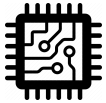
falkonry
Smarter Fab Operations
AI-driven Equipment Performance Visibility

Challenges in semi operations



Greater Precision for Higher Quality

Process variations can result in lower bin chips or even in scrap

Removing Unplanned Downtime

High utilization needed to meet market demand means increased opportunity costs of equipment failure

Resource Usage Optimization

Characterization and monitoring of equipment performance to minimize unnecessary power, water or chemical use

Maintain High Data/IP Security

Huge risks involved in the handling of confidential process and product data

Falkonry © 2021

AI for augmenting human ability is now necessary

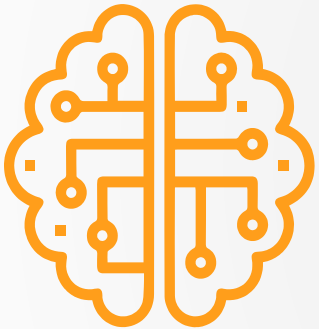
Numerous low probability issues
to prevent and understand

+

Faster data sampling
rates to achieve precision during manufacturing

→

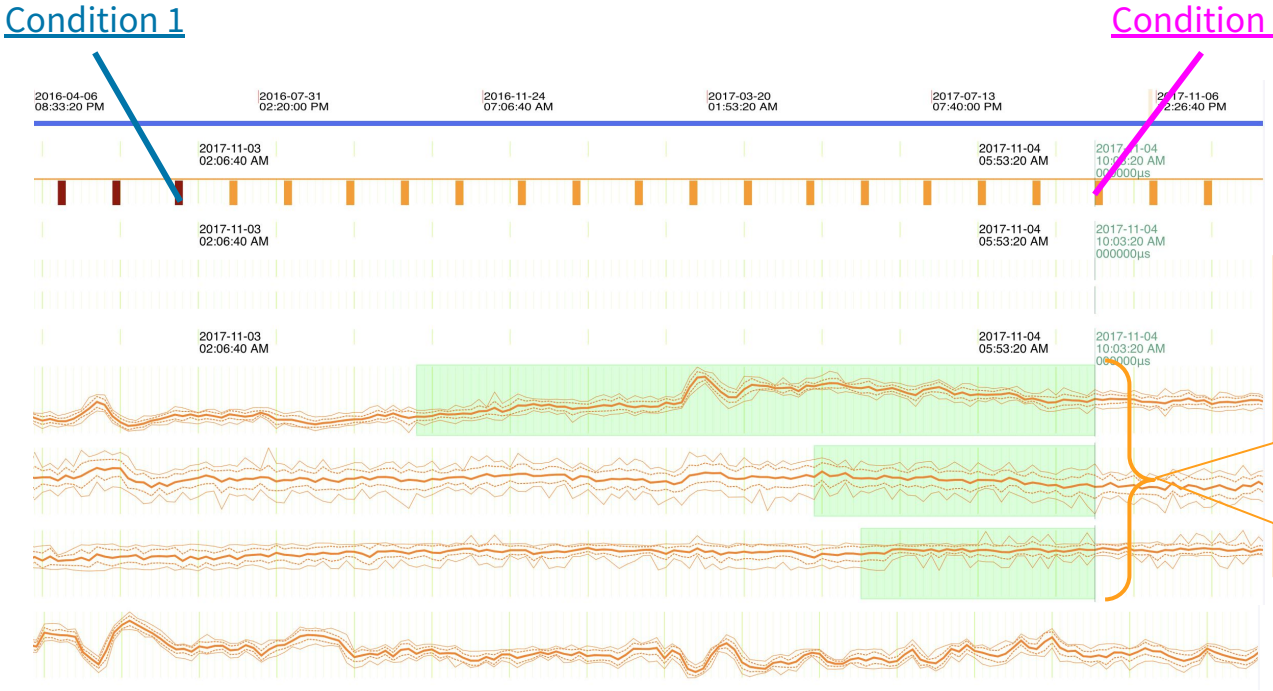
Large amount of time series data
is produced but is highly underutilized



Time series AI extracts facts of equipment performance from patterns in equipment data.

Falkonry © 2021

Time series AI: Mining & organizing multivariate, temporal patterns



Pattern:

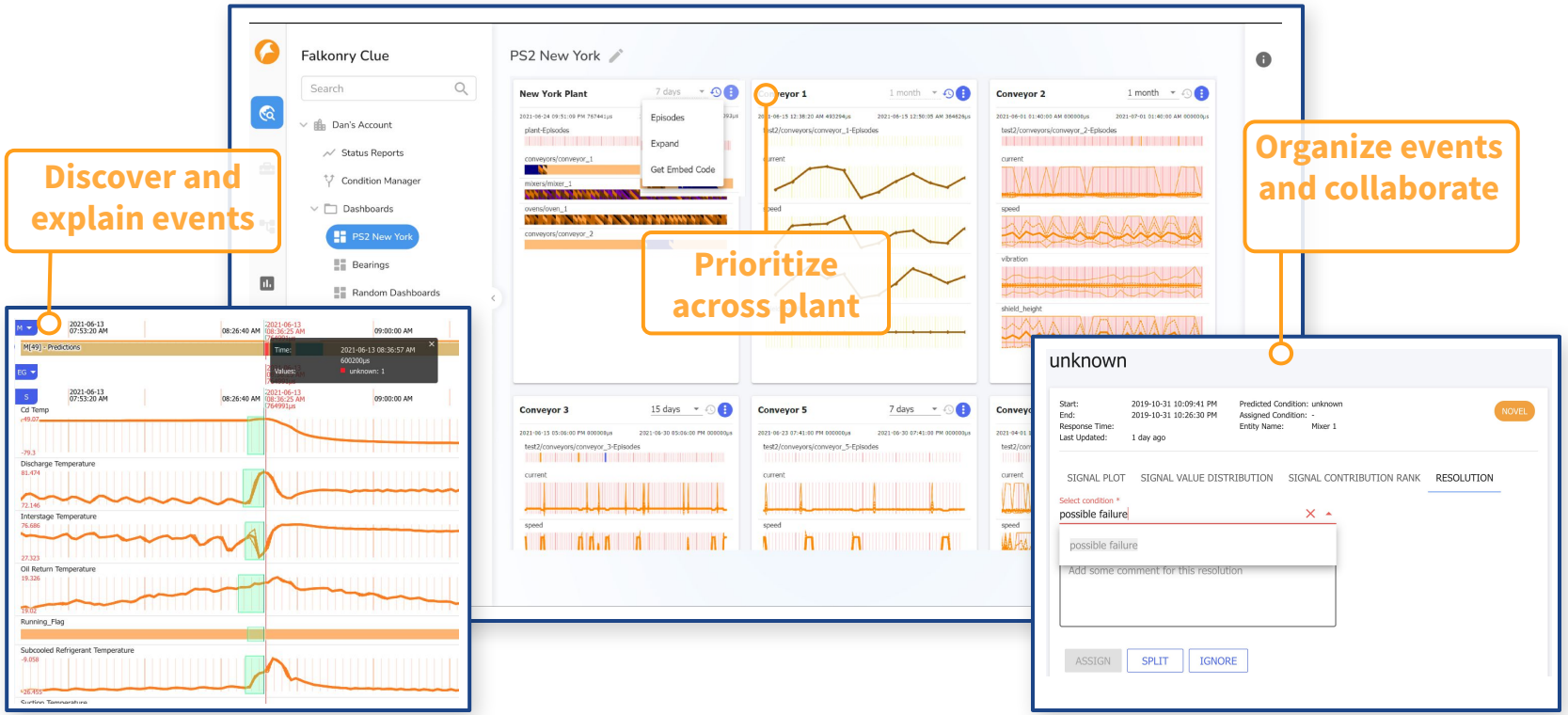
- Uniqueness
- Important parameters
- Relative weights
- History duration
- Shapes & waveforms

AI automatically discovers and distinguishes between conditions

Without requiring data scientists or data engineers

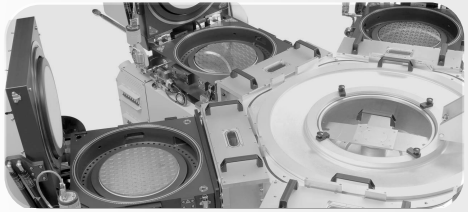
Falkonry © 2021

Falkonry enables smarter decisions with AI on time series data



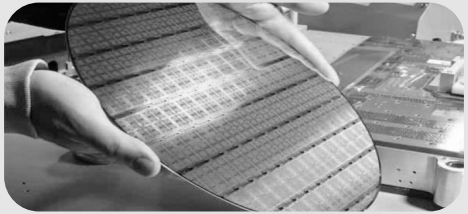
Smarter semi operations using time series AI

PREDICTIVE MAINTENANCE



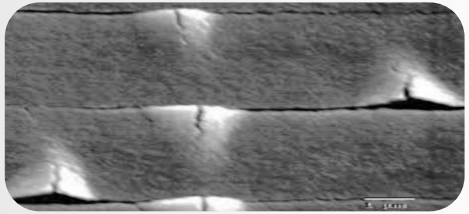
Etching

PREDICTIVE QUALITY



Metrology Sampling

ROOT CAUSE ANALYSIS



Delamination (Deposition)

EQUIPMENT FINGERPRINTING

Equipment installation
PM recovery

EQUIPMENT CHARACTERIZATION

New Equipment or process

Falkonry © 2021

Predictive maintenance of Ion Beam Etcher

PROBLEM

ESD damage to chamber and substrates occurring due to unexpected failure of neutralizer

SOLUTION

Time series AI on equipment sensor data detects variations in neutralizer behavior which indicate impending part failure

ADVANTAGES

Identify early part failure to reduce scrap and unscheduled equipment downtime

Falkonry © 2021

Neutralizer failure prediction development

1. Collect sensor data and known events
2. Review historical system behavior
3. Separate pre-failure from normal behavior
4. Verify on a different known event
5. Deploy against streaming data

Falkonry © 2021

Neutralizer failure prediction development: Step 1

1. Collect sensor data and known events
   a. Etcher sensor data
   b. Neutralizer failure events date+time
2. Review historical system behavior
3. Separate pre-failure from normal behavior
4. Verify on a different known event
5. Deploy against streaming data

~5 months of time series data from etcher sensors including:

- Currents & voltages
- Gas flow rates
- RF reflected power

Two confirmed neutralizer failure events

- Timestamp of each event

Falkonry © 2021

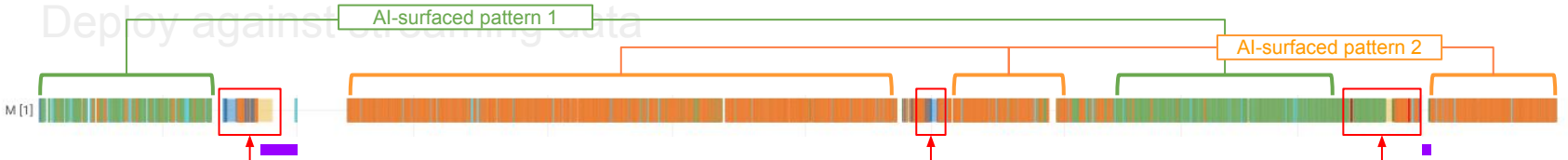
Neutralizer failure prediction development: Step 2

1. Collect sensor data and known events
2. Review historical system behavior
   a. Unsupervised learning on sensor data
   b. Compare failure events to unusual behavior
3. Separate pre-failure from normal behavior
4. Verify on a different known event
5. Deploy against streaming data

Two confirmed neutralizer failure events
- Purple bars

Two main patterns of historical behavior
- Green and orange

Three periods of “unusual” behavior
- Red boxes



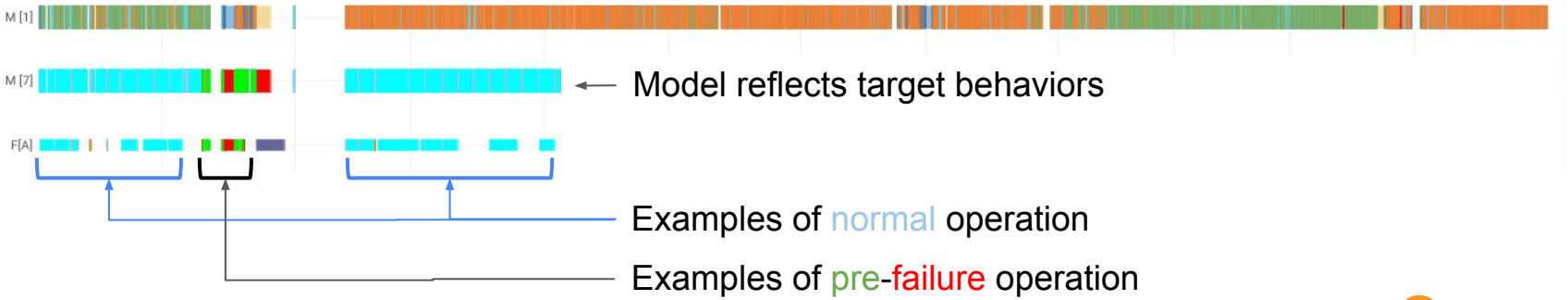
Something unreported happened here?

Interesting overlap between known neutralizer failures and unusual historical behavior

Falkonry © 2021

Neutralizer failure prediction development: Step 3

1. Collect sensor and ground truth data
2. Understand historical system behavior
3. Separate pre-failure from normal behavior
4. Verify on a different known event
5. Deploy against streaming data



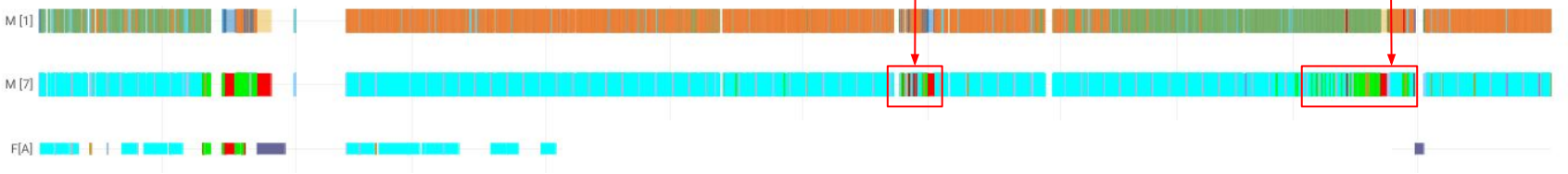
Falkonry © 2021

Neutralizer failure prediction development: Step 4

1. Collect sensor data and known events
2. Review historical system behavior
3. Separate pre-failure from normal behavior
4. Verify on a different known event
5. Deploy against streaming data

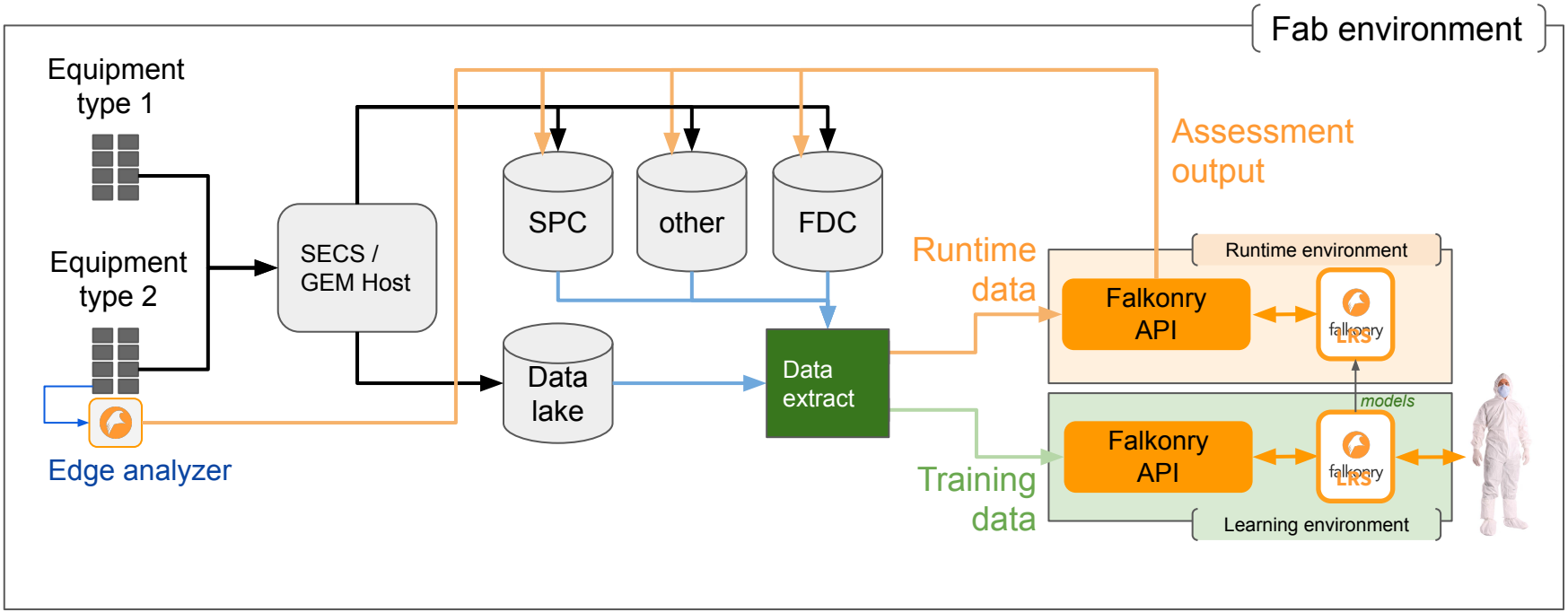
Abnormal patterns precede additional known neutralizer failure

Model indicates abnormal behavior. Was equipment serviced without a record?



Falkonry © 2021

Deploy against streaming data: Step 5



Architecture reads from and writes to existing data systems in the fab

Falkonry © 2021

Defectivity analysis of etching process

PROBLEM

Defect inspection adds time and cost to wafer processing

SOLUTION

Time series AI applied to etcher signal data finds patterns that differentiate low and high defectivity wafers

ADVANTAGES

Focus inspection on high-defectivity wafers to reduce inspection cost

Falkonry © 2021

Equipment fingerprinting and characterization

PROBLEM

PM performance errors result in lost productivity and reduced yield

SOLUTION

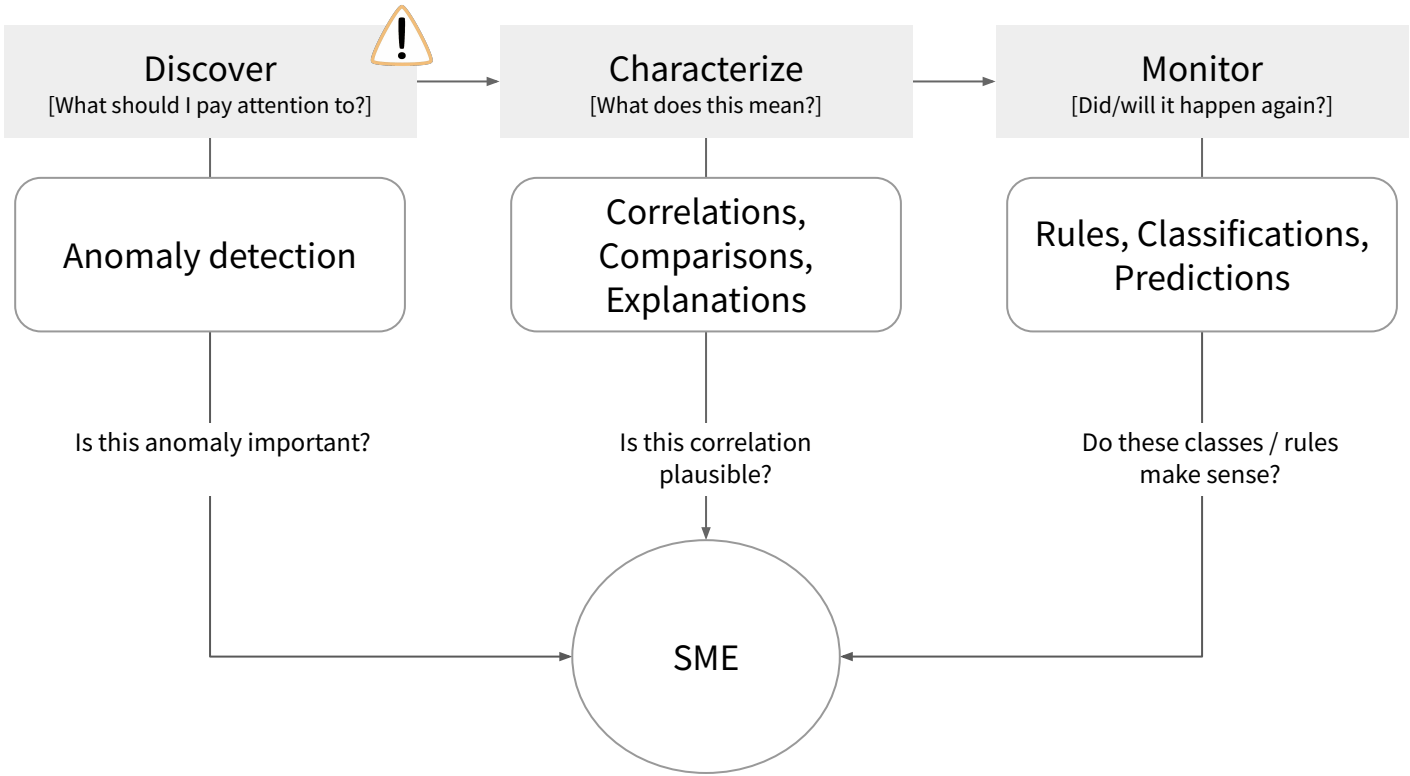
Operational pattern of a reference process for a known good tool (“golden fingerprint”) is compared to the patterns of newly serviced / installed tools to report significant deviations.

ADVANTAGES

Automate verification of PM and reduce downstream yield loss

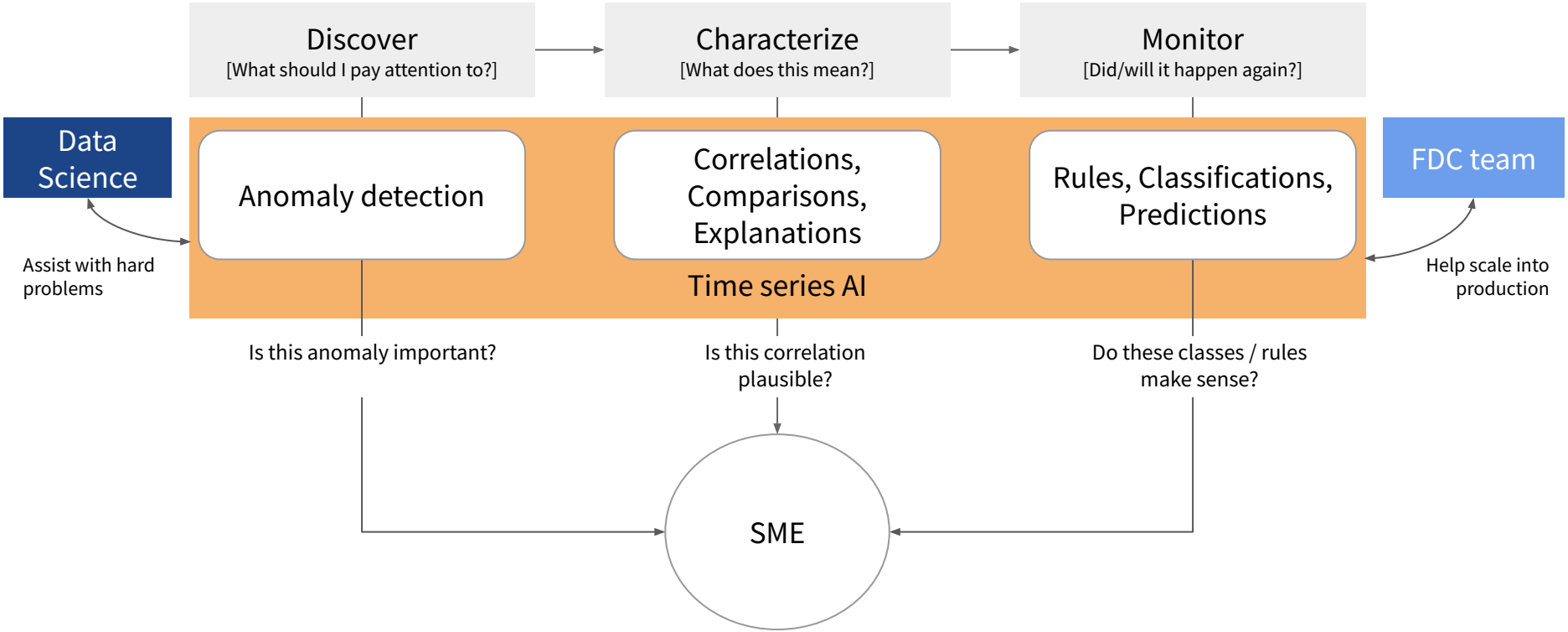
Falkonry © 2021

Subject matter experts are key to making sense of data



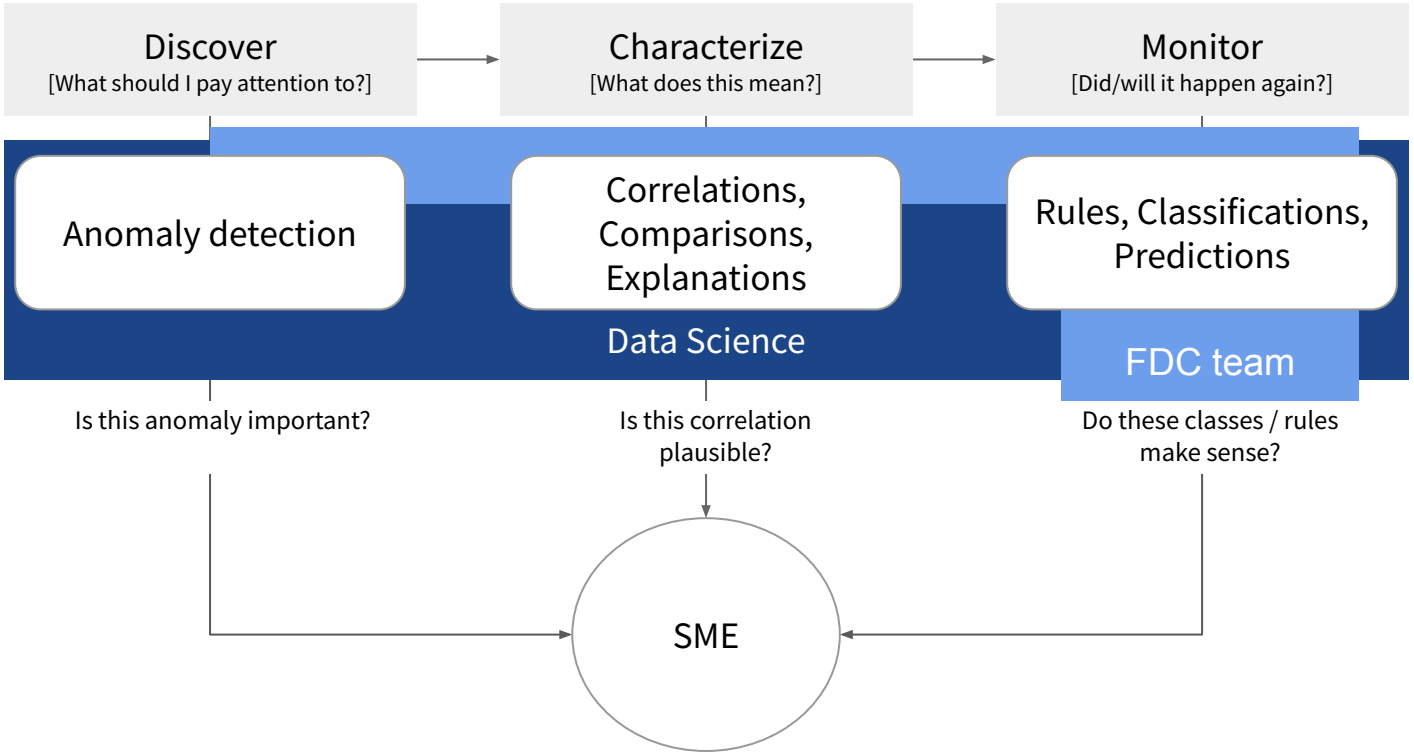
Falkonry © 2021

Time series AI allows subject matter experts to do tasks themselves



Falkonry © 2021

Coordination and alignment makes conventional data science hard



Key requirements for Time series AI

Fit into existing workflows

Daily Meetings

Analytic and reporting approach which supports daily operations

End-to-end workflows

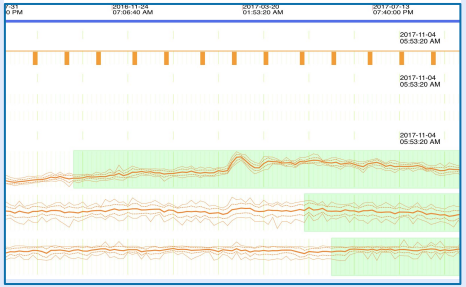
Data sources and findings integrate across fab systems

Usable by domain experts, not just data experts

Domain knowledge is as important as the right data for AI to be effective.

Achieving scale requires domain experts to be involved first-hand.

Understand the role of time



“Interesting” behaviors are time-dependent. Effectively handling different time scales is critical.

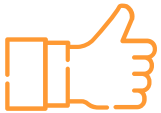
Explain insights and build expert confidence

Explanation → **Actionable assessment**

Falkonry makes the *physical* world's information accessible and useful

HIGHLIGHTS IMPORTANT EVENTS

We focus human attention on important signals in very noisy data



WORKS FOR END-USERS

We do not need data scientists or data engineers

SAAS ANYWHERE

We run efficiently on any available compute

RECOGNIZED & RESPECTED

Forbes AI50 TOP AI FIRMS TO WATCH 2021

Highest private AI company recognition

AFWERX

First large-scale strategic sensor DoD AI capability

AI 100 CBINSIGHTS 2020

Selected from 5,000 companies globally

21 Patents issued and pending globally

Falkonry © 2021

falkonry

Operational Excellence with AI

falkonry

Thank you!

Dr. Nikunj Mehta

Founder & CEO
Falkonry

nikunj@falkonry.com