Using AI to make roller coasters safer

Customer: One of the leading integrated resorts

Summary

The customer an integrated resort on the island in Singapore. They offer some world-class attractions one of which is the Battlestar Galactica, the most enticing duel rollercoaster ride at the resort. They decided to cater to preventive maintenance of the wheels of this ride to ensure top-class safety. They planned to adopt Machine Learning (ML) based solution via Google cloud platform (GCP).

Problem Statement

- The Customer's Battlestar Galactica ride is financially quite demanding and requires high maintenance.
- The wheel detection process is time-consuming and a high maintenance manual job.
- Decision making on the good versus the bad wheel is based on human judgement and expert's experience.

The ultimate goal was to remove human intervention and automate the decision making on the identification of a bad wheel using machine learning. The machine learning model needed to be trained on currently available data and ingest real-time data over a period of time to help identify patterns of range and intensity values of wheels. This would in turn help in identifying the wheel as good or bad at the end of every run.

Proposed Solution

Project pre-requisites

Ordering of .dat files generated by SICK cameras to be maintained in a single date-time format for appropriate Radio-frequency identification (RFID) wheel mapping. Bad wheel data should be stored in the same format as a good wheel (.dat files) in order to train the classifier. The dashboard to contain the trend of intensity and height values. Single folder to be maintained for Cam_01 and another folder for Cam_02, folder name or location should not change.

Solution

- *Data ingestion and storage*

An image capturing software tool named Ranger Studio was used to absorb the complete information on wheels. The Ranger Studio onsite machine generates .dat files for wheels post

every run and stores in a local machine. An upload service picks these .dat files from the storage location at pre-defined intervals and runs C# code on it to provide CSV output with range and intensity values.

CSV files are pushed to Google Cloud Services (GCS) using Google Pub/Sub real-time messaging service. The publisher is used to publish files from the local machine using two separate python scripts for Cam01 and Cam02. The subscriber is then used to subscribe to the published files for Cam01 and Cam02.

- *Data Processing*

Powerup is responsible to ingest the data into cloud storage or cloud SQL based on the defined format. Processing of data would include the timestamp and wheel run count. There is a pub tracker and a sub tracker maintained to track the files for both cameras so that the subscribed files can be stored on GCS for both the cameras separately. After CSV data is processed, it is removed from the local machine via a custom script to avoid memory issues.

- *Data modelling Cloud SQL*

Once data is processed, Powerup to design the data model in cloud SQL where all the data points will be stored in relational format.

The CSV files of individual wheels are then used to train the classifier model. The classifier model is built with an application programming interface named Keras. The trained classifier helps generate a prediction model (.pkl file) to identify good and bad wheels. The prediction model resides on a GCP VM. The generated CSV files are passed through the prediction model and are classified as good or bad based on an accuracy value.

- *Big Query and ML Model*

Once the prediction for a wheel is done, the predicted accuracy score, timestamp and wheel information is stored into the Big Query tables. The average wheel accuracy for wheels is then displayed on Google Data Studio.

Powerup to ensure optimization of data performance via tuning and build the ML model. This would enable the customer to obtain large volumes of height and intensity data, post which, they score the ML model with new data.

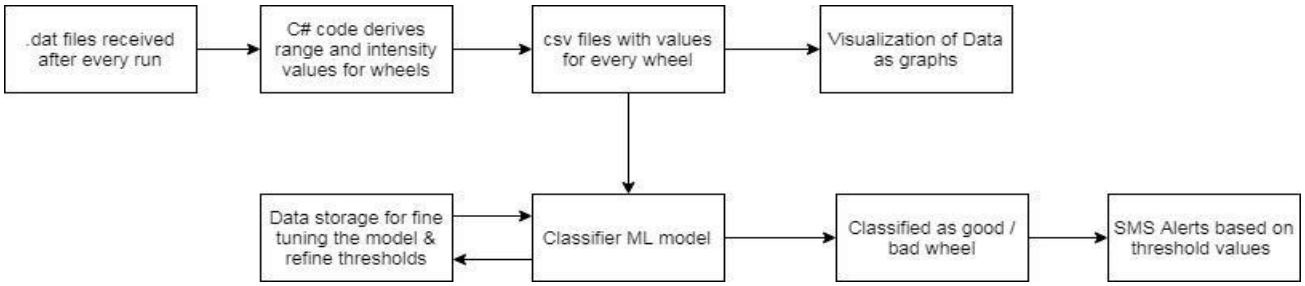
Current accuracy threshold for SMS trigger is set at 70. Accuracy of prediction is set to improve over a period 6 months when the model has enough bad wheel data reported for training the ML classifier model. SMS will be triggered if the accuracy value is below 70.

SMS will also be triggered if a file is not received from the local machine to Google Cloud Storage via Google Pub/Sub. The reason for file not being received needs to be checked by the client's SICK team as it may be due to multiple reasons like source file not generated due to camera malfunction, system shutdown or maintenance and so on. Powerup team to be informed about the same as the restart of instances may be required in such cases. Twilio is the service used for SMS whereas SendGrid is used for email notifications.

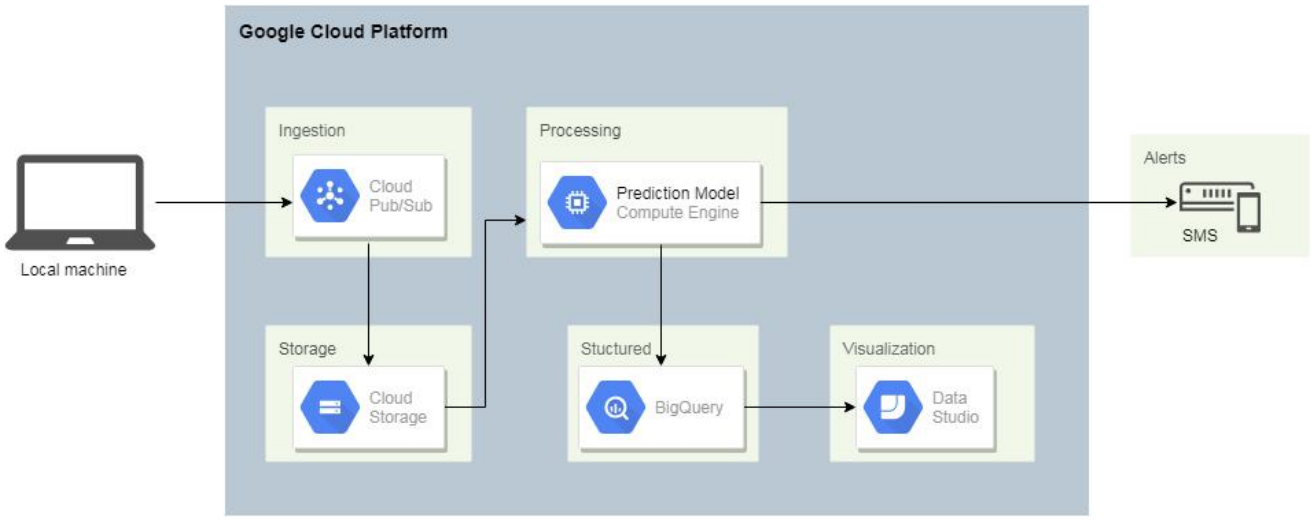
- *Security and Deployment*

Powerup to build a secure environment for all third party integrations. Deploy User Acceptance Test (UAT) environments, conduct regression tests and provide

Go Live Support to off-site applications. The number of servers and services supported with the production was 10 where support included server management in terms of security, network, DevOps, backup DR and audit. Support also included adjusting ML models to improvise training.



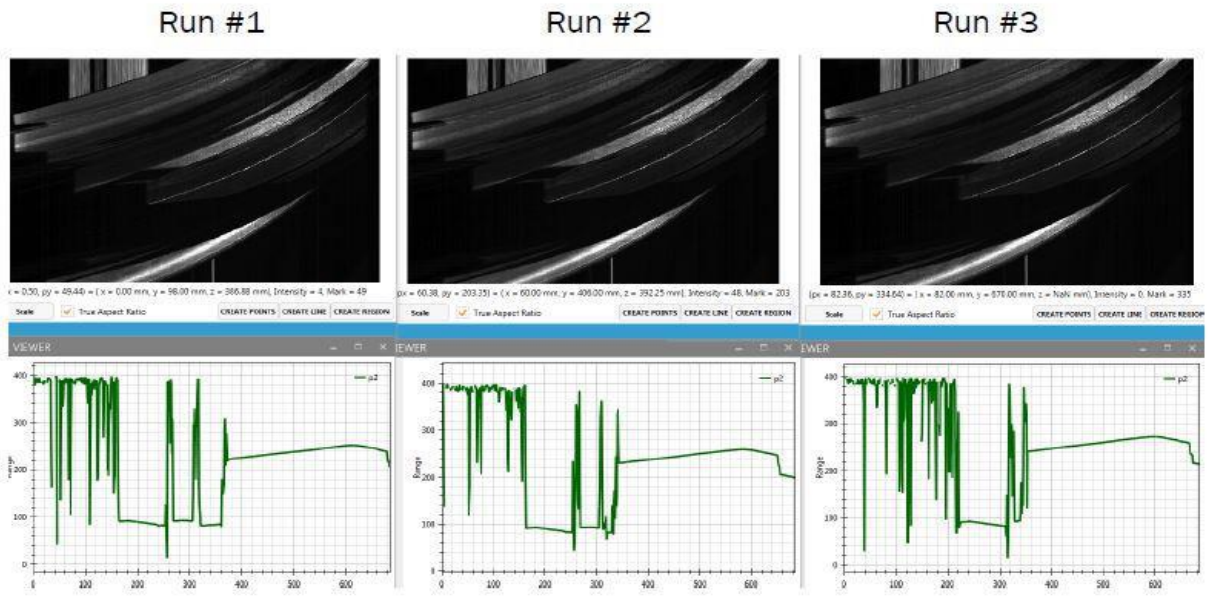
[Solution Workflow]

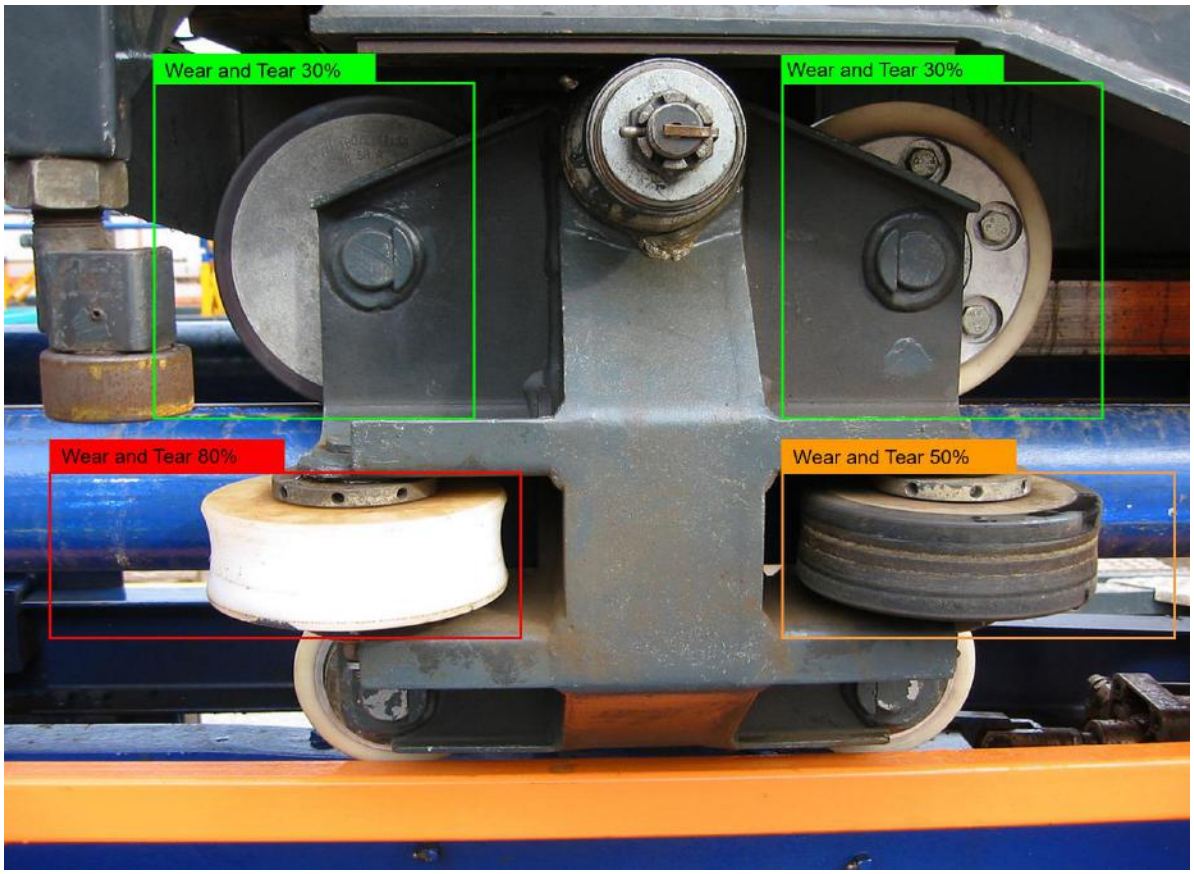


[Solution Architecture]

Limitations

Since the request payload size was higher, Google ML / Online Predictor could not be used. A custom prediction model was built with Keras to overcome this.





[Artificial Intelligence]

Cloud platform

Google Cloud Platform.

Technologies used

Cloud Storage, Bog Query, Data Studio, Compute Engine.

Business Benefits

Powerup has successfully been able to train the classifier model with a limited set of good and bad wheel real-time data. The accuracy of the model is expected to improve over time. With current data, the accuracy of the model stands at **60%** ensuring cost-effectiveness and world-class safety.