AVEVAWORLD

Albemarle Intelligence

Top 10 Reasons Why You are Stuck in Pilot Purgatory:

Preventing ROAI & Realizing Economies of Scale

Presented by: Jonathan Alexander

Albemarle

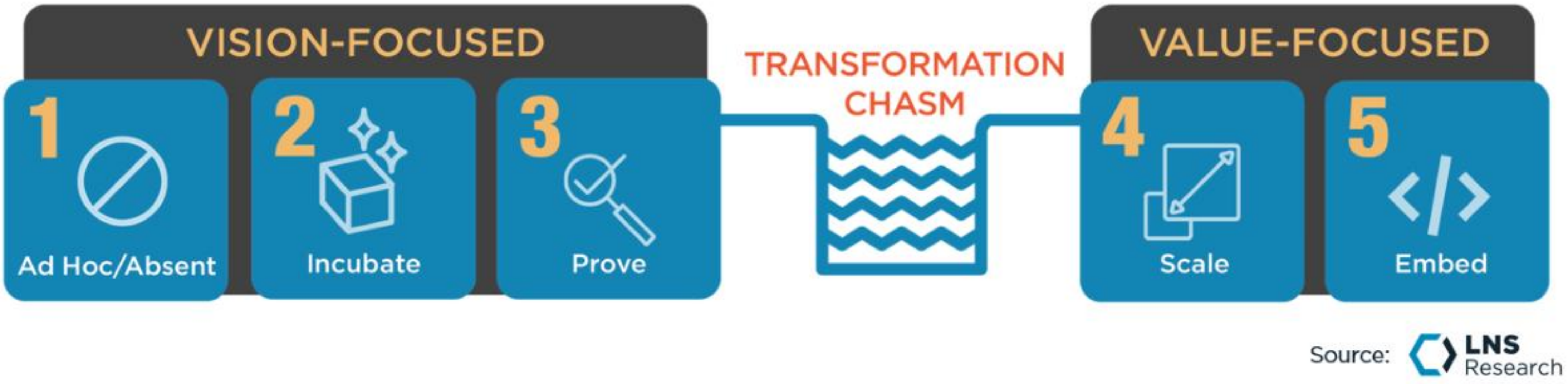
ALBEMARLE INTELLIGENCE

Current Estimated Improvements

>$150,000,000/yr

Estimated improvements include projects at multiple sites with various time periods and benefits including cost savings, cost avoidance and/or revenue enhancement.

Five Stages of Transformation Maturity




Top 10 Reasons you're stuck in Pilot Purgatory

Reason #1


Rome wasn't
built in a day

The Journey to Realizing Economies of Scale

Competing on Analytics - Five Stages of Analytical Maturity

AI Maturity Transformation

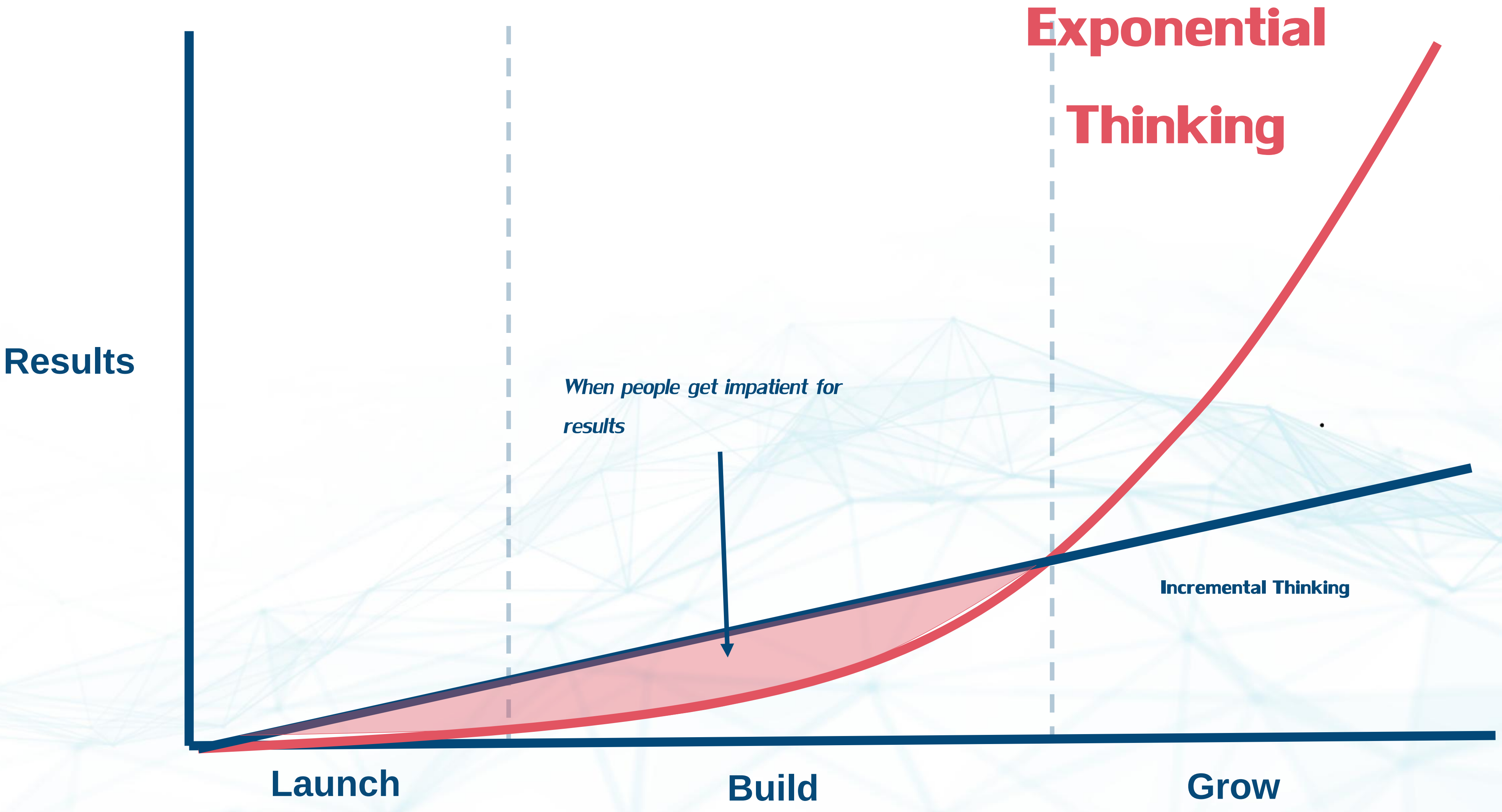
Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Analytically Impaired	**Localized Analytics**	**Analytical Aspirations**	**Analytical Company**	**Analytical Competitor**
The company has some data and management interest in analytics.	Functional management builds analytics momentum and executives' interest through applications of basic analytics.	Executives commit to analytics by aligning resources and setting a timetable to build a broad analytical capability.	Enterprise-wide analytics capability under development; top executives view analytic capability as a corporate priority.	The company routinely reaps benefits of its enterprise-wide analytics capability and focuses on continuous analytics review.

AI Maturity Index

ALBEMARLE INTELLIGENCE

	Beginner	Foundational	Advanced	World Class
Data Governance	Minimal data governance; siloed and unstructured data.	Basic data management policies in place; some centralized storage.	Enterprise-wide data governance framework; standardized data practices.	Fully integrated, automated data governance with real-time compliance.
Statistical Process Control	No formal SPC; reactive quality control.	Basic SPC tools implemented; manual monitoring.	Automated SPC with real-time alerts and analytics.	AI-driven SPC with predictive quality insights and autonomous adjustments.
Machine Learning	Limited awareness; isolated experiments.	Early adoption; ML models used for specific tasks.	Scalable ML models integrated into workflows.	AI-powered decision-making with continuous learning and optimization.
Predictive Analytics	Basic dashboards with historical data analysis.	Simple trend analysis and forecasting.	Predictive models guiding business decisions.	AI-driven prescriptive analytics optimizing operations in real-time.
Generative AI	No generative AI implementation.	Experimentation with text/image generation in isolated use cases.	Generative AI integrated into product design and optimization.	Fully autonomous generative AI creating insights, reports, and designs with minimal human input.

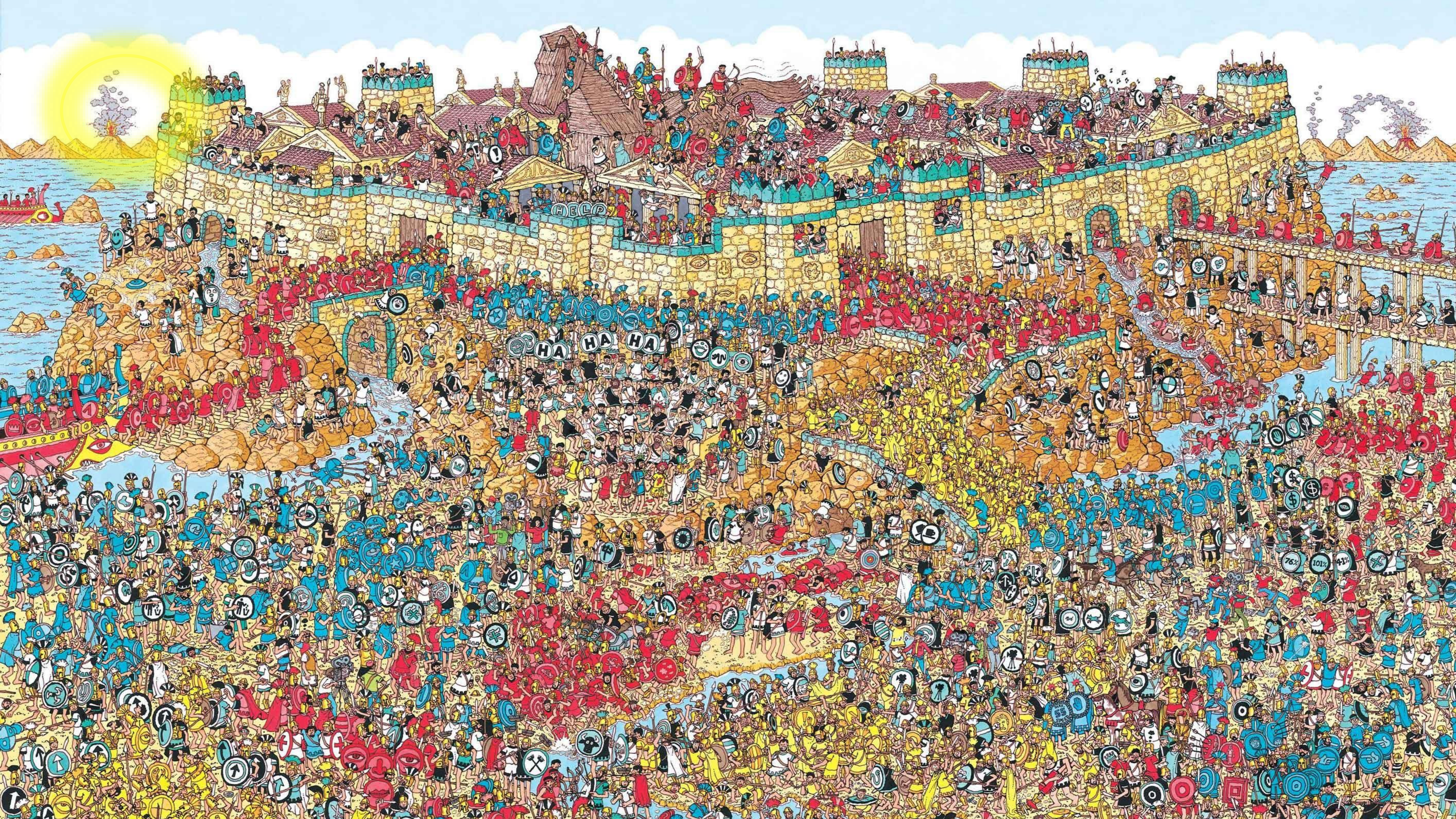
Phases of Digital Transformation – Incremental vs. Exponential



Reason #2

Garbage In, Garbage Out


THE FANTASTIC FLOWER GARDEN


HELP
HA HA HA


MAX 55

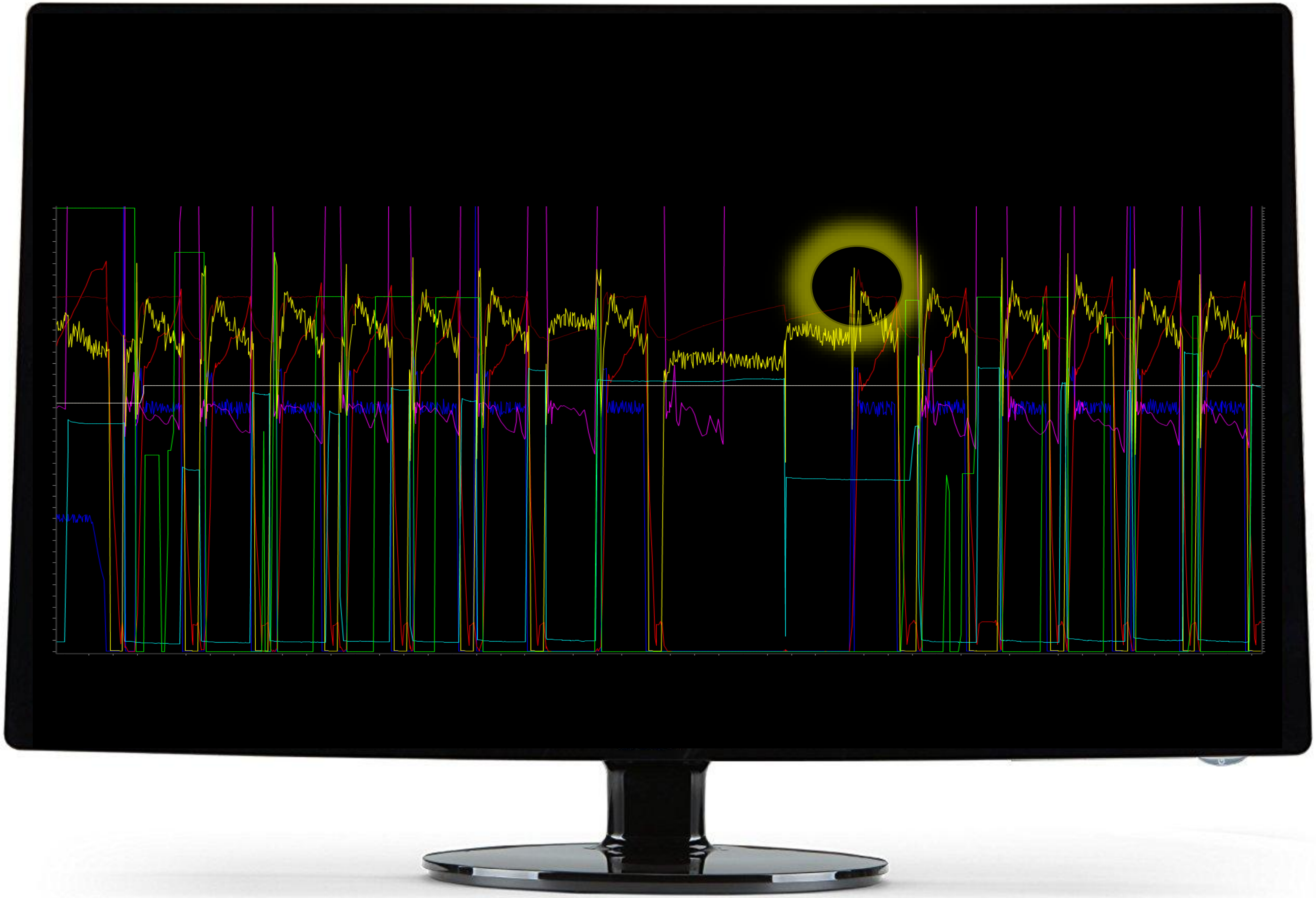
ChatGPT 4.5

What can I help with?

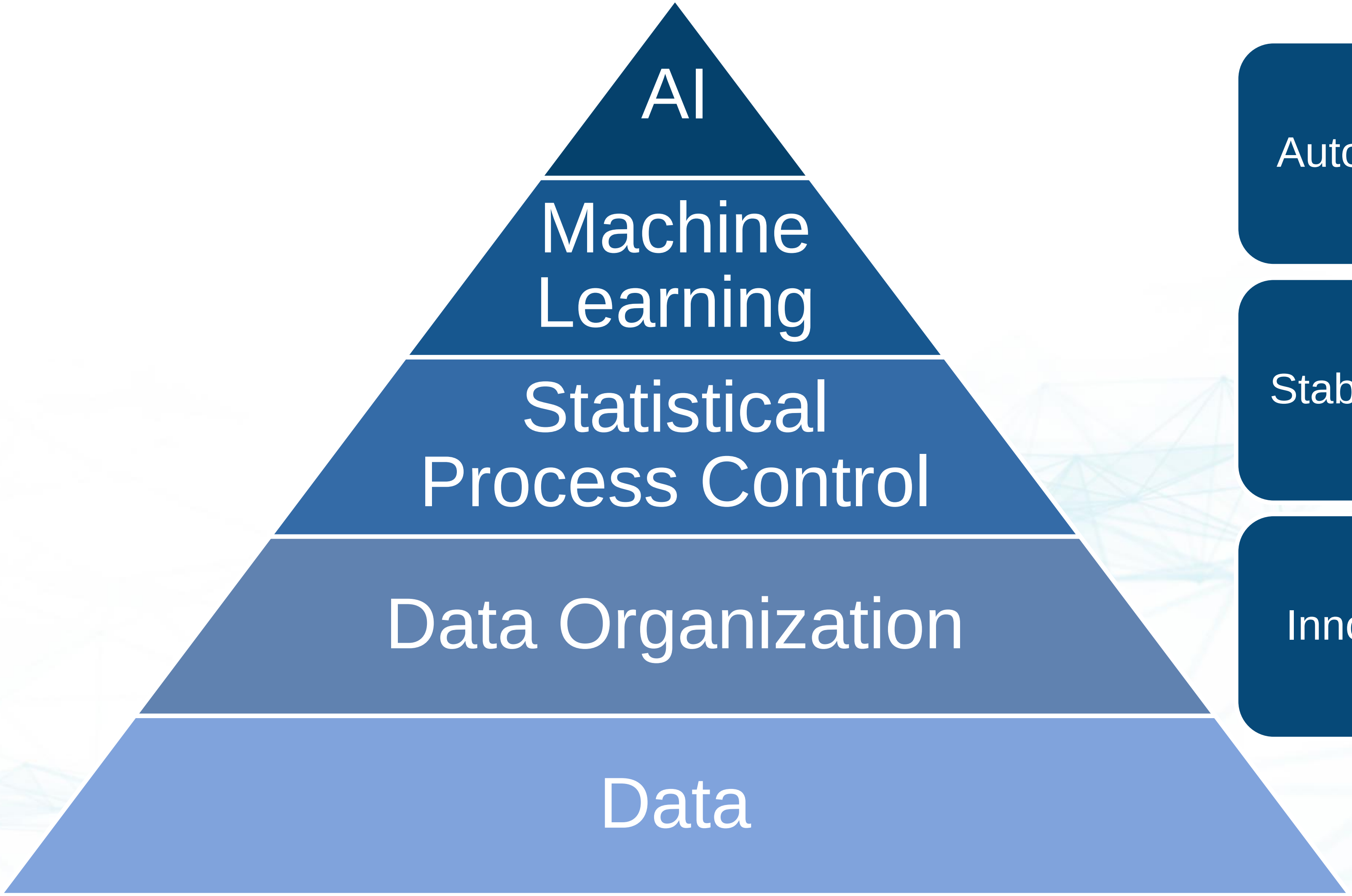
Ask anything

Search | Deep research

Create image | Help me write | Summarize text | Code | Brainstorm | More



AI Strategy



Automation

- Key Process Variables Monitored Automatically
- Standardized Global Data Structure
- Supports Global Growth & Economies of Scale

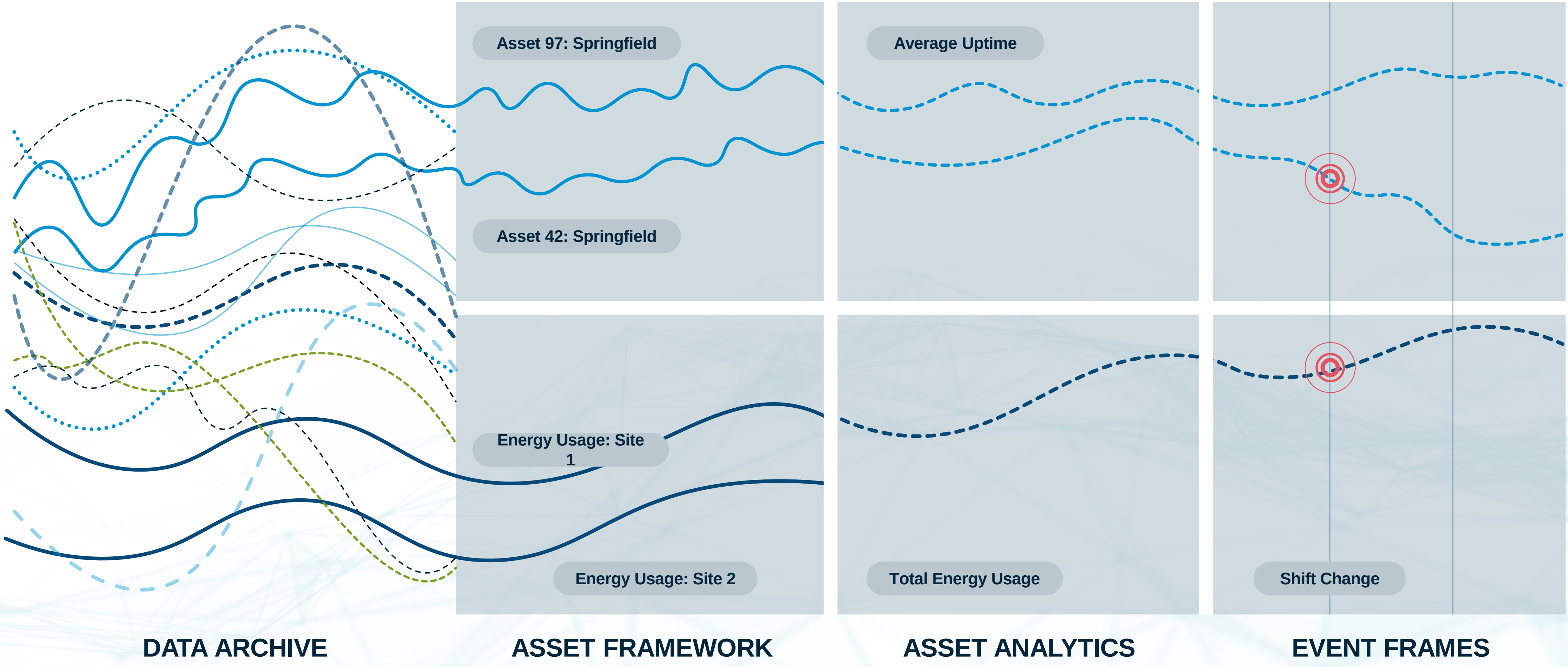
Stabilization

- Statistical Actionboards enable Engineers & Operations to minimize Firefighting
- Improved Process Control
- Improved Equipment Reliability

Innovation

- "Data at your fingertips" enables Engineers to do more Engineering
- Advanced Analytics & Machine Learning techniques unlock unknown correlations and pre
- Positions Albemarle as a global leader in Digital Manufacturing & Industry 4.0

Scaling Event Frames as an Analytical Engine



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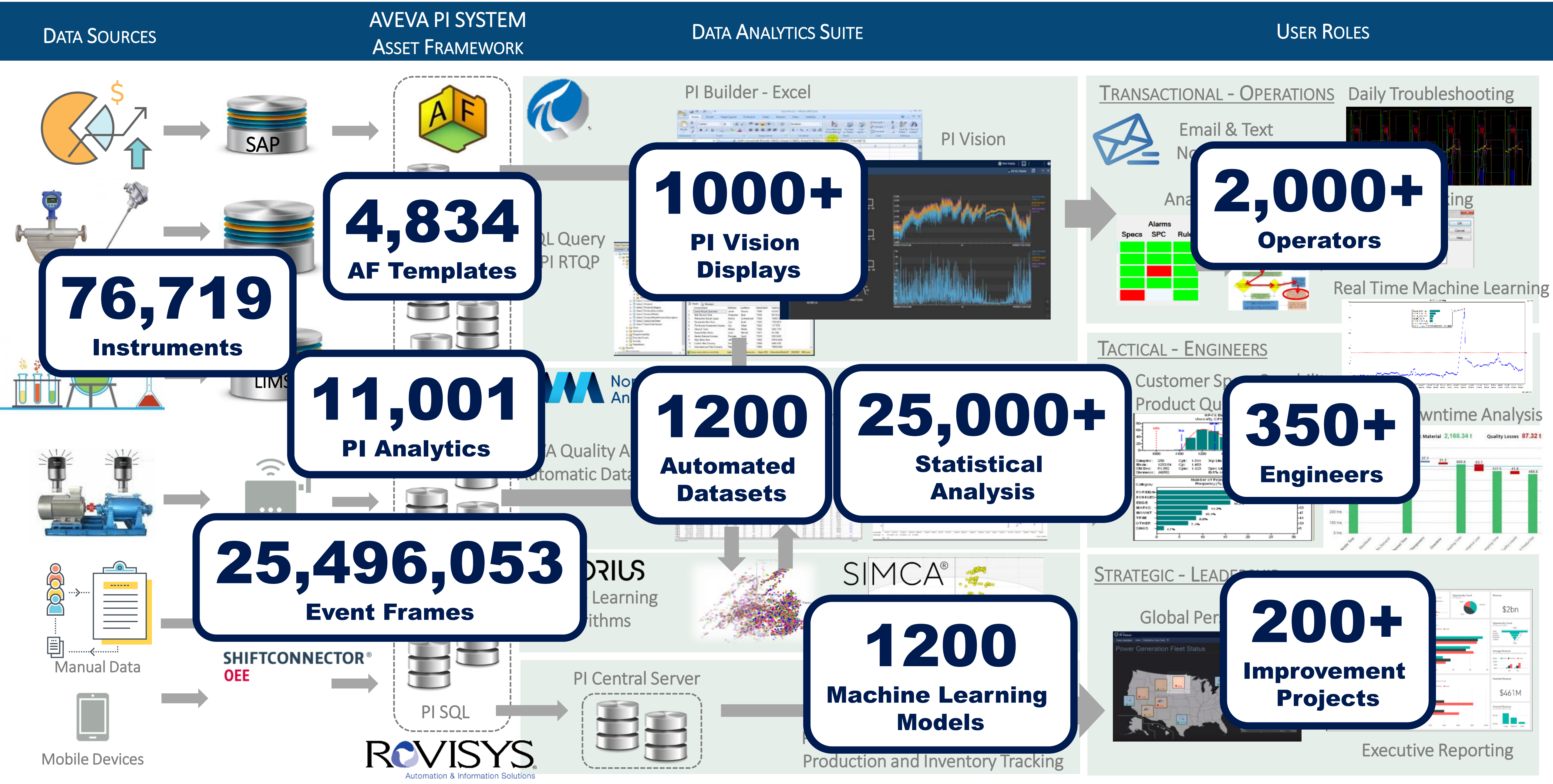
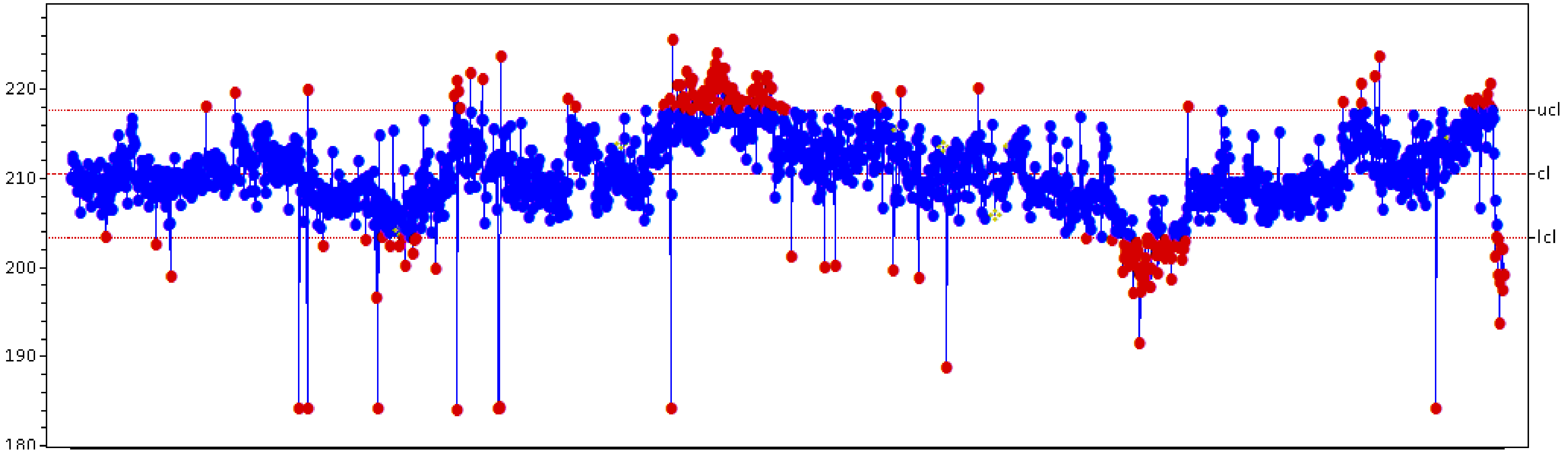


Reason #3


You miss the forest from the trees

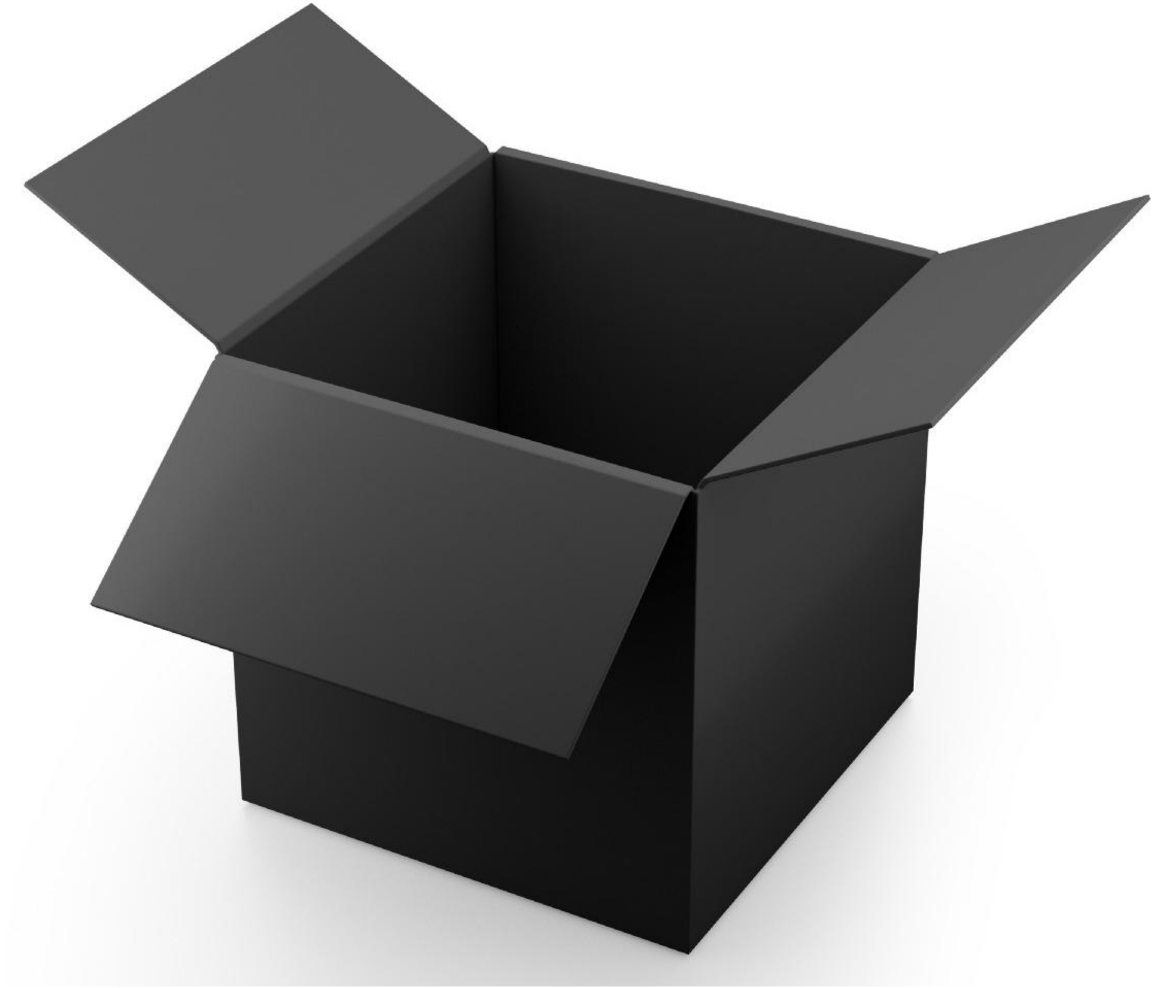

A-Shift
vs
C-Shift

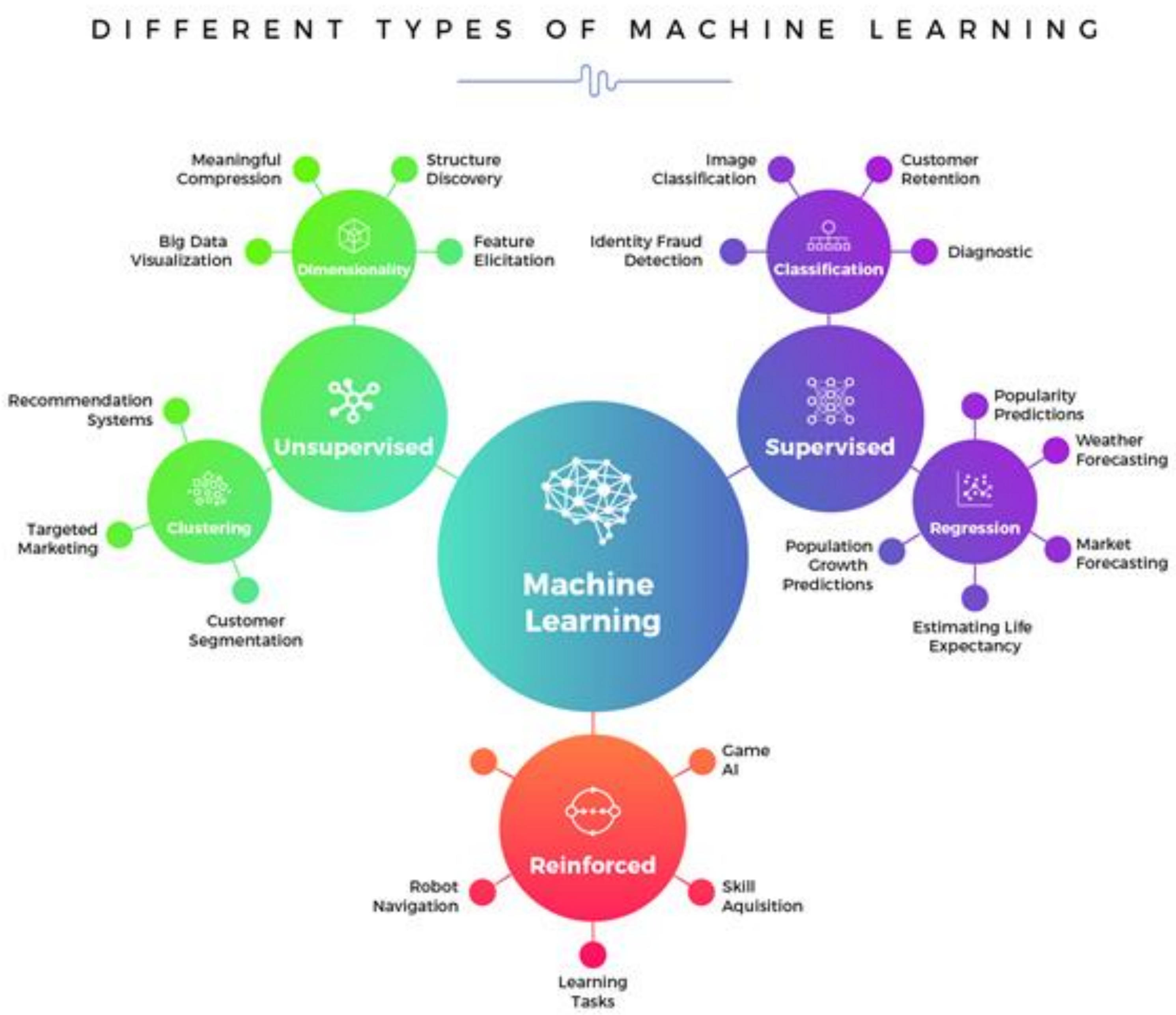
3 Month Statistical Analysis – w/ Event Frames



Northwest Analytics

Dissecting the "Black Box" with Machine Learning

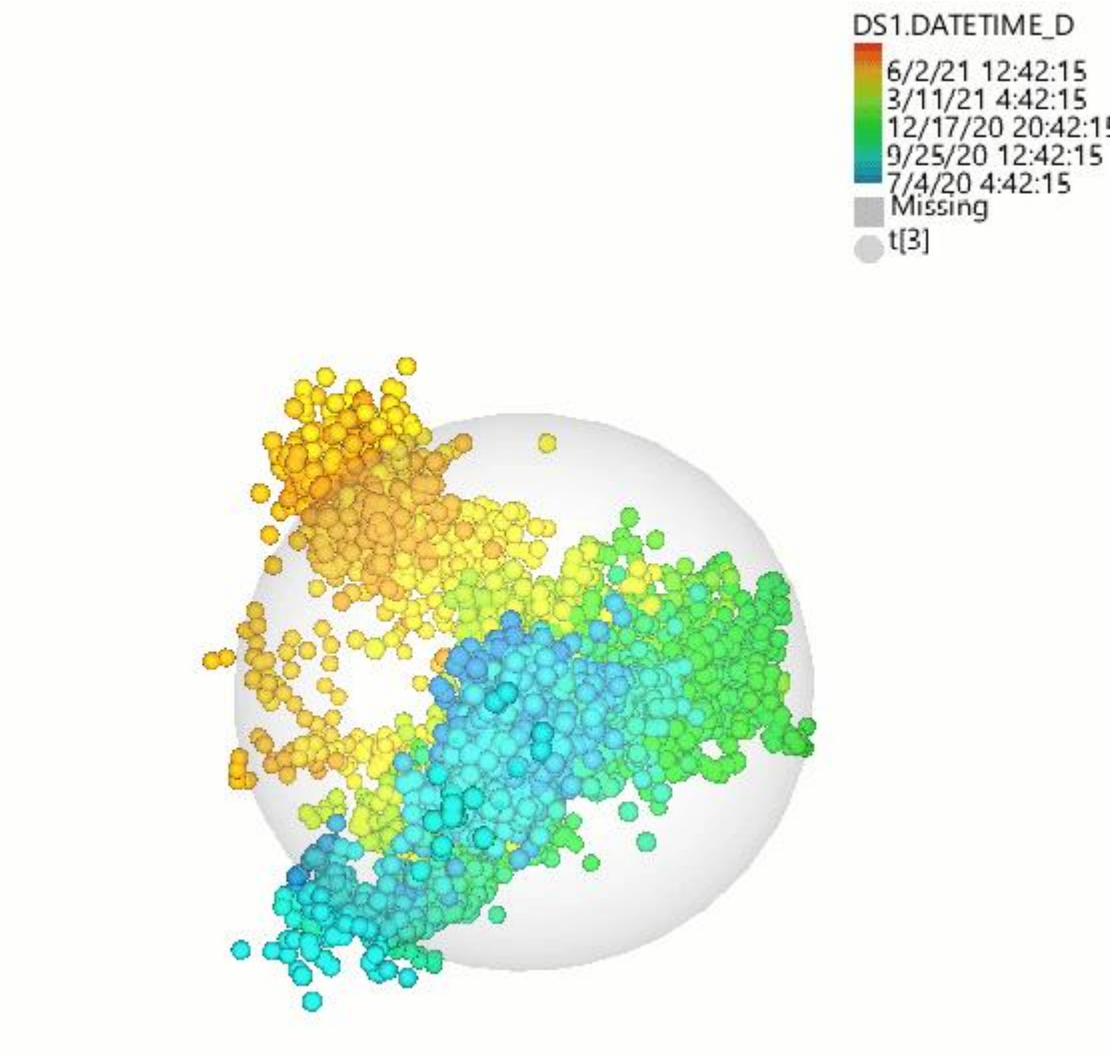



DIFFERENT TYPES OF MACHINE LEARNING
Machine Learning
Unsupervised
Dimensionality
Meaningful Compression
Structure Discovery
Big Data Visualization
Feature Elicitation
Clustering
Recommendation Systems
Targeted Marketing
Customer Segmentation
Supervised
Classification
Image Classification
Customer Retention
Identity Fraud Detection
Diagnostic
Regression
Popularity Predictions
Weather Forecasting
Population Growth Predictions
Market Forecasting
Estimating Life Expectancy
Reinforced
Game AI
Robot Navigation
Skill Aquisition
Learning Tasks

Principle Component Analysis

DATA EXPLORATION

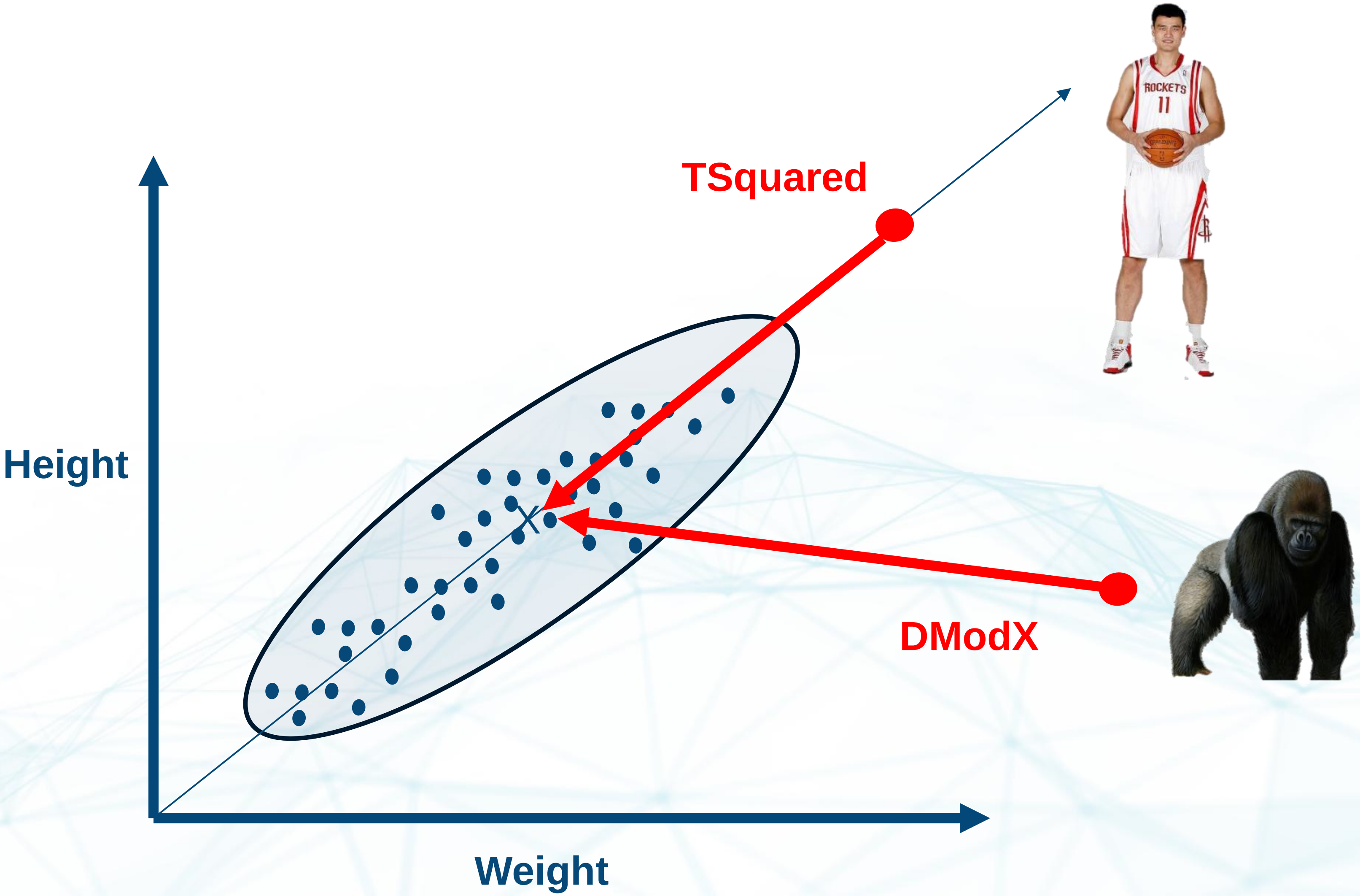
FINDING HIDDEN PATTERNS / STRUCTURE

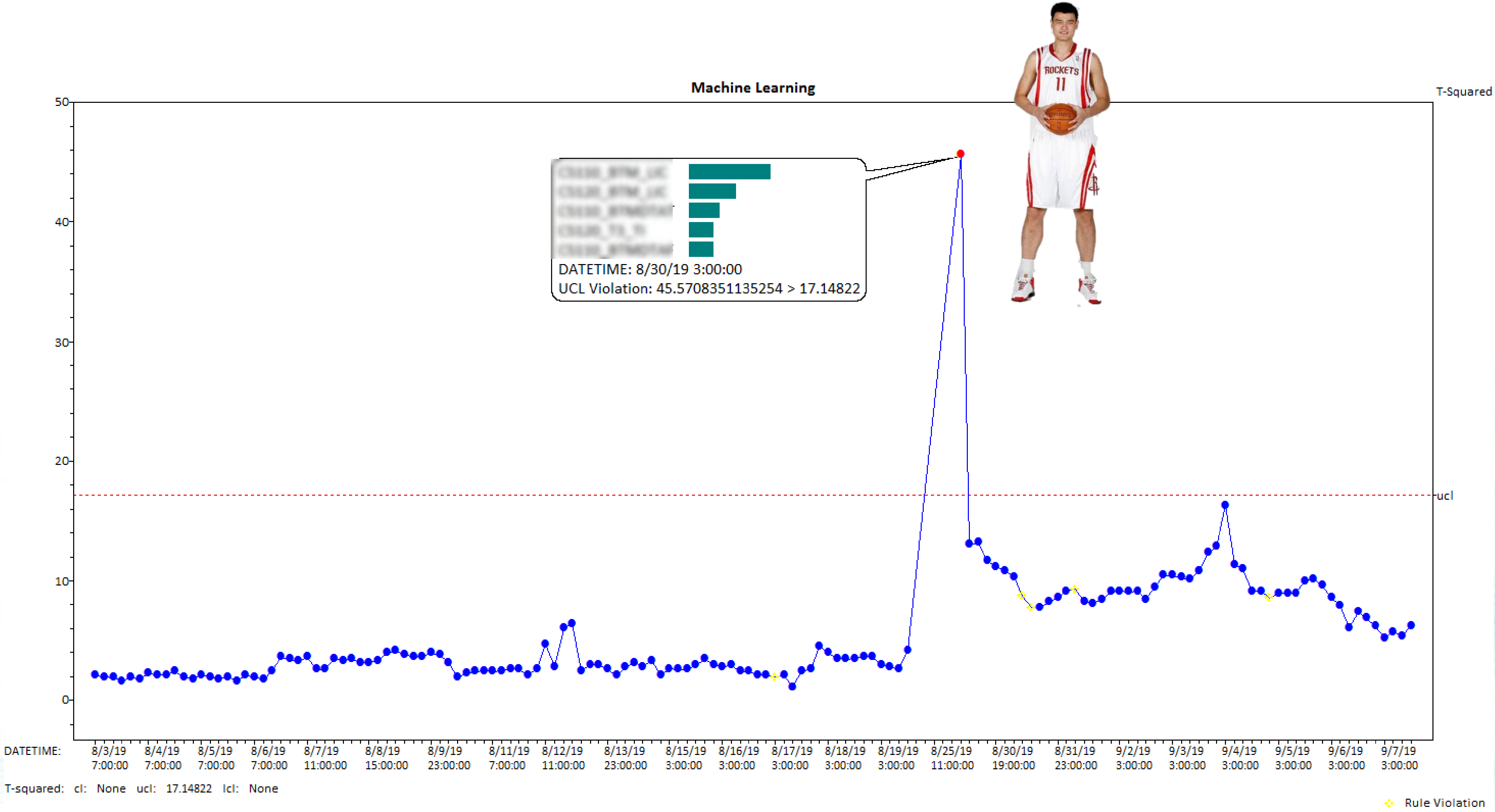


ANOMALY & OUTLIER DETECTION

CHANGE IN OPERATING CONDITIONS

Machine Learning – Outlier & Anomaly Detection





Machine Learning
T-Squared
50
40
30
20
10
0
DATETIME: 8/30/19 3:00:00
UCL Violation: 45.5708351135254 > 17.14822
ucl
DATETIME:
8/3/19 7:00:00
8/4/19 7:00:00
8/5/19 7:00:00
8/6/19 7:00:00
8/7/19 11:00:00
8/8/19 15:00:00
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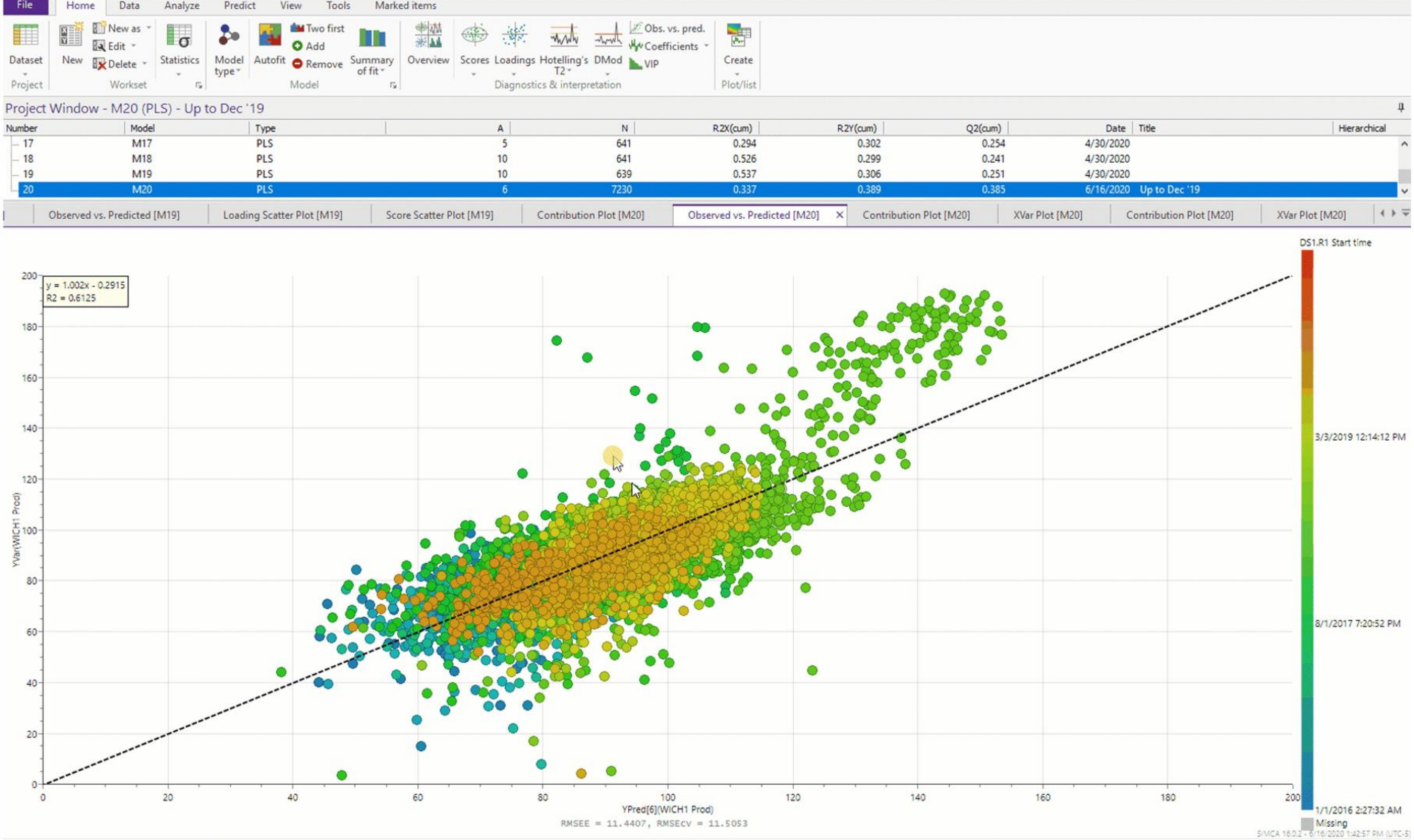
9/6/19 3:00:00
9/7/19 3:00:00
T-squared: cl: None ucl: 17.14822 lcl: None
Rule Violation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View
Tools
Marked items
Dataset
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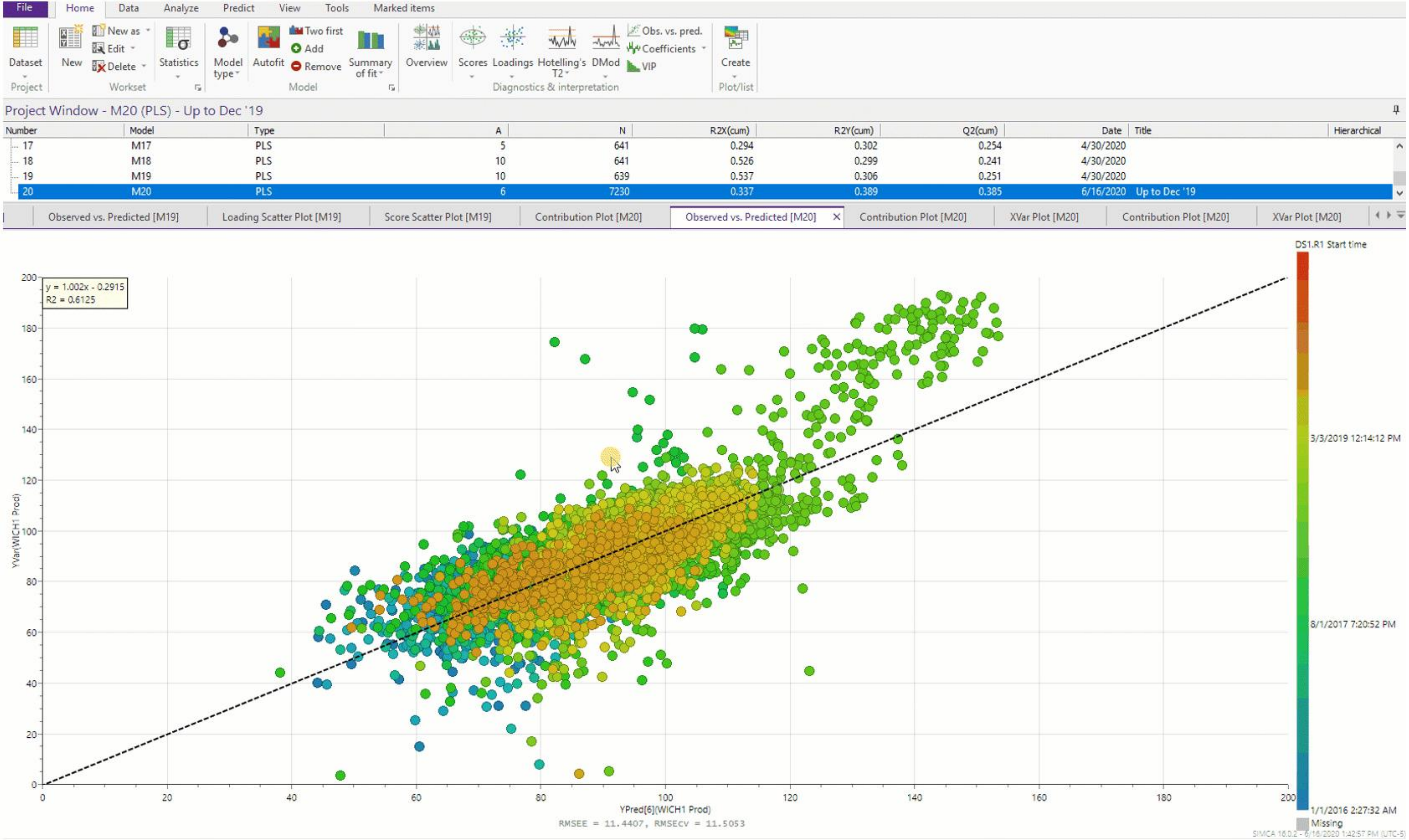
New as
Edit
Delete
Statistics
Model type
Autofit
Two first
Add
Remove
Summary of fit
Overview
Scores
Loadings
Hotelling's T2
DMod
Obs. vs. pred.
Coefficients
VIP
Create
Project
Workset
Model
Diagnostics & interpretation
Plot/list
Project Window - M20 (PLS) - Up to Dec '19
Number | Model | Type | A | N | R2X(cum) | R2Y(cum) | Q2(cum) | Date | Title | Hierarchical
17 | M17 | PLS | 5 | 641 | 0.294 | 0.302 | 0.254 | 4/30/2020
18 | M18 | PLS | 10 | 641 | 0.526 | 0.299 | 0.241 | 4/30/2020
19 | M19 | PLS | 10 | 639 | 0.537 | 0.306 | 0.251 | 4/30/2020
20 | M20 | PLS | 6 | 7230 | 0.337 | 0.389 | 0.385 | 6/16/2020 | Up to Dec '19
Observed vs. Predicted [M19]
Loading Scatter Plot [M19]
Score Scatter Plot [M19]
Contribution Plot [M20]
Observed vs. Predicted [M20]
Contribution Plot [M20]
XVar Plot [M20]
Contribution Plot [M20]
XVar Plot [M20]
y = 1.002x - 0.2915
R2 = 0.6125
YVar(WICH1 Prod)
YPred[6](WICH1 Prod)
RMSEE = 11.4407, RMSEcv = 11.5053
DS1.R1 Start time
3/3/2019 12:14:12 PM
8/1/2017 7:20:52 PM
1/1/2016 2:27:32 AM
Missing


File
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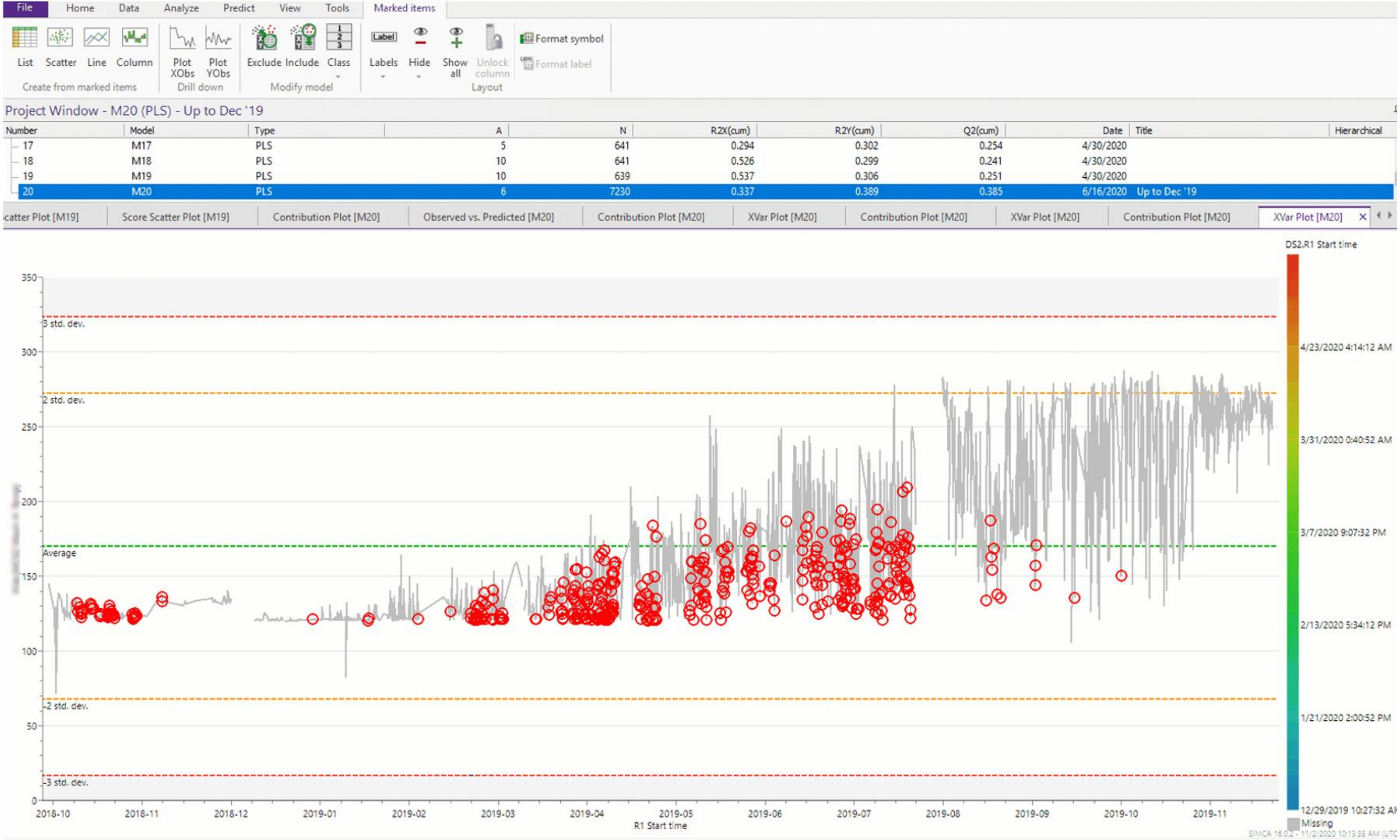

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19	M19	PLS	10	639	0.537	0.306	0.251	4/30/2020		
20	M20	PLS	6	7230	0.337	0.389	0.385	6/16/2020	Up to Dec '19	

Reason #4


Your Insights
never convert
to Action

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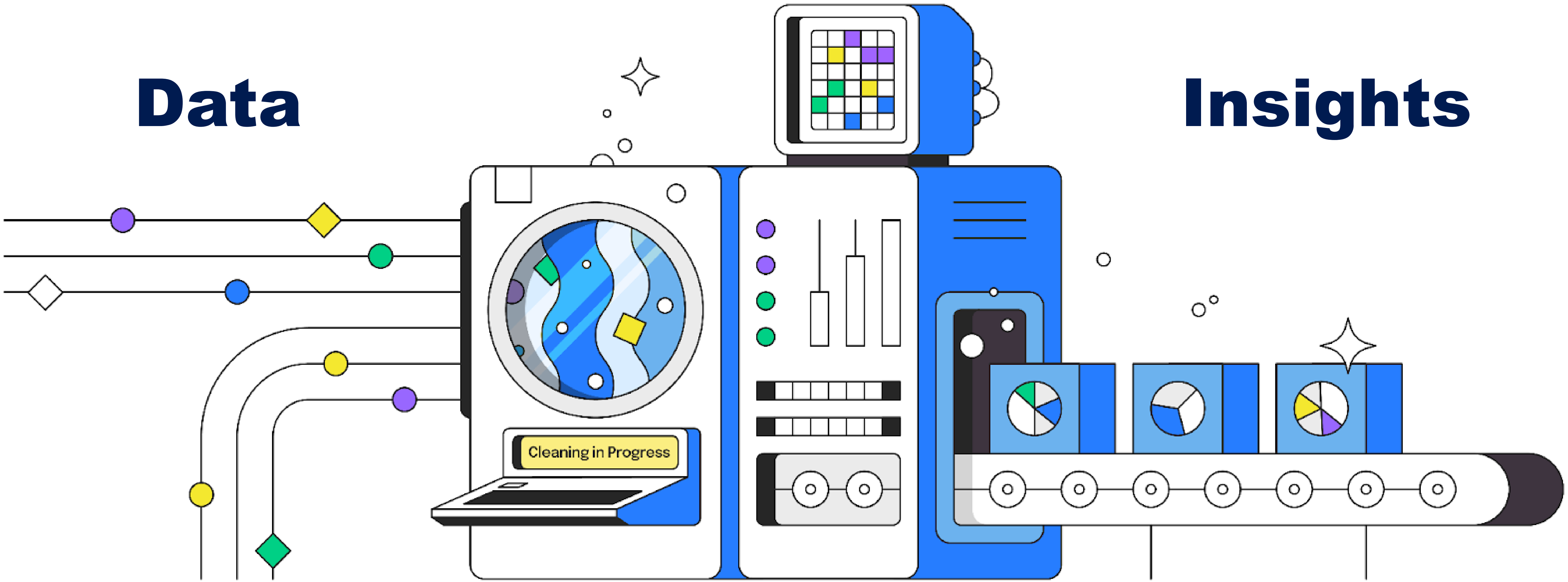
Data

Insights

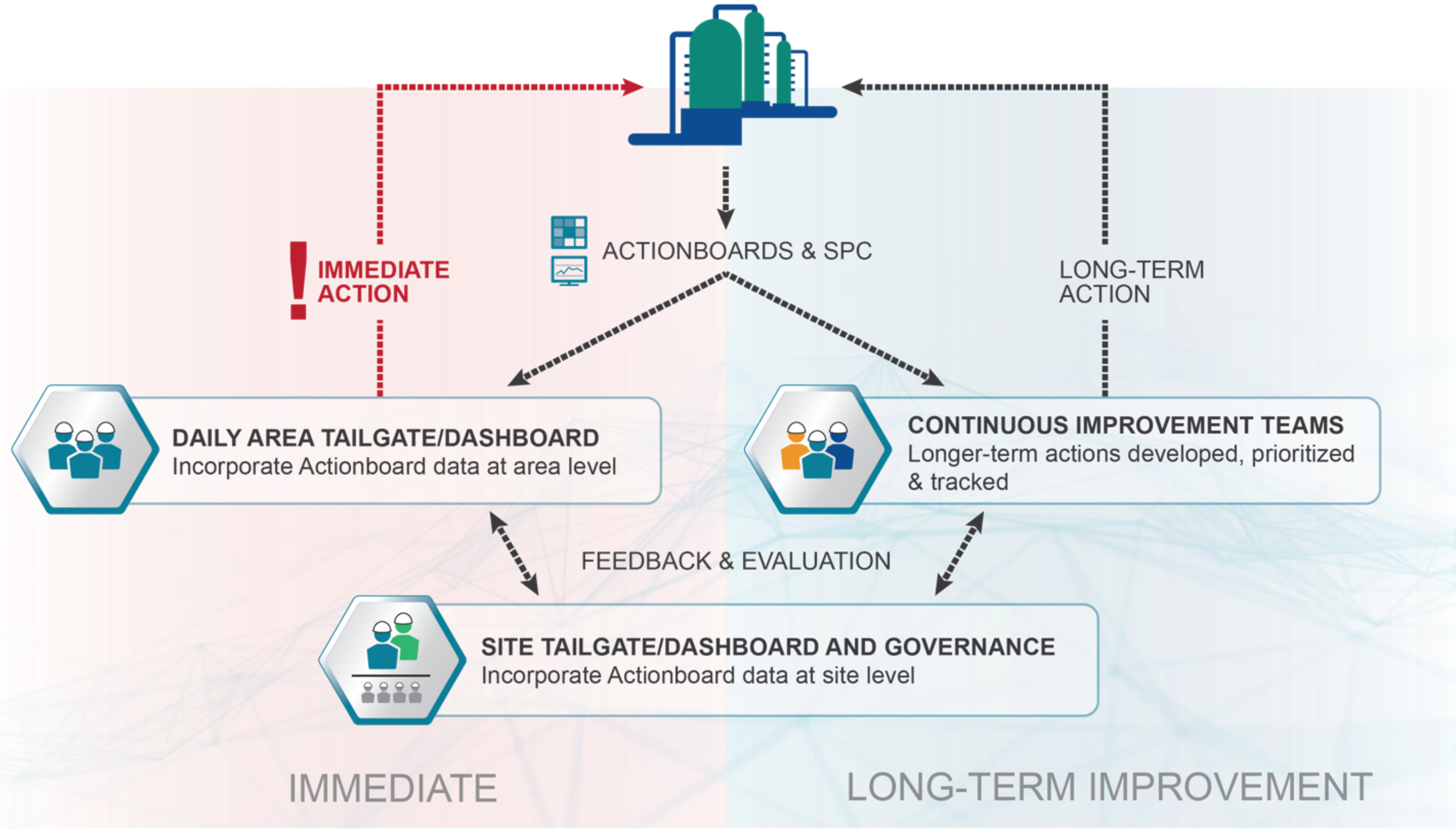



I GOT A FEVER, AND THE ONLY PRESCRIPTION IS
MORE DASHBOARD!

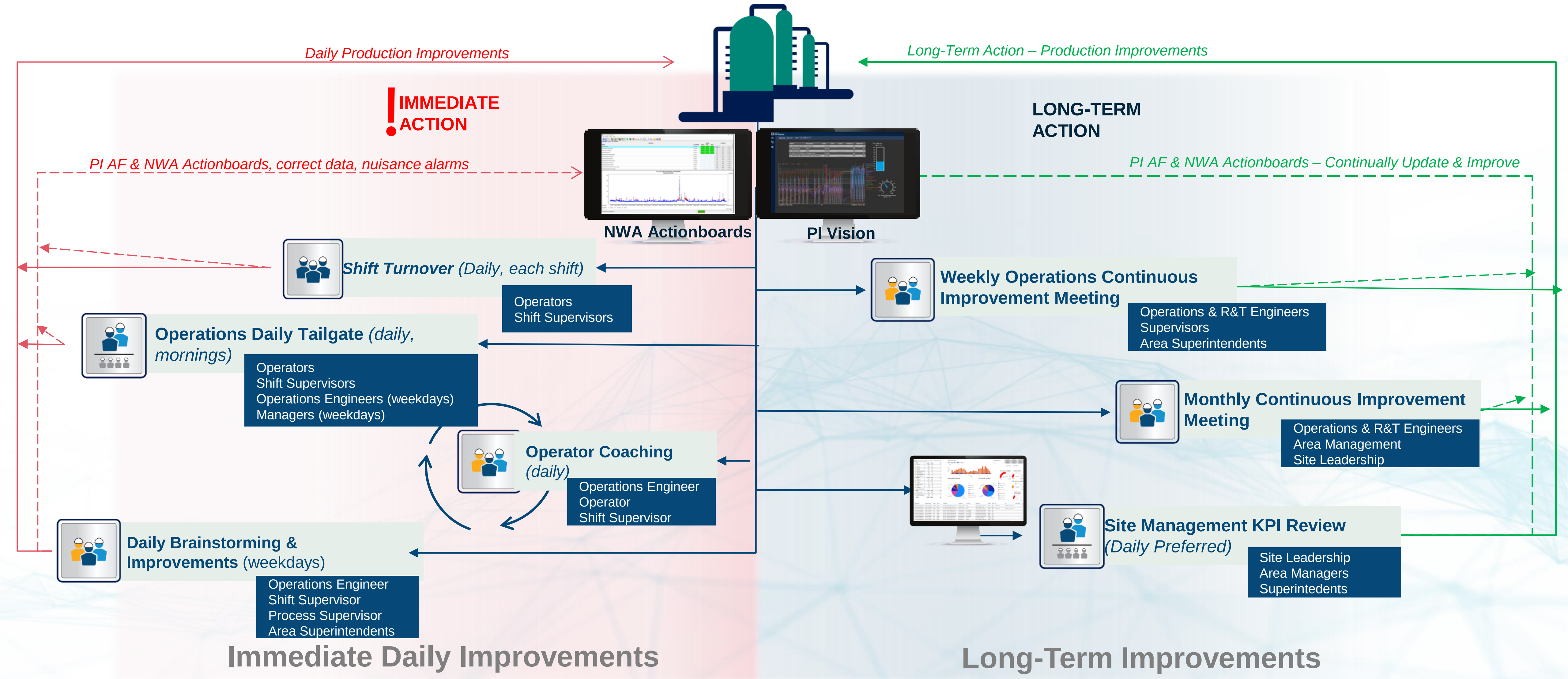
SARTORIUS SIMCA®

Northwest Analytics

AI-Powered Continuous Improvement

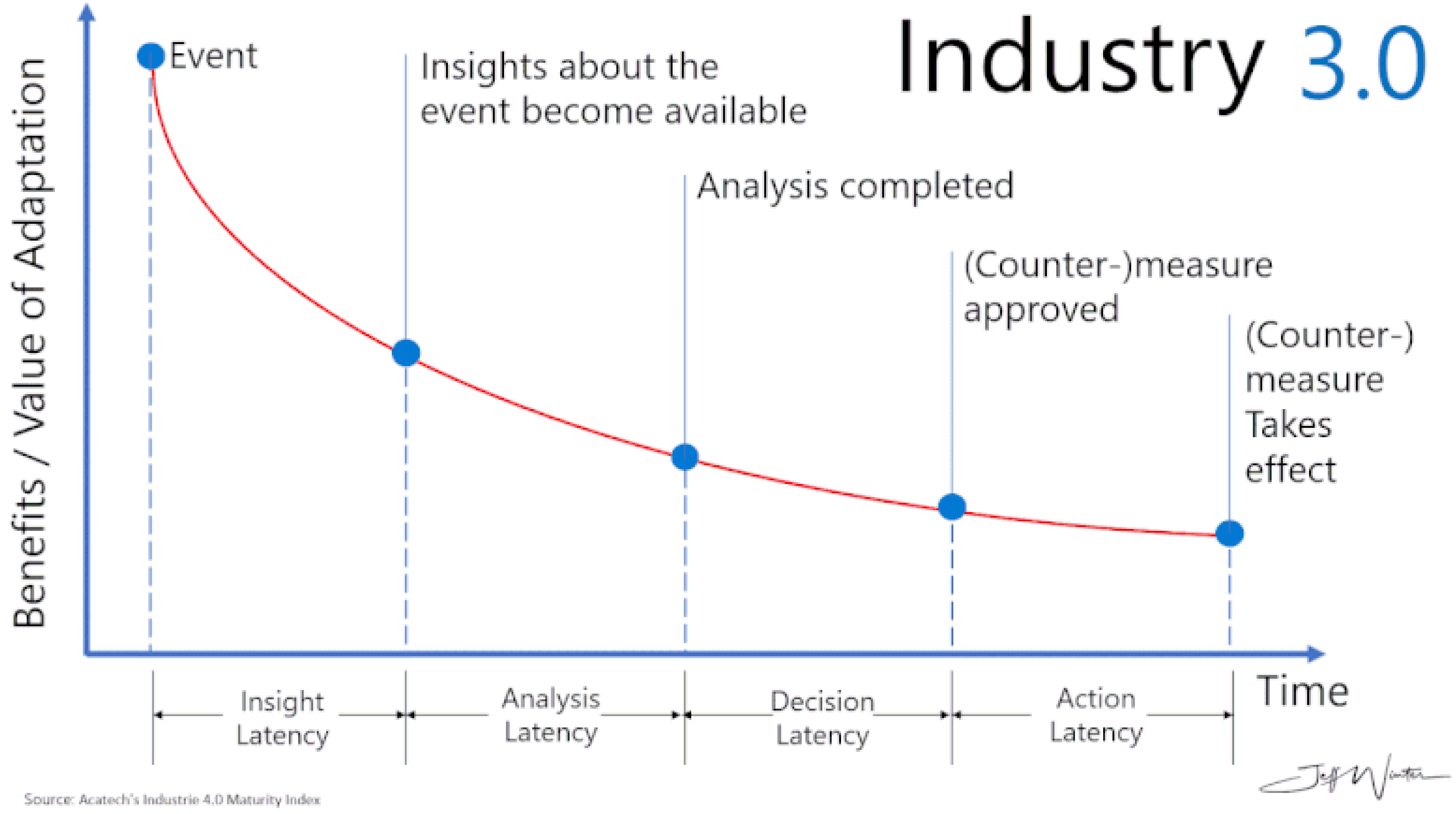


Actionboard Standard Work – Continuous Improvement



Reason #5


Shiny Object
Syndrome

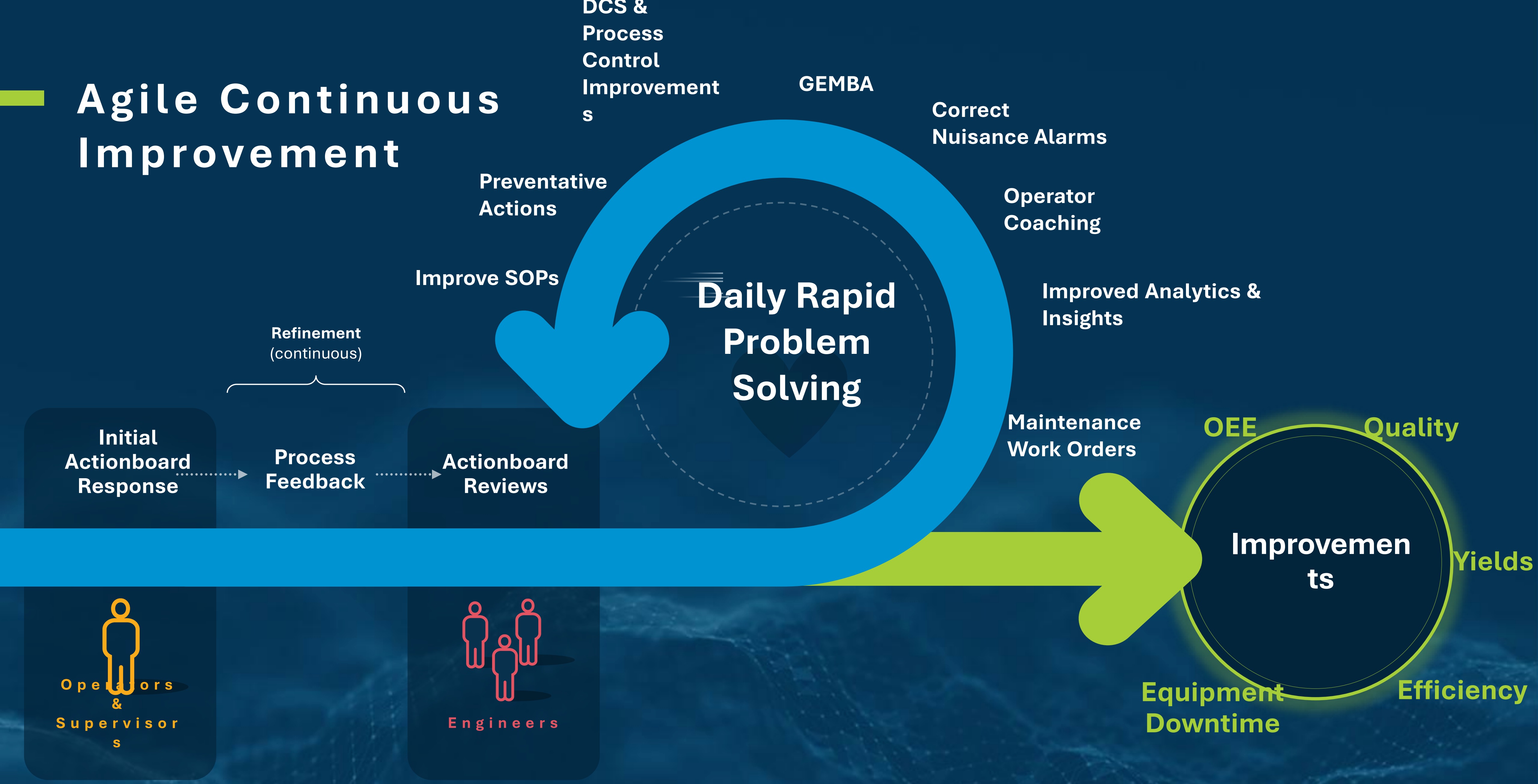


Industry 3.0
Event
Insights about the event become available
Analysis completed
(Counter-)measure approved
(Counter-) measure Takes effect
Benefits / Value of Adaptation
Time
Insight Latency
Analysis Latency
Decision Latency
Action Latency
Source: Acatech's Industrie 4.0 Maturity Index

IMPROVE

1. Reduce Variation
2. Change the Average

Agile Continuous Improvement



ALBEMARLE INTELLIGENCE

Define

Define the Problem
- Business Opportunity
- Stakeholder Alignment
- Problem Statement
- PI Asset Framework
- Process Knowledge

Measure

Quantify the Problem
- PI AF Event Frames
- Critical to Quality Control
- SQL Queries
- Data Quality & Fidelity
- NWA Automated Datasets

Analyze

Identify the Cause
- Statistical Process Control (SPC)
- NWA Quality Analyst
- SIMCA Machine Learning
- Principle Component Analysis
- Partial Least Squares

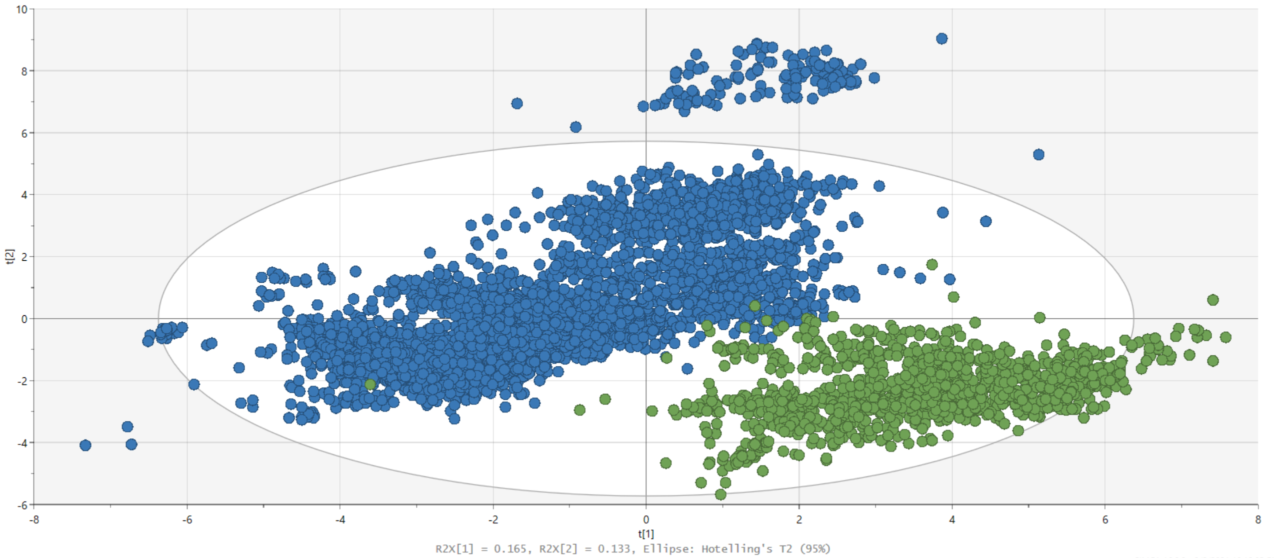
Improve

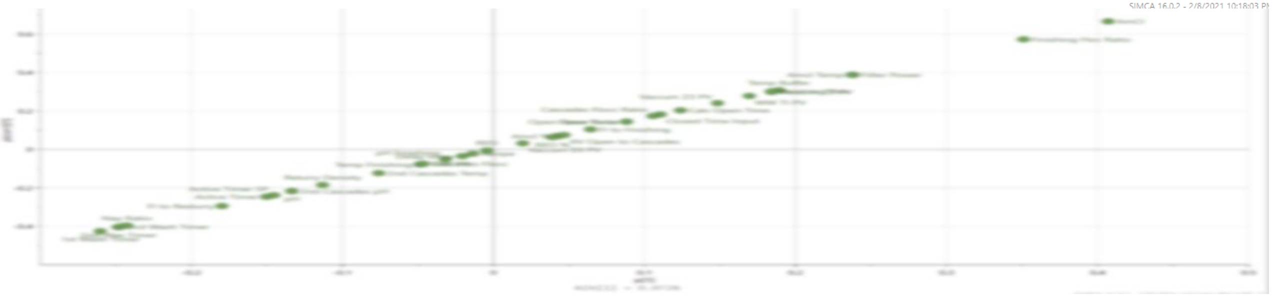
Implement the Solution
- Variation Reduction
- Design of Experiments
- Brainstorming
- 5 Why Analysis
- Cause & Effect
- DCS Process Control Improvements

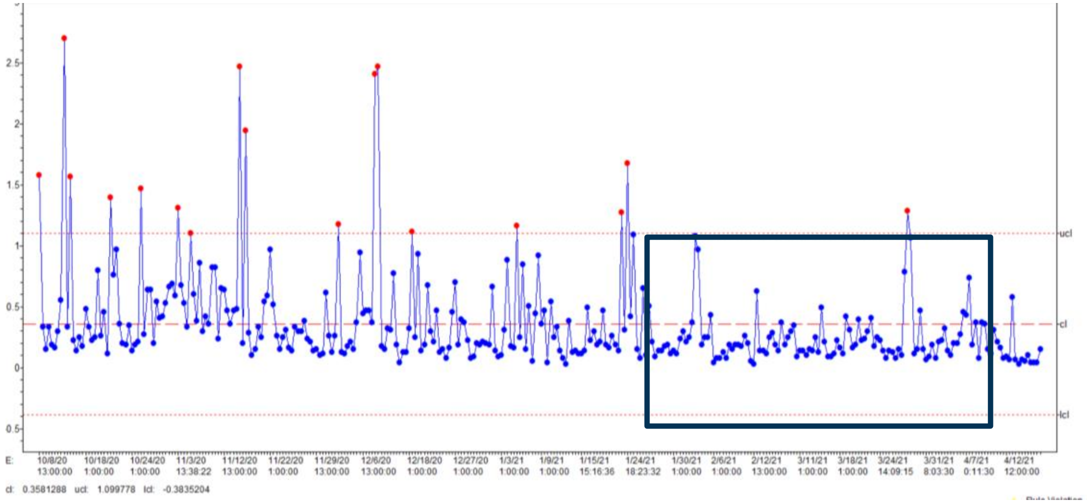
Control

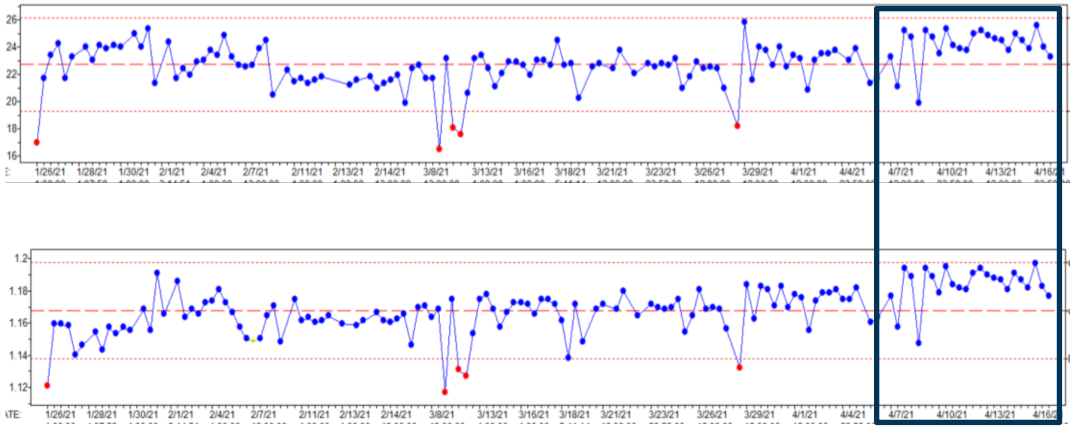
Maintain the Solution
- Sustainability
- Actionboards
- Procedures & Guidelines
- Governance
- Roles & Responsibilities
- Change Management

Albemarle Intelligence – Engineer Improvement Project

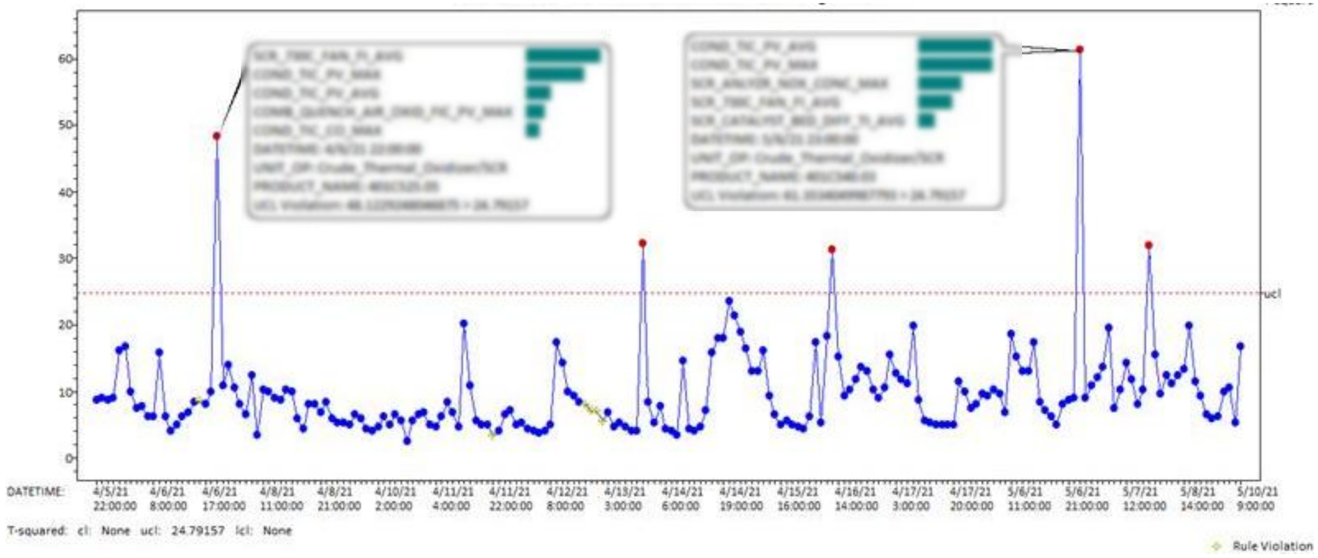


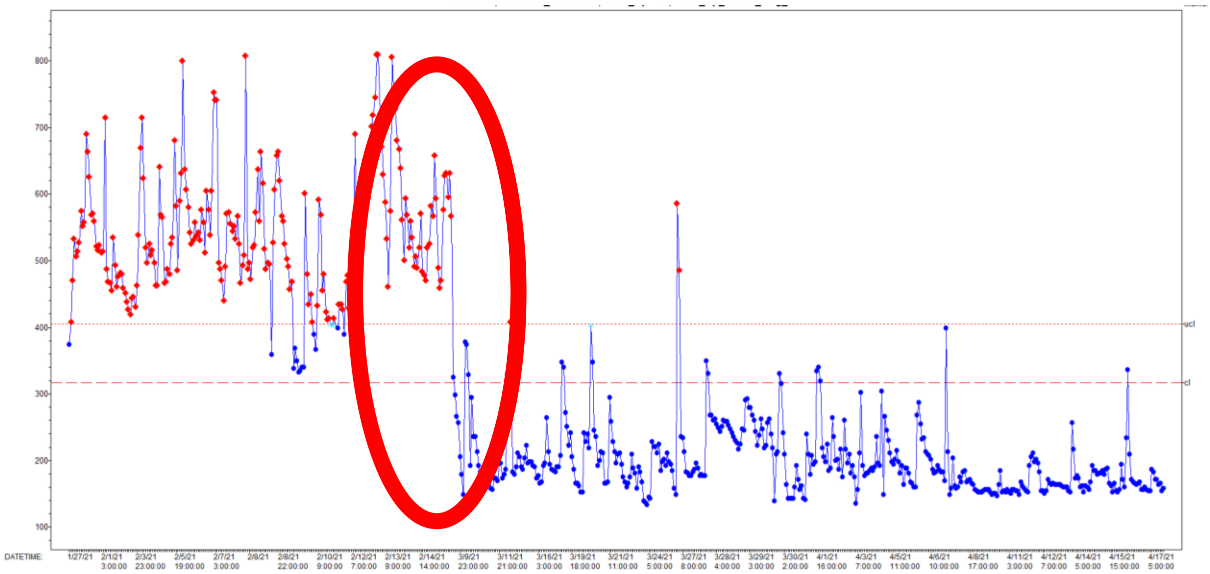


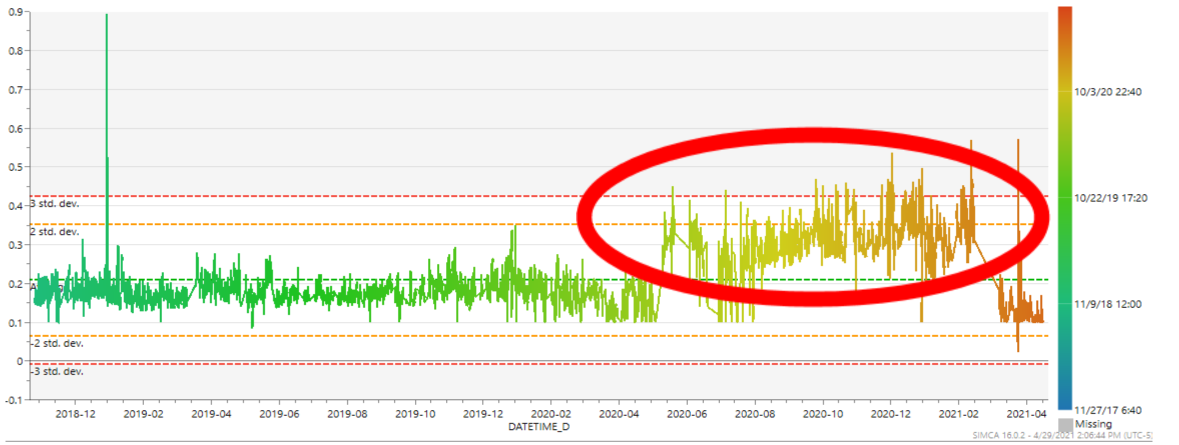




Albemarle Intelligence – Engineer Improvement Project







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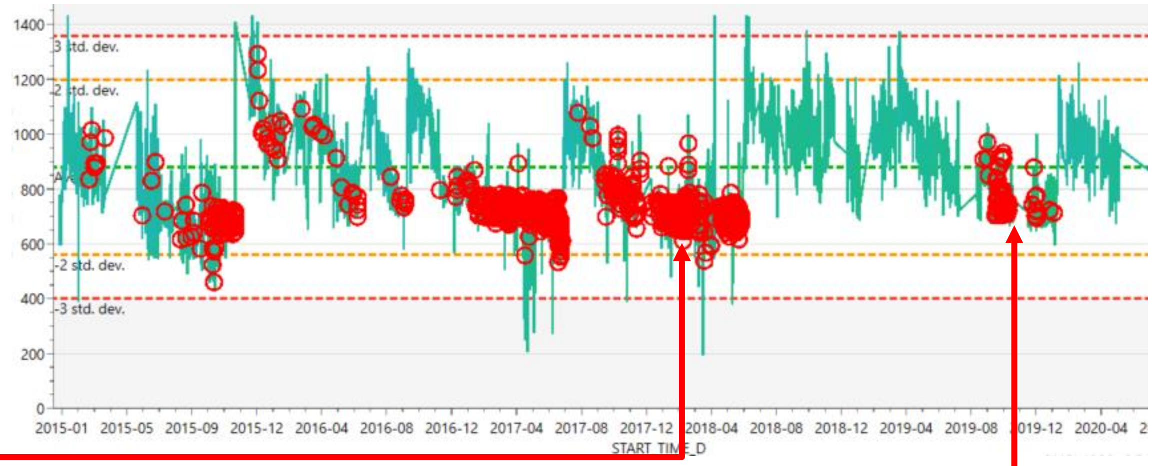
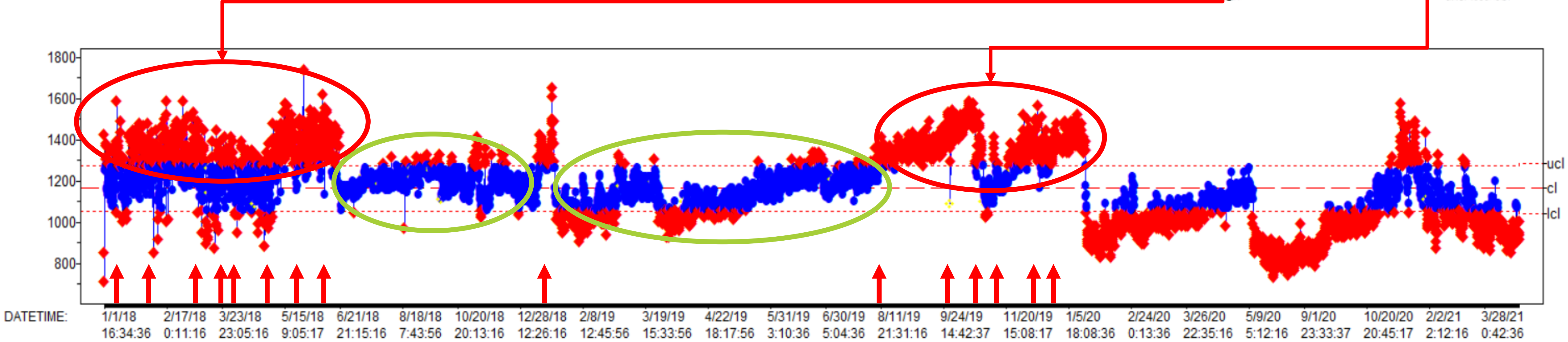
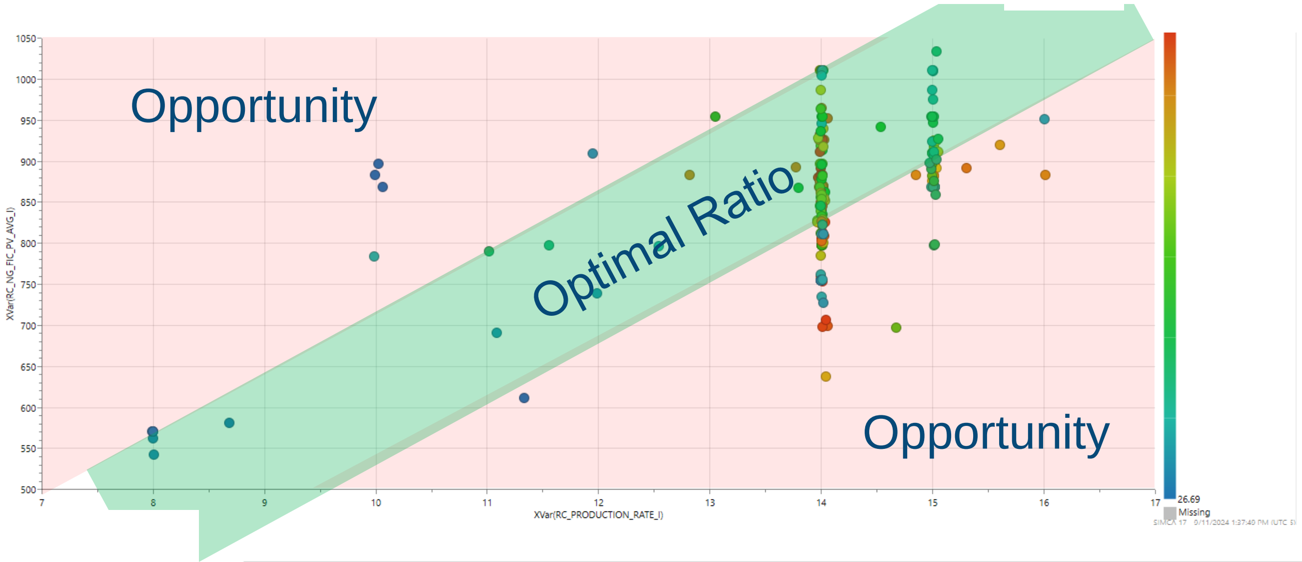
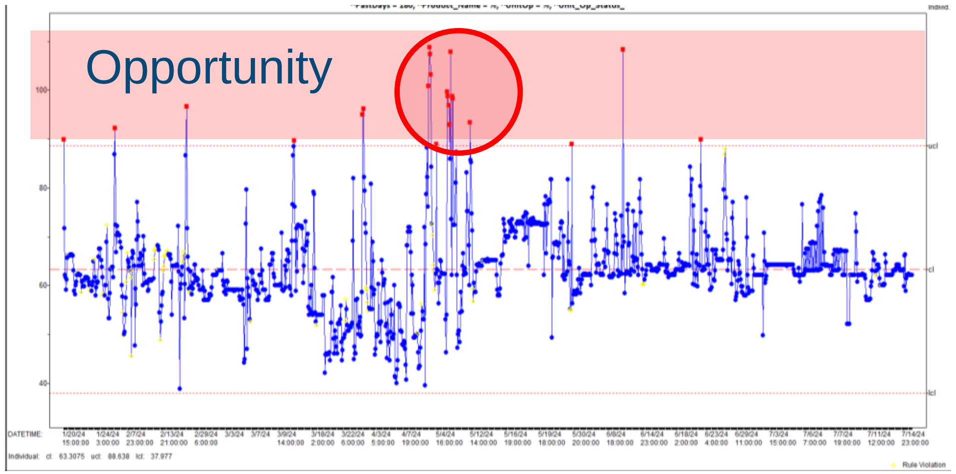
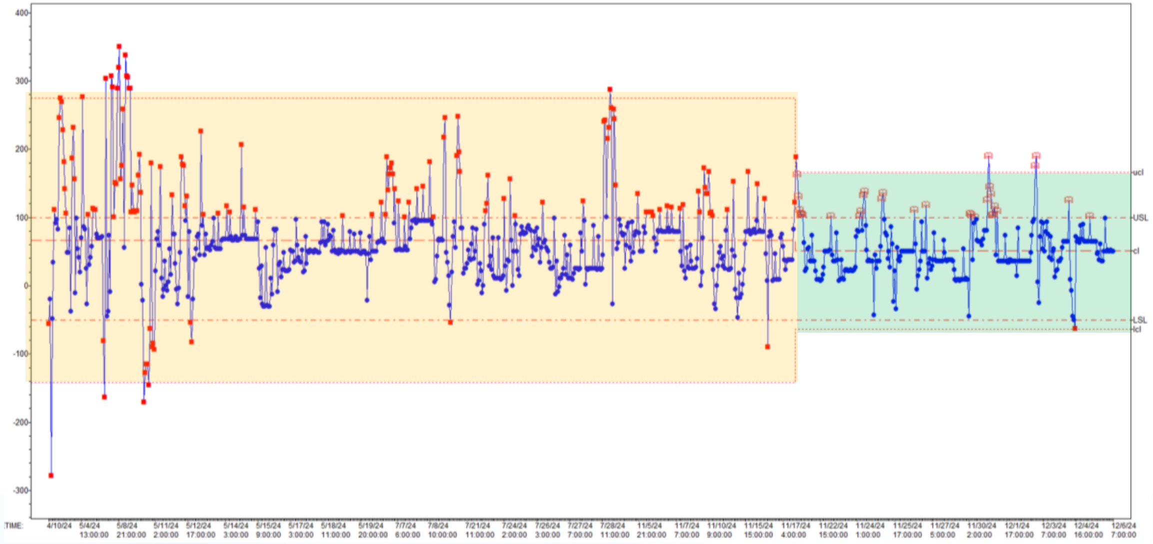




Albemarle Intelligence – Engineer Improvement Project







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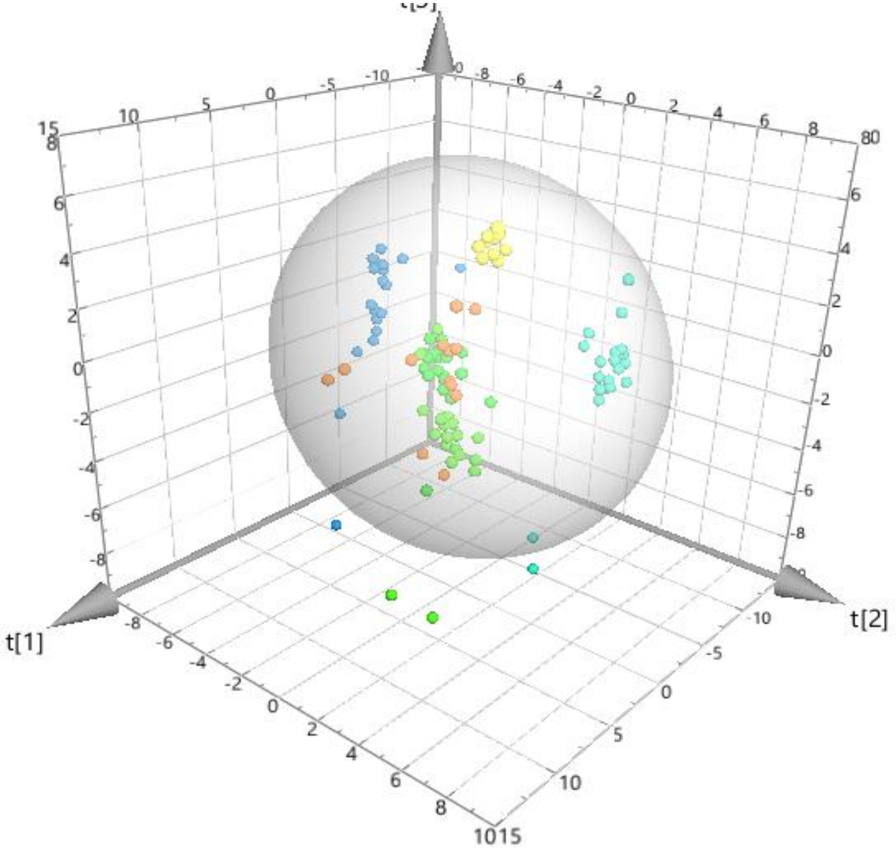
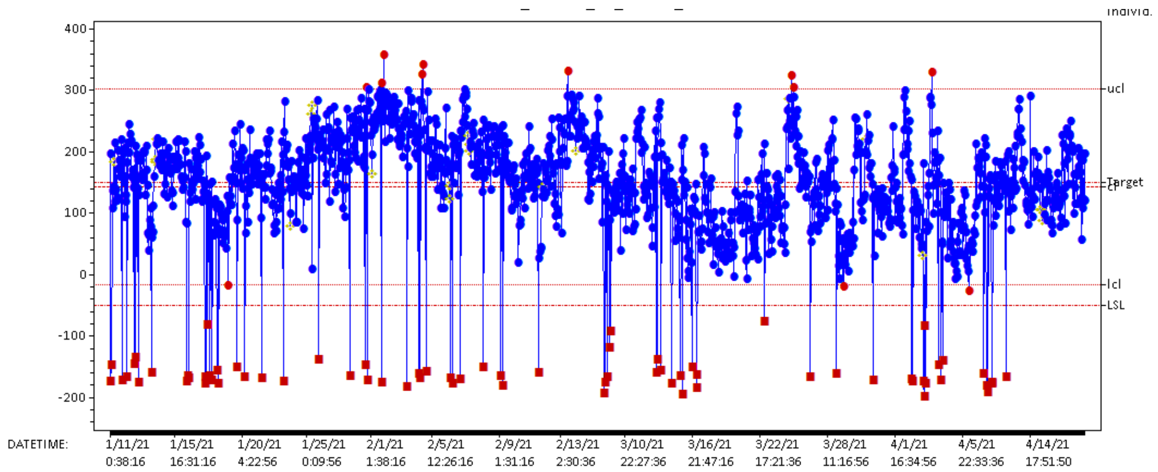
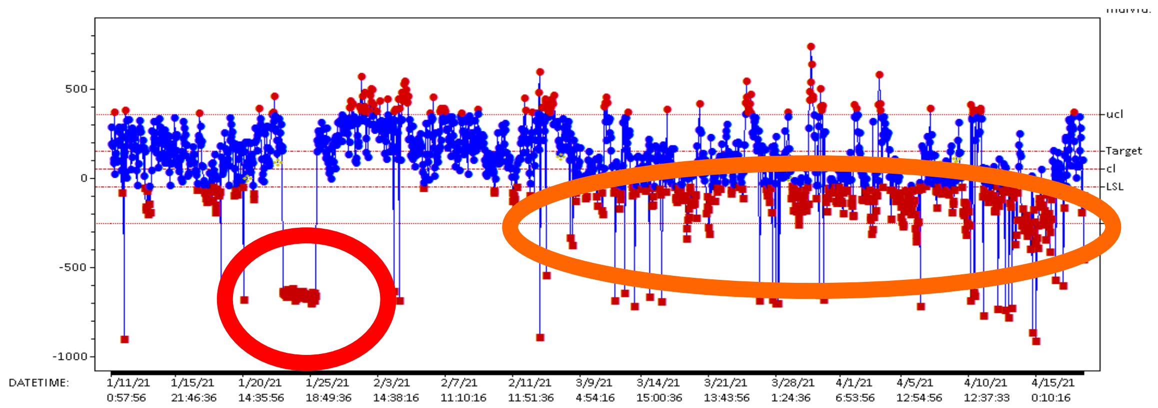
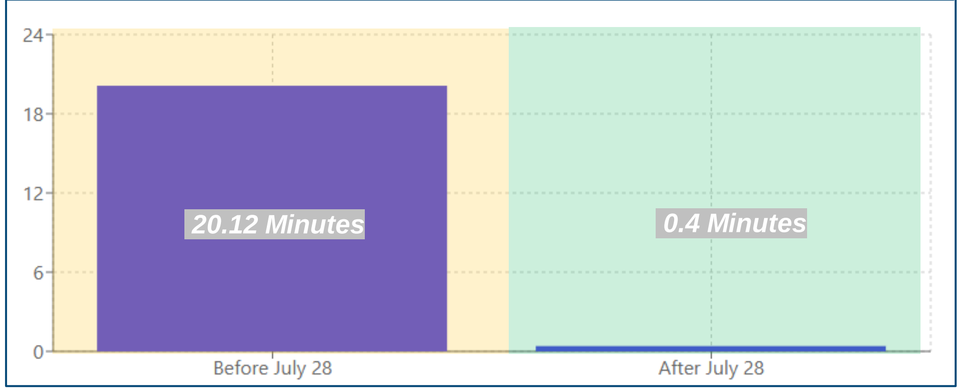




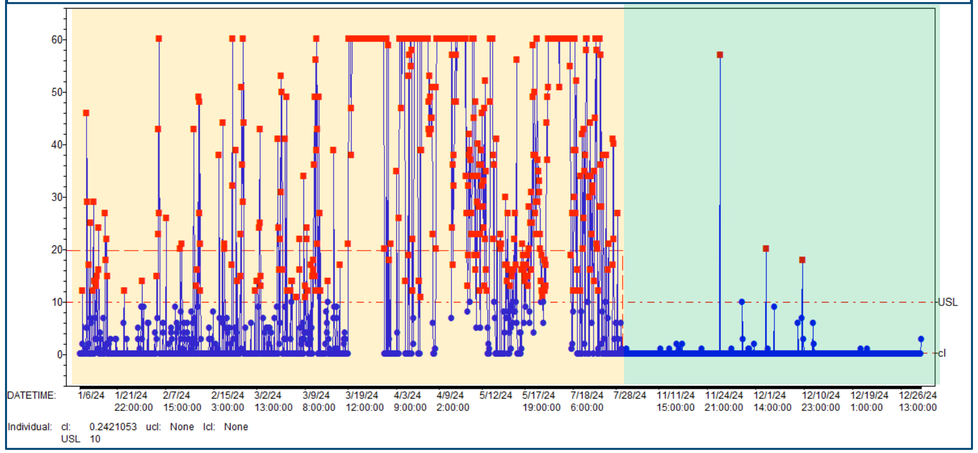


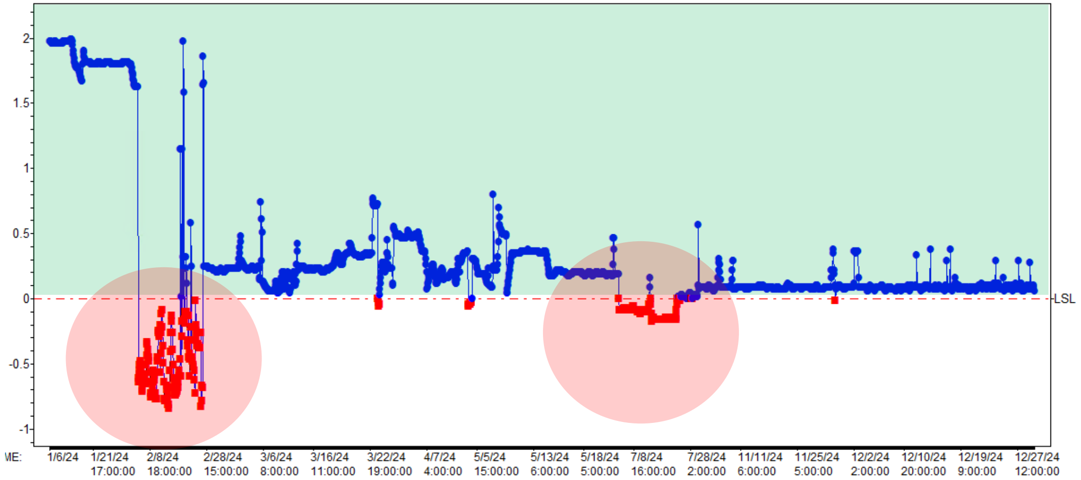
Albemarle Intelligence – Engineer Improvement Project

Avg Minutes per Hour Where Ratio Was Out Of Optimal*

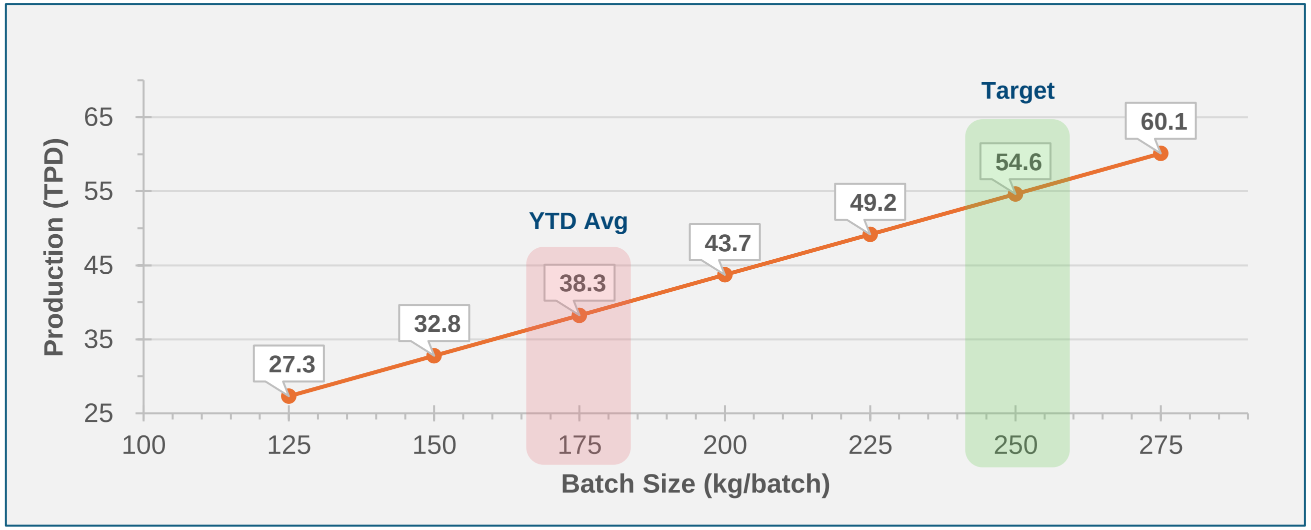


Minutes per Hour Where Ratio Was Out Of Optimal



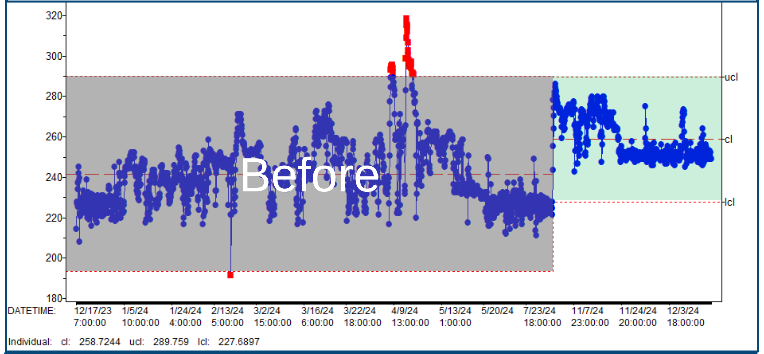


Albemarle Intelligence – Engineer Improvement Project

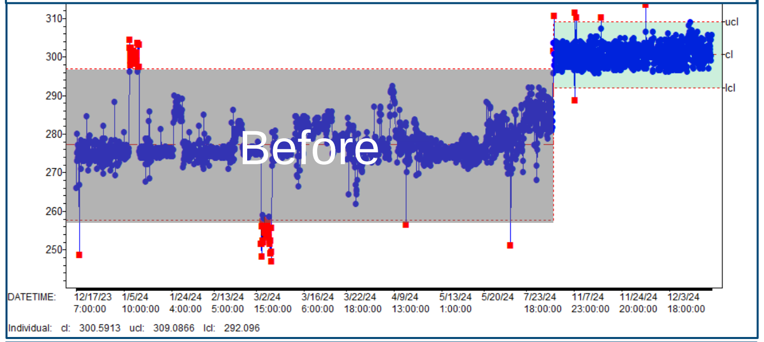


Albemarle Intelligence – Engineer Improvement Project

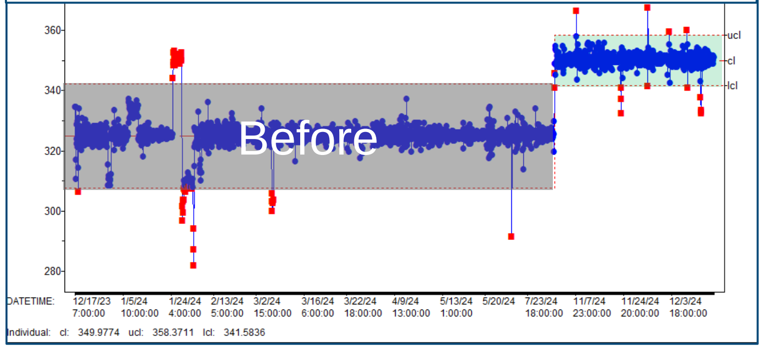
Temperature 1

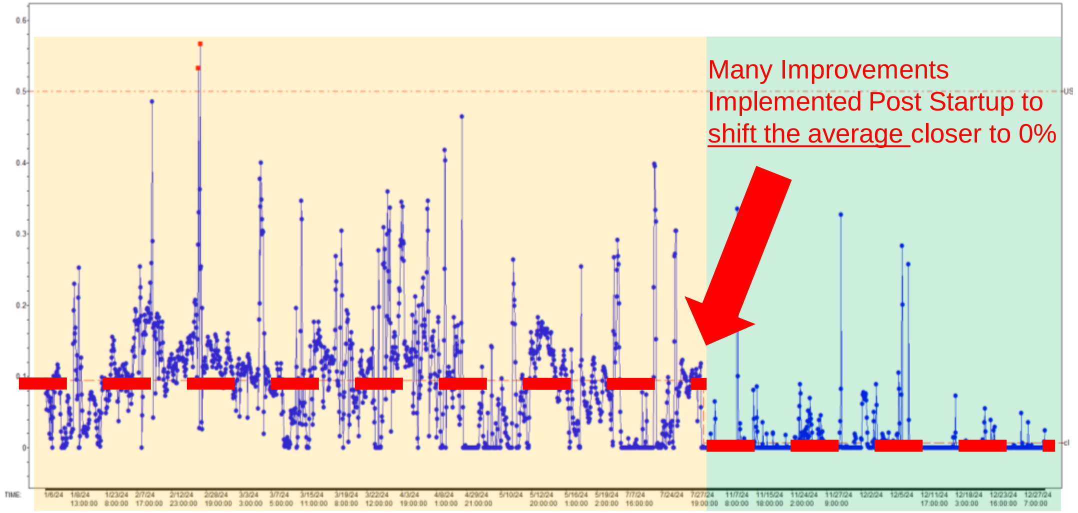


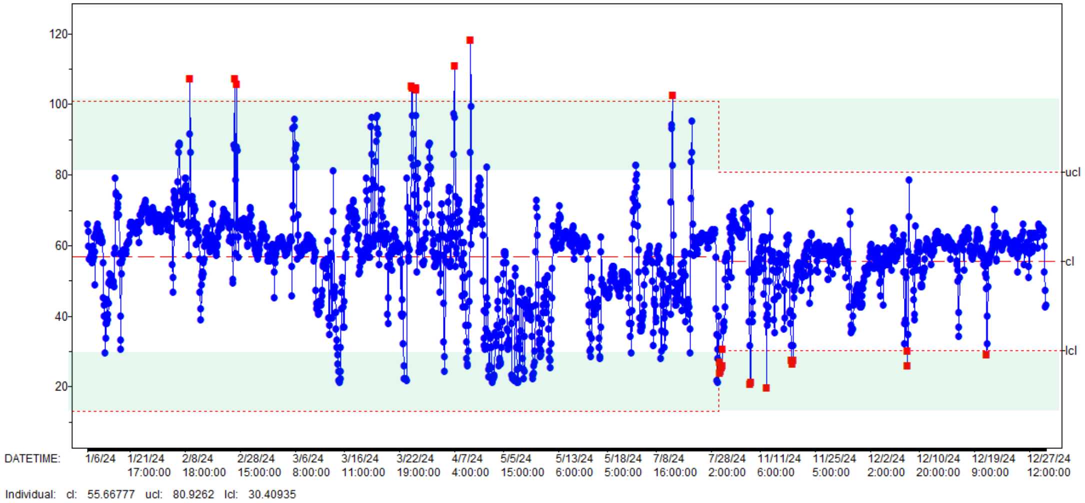
Temperature 2



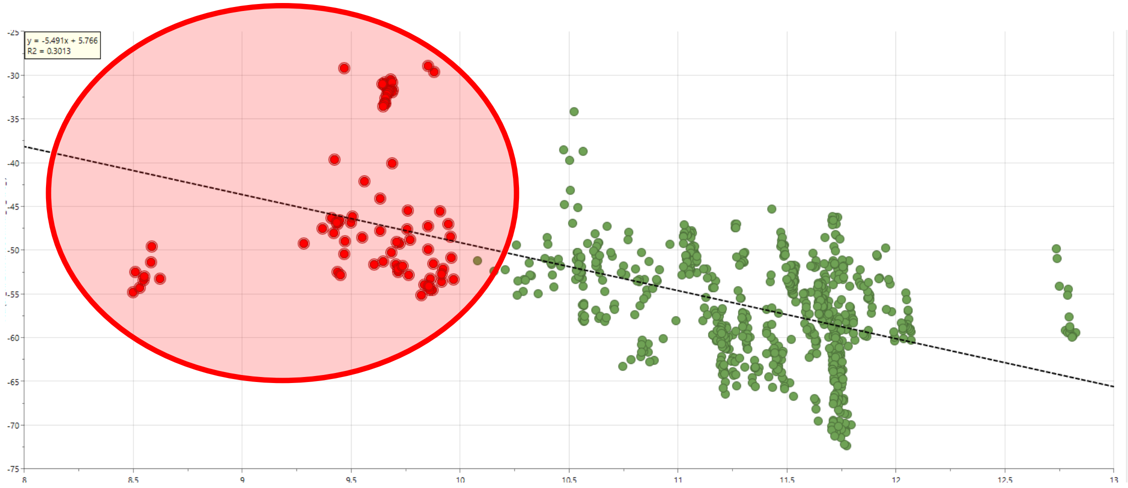
Temperature 3

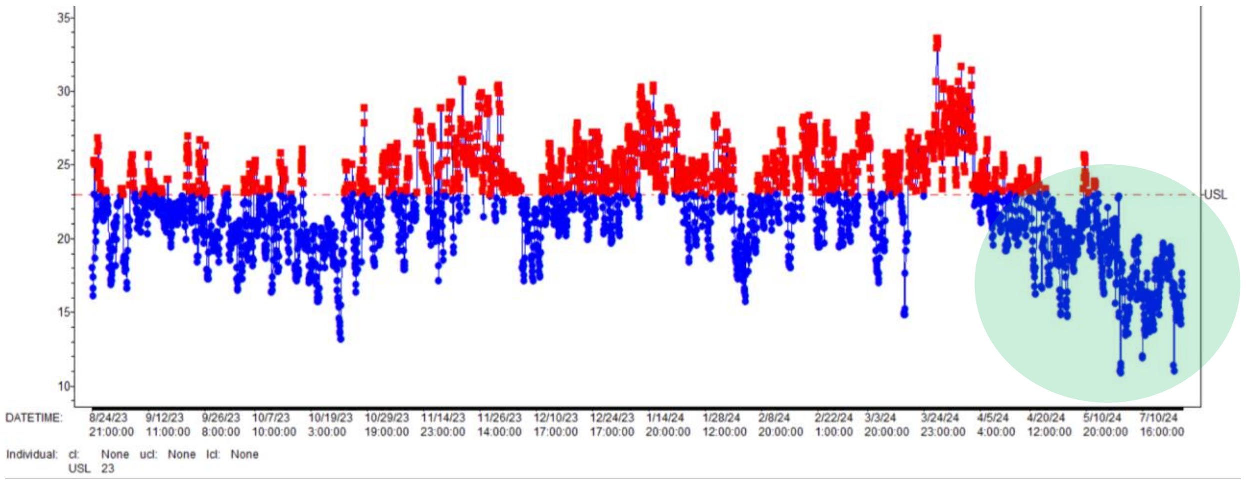


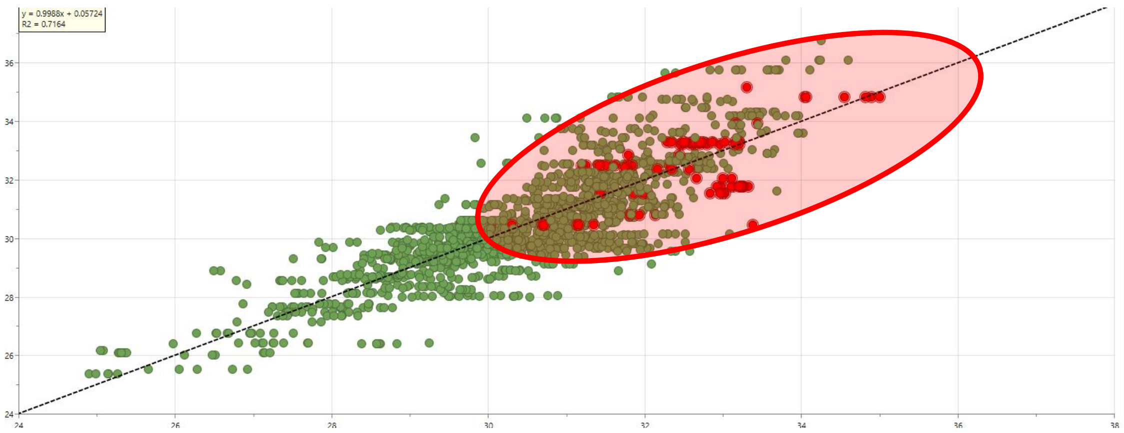


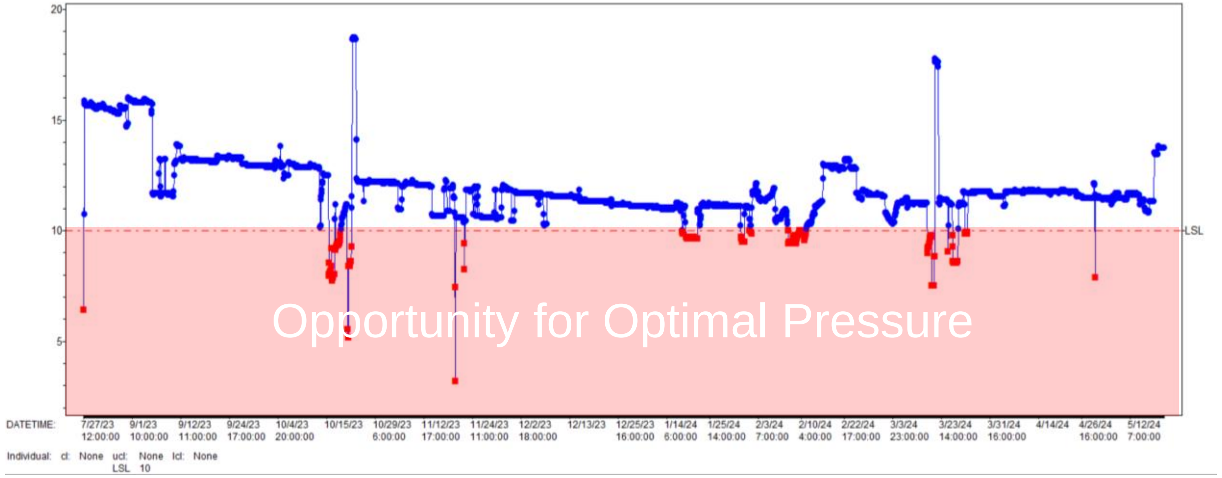


Albemarle Intelligence – Engineer Improvement Project

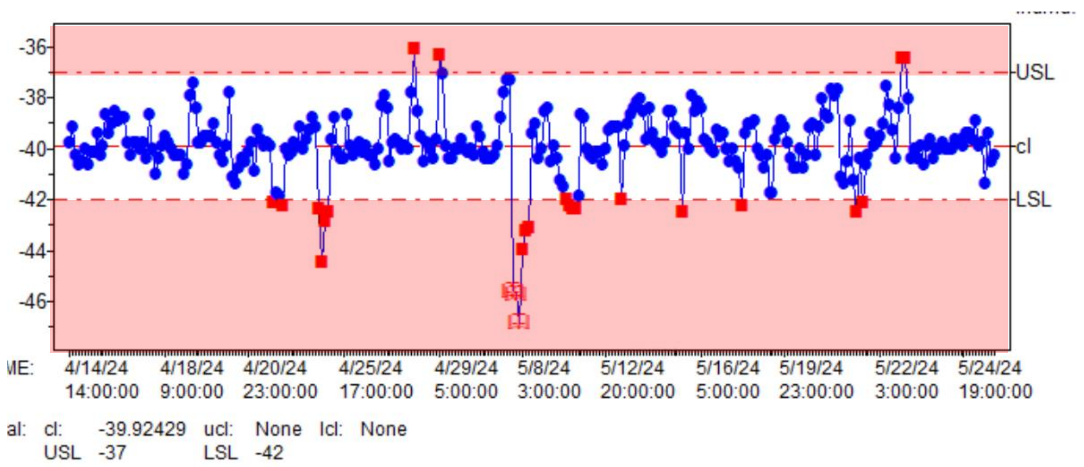


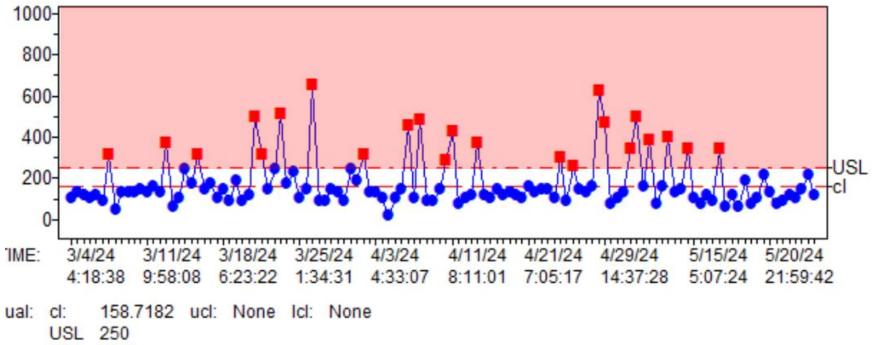


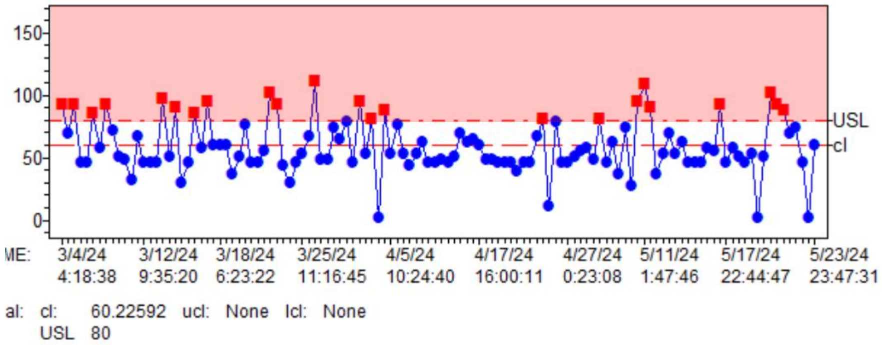


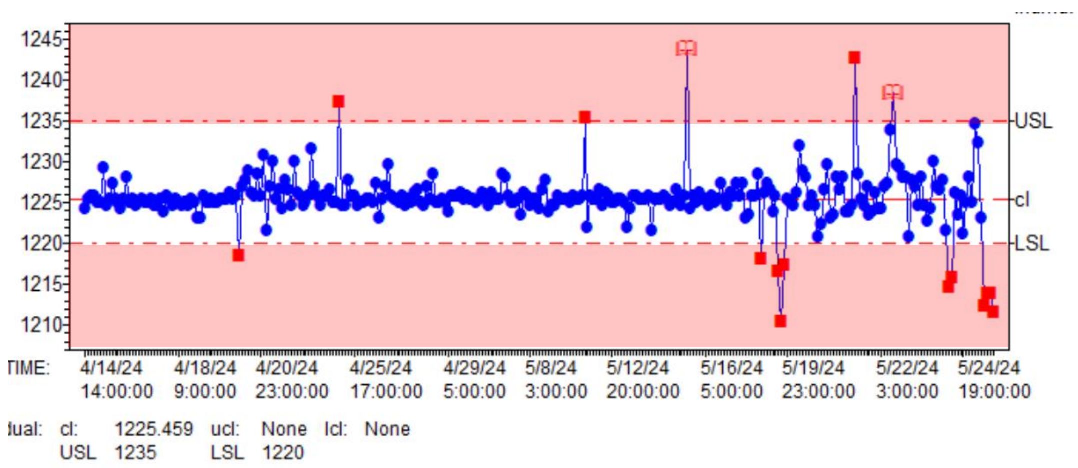


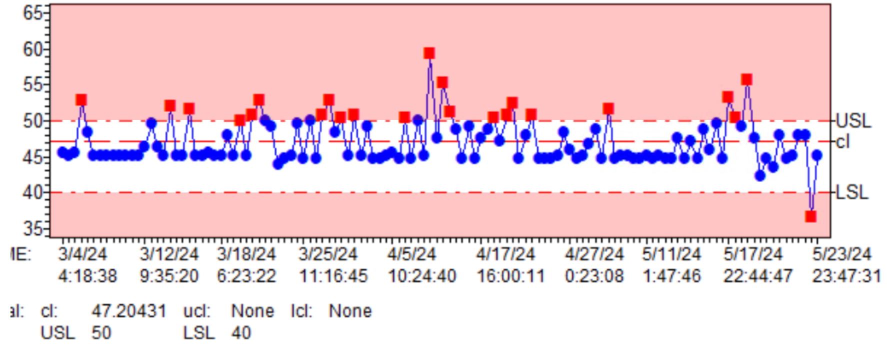
Albemarle Intelligence – Engineer Improvement Project



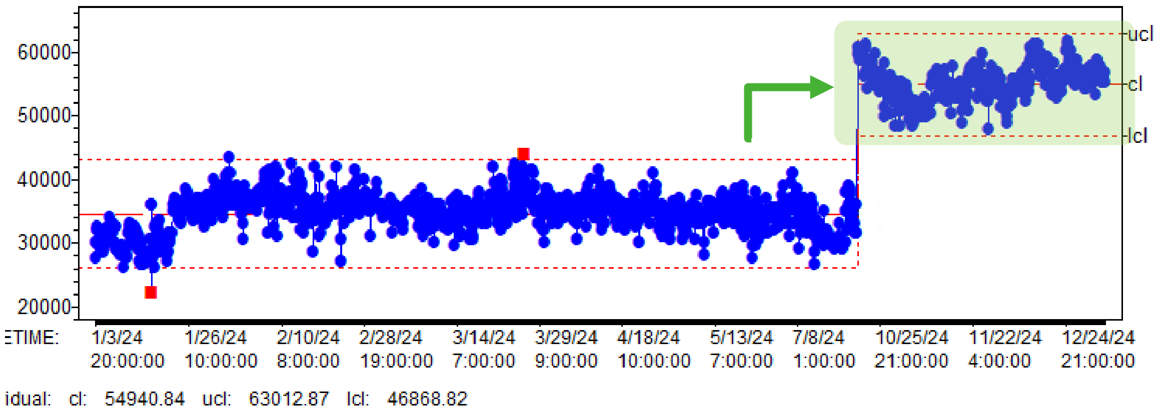


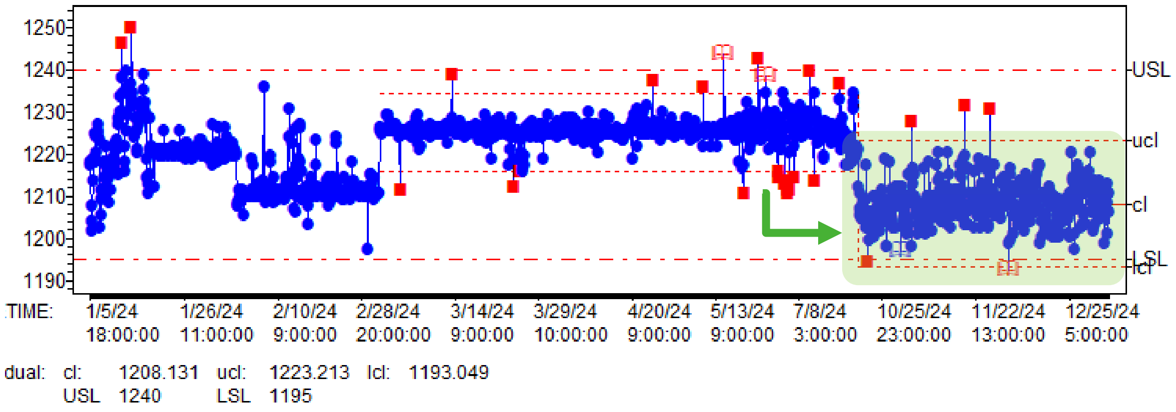


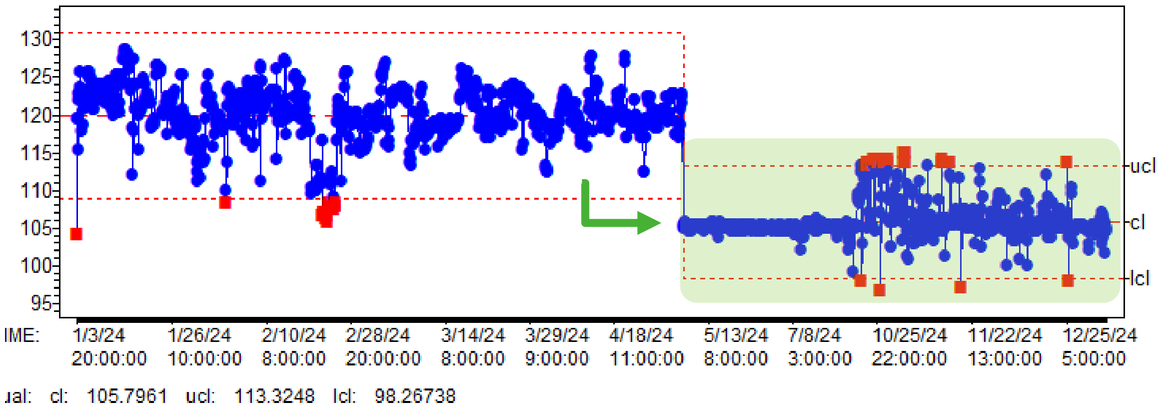




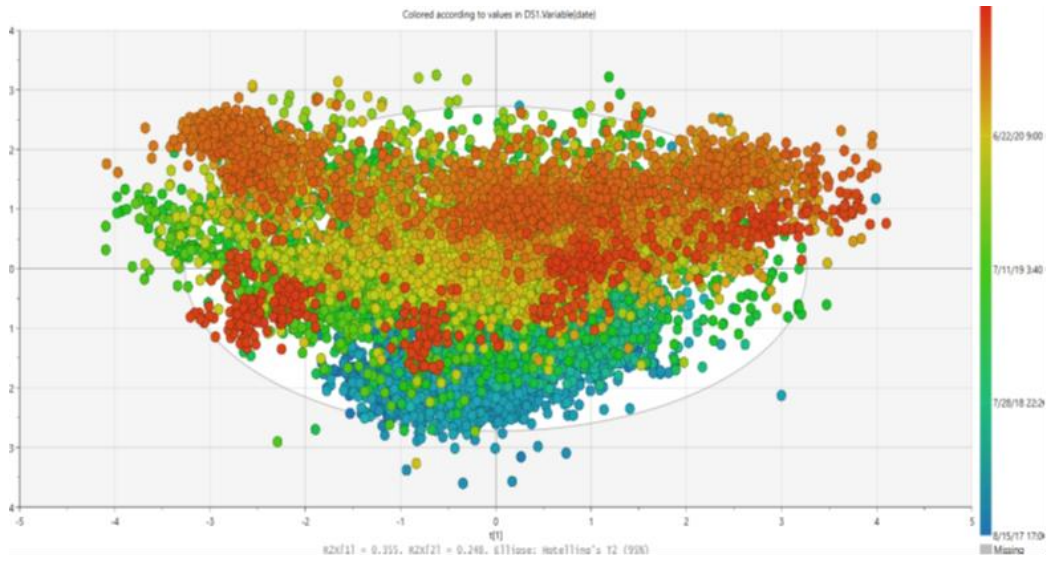
Albemarle Intelligence – Engineer Improvement Project

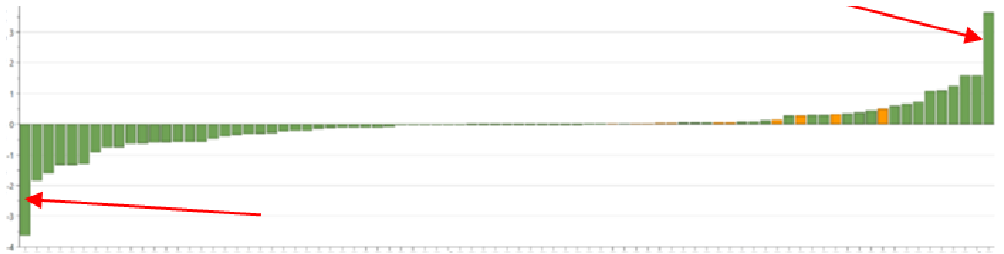


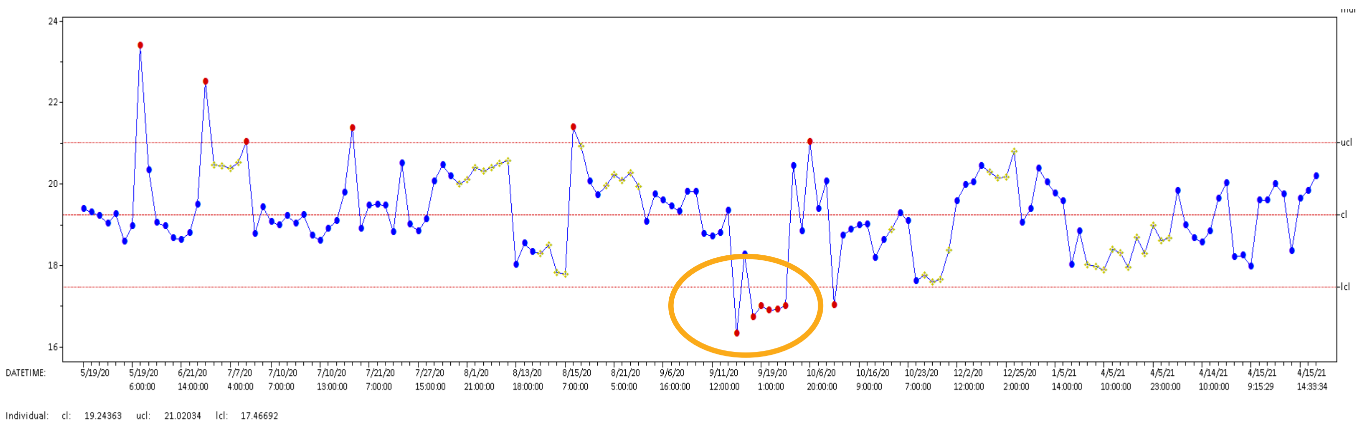


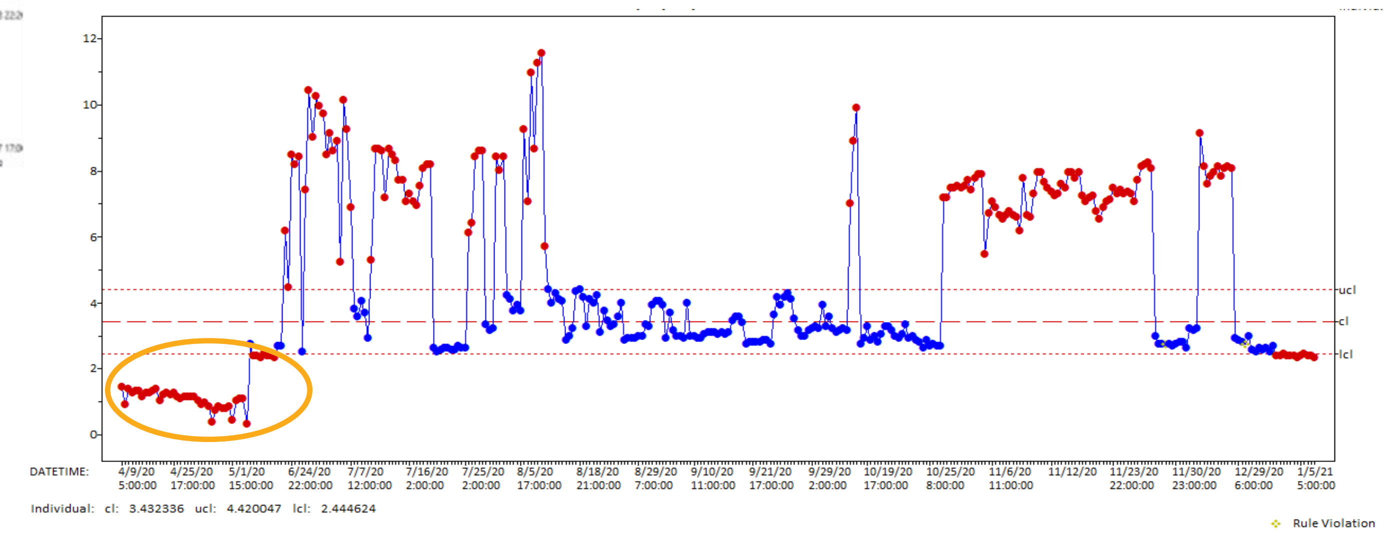


Albemarle Intelligence – Engineer Improvement Project









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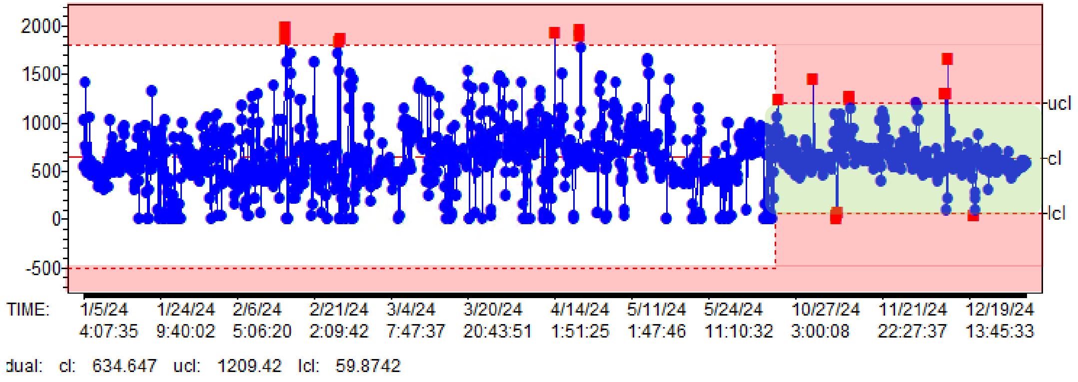

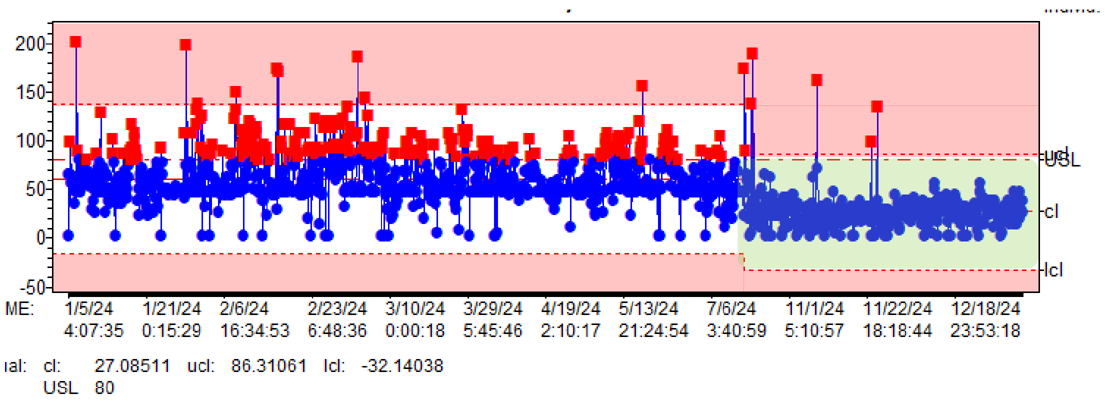

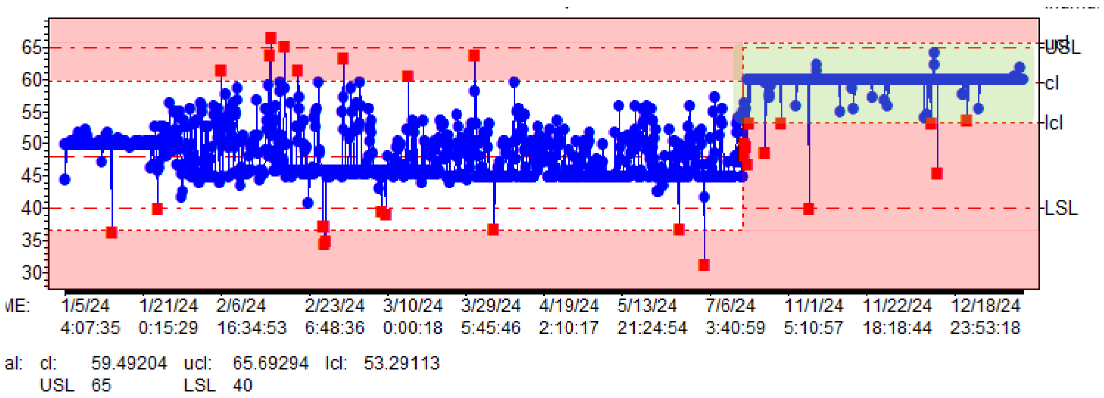

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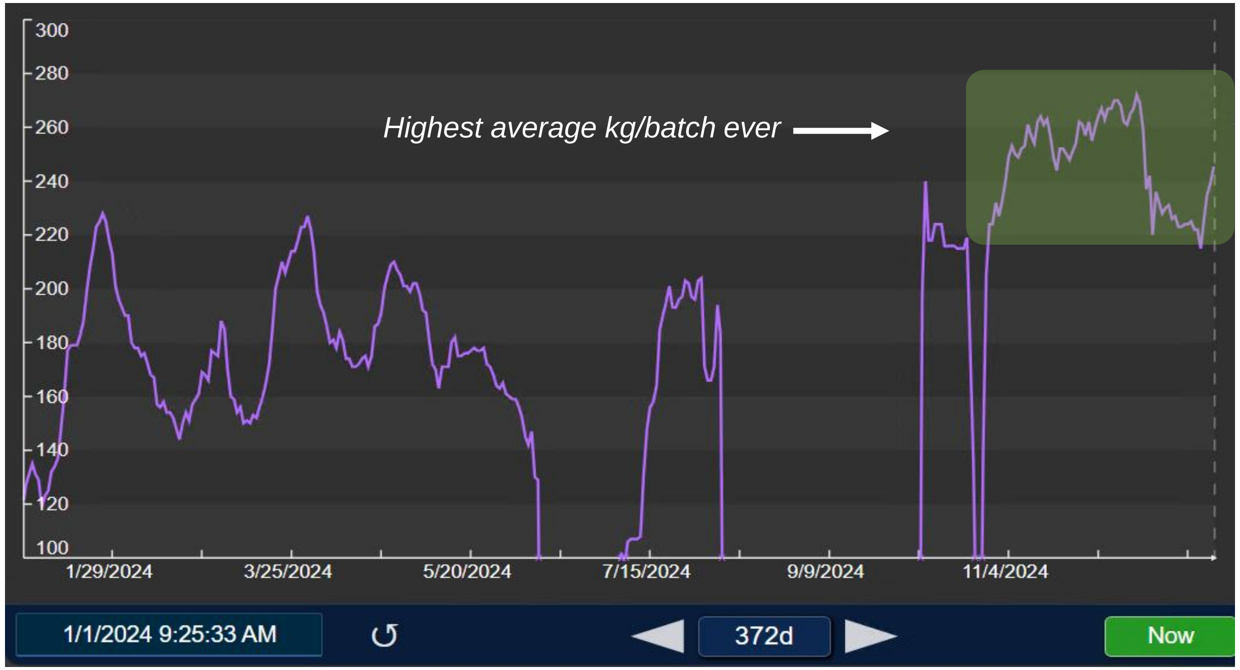

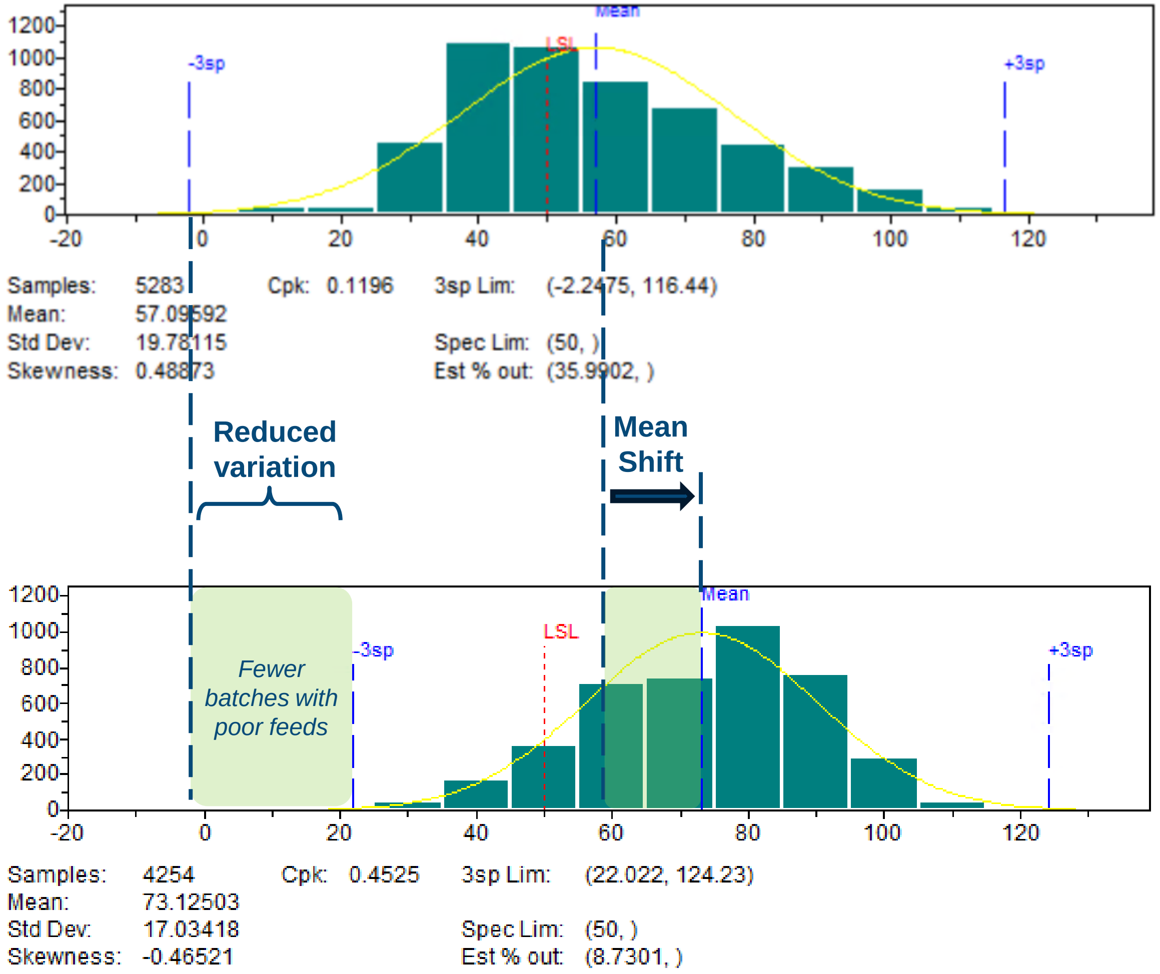

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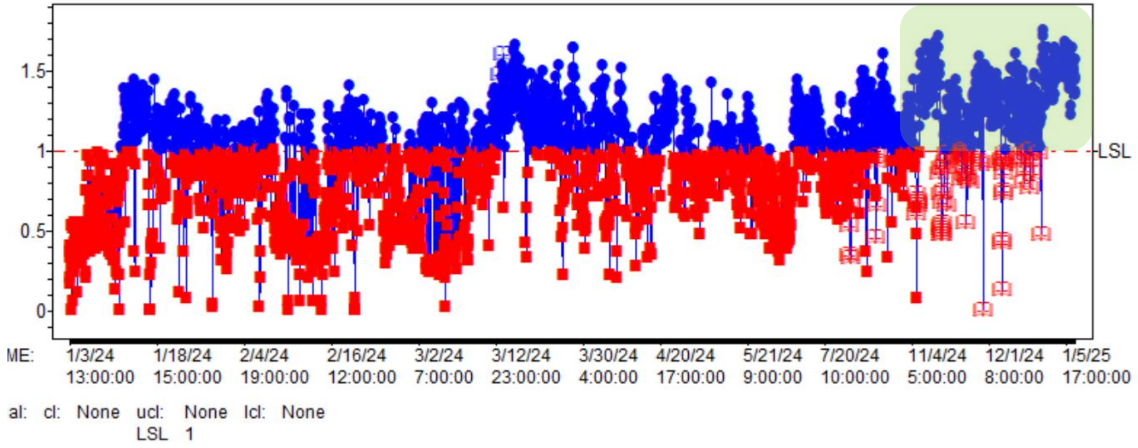
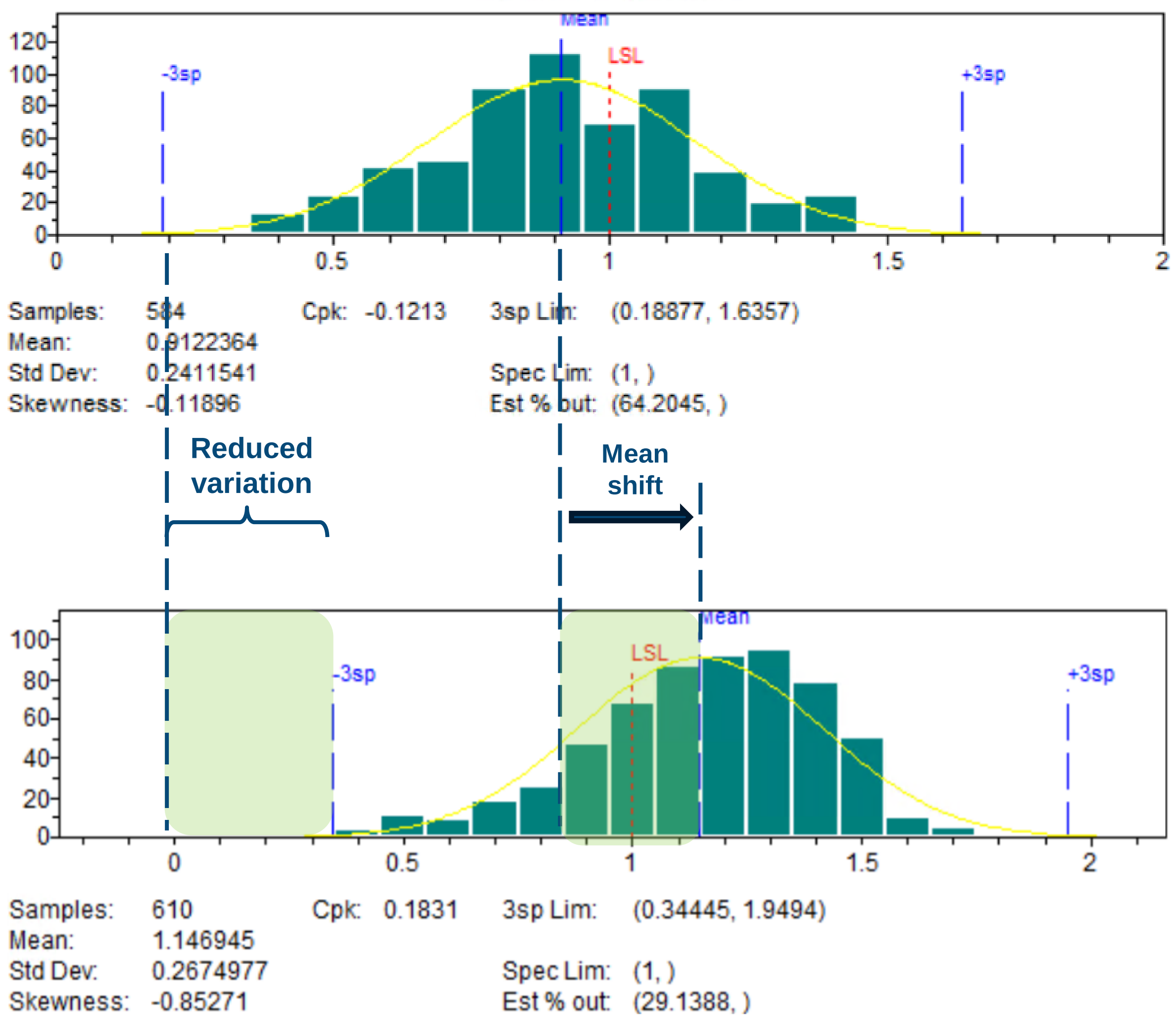
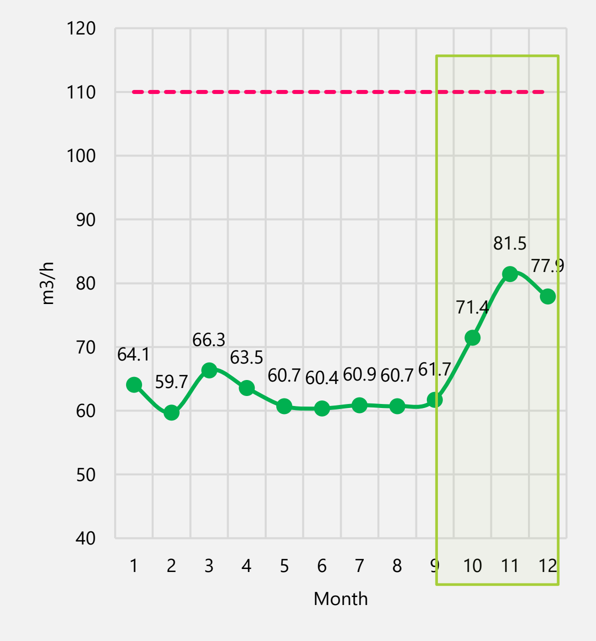
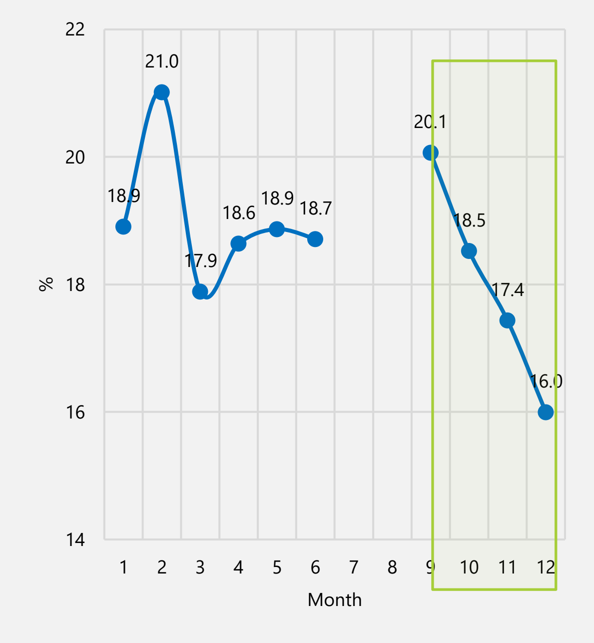




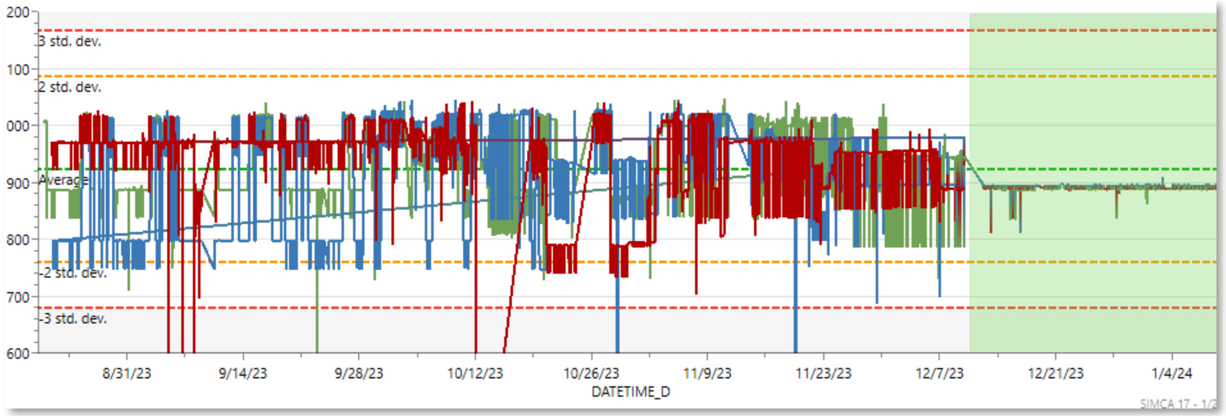
Albemarle Intelligence – Engineer Improvement Project

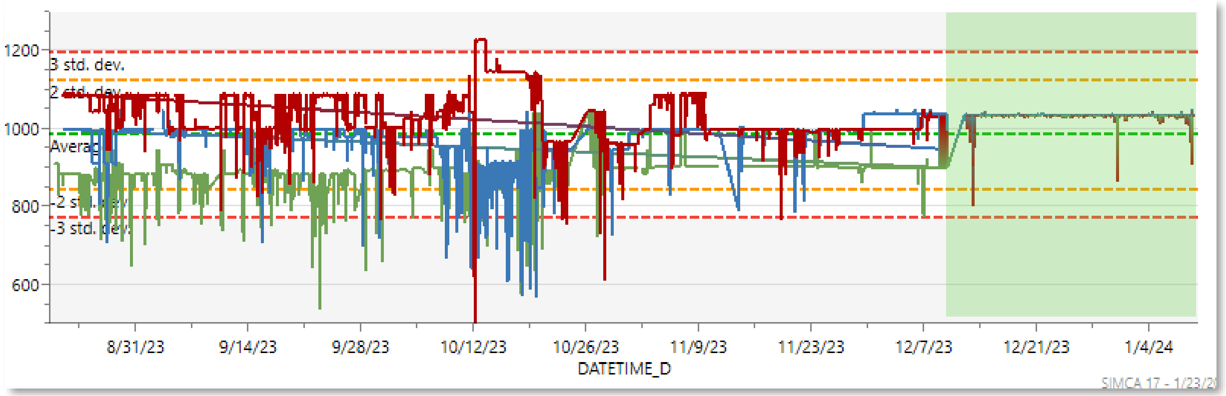


Increase in production rate



Quality Improvement





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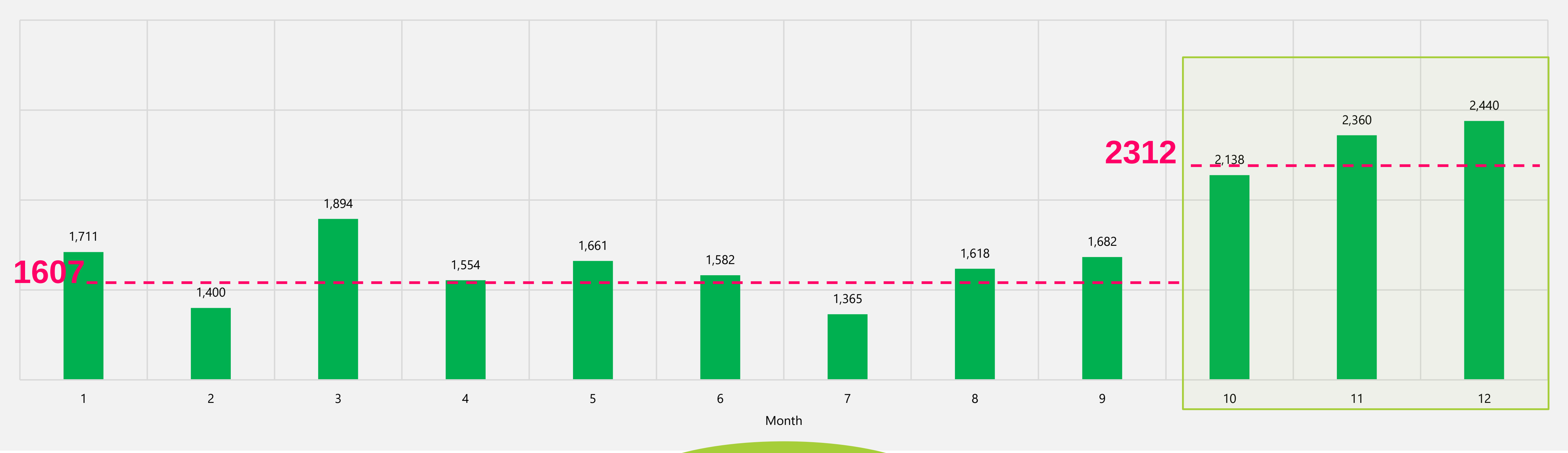
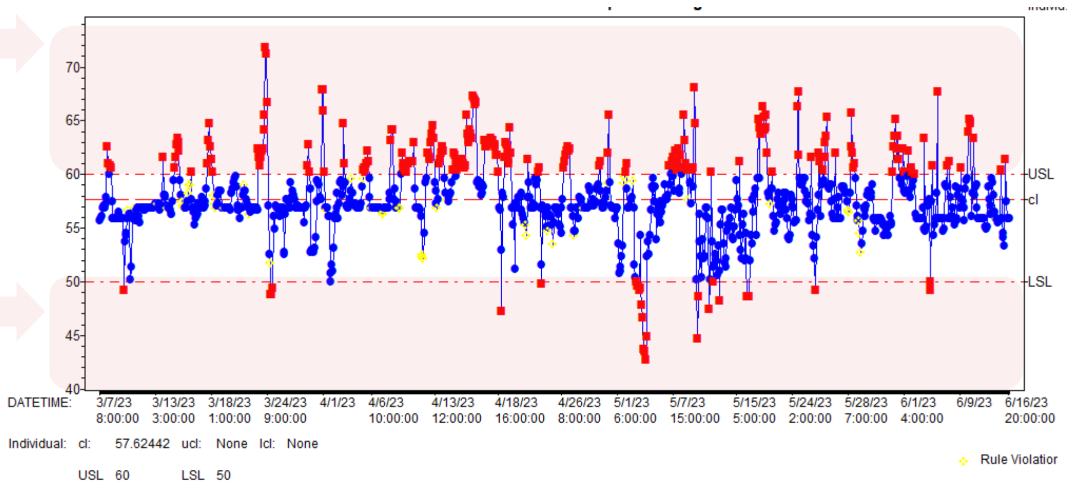
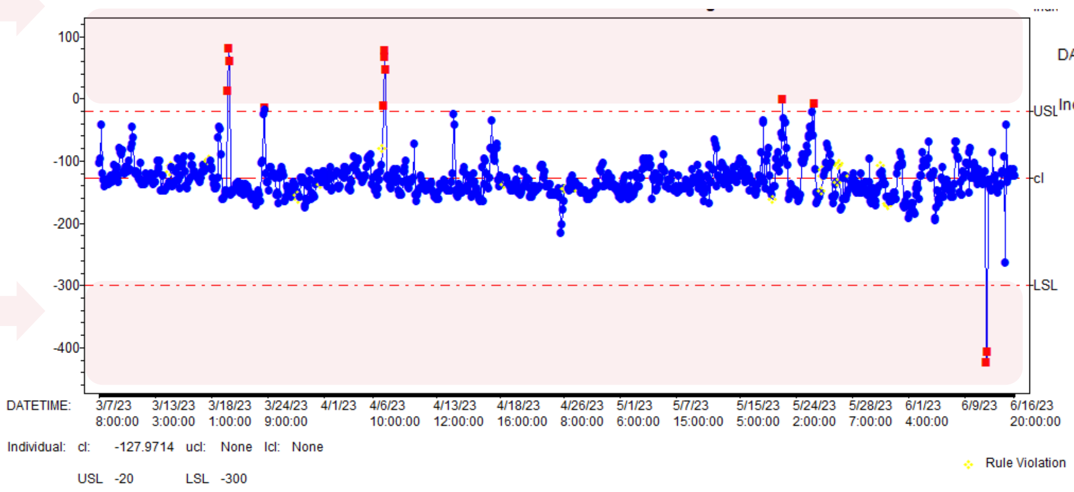


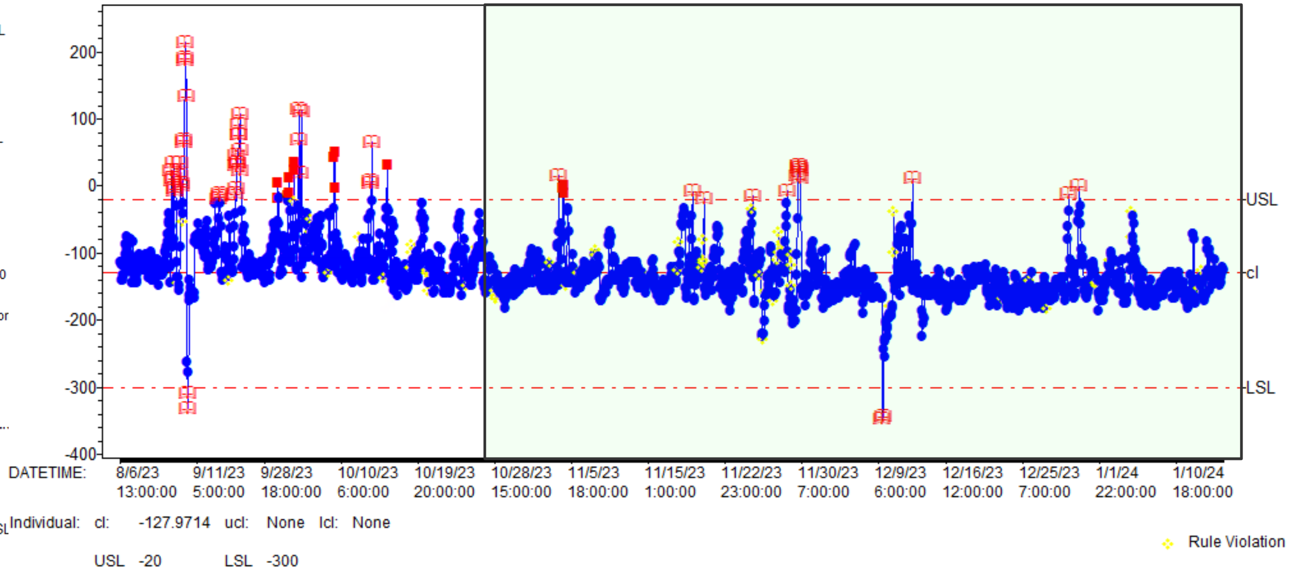
Increase in the monthly production

Albemarle Intelligence – Engineer Improvement Project

Opportunities







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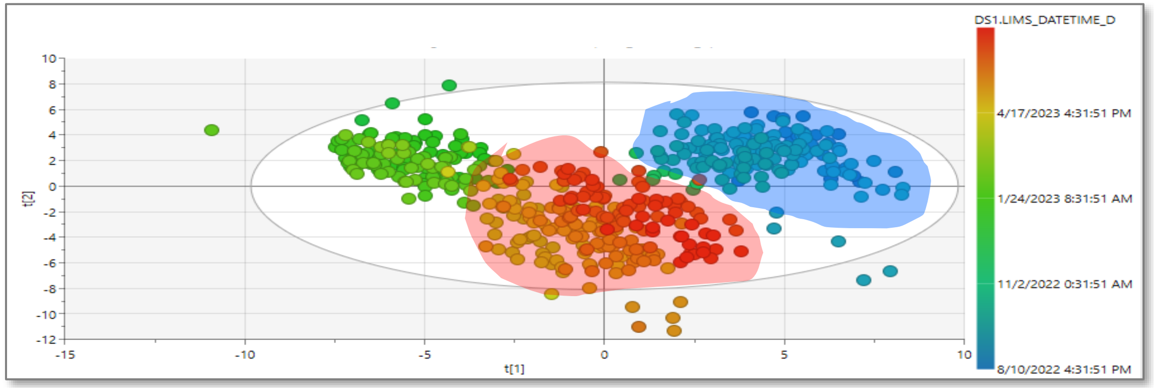

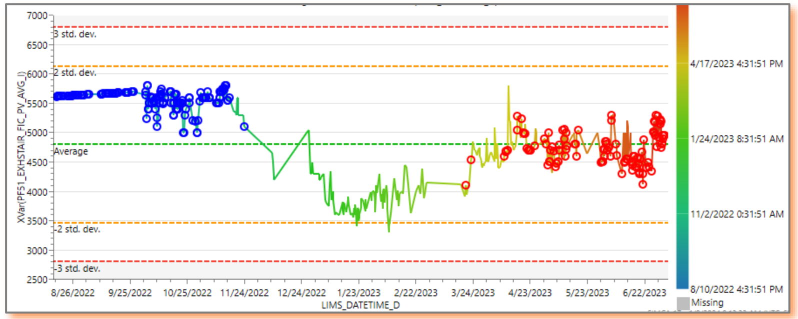

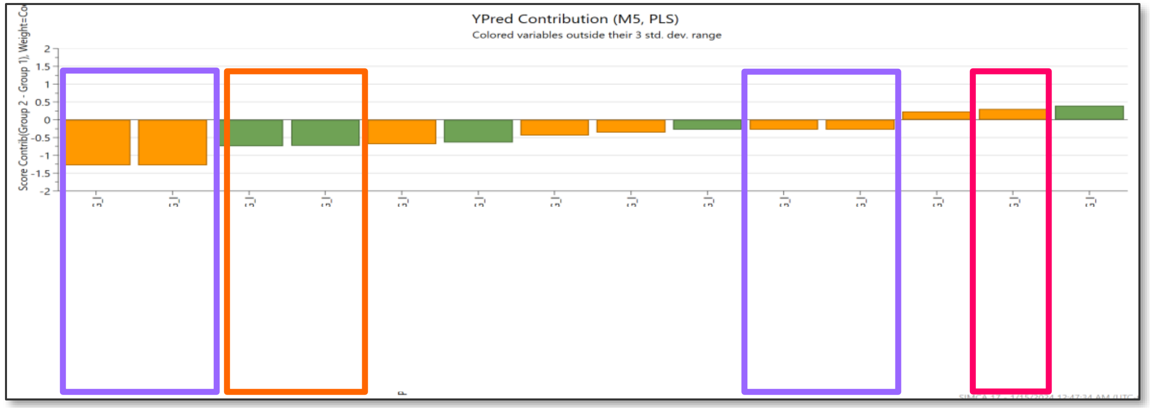

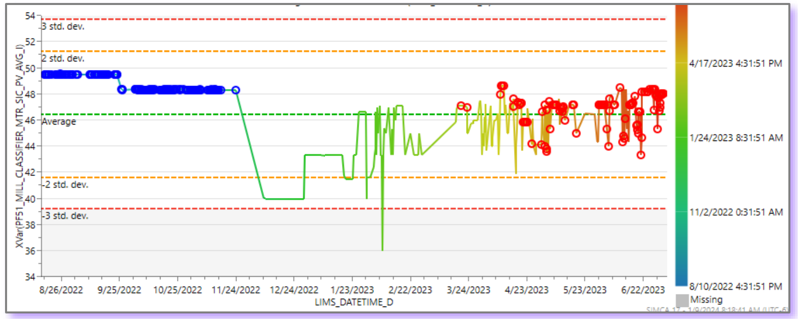

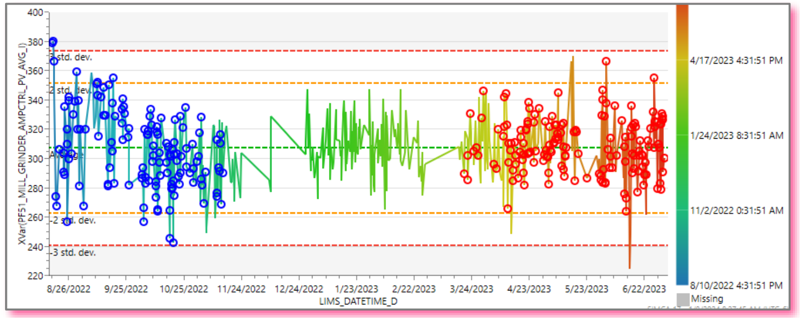

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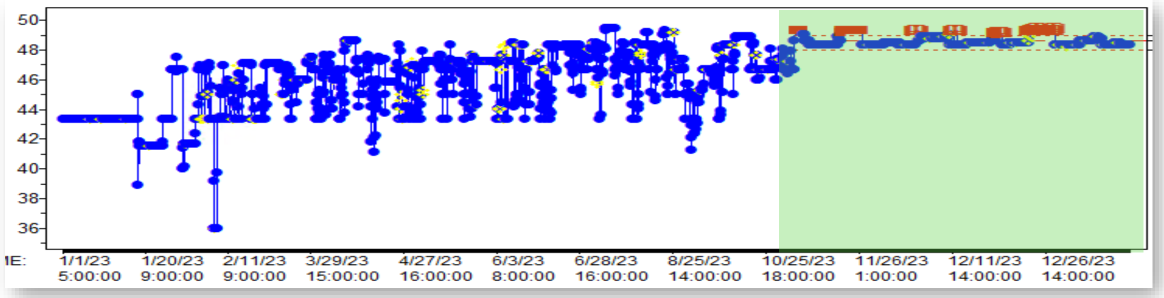

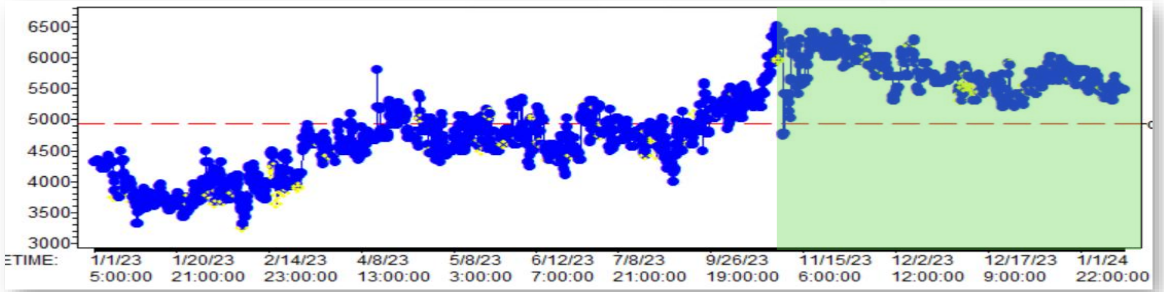

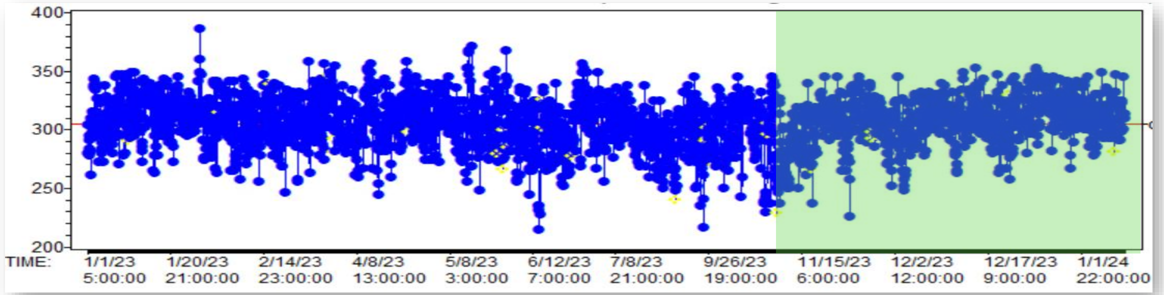

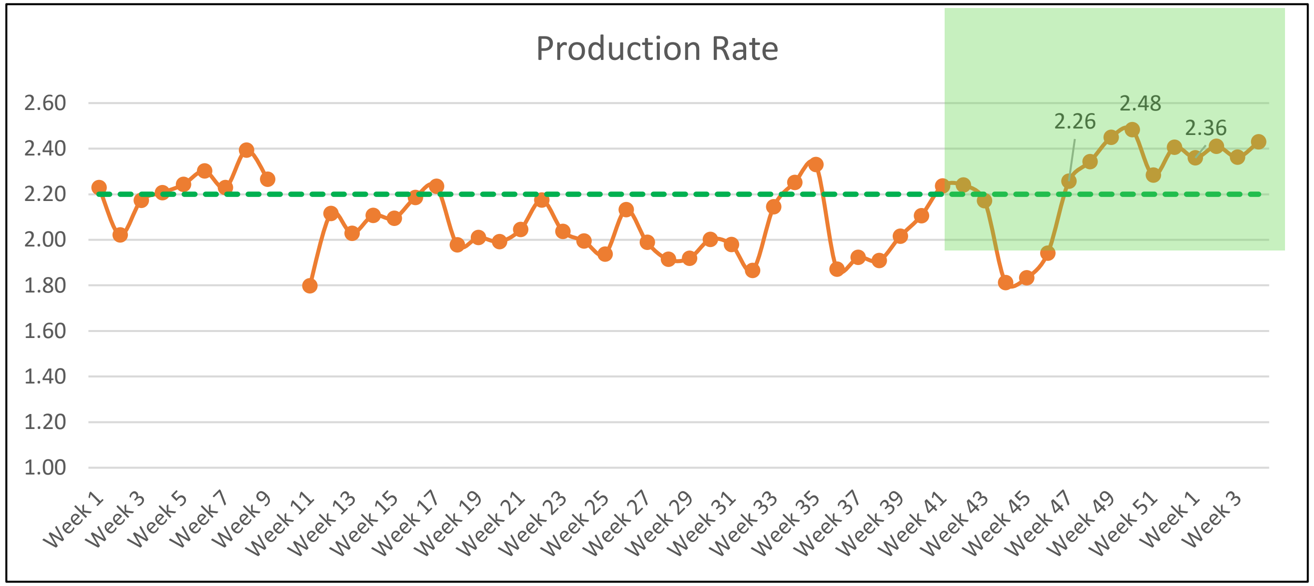

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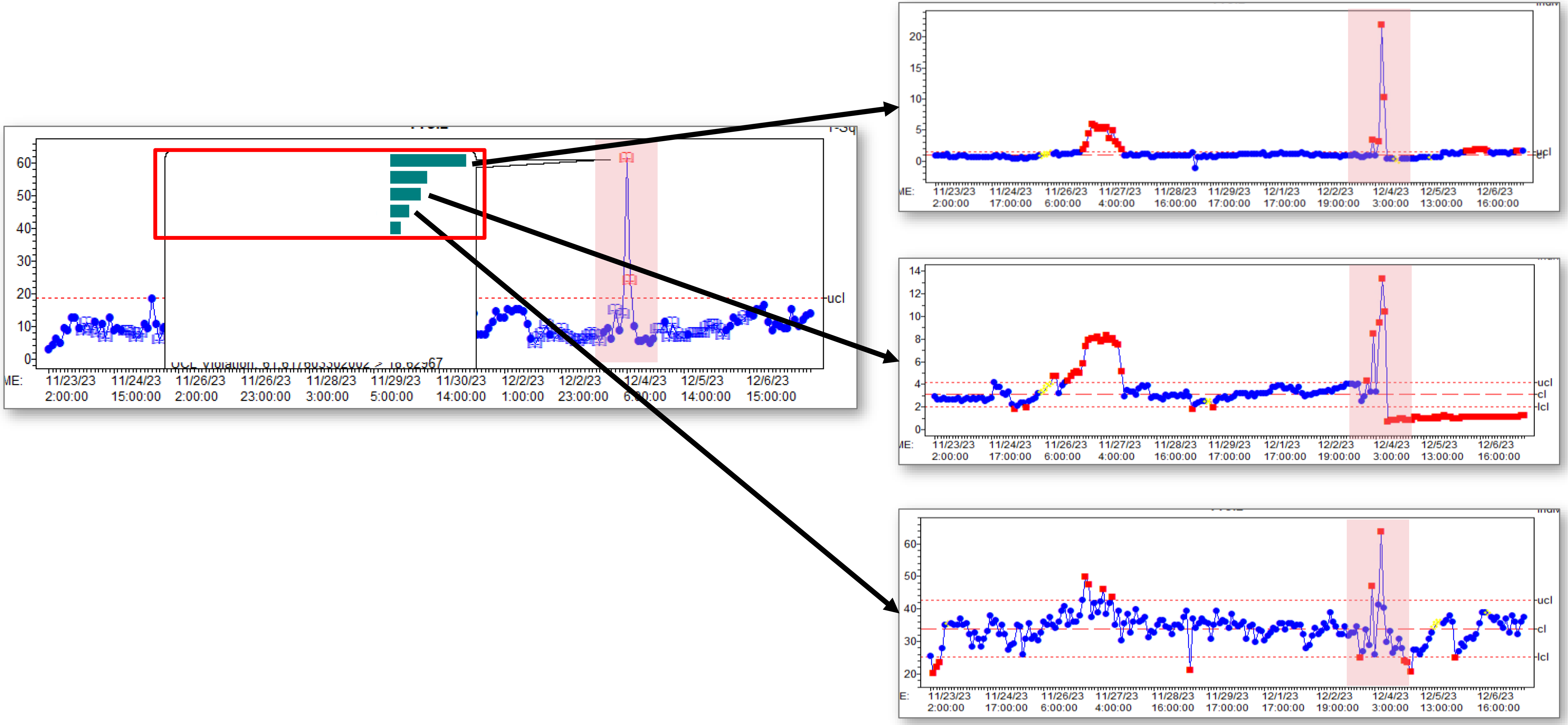

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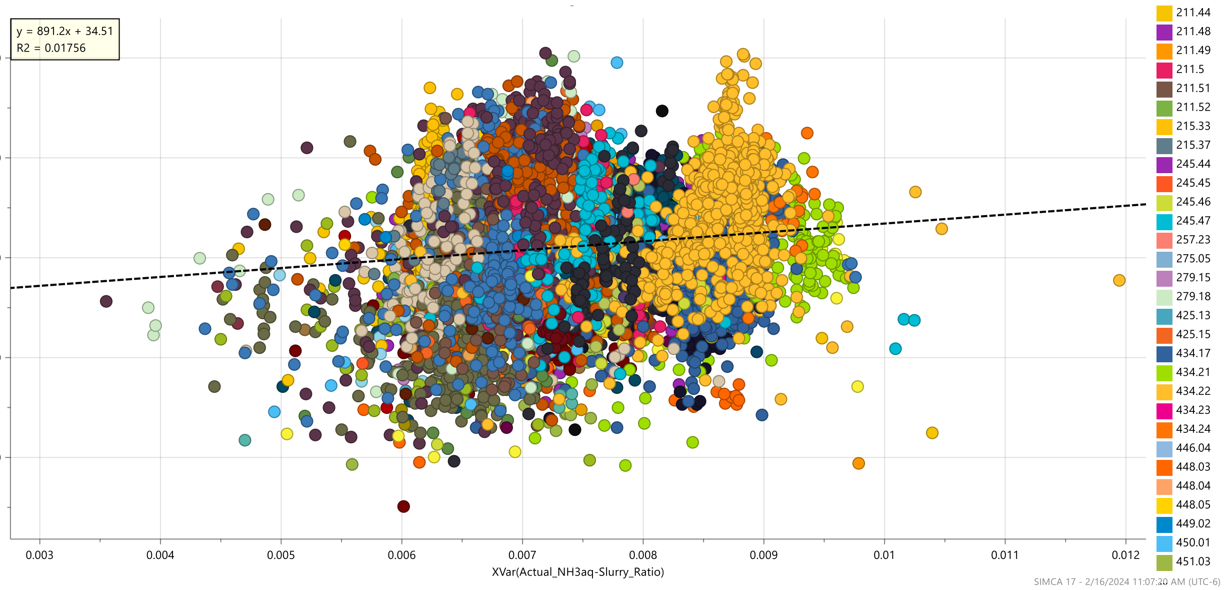
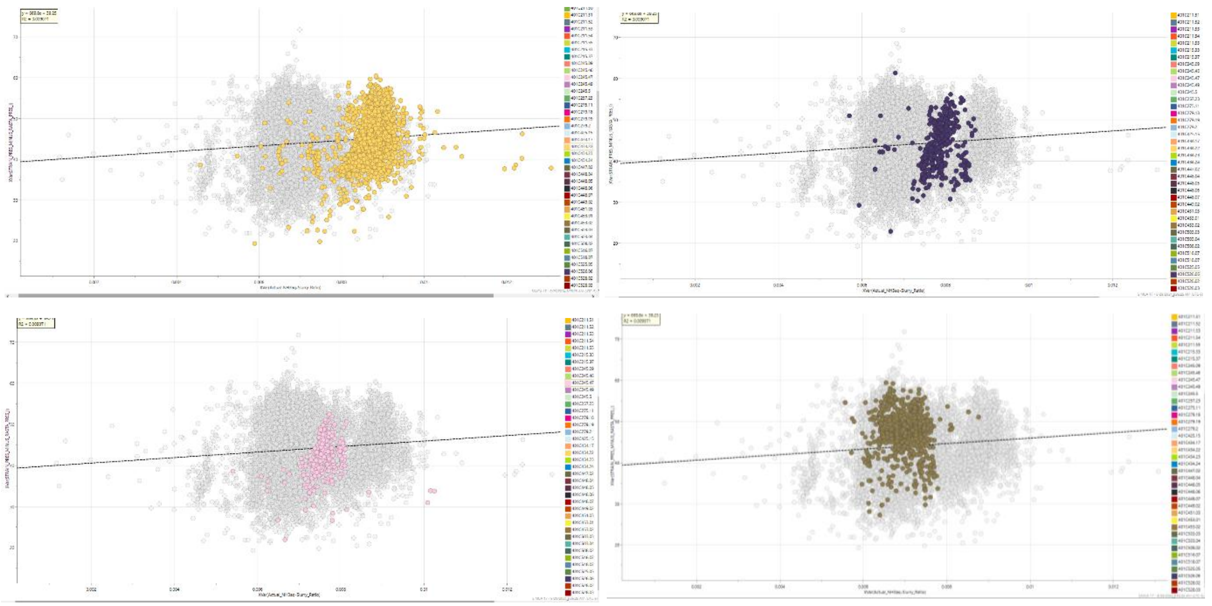
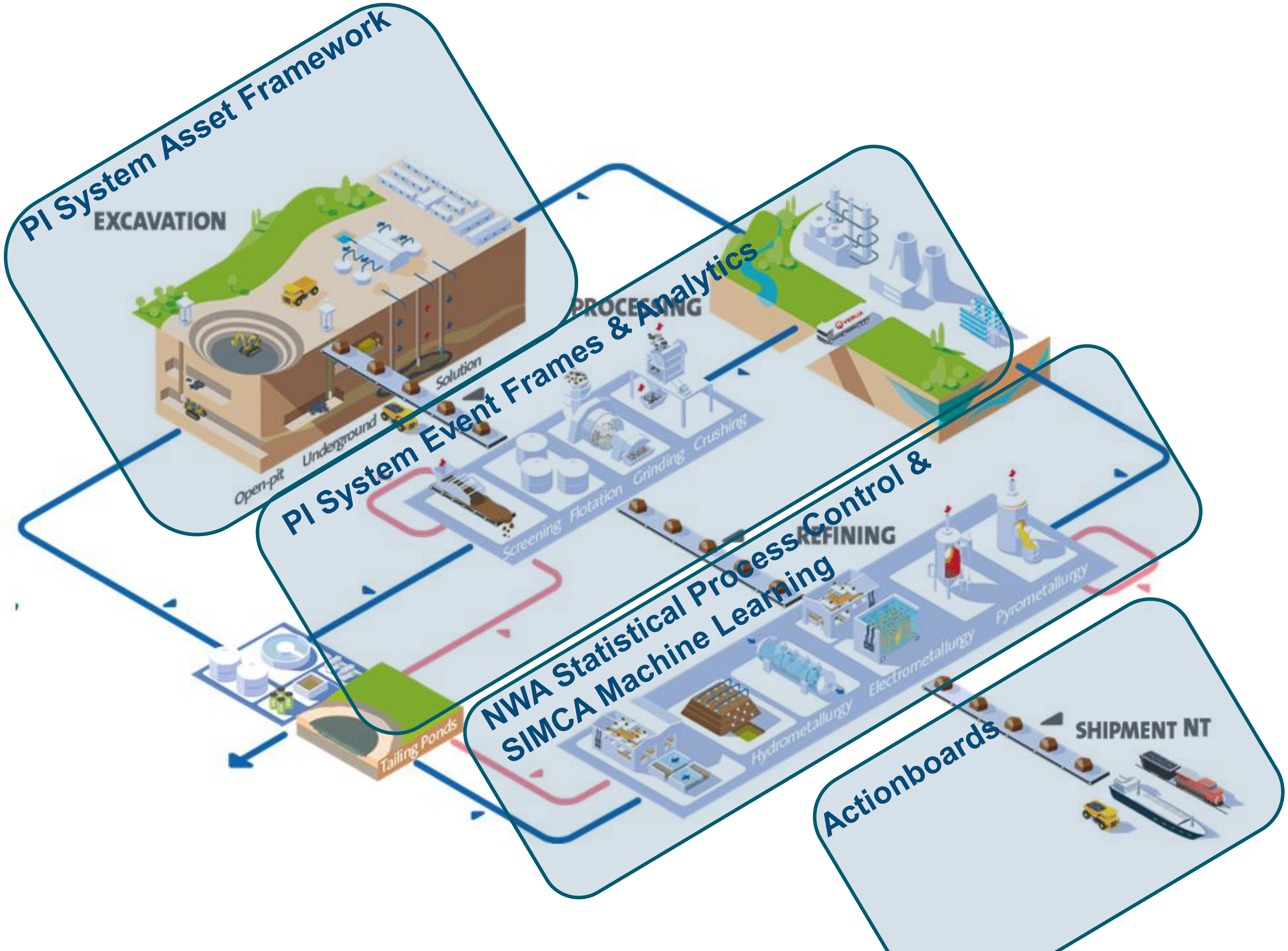




Reason #6

Fragmented Technology, Fragmented Results


PI System Asset Framework
EXCAVATION
Open-pit
Underground
Solution
PI System Event Frames & Analytics
PROCESSING
Screening
Flotation
Grinding
Crushing
NWA Statistical Process Control &
SIMCA Machine Learning
REFINING
Hydrometallurgy
Electrometallurgy
Pyrometallurgy
Tailing Ponds
Actionboards
SHIPMENT NT

1	12/19/18 13:21:45	13691	1	606	304.1	80.0	2098	44.5	22	104	107	77	164.46	7149	6419.3	2.3	8847.334
2	12/19/18 19:31:45	13692	1	606	303.0	80.2	2048	44.5	23	101	136	77	164.01	7148	6360.6	2.3	8409.153
3	12/20/18 1:36:45	13693	1	607	303.7	81.4	2226	44.5	24	101	125	77	164.13	7149	6386.1	2.3	8478.928
4	12/20/18 7:45:45	13694	1	610	303.7	81.8	2316	44.5	25	98	132	77	164.01	7151	6327.4	2.3	8499.396
5	12/20/18 14:25:45	13695	1	610	*	109.1	2060	44.5	26	98	160	79	162.23	7150	6338.3	2.3	8611.963
6	12/21/18 7:50:45	13696	1	608	305.6	81.4	1227	45	27	108	148	80	162.42	7149	6447.5	2.3	8683.598
7	12/21/18 14:09:45	13697	1	606	304.9	82.7	2054	45	28	98	146	79	162.27	7151	6362.6	2.3	8832.448
8	12/21/18 20:24:45	13698	1	610	303.9	83.4	2061	45	29	97	144	80	162.08	7150	6406.9	2.2	7730.021
9	12/22/18 2:37:45	13699	1	610	303.2	81.2	*	45	30	97	67	80	162.21	7150	6440.3	2.2	8021.211
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22	12/26/18 6:03:45	13712	1	569	309.7	83.9	2146	45	43	94	139	72	158.57	7158	5812.0	2.8	11360.13
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25	12/27/18 1:04:45	13715	1	606	308.3	84.7	1971	45	46	100	111	81	162.26	7150	6211.3	2.9	7109.498
26	12/27/18 6:48:45	13716	1	606	308.8	83.8	2158	45	47	101	109	80	162.03	7149	6233.1	2.9	8123.546
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30	12/28/18 7:06:45	13720	1	602	309.8	85.0	2012	45	51	103	130	78	161.62	7151	6163.3	2.7	9939.528
31	12/28/18 16:17:45	13721	1	598	308.8	85.6	1937	45	52	118	288	85	161.21	7151	6504.8	2.7	9986.976
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33	12/29/18 5:20:45	13723	1	596	307.0	85.0	1852	45	54	117	130	83	161.17	7151	6356.3	2.7	9537.63
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48	1/15/19 14:26:45	13739	1	602	312.1	83.6	1990	45	70	119	124	81	161.91	7147	6095.9	2.4	10440.04

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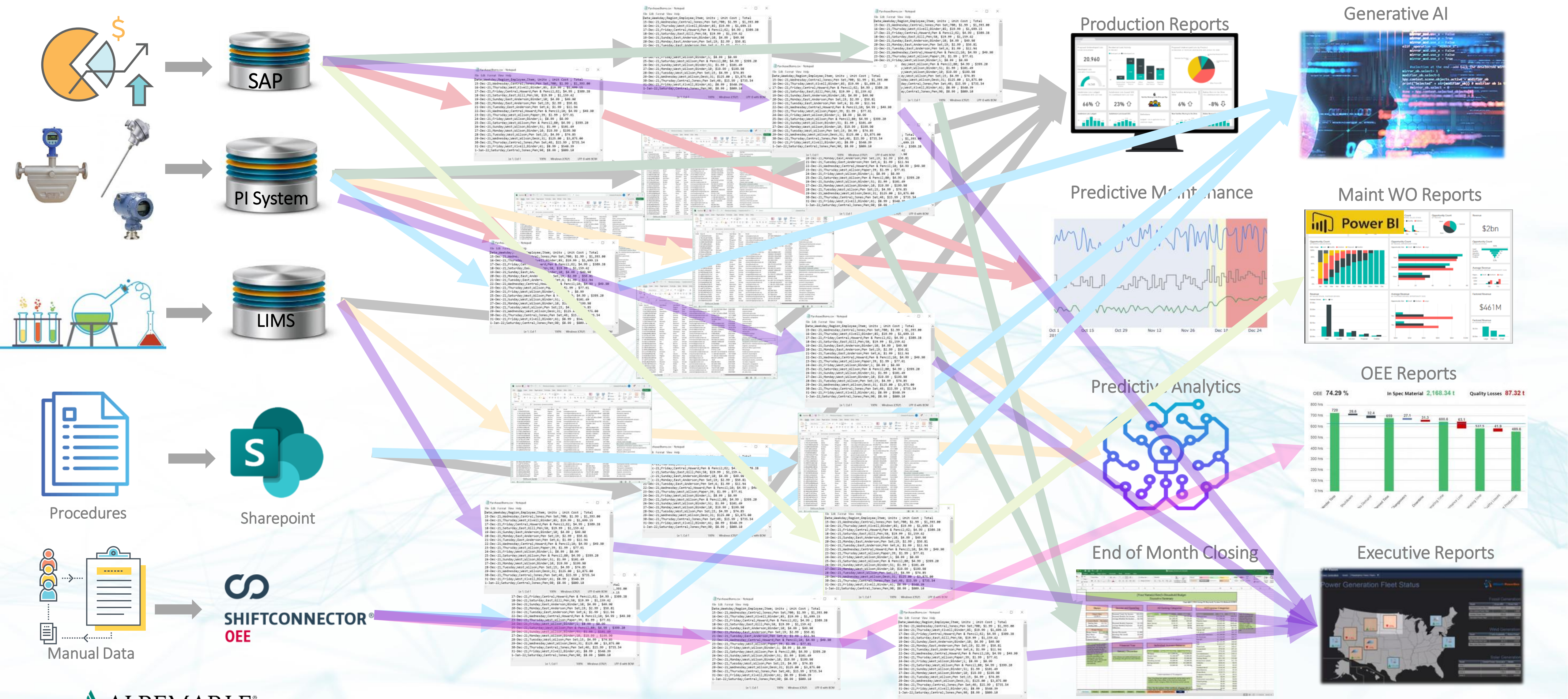
Data Sources	Data Pipelines	End Users



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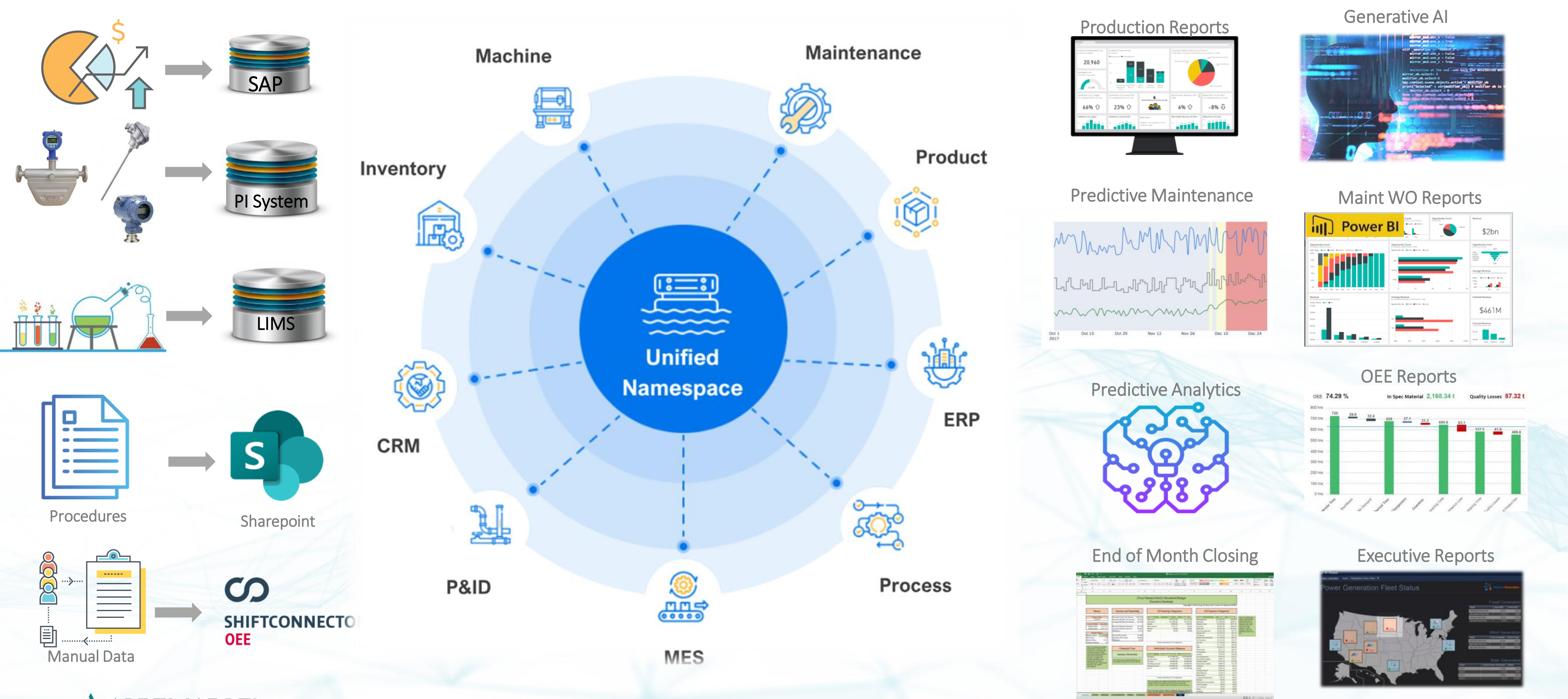
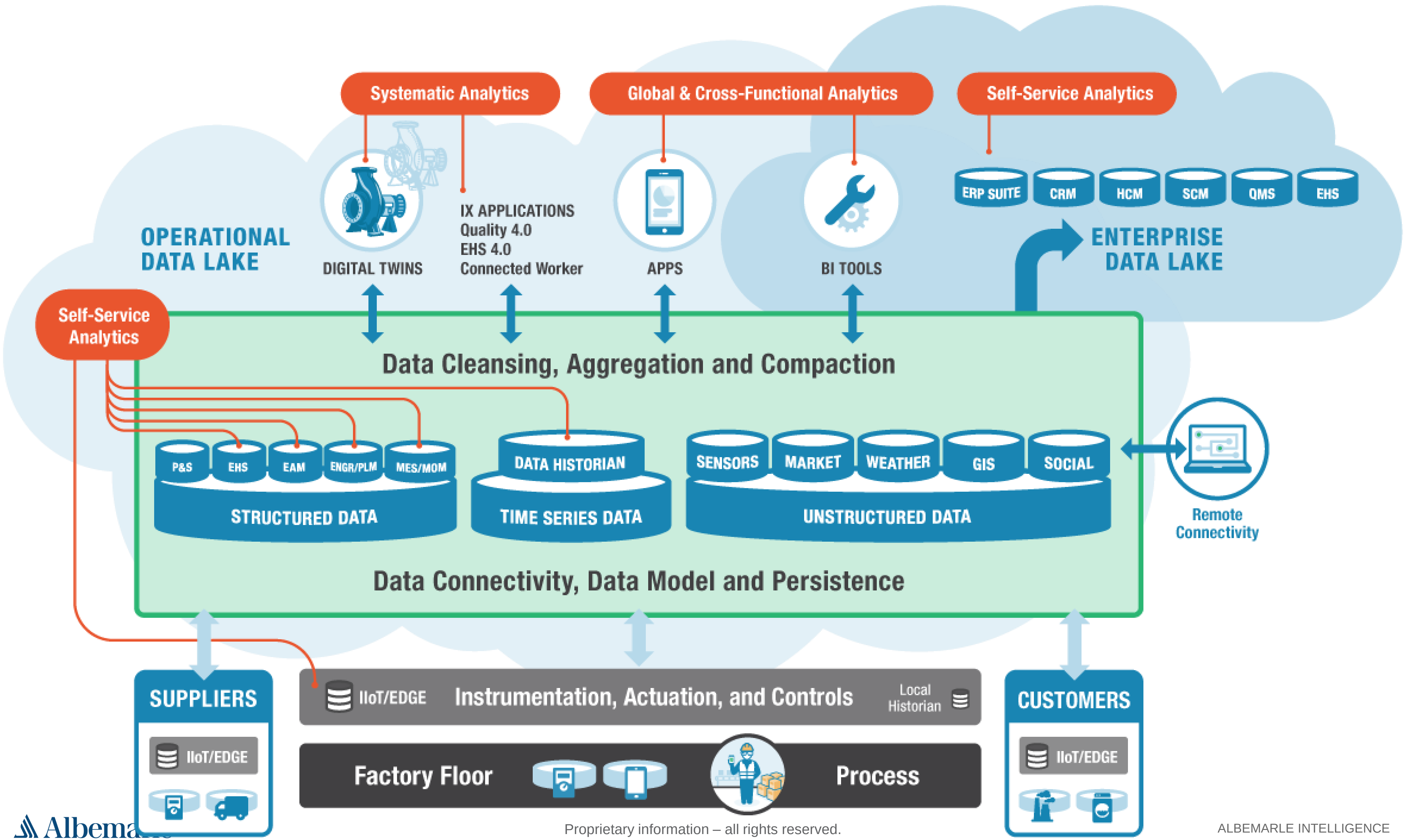
ALBEMARLE INTELLIGENCE

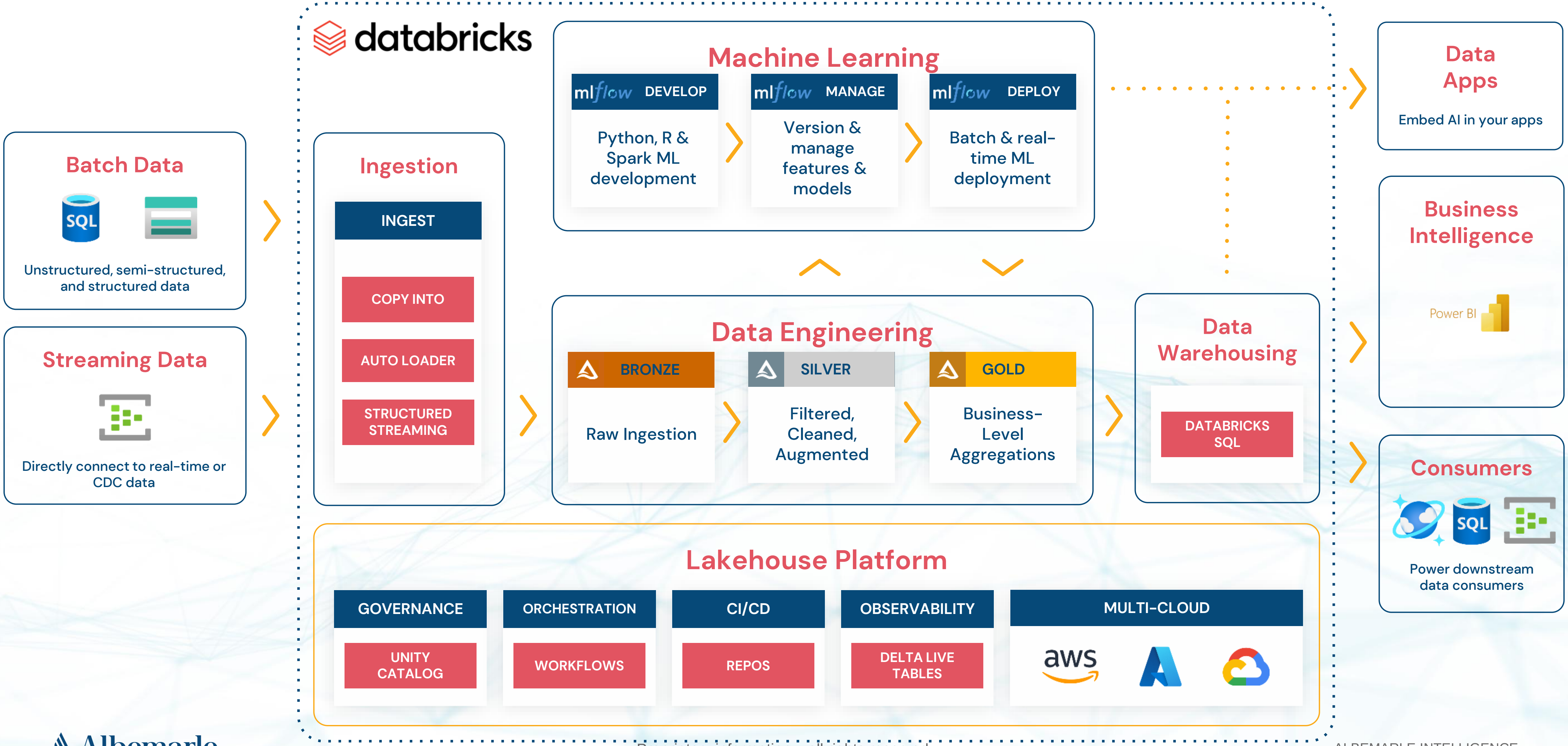
Data Sources	Data Pipelines	End Users



ALBEMARLE

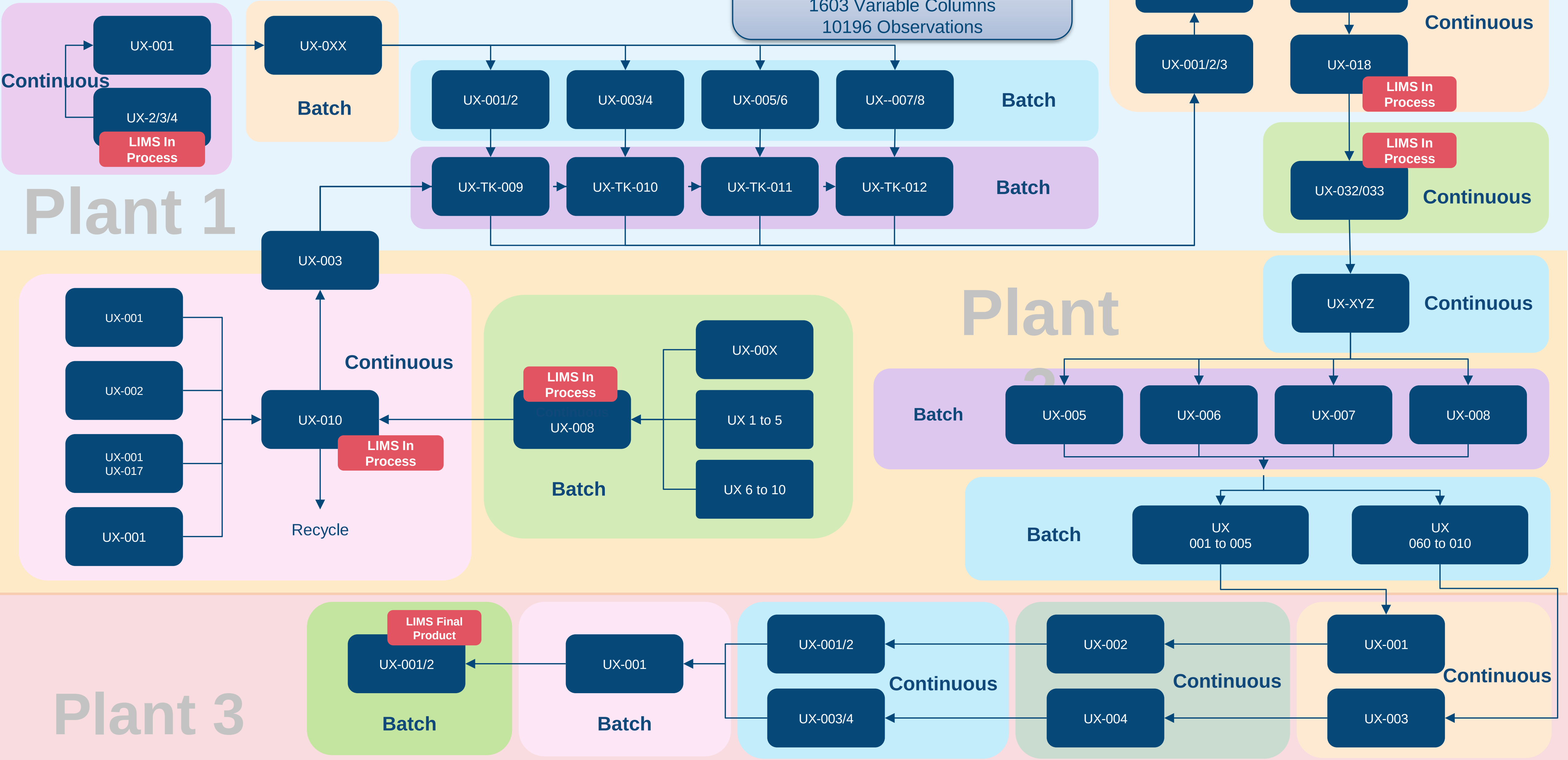

Systematic Analytics
Global & Cross-Functional Analytics
Self-Service Analytics
OPERATIONAL DATA LAKE
DIGITAL TWINS
IX APPLICATIONS
Quality 4.0
EHS 4.0
Connected Worker
APPS
BI TOOLS
ERP SUITE
CRM
HCM
SCM
QMS
EHS
ENTERPRISE DATA LAKE
Self-Service Analytics
Data Cleansing, Aggregation and Compaction
P&S
EHS
EAM
ENGR/PLM
MES/MOM
STRUCTURED DATA
DATA HISTORIAN
TIME SERIES DATA
SENSORS
MARKET
WEATHER
GIS
SOCIAL
UNSTRUCTURED DATA
Remote Connectivity
Data Connectivity, Data Model and Persistence
SUPPLIERS
IIoT/EDGE
IIoT/EDGE
Instrumentation, Actuation, and Controls
Local Historian
Factory Floor
Process
CUSTOMERS
IIoT/EDGE

Azure Databricks Lakehouse Architecture



Data Merging Map

Sitewide Dataset Statistics
45 Unit Ops
8 LIMS sample points
1603 Variable Columns
10196 Observations



Albemarle

Sitewide Data Merging Map

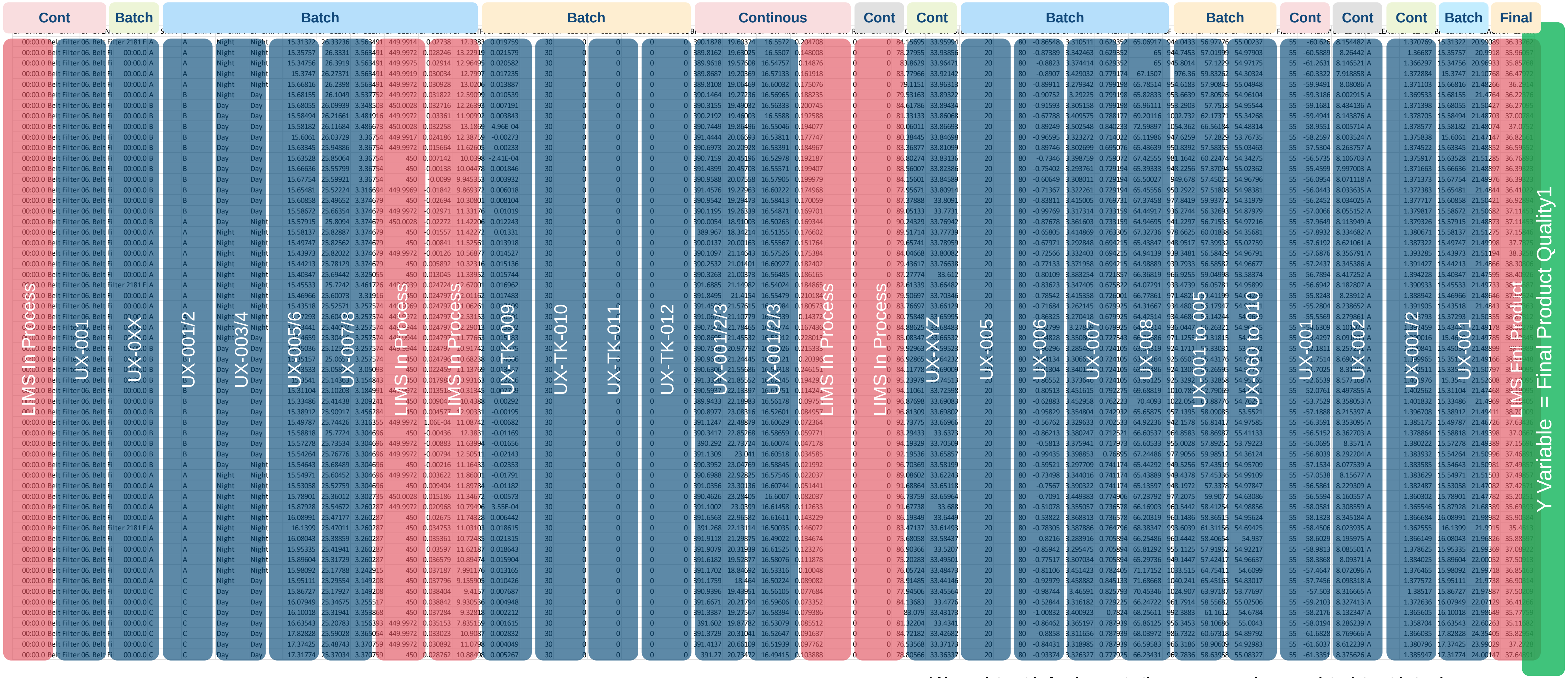
PIAF Dataset

LIMS Dataset

Sitewide Dataset Statistics

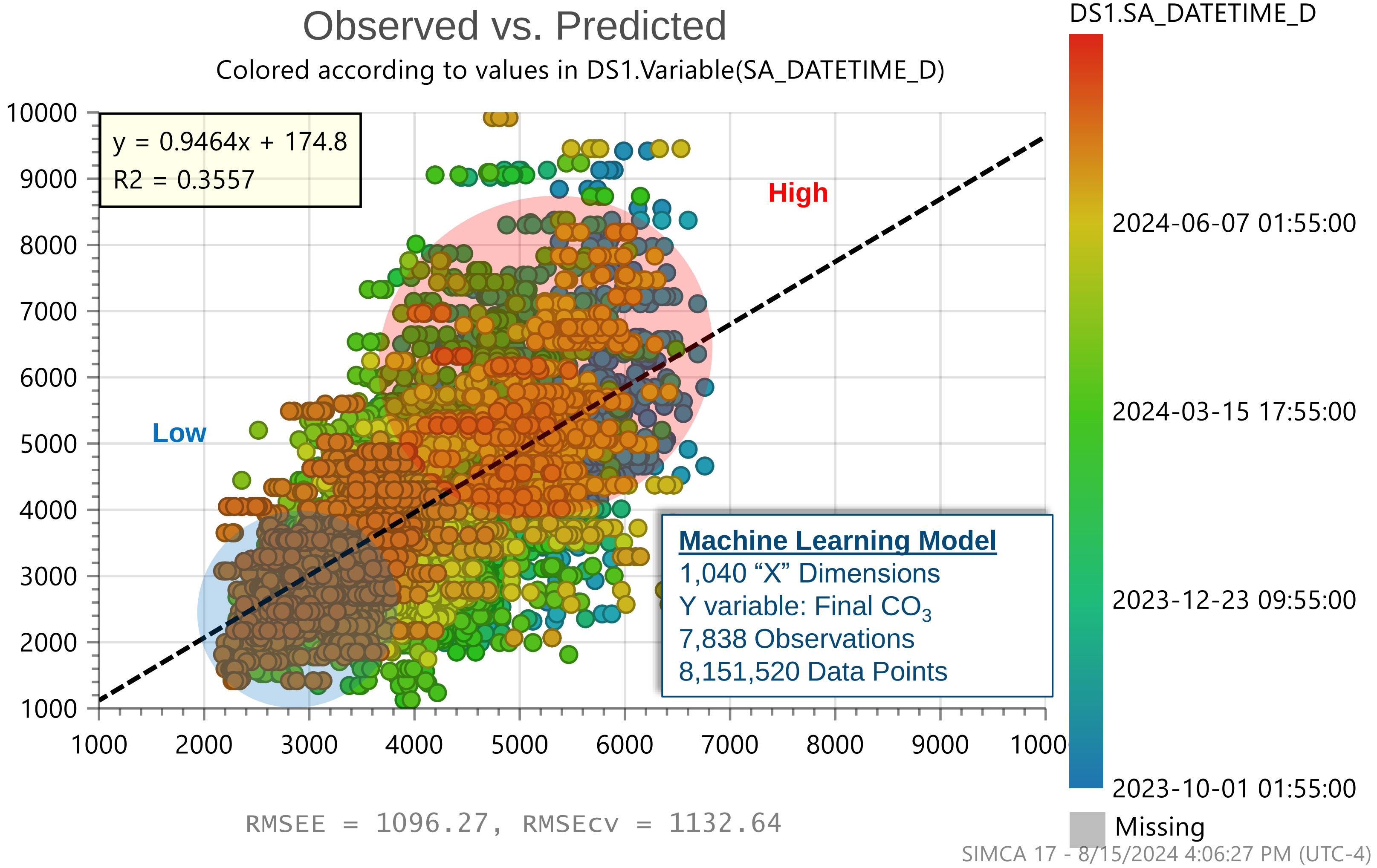
45 Unit Ops
8 LIMS sample points
1603 Variable Columns
10196 Observations

Each row represents the same material passing through the plant as it travels through each unit and sample point.

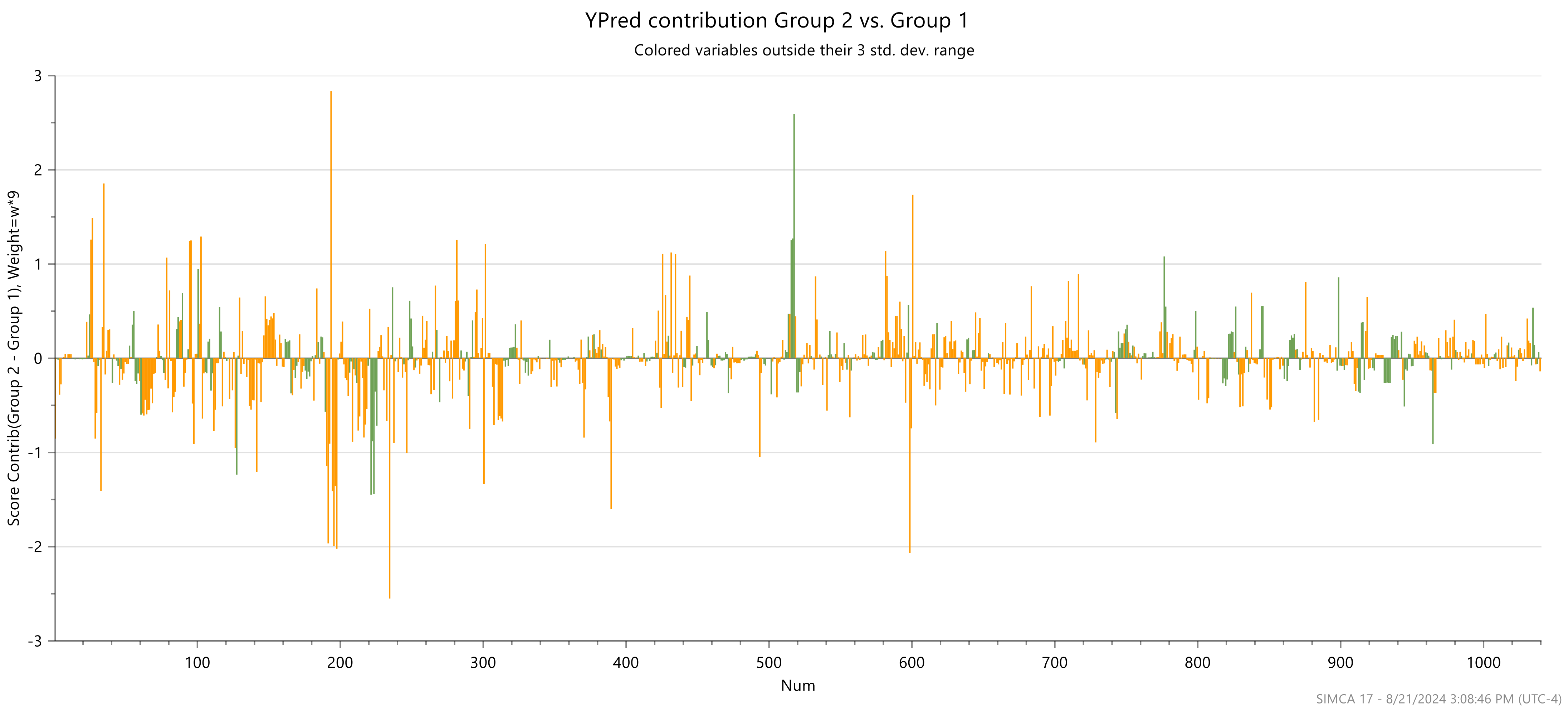


**Above dataset is for demonstration purposes only – complete dataset is too large*

Machine Learning Predictive Modeling – Quality Parameter 1



Machine Learning Predictive Modeling – Quality Parameter 1



Sitewide Data Merging Map

PIAF Dataset

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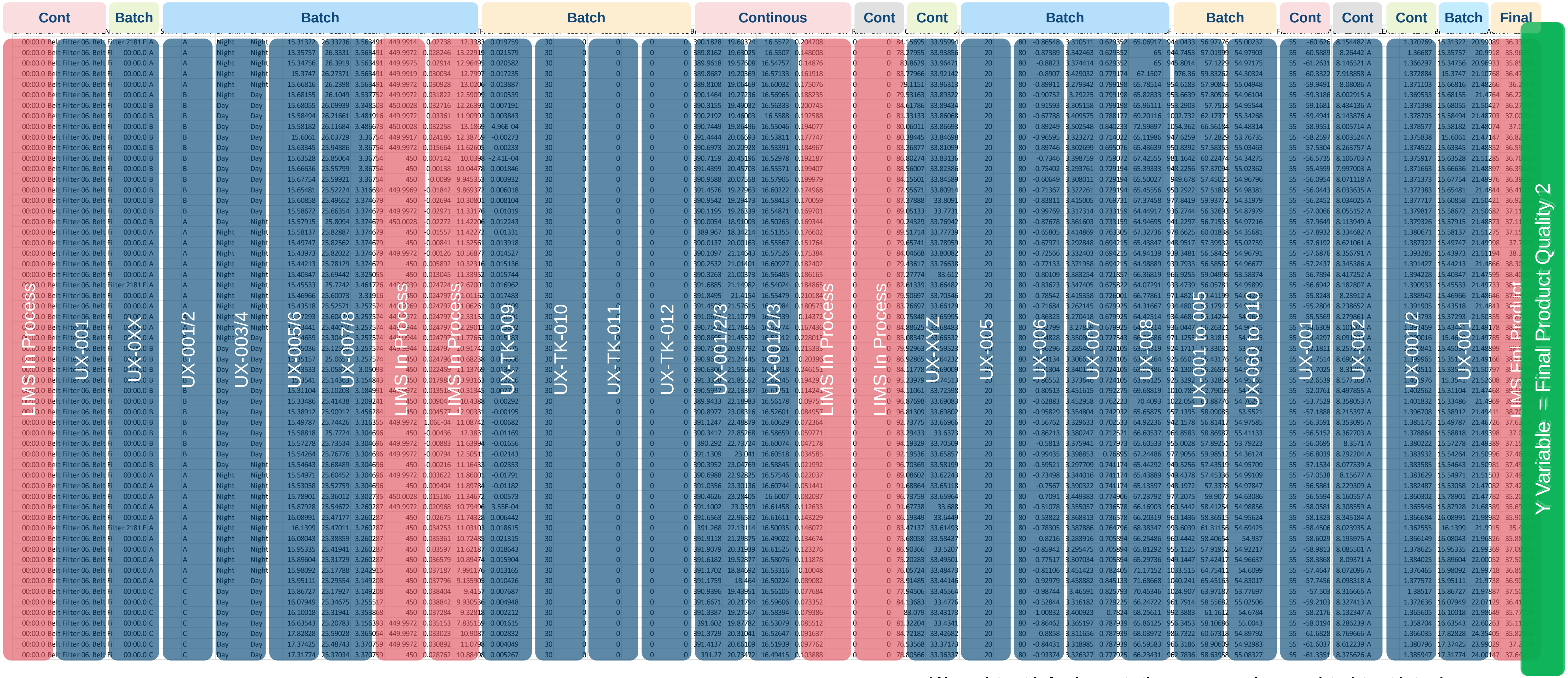
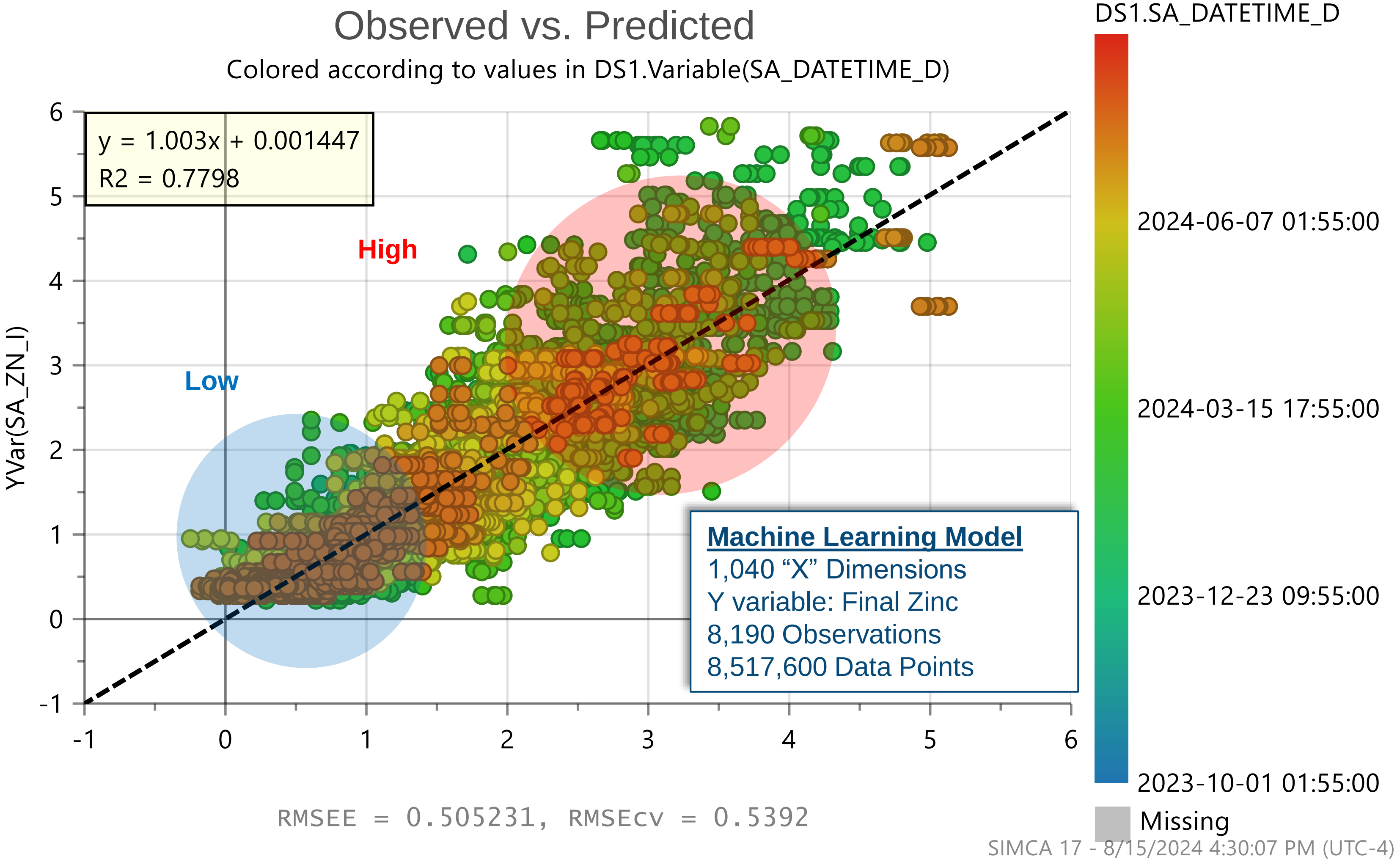
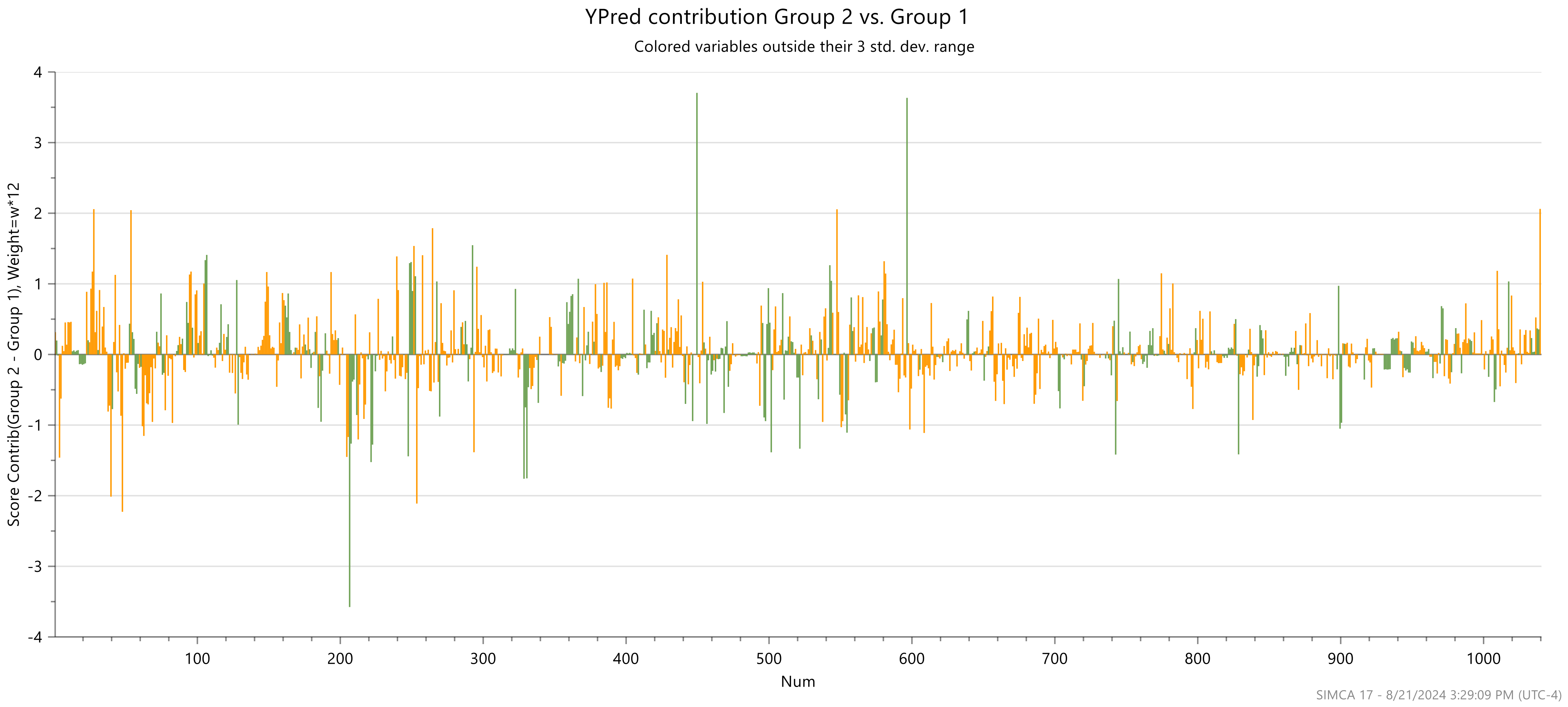


**Above dataset is for demonstration purposes only – complete dataset is too large*

Machine Learning Predictive Modeling – Quality Parameter 2



Machine Learning Predictive Modeling – Final Prod Zinc



Modern Machine Learning for Time Series – XGBoost

databricks

Feature Importance (Python)

Import Notebook

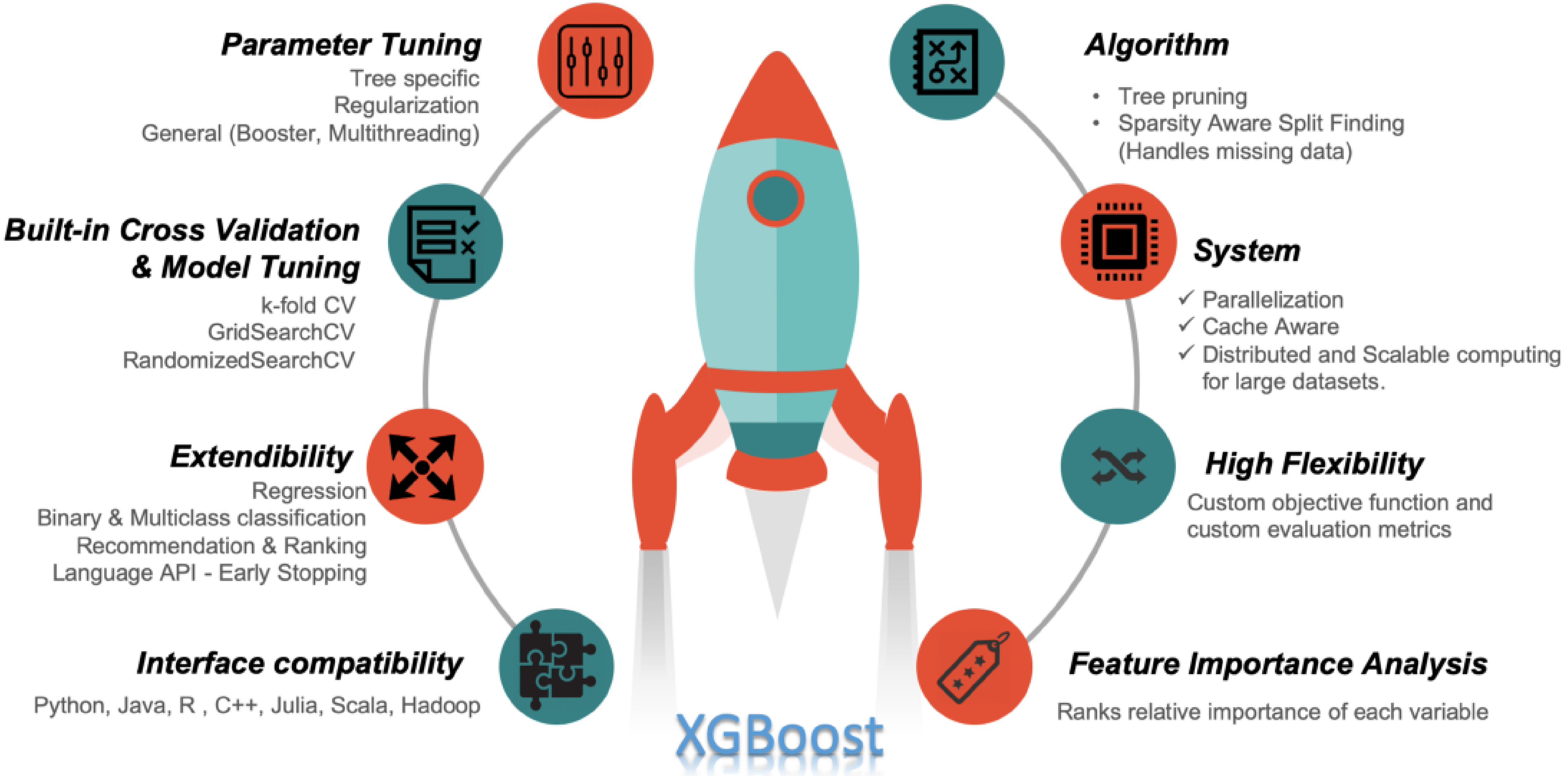
1

```
from pyspark.sql import SparkSession
from pyspark.sql.functions import col
from pyspark.sql.types import NumericType
import pandas as pd
import numpy as np
!pip install networkx
import networkx as nx
import warnings
warnings.filterwarnings("ignore")
%pip install xgboost
from sklearn.ensemble import IsolationForest
from sklearn.impute import SimpleImputer
import xgboost as xgb
from sklearn.model_selection import train_test_split, cross_val_score, KFold
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import make_scorer, mean_squared_error
from sklearn.preprocessing import MinMaxScaler
from sklearn.preprocessing import RobustScaler
```

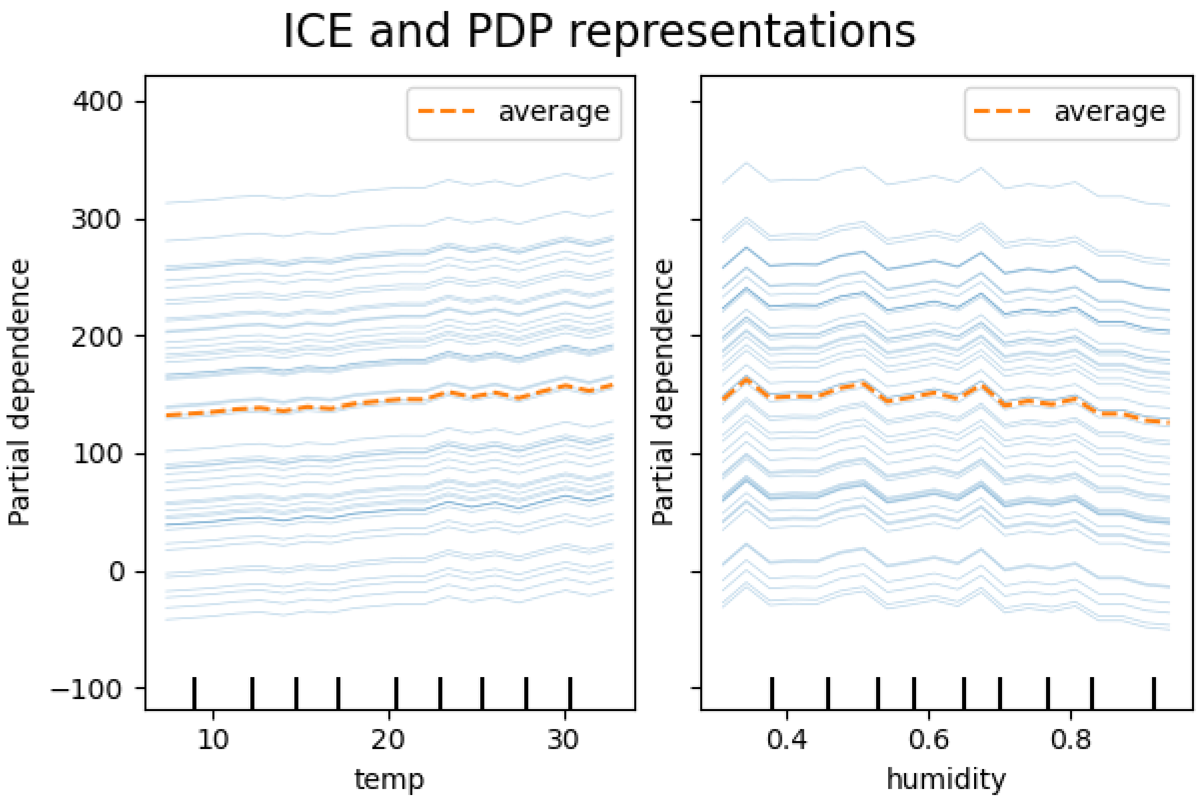
```
# Drop rows with NaN values in the target column from the original dataframe before splitting
df_filtered_zn_clean = df_filtered_zn.dropna(subset=[target_column])

X = df_filtered_zn_clean.drop(target_column, axis=1)
y = df_filtered_zn_clean[target_column]

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

xgb_model = xgb.XGBRegressor(missing=None, random_state=42)
kf = KFold(n_splits=5, shuffle=True, random_state=42)
mse_scorer = make_scorer(mean_squared_error, greater_is_better=False)
cv_scores = cross_val_score(xgb_model, X_train, y_train, cv=kf, scoring=mse_scorer)


xgb_model.fit(X_train, y_train)
```

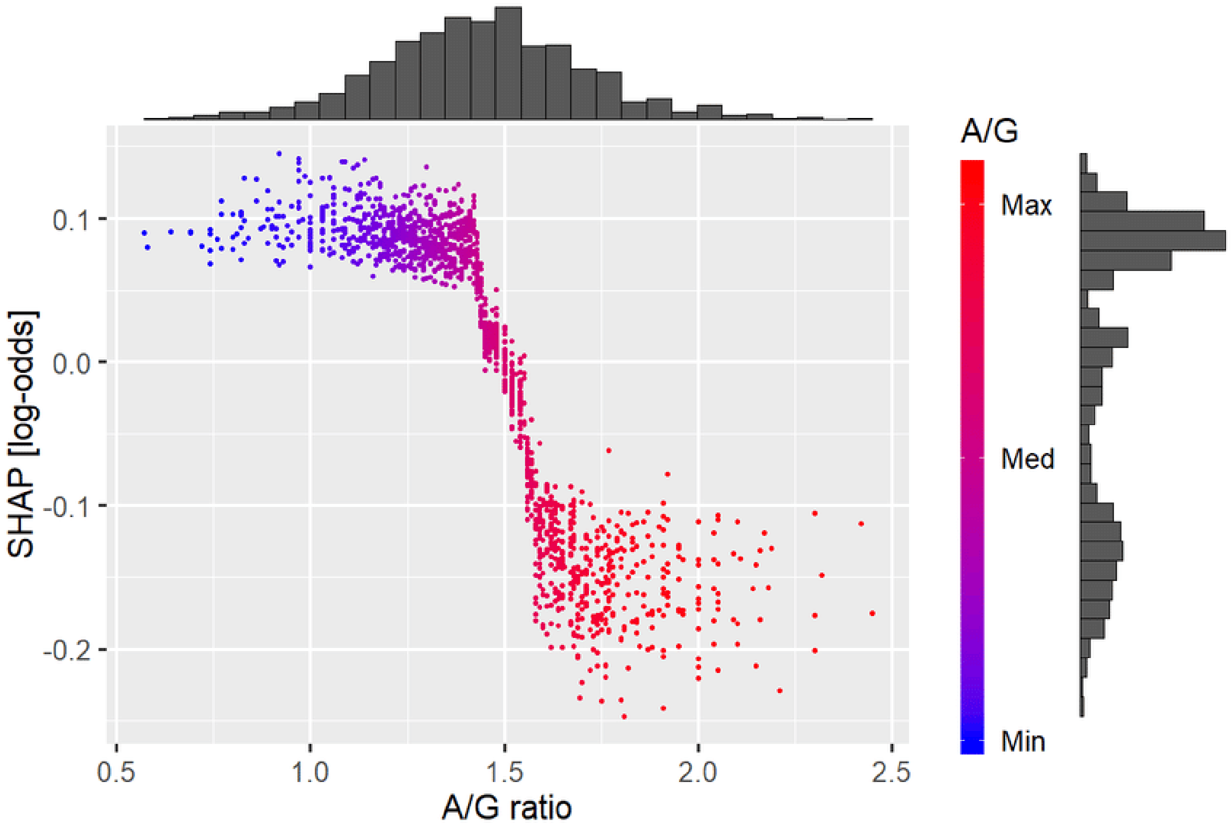
E

Modern Machine Learning for Time Series – XGBoost

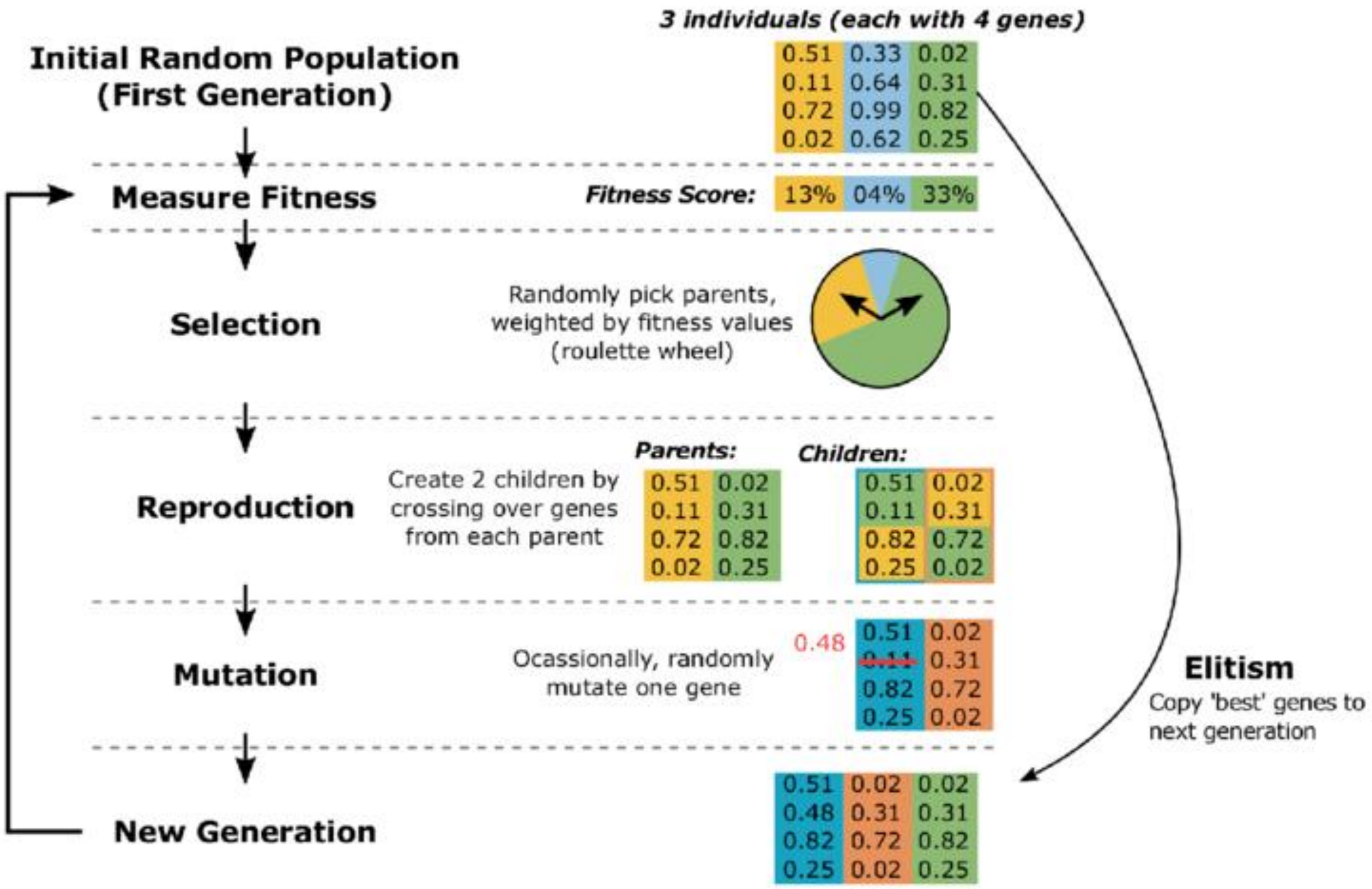


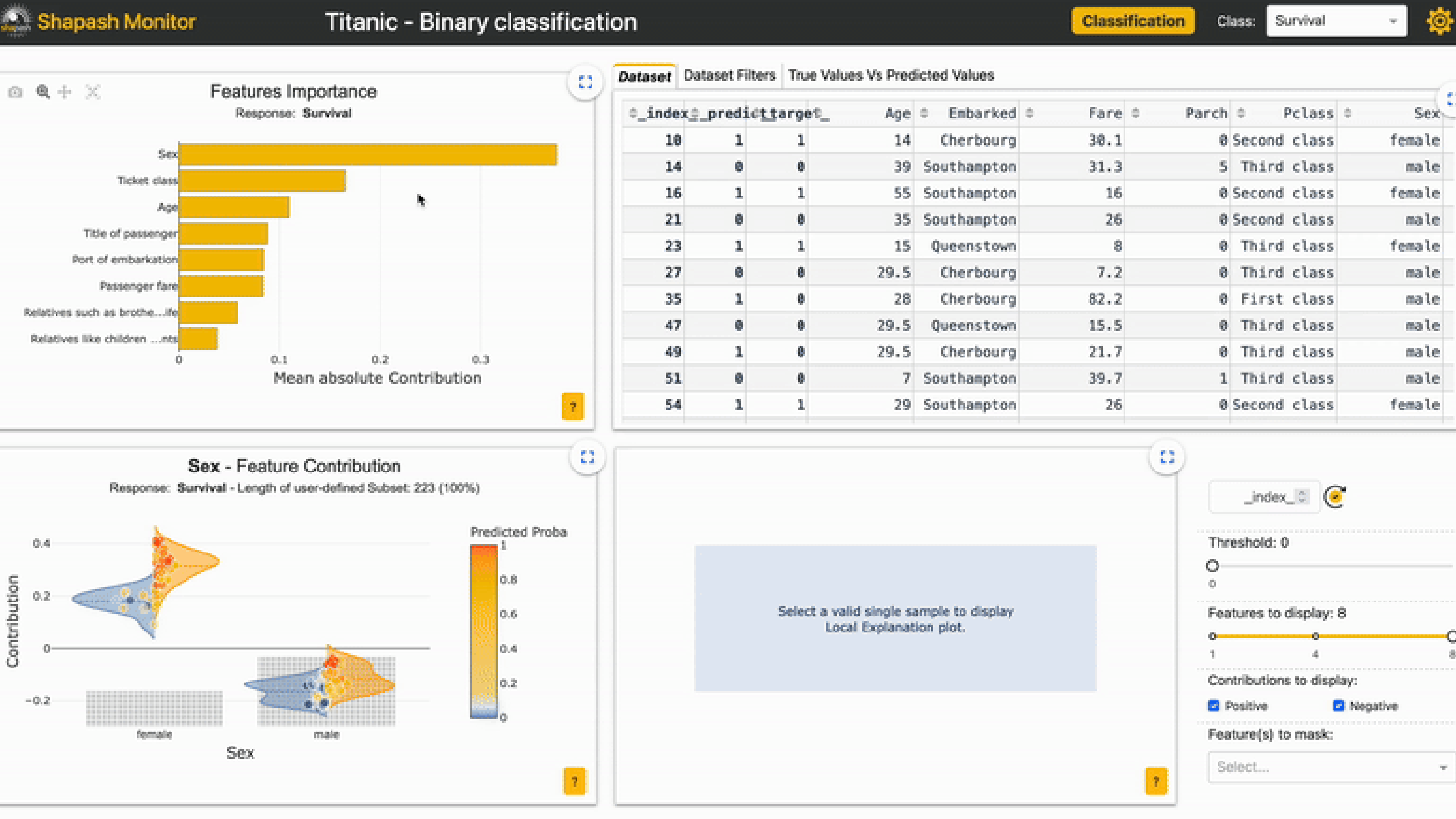
XGBoost Optimization – SHAP & Partial Dependency





Optimization – NSGA II Genetic Algorithms



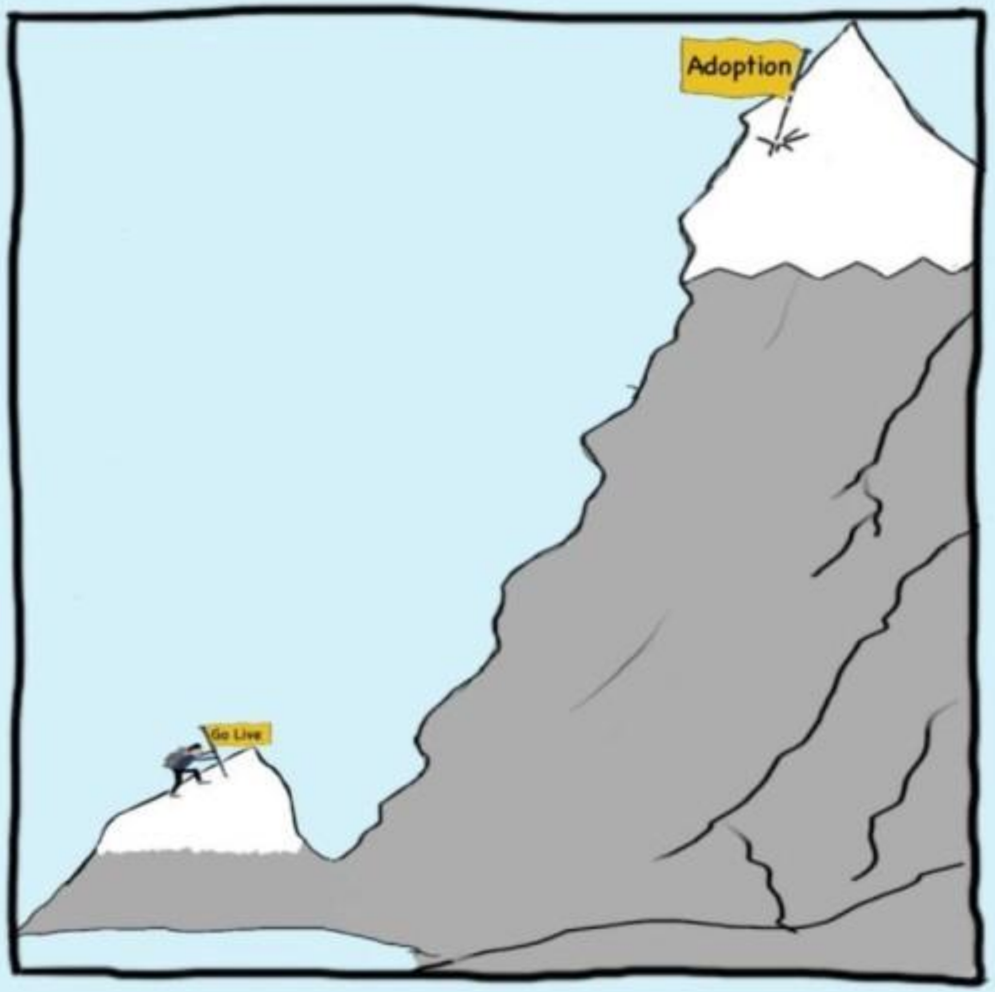


Shapash Monitor
Titanic - Binary classification
Classification
Class:
Survival
Features Importance
Response: Survival
Sex
Ticket class
Age
Title of passenger
Port of embarkation
Passenger fare
Relatives such as brothe...ife
Relatives like children ...nts
0
0.1
0.2
0.3
Mean absolute Contribution
Dataset
Dataset Filters
True Values Vs Predicted Values
index _predict_ _target_ Age Embarked Fare Parch Pclass Sex
10 1 1 14 Cherbourg 30.1 0 Second class female
14 0 0 39 Southampton 31.3 5 Third class male
16 1 1 55 Southampton 16 0 Second class female
21 0 0 35 Southampton 26 0 Second class male
23 1 1 15 Queenstown 8 0 Third class female
27 0 0 29.5 Cherbourg 7.2 0 Third class male
35 1 0 28 Cherbourg 82.2 0 First class male
47 0 0 29.5 Queenstown 15.5 0 Third class male
49 1 0 29.5 Cherbourg 21.7 0 Third class male
51 0 0 7 Southampton 39.7 1 Third class male
54 1 1 29 Southampton 26 0 Second class female
Sex - Feature Contribution
Response: Survival - Length of user-defined Subset: 223 (100%)
Predicted Proba
Contribution
female
male
Sex
Select a valid single sample to display Local Explanation plot.
index
Threshold: 0
Features to display: 8
Contributions to display:
Positive
Negative
Feature(s) to mask:
Select...

Reason #7


Success Doesn’t End at Launch


GO LIVE


Adoption
Go Live

Implementation Roadmap

3 Months — Discovery & Installation

Discovery
- Resources
- Data Quality
- Infrastructure

Hardware
- Servers
- IT Security

Enterprise Software
- PI System
- NWA
- SIMCA

3 Months — Prework & Training

Prework
- Business Case
- PI System AF Hierarchy
- Process Flow Diagrams
- P&IDs

Training
- PI System
- NWA
- SIMCA

3 Months — Sprints

Organize Process Data
- PI System Asset Framework

Custom Process Analytics
- PI System Analytics
- PI System Event Frames

Automated Datasets
- NWA Datasets
- SQL

Actionboard Configuration
- Real-Time SPC & SQC

1 Month — Process Optimization Academy & Go Live

Process Optimization Academy
- High Level Software Training
- Practice on Albemarle data
- DMAIC Six Sigma Improvement Methodology
- Improvement Brainstorming
- Change Management

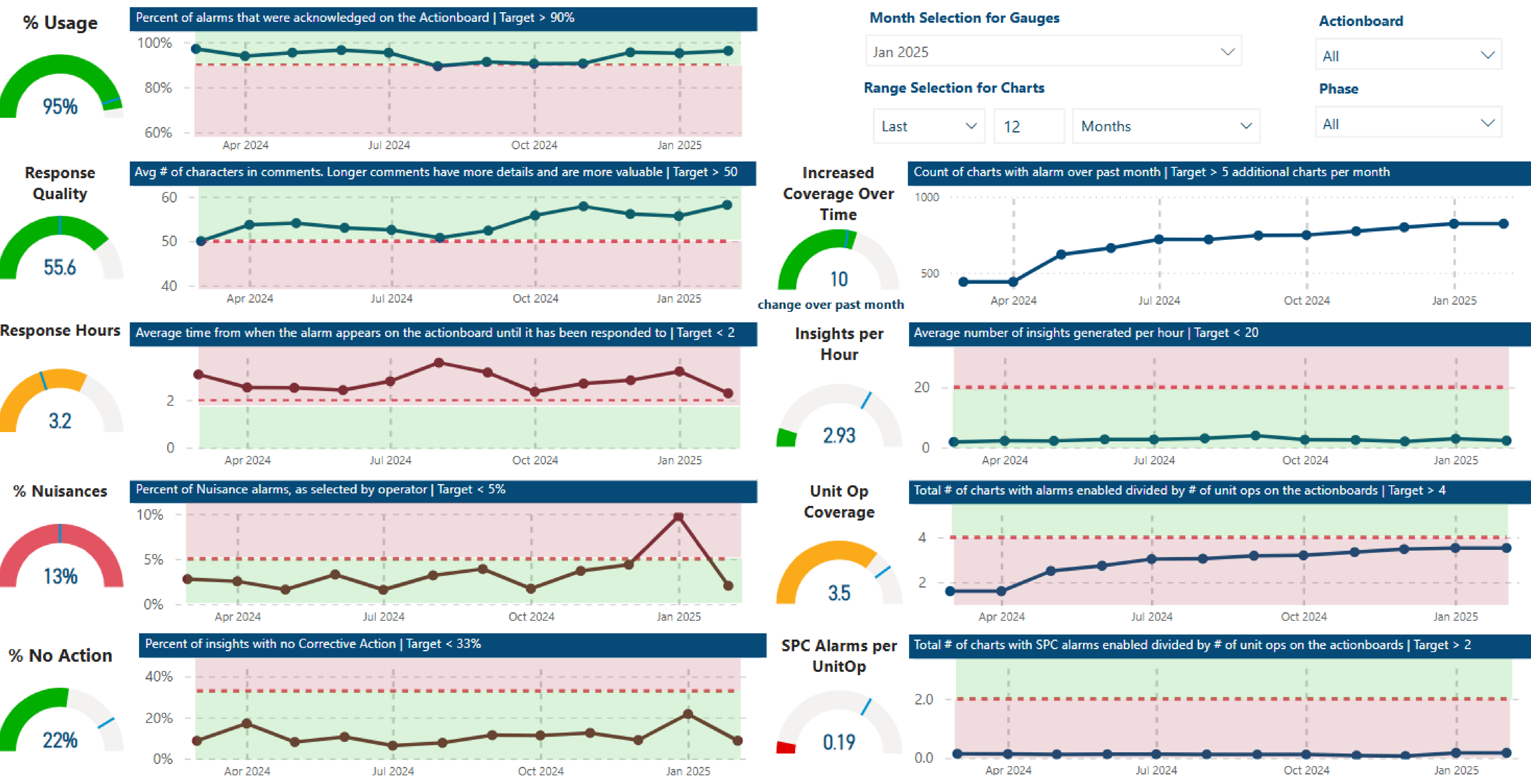
Go Live
- Commissioning of Actionboards in Control Room
- New Roles & Responsibilites

3 - 6 Months — Operation AI

Improvement Projects
- Site Engineers use AI tools to drive site Improvements
- Priorities set by site Leadership
- Continuous Improvement

Actionboards
- Continuous Improvement in the Control Room
- Bringing Actionable Analytics to the Shop Floor

Actionboard Executive Summary



Reason #8


If You Build it,
They Won’t
Come

Digital Transformation Framework

The key elements to modernize your business

Leadership & Vision

Having a clear vision for the digital transformation journey and effectively communicating it to all employees

Digital Skills & Training

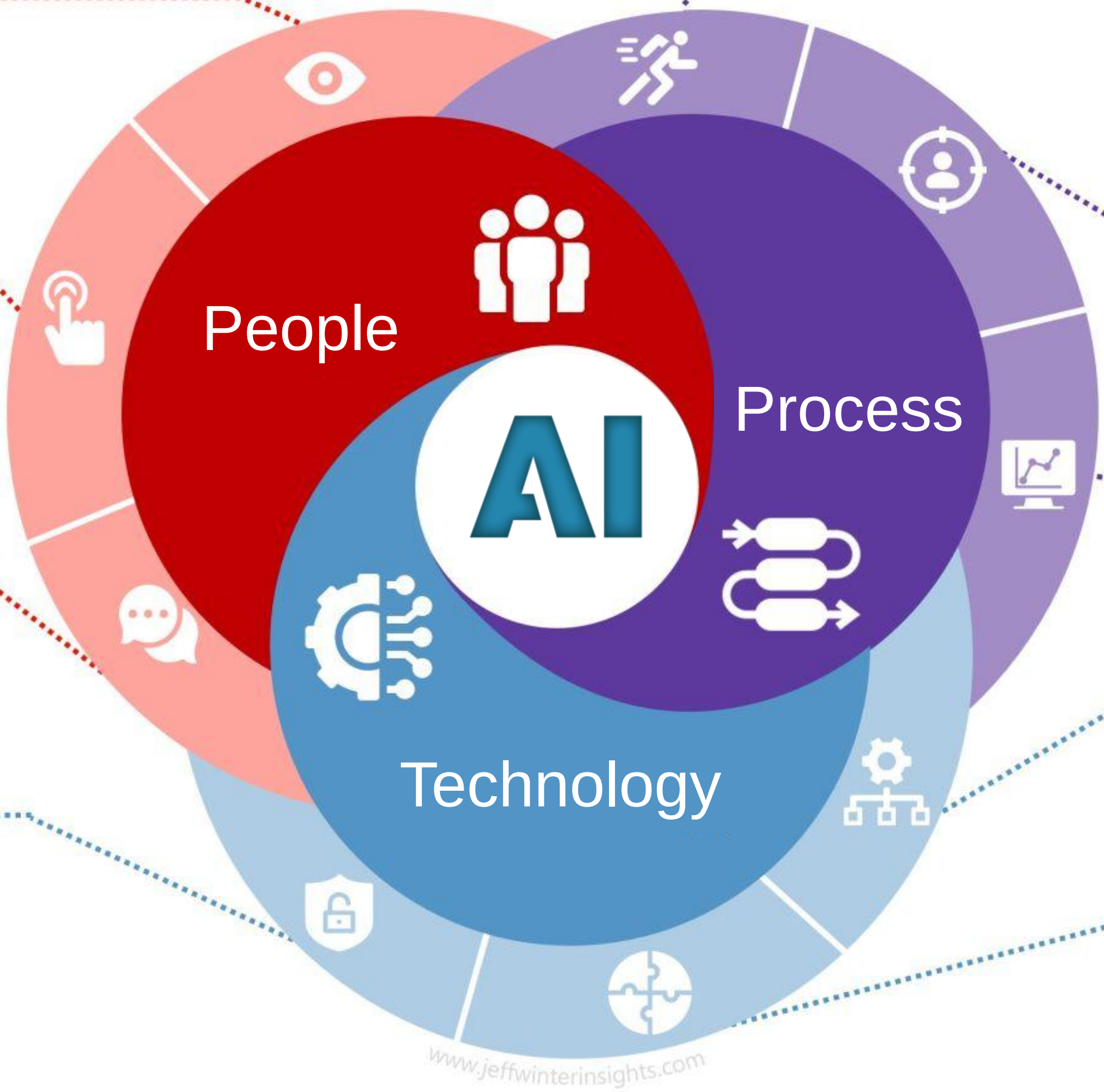
Equipping the employees with the necessary digital skills to navigate new technologies and tools

Collaboration & Communication

Fostering the right culture by breaking down silos, encouraging cross-functional teams, and facilitating knowledge sharing across the organization

Cybersecurity

Implementing strong cybersecurity measures to protect data, systems, and networks from potential attacks



Agile Methodologies

Implementing iterative and incremental approaches to project management and product development to be nimbler and more responsive to change

Customer-Centricity

Adopting a design thinking approach and continuously seeking feedback from customers

Data-Driven Decision-Making

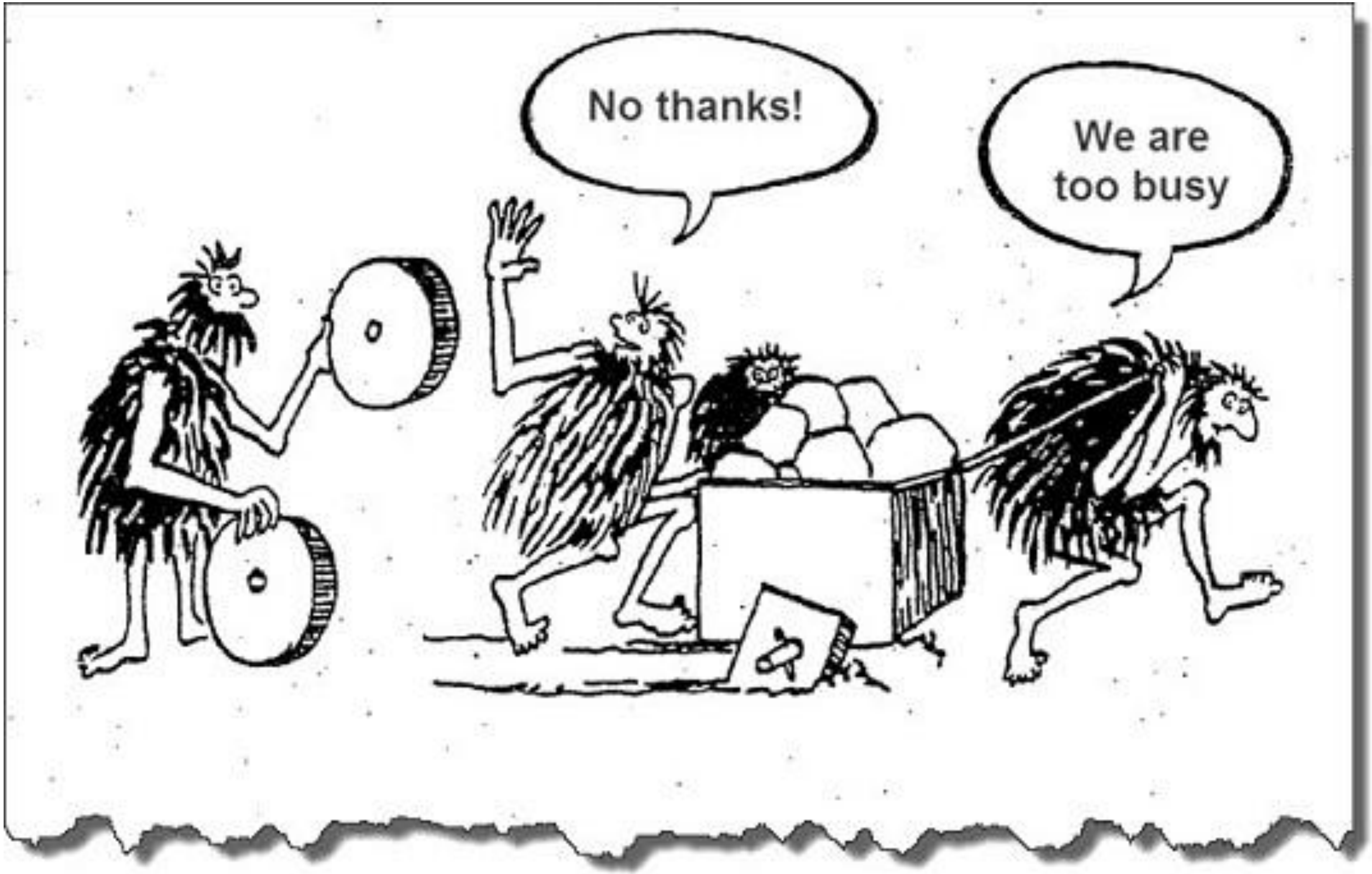
Leveraging data and analytics as an integral part of decision-making processes

Infrastructure

Investing in a robust and scalable digital infrastructure that can support the organization’s needs

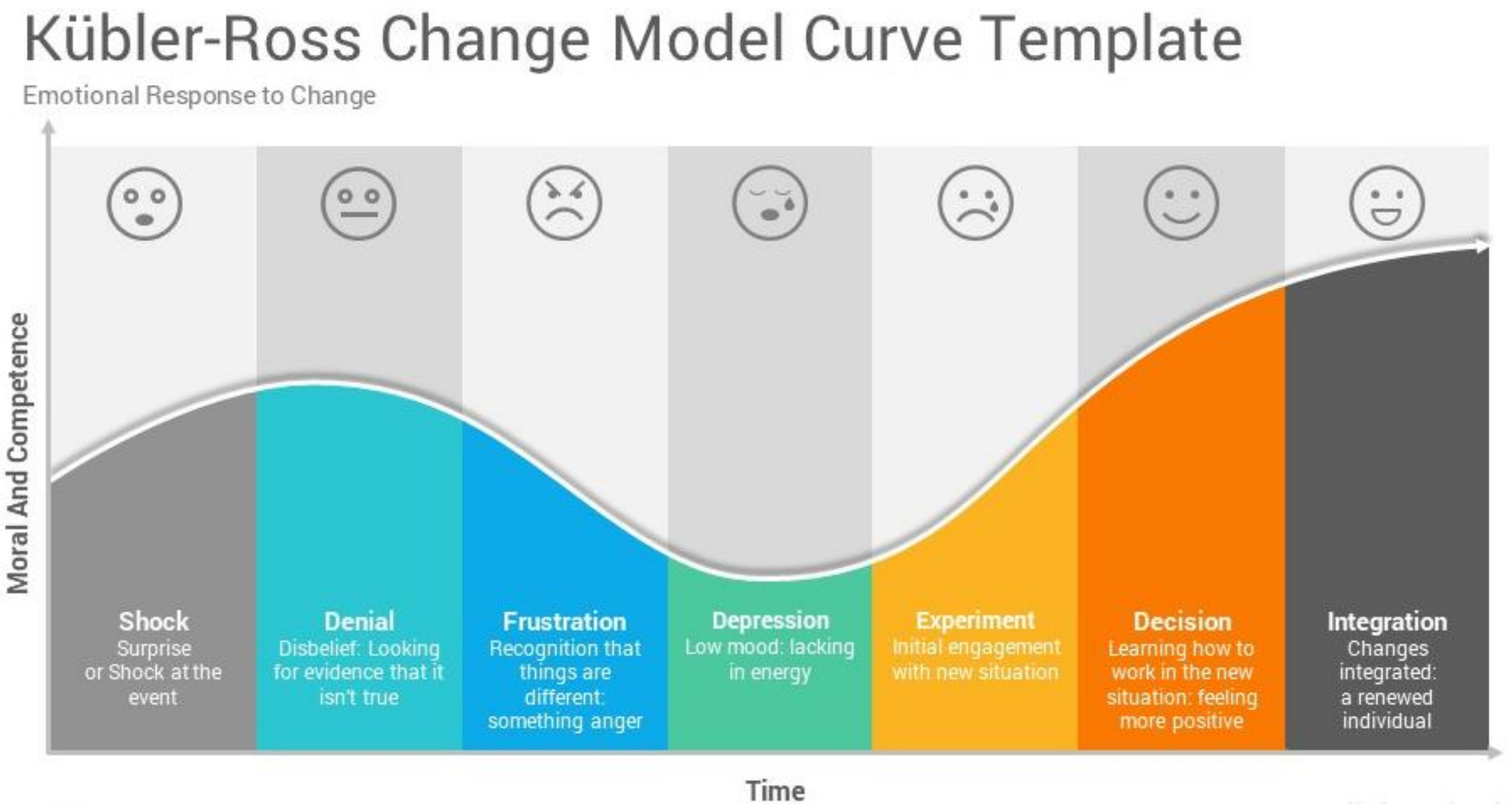
Integration

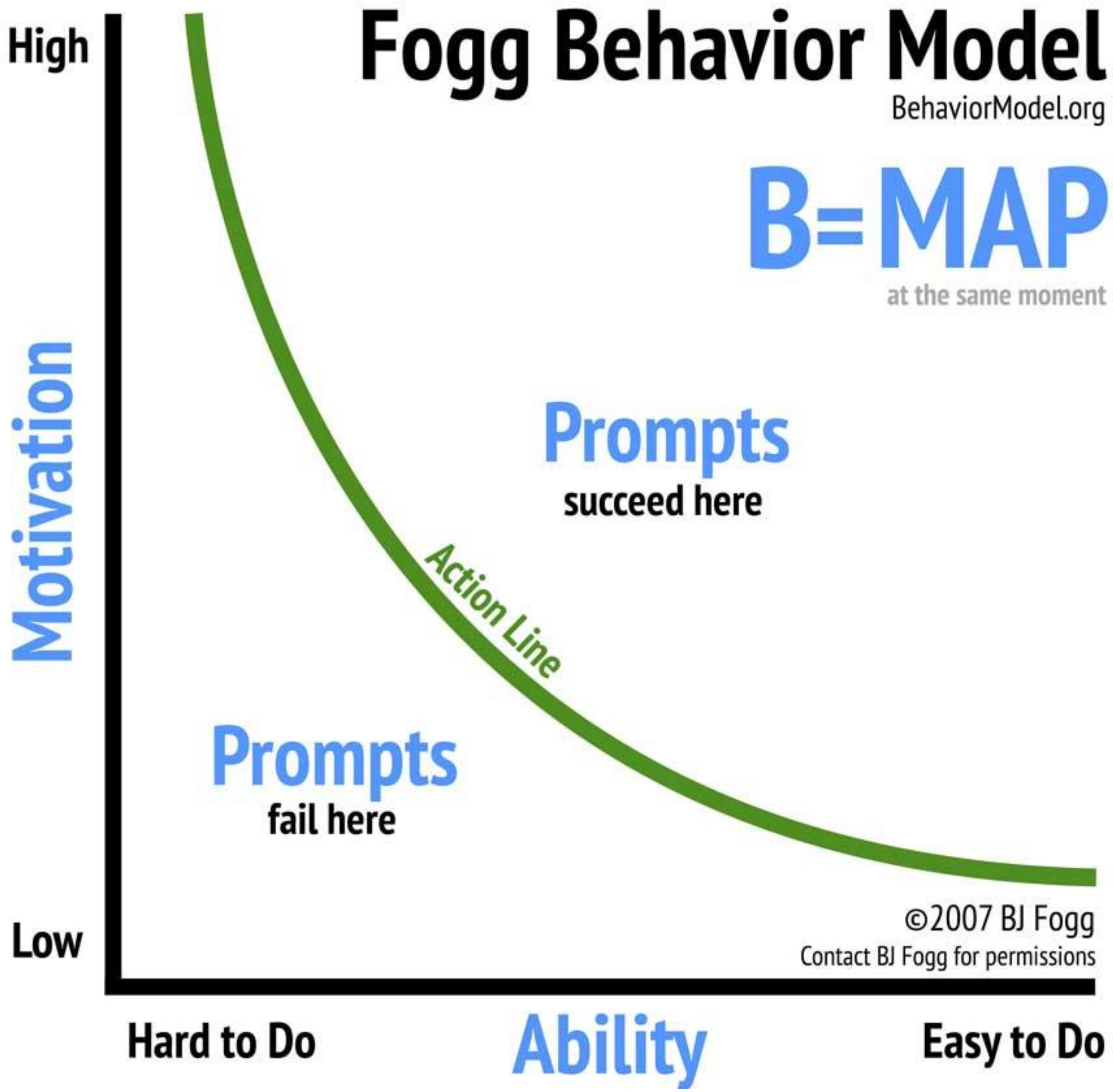
Ensuring seamless integration of different systems and platforms across business functions


No thanks!
We are
too busy

ADKAR Change Management

Pre-contemplation	Contemplation	Preparation	Action	Maintenance
A	**D**	**K**	**A**	**R**
Awareness	**Desire**	**Knowledge**	**Action**	**Reinforcement**


Kübler-Ross Change Model Curve Template
Emotional Response to Change
Moral And Competence
Shock
Surprise or Shock at the event
Denial
Disbelief: Looking for evidence that it isn't true
Frustration
Recognition that things are different: something anger
Depression
Low mood: lacking in energy
Experiment
Initial engagement with new situation
Decision
Learning how to work in the new situation: feeling more positive
Integration
Changes integrated: a renewed individual
Time

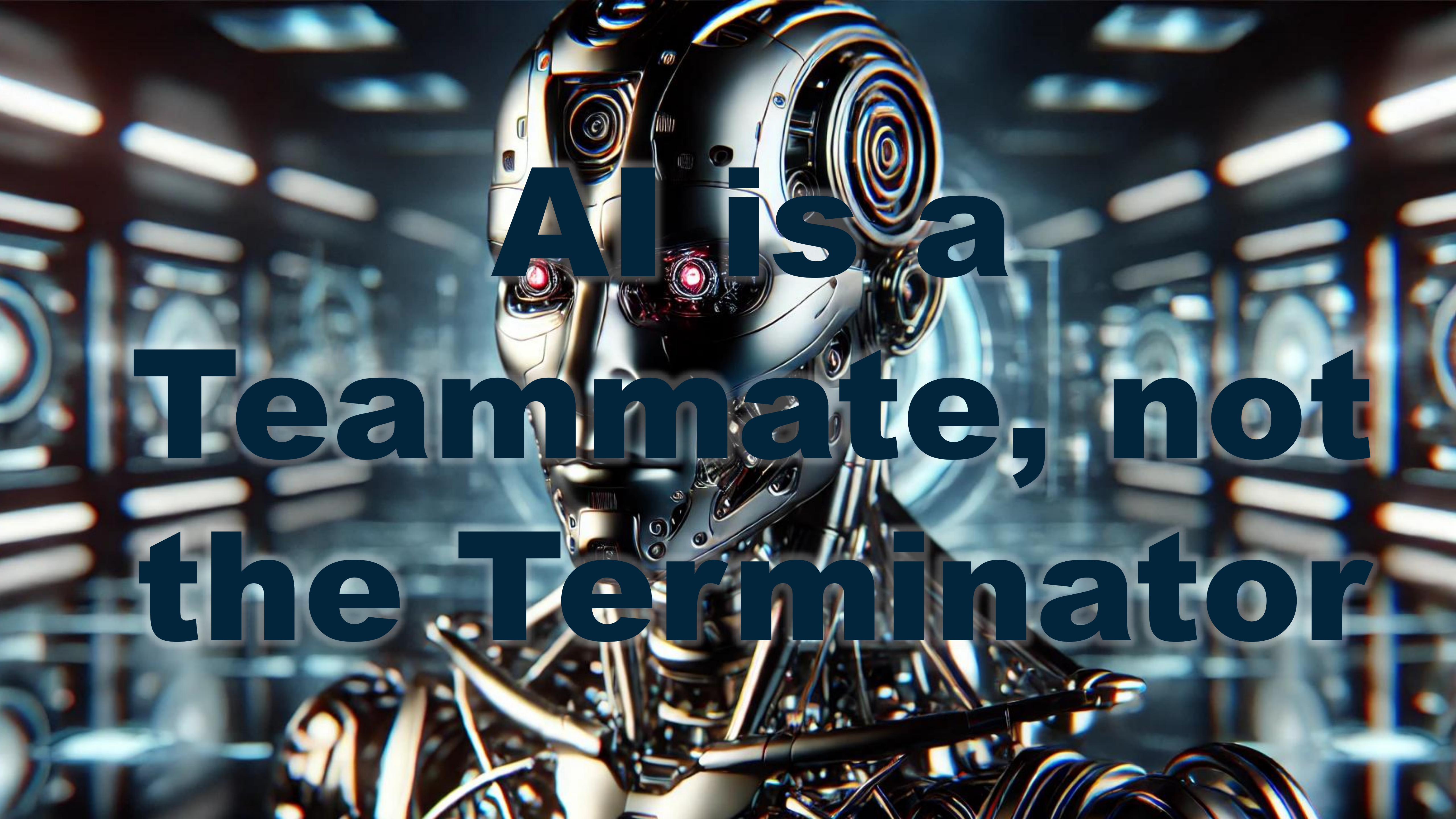

Fogg Behavior Model
BehaviorModel.org
B=MAP
at the same moment
High
Motivation
Low
Prompts
succeed here
Action Line
Prompts
fail here
©2007 BJ Fogg
Contact BJ Fogg for permissions
Hard to Do
Ability
Easy to Do

Reason #9

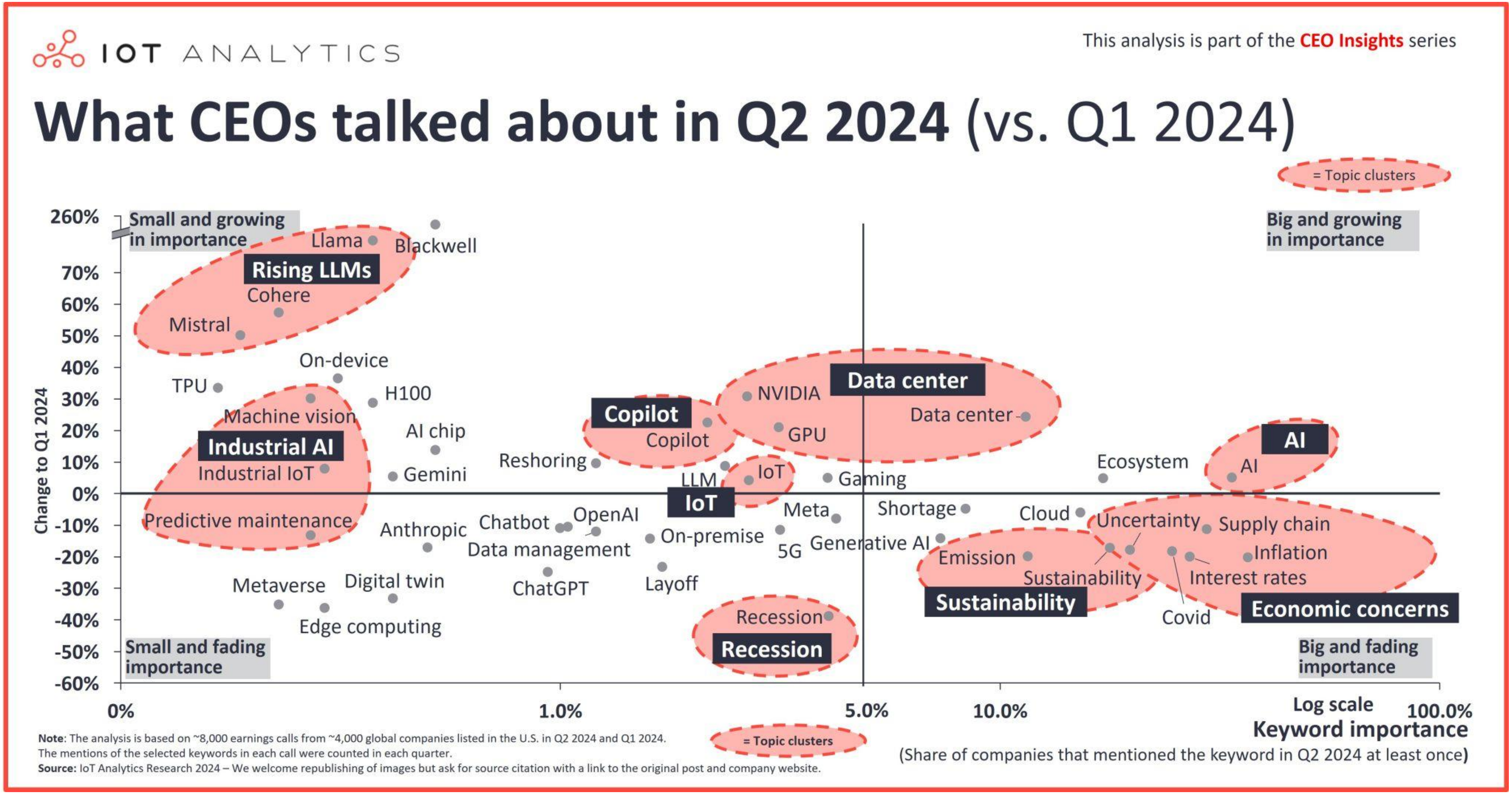

Culture Eats
Strategy for
Breakfast

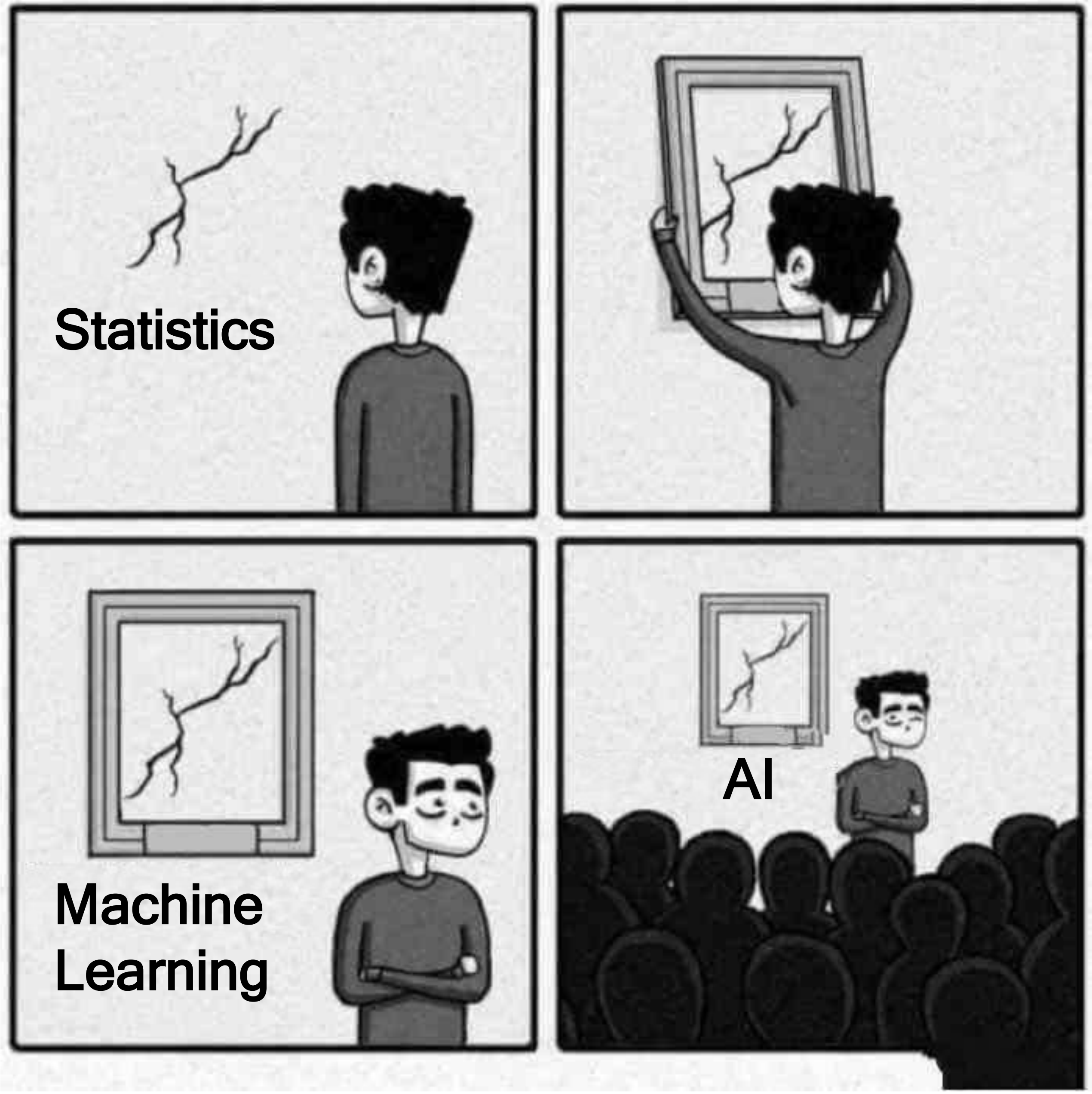
ALBEMARLE INTELLIGENCE

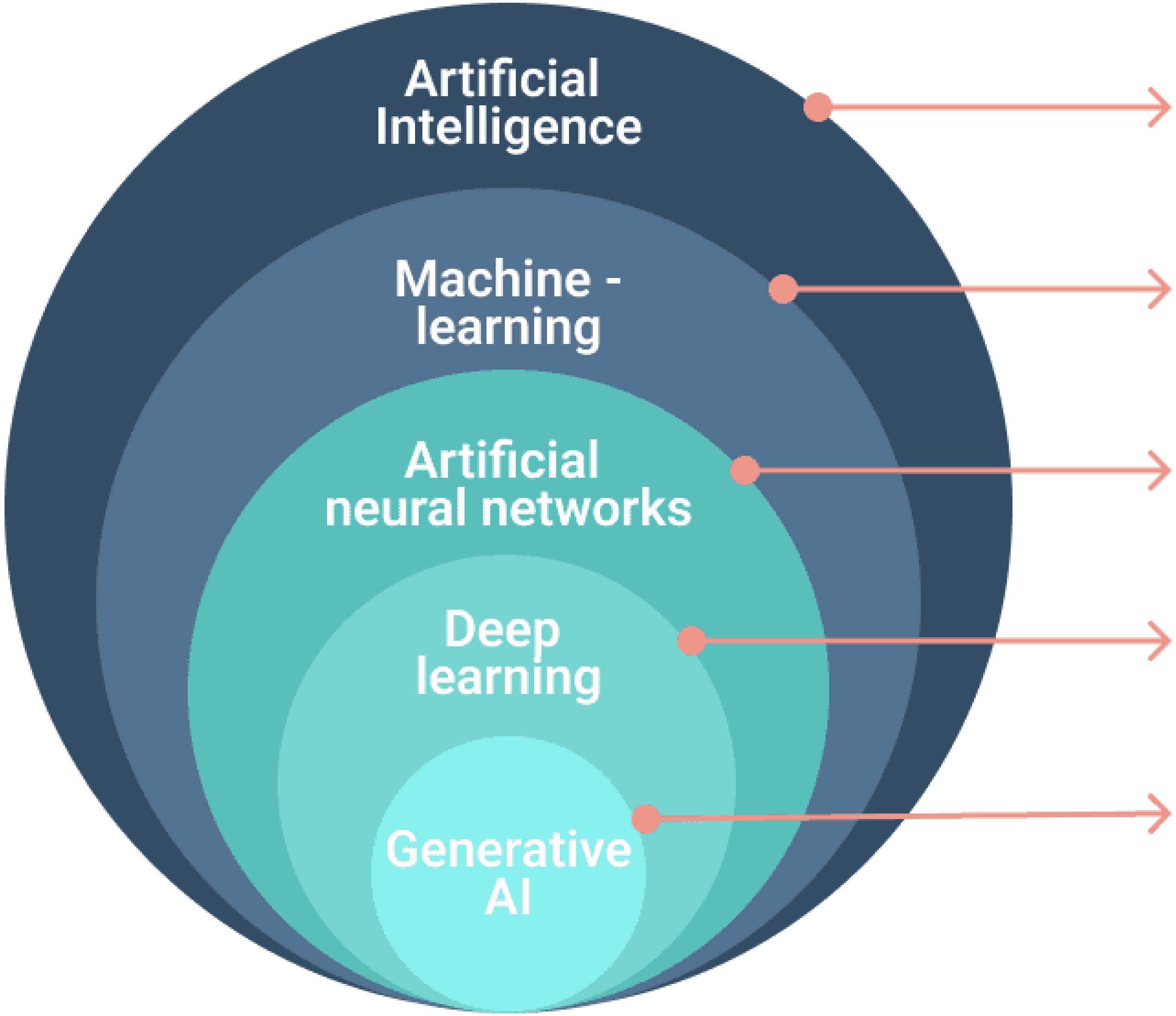
Reason #10


AI is a
Teammate, not
the Terminator


AI
AI


IOT ANALYTICS
This analysis is part of the CEO Insights series
What CEOs talked about in Q2 2024 (vs. Q1 2024)
= Topic clusters
Small and growing in importance
Big and growing in importance
Small and fading importance
Big and fading importance
Rising LLMs
Llama
Blackwell
Cohere
Mistral
On-device
TPU
H100
Machine vision
Industrial AI
Industrial IoT
AI chip
Gemini
Predictive maintenance
Anthropic
Chatbot
OpenAI
Data management
ChatGPT
Metaverse
Digital twin
Edge computing
Copilot
Copilot
Reshoring
Data center
NVIDIA
GPU
Data center
LLM
IoT
IoT
Gaming
On-premise
Layoff
Meta
5G
Generative AI
Shortage
Recession
Recession
Ecosystem
AI
AI
Cloud
Uncertainty
Supply chain
Inflation
Interest rates
Emission
Sustainability
Sustainability
Covid
Economic concerns
260%
70%
60%
50%
40%
30%
20%
10%
0%
-10%
-20%
-30%
-40%
-50%
-60%
Change to Q1 2024
0%
1.0%
5.0%
10.0%
100.0%
Log scale
Keyword importance
(Share of companies that mentioned the keyword in Q2 2024 at least once)
Note: The analysis is based on ~8,000 earnings calls from ~4,000 global companies listed in the U.S. in Q2 2024 and Q1 2024. The mentions of the selected keywords in each call were counted in each quarter.
Source: IoT Analytics Research 2024 – We welcome republishing of images but ask for source citation with a link to the original post and company website.


Statistics
Machine Learning
AI



Artificial Intelligence (AI)
Development of machines that can perform tasks requiring human-like intelligence.

Machine-learning (ML)
Training of computers to learn and make predictions or decisions without being explicitly programmed.

Artificial neural networks (ANN)
Human brain-inspired machine-learning models.

Deep learning (DL)
Neural networks with multiple layers to extract complex patterns and make accurate predictions or decisions.

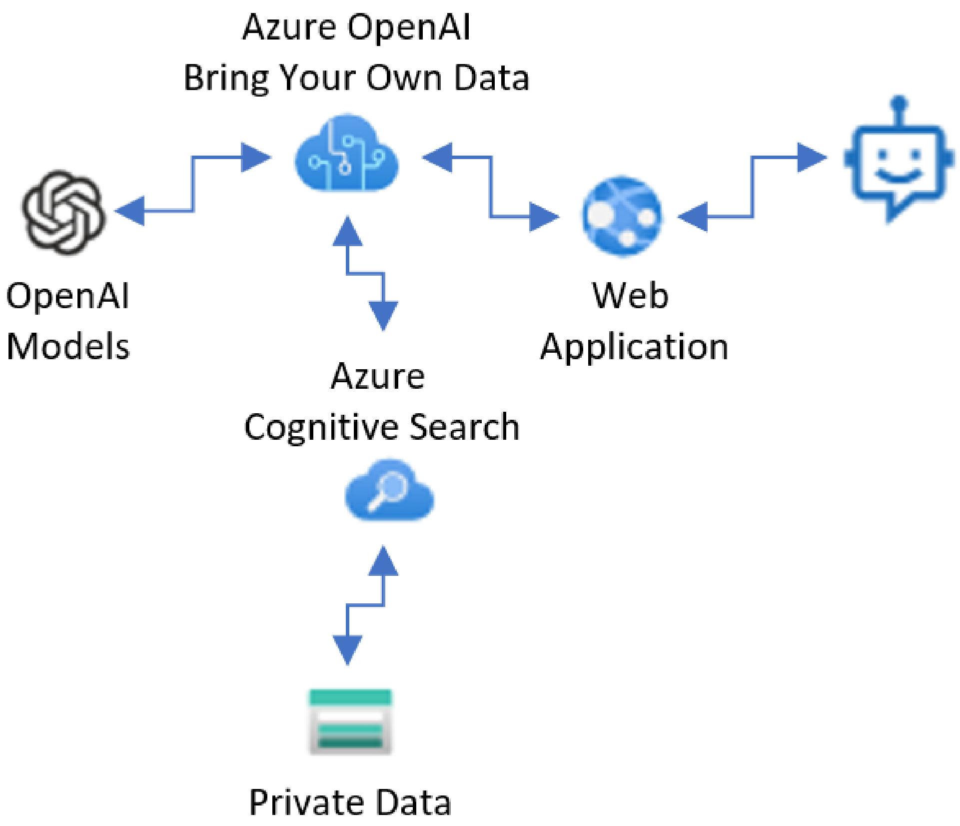
Generative AI (GenAI)
Creating models and systems that can generate new and original content.

Image 2. AI subsets

OpenAI + Microsoft

Ensure that artificial general intelligence (AGI) benefits humanity.

Empower every person and organization on the planet to achieve more



Azure OpenAI Service

- Enterprise-grade, scalable infrastructure
- Custom AI models fine-tuned with your data and hyperparameters
- Enterprise-grade security with role-based access control and private networks
- Built-in responsible AI to detect and mitigate harmful use

GPT + Enterprise data   Chat   Ask a question   Azure OpenAI + AI Search

Clear chat   Developer settings

Albemarle

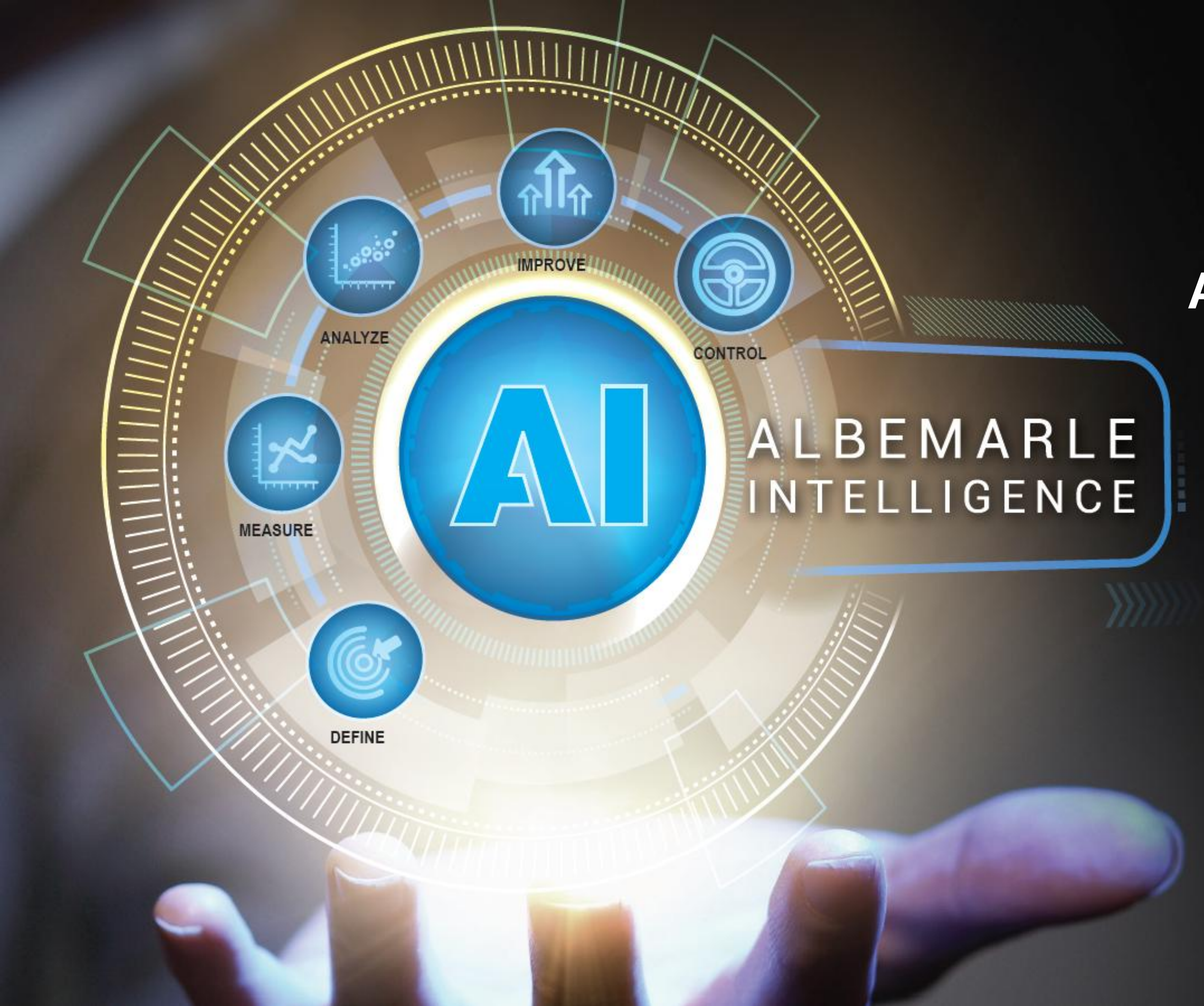
Chat with your data

Ask anything or try an example

- Where does my raw water pump get its water from?
- What modes does my BMS have on my calciner?
- How does my fuel/air ratio control work for my calciner burner?

Type a new question (e.g. does Functional Control Description include Software standards?)


Hey Chat GPT,
finish this building...
Hey Chat GPT,
finish this building...
Your skills are irreplaceable.
IMPACT
Satisfying jobs in construction and
Apply on
impact.be
Quick is open
Quick is open



Automated Information

Analytics Innovation

Actionable Insight

AI ALBEMARLE INTELLIGENCE

Albemarle People
Empowered by Technology
Unlocking the value of information

AUTOMATIZACIÓN DE LA INFORMACIÓN

ANALÍTICA CON INNOVACIÓN

ACCIONES INFORMADAS

ALBEMARLE INTELLIGENCE

Personal de Albemarle,
Empoderados por la Tecnología,
Liberando el Valor de la Información

自动信息

分析创新

切实可行的洞察

ALBEMARLE INTELLIGENCE

雅保人，
技术赋能，
释放信息的价值

CHEMICALS & MINING| AMERICAS

Albemarle creates 25Million Event Frames, with estimated improvements >$150 million annually

Challenge

- Hundreds of thousands of data points
- Manual data sharing and reporting processes led to information bottlenecks
- Massive manufacturing growth and demand – fueling the need for more efficient manufacturing processes

Solution

- Deployed a massive, standardized implementation of the full AVEVA™ PI System™
- Created Albemarle Intelligence Program, merging the experience and skillset from all of our manufacturing employees, with world-class technology

Results

- **>$150 million in estimated annual improvements**

AVEVA

Jonathan Alexander

Manufacturing AI & Advanced Analytics Manager

Albemarle

jonathan.alexander@albemarle.com