AMIDST

Analysis of Massive Data STreams

Use Cases in Drilling Domain

Sigve Hovda

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Principal Research Engineer, Verdande Technology

Greetings from Norway!

Outline

1. Automatic Formation Detection
2. Mechanical Specific Energy

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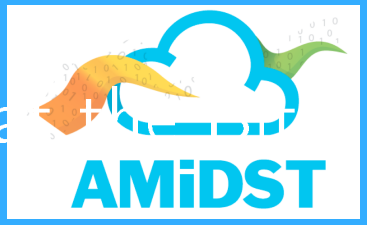
Motivation for Automatic Formation Detection a



- Optimization of casing positions

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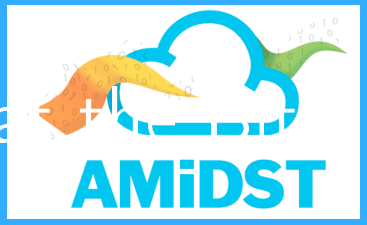

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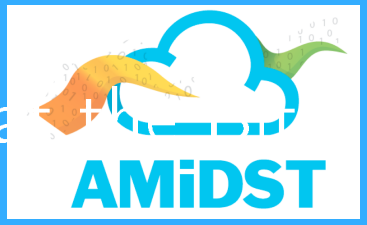

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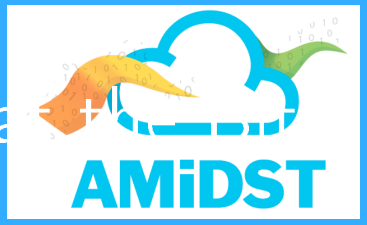

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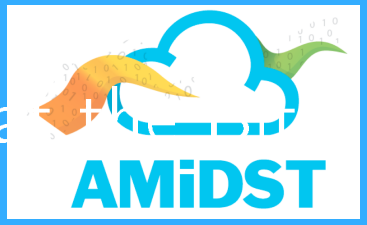

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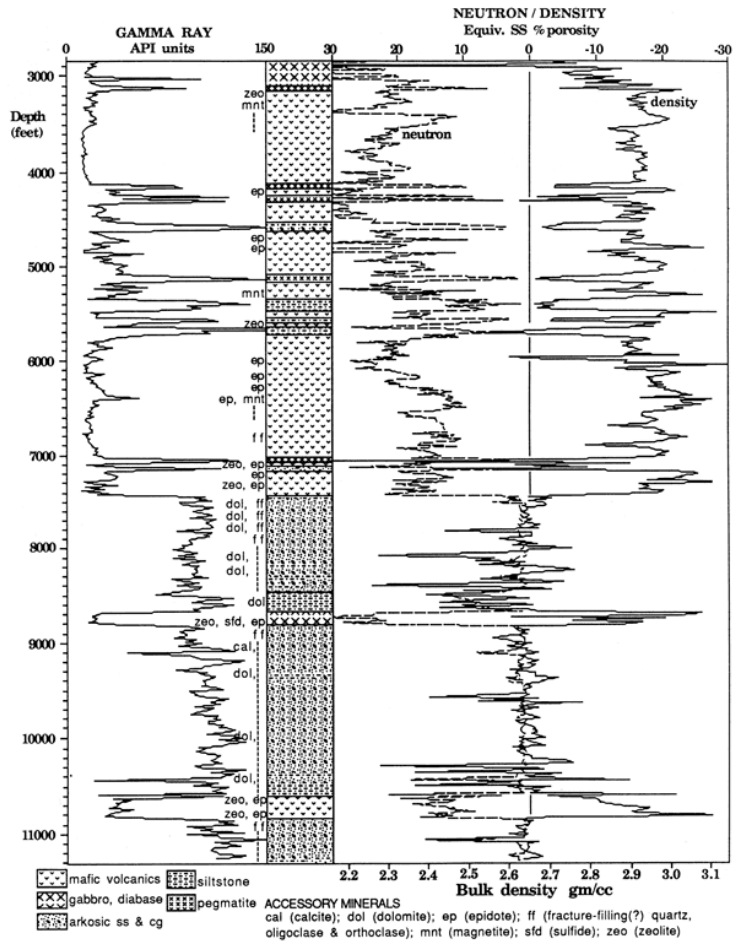
- Optimization of casing positions
- Identification top and bottom of reservoir
- Optimization of drilling parameters
- Detection of drilling inefficiencies (with MSE)
- Better diagnostics of improper hole cleaning, instability and vibration issues
- Important step on the path to automation

Current Solution to Formation Detection

- Manual inspection of:
  - Petrophysical measurements from the LWD tool
  - Drilling parameters at the bit
  - Cuttings analyses at lag depth
  - Lithology chart



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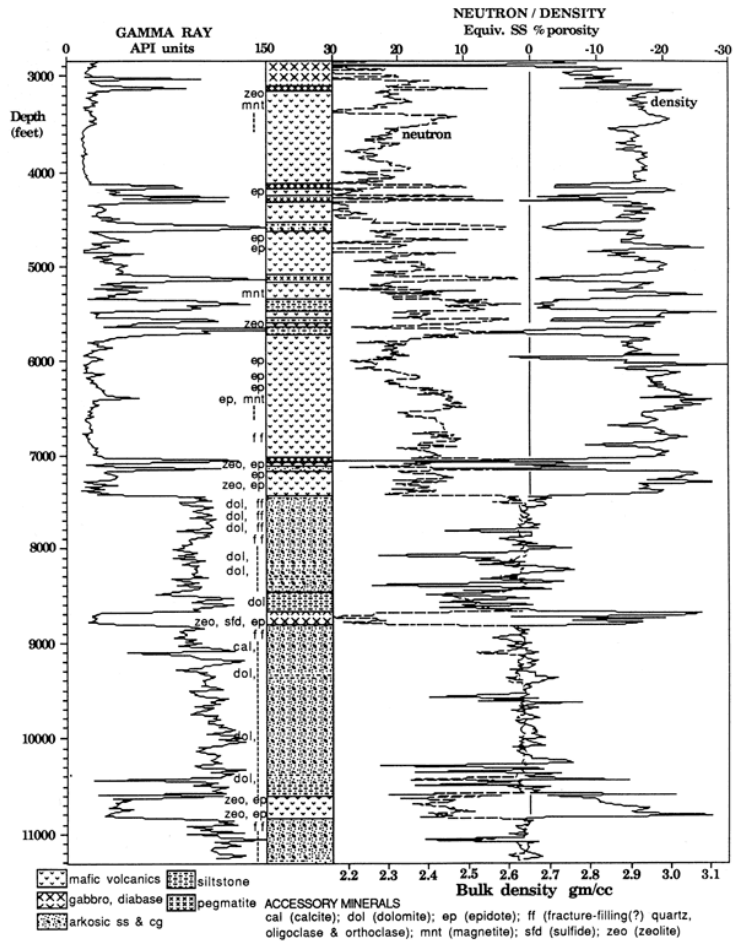

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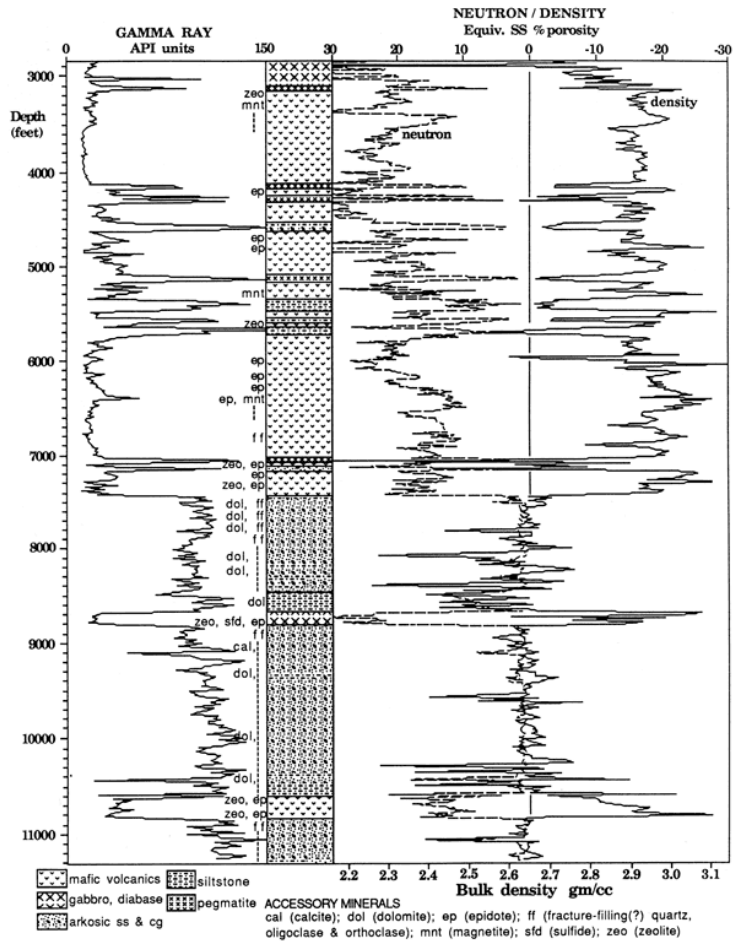

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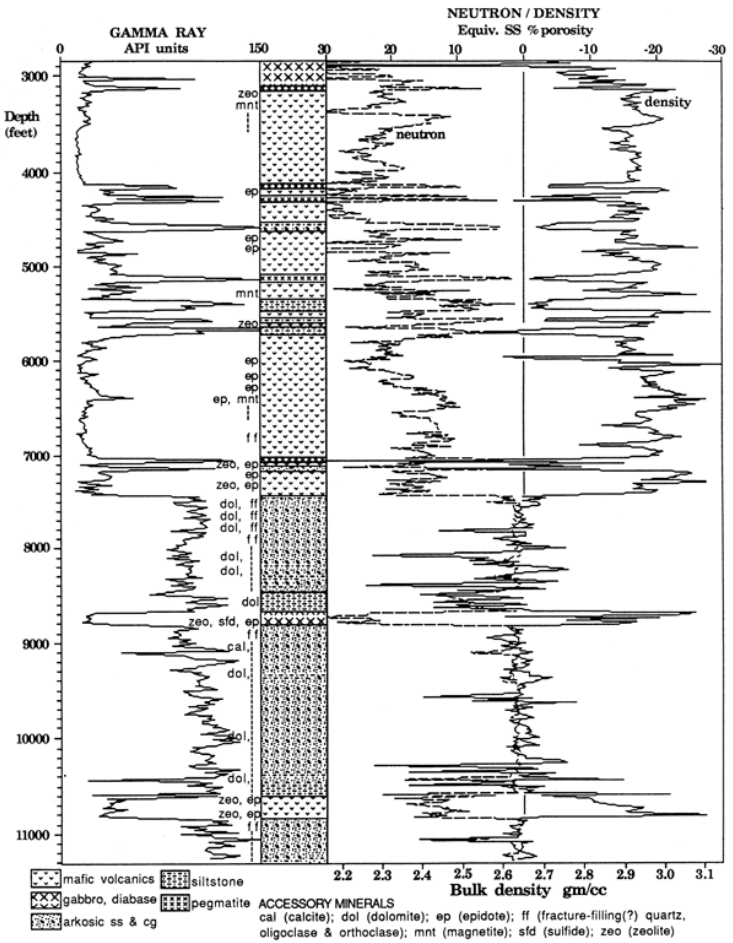

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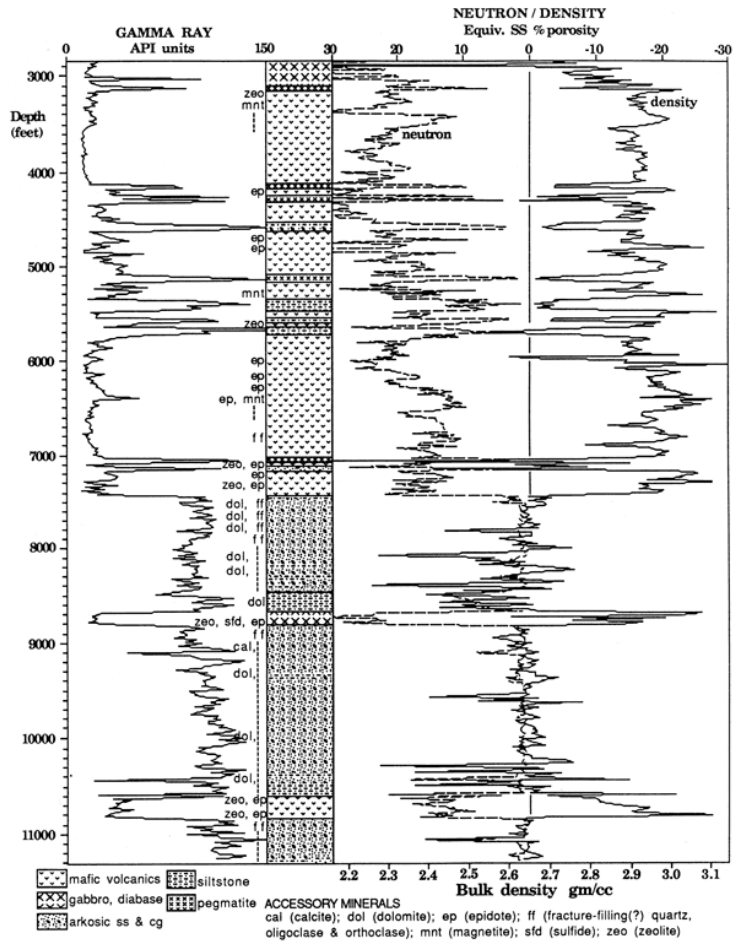

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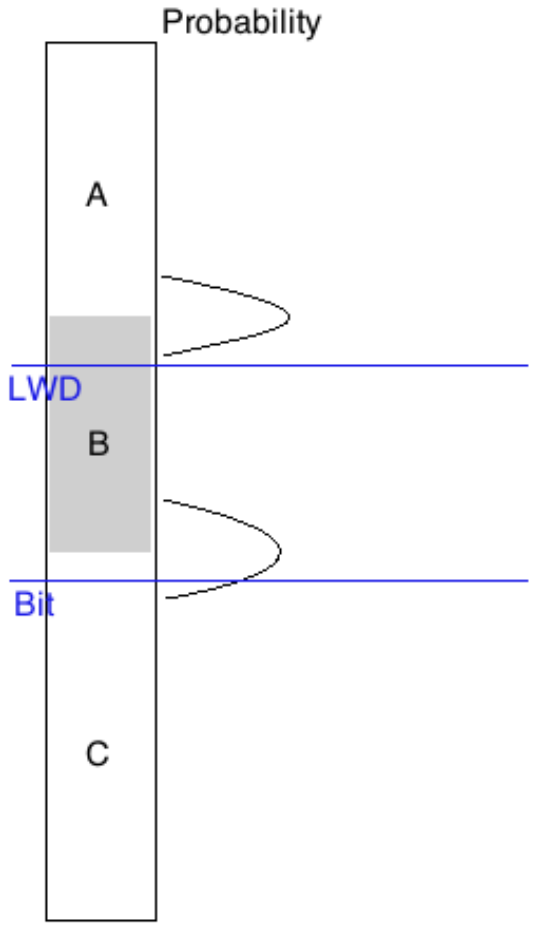

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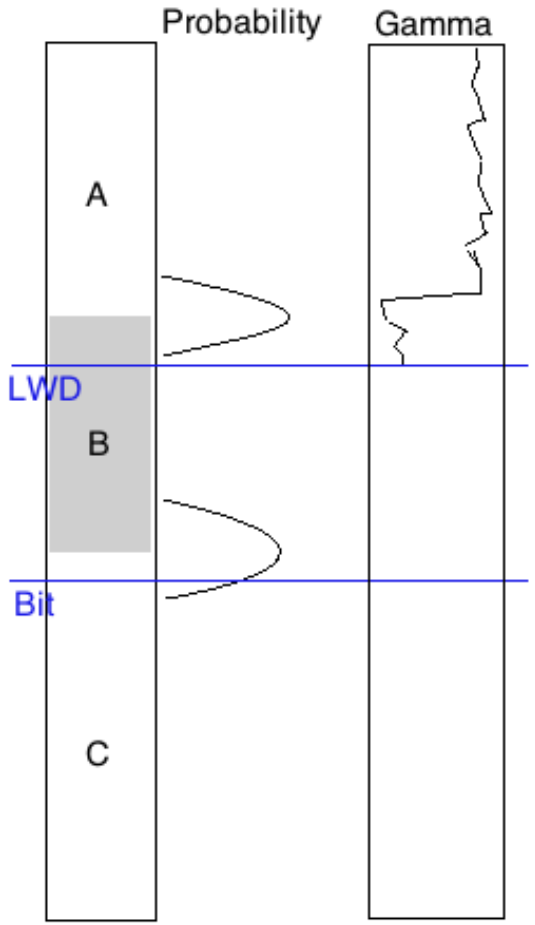

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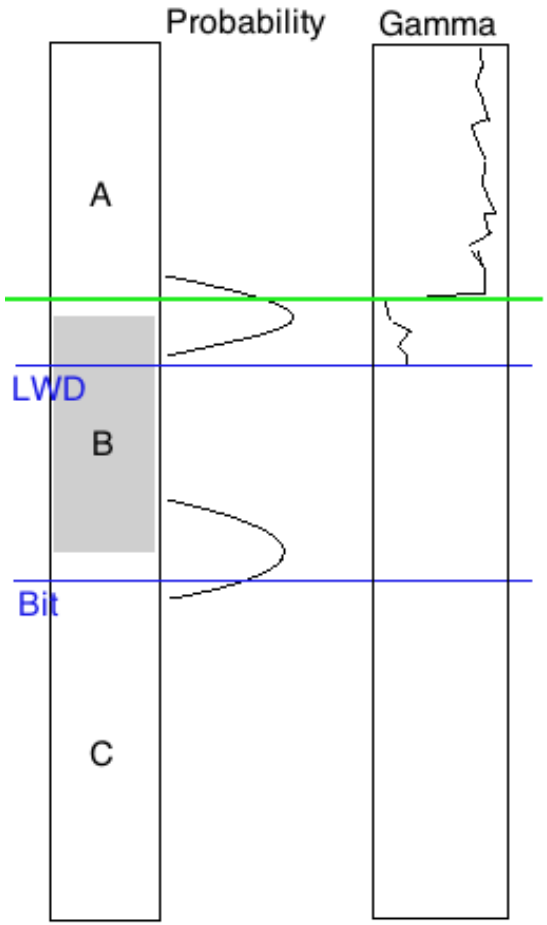

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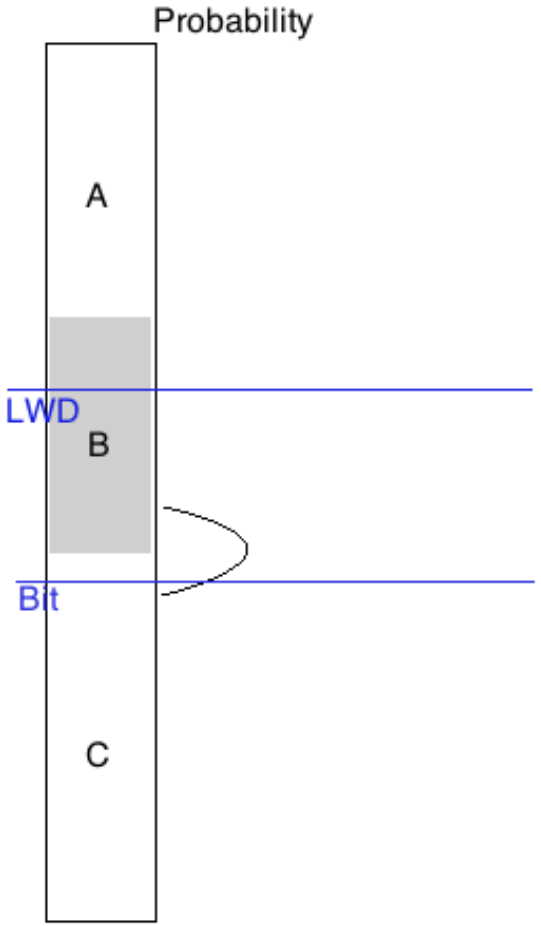

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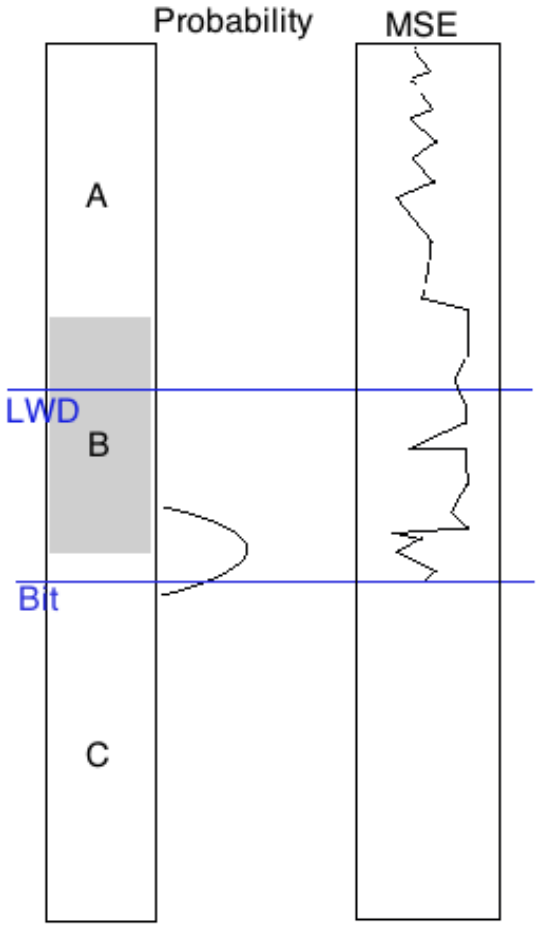

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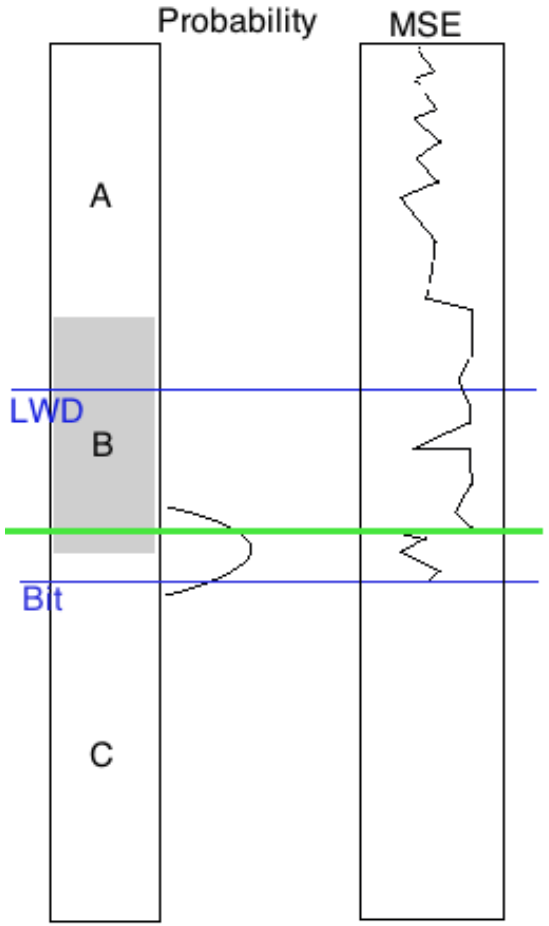
  - Decide what is the most likely lithology chart above the bit



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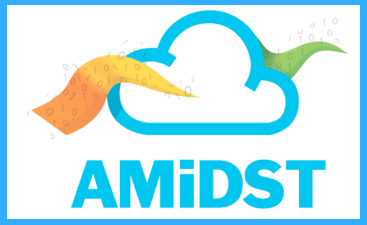

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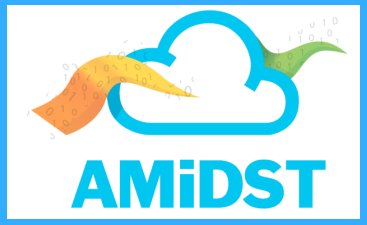

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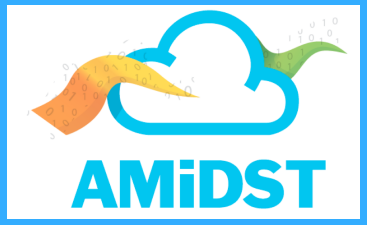
- And there are data driven approaches...

Data Driven Approach to Formation Detection



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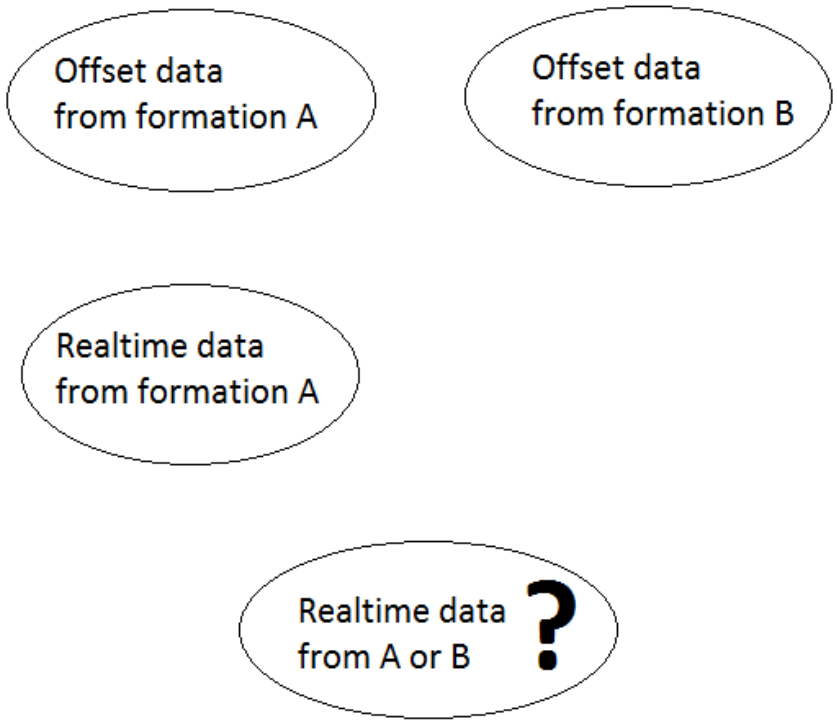
- Classification problem



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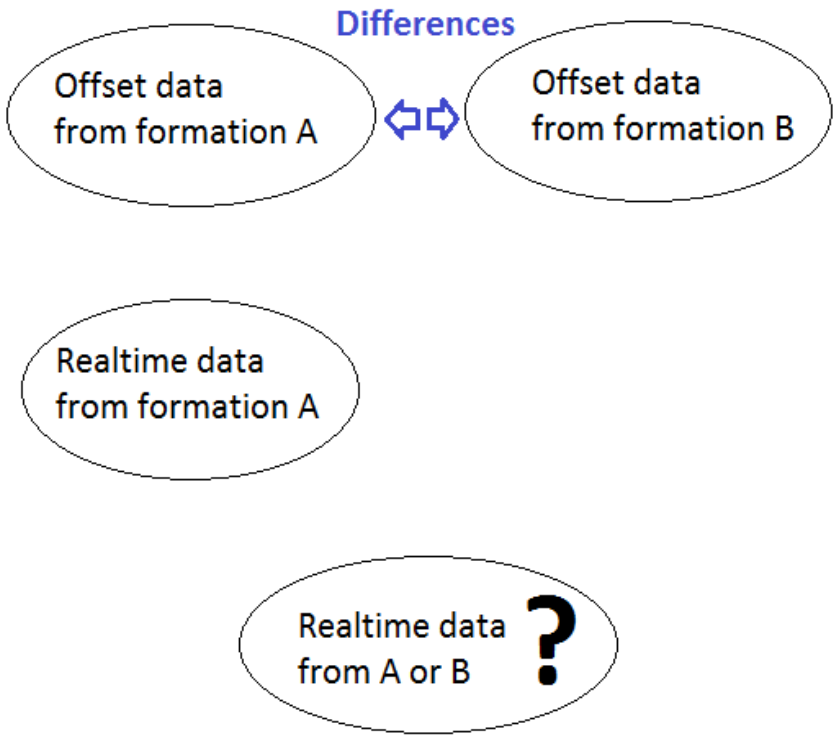

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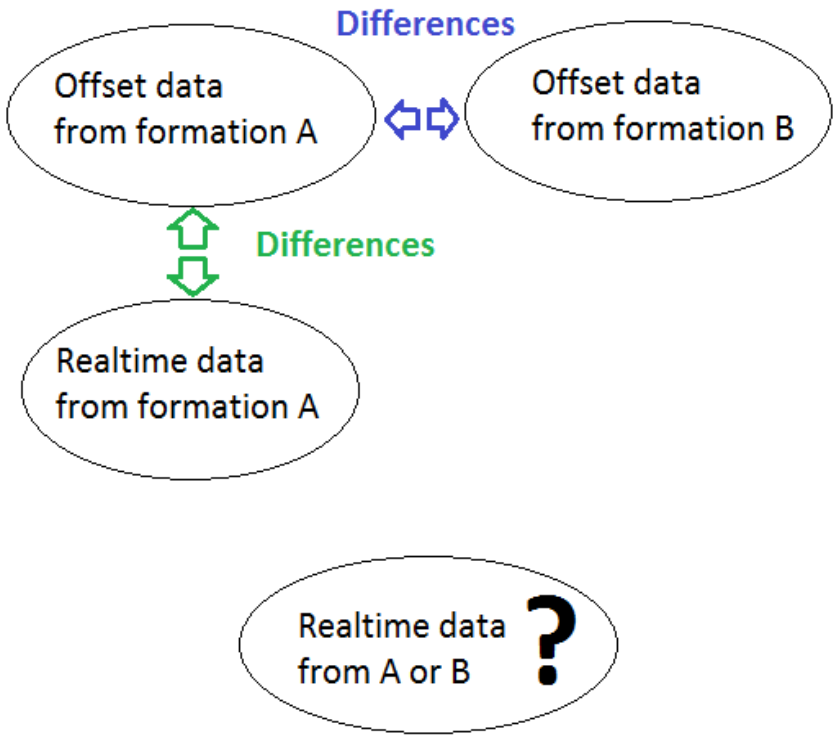

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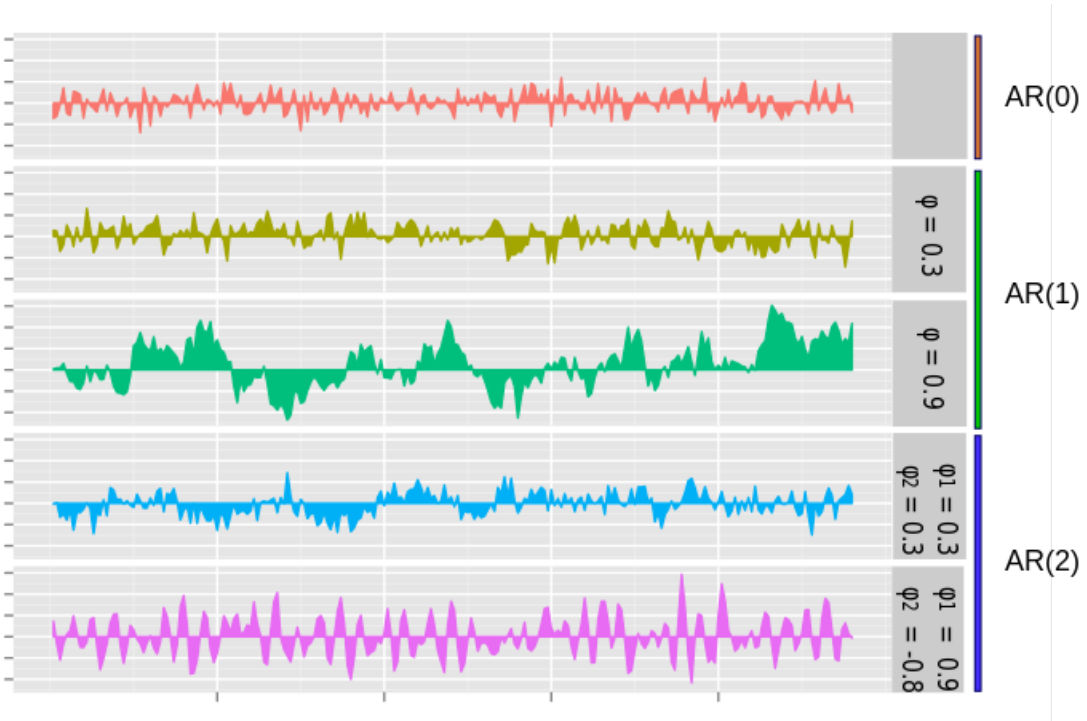

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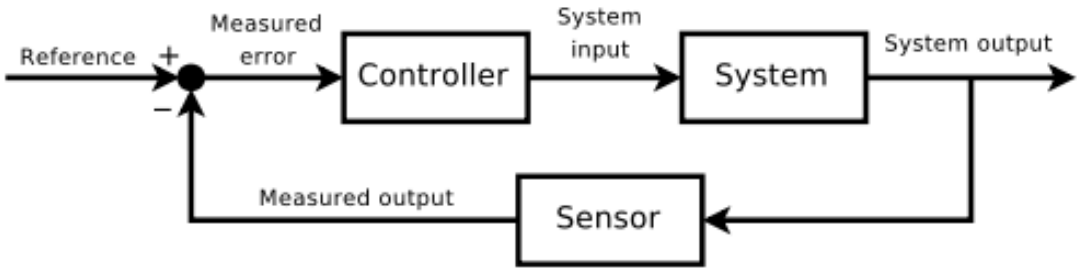

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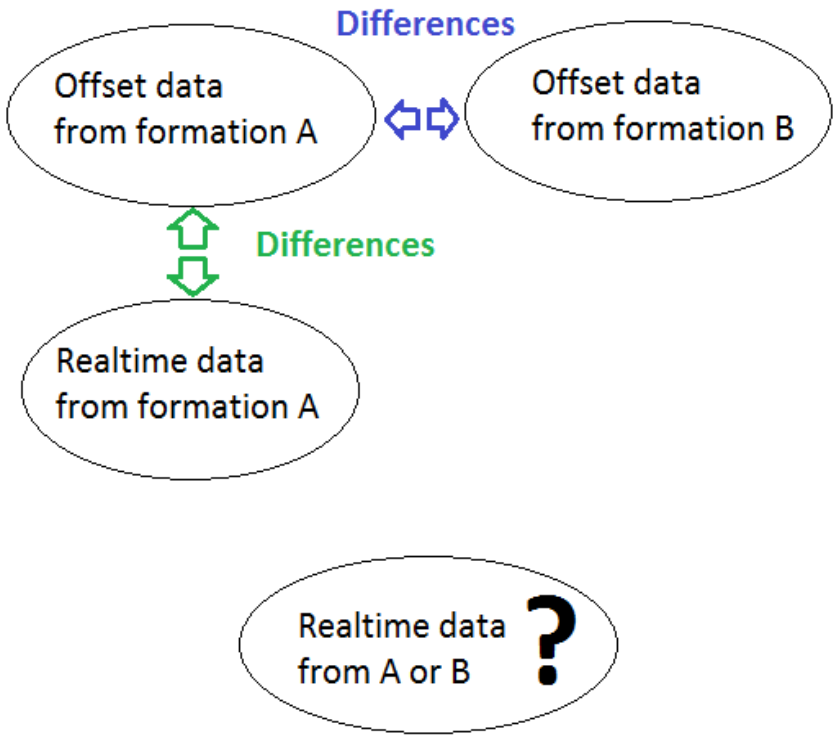

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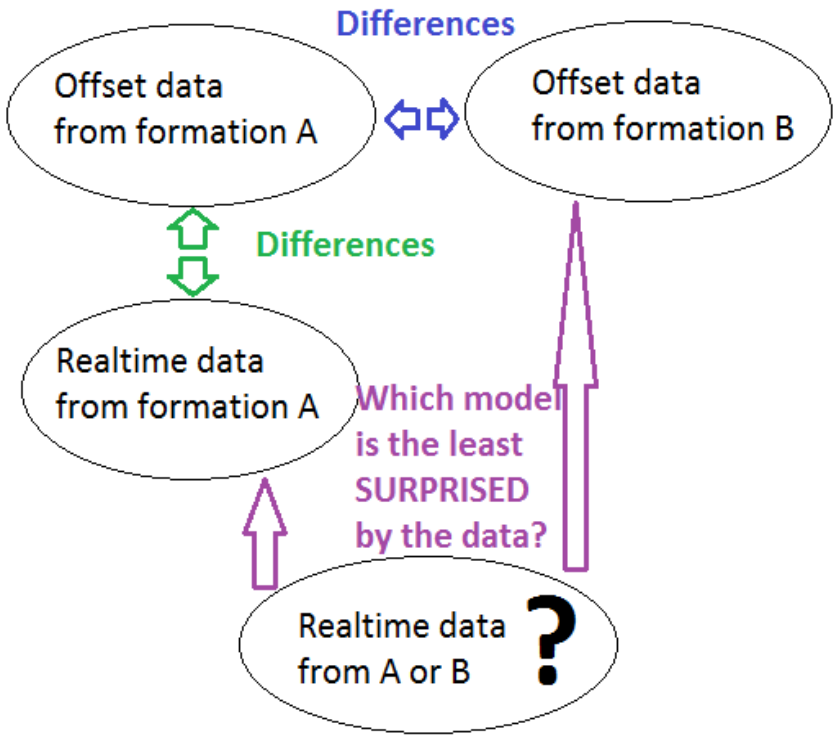

Outline

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2 Mechanical Specific Energy

Mechanical Specific Energy MSE

- Definition:

$$MSE(d) = \frac{\sum_{k \in S} W_k d_k + \frac{\pi}{30} \sum_{k \in S} T_k N_k t_k}{\pi r^2 \sum_{k \in S} d_k}$$

S is set of data points that are measured less than a distance $b/2$ from the current depth d. d_k and t_k are depth and time increments. W_k, T_k and N_k are weight, torque and rotation speed at measurement k.

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- MSE is a measure of compression strength of the formation, but also how effective the drilling operation is.

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- Challenges with this measure:
  - What is downhole torque? Estimate from surface or differential pressure?
  - Drifting of WOB. When is it calibrated?
  - How to set the smoothing parameter b?

Optimizing smoothing parameter for MSE

- Definition of normalised RMS-measure:

$$RMS = \frac{\sum_{i=1}^{n}(S_i - f(MSE_i))^2}{\sum_{i=1}^{n}(S_i)^2}$$

S_i is sonic measurements (or equivalent) at i and f is some monotone function.

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- RMS is a measure of how well the shape of MSE fits the shape of the sonic data.
- Advantages:
  - More intuitive interpretation of MSE graphs when compared with downhole data.
  - Potential input to formation detection at the bit algorithm.

This project has received funding from the European Union's Seventh Framework Program for research, technological development and demonstration under grant agreement no 619209