Assignment #1 - Inertial Sensors
ECE 382V Human Signals: Sensing and Analytics - Spring 2026

*Due **February 10th 2026***

Turn-in your assignment as a zip file including your code and data. Label which files correspond to which answers very carefully. Make it intelligible. If this is not clear, you will not receive credit for your solution.

Q1. (50 pts) Smartphones have inertial measurement units (IMUs) that can output accelerometer, gyroscope, and magnetometer data. In this assignment, you will perform all the steps required to leverage accelerometer signals collected with your smartphone to recognize a set of common human activities.

Setup

Step 1. Download a motion sensor logging app on your phone. Two suggested options are SensorLog on iOS and AndroSensor for Android. These applications let you capture motion sensor data into a CSV file. Set it to capture accelerometer data at 0.01 second intervals (100 Hz). The 3-axis accelerometer will output 3 sensor streams (i.e., x, y, and z). Test the application that you select by collecting some data and transferring it to your computer. You should be able to move the file to your computer through access to the phone's file system or by sending an email with the file to yourself.

Step 2. Using the sensor logging app that you setup, collect 3 minutes of data for each of the following activities: (1) walking, (2) running, (3) climbing stairs, (4) riding a car or bus, (5) dancing to your favorite song. If you cannot do any of these activities, ask a friend to collect data for you. Save all the data in a single CSV file titled "yourname-q1-data.csv" and add a column to the CSV file with the label corresponding to each example/instance.

Problem

Leveraging what you learned in class about supervised machine learning methods and signal processing:

a) Build a multi-class classifier for the 5 activities using a *discriminative* learning algorithm. Evaluate its performance using the split train/test approach using your "yourname-q1-data.csv" file.

b) Build a multi-class classifier for the 5 activities using a *generative* learning algorithm. Evaluate its performance using the split train/test approach using your "yourname-q1-data.csv" file.

For this problem, you will need to preprocess the signal, and then extract frames and features. The way you design these steps is up to you. Your grade will be based on your understanding of the pipeline, we are not interested in top performance. However, you should obtain some reasonable results. Your deliverables for this problem should be two scripts, one each for parts "a" and "b", and also your "yourname-q1-data.csv" file. Include all the files in a q1 folder/ directory. You can deliver these either as .py files or as Jupyter Notebook.

Tip: It is always a good idea to visually inspect the data to make sure it matches your expectations. Plot the training data for each activity as line graphs using your visualization tool of choice.

Q2. (50 pts). Prof. Thomaz lost his smartwatch and would like you to build him a new step counter based on the raw inertial sensor signals of his smartphone. To help you, he provided a file called "steps.csv"; It contains accelerometer and gyroscope data that he collected at 30Hz while walking and running with his smartphone in his right hand. The csv file contain headers that indicate what each column refers to (e.g., accelerometer X axis, gyroscope Z axis).

Your deliverable for this problem should be a python script titled "q2" (or Jupyter Notebook) that computes and outputs the number of steps recorded in the "steps.csv" file. To see how your approach generalizes, your code will be evaluated not only on the "steps.csv" file collected by Prof. Thomaz but also on walking/running data of another yet-to-be-determined person. Feel free to test it out with your own walking-running data to see how it performs. To do this you will need to collect some data using one of the apps you downloaded for question 1.