To,

IITD-AIA Foundation of Smart Manufacturing

Subject: **Weekly Progress Report**

INTP23-ML-05: Equipment Failure Prediction for Predictive Maintenance

What is happening this week:

- Continued Learning more about Deep Learning
- Working on NASA Turbofan Jet Engine Dataset
    1. Implemented various models
    2. After balancing/ sampling the data, get the result from models
    3. Comparing results: precision value, recall value, F1 value of models implemented
    4. Documenting these results for future reference and learnings
- Read about working of Shearing machine

My Understandings of this week:

The techniques or models for predictive maintenance are:

- A regression model would show how much time is left before the next possible failure also called remaining useful life (RUL).
- In classification, you can predict a possibility of failure in a certain number of steps.
- Anomaly detection models to identify abnormal patterns or behaviors of the equipment that indicate potential failures
- Survival analysis models to estimate the remaining useful life of the equipment based on their degradation over time.

After implementing model on balanced data, obviously, we get better results. For this SMOTE gives better result than adasyn and other techniques. SMOTEENN has good results overall (precision, recall, confusion metrics and roc auc score).

Week 3

20th June:

- Learning from the shared resources of Deep Learning
- Working on NASA turbofan jet engine dataset
- Learning about in detail about working of a smart shearing machine

  i) Learnt about sensors/ actuators, location of these sensors and their application
  ii) Learnt about working sequence, data communication
  iii) Learnt about various tags

21th June:

- Learning from the shared resources of Deep Learning
- Working on NASA turbofan jet engine dataset
  i) After extensive Exploratory data analysis (EDA). I found that data can be linearly separable
  ii) Implemented SVM, Logistic Regression, Decision Tree, KNN models
  iii) Plot the ROC AUC curves
  iv) Taking different-length time series for the LSTM network

22th June:

- Learning from the shared resources of Deep Learning
- Working on NASA turbofan jet engine dataset
- Tried to implement ANN to predict remaining useful life
- Tried to implement PCA model
- Learning about CNN and how to implement it on chosen dataset

23th June:

- Learning from the shared resources of Deep Learning
- Working on NASA turbofan jet engine dataset
  i) implemented XGBoost classifier
  ii) implemented Stochastic Gradient Descent classifier

iii) Tried to improve model accuracy by balancing data (underfitting and overfitting data)

iv) SMOTE technique: Although I applied SMOTE technique on Training data as I read a research paper about predictive maintenance and understood that it is required to SMOTE training data only to build the model which represent the reality.

24th June:

- Learning from the shared resources of Deep Learning
- Working on NASA turbofan jet engine dataset
- implemented PCA for predicting remaining useful life of engine
- Gone through documentation of different models to understand better the difference in their results.
- Comparing Results of different model and checking which would be most appropriate model

25th June:

- Learning from the shared resources of Deep Learning
- Learnt about emsembles methods
- Working on NASA turbofan jet engine dataset
- implemented LGBM classifier
- Comparing Results of different model, their roc auc, F-score and precision and recall values
- Understanding again about LSTM and its implementation

Reference:

1) https://www.infoq.com/articles/machine-learning-techniques-predictive-maintenance/
2) https://www.sciencedirect.com/science/article/pii/S2405896315017619
3) http://colah.github.io/posts/2015-08-Understanding-LSTMs/
4) https://gallery.azure.ai/Experiment/Predictive-Maintenance-Step-2A-of-3-train-and-evaluate-regression-models-2
5) machine_failure/Machine Learning for Equipment Maintenance - 2022.ipynb at master ·shadgriffin/machine_failure · GitHub
6) https://www.infoq.com/articles/machine-learning-techniques-predictive-maintenance/
7) MIT 6.S191: Introduction to Deep Learning - YouTube
8) How to Calculate Precision, Recall, and F-Measure for Imbalanced Classification - MachineLearningMastery.com
9) SMOTE for Imbalanced Classification with Python - MachineLearningMastery.com