Machine Learning with Accelerometer and GPS Data
Deliverable #4

Data Files

- **New_LA_Data1.csv**:
  - **X**: Horizontal jolt (left and right, measured in meters per second squared)
    Horizontal jolt is calculated as the incremental difference of X between timestamp t and t-1.
  - **Y**: Forward jolt (forward and back, measured in meters per second squared)
    Forward jolt is calculated as the incremental difference of Y between timestamp t and t-1.
  - **Z**: Vertical jolt (up and down, measured in meters per second squared)
    Vertical jolt is calculated as the incremental difference of Z between timestamp t and t-1.
- **New_LA_Data2.csv**:
  - **X**: Horizontal jolt (left and right, measured in meters per second squared)
    Horizontal jolt is calculated as the incremental difference of X between timestamp t and t-1.
  - **Y**: Forward jolt (forward and back, measured in meters per second squared)
    Forward jolt is calculated as the incremental difference of Y between timestamp t and t-1.
  - **Z**: Vertical jolt (up and down, measured in meters per second squared)
    Vertical jolt is calculated as the incremental difference of Z between timestamp t and t-1.
- **New_LA_Data3.csv**:
  - **X**: Horizontal jolt (left and right, measured in meters per second squared)
    Horizontal jolt is calculated as the incremental difference of X between timestamp t and t-1.
  - **Y**: Forward jolt (forward and back, measured in meters per second squared)
    Forward jolt is calculated as the incremental difference of Y between timestamp t and t-1.
  - **Z**: Vertical jolt (up and down, measured in meters per second squared)
    Vertical jolt is calculated as the incremental difference of Z between timestamp t and t-1.

Python Scripts:

- **sklearn_CVGrid.py**
  - Parameter estimation using grid search with cross validation

    - sklearn.model_selection.GridSearchCV Model 1
        - Features: speed, X-accel, Y-accel, Z-accel, Z-jolt
        - Labels: speedbump (1 = yes, 0 = no)
        - Average F1 score: 0.868
        - StdDev F1 score: 0.108
        - Learning rate = 0.01
        - Minimum sample leafs = 1
        - N estimators = 150
        - Minimum sample split = 6
        - Max features = 4
- **sklearn_CVRandomized.py**
    - Randomized search on hyper parameters
    - Model with Rank 1:
        - Mean validation score: 0.868 (std: 0.108)
        - Hyper-parameters: {'learning_rate': 0.01, 'min_samples_leaf': 1, 'n_estimators': 150, 'max_features': 4, 'min_samples_split': 6, 'max_depth': None}
    - Model with Rank 2:
        - Mean validation score: 0.852 (std: 0.099)
        - Hyper-parameters: {'learning_rate': 0.1, 'min_samples_leaf': 1, 'n_estimators': 150, 'max_features': None, 'min_samples_split': 2, 'max_depth': None}
    - Model with rank: 2
        - Mean validation score: 0.852 (std: 0.099)
        - Hyper-parameters: {'learning_rate': 0.1, 'min_samples_leaf': 1, 'n_estimators': 150, 'max_features': 3, 'min_samples_split': 2, 'max_depth': None}
    - Model with rank: 2
        - Mean validation score: 0.852 (std: 0.099)
        - Hyper-parameters: {'learning_rate': 0.1, 'min_samples_leaf': 1, 'n_estimators': 150, 'max_features': 3, 'min_samples_split': 6, 'max_depth': 10}
    - Model with rank: 2
        - Mean validation score: 0.852 (std: 0.099)
        - Hyper-parameters: {'learning_rate': 1, 'min_samples_leaf': 1, 'n_estimators': 100, 'max_features': None, 'min_samples_split': 2, 'max_depth': None}
    - Model with rank: 2
        - Mean validation score: 0.852 (std: 0.099)

        - Hyper-parameters: {'learning_rate': 0.1, 'min_samples_leaf': 1, 'n_estimators': 150, 'max_features': 3, 'min_samples_split': 2, 'max_depth': 5}
- **sklearn_MLPClassifier.py**
    - Multi-Layer Perceptron (neural network) Classifier model
    - sklearn.neural_network.MLPClassifier Model 1
        - Features: speed, X-accel, Y-accel, Z-accel, Z-jolt
        - Labels: speedbump (1 = yes, 0 = no)
        - Average F1 score: 0.760686122
        - StdDev F1 score: 0.1537659455829
        - Median F1 score: 0.77350427350
        - IQR F1 score: 0.1333334
        - Skewness F1 score: -0.17764724445877225
    - sklearn.neural_network.MLPClassifier Model 4
        - Features: speed, X-accel, Y-accel, Z-accel, Z-jolt
        - Labels: speedbump (1 = yes, 0 = no)
        - Average F1 score: 0.7709969
        - StdDev F1 score: 0.1402254
        - Median F1 score: 0.80000000
        - IQR F1 score: 0.13333334
        - Skewness F1 score: -0.17764724445877225
- **sklearn_DTClassifier.py**
    - Decision Tree Classifier model
    - sklearn.tree.DecisionTreeClassifier Model 1
        - Features: speed, X-accel, Y-accel, Z-accel, Z-jolt
        - Labels: speedbump (1 = yes, 0 = no)
        - Average F1 score: 0.89899393769
        - StdDev F1 score: 0.118201302569
        - Median F1 score: 0.9230769231
        - IQR F1 score: 0.0921034
        - Skewness F1 score: -0.9312941130701623
    - sklearn.tree.DecisionTreeClassifier Model 5
        - Features: speed, Z-accel, Z-jolt
        - Labels: speedbump (1 = yes, 0 = no)
        - Average F1 score: 0.84655181
        - StdDev F1 score: 0.10527561
        - Median F1 score: 0.866071428
        - IQR F1 score: 0.138907
        - Skewness F1 score: -0.489563

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- **sklearn_RFClassifier.py**
    - Random Forest Classifier model
    - sklearn.ensemble.RandomForestClassifier Model 1
        - Features: speed, X-accel, Y-accel, Z-accel, Z-jolt
        - Labels: speedbump (1 = yes, 0 = no)
        - Average F1 score: 0.744434045
        - StdDev F1 score: 0.160948970
        - Median F1 score: 0.75
        - IQR F1 score: 0.231867
        - Skewness F1 score: -0.391874
    - sklearn.ensemble.RandomForestClassifier Model 5
        - Features: speed, Z-accel, Z-jolt
        - Labels: speedbump (1 = yes, 0 = no)
        - Average F1 score: 0.74717207
        - StdDev F1 score: 0.172979588
        - Median F1 score: 0.769230769
        - IQR F1 score: 0.222222222222
        - Skewness F1 score: -0.98346783
- **sklearn_GBClassifier.py**
    - Gradient Boosting Classifier model
    - sklearn.ensemble.GradientBoostingClassifier Model 1
        - Features: speed, X-accel, Y-accel, Z-accel, Z-jolt
        - Labels: speedbump (1 = yes, 0 = no)
        - Average F1 score: 0.8221567168
        - StdDev F1 score: 0.0.120072183
        - Median F1 score: 0.0.857142856
        - IQR F1 score: 0.16923077234
        - Skewness F1 score: -0.621688196
    - sklearn.ensemble.GradientBoostingClassifier Model 2
        - Features: speed, Z-accel, Z-jolt
        - Labels: speedbump (1 = yes, 0 = no)
        - Average F1 score: 0.3518205293
        - StdDev F1 score: 0.13588175
        - Median F1 score: 0.33333333
        - IQR F1 score: 0.1246923817
        - Skewness F1 score: 0.76200239
    - sklearn.ensemble.GradientBoostingClassifier Model 3
        - Features: speed, Z-accel, Z-jolt
        - Labels: speedbump (1 = yes, 0 = no)

        - Average F1 score: 0.8399761
        - StdDev F1 score: 0.11177313
        - Median F1 score: 0.857142857
        - IQR F1 score: 0.20003817
        - Skewness F1 score: -0.66963835
    - sklearn.ensemble.GradientBoostingClassifier Model 4
        - Features: speed, Z-accel, Z-jolt
        - Labels: speedbump (1 = yes, 0 = no)
        - Average F1 score: 0.8191443628
        - StdDev F1 score: 0.104556871
        - Median F1 score: 0.80000000
        - IQR F1 score: 0.16734588
        - Skewness F1 score: -0.8265433
    - sklearn.ensemble.GradientBoostingClassifier Model 5
        - Features: speed, Z-accel, Z-jolt
        - Labels: speedbump (1 = yes, 0 = no)
        - Average F1 score: 0.84139751
        - StdDev F1 score: 0.10140479
        - Median F1 score: 0.84210526
        - IQR F1 score: 0.237768
        - Skewness F1 score: -0.1524893

- **sklearn_Logistic.py**
    - sklearn.linear_model.LogisticRegression Model 1
        - Features: speed, X-accel, Y-accel, Z-accel, Z-jol
        - Labels: speedbump (1 = yes, 0 = no)
        - Average F1 score: 0.32698412
        - StdDev F1 score: 0.07853534
        - Median F1 score: 0.333333333
        - IQR F1 score: 0.1222243222
        - Skewness F1 score: -0.5984130
    - sklearn.linear_model.LogisticRegression Model 2
        - Features: speed, Z-accel, Z-jolt
        - Labels: speedbump (1 = yes, 0 = no)
        - Average F1 score: 0.480952380
        - StdDev F1 score: 0.131621666
        - Median F1 score: 0.5
        - IQR F1 score: 0.0888888888889
        - Skewness F1 score: 0.063076006