A Project Proposal on “Using Machine Learning Approach by Python to Predict Optimum Engine Parameters”

**Introduction**

According to recent predictions [1], the worldwide demand for energy consumed in the transportation sector is anticipated to keep growing at a pace of 1–1.5% year by 2040. This growth is mostly due to the anticipated increases in living standards, GDP, and population. Therefore, the optimization of engine parameters is critical in the design of efficient and high-performing engines. The traditional trial-and-error approach is time-consuming and expensive. In recent years, machine learning (ML) techniques have been increasingly used to optimize engine parameters as significant progressions have been made in the field of artificial intelligence (AI) in the last couple of decades. The aim of this project is to explore different machine learning approach that can predict engine parameters with high accuracy and provide insights for optimizing engine performance and emissions.

**Objectives**

The main objectives of this project are as follows:

* To analyze a dataset from four-stroke, six-cylinder Cummins ISX15 [2] engine with a variable-geometry turbocharger, high-pressure cooled exhaust gas recirculation (EGR) loop and charge air cooler.
* To preprocess the dataset by performing data cleaning, missing value imputation, normalization and scaling.
* To determine the key features that mostly affect engine performance and emissions.
* To implement different regression-based machine learning algorithm and analyze and compare their performances.
* To select the best machine learning algorithm that can accurately predict engine performance and emissions based on the identified features.
* To provide insights for optimizing engine performance and emissions based on the results of the machine learning model.

**Data**

The dataset should contain 2000 samples of engine operating parameters such as the Number of Nozzles (nNoz), Start of Injection (SOI), Total Nozzle Area (TNA), Nozzle Angle, Swirl Ratio (SR), Exhaust Gas Recirculation (EGR), Injection Pressure (Pinj), Intake Valve Closing Pressure (Pivc) and Temperature (Tivc) as well as the engine out parameters include soot, NOx, Mean Piston Ring Radial Pressure (MPRR), Peak Cylinder Pressure (PCP), and Indicated Specific Fuel Consumption (ISFC). The dataset will be split into training and testing sets, where the training set will be used to develop the machine learning model, and the testing set will be used to evaluate its performance.

**Methodology**

* Data Visualization and Preprocessing: The dataset will be visualized by performing data visualization tools such as Python Panda and Seaborn package. Data preprocessing will be performed by cleaning, missing value imputation, normalization.
* Feature Selection: Feature selection techniques such as correlation analysis, principal component analysis (PCA), and feature importance will be used to identify the most important features that influence engine performance and emissions.
* Model Selection: Different machine learning algorithms such as linear regression, decision trees, random forests will be implemented, and their performance will be compared using evaluation metrics such as mean squared error (MSE), root mean squared error (RMSE), and R-squared.
* Hyperparameter Tuning: Hyperparameter tuning techniques such as grid search and random search will be used to optimize the performance of the selected machine learning algorithm.
* Model Evaluation: The final machine learning model will be evaluated using the testing set and compared with the baseline model.

**Expected Outcomes**

Exploring machine learning models that can precisely forecast engine performance and emissions based on multiple engine operating factors is the goal of the proposed study. The study's findings can be utilized to improve engine settings for greater fuel economy and lower emissions. The goal is to create a machine learning model that can accurately forecast engine characteristics and offer guidance for improving emissions and performance.

**Conclusion**

The proposed study aims to use machine learning techniques to predict engine performance and emissions based on various engine operating parameters. The developed machine learning model can be used to optimize engine parameters for better fuel efficiency and reduced emissions. The results of this study can provide valuable insights for the development of more efficient and environmentally friendly engines.

**References**

1. ExxonMobil, 2018, “Outlook for Energy: A View to 2040,” ExxonMobil, TX, https://corporate.exxonmobil.com/en/energy/energy-outlook, Accessed March 24, 2023.
2. Zhang, Y., Kumar, P., Traver, M., and Cleary, D., “Conventional and Low Temperature Combustion Using Naphtha Fuels in a Multi-Cylinder Heavy-Duty Diesel Engine,” SAE Int. J. Eng. 9 2016-01-0764, 1021-1035, 2016, doi:10.4271/2016-01-0764.