Smart Manufacturing

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Motivation

Predictive Maintenance for Smart Manufacturing

The Challenge: High Downtime Costs

- Unexpected production halts lead to **significant financial losses**.
- Anomalies often occur without warning, causing operational bottlenecks.

The Strategy: Proactive Over Reactive

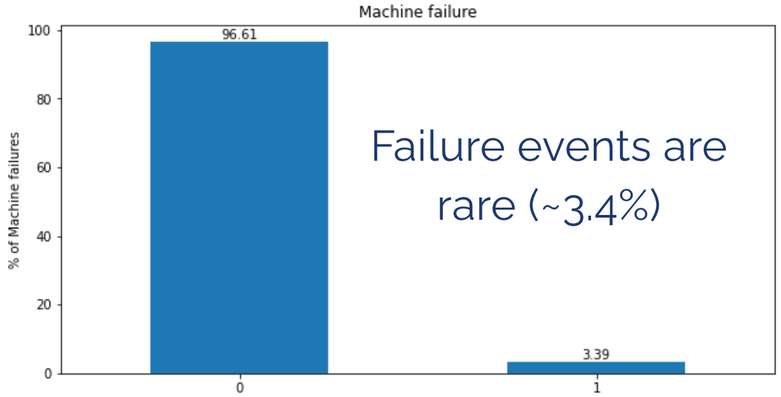
- **Cost Reduction**: Shifting from reactive repairs to proactive maintenance is the key to minimizing overhead.
- **Efficiency**: Maximizing equipment uptime and extending tool life.

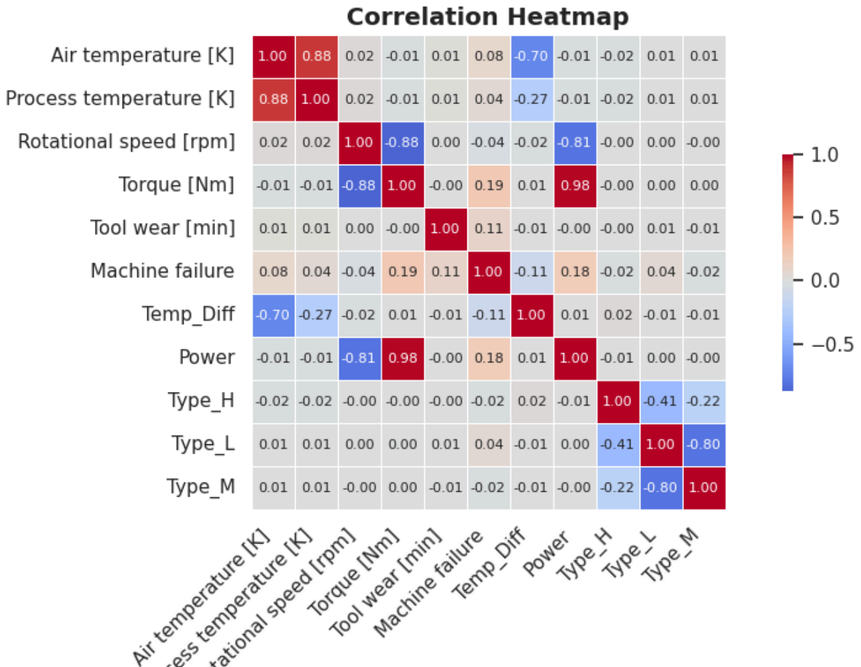
Our Objective

- Develop an model using the **AI4I 2020 Dataset** to identify failure risks early.
- **Cloud Deployment**: The model is hosted on a cloud platform, allowing users to access predictions and real-time visualization through a web interface.

AI4I 2020 Dataset

- Total of **10,000** machine operation logs.
- Target Variable: **Machine Failure (1: Failure, 0: Normal).**
- Original Features:
  a. **Type**: Machine quality variant (L / M / H).
  b. **Air temperature** [K], **Process temperature** [K]
  c. **Rotational speed** [rpm] & **Torque** [Nm]: Mechanical power metrics.
  d. **Tool wear** [min]: Cumulative tool usage time.
- Engineered Features :
  - **Temp Diff**: Process temperature - Air temperature
  - **Power**: Torque x Rotational speed



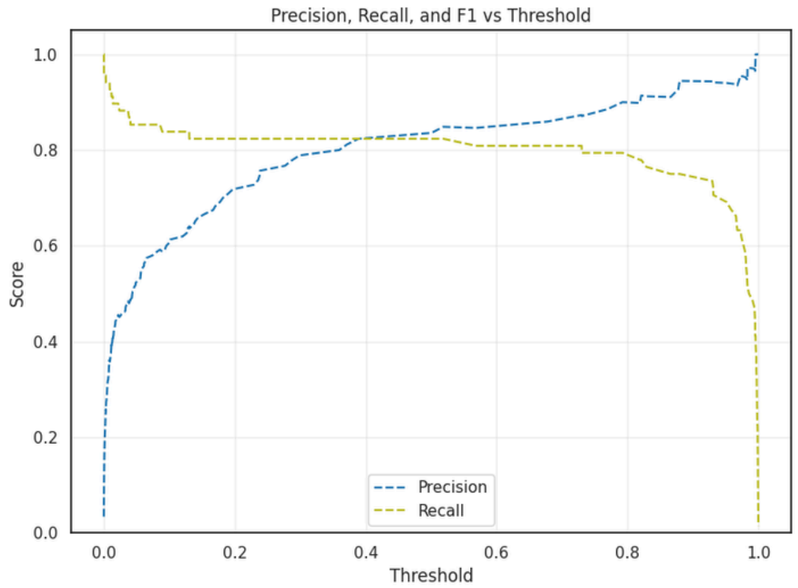


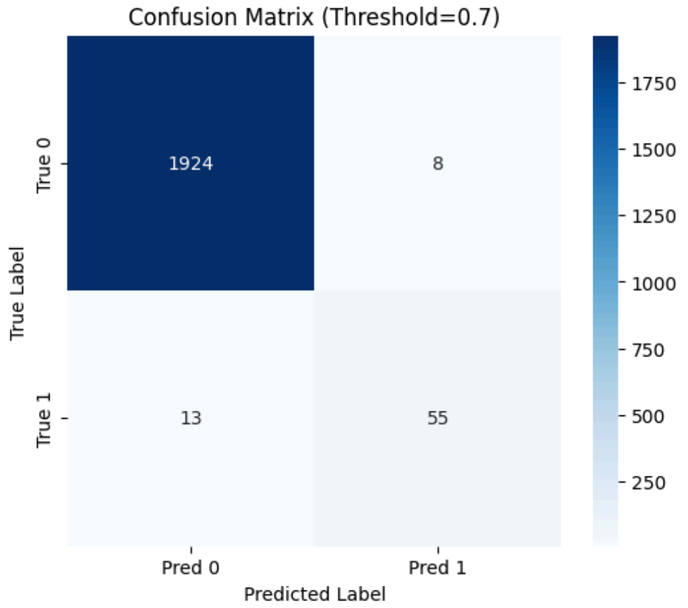
Model Selection

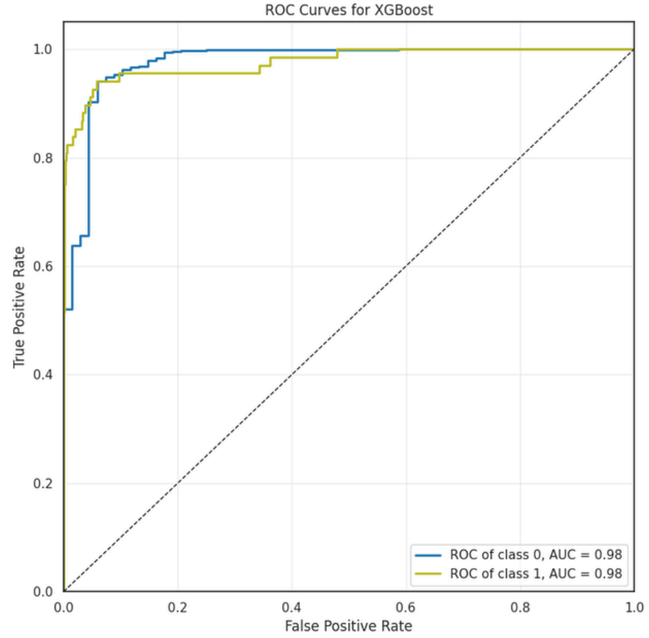
- **Data Partitioning: Train: 8,000 samples | Test: 2,000 samples (Stratified Split).**

Model Approach	Test Accuracy	Precision (Failure)	Recall (Failure)	F1-Score (Failure)
Logistic Regression	87%	0.19	0.81	0.30
SVM (RBF Kernel)	92%	0.27	0.81	0.40
Random Forest	97%	0.51	0.72	0.59
XGBoost (Selected)	**98.95%**	**0.87**	**0.81**	**0.84**

XGBoost Results





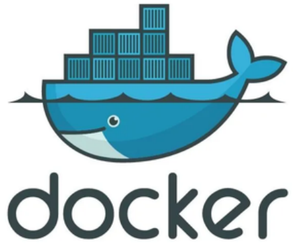


System Architecture

Streamlit

1. **Provides an interactive interface for inputting parameters**
2. **Performs real-time machine failure risk prediction**
3. **Visualizes model explanations through global and individual SHAP plots**

System Architecture



Ensures the same code and execution environment across different machine

System Architecture

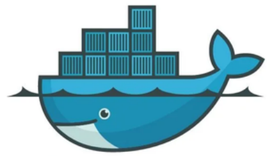
website.py
XGB.pkl
requirements.txt
Dockerfile

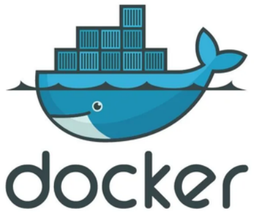
gcloud
builds
submit

Artifact Registry
- Docker image storage

Google Cloud Run
1.Set constraints
- Set 2 CPU/4GB
- Concurrency = 6
- Max Instances = 6

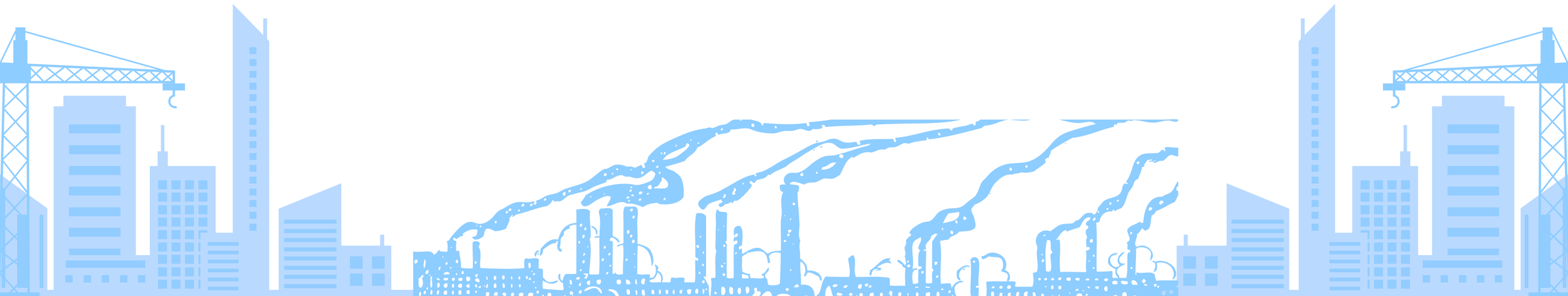
2.Generated HTTPS URL



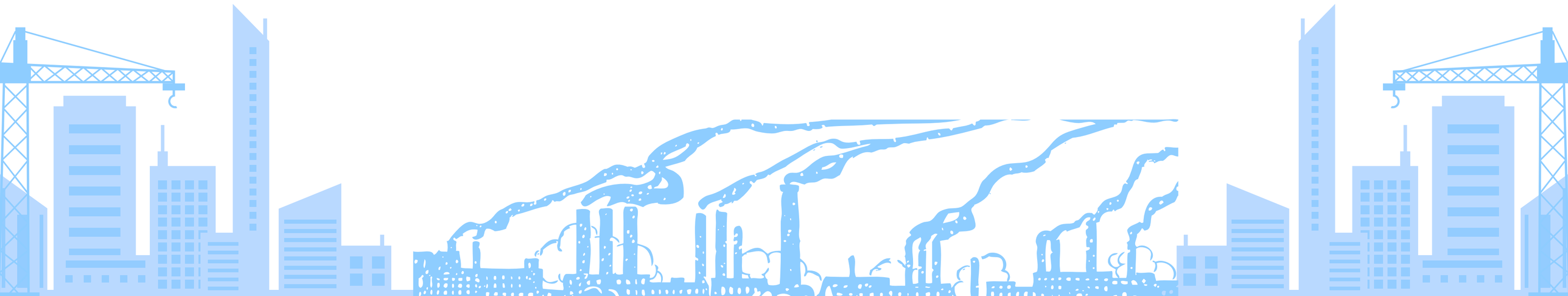


Why Cloud Run ?

1. Shares access across departments and factory sites
2. Serverless deployment with minimal infrastructure maintenance

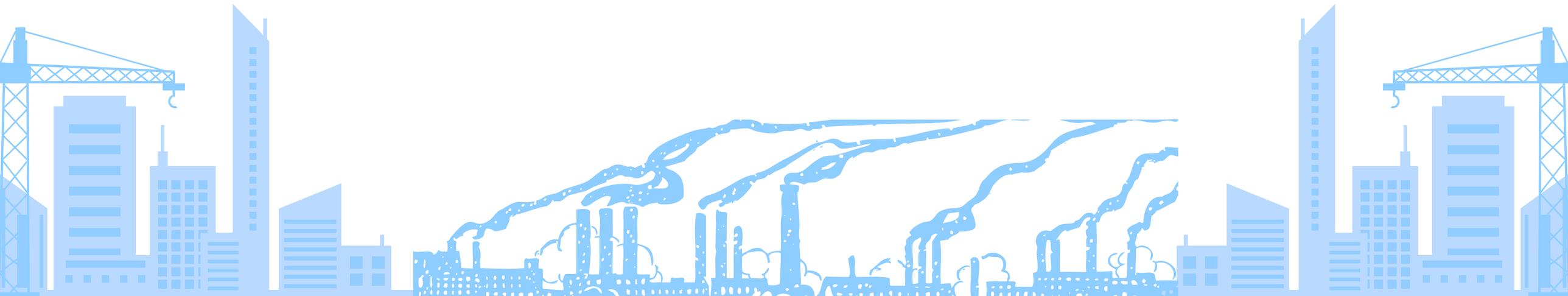


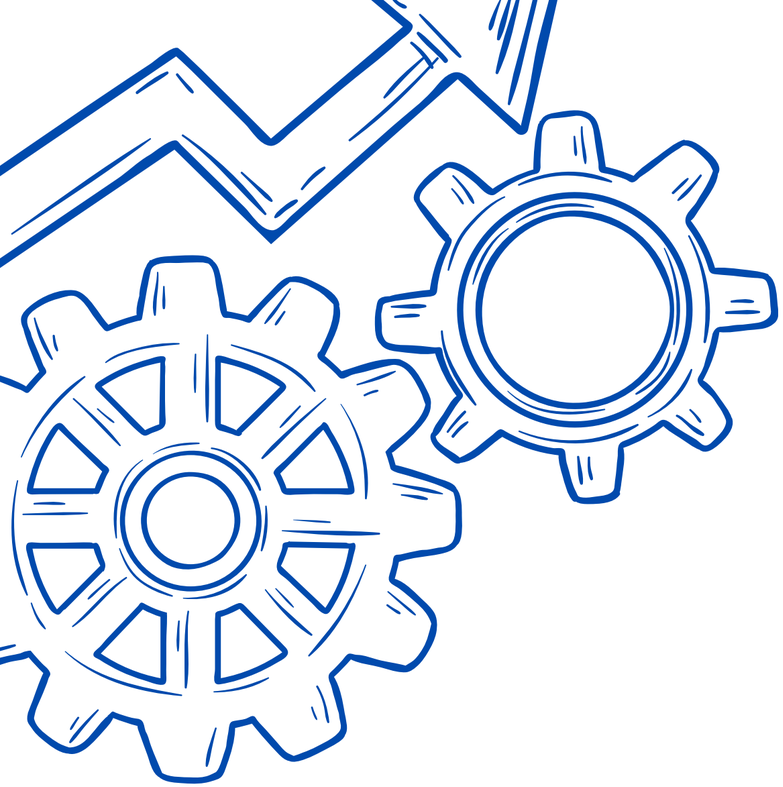
Demo



Future Work

1. Extend from single-point prediction to time-series risk assessment
2. Extend the system to predict specific failure types





Thank You