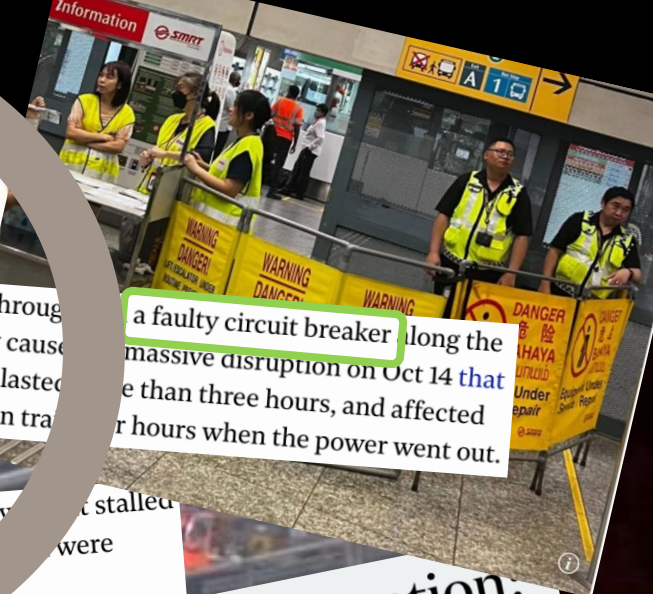




The Future of Maintenance: AI-Driven Failure Prediction & Anomaly Detection

Lionel Low, Capstone Project



A section of power that burned through
Tuas West Extension were the primary cause
affected three MRT lines. The incident lasted
123,000 commuters. Many were stuck in train

a faulty circuit breaker along the
massive disruption on Oct 14 that
more than three hours, and affected
hours when the power went out.

During the accident, the train had pulled into Joo Koon station and stalled
because of an anomaly in the signaling system. Passengers on the train were
offloaded, except for a few who remained on board.

Investigations into the incident found that a sewerage water pipe near
Bishan and Braddell MRT stations – designed to collect and pump out rainwater –
was likely close to full before the incident. It also found that due to a lapse in
maintenance, sludge and debris had accumulated in the water pit, which could have affected
switches. The investigation also pointed out the need for better compartment or the
capabilities of pumps and float

East-West Line MRT disruption: How a faulty train left a trail of destruction


Train services along a stretch of the East-West Line (EWL) have been
disrupted since Sept 25, affecting more than 1.3 million passengers.
What exactly happened?



\$1,300,000 / h



Objectives



How to predict
machine failures?

How to detect
anomalies in machine?



Stakeholders



Agenda



Maintenance Explained



Data Summary



Failure Predictions



Detecting Anomalies



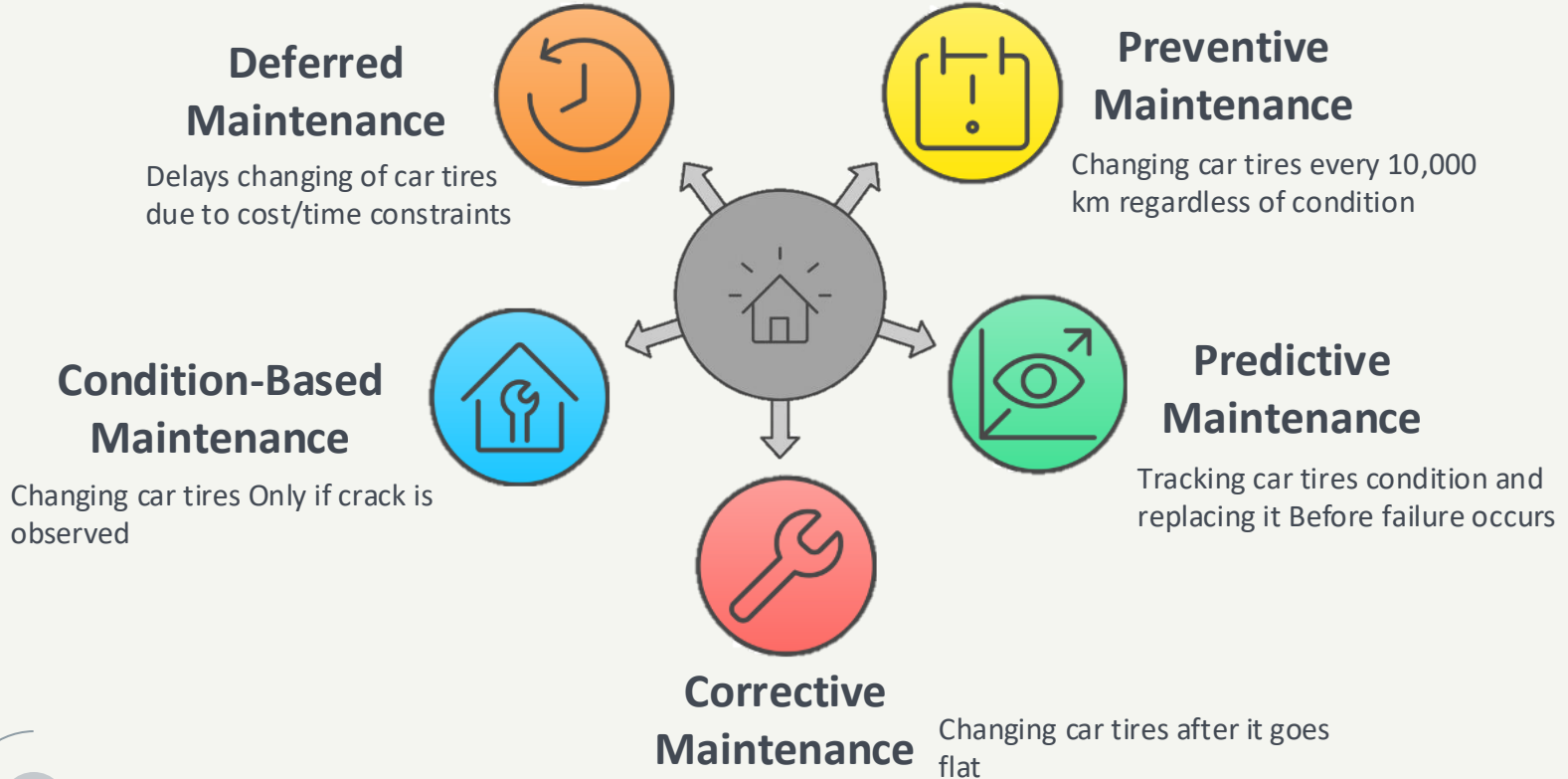
Business recommendations

What is Maintenance?



Maintenance involves the regular actions taken to **keep equipment or systems in working condition**, prevent failures, and optimize performance, ensuring longevity and reliability. It aims to **reduce downtime** and **improve operational efficiency**.

What are the different types of Maintenance?



Data Summary

Ensure data is curated for machine learning

Identify relevant sources such as fact and dimension tables.

Validate data to ensure data integrity

Failure Predict using Random Forest

Predicting failure with supervised modeling with actual deployment

Data Preparation

Unsupervised modelling

Data Sourcing

(from Kaggle, synthetic)

Supervised prediction

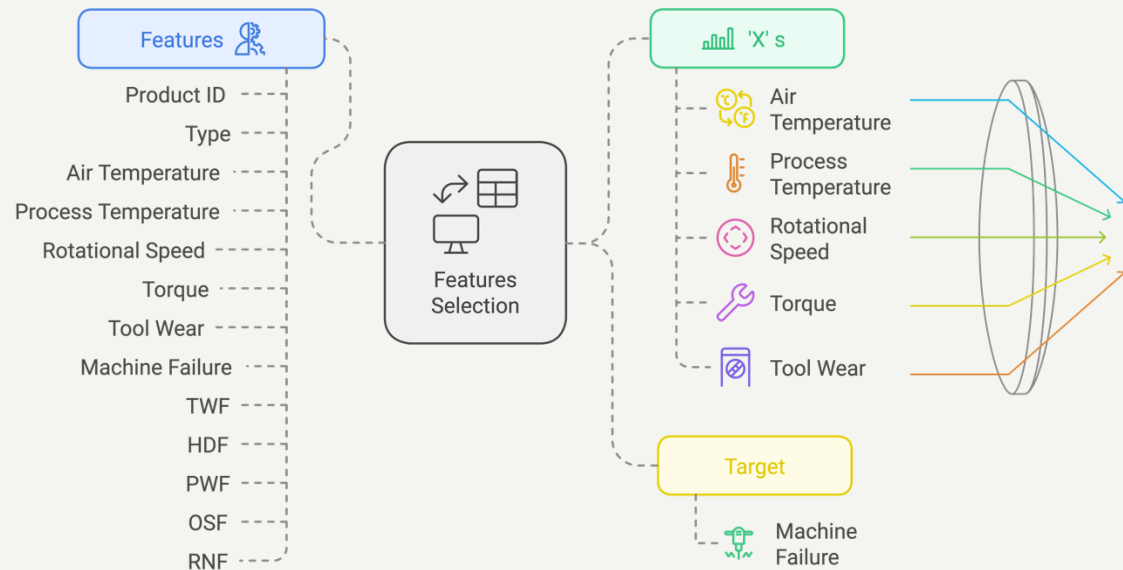
Prepare data so that it meets modeling specifications

Check data for missing values, identify patterns and clean data according to patterns
(13 features, 10,000 rows)

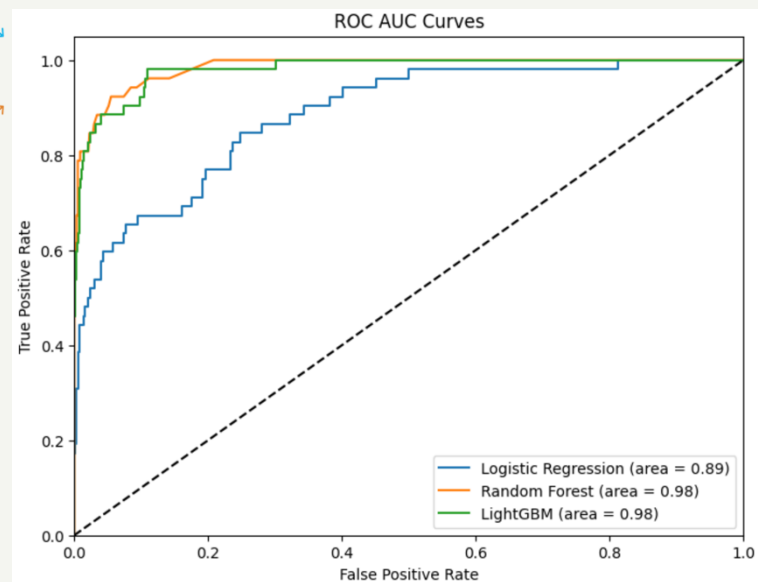
Anomaly Detection using Autoencoder

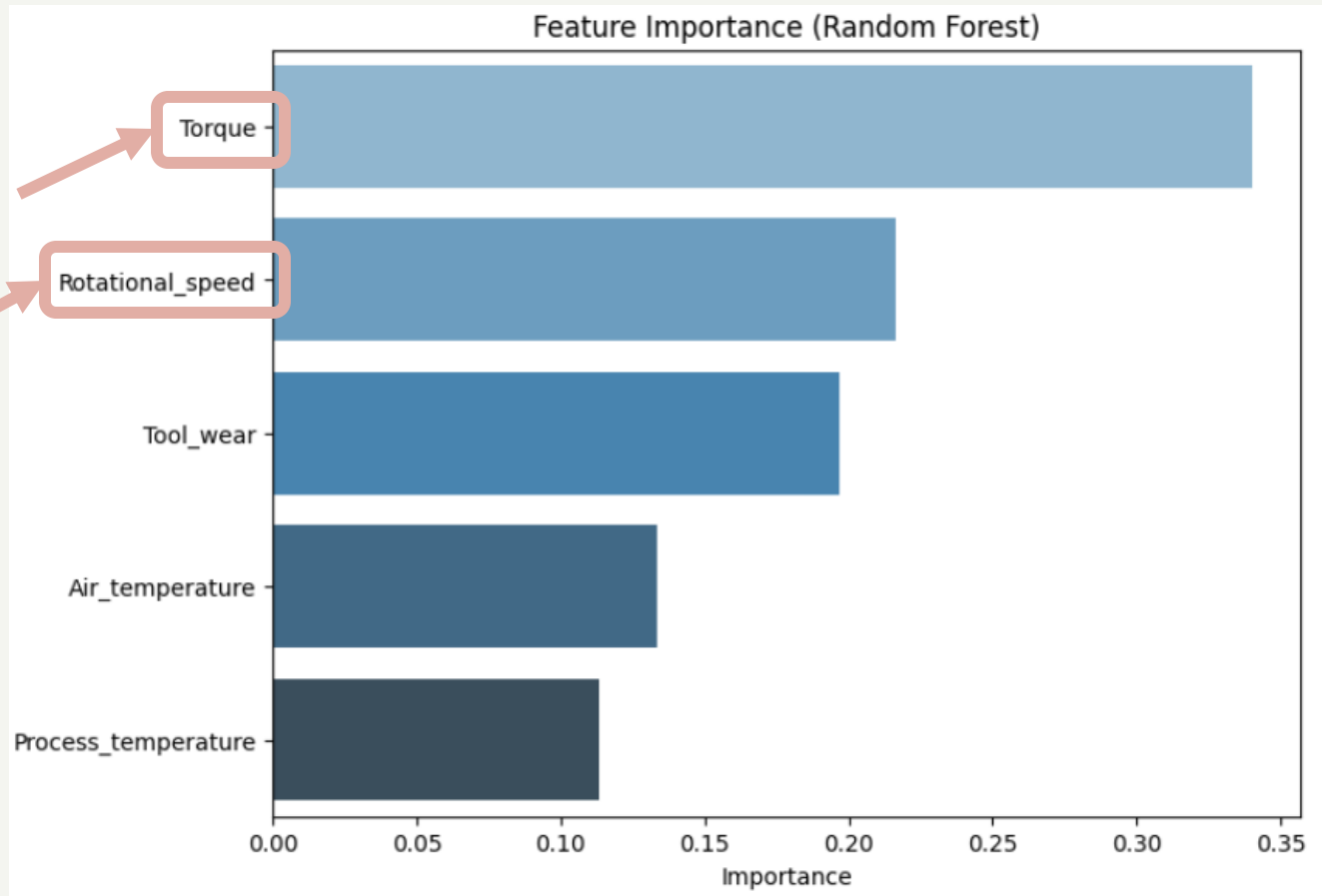
Defining the optimal parameters for machine learning to identify anomalies

Failure Prediction



	Model	Precision	Recall	F1-Score	Accuracy
0	Random Forest	0.980159	0.980833	0.978770	0.980833
1	LightGBM	0.977803	0.979167	0.977208	0.979167
2	Logistic Regression	0.960905	0.965833	0.958135	0.965833





Demo – Predicting Failure

Select Machine Group

L

Machine Failure Prediction App

Input Features for Machine Group L

Air Temperature (K)

200

-

+

Process Temperature (K)

200

-

+

Rotational Speed (rpm)

0

-

+

Torque (Nm)

0

-

+

Tool Wear (min)

0

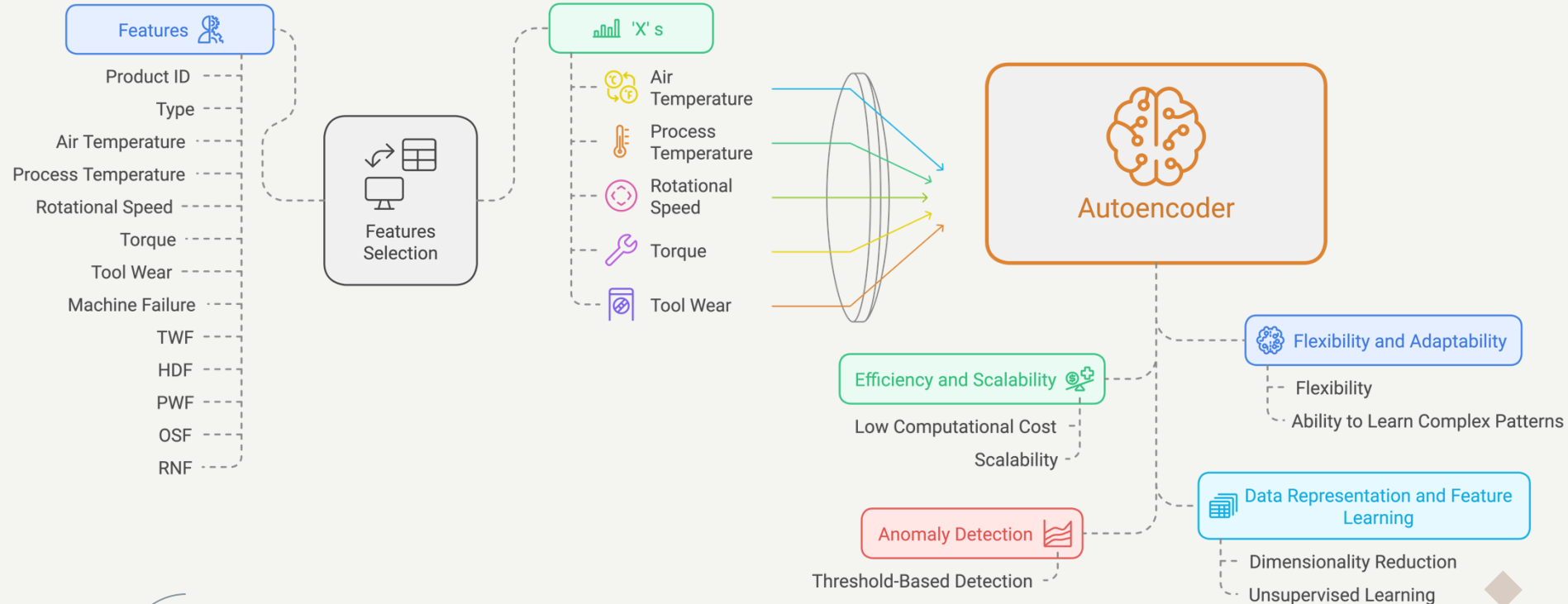
-

+

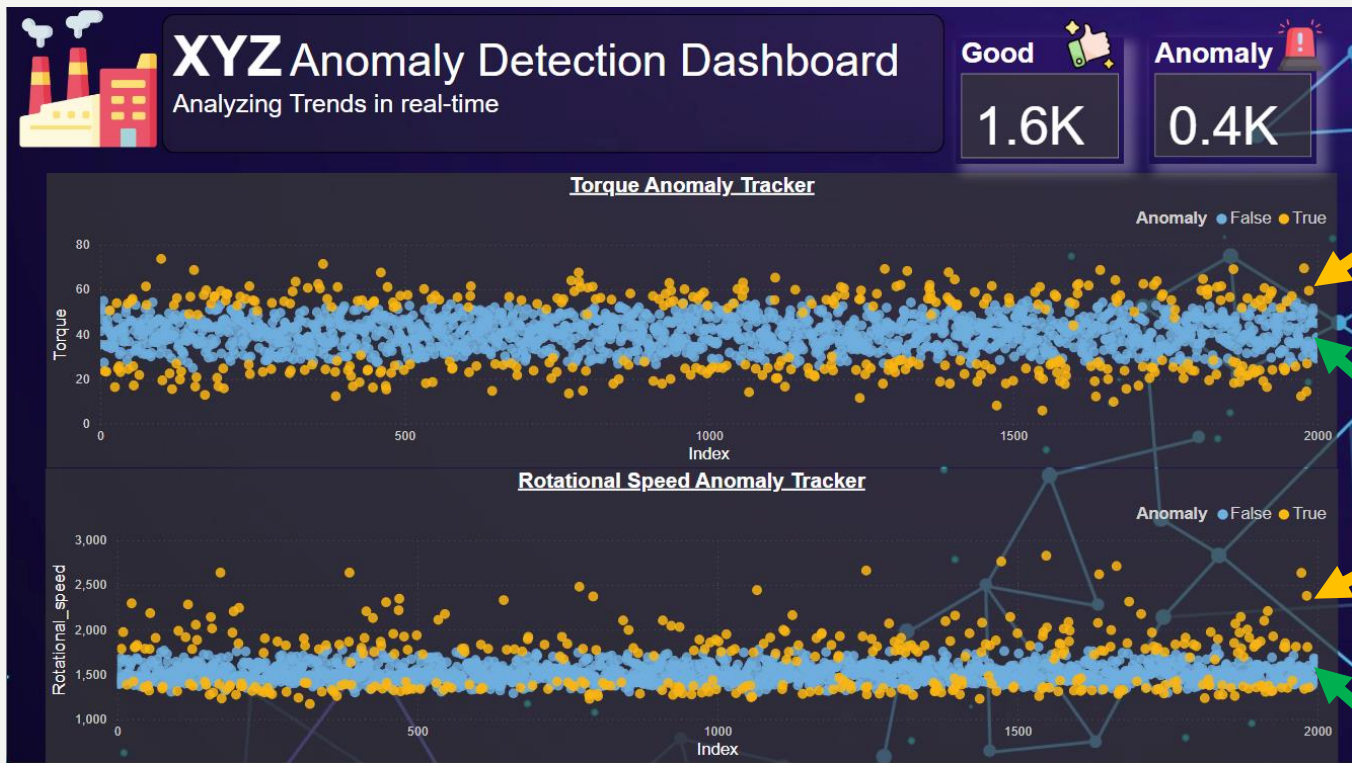
Predict Failure

<https://machine-prediction.streamlit.app/>

Anomaly Detection



Dashboard Deployment (PowerBI)



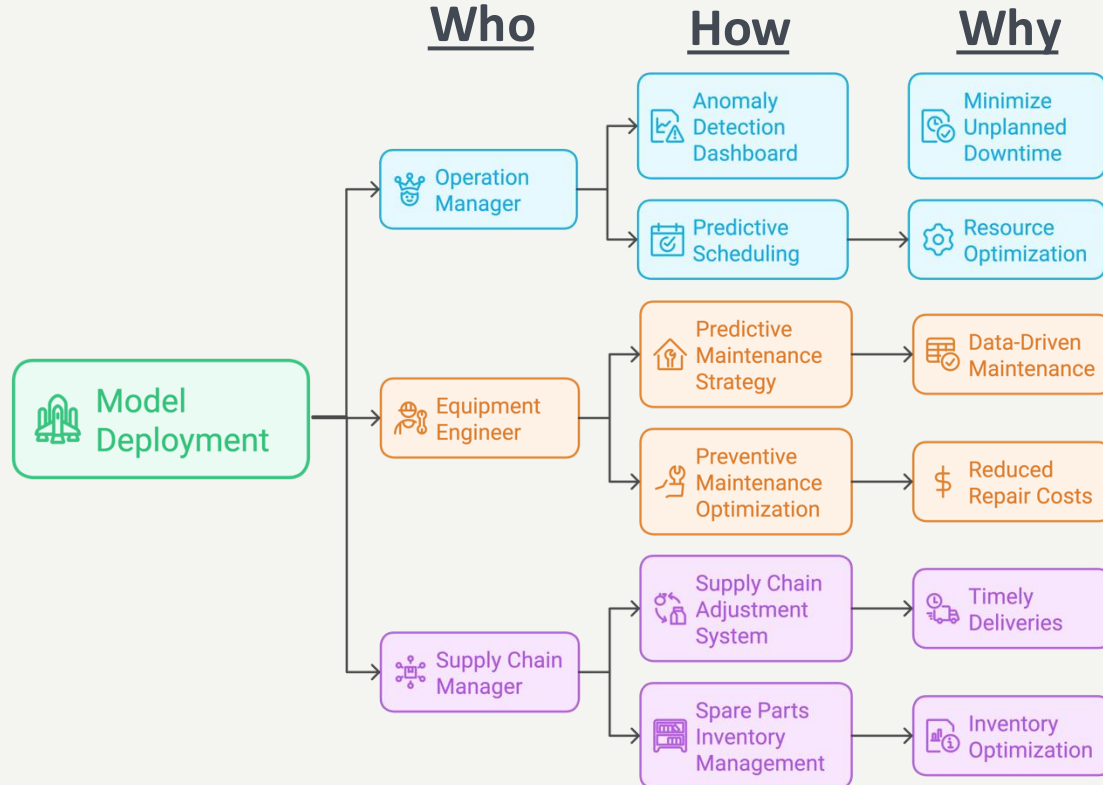
Anomaly

Normal

Anomaly

Normal

Enhancing Business Strategies

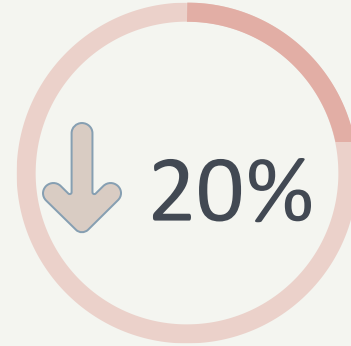


Next Steps

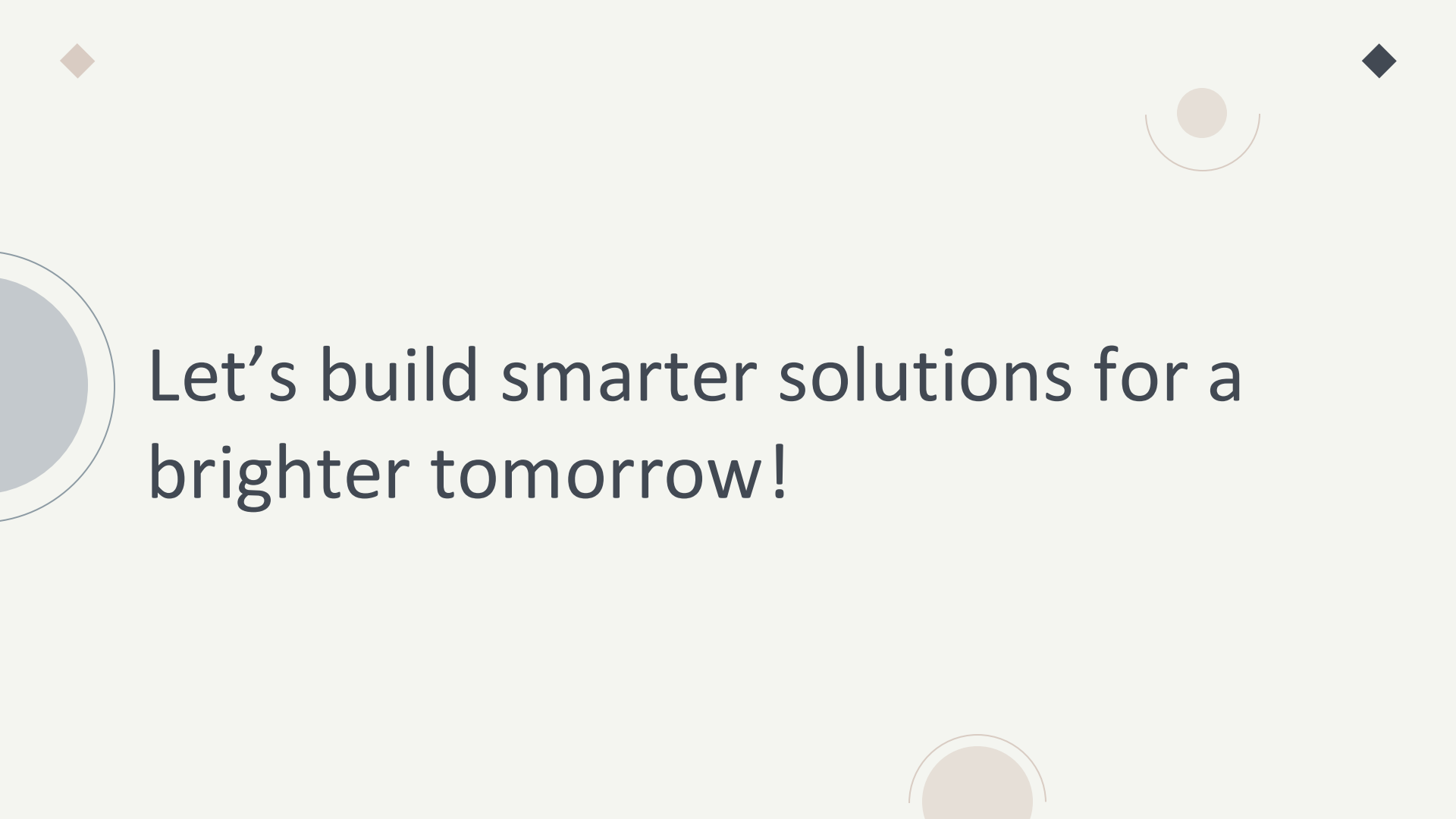
Machine Downtime



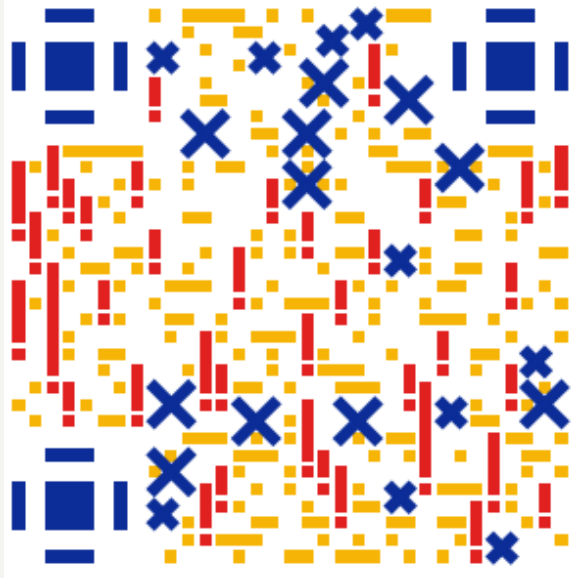
Maintenance Cost



1. Incorporate **time-series features** to make **time-to-failure predictions**.
2. Integrate **sensor data & IoT technologies** to collect real-time data. **Automated maintenance alerts** could be setup to notify the stakeholders when certain threshold are exceeded.
3. Expanding the dashboard features that facilitates **decision-making**. Features such as past **historical trends** and **visualization of the machine health** can be included.



Let's build smarter solutions for a
brighter tomorrow!



**Professional in Data Science & Artificial
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+65 9871 5633



lionel.lowyy@gmail.com



<https://www.linkedin.com/lionel-low-yy>



<https://github.com/lioneltechjourney>