

Externship Program on Applied Data Science

Project Report

TOPIC: *Machine Learning Approach For Predictive Maintenance Aircraft Engine Using IBM Watson Studio*

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June 2022

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1 Introduction

1.1 Overview

Engine failure is highly risky and needs a lot of time for repair. Unexpected failure leads to loss of money and time. Predicting the failure prior, will save time, effort, money and sometimes even lives. The failure can be detected by installing the sensors and keeping a track of the values. The failure detection and predictive maintenance can be for any device, out of which we will be dealing with the engine failure for a threshold number of days.

1.2 Purpose

The project aims to predict the failure of an engine by using Machine Learning to save loss of time & money thus improving productivity.

2 Literature Survey

2.1 Existing Problem

Every tools, machinery, and other durable equipment has to be checked for maintenance after a certain period of time. Though all those hardware has defined useful life, due to unfortunate damages their remaining useful life (RUL) reduces significantly leading to undesirable incidents. Nevertheless with regular check ups and proper maintenance we can prevent those incidents and make sure those hardwares last as long it supposed to.

And aircraft is one of the machinery which has really high cost maintenance as according to 'Airline maintenance cost executive commentary FY2019 data Public Version' cost of aircraft maintenance is estimated to be 10.3% of the total airline operating costs, with approximately 3.3 million dollars spent on maintenance per aircraft in 2019. With such high maintenance cost, engineers are doing thier work deligently and numerous research as also been done on this issue.

Individual data science enthusiasts have published thier works on popular platform such as towardsdatascience[2] and kaggle[3].

Published papers on this issue includes [4] where Sourajit et al used ensemble trees algorithm with IIoT for turbofan engines predictive maintenance.

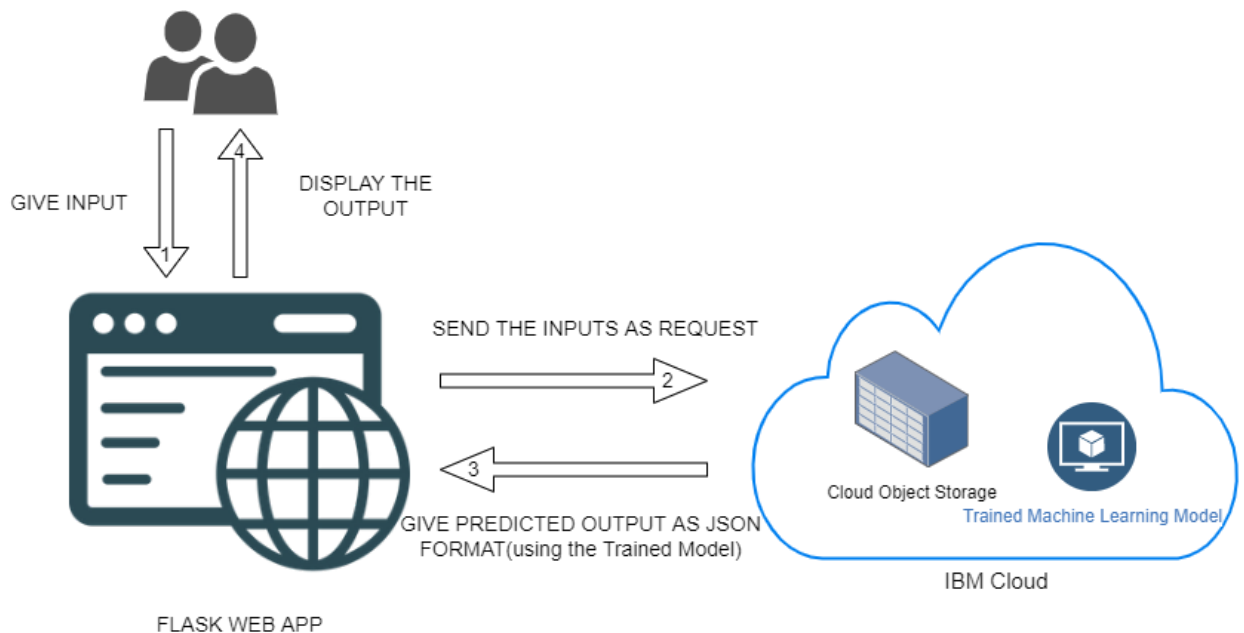
2.2 Proposed Solution

To solve this problem, we used the available datasets of an aircraft engine with total of 21 sensors throughout the multiple cycles. We used machine learning algorithm called Logistic Regression to classify whether the engine needs a maintenance or not with 30days as threshold period and then displaying suggestive message for both the cases.

Then a beautiful interface is made in flask application and sending input as request to ibm cloud with trained model. The predicted output is then send back through an api.

3 Theoretical Analysis

3.1 Block diagram



3.2 Hardware / Software designing

Hardware requirements includes

- i) Processor generation 8 or above
- ii) 4 cores or more and 8 threads or more
- iii) Compatible with 4GB but should go for 8 and above

iv) Operating system: windows 10, linuxs

Software requirements includes

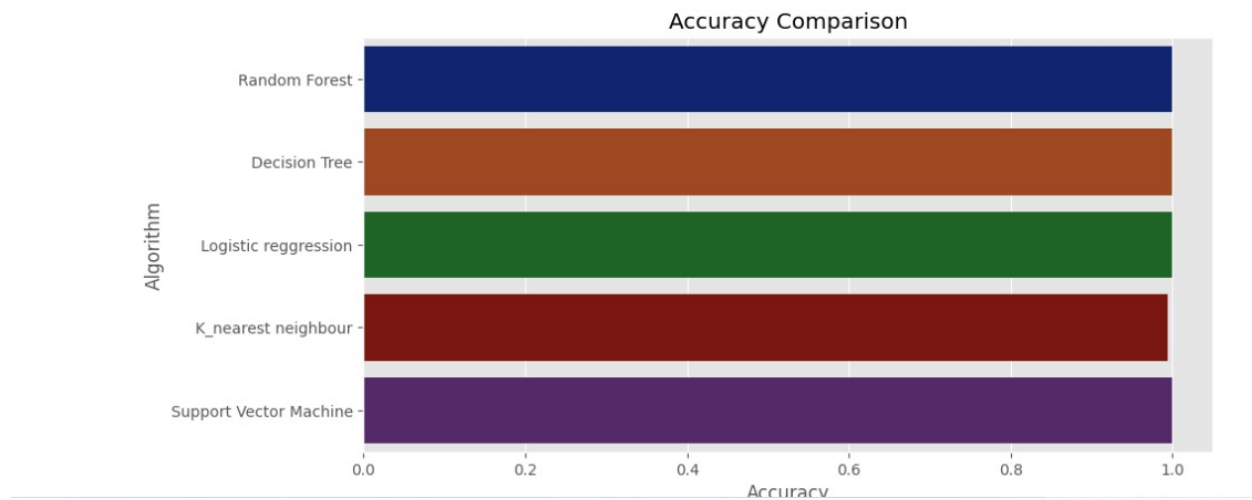
i) Python

ii) Flask with its modules(render_template, request)

iii) IBM Cloud account

iv) Machine Learning modules i.e sklearn, numpy, pandas, etc...

4 Experimental Investigations

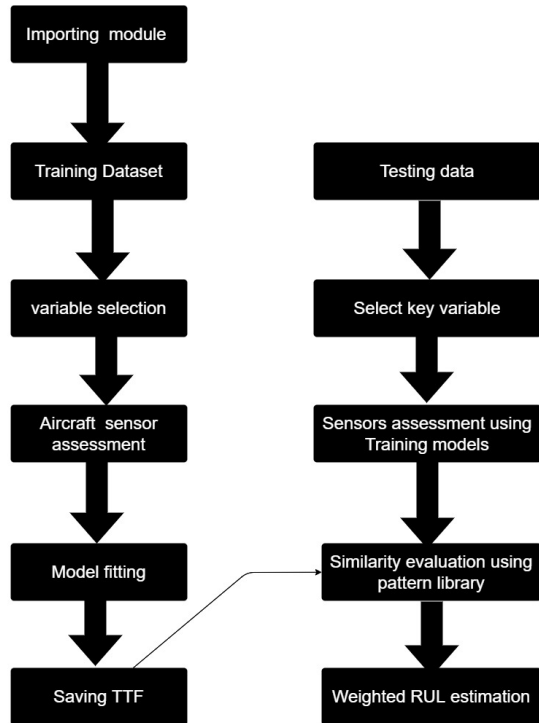


To find the best solution (or model), we tried various algorithms as you can see in above diagram. Here all the algorithm are giving 100% accuracy except k nearest neighbour giving 99.45%. And we chose Logistic Regression because of its simplicity among other algorithms.

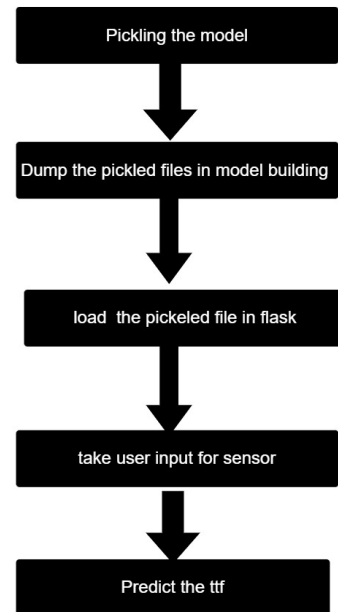
5 Flowchart

Visual Paradigm Online Free Edition

model Building part



Application Building Part



Visual Paradigm Online Free Edition

6 Result

We were able to achieve 100% accuracy on 13096 test instances after training with 20631 training data instances using Logistic Regression.

Machine Learning Approach For Predictive Maintenance Aircraft Engine Using IBM Watson Studio

About Project:

Engine failure is highly risky and needs a lot of time for repair. Unexpected failure leads to loss of money and time. Predicting the failure prior, will save time, effort, money and sometimes even lives. The failure can be detected by installing the sensors and keeping a track of the values. The failure detection and predictive maintenance can be for any device, out of which we will be dealing with the engine failure for a threshold number of days. The project aims to predict the failure of an engine by using Machine Learning to save loss of time & money thus improving productivity.

Maintenance Required!! Expected a failure within 30 days.

ID

Number of Cycles per minute

7 Advantages & Disadvantages

7.1 Advantages

- i)The model had high accuracy on test data set, so it will perform well on unseen datasets.
- ii)The project has an attractive interface for manual prediction which make it easy to use for non-technical people.
- iii)Code modification can be done easy from ibm jupyter notebook if any changes has to be made directly.

7.2 Disadvantages

- i)The trained Machine Learning model is stored in ibm cloud connected through account on limited free period.
- ii)The services being used on ibm cloud has restrictions on resources provided such as storage, number of request, capacity..
- iii) The logistic model had 100% accuracy on both training and test dataset. Though the performance of the model is beyond outstanding there could be a case that the dataset was too simple and wasnt drawn from wide area of range.

8 Applications

This project can used for real time manual prediction of aircraft engine with proper data input and can be a reference for any hardware maintenance issue research purposes. The neccesay codes and documentation including this will be available in any of our members github account.

9 Conclusion

We would like to humbly concluded that we made an complete web application regarding predicting maintenance issue on Aircraft Engine collated with IBM Watson Studio.

10 Future scope

For future, we could make the User Interface(UI) more interactive including dashboards and details happening in behind the scene.

11 Bibliography

[1] <https://smartinternz.com/externship>

[2] <https://towardsdatascience.com/predictive-maintenance-of-turbofan-engines-ec54a083127>

[3] <https://www.kaggle.com/datasets/matnusherold/pred-maintanance-data>

[4] <https://dl.acm.org/doi/abs/10.1145/3297280.3297363>