Transforming Reliability with AI

Arun Gowtham P.Eng, CRE, CMRP

Apex Ridge Reliability

IEEE Boston Chapter – January 2024

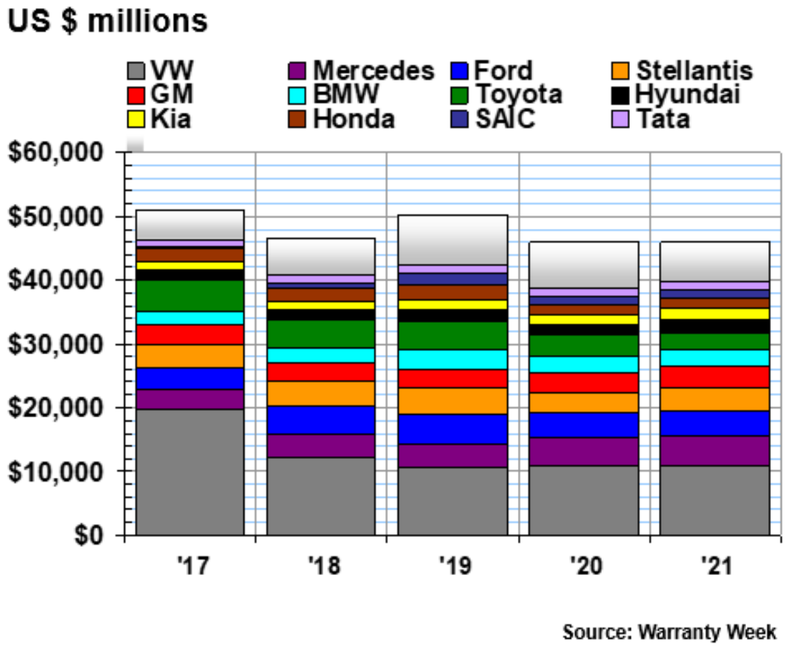
Intro

- Reliability Engineering Consultant at Apex Ridge Reliability
- Industry Experience: Semiconductors, Fuel Cells, Pharmaceuticals, Chemicals, Composites
- Certified Reliability Engineer (CRE), CMRP, P.Eng (PEO)
- M.S. Mechanical Engineering (Reliability), Drexel University, PA, USA
- PEMAC (President), SRE (Education Chair)
- Enjoys Hiking, Reading, and Basketball

Business Priorities

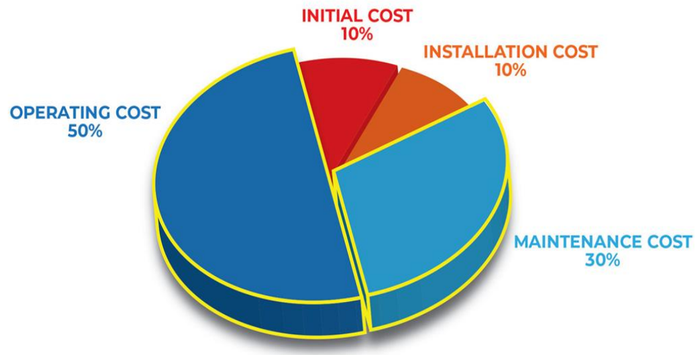
Share of Reliability & Maintenance

Warranty Costs 0.5-5 % of Total Sales



Source: Warranty Week

Maintenance Costs 20-60 % of OPEX



BREAKDOWN OF PUMP LIFE CYCLE COSTS

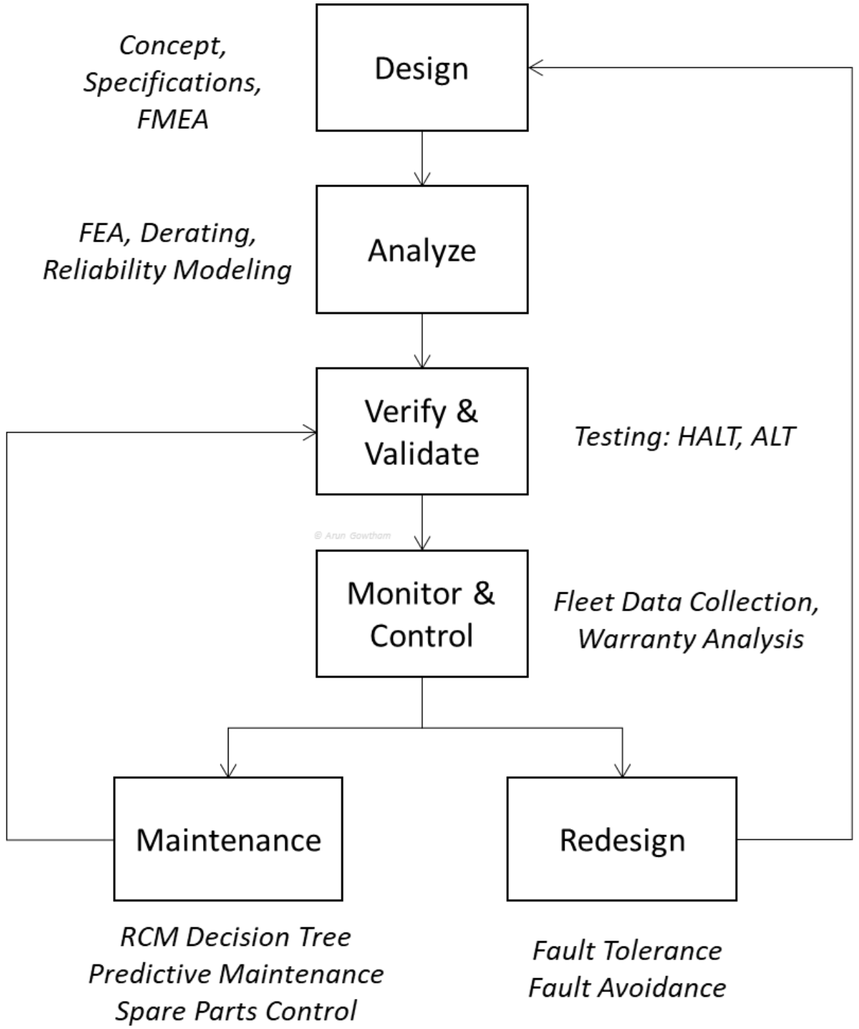
Failure Impact

Avg. Cost of Unplanned Downtime in Heavy Industries

$187,000 /hour

Leading Cause: Equipment Failure

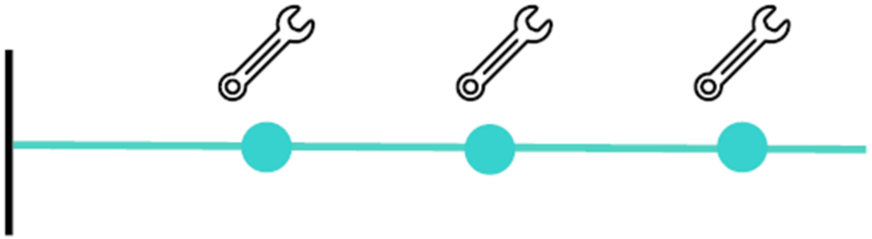
Avoiding Failures



Avoiding Failures

Corrective Maintenance

Preventive Maintenance

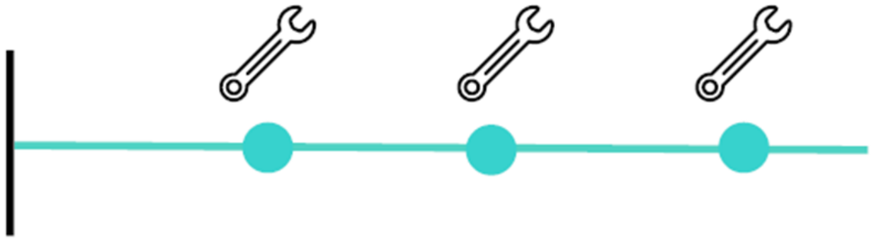


13% Reduction in Unplanned Downtime*

*GE:Impact of Digital on Unplanned Downtime

Avoiding Failures

Preventive Maintenance

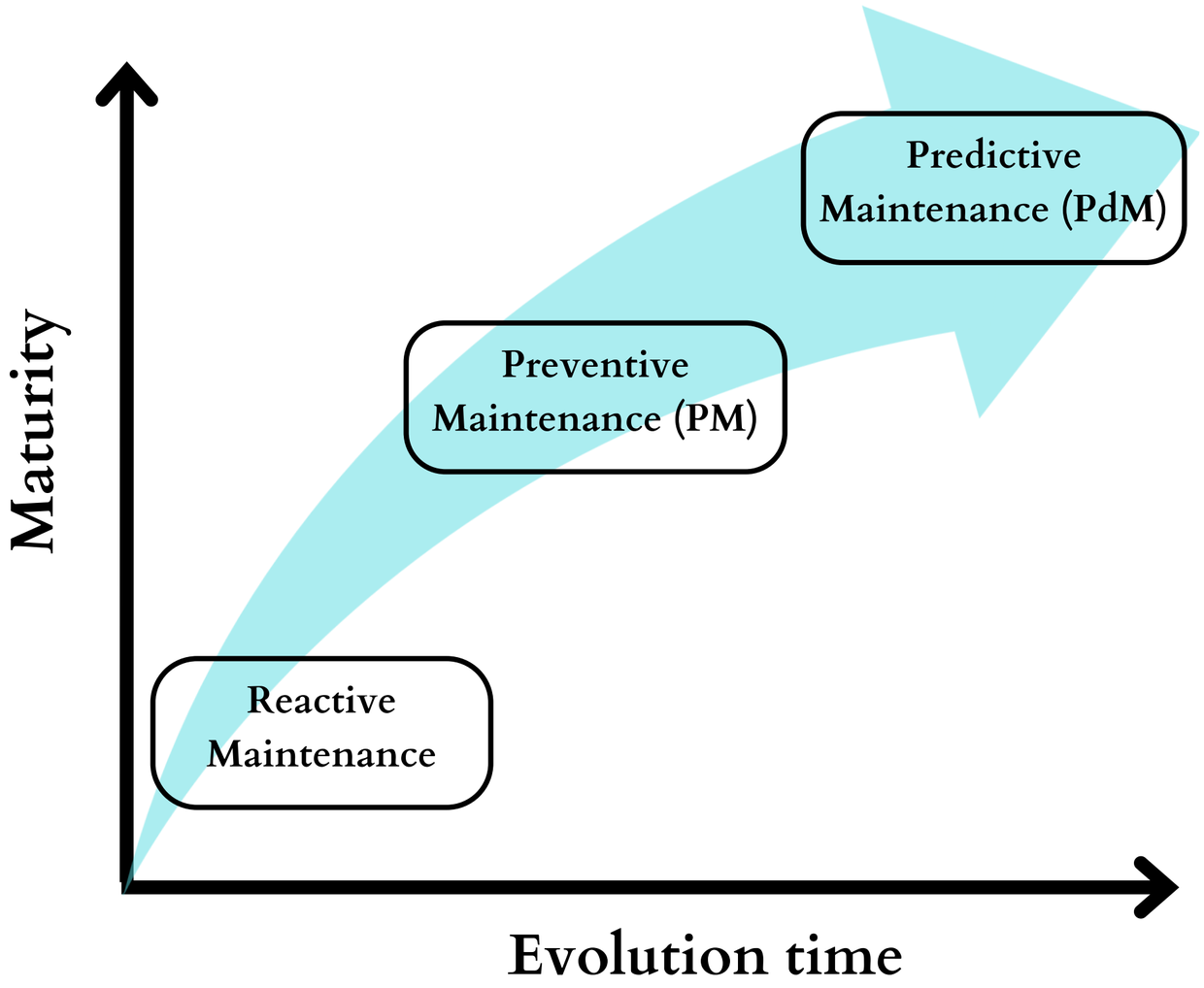


47% Reduction in Unplanned Downtime*

Predictive Maintenance

GE:Impact of Digital on Unplanned Downtime

Optimizing Maintenance



There is no one solution for all

Maturity increases complexity

Challenges remain

Overcoming Challenges

To predict Equipment failure:

Need more data points

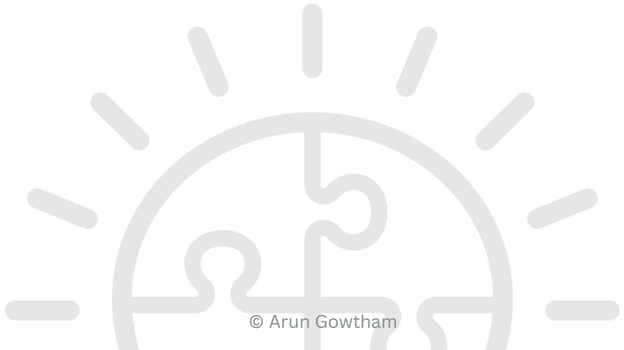
↓

Industrial Internet of Things (IIoT)

Need accurate predictions

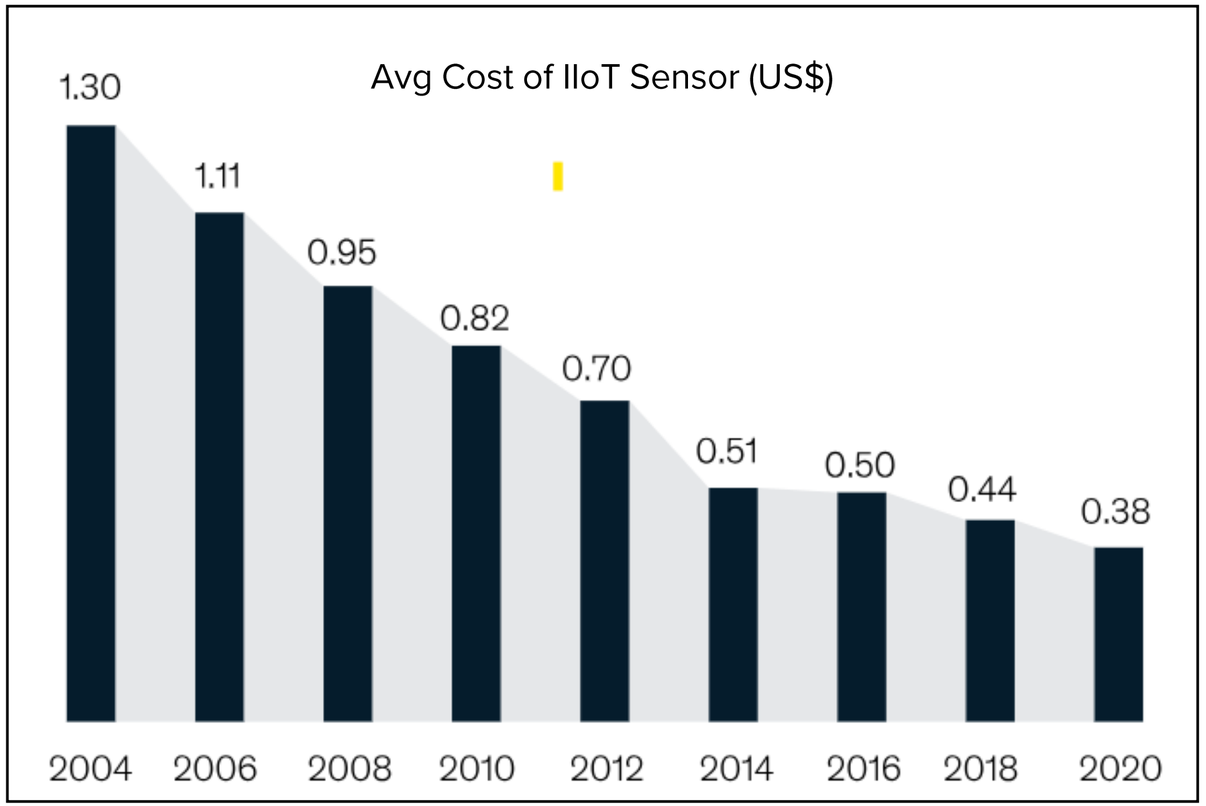
↓

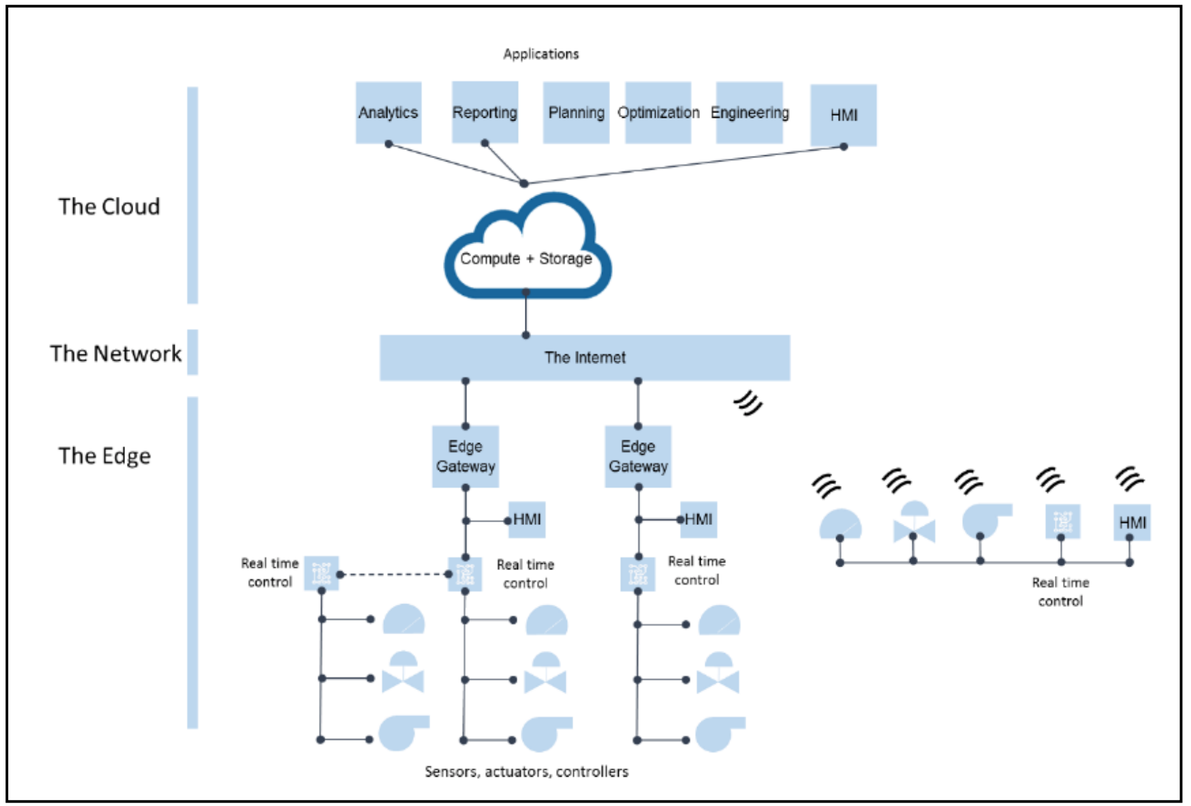
Artificial Intelligence (AI/ML)



Industrial Internet of Things (IIoT)

Industrial Internet of Things (IIoT)





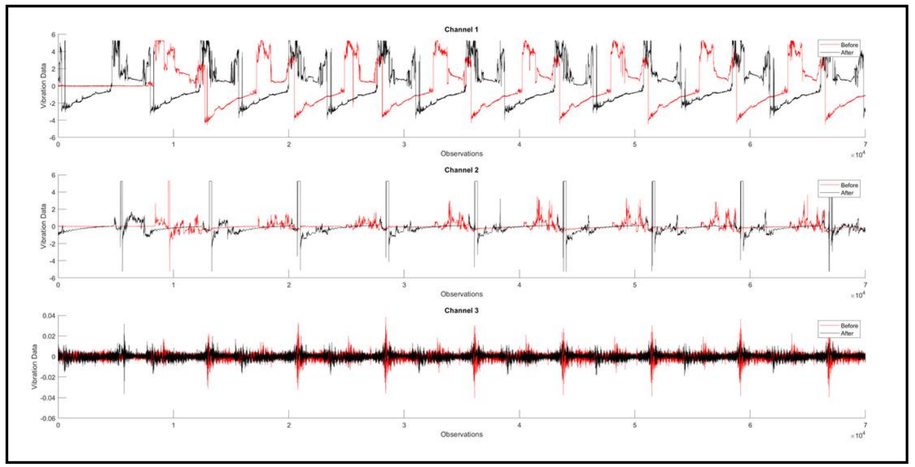
Various protocols available:
LTE, Wifi, Modbus, ZigBee, Ethernet, etc

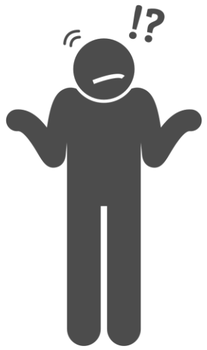
What IIoT enables

- Copious data collection on Equipment Condition
- Remote Monitoring
- Automated Controls

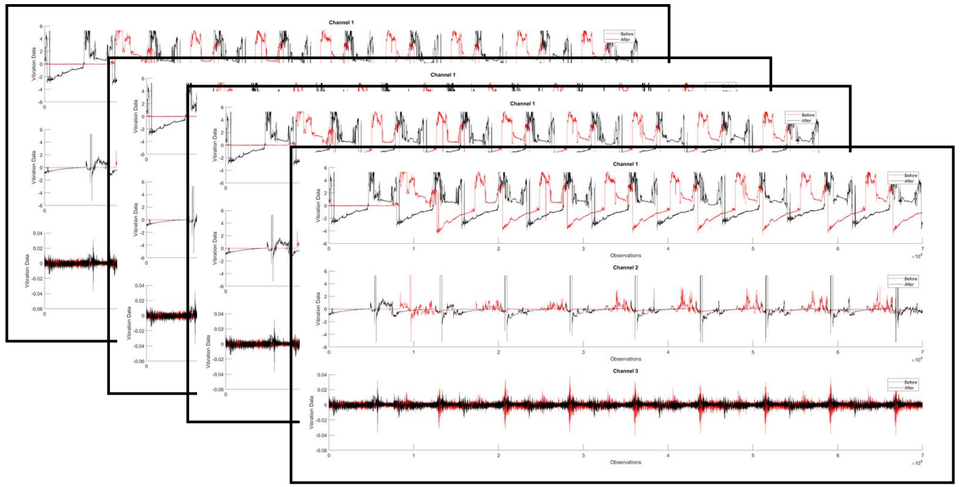
What IIoT enables

Data from 1 vibration sensor on 1 Pump



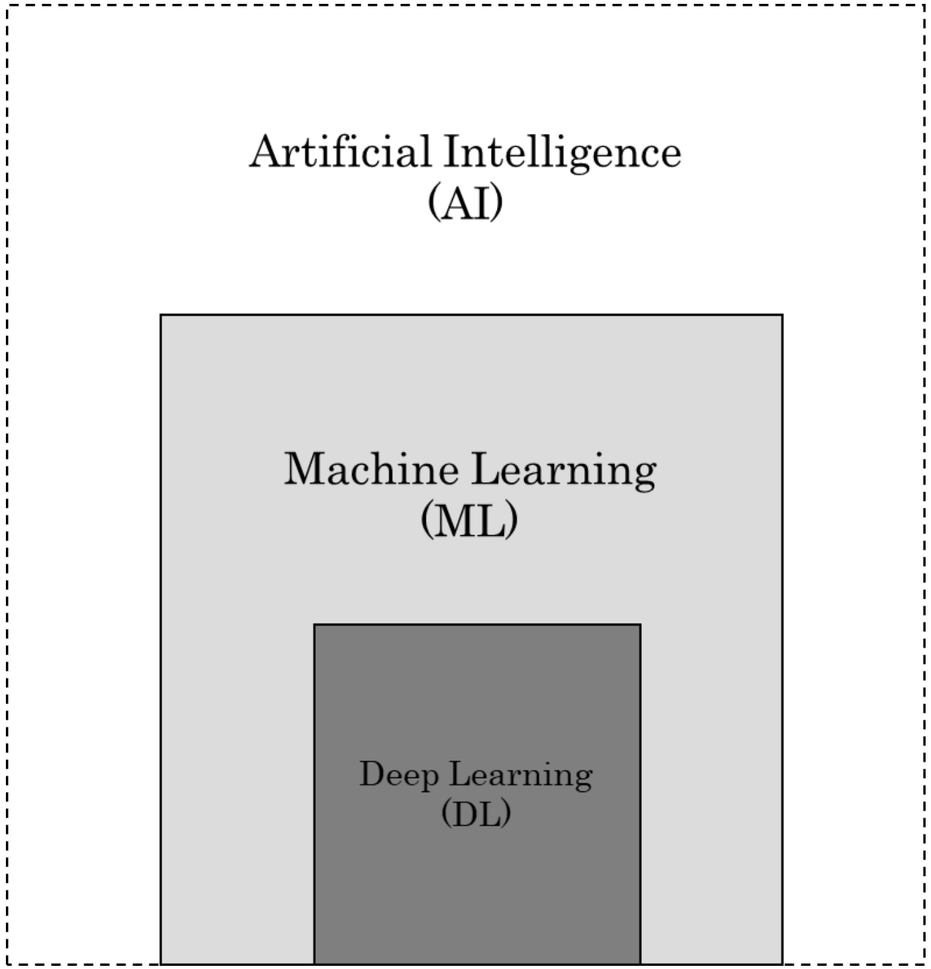


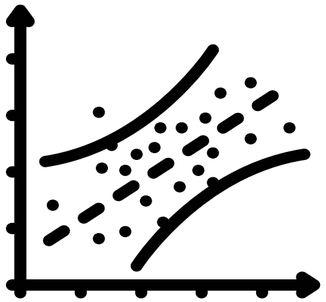
How much data will all sensors generate?



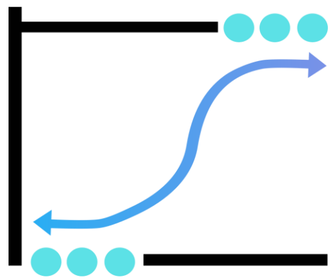
Study: 73 ZB of IIoT data by 2025

Enter Artificial Intelligence (AI)

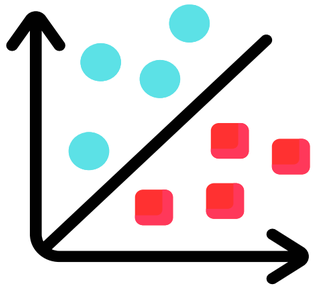




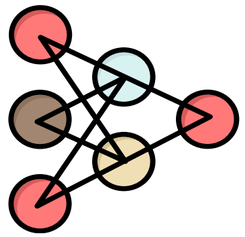
Regression



Classification

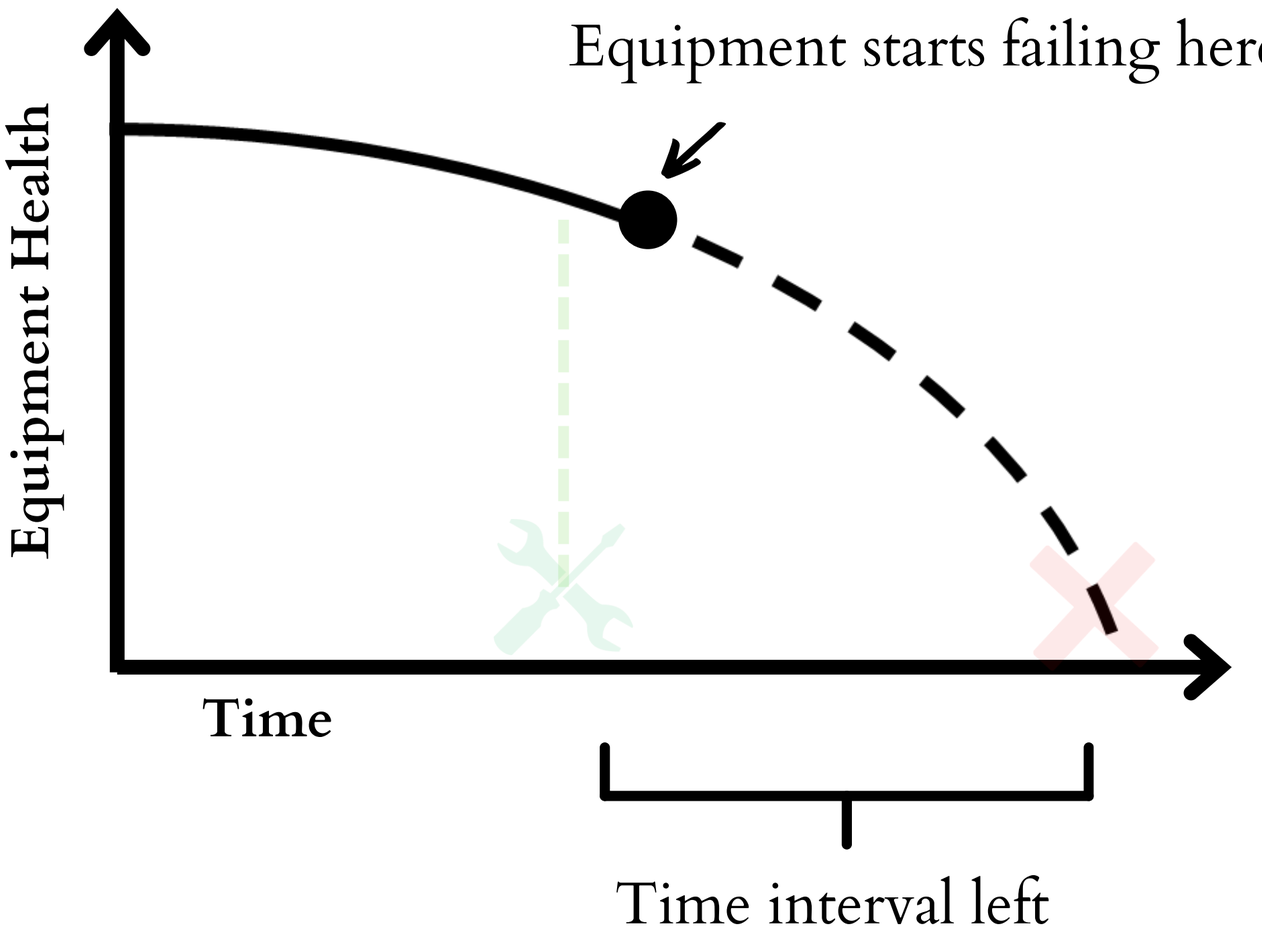


Clustering



Neural Networks

Using AI to Predict Maintenance

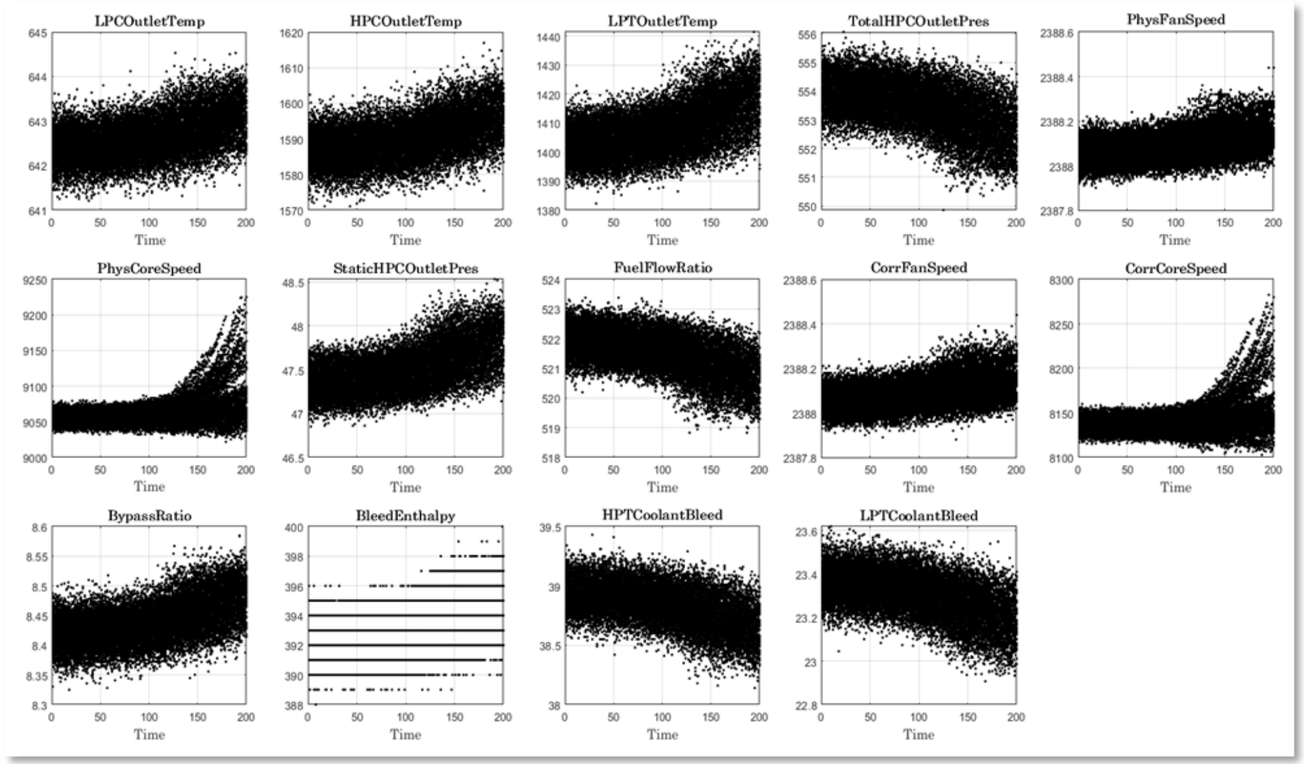


Goal 1: Detect this point – deviation from normal behavior

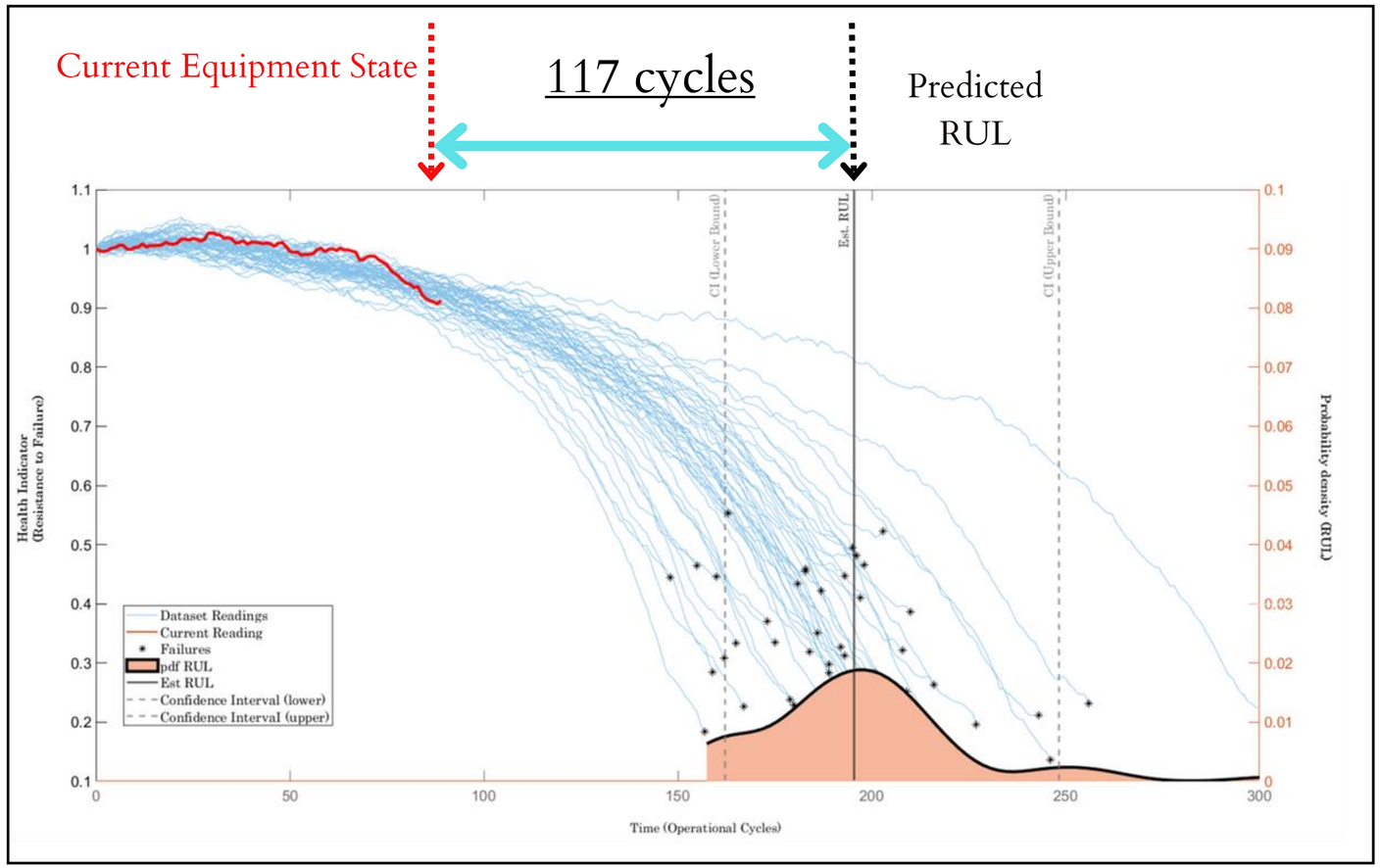
Goal 2: Estimate time left – from now to complete failure

AI-based Predictive Maintenance

Extract features from data → Train ML Model → Detect Faults Predict Life



AI-based Predictive Maintenance



Maintenance team has 117 cycles to perform maintenance

- Prediction will change in real-time
- Need to account for Admin delay, Diagnosis time, Production Window, etc

Other Applications in Reliability

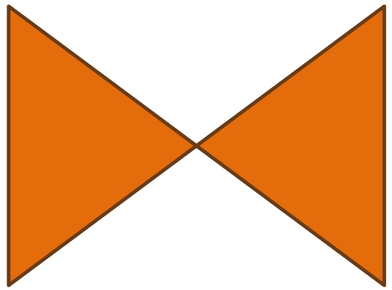
Product Remote Monitoring
+ AI

In Field

Optimize maintenance – PdM

Fault Diagnosis

Anomaly Detection



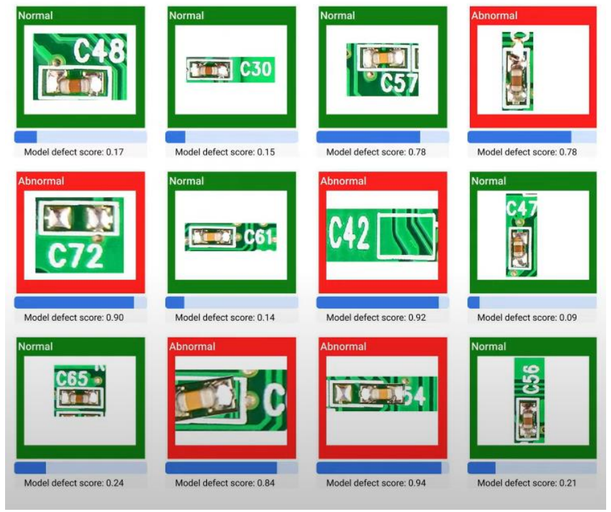
In Design

Verification & Validation Testing

RG/ALT (Theoretical)

Other Applications in Reliability

Manufacturing Defect Inspection



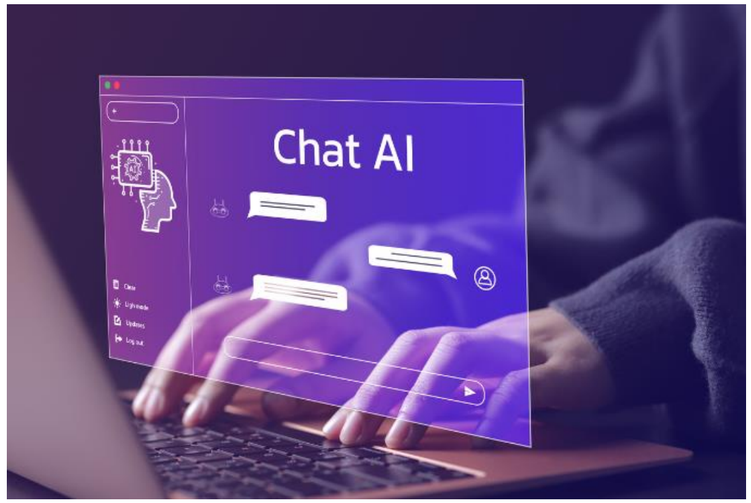
Design Optimization multiple variables

Text extraction from Field Reports

Source: Google Cloud AI Demo

Other Applications in Reliability

Changing our work interface with Generative AI



You

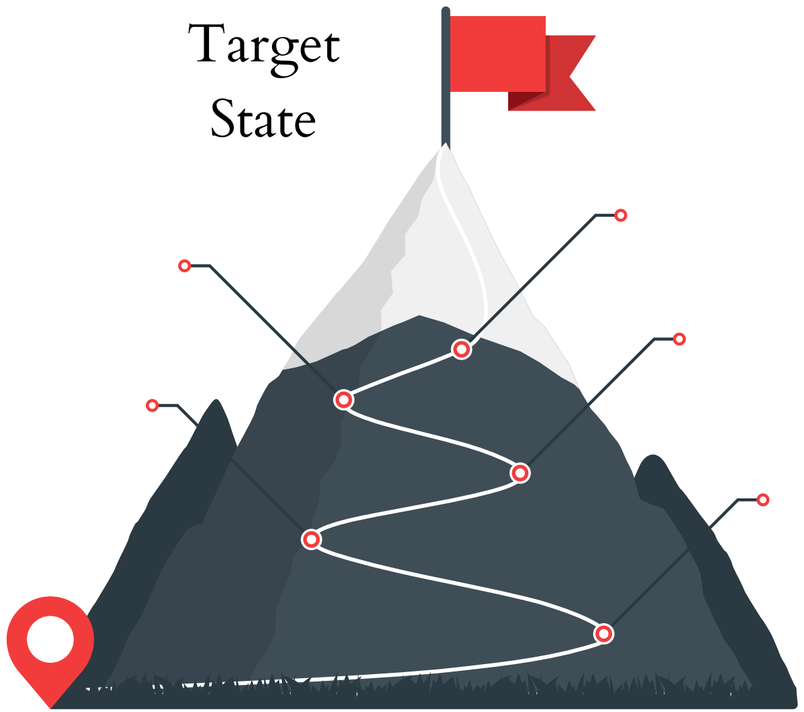
Perform Weibull analysis on the following TTF data: 12, 18, 35, 45, 75, 90, 116 days and plot the result

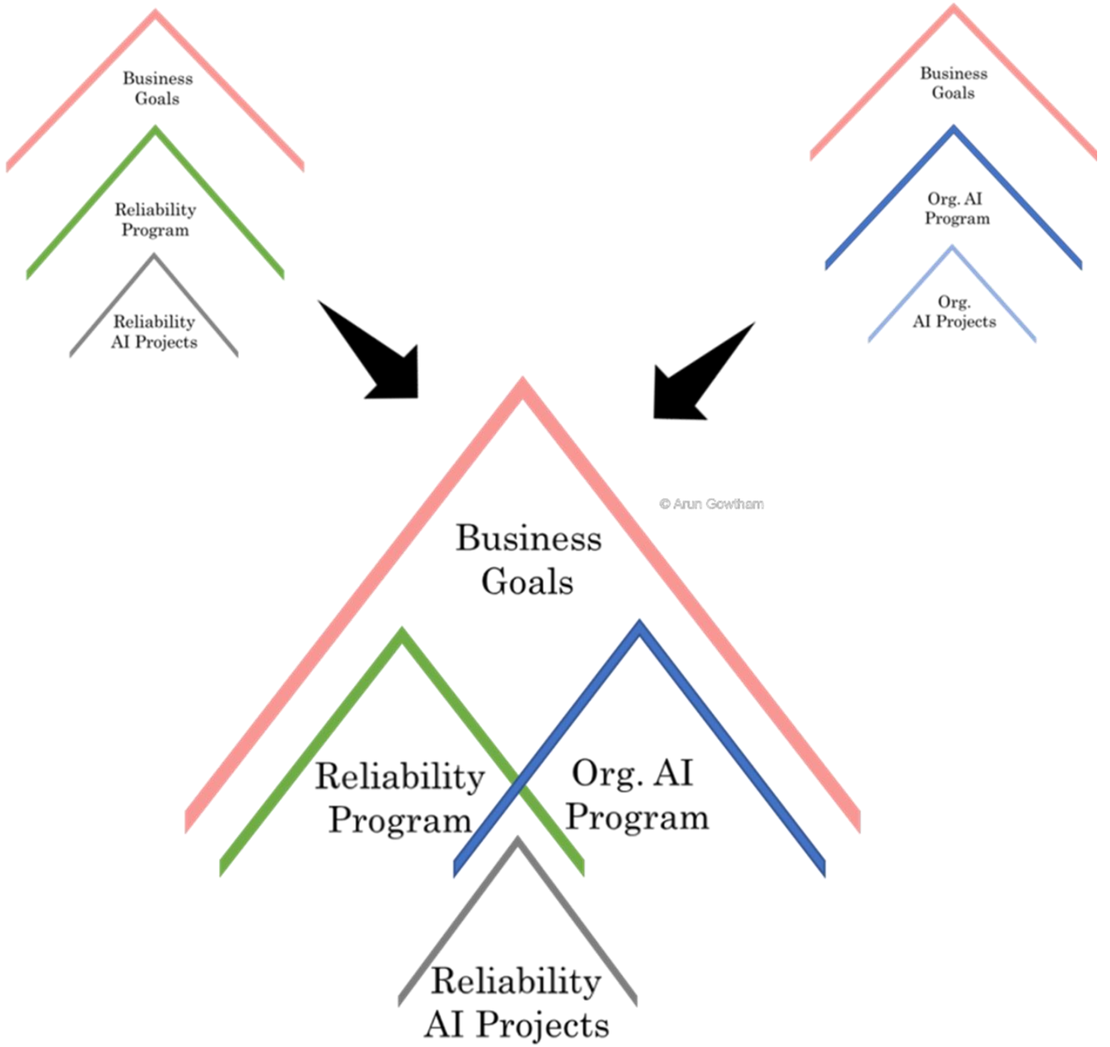
ChatGPT

Weibull analysis is a method used for reliability analysis, often applied to time-to-failure (TTF) data. In order to perform Weibull analysis and create a plot, you'll typically need statistical software or programming languages like Python, R, or MATLAB. Here, I'll provide you with a Python code example using the `scipy` library, assuming you

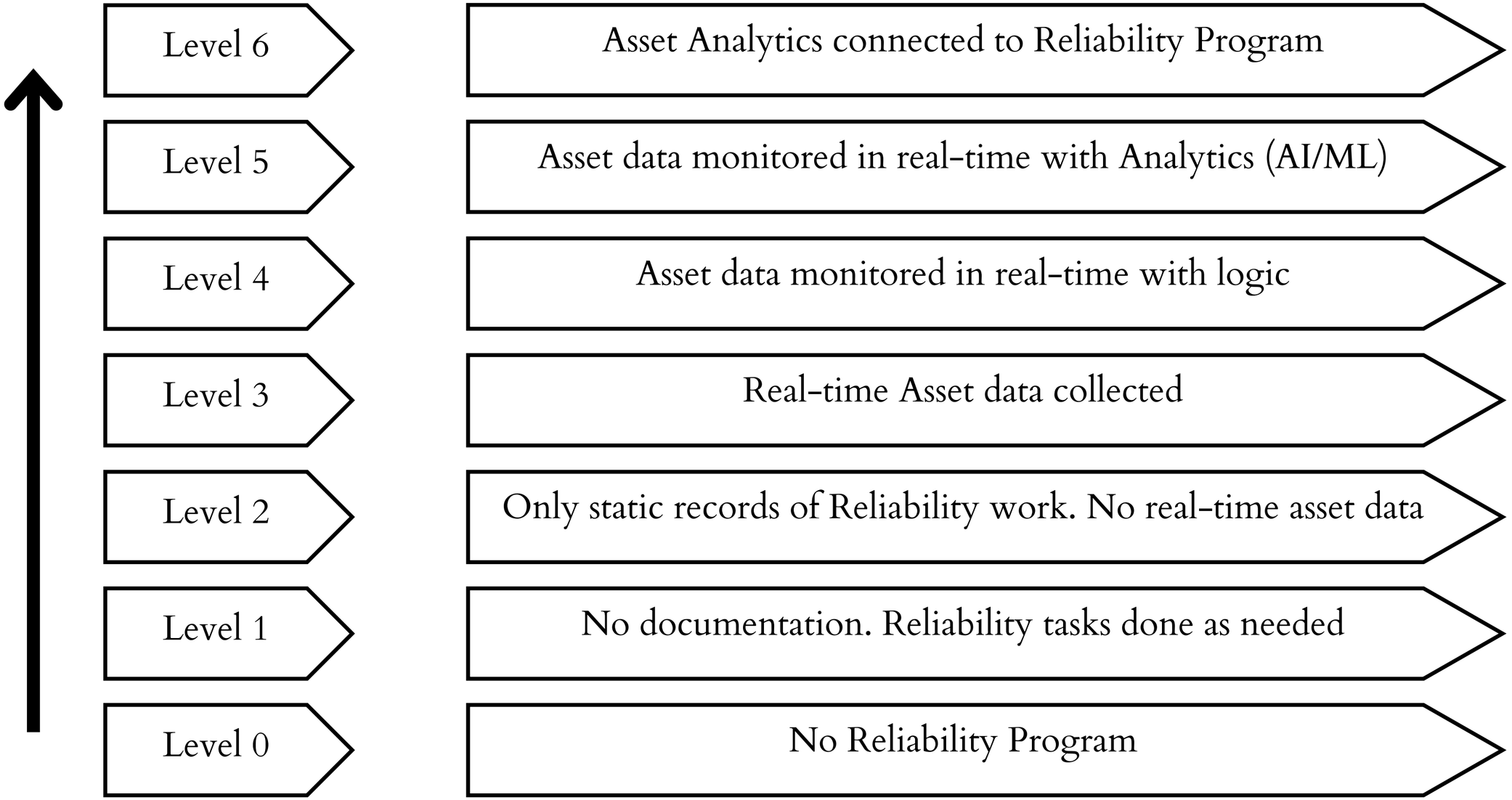
Source: Open AI ChatGPT

Organizational Transformation





Readiness Scale



Thank you!

LinkedIn

Contact:

arungowtham@apexridge.com