

## 1. Instructions to Run Code

Step	Notebook	Description
<b>1: Data Prep</b>	Assignment_Preprocessing.ipynb	<b>Load Data:</b> Reads the raw telemetry data. <b>Clean &amp; Engineer:</b> Performs time synchronization, handles non-finite values, calculates Haversine distance, and converts quaternions to Euler angles. <b>Scale &amp; Split:</b> Scales the data and saves the final Train, Validation, and Test sets.
<b>2: SVC Model</b>	Final_SVC.ipynb	<b>Train:</b> Trains the SVC model. <b>Evaluate:</b> Generates classification reports and confusion matrices. <b>Explain:</b> Runs LIME and SHAP analysis to determine local and global feature importance.
<b>3: LSTM Model</b>	Final_LSTM.ipynb	<b>Train:</b> Trains the LSTM with Attention model, testing hyperparameter configurations <b>Evaluate:</b> Tracks validation performance over epochs. <b>Explain:</b> Runs SHAP and Partial Dependence Plots (PDPs) to interpret sequence model decisions.

<b>4: VAE Model</b>	Final_VAE.ipynb	<b>Train:</b> Trains the Variational Autoencoder exclusively on <b>Normal</b> data. <b>Test:</b> Calculates reconstruction error on all classes to identify anomalies. <b>Explain:</b> Uses SHAP/PDP to explain the features driving the anomaly score.
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## 2. List of Required Libraries and Versions

Library	Version (Example)	Purpose
<b>Python</b>	3.10+	Core programming environment.
<b>pandas</b>	2.1.0	Data manipulation and analysis.
<b>numpy</b>	1.25.2	Numerical operations.
<b>scikit-learn</b>	1.3.0	\$\text{StandardScaler}\$, \$\text{SVC}\$ model, and general evaluation metrics.
<b>torch</b>	2.0.1	Core framework for \$\text{LSTM}\$ with Attention and \$\text{VAE}\$ models.
<b>torchvision</b>	0.15.2	Utility for PyTorch (often installed with torch).
<b>matplotlib</b>	3.7.2	Data visualization and plotting.
<b>seaborn</b>	0.13.0	High-level statistical visualizations (for EDA).
<b>shap</b>	0.43.0	Explainable AI (SHapley Additive exPlanations).
<b>lime</b>	0.2.0	Explainable AI (Local Interpretable Model-agnostic Explanations).
<b>joblib</b>	1.3.2	Saving and loading trained models (SVC).

### 3. Expected Runtime for Training

Model / Task	Recommended Platform	Approximate Time (Total)	Notes
<b>Data Preprocessing</b>	CPU	30 minutes	Time dominated by feature engineering.
<b>SVC Training</b>	CPU	40 minutes	The SVC kernel calculation can be intensive on a large dataset.
<b>LSTM Training</b>	<b>GPU (NVIDIA T4)</b>	60 minutes	Based on \$text{EPOCHS}=100\$ and \$text{PATIENCE}=10\$.
<b>VAE Training</b>	<b>GPU (NVIDIA T4)</b>	60 minutes	Requires GPU for efficient backpropagation.