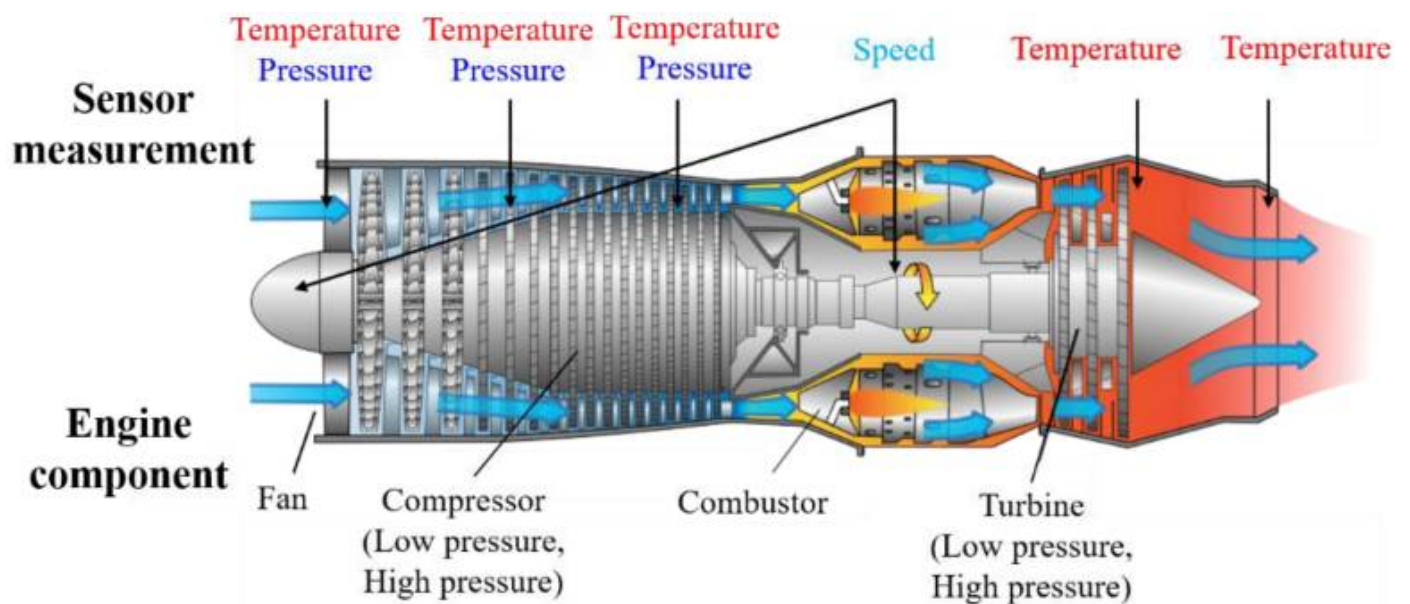


- [Remaining Useful Life \(RUL\) Prediction for Turbofan Engines](#)
 - [Objective](#)
 - [AWS Deployment Link:](#)
 - [Project Description :](#)
 - [Abstract](#)
 - [Data Set Organization](#)
 - [EDA](#)
 - [Visualization:](#)
 - [RESULTS:](#)
 - [INSTALLATION STEPS:](#)
 - [Deployment:](#)
 - [Thanks](#)

Remaining Useful Life (RUL) Prediction for Turbofan Engines

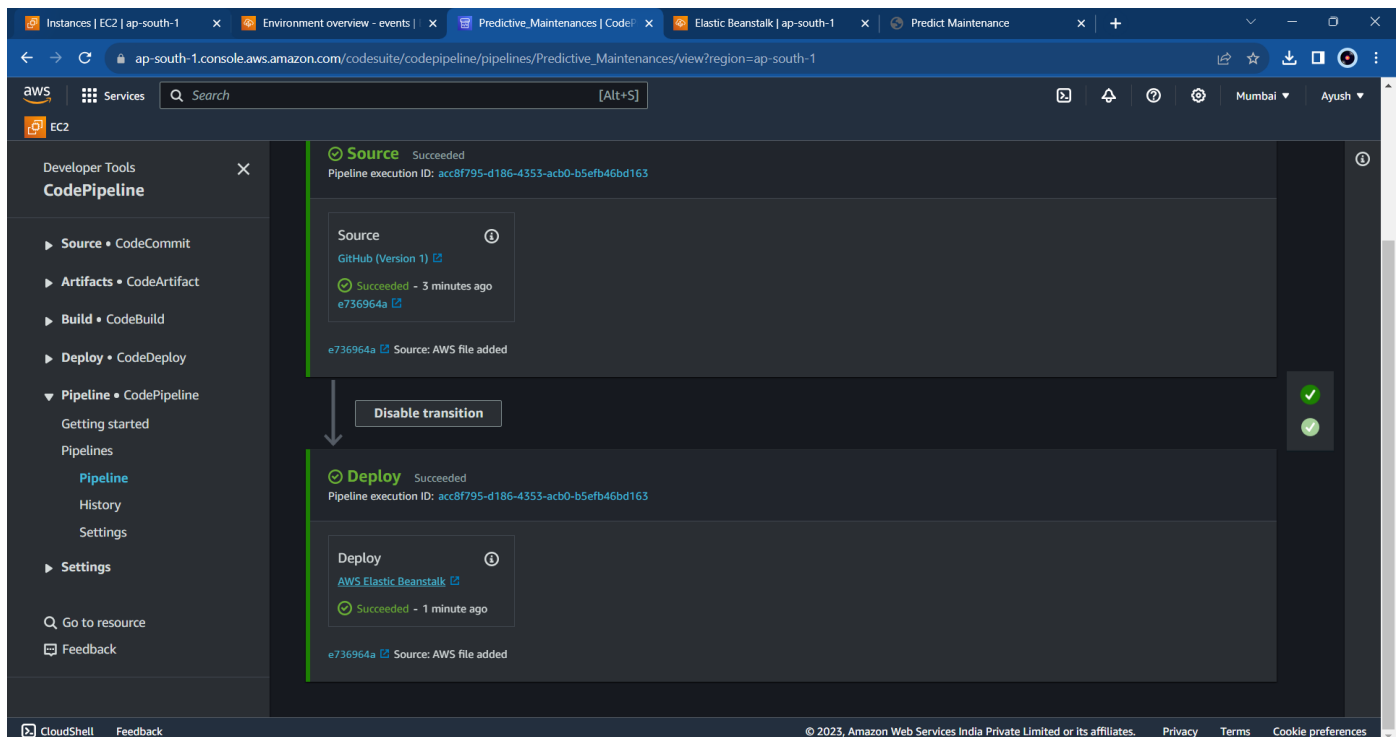
Objective

The objective of this project is to develop a machine learning model to predict the remaining useful life of aircraft turbofan engines. The Remaining Useful Life (RUL) is the amount of cycles an engine has left before it needs maintenance.



[AWS Deployment Link:](#)

AWS deployment link: <http://predictive-env-1.eba-5bwnxpqm.ap-south-1.elasticbeanstalk.com/>



Project Description :

In industry, prognostics and health management are key topics for anticipating asset state and avoiding downtime and breakdowns. Run-to-Failure simulation data from turbofan jet engines is included.

The C-MAPSS software was used to simulate engine degradation. Four separate sets of operational conditions and fault modes were simulated in four different ways. To characterize fault progression, record numerous sensor channels. The Prognostics CoE at NASA Ames provided the data set.

Abstract

- ❑ NASA released dataset of 218 turbofan engines in 2008. The data was recorded until the point of breakdown.
- ❑ In this project, we would try to understand the data-set, and predict Remaining Useful Life (RUL) of engines from testing data.
- ❑ We would try to deploy several machine learning models on this data-set, and discuss their performance. And finally, we would try to solve this problem using a mix-match of various algorithms to the best of our knowledge

Data Set Organization

Data Set: FD001 Train trjectories: 100 Test trajectories: 100 Conditions: ONE (Sea Level) Fault Modes: ONE (HPC Degradation)

Data Set: FD002 Train trjectories: 260 Test trajectories: 259 Conditions: SIX Fault Modes: ONE (HPC Degradation)

Data Set: FD003 Train trjectories: 100 Test trajectories: 100 Conditions: ONE (Sea Level) Fault Modes: TWO (HPC Degradation, Fan Degradation)

Data Set: FD004 Train trjectories: 248 Test trajectories: 249 Conditions: SIX Fault Modes: TWO (HPC Degradation, Fan Degradation)

There are 4 dataset . In this repo I work on only First dataset

EDA

❑ Train1 shape: (20631, 26)

❑ Test1 shape: (13096, 26)

❑ Rul1 shape: (100, 1)

❑ Train1 have data from 100 engine.

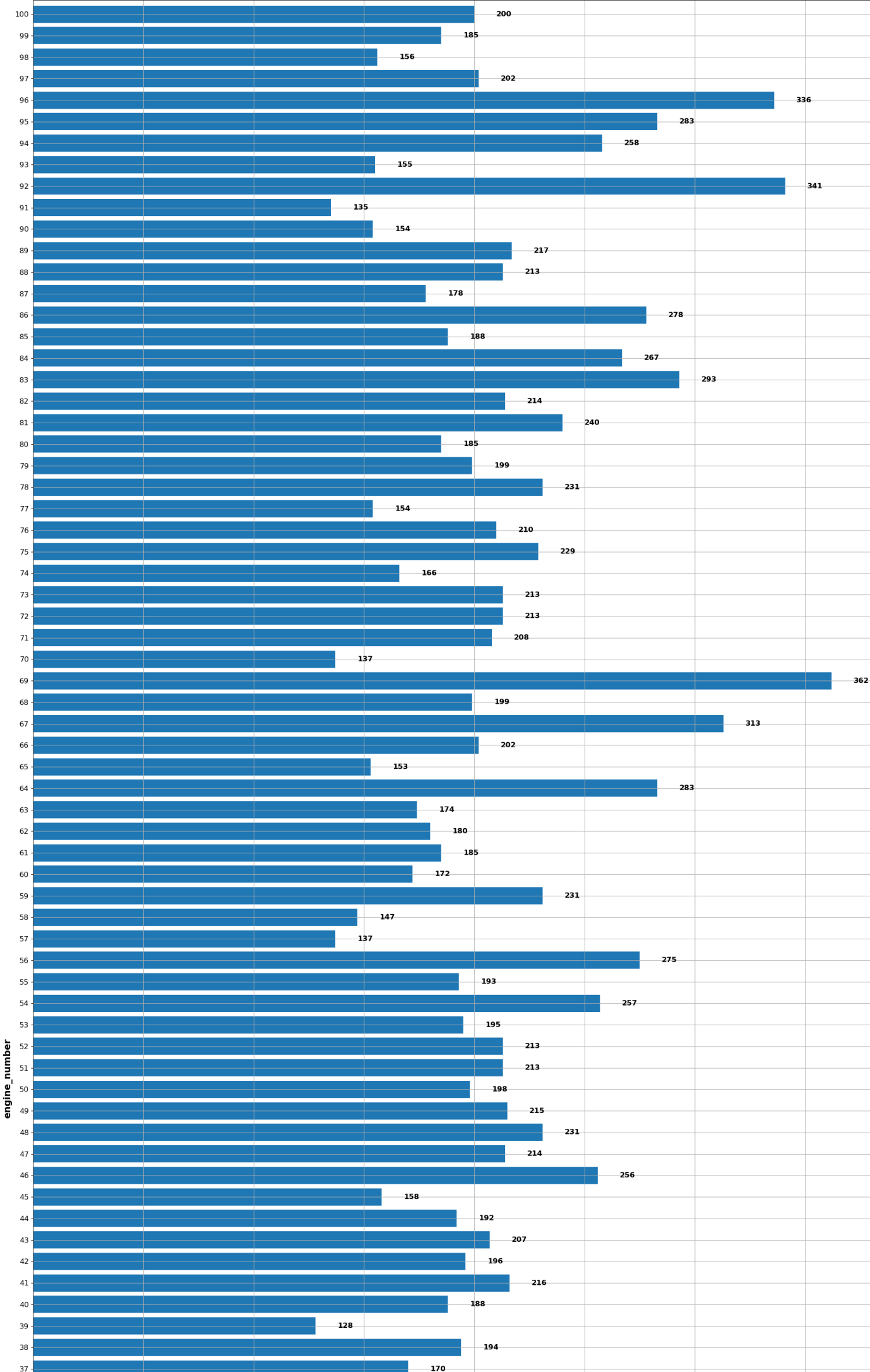
❑ Training data had following features:

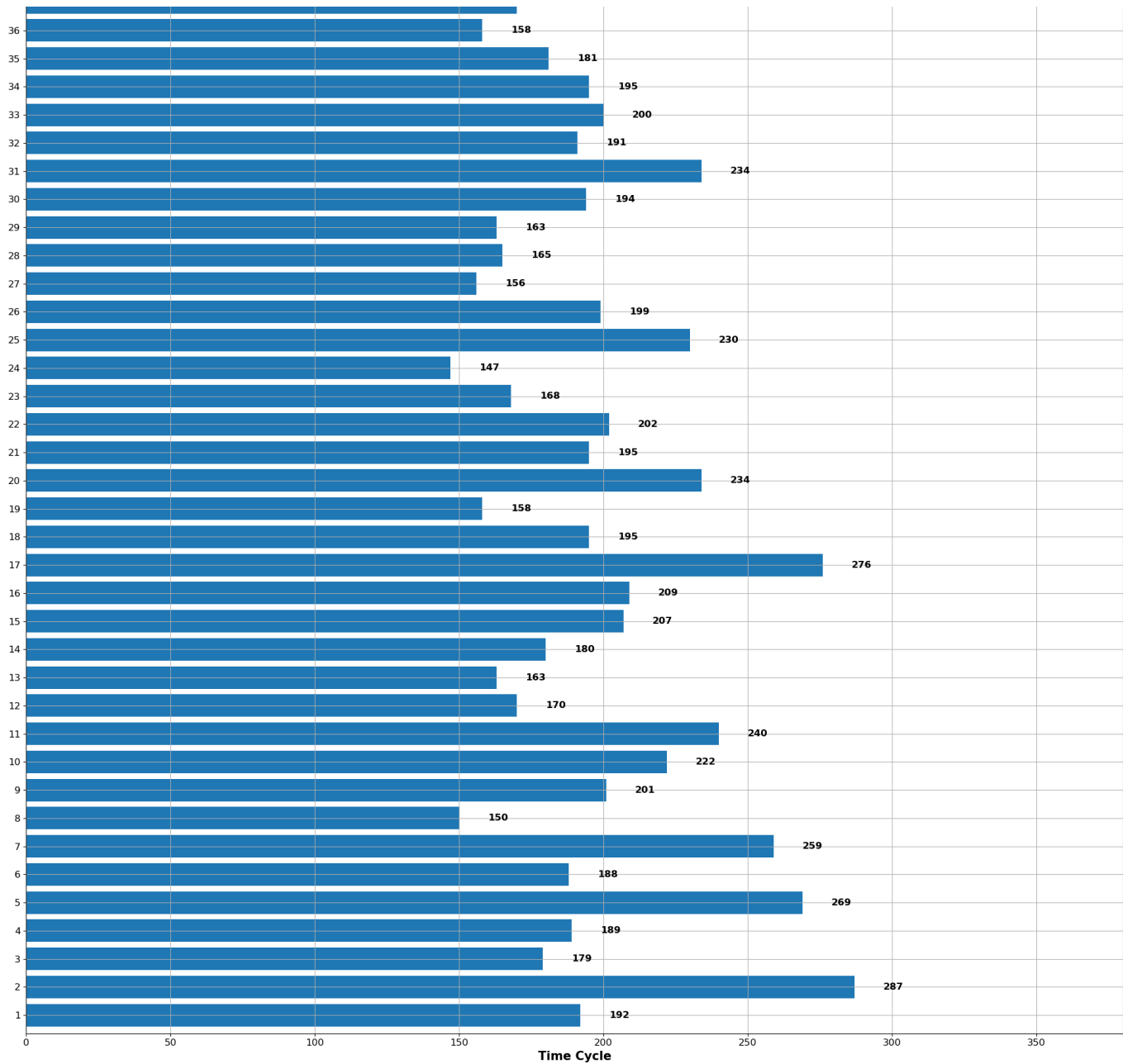
- ❑ Unit number of engine
- ❑ nth cycle in operation
- ❑ 3 operational settings
- ❑ 21 sensor's readings
- ❑ Each unit number was associated with a specific engine

operational settings does not impact to predict Rul of engine and Few sensor have constant data.

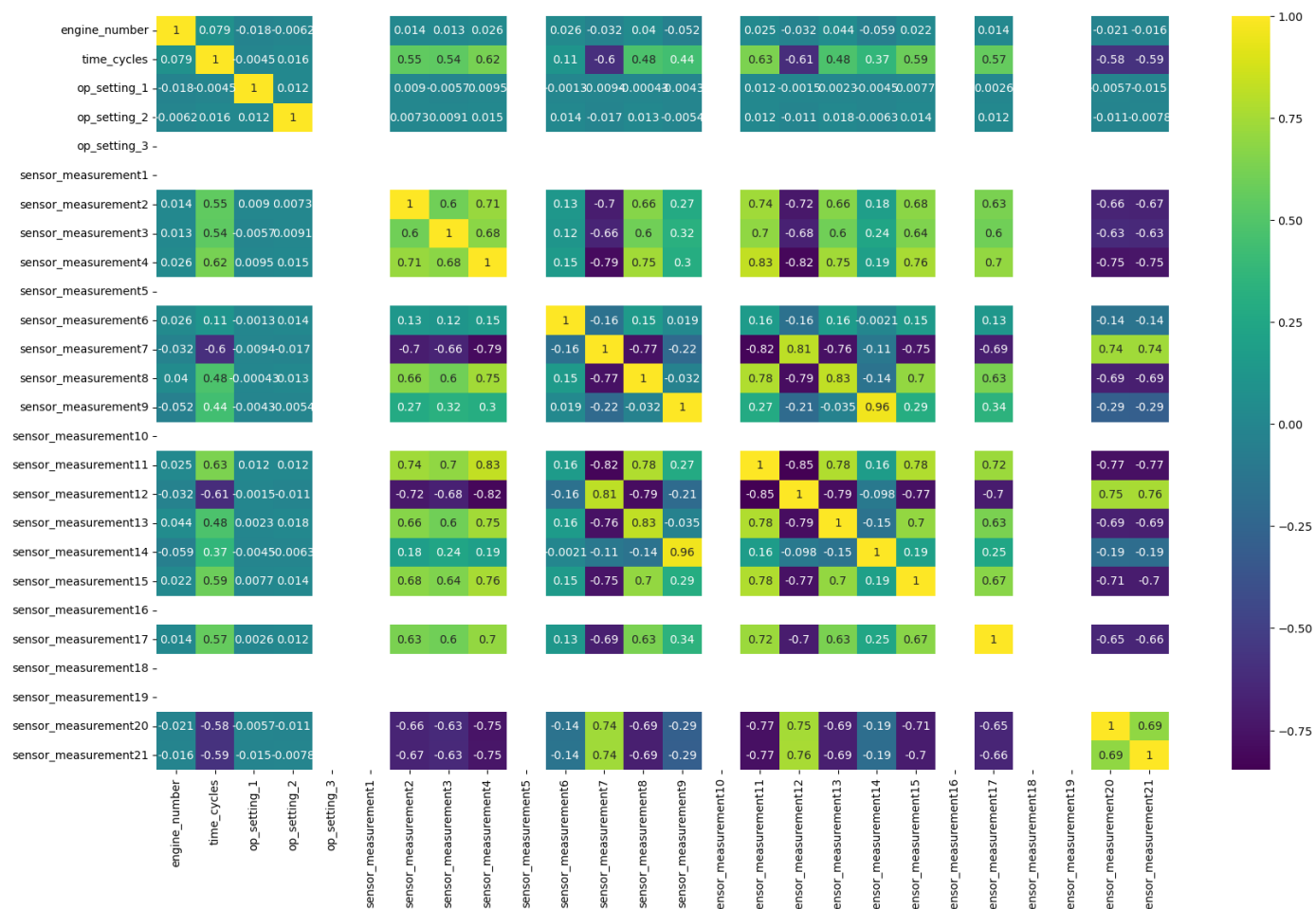
Visualization:

Turbofan Engines Lifetime

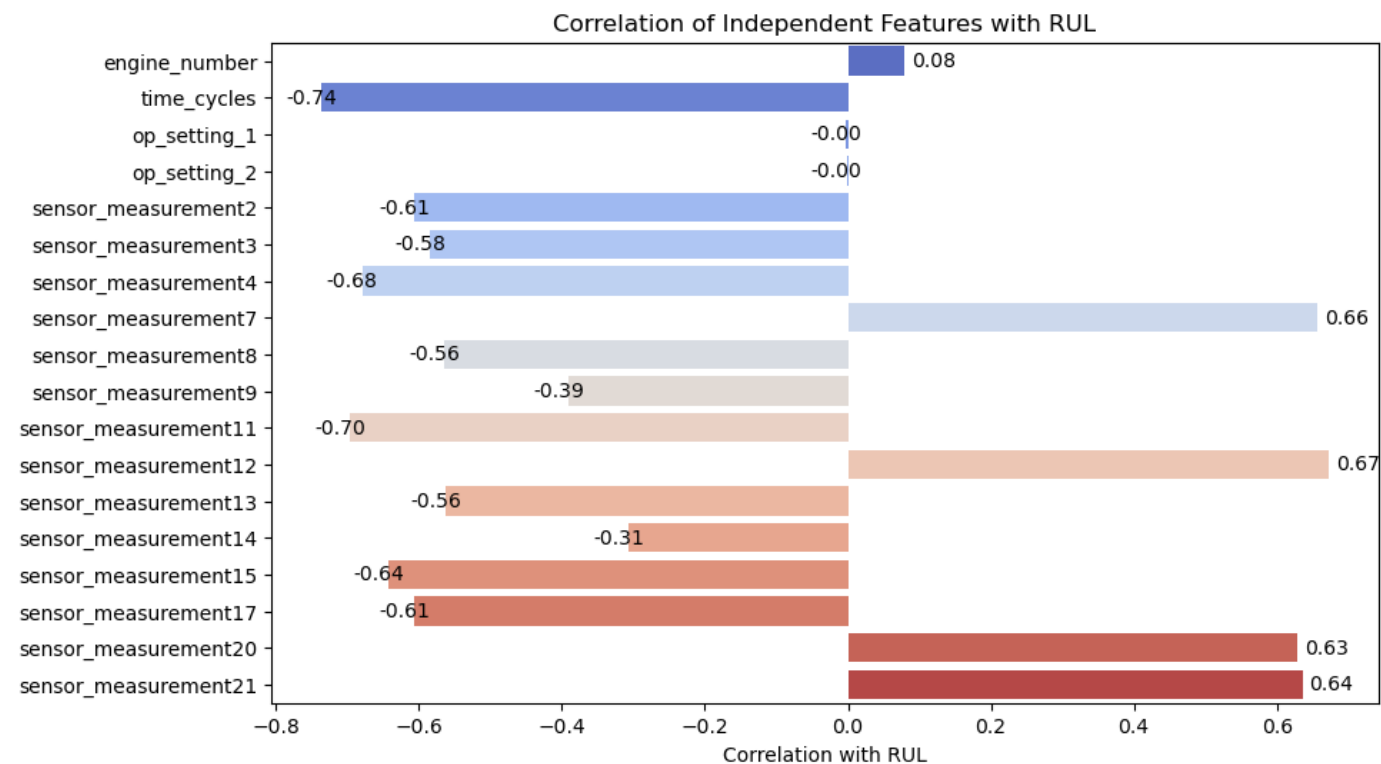




Corelation Heatmap

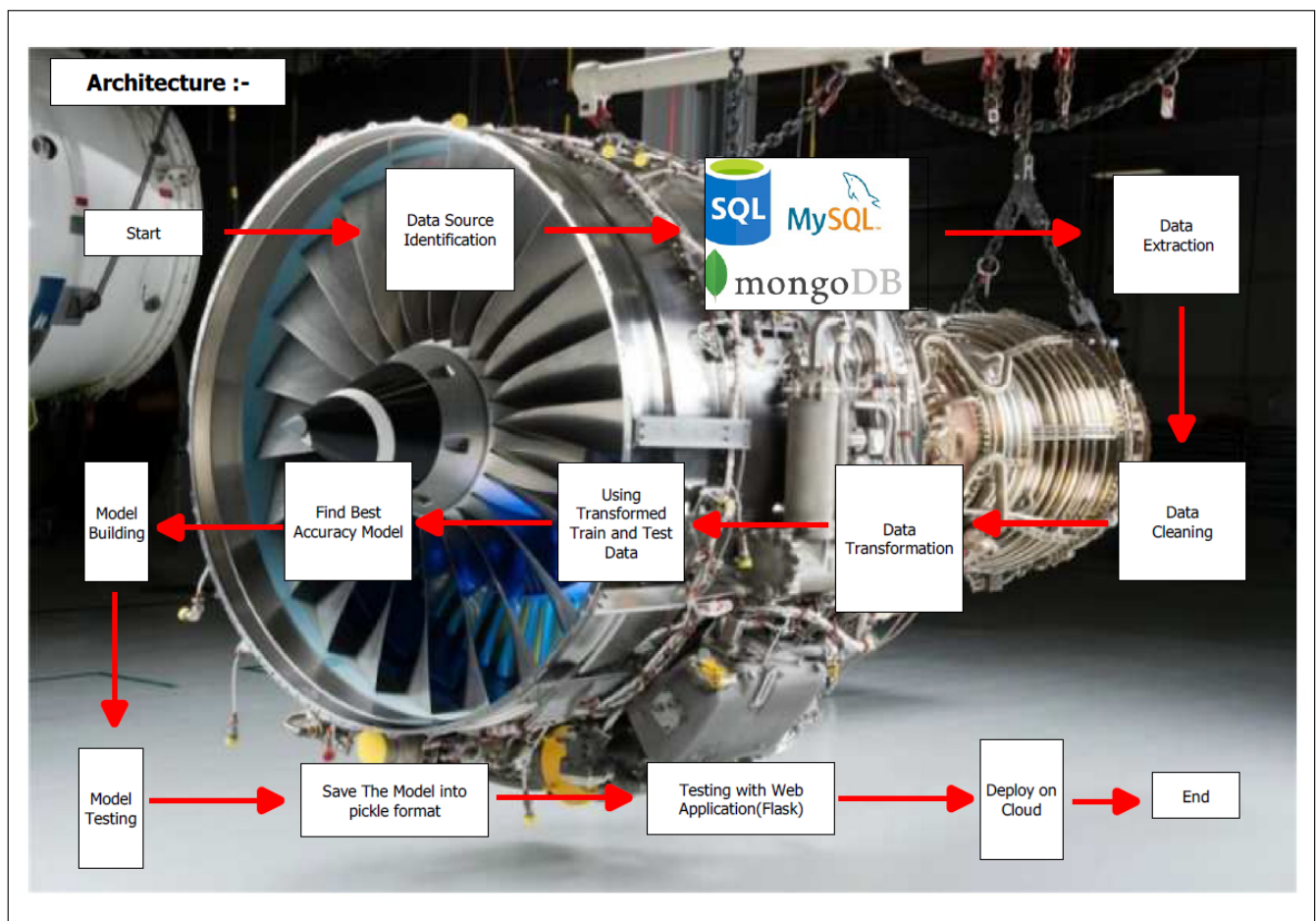


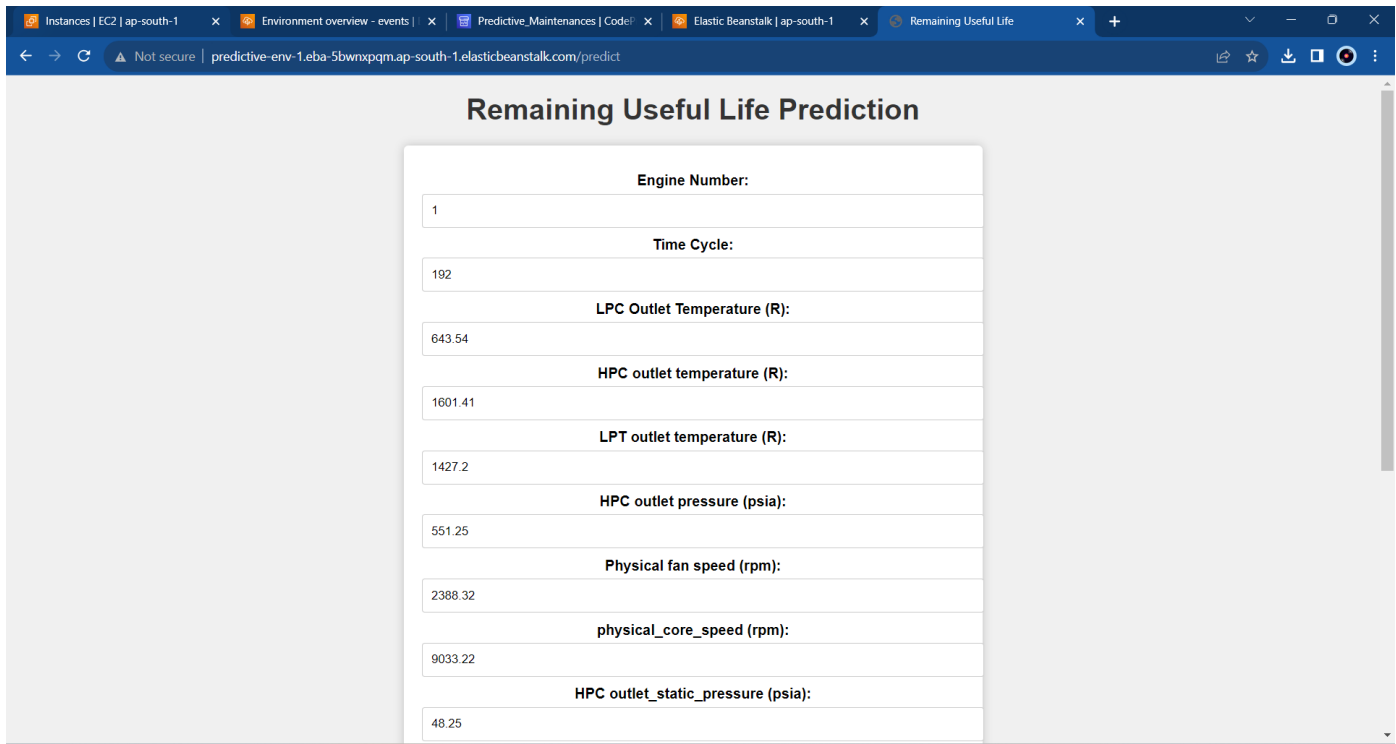
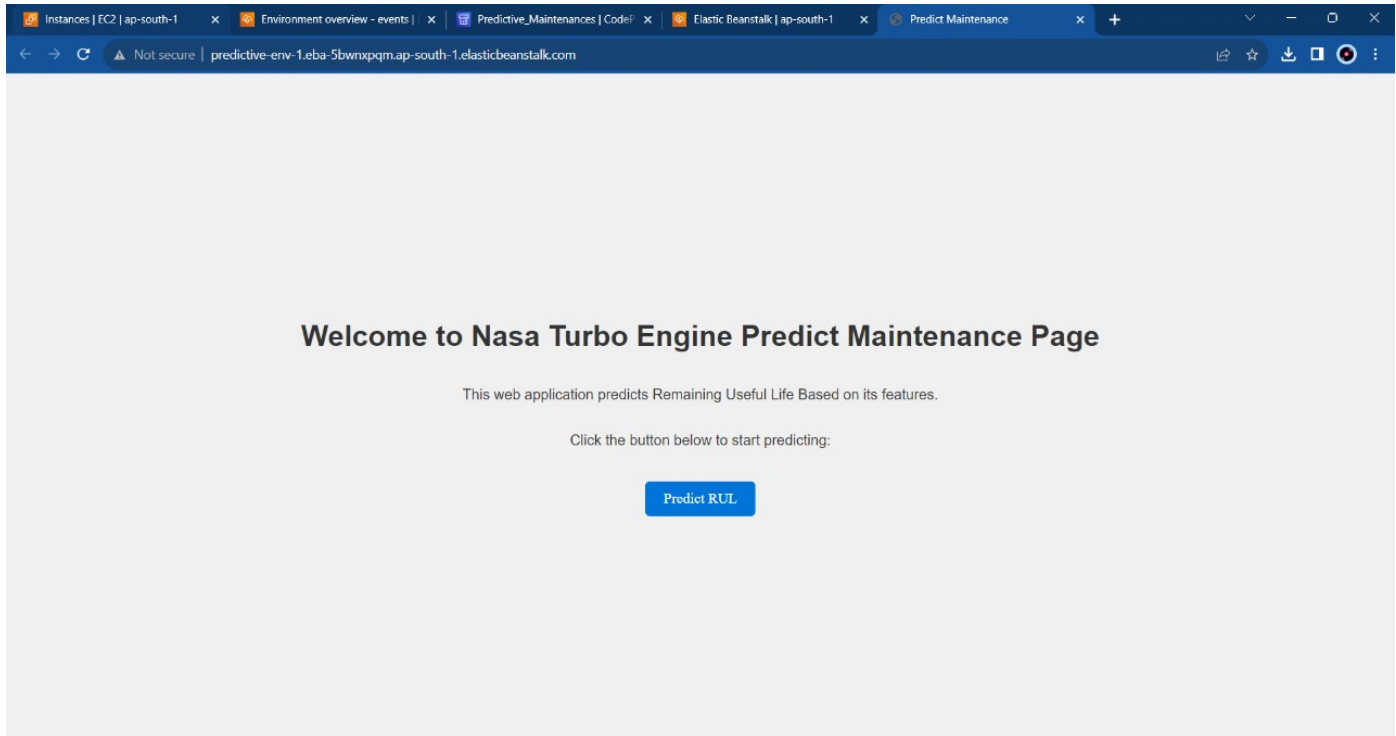
After Dropping Constant Column



RESULTS:

	Model	MAE	RMSE	R2
0	Lasso	12.183683	15.168114	0.417514
1	LinearRegression	11.795560	14.784870	0.446577
2	SupportVectorMachine	5.558247	10.882363	0.700174
3	KNeighborsRegressor	6.525596	11.855887	0.644131
4	RandomForestRegressor	6.741745	11.632604	0.657409
5	GradientBoostingRegressor	6.988650	11.137308	0.685962
6	XGBRegressor	7.627333	12.146310	0.626482





Instances | EC2 | ap-south-1

Environment overview - events

Predictive_Maintenances | CodeI

Elastic Beanstalk | ap-south-1

Remaining Useful Life

Not secure | predictive-env-1.eba-5bwnxpgm.ap-south-1.elasticbeanstalk.com/predict

551.25

Physical fan speed (rpm):

2388.32

physical_core_speed (rpm):

9033.22

HPC outlet_static_pressure (psia):

48.25

Fuel flow ratio:

520.08

Fan speed (rpm):

2388.32

Bypass Ratio:

8.51

Bleed enthalpy:

396

High pressure cool air flow (lbm/s):

38.48

Low pressure cool air flow (lbm/s):

22.96

Submit

Instances | EC2 | ap-south-1

Environment overview - events

Predictive_Maintenances | CodeI

Elastic Beanstalk | ap-south-1

Predict Maintenance Result

Not secure | predictive-env-1.eba-5bwnxpgm.ap-south-1.elasticbeanstalk.com/predict

✓


Safe: Prediction Result

85

Remaining Useful Life

Instances | EC2 | ap-south-1 x Environment overview - events | x Predictive_Maintenances | CodeI x Elastic Beanstalk | ap-south-1 x Predict Maintenance Result x +

Not secure | predictive-env-1.eba-5bwnxpgm.ap-south-1.elasticbeanstalk.com/predict


 **Warning: Prediction Result**

28

Remaining Useful Life

Instances | EC2 | ap-south-1 x Environment overview - events | x Predictive_Maintenances | CodeI x Elastic Beanstalk | ap-south-1 x Predict Maintenance Result x +

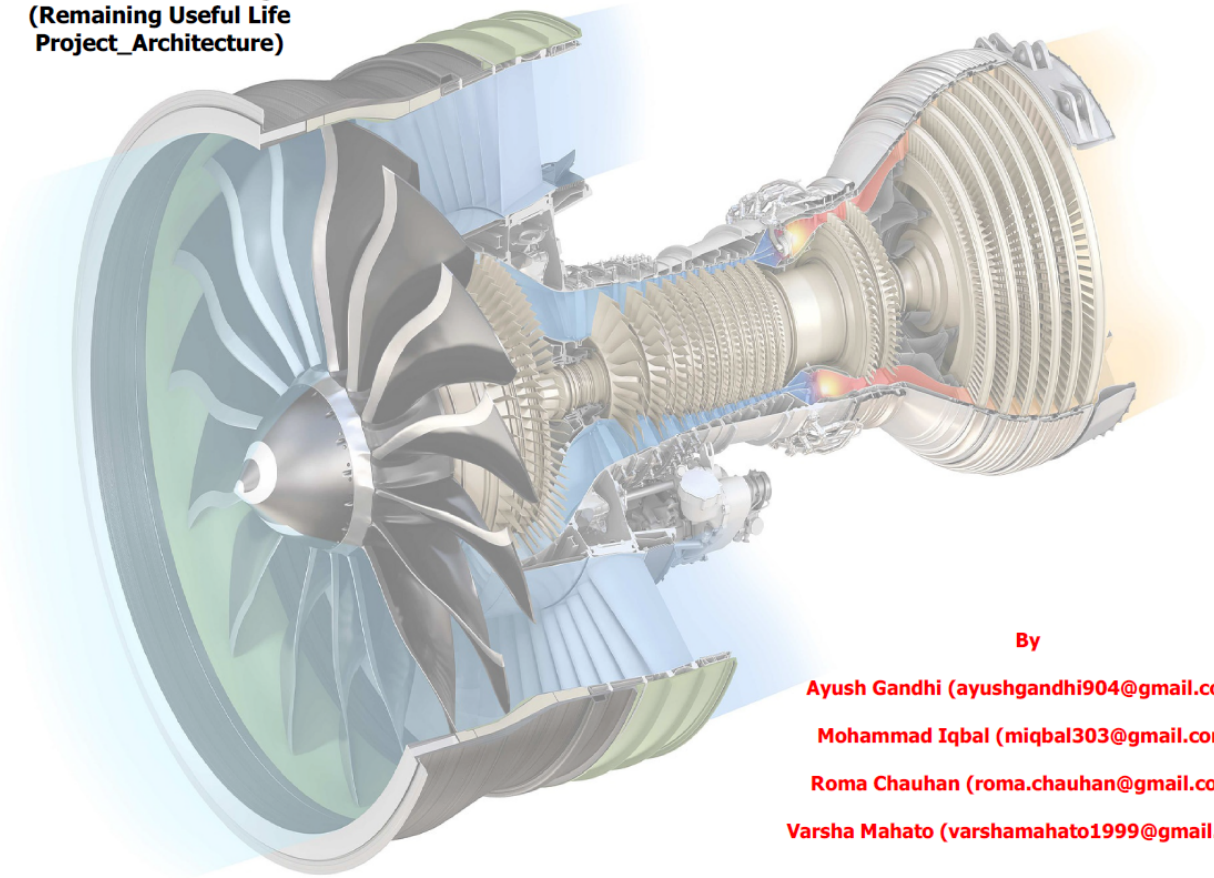
Not secure | predictive-env-1.eba-5bwnxpgm.ap-south-1.elasticbeanstalk.com/predict

 **Danger: Prediction Result**

2

Remaining Useful Life

NASA Turbofan Jet Engine (Remaining Useful Life Project_Architecture)



By

Ayush Gandhi (ayushgandhi904@gmail.com)

Mohammad Iqbal (miqbal303@gmail.com)

Roma Chauhan (roma.chauhan@gmail.com)

Varsha Mahato (varshamahato1999@gmail.com)

INSTALLATION STEPS:

```
conda create -p venv python==3.9 -y
```

```
conda activate venv/
```

```
pip install -r requirements.txt
```

Deployment:

```
python application.py
```

This is a Group Project. If anybody have any query , contact on below mails

ayushgandhi904@gmail.com

miqbal303@gmail.com

roma.chauhan@gmail.com

varshamahato1999@gmail.com

Thanks