# BUSINESS FUNDAMENTALS:
# PREDICTIVE MAINTENANCE OF SIMULATED AIRCRAFT GAS TURBINE ENGINE

METIS BOOTCAMP | June 25, 2021
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# OUTLINE

- Problem Statement

- Dataset/EDA

- Interactive Dashboard - Tableau

- Future Work

# PROBLEM STATEMENT

Using historic dataset to find failure patterns that could be used to predict failures in the future.

Catastrophic Failure ⟹ Damaged Reputation ⟹ Loss of Future Work

# IMPACT OF ENGINE FAILURE

- Catastrophic Loss
  - Fatality
  - Reputation Damage

| Incident Severity | Total Non Productive Time | Total Estimated Loss ($) |
|---|---|---|
| LIGHT | < 4Hrs | < 10K |
| SERIOUS | > 4 Hrs - < 24 Hrs | > 10K - <100K |
| MAJOR | > 24 Hrs - < 48 Hrs | > 100K - < 1000K |
| CATASTROPHIC | > 48 Hrs | > 1M |

- Business Impact

Reduce the quarterly rate of engine failure.

# IMPACT HYPOTHESIS AND SOLUTION PATH

**Impact Hypothesis**

> Predicting engine failure will help reduce rate of engine failures since maintenance will be scheduled accordingly.

**Solution  Path**

> Build a model to predict when an engine is likely going to fail.
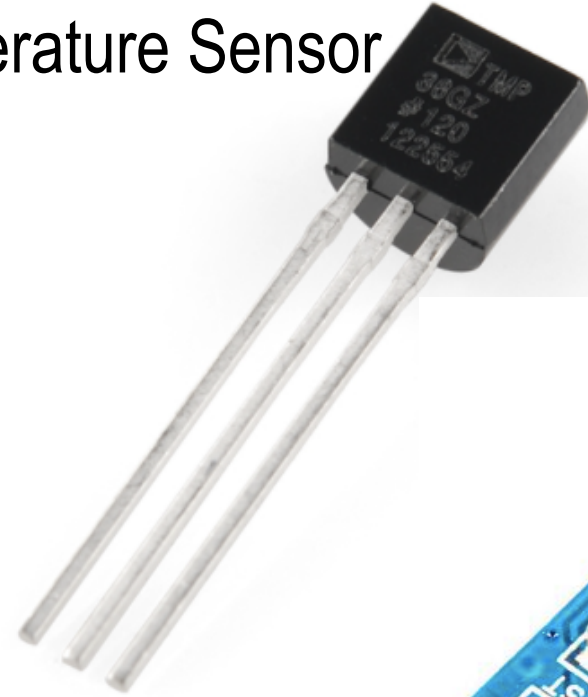
# ASSUMPTIONS AND MEASURE OF SUCCESS

- Temperature Sensor

- Assumptions

  - Highly reliable Real-Time sensor readings.
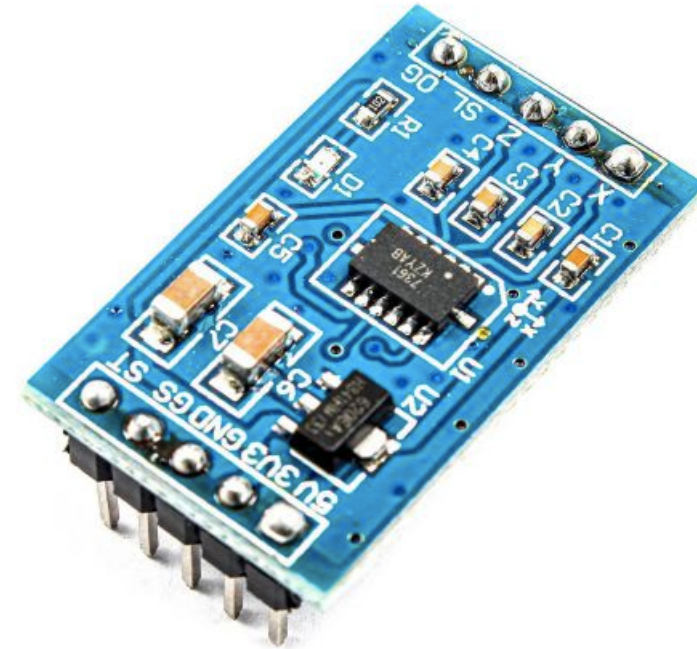  - Absence of severe natural disturbances (weather)

- Accelerometer

- Measure of success

  - Predicting over 70% of failures.
  - Parts can be salvaged from an engine that did not fail catastrophically

# DATASET - NASA TURBOFAN DATASET (100 ENGINES)

**Train Dataset**
20631 x 26

**Test Dataset**
13096 x 26

**Remaining Useful Life (RUL)**
100 x 1

**26 Features**
- Engine ID
- Operation Settings
- Cycles of operation
- 23 sensor readings
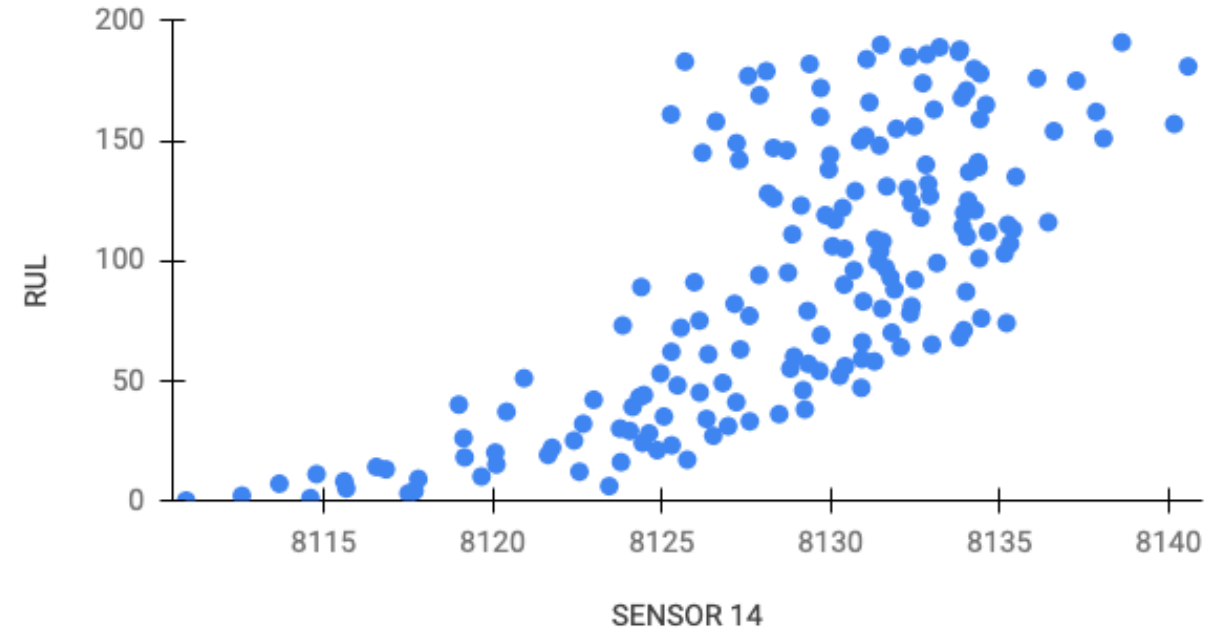
■ Test dataset

## Max Cycle and Min RUL per Engine

■ MAX of CYCLE   ■ MIN of RUL

CYCLES
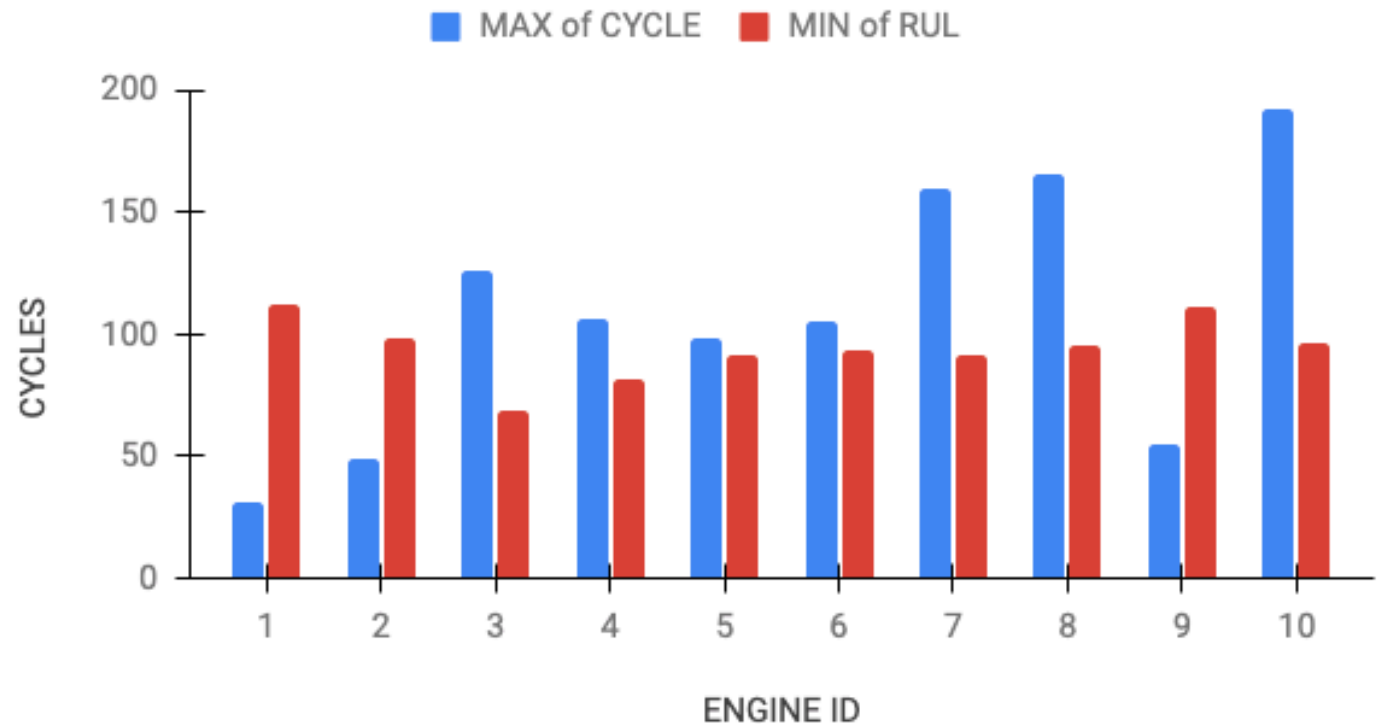
ENGINE ID

# EDA - TRAIN DATASET



Scatter Plot of SENSOR 2 (Engine 1)
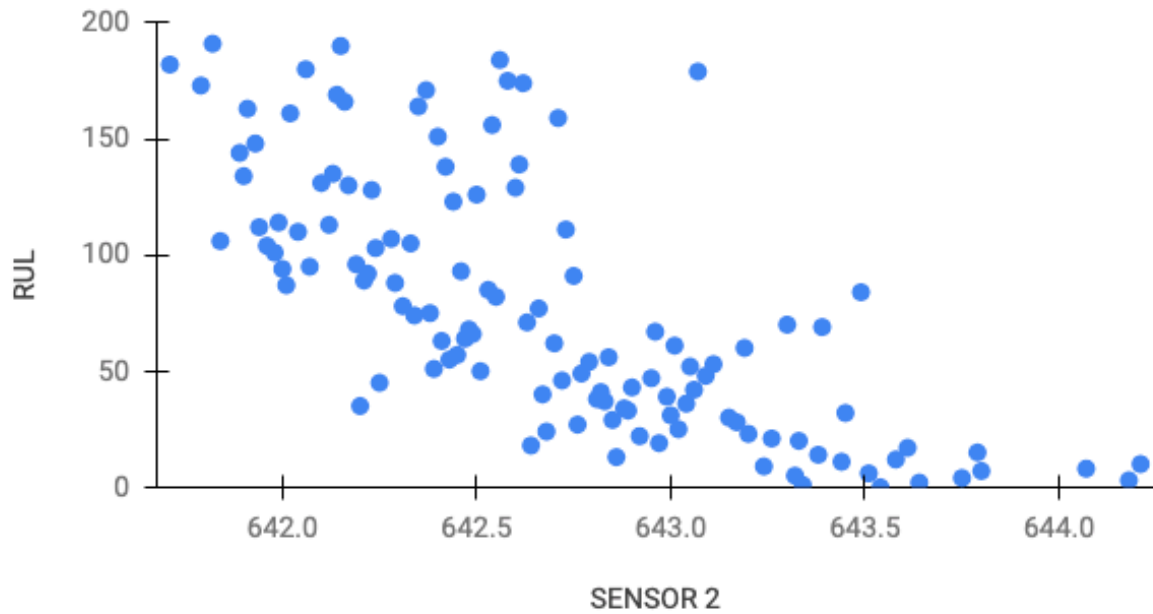
Scatter Plot of SENSOR 14 (Engine 1)
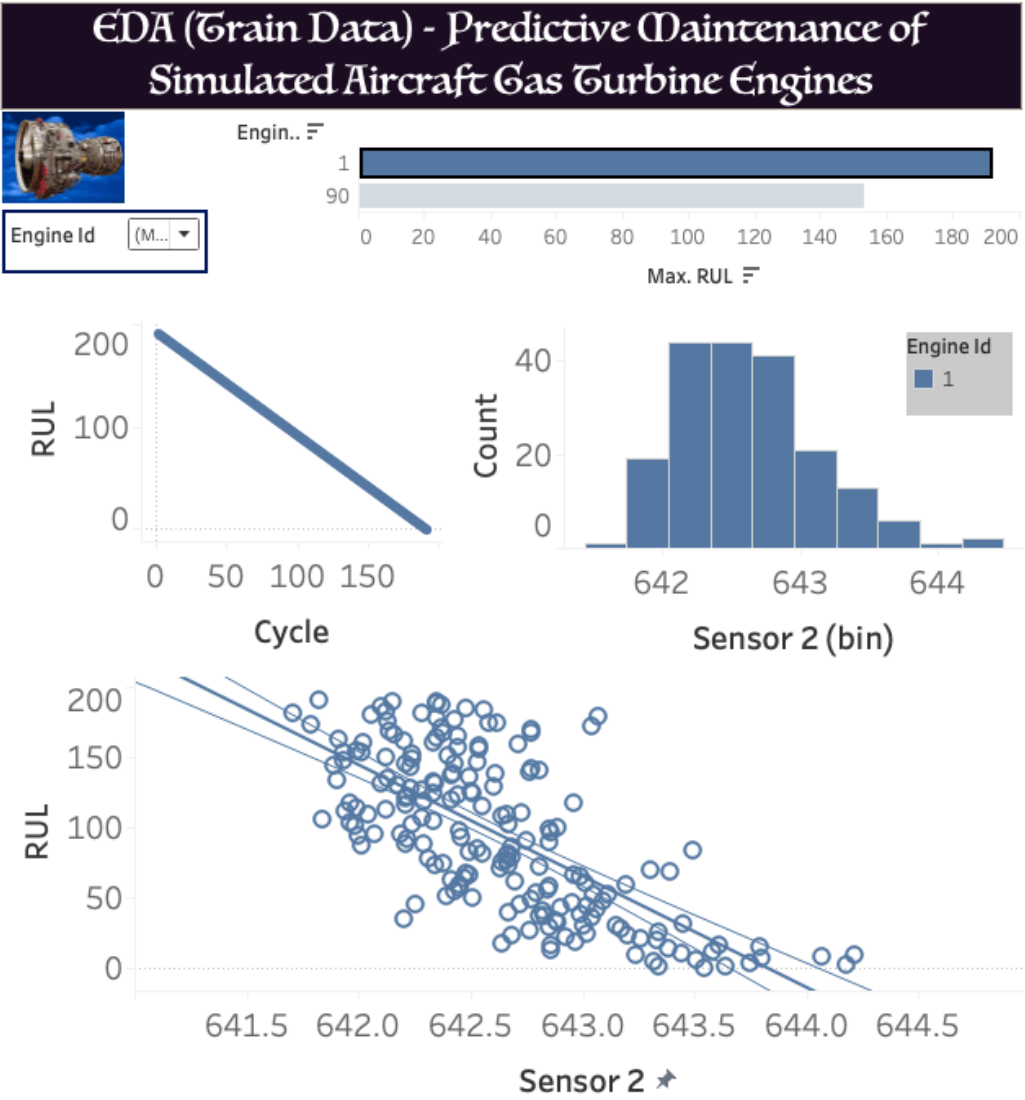
# EDA - TRAIN DATASET



Positive Trend - RUL and SENSOR 14 (ENGINE 1)
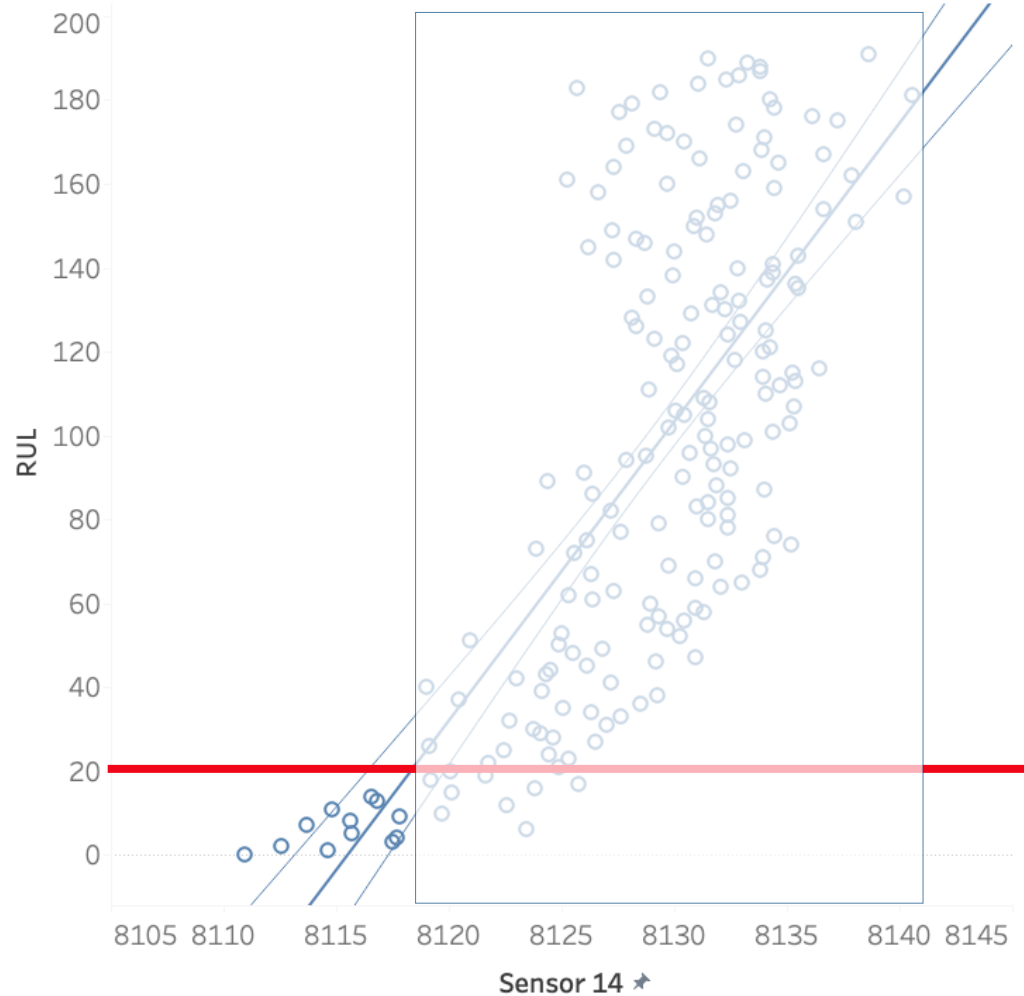
# MODELLING

- Classification model  - Gradient Boosting Classifiers (Label by set RUL)
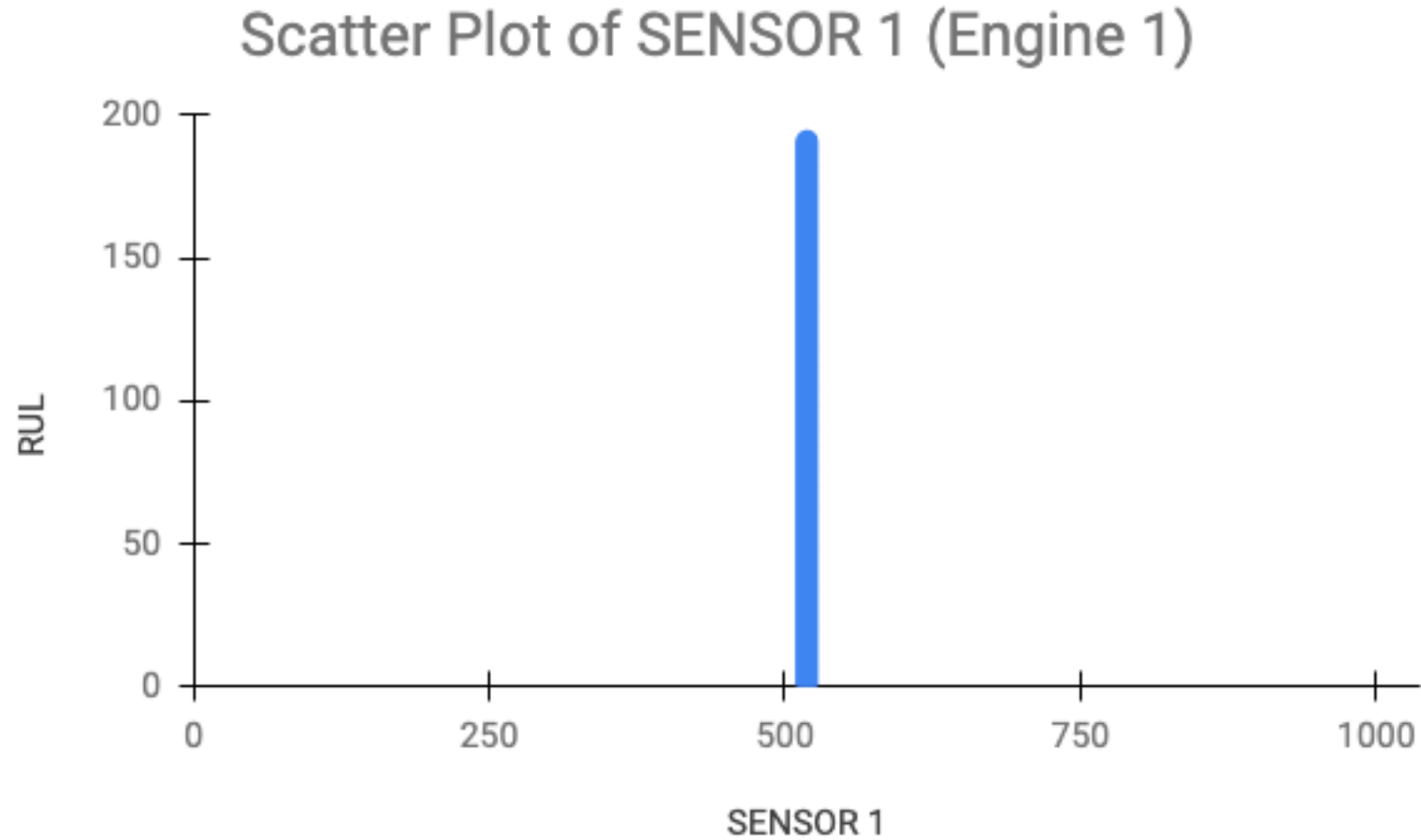
- Regression - Survival Models (Predict RUL)
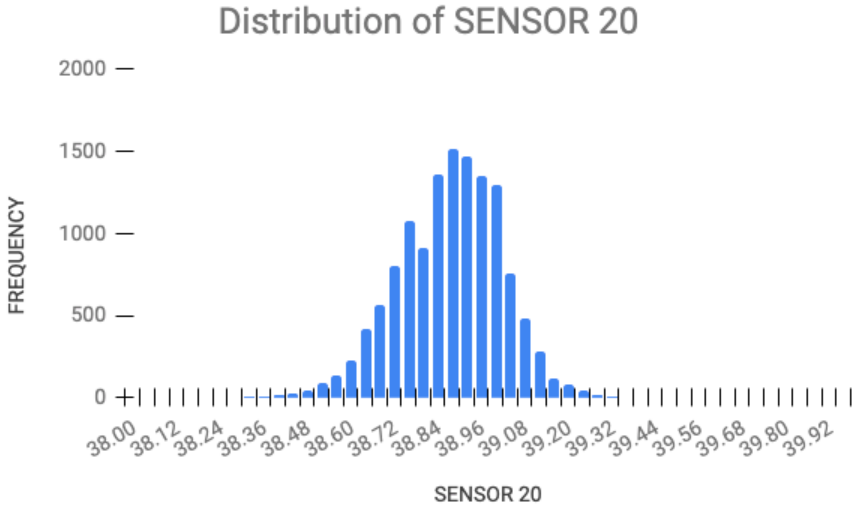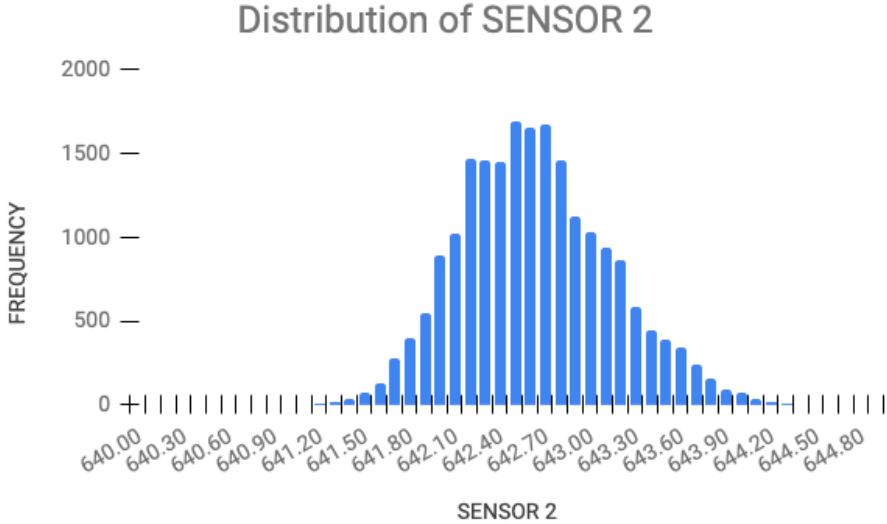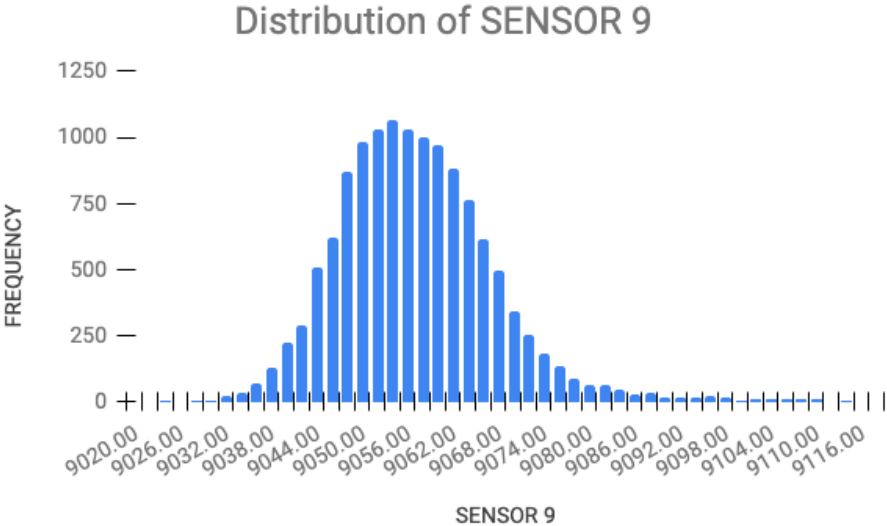
# INTERACTIVE DASHBOARD - TABLEAU

# FUTURE WORK

- Build a regression model using python packages.

- Build a classification model using python packages.

- Update dashboard to show predicted and actual RUL of test set from regression model.
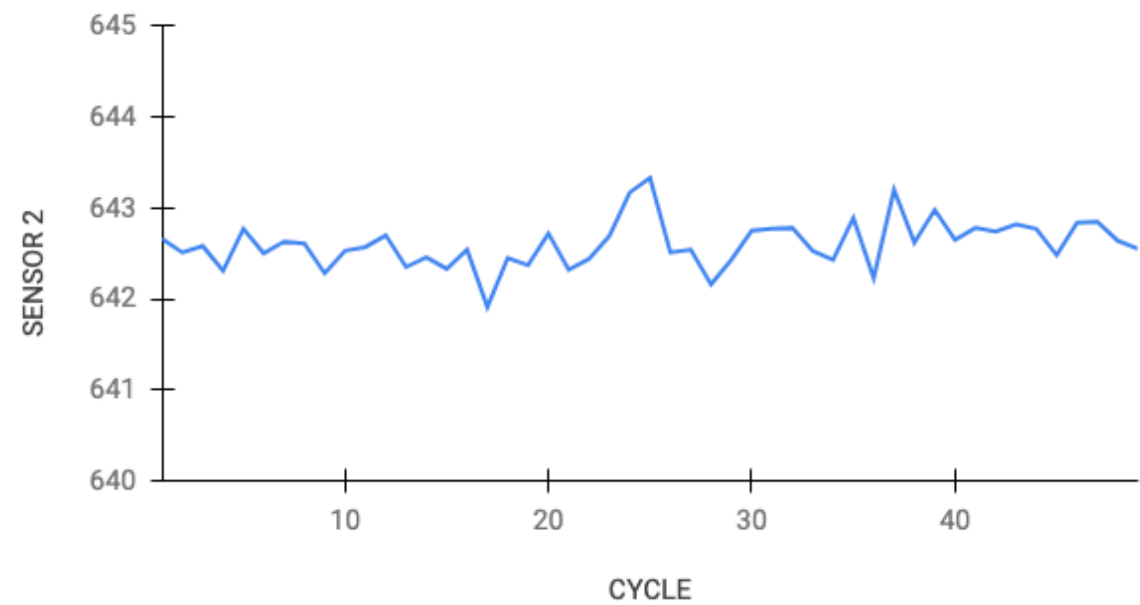
# APPENDIX - TRAIN DATASET



Scatter Plot of SENSOR 1 (Engine 1)

# APPENDIX - TEST DATASET



Distribution of SENSOR 9



Distribution of SENSOR 2
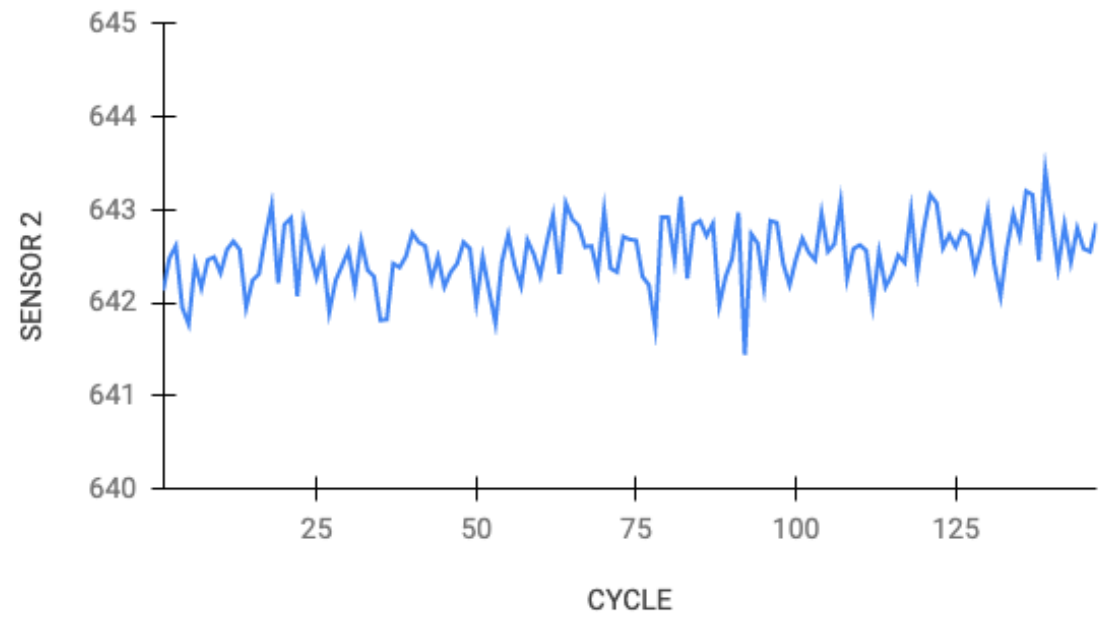


Distribution of SENSOR 20

# APPENDIX - TEST DATASET
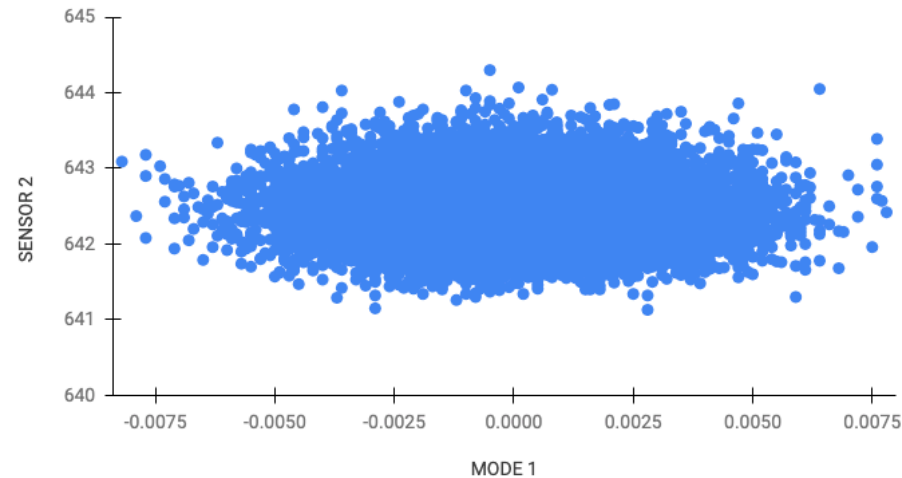


SENSOR 2 readings on Engine 2
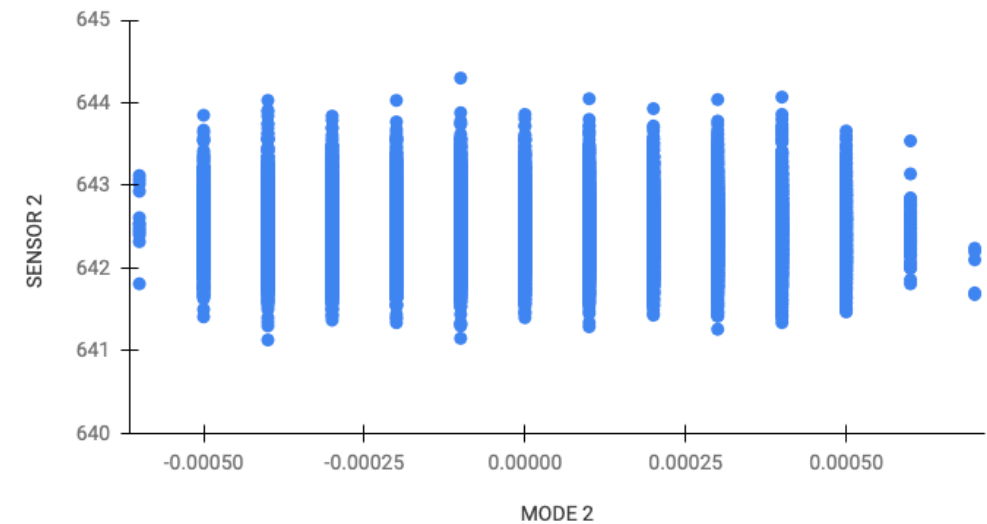


SENSOR 2 reading for Engine 89
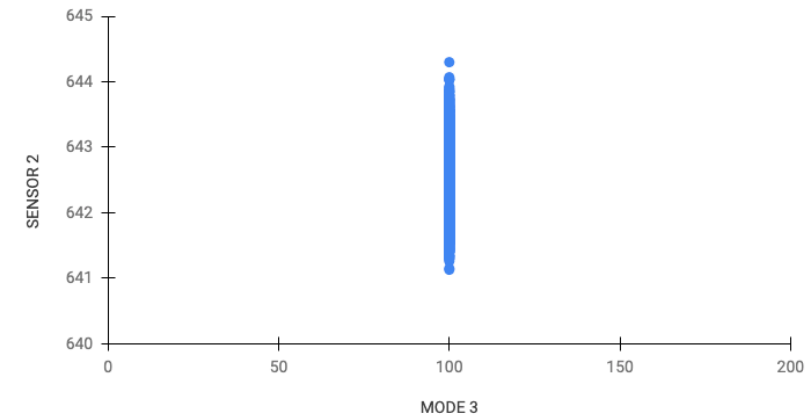
# APPENDIX - TEST DATASET
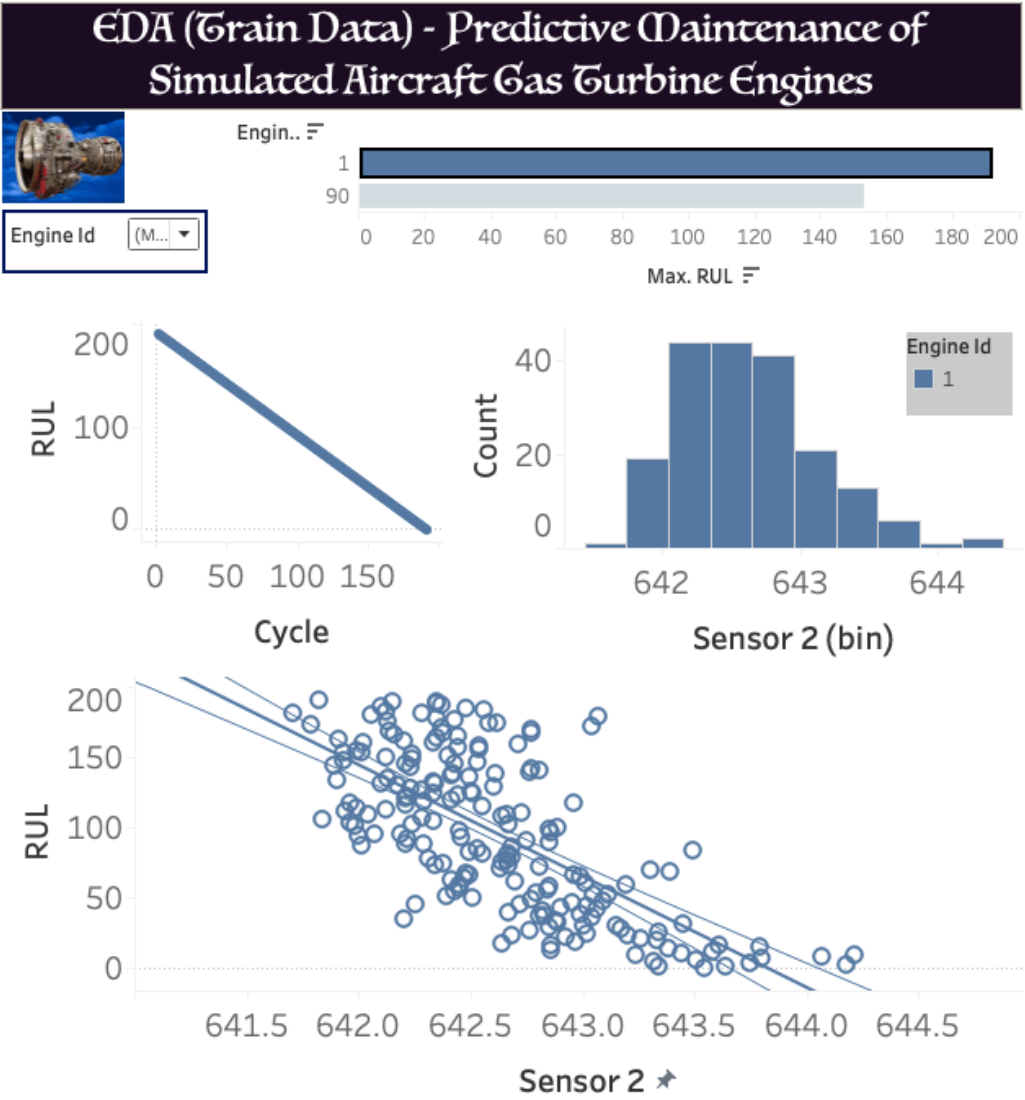


Scatter plot of MODE 1 and SENSOR 2



Scatter plot of MODE 2 and SENSOR 2



Scatter plot of MODE 3 and SENSOR 2

# APPENDIX - TABLEAU

# INTERACTIVE DASHBOARD