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SPE Summit: AI – The Next Evolution of DDAA

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Practical Machine Learning Workflow to Better Understand ESP Failures

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What's the Story?



Total Field
11
Fields

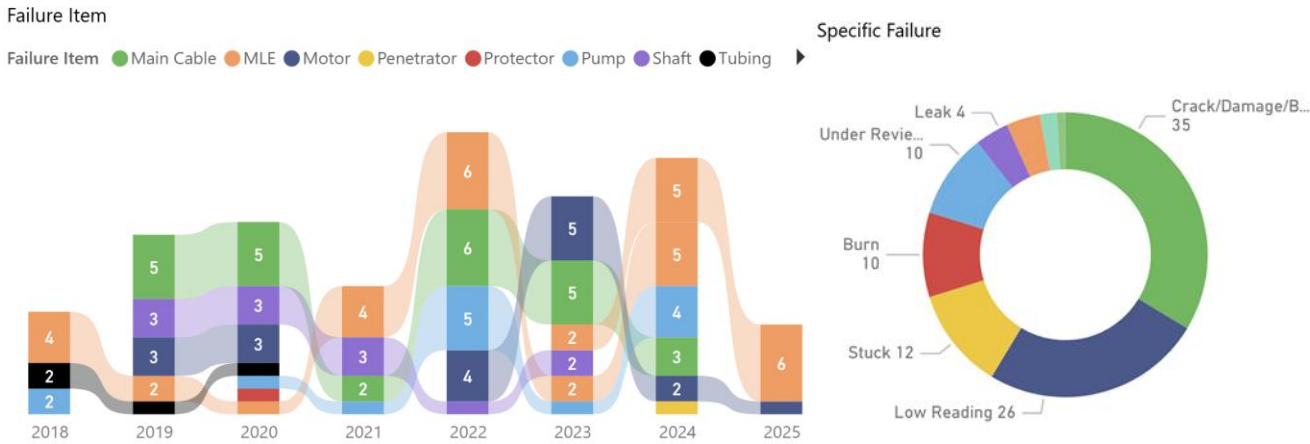
Total Well
154
Wells

Total Active
127
ESP Wells

82% of wells utilize **ESP for artificial lift**

CURRENT CHALLENGE

- × Delayed failure logging
- × Unplanned shutdown cause lost production
- × Insufficient Equipment Readiness



OPPORTUNITY

- ✓ **Predict failure** before they happen
- ✓ Ensure **better preparation** of equipment for the DHP job

SOLUTION = ML ESP FAILURE CLASSIFICATION

Solution

Target

Improve Uptime | Enhance Production Reliability | Cost Savings



Automate Failure Loging to improve data accuracy and sensor data (Ampere, Volt, Frequency)

Use Machine Learning to detect early failure

Improve Remote Monitoring

Implement classification Maintenance based on performance data

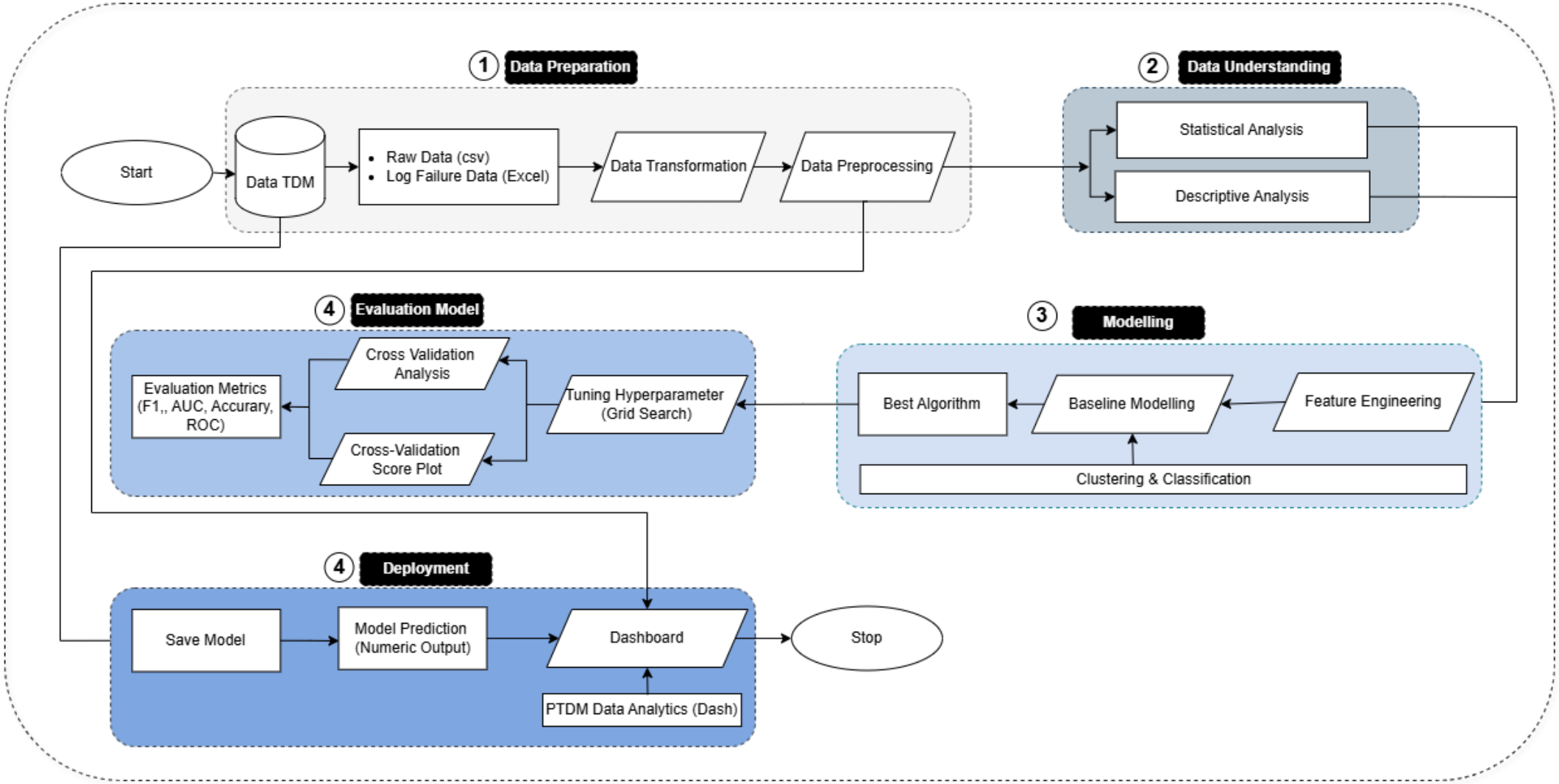
Leverage Analytics Dashboard for proactive decision-making

Reduce Unplanned Shutdowns by taking preventive actions

Automate Reporting by generate reports in real time

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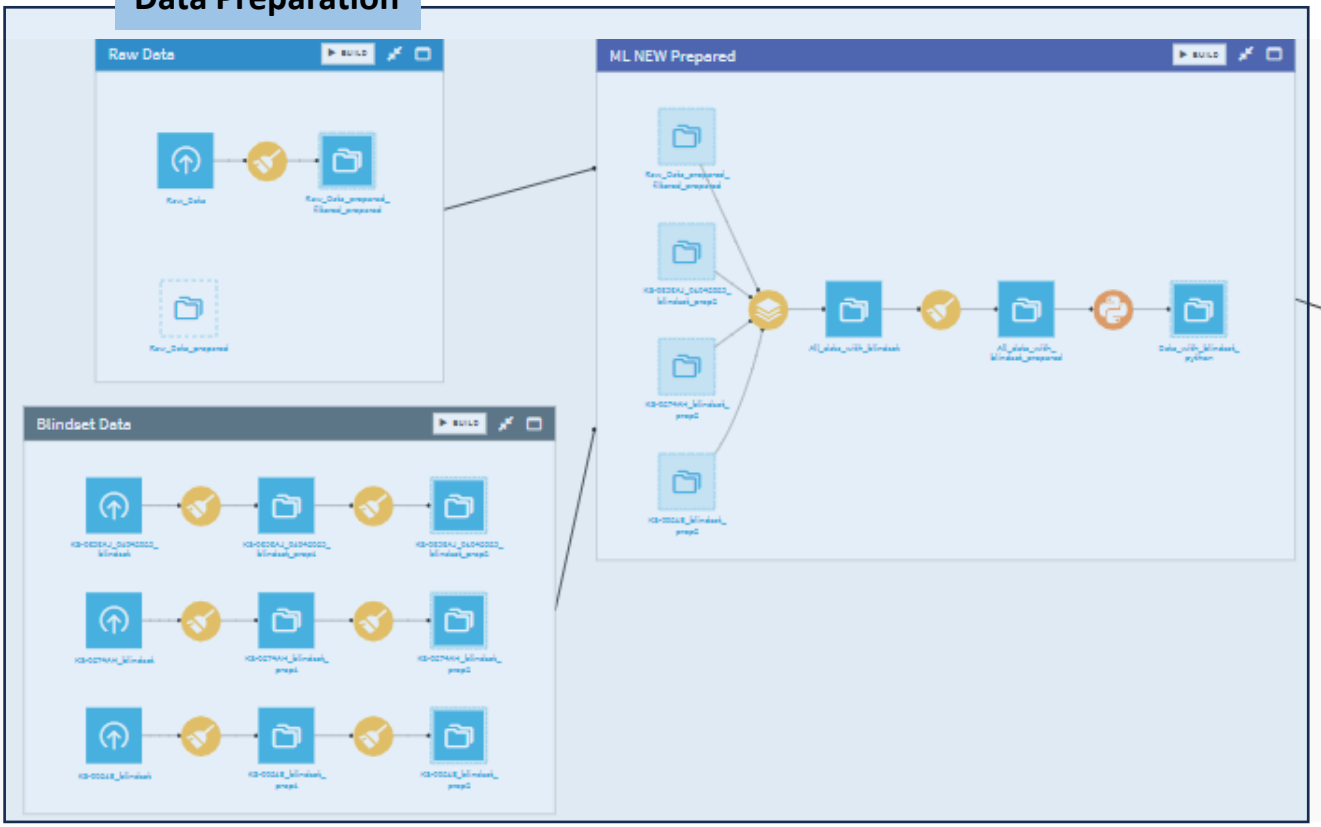
Methodology



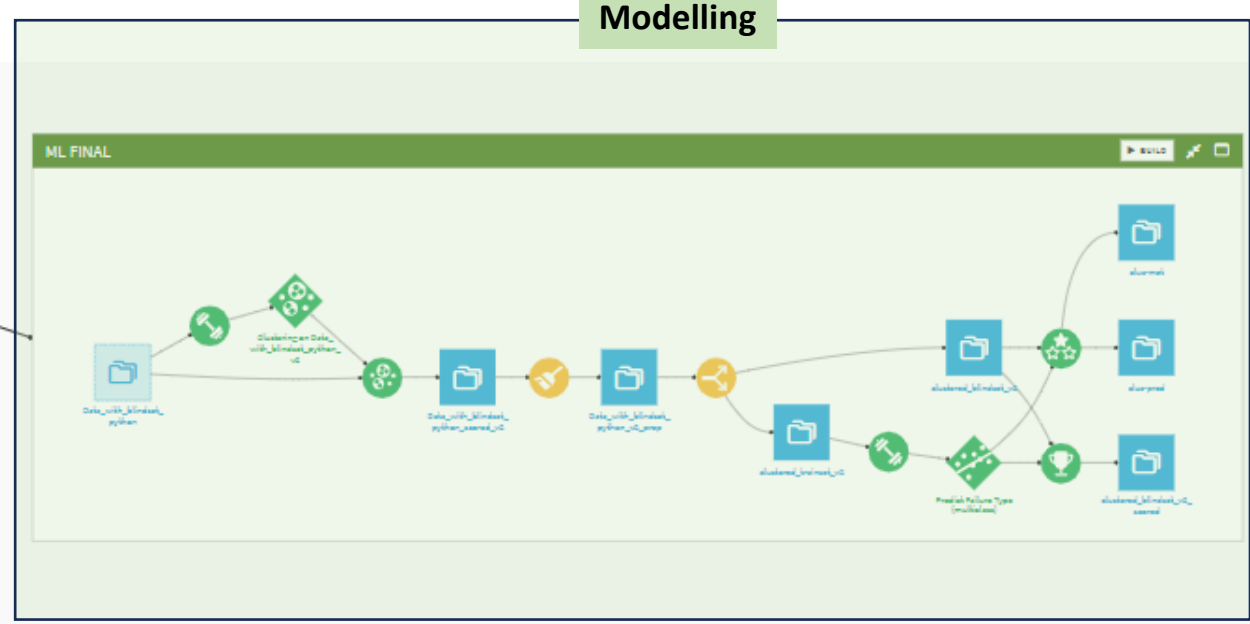
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Dataiku Workflow

Data Preparation

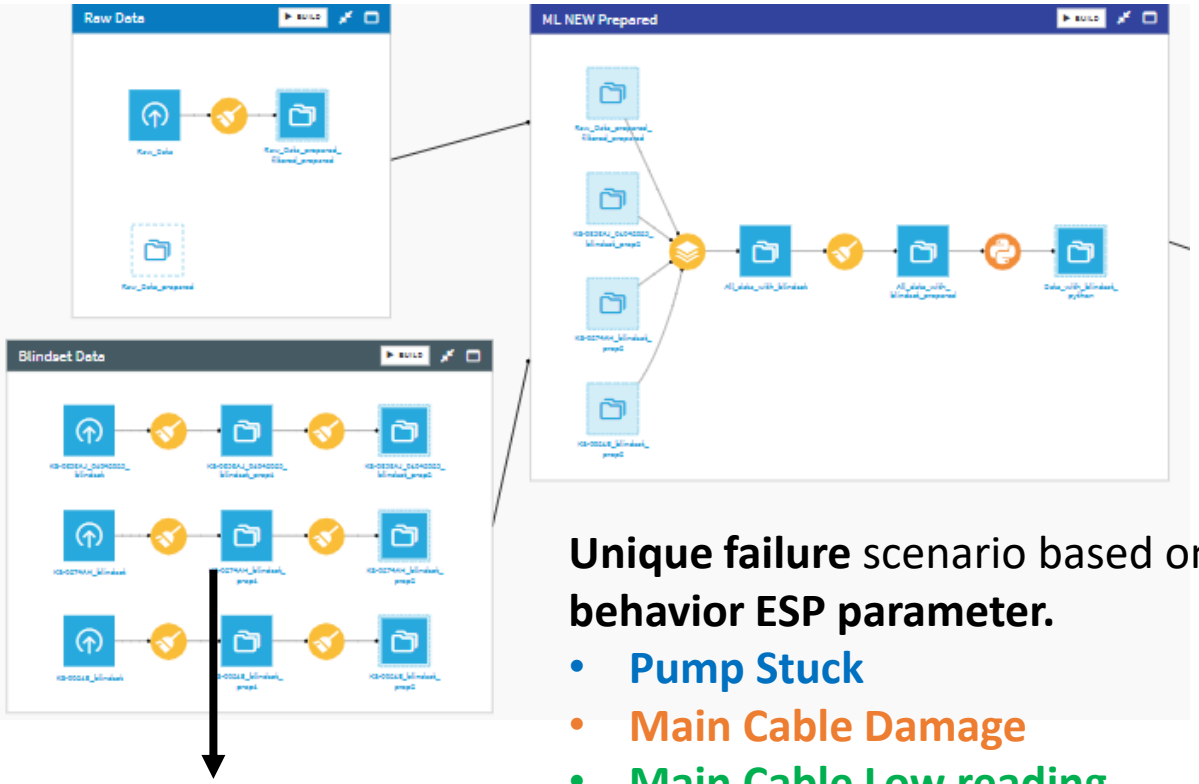


Modelling



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Dataiku Workflow – Data Preparation



Prepare other well for blind test

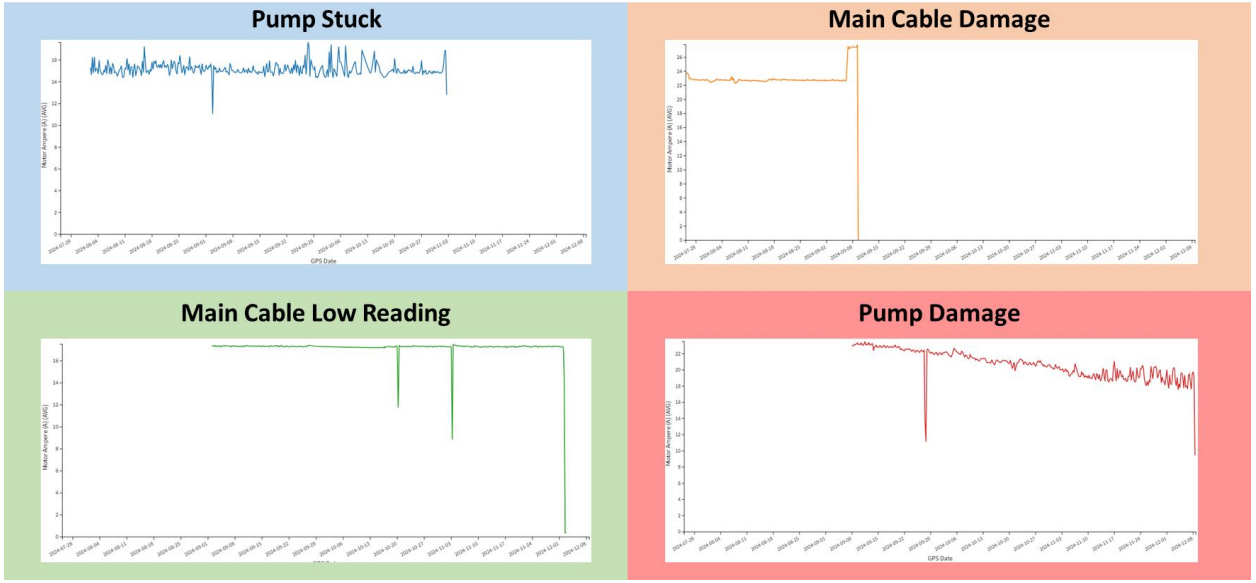
Unique failure scenario based on **behavior ESP parameter.**

- **Pump Stuck**
- **Main Cable Damage**
- **Main Cable Low reading**
- **Pump Damage**
- **Other**

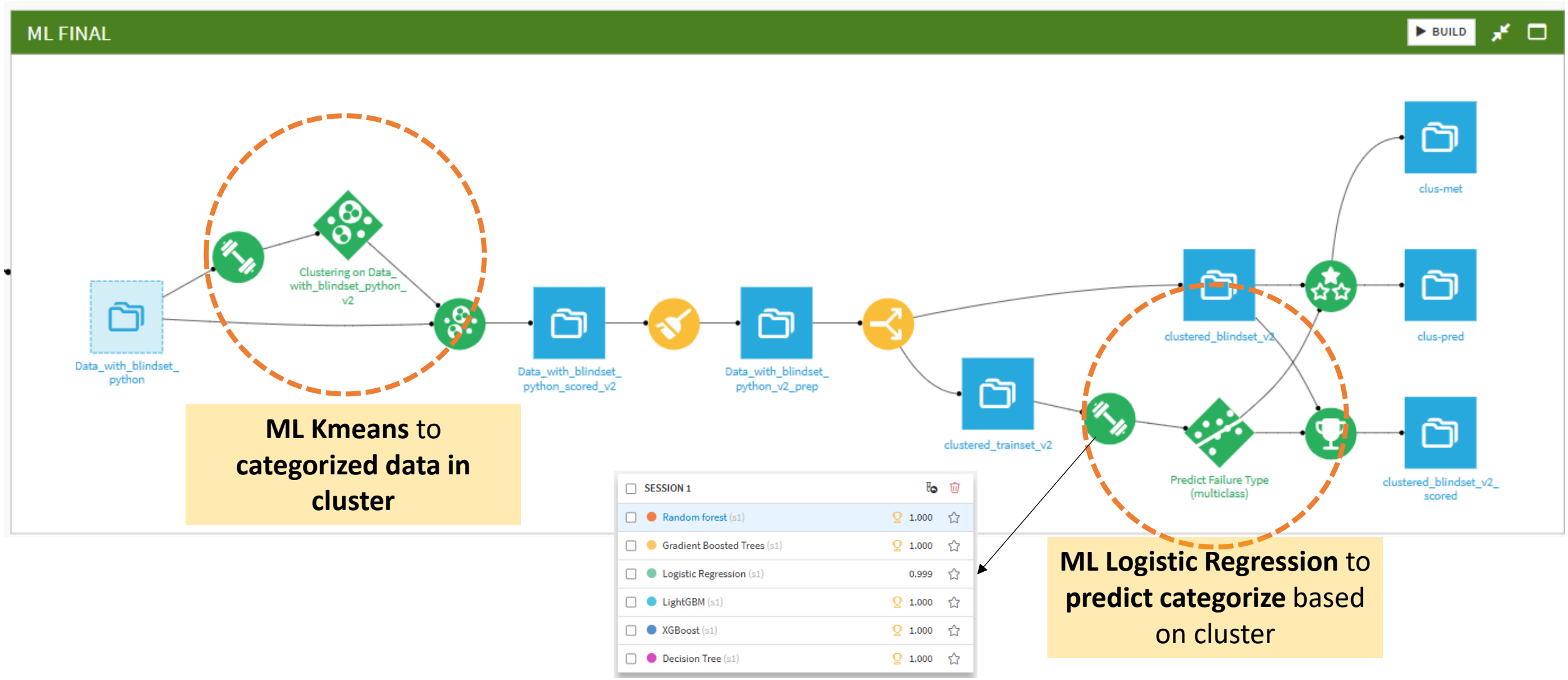
Input data: 5 wells – ESP Parameter: Ampere, Frequency, Voltage

Prepare data: Take out null/blank data & Change "GPS Date" to Timeseries data

Well Name	GPS Date	Output Voltage (V)	Output Frequency (Hz)	Motor Ampere (A)	Failure Type
string	string	double	double	double	string
Text	Datetime with tz	Decimal	Decimal	Decimal	Text
Well-105	2024-09-02T00:00:00.000Z	364.0	45.0	17.3	Main Cable Low Reading
Well-105	2024-09-02T01:00:00.000Z	364.0	45.0	17.5	Main Cable Low Reading
Well-105	2024-09-02T02:00:00.000Z	364.0	45.0	17.3	Main Cable Low Reading
Well-105	2024-09-02T03:00:00.000Z	364.0	45.0	17.3	Main Cable Low Reading
Well-105	2024-09-02T04:02:00.000Z	364.0	45.0	17.4	Main Cable Low Reading
Well-105	2024-09-02T05:00:00.000Z	364.0	45.0	17.4	Main Cable Low Reading
Well-105	2024-09-02T06:00:00.000Z	364.0	45.0	17.4	Main Cable Low Reading



Dataiku Workflow - Modelling



ML Kmeans to **categorized data in cluster**

ML Logistic Regression to **predict categorize** based on cluster

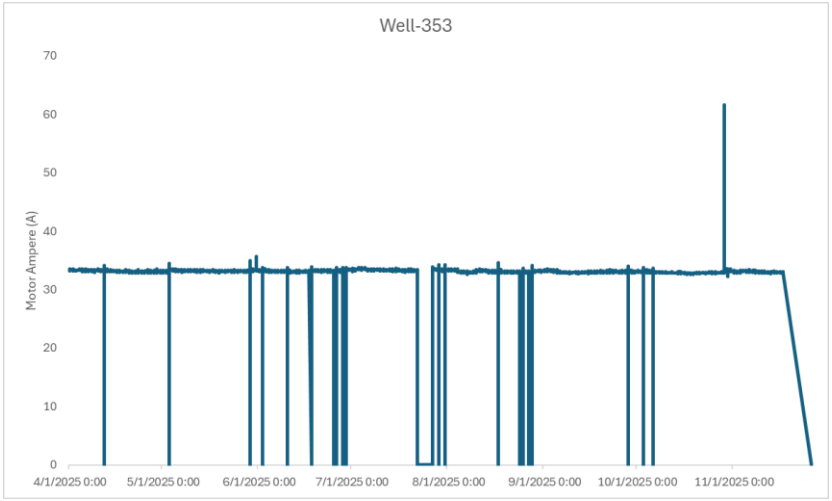
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Result

Model	Recall	Precision	Accuracy	F1
Random Forest	0.58	0.56	0.60	0.57
Gradient Boosted Trees	0.59	0.57	0.61	0.58
Logistic Regression	**0.64**	**0.66**	**0.65**	**0.65**
LightGBM	0.57	0.55	0.59	0.56
XGBoost	0.56	0.54	0.58	0.55
Decision Tree	0.53	0.52	0.55	0.52

Best model with accuracy 65%

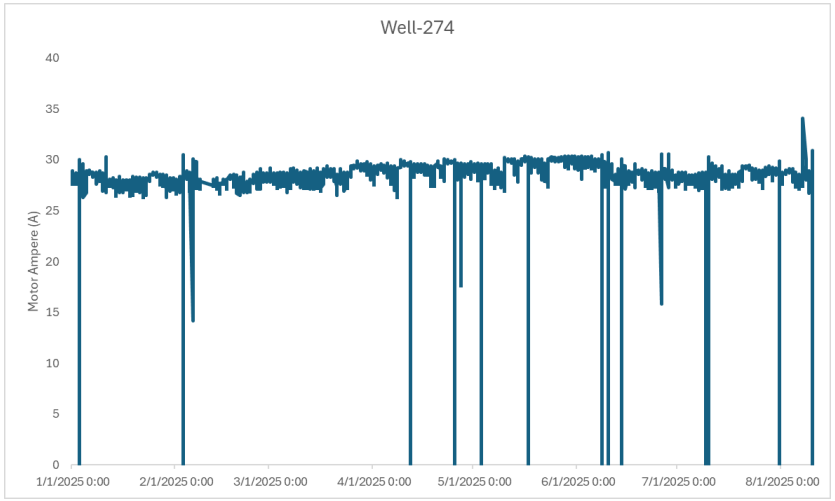
Result



Actual : Main Cable Low Reading

Predict : Main Cable Low Reading

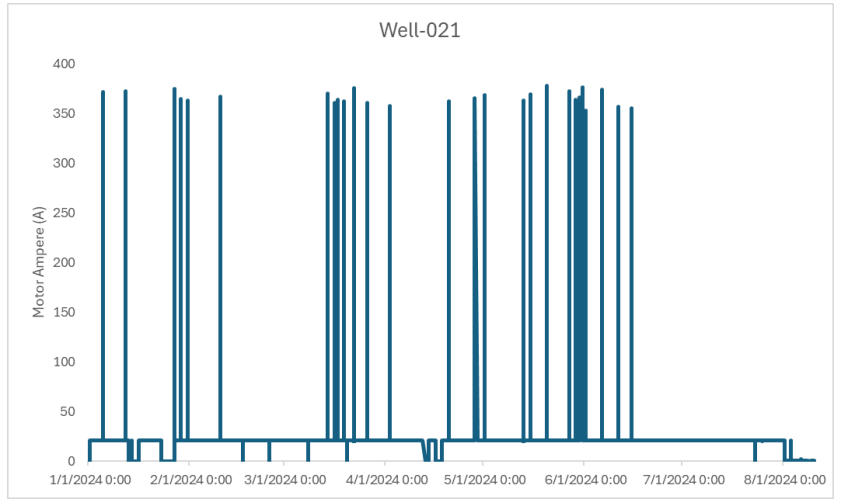
True



Actual : Pump Stuck

Predict : Pump Stuck

True



Actual : Main Cable Low Reading

Predict : Pump Stuck

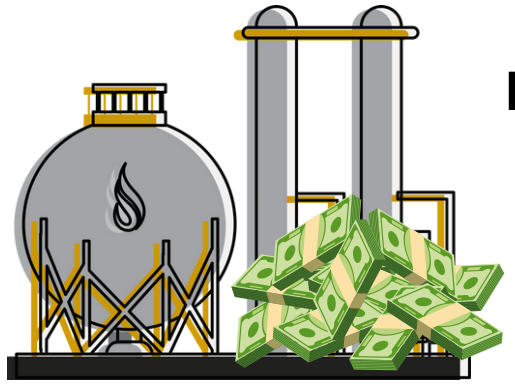
False

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Estimate Financial Benefit

Year	Risk Category	Number of Wells	Preventable Shutdowns	Cost Savings ($)
2020	Warning	1	0.435	21,750
2021	High Risk	6	5.22	261,000
2021	Warning	5	2.175	108,750
2022	High Risk	12	10.44	522,000
2022	Warning	3	1.305	65,250
2023	High Risk	2	1.74	87,000

Disclaimer: Data source from October 2020- April 2023



Reduce Oil Loss

17,221

barrel/year



Saving Cost/year

$2.5M

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Conclusions & Future Improvement



Improved Fault Detection

Immediate detection, accurate timestamping, and structured classification of equipment faults

Minimize Loss Potential Oil

Unplanned shutdowns have been replaced by controlled, scheduled shutdowns that are aligned with maintenance plans and production schedules.

High Equipment Readiness

Availability and operational reliability are consistently achieved, ensuring stable and sustainable production performance.

Best Model

Kmeans → Logistic Regression

1. Pump damage
2. Main cable damage
3. Pump stuck
4. Main cable low reading
5. Others

Accuracy

65%

Future Improvement

