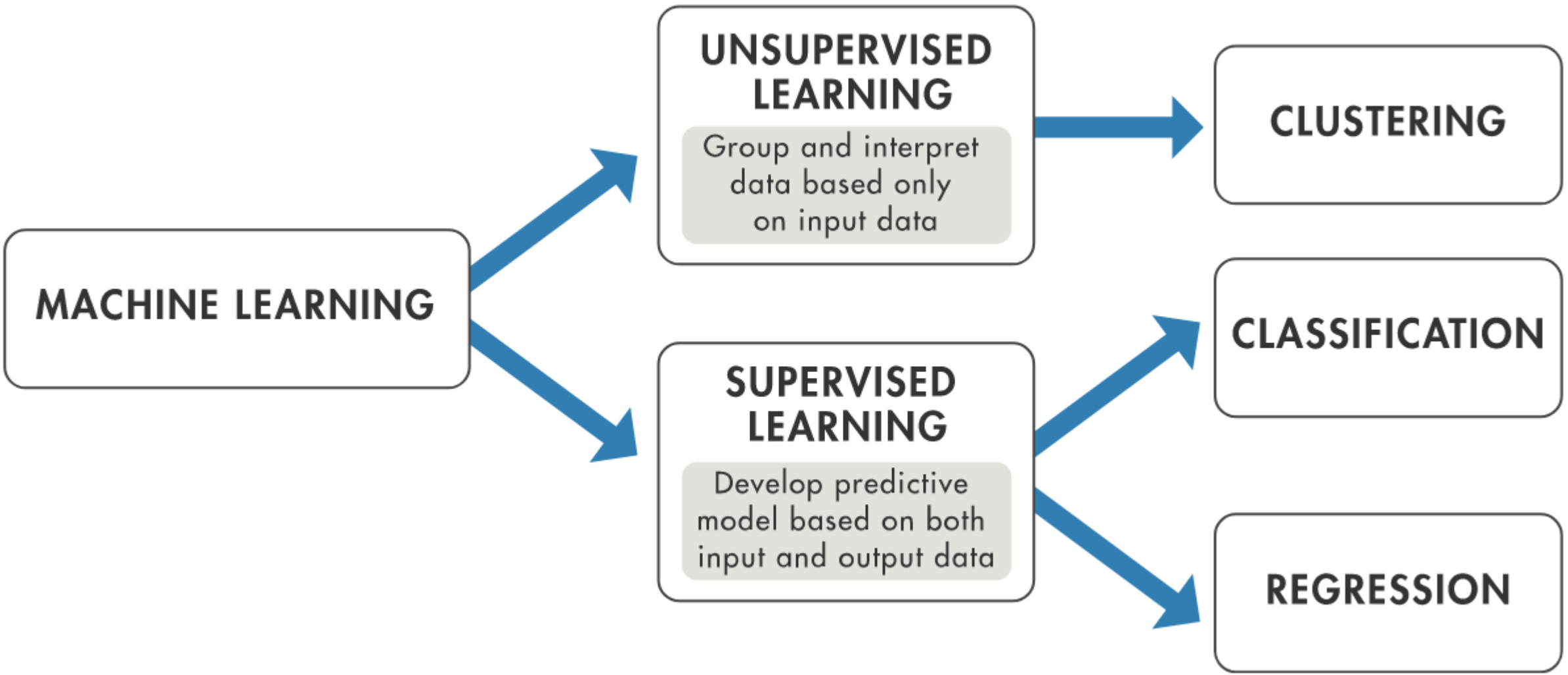


Figure from MathWorks website

Introduction to Machine Learning

- **Supervised Learning**
  - **Regression**
    - Linear model, nonlinear model, regularization, stepwise regression, boosted and bagged regression trees, neural networks, and adaptive neuro-fuzzy learning
  - **Classification**
    - Support vector machine (SVM), boosted and bagged decision trees, k-nearest neighbor, Naïve Bayes, discriminant analysis, logistic regression, and neural networks
- **Unsupervised Learning**
  - **Clustering**
    - k-means and k-medoids, hierarchical clustering, Gaussian mixture models, hidden Markov models, self-organizing maps, fuzzy c-means clustering, and subtractive clustering

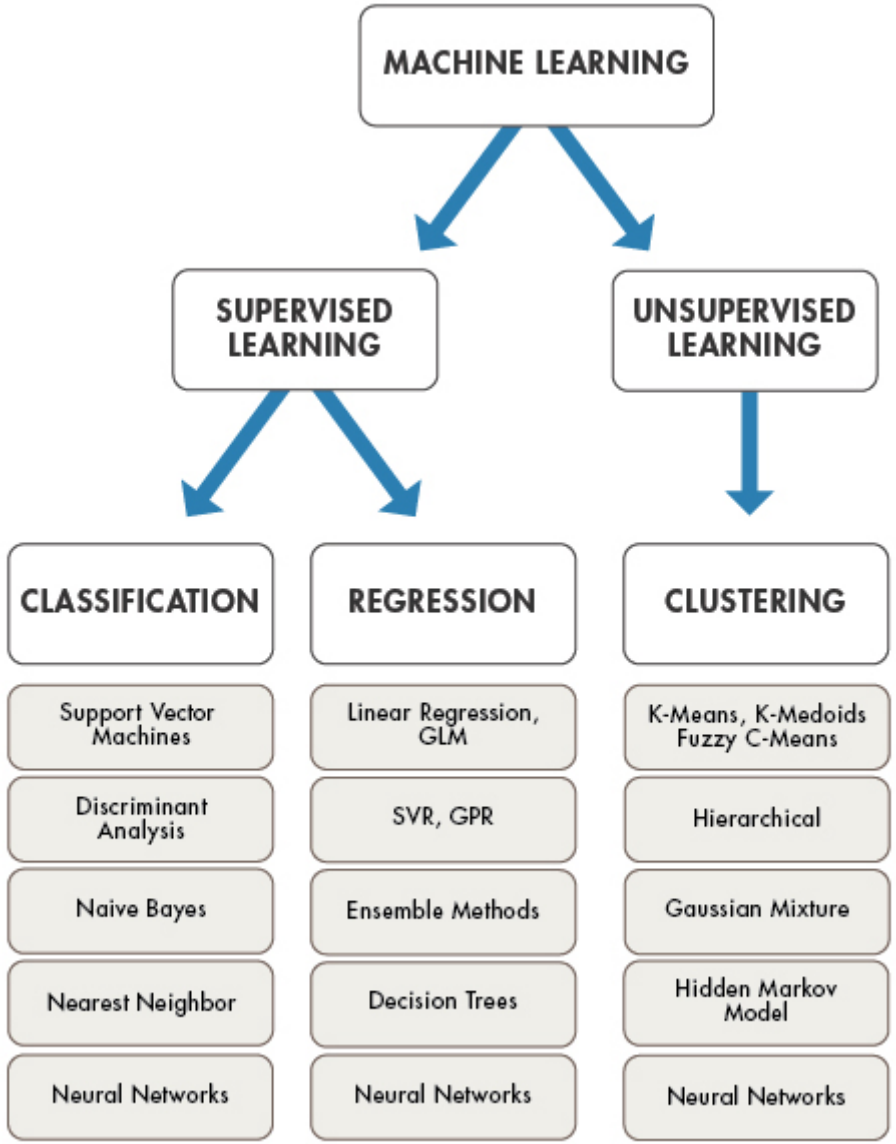


Figure from MathWorks website

Facies Classification with Gradient Boosting

Facies Classification with Gradient Boosting

One of the proposed solutions of a Machine Learning Contest in 2016:

https://github.com/seg/2016-ml-contest

It was a contest to classify facies using the given well logs. The author's solution can be downloaded from:

https://bitbucket.org/polimi-ispl/

Facies Classification with Gradient Boosting

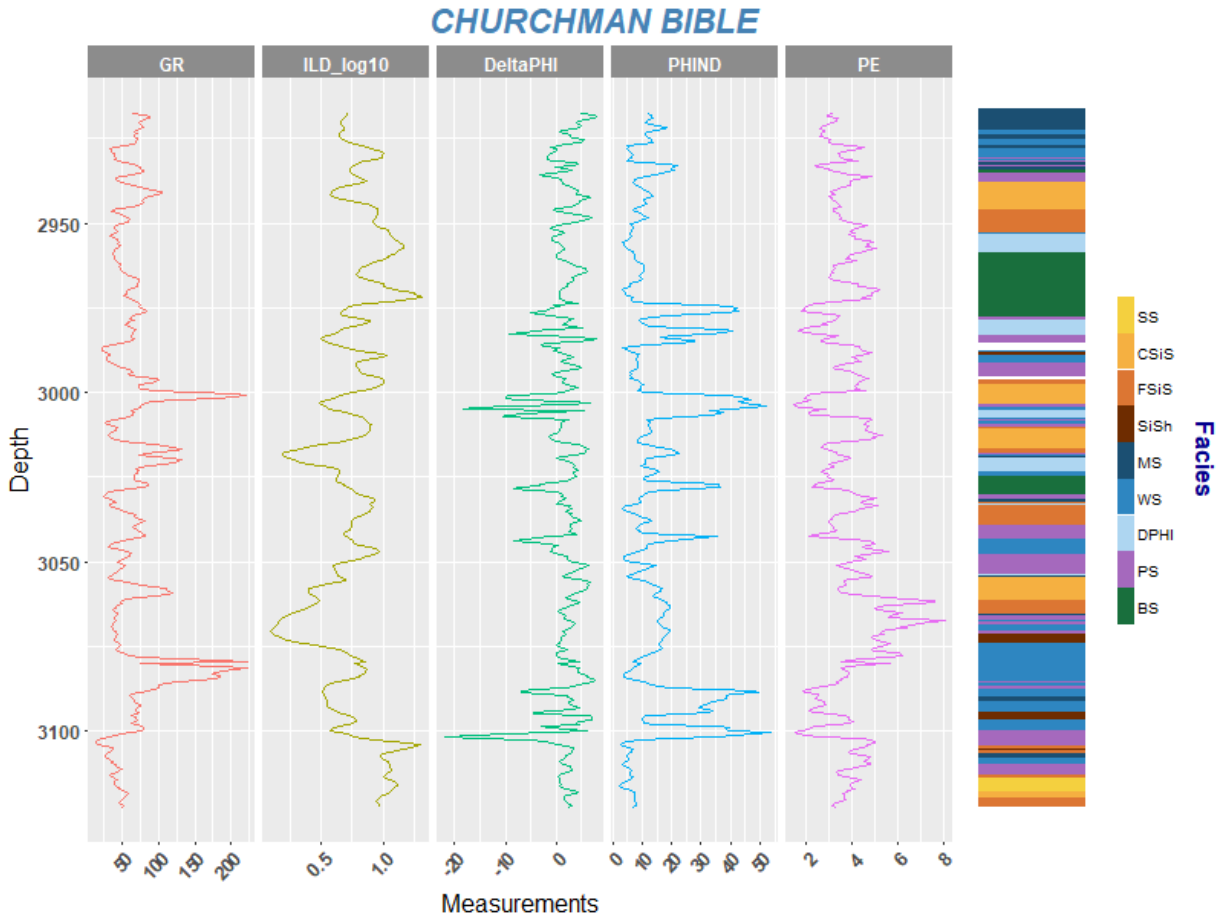
Provided Data

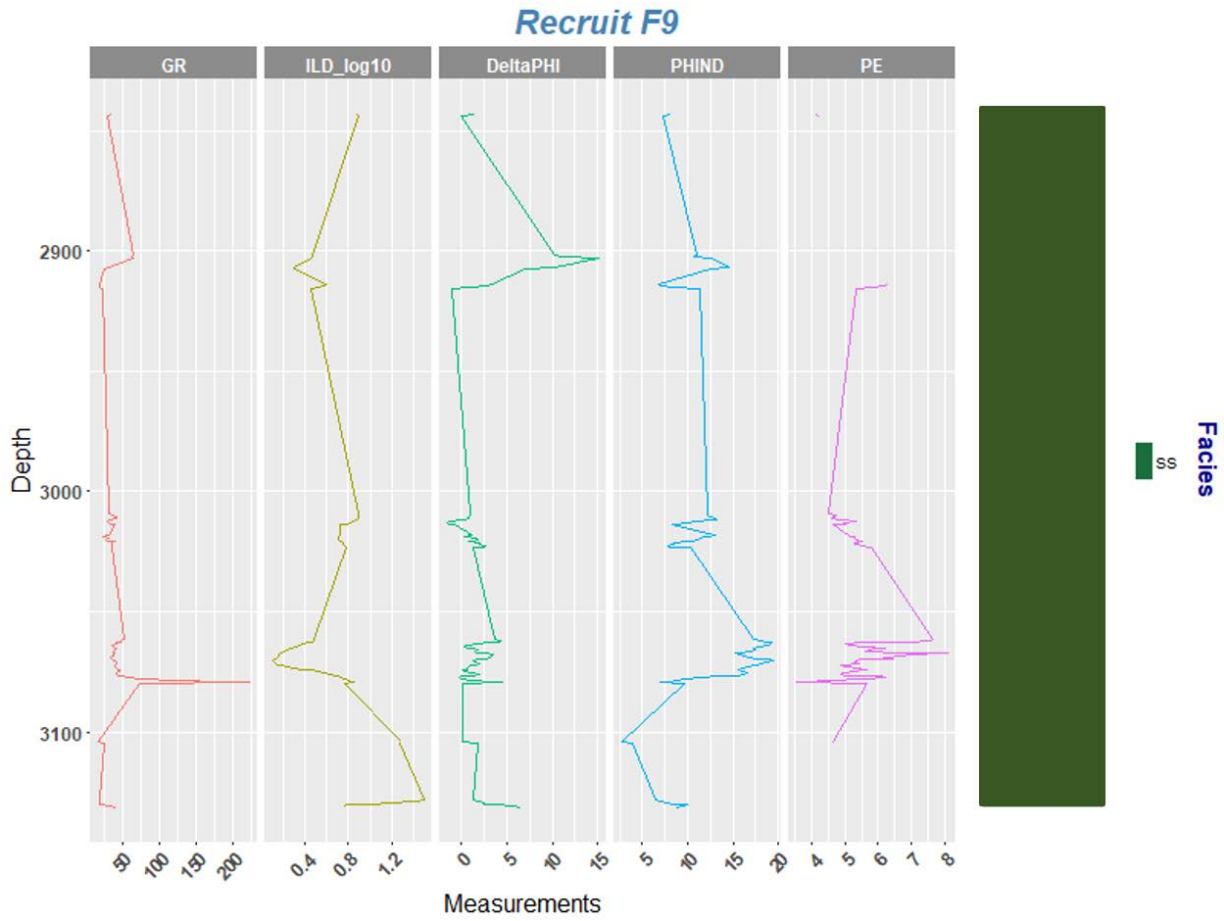
1. Gamma Ray (GR)
2. Resistivity (ILD_log10)
3. Photoelectric effect (PE)
4. Neutron-density porosity difference (DeltaPHI)
5. Average neutron-density porosity (PHIND)
6. Non-marine/marine indicator (NM_M)
7. Relative position (RELPOS)

Facies	Description	Label	Adjacent Facies
1	Nonmarine Sandstone	SS	2
2	Nonmarine coarse siltstone	CSiS	1,3
3	Nonmarine fine siltstone	FSiS	2
4	Marine siltstone and shale	SiSh	5
5	Mudstone	MS	4,6
6	Wackestone	WS	5,7,8
7	Dolomite	DPhi	6,8
8	Packstone-grainstone	PS	6,7,9
9	Phylloid-algal bafflestone	BS	7,8

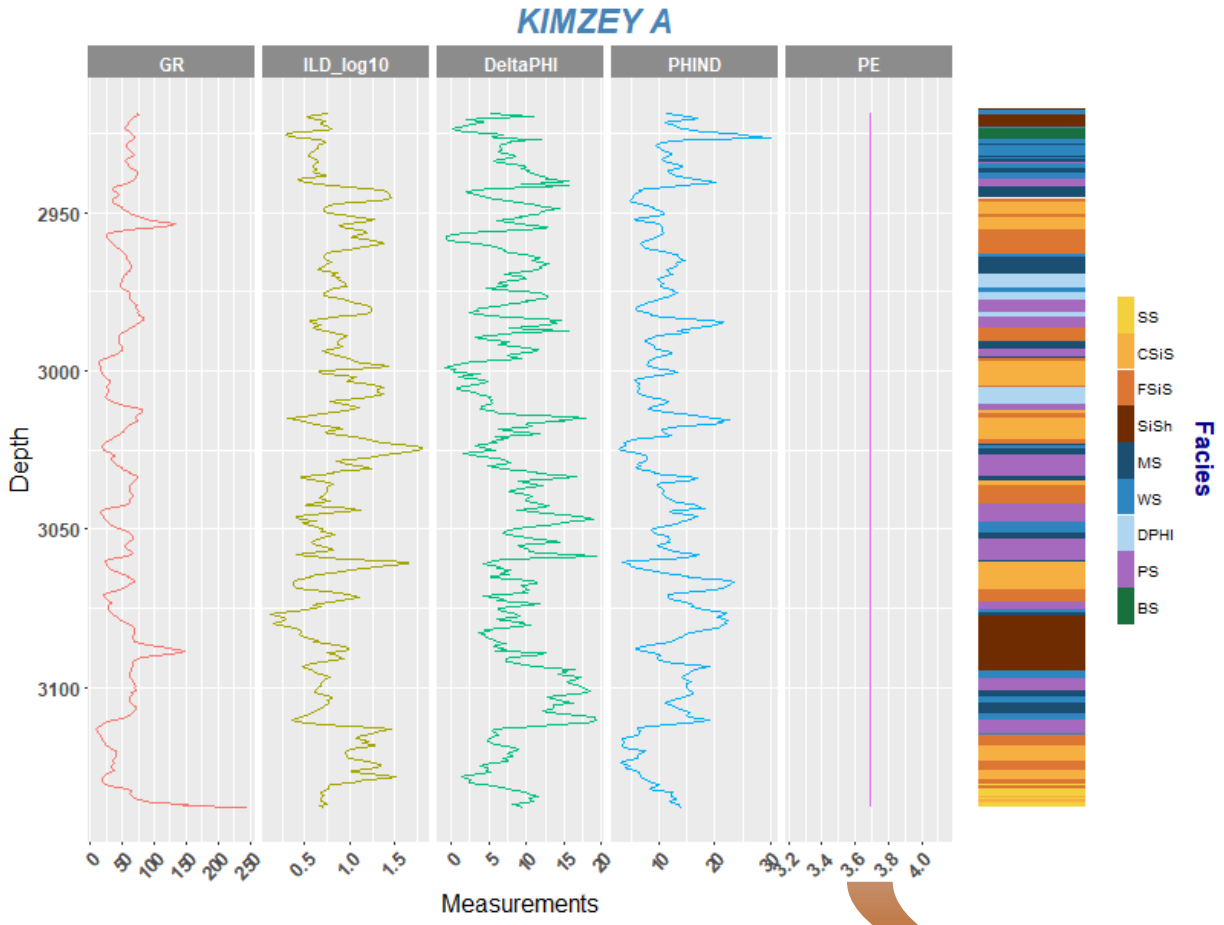
10 different wells

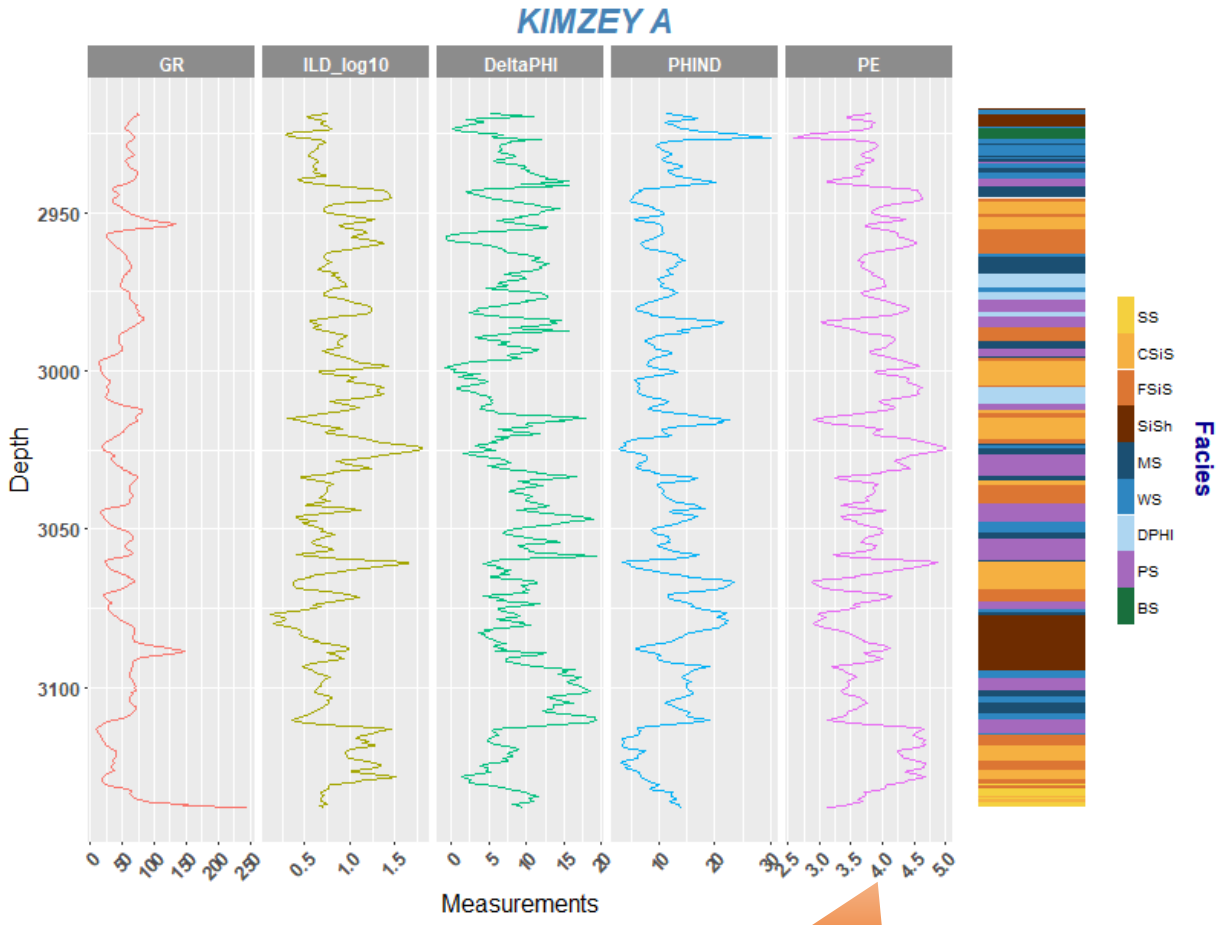
Facies Classification with Gradient Boosting





Facies Classification with Gradient Boosting



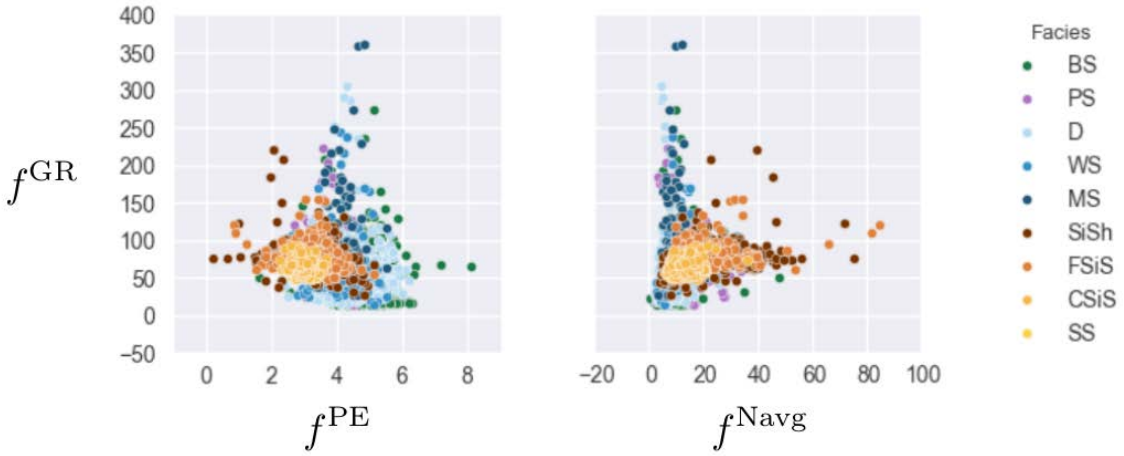


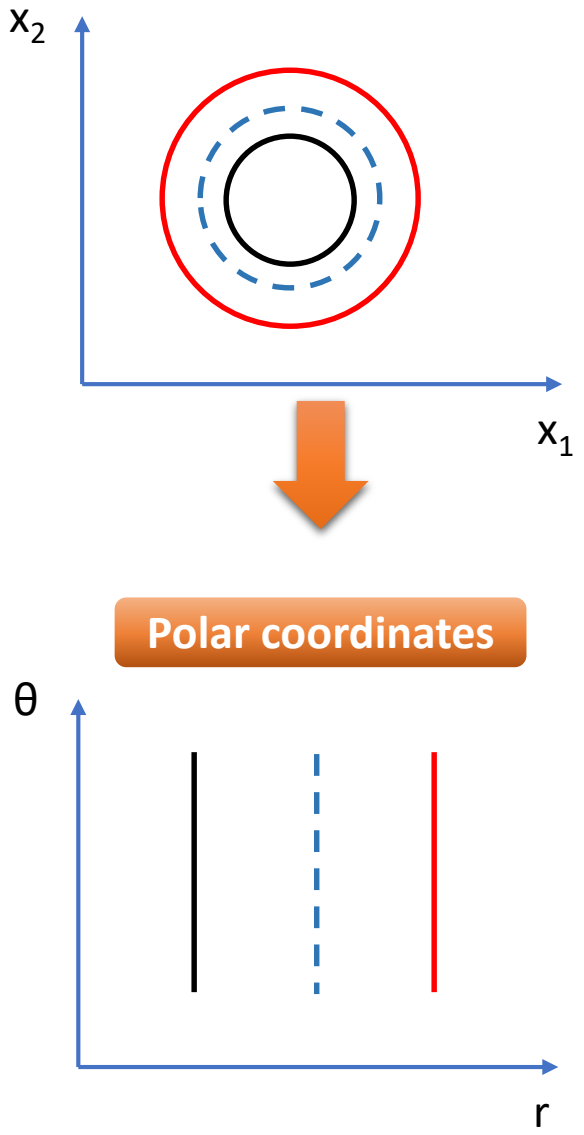
Linear Regression to complete missing data

Facies Classification with Gradient Boosting

Data Augmentation

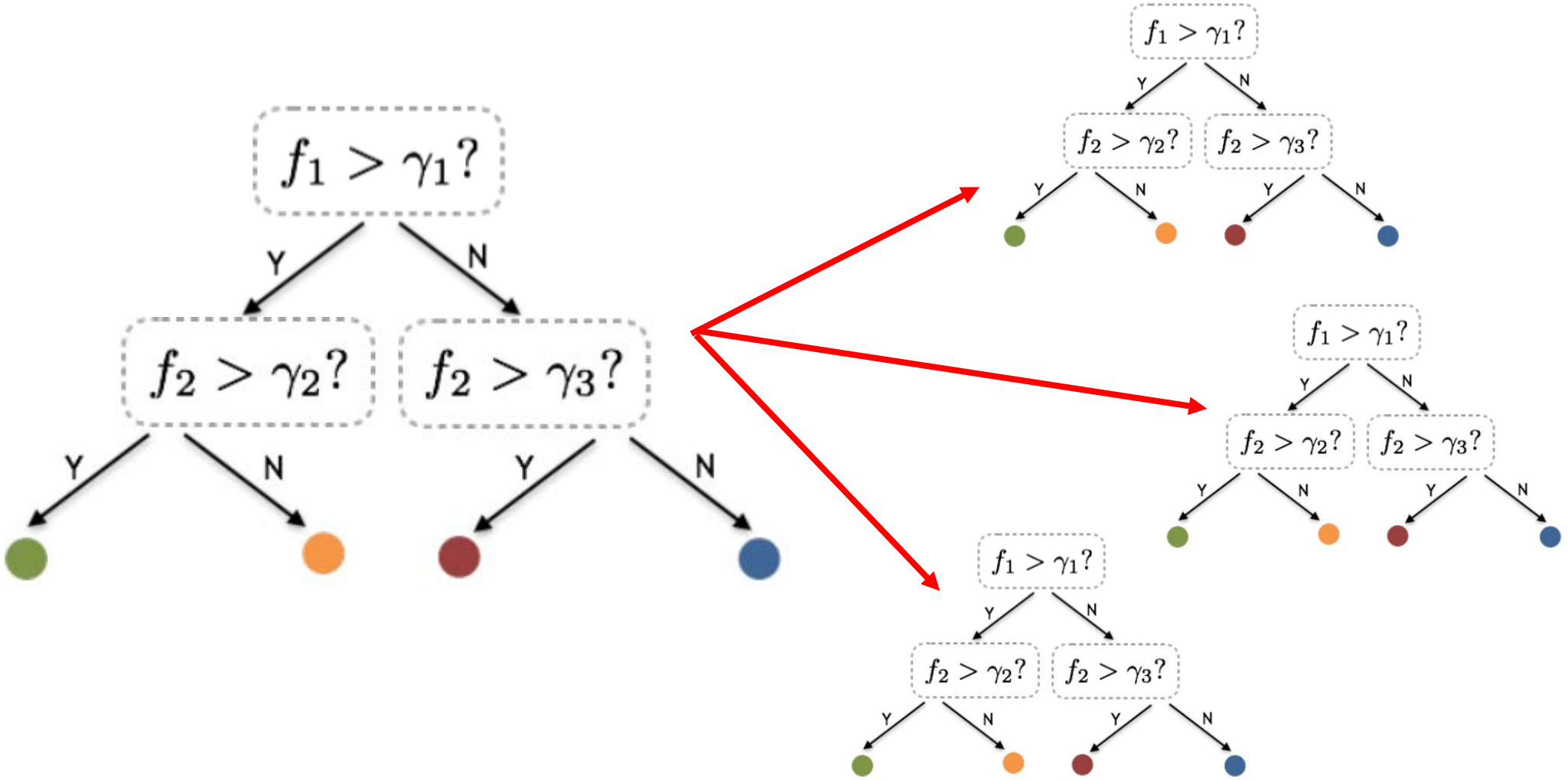
- Gradient
- Clustering



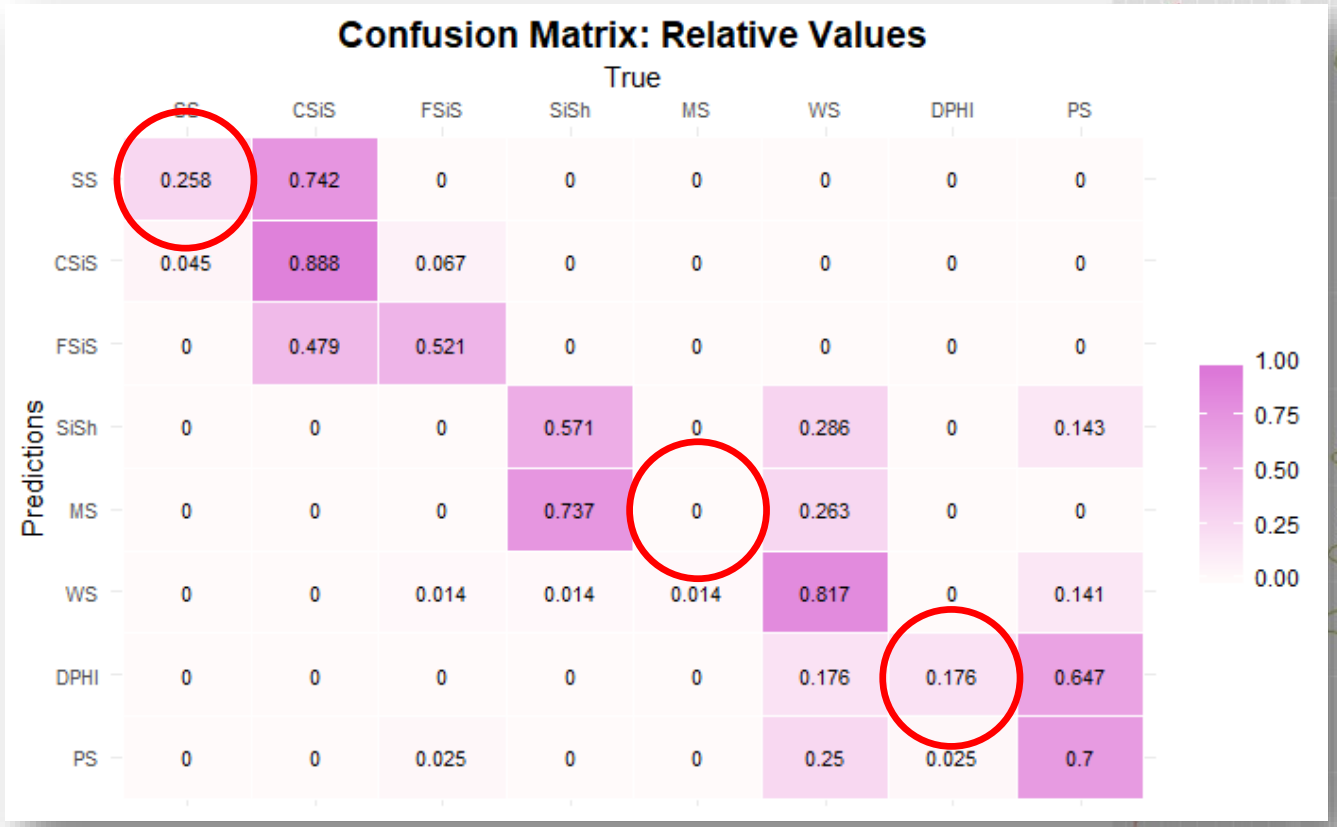


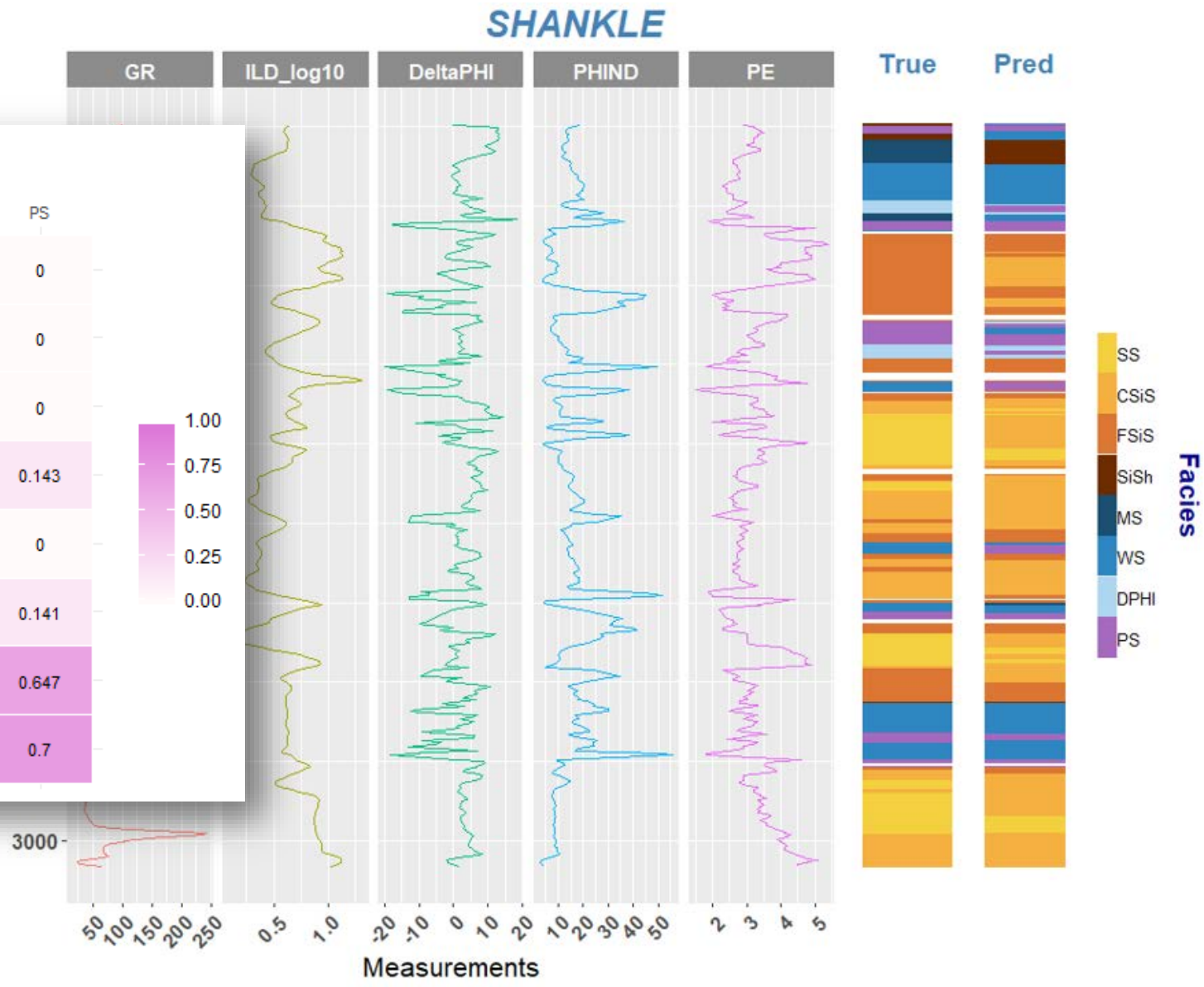
Facies Classification with Gradient Boosting

Classification > *Gradient boosting classifier* (an ensemble of *decision trees*)



Facies Classification with Gradient Boosting





60% accuracy

Salt Identification with Deep Learning

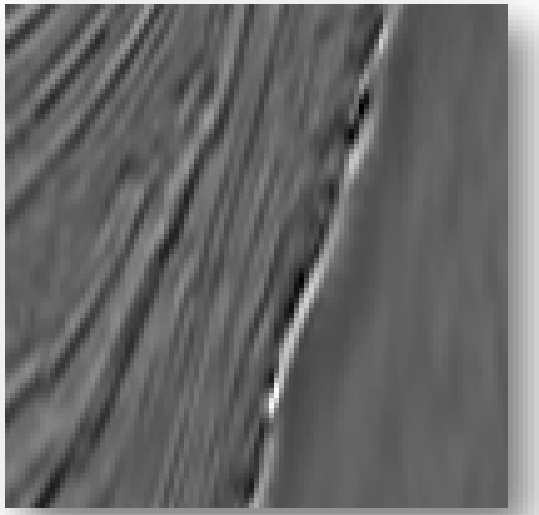
Salt Identification with Deep Learning

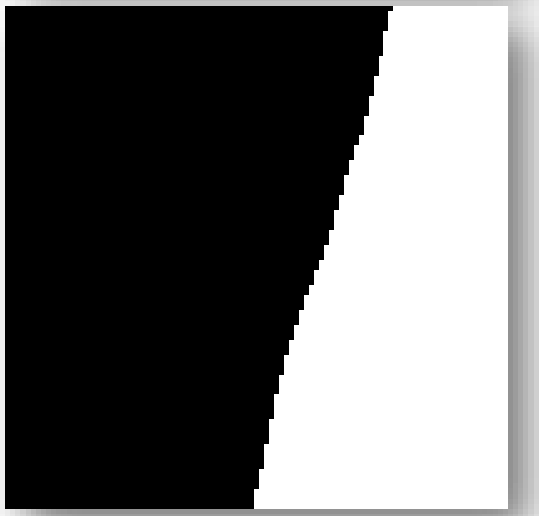
TGS Salt Identification Challenge on Kaggle:

https://www.kaggle.com/c/tgs-salt-identification-challenge

The goal is to use batches of seismic images to train a ML model that can predict salt bodies on not interpreted images

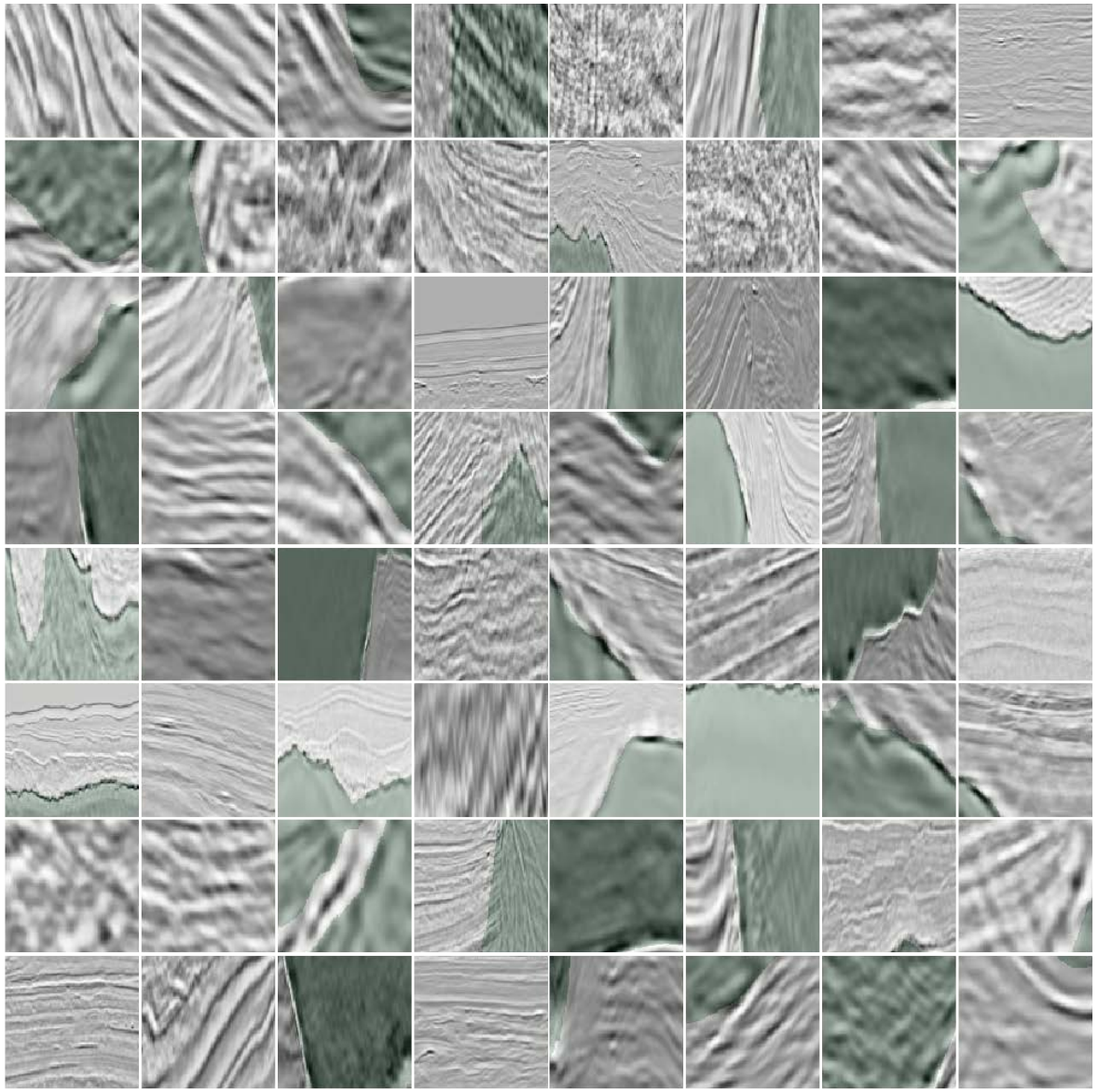
Salt Identification with Deep Learning





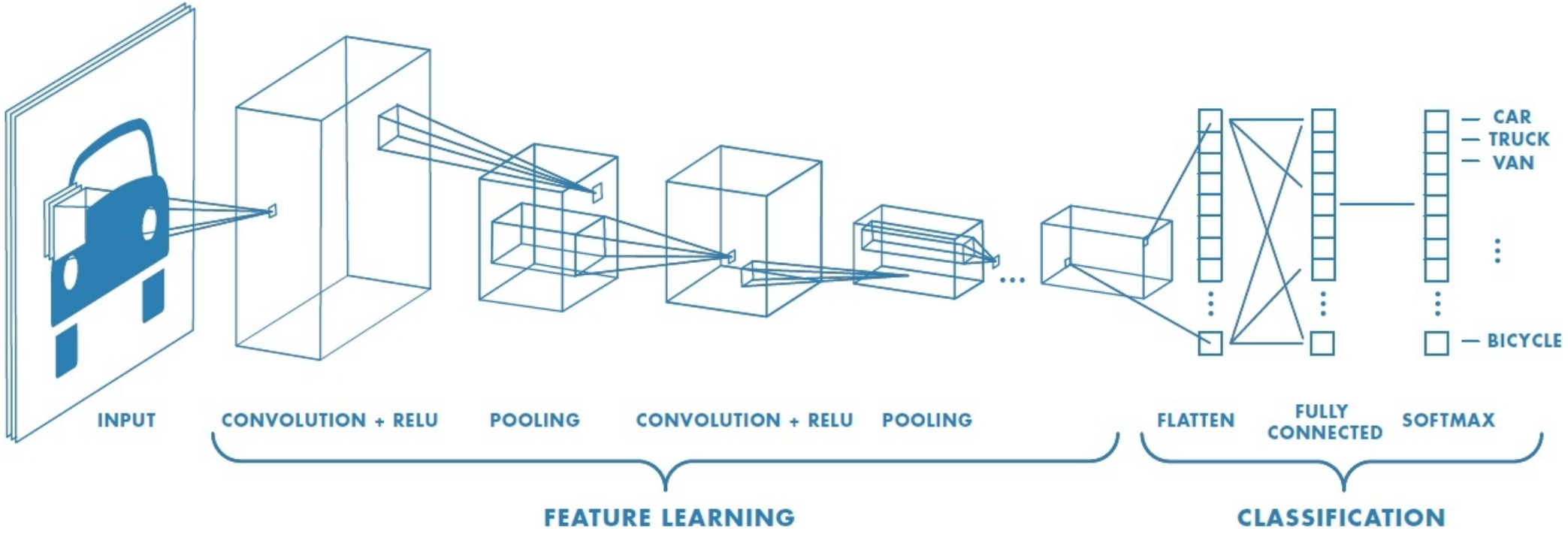
Seismic

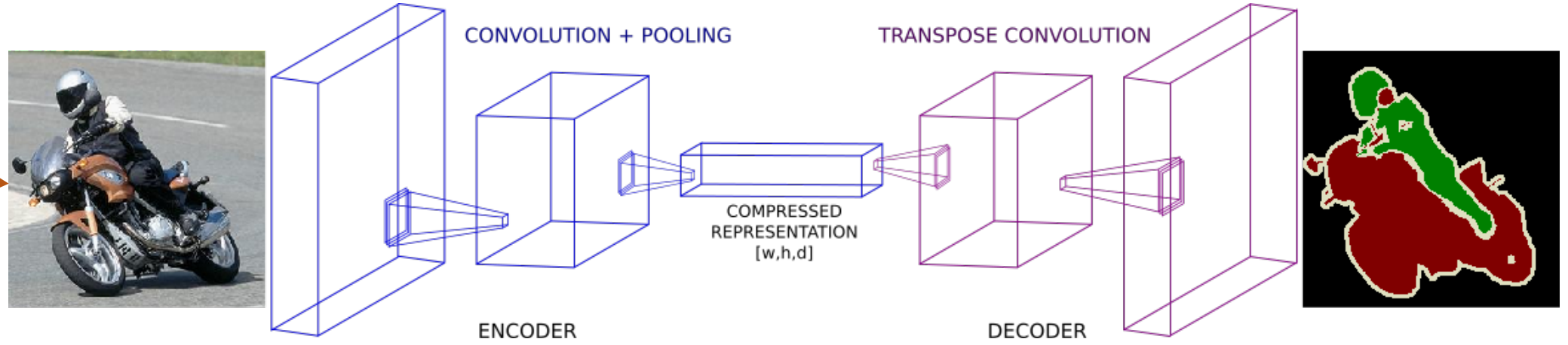
Mask



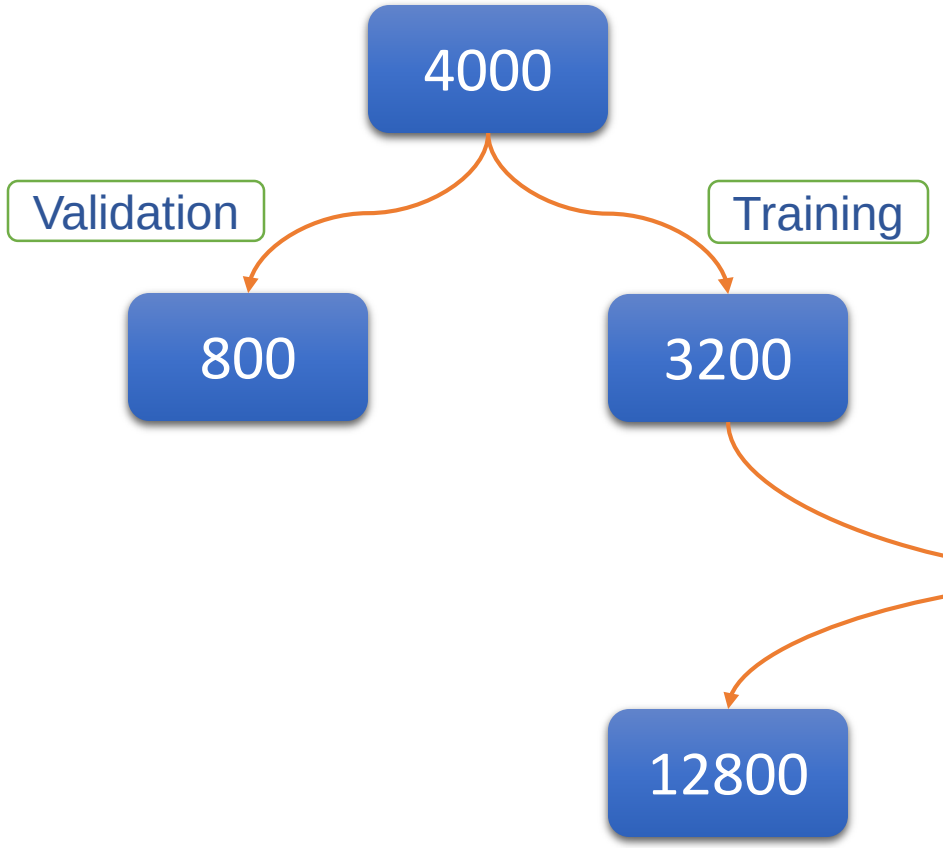
Salt Identification with Deep Learning

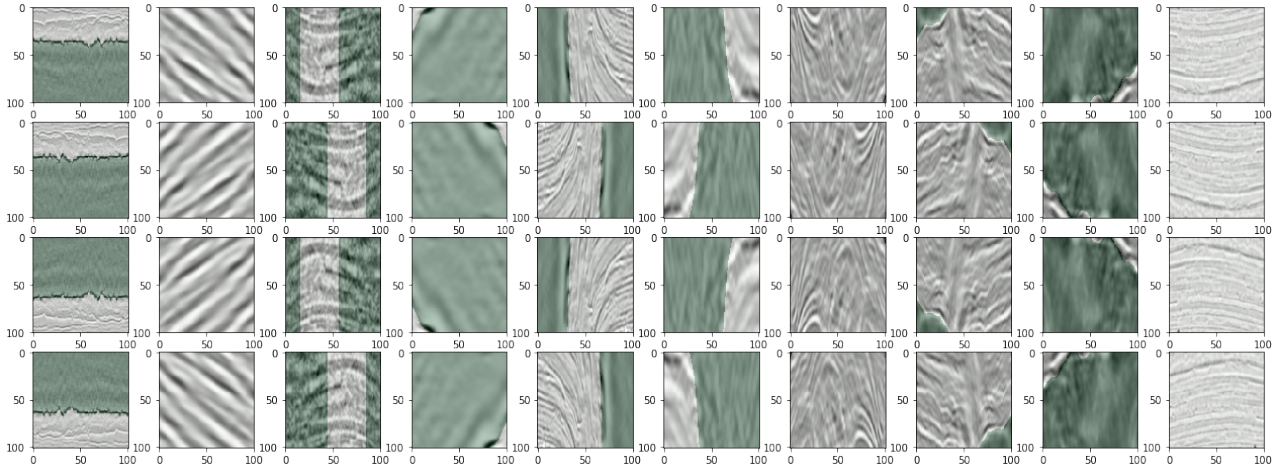
Modified Convolutional Neural Networks for pixel classification





Salt Identification with Deep Learning

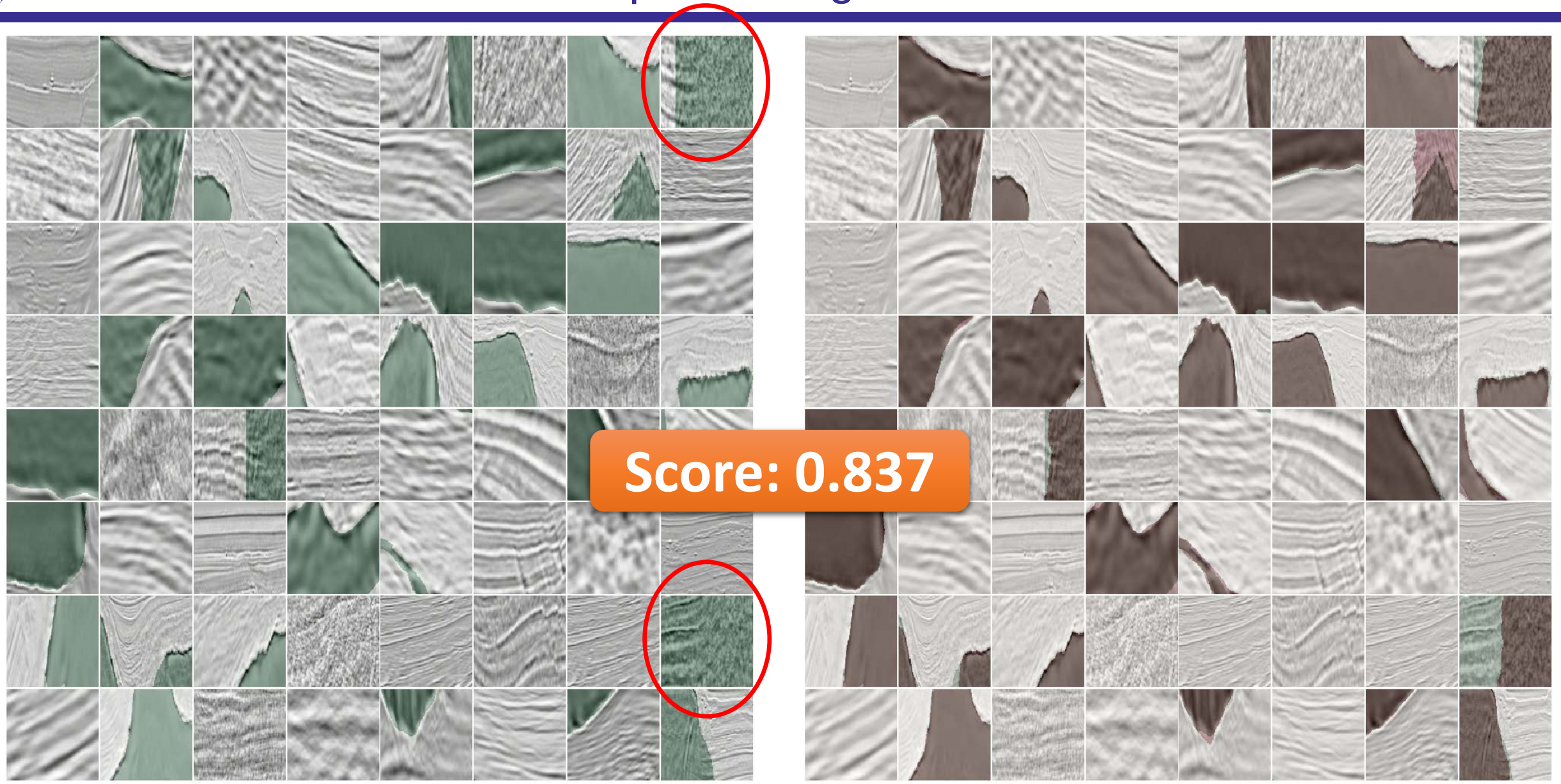




Augmented data

Helps on the model training

Salt Identification with Deep Learning



True (green) and predicted (red) labels. Purple(ish) is the overlap.

Conclusions

- Different applications
- Facies classification is 5 to 6 times more accurate than random guess
- Salt identification model has high accuracy
- Data limitation:
  - Quantity
  - Quality

Acknowledgments

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Thank you!!!